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Abstracts of papers from the American Microscopical Society
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Transactions of the American Microscopical Society.

1

ROLE OF ODORS IN PREY LOCATION AND PREDATOR AVOIDANCE IN AQUATIC INSECTS. R. D. Soucek, Texas A&M Univ., College Station.

An observation system consisting of a behavioral chamber, video camera, Apple IIe computer, and electronic valve interface system has been developed. The apparatus has been used to determine the role of olfaction in the predator-prey relationships that exist among aquatic organisms, especially insects. Predators include the hemipterans Lethocerus, Belostoma, Ranatra, Buena, Notonecta, the beetle Dytiscus, and the mosquito fish Gambusia. Prey groups include the hemipterans Trichocorixa and the larval mosquitos Culex and Psorophora.

2

EARTHWORM LOCATION BY FORAGING GARTER SNAKES, THAMNOPHIS SIRTALIS. J.C. Gillingham and M.A. Weins.* Central Michigan University, Mt. Pleasant, MI.

A north temperate population of eastern garter snakes, Thamnophis sirtalis, was studied to ascertain the search pattern and cues involved in their location of earthworm prey. Snakes were observed under natural conditions from an elevated scaffolding using portable event recorders and photographic equipment. The garter snakes studied used an active foraging pattern and were capable of locating earthworms at a top observed rate of 13/hr with the maximum number of worms in any one snake being 24. Prior to earthworm capture garter snakes demonstrated an elevated tongue-flick rate followed by a shallow lunge into the soil and subsequent worm retrieval. Tests run in the laboratory showed that fresh-captured garter snakes could distinguish earthworm castings from ordinary soil and other substrate material. A significant preference was shown for castings less than 24 hrs old. Eastern garter snakes are apparently capable of successful foraging using earthworm castings as location cues.

3

THE MEASUREMENT OF INDIVIDUAL ASSOCIATION. S.J. Cairns and S.J. Schwager*.

A variety of indices of association are currently in use in field studies of animal behavior. Two of the most common ones are borrowed from ecological studies of species association and may not be the best choice for the measurement of individual association. The behavior of these and other indices is compared using simulations and analytic techniques. Several models of individual association are proposed, and the maximum likelihood estimator for p , the proportion of time spent together by two animals, is derived. Simulations based on these models clarify the effect of sampling bias on the different indices and show the maximum likelihood estimators to be more accurate and precise than the species-association indices. The results clearly indicate which indices are more accurate when specific types of bias occur during sampling, and suggest the possibility of improving on these indices.

4

STATISTICAL METHODS FOR DETECTING MULTIPLE PATERNITY AND QUANTIFYING SPERM COMPETITION. D. G. Heckel. Clemson Univ., S. C.

When data are available on genotypes of mothers and their offspring, it is possible to test hypotheses concerning the population's mating system. A general method based on likelihood ratio tests is presented which allows a hierarchy of such hypotheses to be examined. These include random vs. non random mating with respect to genotype, single vs. multiple mating of females, and equal mixing vs. prior- or latter-sperm-preference patterns. This approach is valid for two or more alleles at each genetic locus, and hence combines the advantages of multiallelic methods of detecting three or more paternal alleles in progeny, and the "analysis of variance" method of Wilson (*Evolution* 35: 664) which is restricted to biallelic loci. The approach is most powerful when relatively large broods can be analyzed. Supported by Grant # BSR-8415756 from NSF.

5

VARIATION IN MALE MATING STRATEGIES OF THE CARPENTER FROG, RANA VIRGATIPES. M.F. Given. Univ. of Connecticut, Storrs.

A hypothesis is proposed suggesting that in prolonged breeding anurans, selection has favored small males investing most of their energy in growth if male reproductive success is strongly influenced by body size. A population of 75 adults was studied 1983-85 at Cedar Run Lake, Medford, N.J. Males are territorial and use physical interactions and vocalizations to defend calling sites. Variability in male behavior is apparent when 48mm snout-vent length is used as a criterion for division, the point beyond which peak intensity of vocalizations is constant. Small males differ from large males in that they a) have calls of lower intensity and higher dominant frequency, b) are more likely to retreat or be silent in response to playback stimuli, c) are more likely to adopt a satellite posture, and d) grow faster than larger males. In a playback experiment using stimuli of a small vs. large male, males responded to the call of the smaller male with more total notes and aggressive calls. Focal animal data suggest a trade-off between calling activity and growth.

6

WHISTLE REPERTOIRES OF TWO BOTTLENOSED DOLPHINS, Tursiops truncatus: MIMICRY OF SIGNATURE WHISTLES? Tyack, Peter L. Woods Hole Oceanographic Institution, Woods Hole MA 02543

The whistle vocalizations of two bottlenosed dolphins, Tursiops truncatus, were recorded at the Sealand Aquarium in Brewster, MA. A telemetry device, called a vocalight, was developed for this study to identify which dolphin within the group produced a vocalization. The vocalight is attached to a dolphin's head with a suction cup and it lights up a variable number of light emitting diodes depending upon the loudness of sounds produced by the dolphin.

77% of the identified whistles (219 out of 284) fell into two primary categories, type 1 and type 2. The remaining 23% of whistles fell into five secondary categories. Of the primary whistles produced by one dolphin, 78% were of type 1 (22% type 2), while 69% of primary whistles from the other dolphin were of type 2 (31% type 1). The result that each of the dolphins favored a different primary whistle supports the signature whistle hypothesis of Caldwell and Caldwell. But in the present study, both dolphins produced both primary whistle types. This may represent mimicry of signature whistles.

7

THE FUNCTION OF VOCAL DUETTING IN THE BAY WREN (THRYOTHORUS NIGRICAPILLUS). R.N. Levin. Cornell University, Ithaca, NY.

Many hypotheses proposed for the function of duetting suggest that duets are a signal between members of a mated pair of birds and therefore assume both long term mate fidelity and that learning is required for pairs to sing precisely. Bay wrens in Panama do not consistently exhibit long term pair bonds and in experiments where one member of a pair was removed from a territory, newly formed pairs sang well-coordinated duets within minutes of the arrival of the new bird on the territory. Experimental exchanges of birds between territories demonstrate that these results are not due to prior learning of residents' songs by floaters. Thus, duets must be signals from a mated pair to conspecifics outside of the pair bond. However, the most likely "outside of pair" hypothesis, territory defense, does not seem to be supported in bay wrens. Duets are not critical to successful territory defense; birds whose mate was removed did not lose their territories. Remaining hypotheses are being tested through playback and muting experiments. Results of this study suggest that male and female bay wrens are sending very different signals within their well-coordinated songs.

8

EFFECTS OF ANDROGEN AND ANTI-ANDROGEN ON THE BEHAVIOR AND REPRODUCTION OF FREE-LIVING HOUSE SPARROWS, PASSER DOMESTICUS. Robert E. Hegner and John C. Wingfield, Rockefeller University Field Research Center, Millbrook, NY 12545.

Plasma levels of testosterone in male House Sparrows are maximal during egg-laying, decline during incubation and the first 2/3 of the nestling stage, and rise again during the last 1/3 of the nestling stage. This pattern was altered by giving silastic implants of testosterone (T), the anti-androgen flutamide (F), or empty implants as controls (C) to males feeding nestlings. Feeding rates of the C-treated males declined significantly as plasma levels of T began to rise. Feeding rates of the T-treated males declined more rapidly, while those of the F-treated males continued to remain high throughout the nestling stage. As a consequence, the F-treated males fledged significantly more of their nestlings than did the T-implanted males. These results support previous suggestions that (1) high plasma levels of T inhibit parental behavior and (2) prolonged high levels of T reduce reproductive success in species with bi-parental care.

NEURAL CONTROL OF COURTSHIP BEHAVIOR IN MALE GARTER SNAKES. R.W. Krohmer and D. Crews. Inst. Reproductive Biol., Univ. of Texas, Austin.

Warm temperatures following a prolonged low temperature dormancy activates courtship behavior in adult male red-sided garter snakes (Thamnophis sirtalis parietalis). Male snakes exhibited varying degrees of courtship behavior in response to brain lesions received prior to hibernation. Animals failing to thermoregulate were found to have lesions in the anterior hypothalamus-preoptic area (AH-POA). Furthermore, snakes with a bilateral lesion in the medial preoptic area (MPOA) or AH-POA showed no courtship activity upon emergence. Males that received sham lesions or lesions outside of the AH-POA courted normally. Other reproductive measures were not altered by lesion placement. These findings suggest that perception of external temperature is important in the activation of courtship behavior and that the AH-POA is essential for the integration of this information. Supported in part by HD 07264, HD 16687 and RSDA MH00135.

COMMUNICATION ABOUT SHELL CONDITION DURING HERMIT CRAB SHELL EXCHANGES.

Brian A. Hazlett, Univ. Michigan, Ann Arbor

Individuals of Clibanarius antillensis usually exchange shells only when both individuals gain in shell adequacy. To investigate the mechanisms involved in this process, in 100 shell exchange interactions, the shell of the initiator was altered following a natural interaction in such a way as to try to change the outcome of the interaction. When only weight of the initiator's shell was altered, the outcome was not different in the second interaction if the shell was a Nerita or a Cerithium. When the internal volume of the initiator's shell was manipulated, the outcome changed in about 70% of the cases for all 3 shell species tested (a shell exchange became a non-exchange, a non-exchange became an exchange). When the shell was that of a Cantharus sp., either weight or volume manipulations altered the outcome of the interaction. The results suggest that during shell rapping by the initiating crab, the non-initiating crab gains information about the other crab's shell via vibratory signals which are correlated with shell internal volume.

INTRASPECIFIC VARIABILITY AND BEHAVIORAL CHANGES IN HERMIT CRABS IN ASSOCIATION WITH A SEA ANEMONE. W.R. Brooks and R.N. Mariscal. Auburn Univ. at Montgomery, Alabama, and Florida State Univ., Tallahassee.

Two populations of the hermit crab Pagurus pollicaris Say were behaviorally distinct in that one population transferred more anemones (Calliactis tricolor (Lesueur)) to their gastropod shells than did the other. Both populations of P. pollicaris and one population of another hermit crab, P. impressus (Benedict), transferred fewer C. tricolor after four weeks in an aquarium than they did in their first week. The chemical presence of the octopus Octopus joubini Robson, however, increased the number of anemone transfers by both species of hermit crab. The more active anemone-transferring population of P. pollicaris was collected from an area with a greater density of O. joubini than the area of the less-active population. Therefore, the differences between the two populations of P. pollicaris may have been due in part to differences in predation pressure by O. joubini or other predators.

AXONAL BASIS IN THE DETERMINATION OF DIFFERENCES IN PIGMENT PATTERN BETWEEN BLACK AND WHITE AXOLOTLIS. G. Vlasto* and I. Brick. Univ. of Conn., Stamford, and New York Univ., New York.

Relative adhesive strength of subepidermal and somite surfaces was assayed by observing the degree of axonal branching on these surfaces. It is known that axons tend to branch more often on strong adhesive surfaces rather than on weak ones. Our results showed that in the black axolotl, its axons tended to branch more on these surfaces than those seen in the white, suggesting that black surfaces tend to be more adhesive than white ones. This could facilitate melanoblast migration in black animals. SEM observations showed a close association of black melanoblasts with their axons more so than seen in white axolotls. These observations along neural tube transplants suggests that black melanoblasts may use axons as additional substrate for migration. Skin grafts showed that white melanoblasts under black tissues have more extensive axon branching on their surfaces than black melanoblasts under black tissues suggest inherent differences between black and white melanoblasts. Graft results also show that black axons fail to enter the white tissues.

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ULTRASTRUCTURAL EXAMINATION OF RANA PIIPIENS GASTRULATION. J. LeBlanc, M. Yoder*, and I. Brick. The College of Staten Island, CUNY, S.I., N.Y. and New York University, N.Y.

Rana pipiens embryos from late blastula through late gastrula are being examined utilizing scanning and transmission electron microscopy. During gastrulation, the body plan of the amphibian embryo is established. Gastrular movements appear associated with specific changes in shape and arrangement of cells. In early R. pipiens gastrulation, translocating cells proximal to the blastopore project extensive contacts to the dorsal and lateral blastocoel lining. Leading-edge cells of the advancing mesoderm/endoderm fold positioned against the dorsal blastocoel lining during gastrulation exhibit filopodia and lamellipodia extending to the blastocoel wall. Often, these processes appear to be making or to have made contact with processes from the cells of the blastocoel lining. The area of the inner ectodermal surface anterior to the mesoderm/endoderm fold exhibits apparently long cell processes.

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LITHIUM CHLORIDE (LiCl) RESCUES ULTRAVIOLET LIGHT (UV)-INDUCED AXIS-DEFICIENT XENOPUS LAEVIS EMBRYOS. Kenneth Kao, Richard Elinson*, and Yoshio Masui., Dept. of Zoology, Univ. of Toronto, Canada.

The embryonic axis in frogs is determined by a cytoplasmic rearrangement before first cleavage of the egg. It is possible to prevent this rearrangement and subsequent axis development by using UV-light. When fertilised Xenopus laevis eggs are UV-irradiated before axis determination, they develop into radially symmetric embryos. We have found that brief treatment of these embryos with LiCl during cleavage rescues axial structures. The type of rescue depends on concentration and duration of exposure to LiCl. UV-irradiated, axis-deficient embryos exposed to low doses of LiCl develop axes consisting of somites but lacking head structures. With higher doses, they become anteriorised, forming only head structures. Embryos treated only with low doses of LiCl show slight abnormalities such as a curved axis. With greater exposure to LiCl, they develop only anterior structures. The rescue of anterior and dorsal structures indicates that LiCl is activating dorsal differentiation which is not otherwise expressed.

This work was supported by a grant from NSERC, Canada.

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CHEMICAL INDUCTION OF A BLASTOPORE-LIKE STRUCTURE IN THE UNFERTILIZED, UNACTIVATED EGG OF RANA PIIPIENS. I.D. Zimmerman (intro. by M. DiBerardino). The Medical College of Pennsylvania, Phila.

Incubation of the unfertilized, unactivated egg of the frog Rana pipiens in a 10% amphibian Ringer's solution containing 1.64 μ M 12-O-tetradecanoyl phorbol acetate (TPA) induces the formation of a dorsal lip in the previously radially symmetrical cell. The dorsal lip appears precociously in about 2 hours or so and is followed in many eggs (50%) by the formation of lateral and ventral lips and a disappearance of the yolk laden vegetal region in imitation of the latter stages of gastrulation. Control eggs show no changes. The symmetry-breaking evidenced by the formation of the blastopore lip is an organizing event. It is hypothesized to result from a chemical reaction in a "far-from-equilibrium" system of the sort known as a "dissipative structure." TPA is assumed to trigger the reaction by virtue of its ability to stimulate protein kinase C.

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ABERRANT PATTERNS OF ENZYME LOCUS EXPRESSION IN HYBRID BARBS. J.S. Frankel. Howard Univ., Washington, D.C.

The expression of isozymal subunits, encoded at 14 structural loci, was investigated in hybrid fishes from the teleost genus Barbus (Cyprinidae) resulting from parentals of increasing degrees of taxonomic (genetic) distance. The developmental schedules of isozyme expression were normalized for all intraspecific embryos and compared with those of interspecific embryos at corresponding stages of development. Taxonomic distance between parentals was determined by analyses of allelic frequencies. With increasing genetic distance between parentals, allelic expression was altered from synchronous expression to synchronous delay or precocious expression of embryonic genes as compared with that in intraspecific embryos. These observations support the hypothesis that structural gene expression is initially regulated by a pool of effector molecules whose concentration and increasing rates of synthesis are under maternal control and, therefore, species specific.

DEVELOPMENTAL EVIDENCE FOR AMPHIBIAN ORIGINS. J. Hanken. Univ. of Colorado, Boulder.

Contrasting patterns of early development among various species of frogs, salamanders, and caecilians have been cited as evidence of a polyphyletic origin of amphibians, and thus tetrapods, from fishes. I evaluated seven such characters with respect to their validity in phylogenetic analysis and their implications for the origins of Recent amphibians. For three characters--mesoderm, notochord, and somite formation, supposedly fundamental differences among the orders are based on consideration of relatively few species and may be blurred by a diversity of developmental patterns within orders, particularly the Anura. Four characters--block to polyspermy, primary germ cell formation, apical ectodermal ridge, and prechondrogenic limb condensations--do reveal consistent differences between at least two of the orders. In the absence of comparable data from putative ancestral taxa and other outgroups, however, it is inappropriate to interpret these differences solely as evidence of polyphyly. Available data do not provide unequivocal proof of any hypothesis of amphibian origins. Supported by NIH grant 1 R23 DE07190-01.

ULTRASTRUCTURE OF EXCRETORY SYSTEM MODIFICATIONS IN THE HOUSE CRICKET (ACHETA DOMESTICUS). S.W. Parker and J.H. Spring. Univ. of Southwestern Louisiana, Lafayette.

The excretory system of the cricket is unique in that the approximately 110 Malpighian tubules empty into a common ampulla which is completely separate from the gut, linked to the lower hindgut by a single ureter. This system has been investigated using light, scanning and transmission electron microscopy. Five bands of smooth muscle spiral the length of each tubule, which has two morphologically distinct regions. The distal 18% of the tubule is transparent and consists of squamous cells with nuclei about one-half the size of those in the rest of the system. The remainder of the tubule is twice the diameter of the distal tip and consists of pigmented cuboidal cells. Cell number increases dramatically as the tubule transitions into the ampulla, which is composed of a single layer of columnar cells. A brush border of densely-packed microvilli lines the entire length of the tubule and the ampulla. The valved, muscular ureter, of ectodermal origin, actively pumps fluid from the ampulla into the hindgut. The production of hyposmotic urine when the system is stimulated *in vitro* is consistent with a reabsorptive function for the ampulla. Supported by NSF grant DCB84-16829.

EFFECTS OF UNRESPONSIVE, A TRANSIENT MUSCLE DYSFUNCTION MUTATION OF XENOPUS LAEVIS, ON THE EXTRACELLULAR MATRIX. J. Tompkins*, Y. Tai*, Q. Le*, C. Olsen*, J. Fuseler*, C. Kaye, R. Tompkins. Tulane University, New Orleans.

Homozygous *unresponsive* embryos show delayed muscle function during embryogenesis. Mutant nerve function and electrophysiological responses of mutant muscle cells are normal. Mutant muscles contract normally in response to caffeine and the calcium ionophore A23187 during the affected stages, despite myofilament disorganization. Chlorotetracycline fluorescence was used to assess calcium localizations in living muscle blocks. Calcium is confined to terminal vesicles in mutant muscle cells during affected stages; many normal embryonic muscle cells and mutant cells after recovery show calcium accumulation in the myoplasm. Mutant animals have reduced collagen deposits in most tissues and electrophoretic analysis of purified collagens showed that one collagen monomer and one dimer were not present in detectable quantities in mutant animals. These results, along with previous work showing that mutant muscle cells can recover normal function following association with normal tissues, suggest that the extracellular matrix plays an important role in embryonic muscle function.

EXPRESSION AND CURE OF CALCIUM METABOLISM ABNORMALITY IN CULTURED UNRESPONSIVE XENOPUS LAEVIS CELLS. P. Kelly*, K. Hanft*, J. Fuseler*, D. Reinschmidt*, R. Tompkins. Tulane University, New Orleans.

Normal and mutant *unresponsive* stage 22 to 25 muscle blocks were dissociated and cultured in modified L-15 medium. Chlorotetracycline fluorescence was used to assess the calcium content of cultured cells. Three day cultured mutant cells were less fluorescent than normal cells, paralleling the results observed *in vivo*. Cultured mutant muscle cells do not recover normal calcium levels within 10 days as they do *in vivo*. Since interaction with normal cells causes early recovery *in vivo*, the effects of culture medium from normal three day cultures on similar mutant cultures was tested. Such treatment, as well as treatment with extracts of normal embryos, caused recovery within 12 hours. These results support the hypothesis that extracellular material produced by normal cells is defective or absent in mutant cultures and that this material is essential for normal calcium metabolism during embryogenesis.

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COINCIDENT PEAKS IN SERUM OSMOLALITY AND HEAT TOLERANCE RHYTHMS IN SEAWATER-ACCLIMATED KILLIFISH (FUNDULUS HETEROCLITUS). A.J. Bulger. Univ. of Virginia, Charlottesville.

Killifish (Fundulus heteroclitus) maintained in seawater (33 ppt S) at constant temperature (27°C) under a LD 14:10 photoperiod showed daily rhythms in both serum osmolality and heat tolerance (critical thermal maximum). The two rhythms appear to be in phase, each with a single peak at midday. A model is proposed which links the two rhythms functionally, and relates these phenomena to data on fresh- and brackish water-acclimated fish.

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THE PHYSIOLOGICAL AND ECOLOGICAL CONSEQUENCES OF BURROW-DWELLING TO THE GREEN IGUANA (IGUANA IGUANA). D.G. Brust. University of Arizona, Tucson.

Most adult green iguanas (Iguana iguana) select sleeping sites high in trees. I have been studying a group of iguanas that, in contrast, regularly uses ground burrows as sleeping sites. By overwintering underground, the animals maintain nighttime body temperatures 8-10°C warmer than tree-dwellers. I compared the effects of a high nighttime body temperature on the ecology and digestive physiology of both groups. Burrow-dwellers have a longer activity period than tree-dwellers and allocate less time to basking before beginning other activities. Even during the non-breeding season, burrow-dwellers regularly return to the same sleeping sites and defend them against other iguanas; tree-dwellers do not. Burrow-dwellers also process food faster than tree-dwellers (passage time - 5.5 vs 6.7 days) and may be digesting food more efficiently. Sleeping in burrows may enable iguanas to have higher rates of energy acquisition, and thus enhance growth rates and reproductive success.

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GEOGRAPHIC VARIATION IN THE RACCOON (PROCYON LOTOR) AND ITS RELATIONSHIP TO ENVIRONMENT. Mark E. Ritke and Michael L. Kennedy*. Memphis State University, TN.

Geographic variation in the raccoon (Procyon lotor) was assessed using univariate and multivariate analyses of twenty-two cranial characters. All characters showed significant interlocality variation for both sexes. Principal component I (a size factor) revealed longitudinal patterns of size variation for both sexes with larger individuals occurring in the western United States and Mexico and smaller in the southeastern United States and Florida. Larger size was positively associated with climatic variables expressing seasonality; smaller body size was negatively associated with evapotranspiration, temperature, precipitation, and humidity. Patterns of interlocality heterogeneity in eastern North America agree with several biological explanations of size variation proposed for homeotherms.

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TEMPERATURE EFFECTS ON WIND TUNNEL FLIGHT OF FRUIT BATS. R.E. Carpenter (intro by W.J. Wilson). San Diego State Univ., CA

Metabolic measurements on flying bats show that they produce heat at 15-20 X their resting rates, with a strong correlation between ambient temperature (T_a) and body temperature (T_b) in flight. Unlike birds, which increase pulmonary ventilation and evaporative water loss (EWL) at high T_a , bats have coupled respiratory and wingbeat cycles, so that EWL is limited to about 10% of heat production. Continuous measurement of foot temperatures (T_f) showed that at $T_a > 15^\circ\text{C}$, blood flow to feet and wings was increased for heat loss. This response was less effective at high T_a , when ($T_b - T_a$) became too small. Bats could not continue flight at $T_a > 25-30^\circ\text{C}$. At $T_a < 15^\circ\text{C}$, heat was conserved by minimizing blood flow to the wings. At $T_a < 10^\circ\text{C}$, wings often became too chilled to function properly, and bats crashed even when $T_a > 37^\circ\text{C}$. Thus, bat flight is more thermally restricted than bird flight by decreased convective cooling when hyperthermic, and a lack of insulation to preserve wing coordination at low T_a . This pattern is associated with absence of daytime flight and the reduction of bat activity during winter in temperature zones.

MAXIMAL RUNNING SPEEDS OF BIPEDAL AND QUADRUPEDAL RODENTS: RELEVANCE FOR COEXISTENCE? M. Dawdan and I. Garland*, University of California, Irvine.

Maximal sprint speeds of nocturnal desert rodents measured in the laboratory on a photocell-timed track were:

Species	n	Mass (g)	Speed (km/h)
			mean±SD, high
<u>Perognathus</u>			
<u>baileyi</u>	9	39.1	12.4±1.33, 14.9
<u>fallax</u>	12	18.0	12.8±0.91, 14.2
<u>longimembris</u>	13	8.9	9.9±0.74, 11.7
<u>parvus</u>	9	24.4	12.5±1.57, 14.6
<u>Microdipodops</u>			
<u>megacephalus</u>	8	12.3	10.9±1.59, 14.2
<u>Peromyscus</u>			
<u>crinitus</u>	14	13.7	11.4±0.82, 12.5
<u>eremicus</u>	7	19.8	13.1±1.05, 14.2
<u>maniculatus</u>	5	20.0	12.7±1.04, 13.8
<u>truei</u>	2	19.3	14.3±0.16, 14.4
<u>Onychomys</u>			
<u>torridus</u>	4	19.4	10.6±0.41, 11.0
<u>Neotoma</u>			
<u>lepida</u>	10	110.6	17.1±1.28, 19.1

All are lower than maximal field speeds of Dipodomys deserti (112 g, 30 km/h, our observations), D. merriami (35 g, 26 km/h; cf. 32 km/h, Kenagy, 1973, Ecology), and D. microps (56 g, 21 km/h, Kenagy, *ibid.*). Higher sprint speeds may facilitate predator avoidance and allow Kangaroo rats to exploit open microhabitats.

BEHAVIORAL RESPONSES DURING STAGED ENCOUNTERS BETWEEN THE SUSPECTED LIZARD COMPETITORS ANOLIS SAGREI AND ANOLIS CAROLINENSIS. R.R. Tokarz and J.W. Beck, Jr.* University of Miami, FL.

Intra- and interspecific encounters were staged with adult A. sagrei and A. carolinensis, two species believed to be in competition in southern Florida. The agonistic behavior of resident males toward heterospecific intruders was much less intense than that of resident males toward conspecific intruders, suggesting that behavioral interference is unlikely to be an important factor in competition between these two species. In staged encounters between males and females, courtship was usually and copulation invariably limited to the conspecific encounters, suggesting that sexual interactions between these species are not important under natural conditions.

FORAGING SUCCESS AND SPATIAL PREFERENCES OF INDIVIDUAL BROWN CAPUCHIN MONKEYS.

C. H. Janson, Department of Ecology and Evolution, SUNY, Stony Brook, NY 11794.

In the wild, individual brown capuchin monkeys (Cebus apella) spend very different amounts of time in different spatial positions within their group. An individual's foraging success depends both on its spatial position in the group and on its social status. Individuals of high dominance rank occupy the areas of highest foraging success, but these same areas yield little to subordinates, which are frequently displaced from food trees. Subordinates actually maximize their food intake by choosing areas of lower absolute foraging success away from the dominant group members. Thus, spatial structure in brown capuchin groups seems to arise from individual efforts to increase foraging success within the constraint of a 'despotic' social system.

FEEDING PREFERENCES OF FERAL BURROS IN A TROPICAL ECOSYSTEM. R. Rudman, A.B. Swanbeck* and D.W. Nellis*. Cornell Univ., Ithaca, NY and Division of Fish & Wildlife, St. Thomas, USVI.

The burro (Equus asinus) evolved in the arid regions of northern Africa, and thriving feral populations have caused problems in the desert American southwest. Concern over the effects of a growing feral burro population on St. John, USVI, prompted a study of burro ecology here. Two methods were employed to study feeding preferences. Direct observations of feral animals and also of a tamed burro captured for this purpose were conducted. Analysis of fecal samples collected monthly also provided information on feeding habits. Both methods indicated that, even in a tropical forest ecosystem, grasses are the preferred food item, followed by legumes, then other forb and browse species. Preferences for specific plant species may significantly alter the structure of the island vegetation, either by eventual elimination of the preferred plants or by enhanced seed distribution of certain species.

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ON THE RELATIONSHIP BETWEEN FIRE PERIODICITY, PLANT STRUCTURE AND HERPETOFAUNAL COMMUNITIES IN FLORIDA. H.R. Mushinsky and E.D. McCoy. Univ. of South Florida, Tampa.

Amphibians and reptiles were collected continuously by an array of drift fences and pitfall traps. Four plots of land (app. 1 ha each) have been burned on 1 yr, 2 yr and 7 yr cycles (since 1976); or protected from fire to serve as a control plot (cp). The structure of the plant community at ground level was assessed. Estimates of bare ground, leaf litter and overstory (up to 30cm above ground) taken on each plot in 1983 and 1985, and counts of herbs and grasses were used to construct a height-density vegetation profile. Herpetofaunal communities appear to respond to changes in the herb/grass layer. Cp had sparse herbs and grasses, a thick layer of litter and few animals. Also the dense herbs/grasses on the 2 yr plot prohibited herpetofaunal residency. Burning yearly reduced both litter and grasses, leaving an open habitat that supported a dense population of *Cnemidophorus sexlineatus*. The 7 yr plot, which resembled cp prior to burning, was temporarily opened by the fire, and had the greatest herpetofaunal diversity.

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PLANT-ANIMAL POLLINATION SYSTEMS 2. FEWER POLLINATOR THAN PLANT SPECIES. H. Wells. Univ. of Tulsa, OK.

A differential equation model was used to study the effects of pollinator individual-constancy foraging behavior on a plant-pollinator system. Individuals of a single pollinator species or population (e.g., bees from a hive) visited two plant taxa (species, varieties or morphs) but any individual was relatively constant to one of the plant taxa. Analyses examined conditions for equilibria, and stability as pollinator individual constancy increased in a two-plant one-pollinator system. Individual constancy reduced the probability of plant minority taxon extinction, and increased the likelihood of a stable system equilibrium involving more plant species than pollinator species.

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STUDIES OF DAMSELFISH GARDEN COMMUNITIES ASSOCIATED WITH ACROPORA COLONIES ON THE GREAT BARRIER REEF. L.G. Harris and A.W.D. Larkum. Univ. of New Hampshire, Durham, and Univ. of Sydney, Sydney.

Comparisons were made of the fauna inhabiting the gardens of three species of damselfish with that associated with dead *Acropora* skeletons outside damselfish territories. Gardens were sampled at One Tree Island and Lizard Island on the Great Barrier Reef. The gardens were produced by *Dischistodus perspicillatus*, *Eupomacentrus nigricans* and *Hemiglyphidodon plagiometapon*. Animals were extracted with a 6% solution of MgCl₂ in seawater. The density of the fauna was related to algal biomass. An experiment was run to compare early community development on newly killed coral skeletons placed inside and outside damselfish territories. The density of invertebrates was significantly higher inside damselfish gardens than on coral skeletons exposed to fish grazing. Copepods comprised the dominant group in the gardens of all three fish species. Community development on newly cleaned coral skeletons was similar, but certain algal species grew much faster when damselfish had direct physical contact with the substrates, suggesting a possible role for the fish in the earliest stages of garden development.

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LET US NOT FORGET THE PAST: FUNCTIONAL ANALYSIS OF A TROPHIC ASSEMBLAGE. L. Kaufman.

New England Aquarium, Boston.
The Great Barrier Reef is inhabited by hundreds of planktivorous fishes, of which 50 or more species can occur at any one site. Models for species coexistence are reexamined here in light of new data on distribution, functional morphology, feeding kinematics and behavior of planktivores. The diurnal planktivore guild, if it can be called one, is composed of distinct species subgroups. Species segregate by position on the continental shelf, zone on a reef, microhabitat within a zone, and feeding height in the water column. They vary in mouth size, jaw protrusibility, feeding velocity, body form, and color pattern. Similar species differ in feeding plasticity when from different clades. Where differences were expected they were not found: individuals tended to associate in large schools with conspecifics or the next most similar species. Where differences were found they were not expected: functional variation was often tied to primitive characters of a genus or family unrelated to present patterns of resource utilization. Great care must be taken before testing competition theory on a system so rich in historical peculiarities and selective forces other than competition.

BENTHIC FAUNAL ZONATION AT A SUBTIDAL ROCK LEDGE IN THE CENTRAL GULF OF MAINE. J.D. Witman and K.P. Sebens. Mar. Sci. Lab. Northeastern University, Nahant, MA.

The abundance and distribution of benthic macroinvertebrates at Cashes Ledge was determined by quantitative photography from the Johnson Sea-Link submersible. Three faunal zones were observed. Zone 1 extends from the top of the ledge at 28 m to 40 m depth and is characterized by sheet-like sponges (Halichondria panicea) and dense aggregations of anenomes (Metridium senile). A striking increase in invertebrate species richness at 40 to 48 m depth marked the beginning of Zone 2. The most conspicuous macrofauna in Zone 2 (~45-70 m depth) were upright and mounding sponges, anenomes (Tealia crassicornis, Bolocera tuediae), comatulid crinoids, brachiopods, and ascidians. Zone 3 is a soft substratum assemblage extending from 70 m to at least 100 m depth. Polychaetes (Myxicola infundibulum) and cerianthid anenomes (Cerianthus borealis) attained high densities in Zone 3. Experimental manipulations were established to test the role of predation and recruitment in maintaining depth zonation on hard substrata.

(Supported by the National Undersea Research Program, NOAA.)

THE ROLE OF BRYOZOANS IN THE BENTHIC COMMUNITY AT LOW ISLAND, ANTARCTICA. J. E. Winston and B. F. Heimberg. American Museum of Nat. Hist., New York.

In the primarily suspension-feeding community in 80-100 m at Low Island (So. Shetland Islands) the four most abundant bryozoan species have bushy erect colonies that may comprise a third of the benthic biomass. Trawl samples taken over the course of the austral summer and fall showed that the most common species, Carbasea ovoidea, is an annual, with high fecundity over a short reproductive season. The other species are perennials, showing yearly growth bands and lower fecundities over more extended reproductive periods. Colonies provide shelter for numerous motile invertebrates fed upon by demersal fish. Bryozoans suffer little predation from fish, but are found in stomach contents of echinoids and the large isopod Glyptonotus. Analysis of bryozoan gut contents showed that they ingest primarily small diatoms (under 40 μm in size) and thick-walled cysts (under 10 μm in size) that may be diatom resting stages.

DESCRIPTION OF A HYDROCARBON-SEEP COMMUNITY ON THE LOUISIANA SLOPE. G.J. Denoux, M.C. Kennicutt, II, R.R. Bidigare, J.M. Brooks, R.R. Fay, Texas A&M Univ., College Station, M.L. Jones, Smithsonian Inst., Washington, D.C., and R.D. Turner, Harvard Univ., Cambridge, MA.

Fourteen separate trawls in areas of known hydrocarbon seepage in the Gulf of Mexico indicate that chemosynthetic, vent-type taxa are important components of Gulf of Mexico deep-sea ecosystems. Initial analyses show that the taxonomic composition of the communities associated with these hydrocarbon seep sites (an area of at least several hundred square miles) is similar to those found at hydrothermal vents and the hypersaline, cold water, hydrogen sulfide seep at the Florida Escarpment. Associated with the chemosynthetic, vent-type taxa is an abundance of non-chemosynthetic species. The communities include vestimentiferan tubeworms, bivalves, mytilids, neogastropods, archeogastropods, decapods, barnacles, octacorals, ophiuroids and fish. The general nature of the mechanism of enrichment (areally and with time) and the enhanced community diversity suggest the possibility that these oil seep communities may indeed be the progenitors of the deep-water vent sites.

THE EFFECT OF SUMMER HYPOXIA ON PLANKTON DENSITY AND COMMUNITY STRUCTURE OFF THE LOUISIANA COAST. T.L. Boullion. Seafood Division, Louisiana Dept. Wildlife and Fisheries, Baton Rouge.

As part of LDWF's ongoing program of monitoring of the Louisiana Offshore Oil Port (LOOP) Project, zooplankton was collected monthly from 8 stations in Louisiana coastal waters. Environmental parameters were measured using a Martek Mark 6 CTD system, and included salinity, conductivity, temperature, and dissolved oxygen. Periodic hypoxia is common in the summer months in the northern Gulf of Mexico, and occurs mainly in the bottom two meters of the water column. A sharp gradient is found between the hypoxic (0.5 to 1.0) and the saturated (5.0 to 7.0) levels, forming an interface as narrow as 1 meter in depth. At these interfaces, zooplankton aggregations with densities as high as 200,000/m³ can be found. Calanoid copepods (especially Acartia tonsa and Labidocera aestiva) dominated most of these communities, except where chaetognaths (Sagitta spp.) and sergestids (Acetes americanus and Lucifer faxoni) were significant. Hypoxic waters yielded very low densities, consisting mainly of the calanoid copepods Acartia tonsa and Eucalanus pileatus. Saturated waters were dominated by hydrozoans, ctenophores, and larvaceans.

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THE ORGANIZATION OF AN ECOLOGICALLY SIMPLE ASSEMBLAGE: THE EPIFAUNAL NEMATODES OF BAY SCALLOPS. Kevin M. Sherman Florida State University, Tallahassee, FL

The fauna and flora of bay scallops was examined from twenty-five consecutive monthly collections. Comparisons with sediments and seagrasses showed that the scallop-shell nematode fauna was unique in that it had much lower diversity and was dominated by three species, Viscosia macramphida (V), Chromadora nudicapitata (C), and Syringolaimus striatocaudatus (S). These species accounted for 74% of the nematodes on scallops. This simplicity was exploited in field and laboratory experiments designed to uncover the ecological factors responsible for the temporal variation of the dominant species.

V is most abundant on scallop shells in late summer, coinciding with a peak in diatom abundance, its preferred food. C is abundant in spring on young scallops that have recently detached from Thalassia testudinum blades. At that time, C is the most abundant nematode on the blades, so its abundance on newly settled scallops is a reflection of the recent history of the shell. S was the overall dominant on scallop shells once C populations declined. A laboratory culture experiment showed that S could outcompete but not eliminate C under natural conditions.

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USE OF PRESENCE-ABSENCE DATA IN THE STUDY OF COMMUNITY STRUCTURE AMONG MARINE GASTROTRICHA. W.D. Hummon, Ohio Univ., Athens.

Presence-absence data, like hydrogen bonds, may be weak individually, but in aggregate can show strength and properties not otherwise seen. Eighty spp. of gastrotrichs were found in 52 intertidal beaches sampled around the coastline of the British Isles. Coefficients of association were calculated for permutation pairs of the 17 most commonly encountered spp. All spp. were found on between 15 and 42 beaches. On average, each sp. was involved in 3 sig. pos. associations (+A's) and 1 sig. neg. association (-A), for a Total (TA) of 4. The dispersion of +A's among spp. was regular but not sig.; that of -A's was aggregated but not sig.; though that of TA's (+A's + -A's) was both regular and sig. This indicates that spp. with many +A's had none to few -A's and that spp. with few +A's tended to have more -A's. Secondly, whereas naive competition theory has held that non-congeners should show +A's more often than congeners and that congeners should show -A's more often than non-congeners, here the opposite was the case, and significantly so. This indicates that accommodation between congeners was more common in these animals than exclusion.

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PREDICTING KEY SPECIES INTERACTIONS IN GUILDS OF PREDATORS WITH SIZE-STRUCTURED POPULATIONS. S.A. Wissinger, Purdue University, West Lafayette, IN.

Overlap indices which describe the potential for predation vs. competition were used to identify the subset of possible interactions most likely to affect coexistence among 14 species of dragonfly larvae (Anisoptera:Odonata). Detailed study of the spatial and temporal distribution of larvae in a small Indiana pond revealed that many species which overlap extensively have highly size-structured populations. Because dragonfly larvae are dietary generalists, similarly sized instars which co-occur in time and space are potential competitors, whereas disparately sized instars should interact as predators and prey. An index was developed to calculate the proportion of all encounters between pairs of species which are potentially predatory or competitive by accounting for both the densities and size ratios of all co-occurring instars. Predictions are made about which species interact most frequently, the relative occurrence of predation and competition, and how intensities of interactions vary during development. Such information is useful for designing manipulative experiments with dragonfly larvae or any other taxa with size-structured populations.

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A METHOD FOR OPTIMIZING SAMPLE SIZE. W.E. Bros AND B.C. Cowell*, UNIV. OF SOUTH Florida, Tampa.

The appropriate sample size (number of replicates) for an experiment is a function of sample precision and sample effort. Sample precision refers to the ability to detect differences between treatments and sample effort refers to the cost in time or money required to achieve a particular level of sample precision. As sample size increases, both sample precision and sample effort increase. Here we present a graphic method for simultaneously determining the effects of sample size on sample precision and sample effort. The method provides the investigator with information needed to choose an appropriate sample size.

The method involves the generation and interpretation of the functions, sample precision versus sample size and sample effort versus sample size, from a preliminary sample collection. Two techniques are described and compared for extracting a range of sample sizes from a preliminary sample collection. The standard error is used as an estimate for sample precision, while sample effort is measured by the factor which imposes the greatest limitations on sample size (e.g. cost of sample processing).

ELEPHANT TRUNKS: MORPHOLOGY AND MOTION. L.J. Croner and S.A. Wainwright. Duke University, Durham, N.C.

Soft tissue appendages are bio-mechanically interesting because they utilize mechanical principles different from those used in appendages with bony frameworks, and because they are versatile. An elephant's trunk is a long tapering structure, nearly circular in cross-section, pierced by two nostrils running up its center, and consisting entirely of soft tissue. Investigation of an embalmed trunk of an Asian elephant confirms that it has four distinct muscle masses--a radial, a longitudinal, and two oblique layers. Analysis of films taken of an elephant as it lifted a payload with the tip of its trunk indicates that the trunk is capable of shortening at least 30% of its maximum length, and that it has three sections, each of which shortens at a predictable time during a lift. Work in progress analyzes the sequential strain patterns at different parts of a trunk during the performance of other tasks.

TOUGHNESS IN HORSE HOOF KERATIN: A KEY PROPERTY IN THIS STRUCTURAL BIOMATERIAL. J.E.A. Bertram. Univ. of Chicago.

An engineering fracture mechanics approach was used to quantify the fracture resistance of equine hoof wall. The effect of morphological organization and hydration level were investigated. Tensile tests were also conducted.

Hoof wall has greatest fracture resistance for cracks running vertically, parallel to the tubular component. The toughness in this direction was nearly 3 times greater than the weakest direction, in which the crack ran parallel to the material between the tubules. The tubules of the wall appear to reinforce against fracture along the weak plane (parallel to the intertubular keratin) and the entire wall organization provides the means to limit and control fracture in this tissue.

Horse hoof keratin proved to be more responsive to variations in hydration level than other hard keratins, the stiffness increased approximately thirty times from saturation to dehydration. Fracture toughness was maximum at an intermediate hydration level which corresponds to that under which the majority of the hoof wall operates *in vivo*.

INFLUENCE OF LOAD CARRYING ON BONE MODELING DURING GROWTH. A.A. Biewener and J. Bertram. Univ. of Chicago, Chicago, IL

The purpose of this study was to test the hypothesis that increased bone loading stimulates increased bone mass during growth to maintain peak bone strain similar to unloaded animals. Growing chicks were trained to carry 20% of their body mass while running at 60% of their top speed. *In vivo* strains were recorded from strain gages at six sites on the tibiotarsus at 4, 8, and 12 wks of age. Peak strains recorded at each site were 1.17 ± 0.03 times greater when the animals carried a load, reflecting the 20% increase in mass. Peak strains at 60% top speed, carrying a load; however, were greater (1.27 ± 0.59 times) than those recorded from chicks that had been previously exercised at 35% of top speed unloaded. Indeed, comparison of peak strain at the same speeds (unloaded) in the two exercise groups indicated no difference ($p > 0.05$) in peak strain levels. These data show no adaptive increase in bone mass during growth in response to increased load bearing by the tibiotarsus of this species. This finding conflicts with data for mature sheep and pigs, and does not support our hypothesis. (Supported by The Whitaker Foundation).

THE INVASION OF THE PERIOSTEUM.

S.F. Tarsitano and B.W. Oelofsen. Queens College of CUNY, New York and Univ. of Stellenbosch, Stellenbosch.

Although there have been many explanations as to the reasons behind fenestration of the tetrapod skull, none have a basis in either bone or muscle function. It is our contention that all striated muscle attaching to bone must do so at very low angles of insertion. In this way the periosteum can best resist the applied tension of the contracting muscle. We have tested this hypothesis by studying jaw adductor and hindlimb muscles of turtles, lizards, crocodilians and birds by dissection and through the use of the scanning electron microscope. We have found that virtually all muscles studied invade the periosteum at less than twenty degrees. Thus, the doming of the cotylosaur skull led to the medial migration of the jaw articulation, generating greater torque. However, this migration also caused the M. pseudotemporalis and M. adductor externus to invade the periosteum at high angles. This dilemma necessitated the fenestration of the temporal region, thus affording the muscles a low insertion angle on the rim of the fenestra.

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SWIMMING DYNAMICS OF A SMALL SEMI-AQUATIC MAMMAL. F.E. Fish. West Chester Univ., West Chester, PA.

The surface swimming of rice rats (*Oryzomys palustris*) was examined by film analysis of individual animals locomoting at various velocities. Thrust was produced by alternate strokes of the hindfeet in the paddling mode. The propulsive cycle was found to remain constant at 5 Hz over the range of velocities. The paddling mode was divided asymmetrically into power and recovery phases, representing 42 and 58 percent of the total cycle. Both phases were characterized by high angular velocities, but the hindfeet during the power phase showed a long radius of rotation in conjunction with increased surface area for effective thrust production. The energy expended in paddling was calculated from a hydrodynamic model using blade-element theory. The mean mechanical efficiency was 0.25. Substantial energy losses were incurred due to the recovery phase and acceleration of the hindfeet and entrained water mass. In comparison to other swimming vertebrates, energy utilization was low due to a lack of specific morphological adaptations for swimming.

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EVALUATING MECHANISMS OF UNDULATORY LOCOMOTION. K.S. Hoff, Dalhousie Univ., Halifax, N.S.

Most aquatic vertebrates use lateral undulation for propulsion. This requires that waves of bending travel along the body from anterior to posterior. Travelling waves of bending can be produced by three patterns of muscular contraction: 1) waves of contraction can travel from anterior to posterior, 2) all the axial muscle on one side can contract simultaneously, alternating with the other side, or 3) waves can be generated by contraction of only the anterior axial muscles and then passively transmitted posteriorly. Several methods were employed to distinguish among these mechanisms using anuran larvae. The body was treated as a variably flexible beam, and predictions of wave form were made on the basis of the three patterns of muscle contraction. Kinematic data from high-speed cine of normal swimming and mechanical oscillation of anaesthetized and curarized animals were used to test the predictions. Analyses were compared to EMG recordings. This study of anuran larvae shows that the pattern of muscle contraction during undulatory swimming varies among species and also within species at different swimming speeds.

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WHALE BLUBBER ELASTICITY. L.S. Orton and P.E. Brodie.* Duke Univ., Durham, N.C., and Bedford Inst., Canada.

We simulated swimming in a dead fin whale, 20 m long, by bending it with steam winches and showed that the blubber stretches and compresses longitudinally by +/-10-15%. Fin whale blubber is fat plus 25+% by volume collagen in an oriented array. In biaxial tension tests, 1 m² blubber samples demonstrate standard J-shaped stress/strain and elastic recovery curves. Our evidence suggests that the low modulus is related to fiber rearrangement within the blubber, and the high modulus is related to the compression resistance of a constant volume tissue.

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SUSPENSORY SUPPORT AND SKELETAL LOADING: AN IN VIVO BONE STRAIN ANALYSIS OF TWO-TOED SLOTHS. S.M. Swartz. University of Chicago.

Suspension of an animal's body by its limbs during support and locomotion creates a mechanical environment for the limb skeleton which is fundamentally different from that imposed on the limb by standing, walking, etc. An *in vivo* bone strain analysis of the forelimb of the habitually suspensory two-toed sloth (*Choloepus hoffmani*) was carried out to determine the patterns of bone loading associated with this unique form of locomotion. Rosette and single element strain gauges were attached to sites on the humerus, ulna and radius, and strain recordings were coordinated with films of the animal's movements. Strain values indicate that sloth limb bones are loaded in bending, with either tension or compression superimposed on the bending in some trials. The peak strain magnitudes were found to be far lower than those recorded from other mammals. Further, the orientation of principle strains demonstrates that largely off-axis principle strains predominate, even during quiescent hanging.

PREY AND PREY PROCESSING IN BLIND SNAKES OF THE GENUS *TYPHLOPS*. Richard Thomas. Univ. of Puerto Rico, Rio Piedras.

Typhlops richardi, studied at a site in Puerto Rico, fed principally on ants of certain species and secondarily on termites. Similar prey was taken by other Antillean species. Feeding by captive snakes showed very rapid sequential processing of the small prey. X-rays of the excursions of the maxillo-pterygoid linkage along with feeding observations demonstrate the mechanism for rapid ingestion of prey.

FREQUENCY RESPONSE CHARACTERISTICS OF NEURONS IN THE MEDULLARY ELECTROSENSORY NUCLEUS OF THE LITTLE SKATE. J. G. New, Dept. of Biology, Wesleyan University, Middletown, CT 06457

Single units within the dorsal octavolateralis nucleus (DON) were studied to determine the response of specific cell classes to electric stimuli of different frequencies. Mature specimens of the little skate, *Raja erinacea*, were anesthetized, decerebrated, and immobilized with tubocurarine chloride. Units recorded within the DON were classified as efferent fibers of the anterior lateral line nerve (ALLN), neurons ascending from DON to the lateral mesencephalic nucleus (LMN) or provisional interneurons, by their responses to anti- and orthodromic stimulation from ALLN and LMN. Tuning curves were generated for cells by measuring maximum firing rate (minimum interspike interval) through a range of frequencies (0.1-25 Hz) at given stimulus intensities. Stimuli were presented via a local dipole in the receptive field of the cell studied. All cell types studied showed a gradual increase in maximum firing rate from 0.1 through 5.0 Hz. The responses dropped rapidly from 10-15 Hz, the cell following the stimuli with 1-2 spikes/cycle. No responses above resting activity were seen above 20 Hz. The similarity in frequency response characteristics among primary ALLN efferents, interneurons, and ascending DON efferents make it appear unlikely that cells within DON selectively filter specific frequencies of behavioral significance to the skate.

ATROPHY OF MUSCLES PROXIMAL TO AUTOTOMIZED LIMB STUMPS IN CRABS. Stacia Moffett. Washington State University, Pullman.

In crabs, leg injury often evokes autotomy, the discarding of the distal part of the limb at a fracture plane near the base. Subsequently, the leg muscles proximal to the fracture plane undergo pronounced atrophy. I quantified the atrophy of these muscles by comparing the wet weights of individual muscles from an intact limb and the corresponding, contralateral muscles of an autotomized limb. For the crab *Uca pugnator*, 32 muscle pairs from 8 crabs were weighed. Muscles proximal to the limb stumps weighed an average of 69% of the contralateral, control muscle weights. For the crab *Carcinus maenas*, muscles proximal to limb stumps averaged 53% of the weight of contralateral, control muscles in 75 muscle pairs from 17 crabs. The degree of atrophy is correlated with time since autotomy (or growth of the limb bud) and with number of limbs autotomized. Factors which could contribute to this atrophy include disuse and/or catabolism to satisfy the protein requirement of the regenerating limb buds.

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COMPARISONS OF ENDOTHERMIC AND ECTOTHERMIC SCOMBRID FISHES: MUSCLE METABOLIC CAPACITY. K. A. Dickson. Scripps Inst. Oceanography, UCSD, La Jolla, CA.

As part of an investigation of the consequences and advantages of endothermy in tuna fishes (Family Scombridae), biochemical indices of red (RM) and white (WM) skeletal muscle aerobic and anaerobic metabolic potential were measured in five tuna species and in four species of ectothermic scombrids (mackerel and bonito). Activities of enzymes of aerobic respiration (citrate synthase) and of anaerobic glycolysis (pyruvate kinase and lactate dehydrogenase) in RM and WM are generally higher in endotherms than in ectotherms. In WM, but not in RM, intracellular buffering capacity is greater in endotherms, due to greater concentrations of low molecular weight (< 2000 daltons) buffering compounds. These differences suggest that endothermic fishes have a greater capacity to produce energy by both aerobic and anaerobic pathways. Thus, endothermy may enhance muscle function and swimming performance in tuna fishes.

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ULTRASTRUCTURE OF AUTOTOMY-INDUCED MUSCLE ATROPHY IN THE CRUSTACEAN CARCINUS MAENAS. D.L. Schmiege and Stacia Moffett. Washington State Univ., Pullman.

The autotomy response to limb injury is mediated by the anterior levator muscle in C. maenas. Muscles proximal to the fracture plane atrophy before regeneration of the limb at a subsequent molt. We have studied the ultrastructural changes associated with atrophy in the nine fibers of the coxal head of the anterior levator. All of these fibers appear to be phasic. The fibers of atrophied muscles can still contract and organelles such as nuclei and mitochondria appear unchanged. However, we observe a decrease in fiber diameter, an increase in thick filament packing density, and isolated areas of myofibril erosion. Our findings thus far indicate similarities between the autotomy-induced atrophy observed here and the molt-induced atrophy of Gecarcinus lateralis claw closer muscle described by Mykles and Skinner (J. Ultrastruct. Res. 75:314-325, 1981).

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ELECTRICAL AND MECHANICAL RESPONSES OF A MOLLUSCAN MUSCLE TO FMRFamide. R.B. Hill and P. Langton*. Univ. of Rhode Island, Kingston and Univ. of Lancaster, U.K.

Auxotonic contractions of the radular protractor muscle (RPM) of Busycon contrarium have often been used for bioassay of FMRFamide (Fa). However, until now sucrose gap recording of electrical responses of the RPM of Busycon canaliculatum has been accompanied by isometric recording of contractions. In a comparison of electrical, auxotonic, and isometric Fa-responses of the RPMs, we have discovered that Fa-responses are accompanied by relatively little depolarization compared to ACh- or K-responses. Although with isometric recording even 10^{-6} M Fa induced only very weak slow rhythmic contraction in the RPM of B. canaliculatum, with auxotonic recording threshold responses were obtained at about 5×10^{-9} M and contractions 4 orders of magnitude greater at 10^{-6} M. Depolarization only increased slightly over the whole range. Auxotonic and depolarization responses of the RPM of B. contrarium were consistently more sensitive to low concentrations of Fa. Contractions typically show a long latency followed by irregular rhythmicity superimposed on a contraction. Depolarization and contraction are Ca-dependent.

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CHEMICAL SENSITIVITY OF ARIOLIMAX COLUMBIANUS

D. M. Stewart* and A. W. Martin, Univ. of Baltimore and Univ. of Washington, Seattle.

Chemical stimulation elicits responses of skin cells in headless, eviscerated preparations. Stimulation was applied by immersion of the posterior chamber in a vial containing the agent in solution. Immersion in slug Ringer produced no fluid output, and in the range of 2/3 to 1 1/3 X tonicity the changes were negligible. Normal blood pH is 8.8. Very acid or very alkaline solutions stimulated production of much fluid, with graded intermediate responses. Geraniol was without significant effect but eugenol (0.01 M) stimulated measurable fluid output. An extract of garlic buds (5×10^{-3} g/ml) evoked a considerable response, but a solution of allyl sulfide, at the same dilution, did not. The responses to chemical stimulation resembled those to mechanical stimulation in that the channel cells ceased to respond after one to three minutes while the mucus response continued longer. The chemical response was somewhat inhibited by 5HT (10^{-3} M).

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LOCALIZATION OF FMRFamide-RELATED PEPTIDES IN THE SLUG, LIMAX MAXIMUS, AND THEIR EFFECTS ON THE ISOLATED CROP AND PENIS. K.G. Krajniak, M.J. Greenberg, K.E. Doble* and D.A. Price*. Whitney Lab., Univ. of Florida, St. Augustine.

Both FMRFamide (Fa) and pyroGlu-Asp-Pro-FMRFamide (pQDP-Fa) were identified in extracts of slug brain by RIA and by HPLC elution-time. Neurons containing immunoreactive Fa were demonstrated in the brain, crop and penis by immunohistochemistry; the density of fluorescent fibers was especially high in the crop. The spontaneous activity of the isolated, perfused crop was inhibited by both Fa and pQDP-Fa, and by ACh and low doses of 5HT; only the peptide SCP_B augmented tone and rhythmicity. The isolated penis was usually quiescent, but rhythmical contractions could be induced by 5HT, Fa or pQDP-Fa. The two peptides modulated 5HT-induced motility, but the effects were phasic and variable. Low doses of SCP_B inhibited penile contractions. These data and others suggest that the Fa-like peptides may have the role of suppressing digestive motility and behavior while stimulating male reproduction. Moreover, SCP_B seems to have an opposite action. These relationships are likely to be characteristic of pulmonate snails in general. Supported by NIH grant HL 28440 to MJG.)

COMPARISON OF MYOTUBE AND MYOFIBRILAR PROTEINS FROM AXOLOTL, NEWT, XENOPUS, AND CHICKEN. R.N. Fontaine*, A.R. Hilgers*, and J.A. Cameron. Univ. Illinois, Urbana.

We obtained muscle proteins from adult muscle, or from myotubes and fibroblasts cultured *in vitro* from three amphibians: larval axolotl, Ambystoma mexicanum; adult newt, Notophthalmus viridescens; and larval Xenopus laevis. Proteins were electrophoresed on SDS gels along with chicken myofibrillar proteins and MW standards. Myosin and actin were the predominant proteins. Proteins migrating with chicken C-protein and small amounts of filamin were also present. Proteins in axolotl, newt, and Xenopus migrated near chicken tropomyosin and they also stained a characteristic olive green with silver stain. However, while there was more of the 35Kd band in chicken myofibrils, the 32Kd band predominated over the 35Kd band in the axolotl. The single green band from the Xenopus migrated slightly faster than the 32Kd band in chicken myofibrils. α -actinin, desmin and proteins more than 250Kd were present in all three amphibians. The myotubes which developed from the primary cultures also had proteins which migrated with proteins described above. In conclusion, muscle from the three amphibians and the chicken have similar quantities and distribution of proteins.

CLOSER MUSCLE APODEME TENSION RECEPTORS IN THE BLUE CRAB CALLINECTES SAPIDUS: H. B. Hartman and B. A. Moulton*. Texas Tech Univ., Lubbock.

Receptors responsive to muscle tension have been located on the closer muscle apodemes of the walking and swimming legs, and the chelipeds of the blue crab Callinectes sapidus. Those of the walking legs have been investigated in detail using neurophysiologic techniques. That they signal tension information is supported by observations that the receptors 1) are unresponsive to passive unopposed movements of the dactyl, 2) respond to isotonic contractions when the dactyl is lifting a load, 3) fire during isometric contractions, 4) abruptly cease firing when isometric contraction is halted by quick release to allow muscle shortening against no load. Individual units show a variety of thresholds including some which respond to tensions of less than one gram. Cobalt backfilling of the tension nerve reveals 25-35 bipolar cells whose cell bodies measure between 25-60 μ m. The axons form a discrete nerve which joins the PD organ nerve. Reflexes evoked during walking and originally attributed to PD organ input alone will probably require reevaluation.

LANTHANUM BLOCKS EXCITATION BY FMRFAMIDE AND 5HT IN THE VENTRICLE OF BIVALVE, MERCENARIA MERCENARIA. C.L. Devlin. Univ. of Rhode Island, Kingston.

The mechanism of cardioexcitation in the bivalve heart by molluscan neurocrines, FMRFamide and 5HT was investigated using intracellular electrodes and sucrose gap techniques. These neurocrines enhanced the amplitude and frequency of cardiac action potentials and coupled force in a dose-dependent manner. Both substances affected the ventricles at parallel concentrations. Spike potentials were especially sensitive to changes in extracellular calcium, more so than other ions. 27 mM calcium slightly potentiated the amplitude of the spike potential, while calcium-free salines caused the cessation of all electrical and mechanical activity of the hearts. 10^{-3} M lanthanum blocked excitation as typically induced by FMRFamide and 5HT; this block was partially overcome by increasing extracellular calcium. This data indicates that FMRFamide and 5HT may activate receptors of the ventricle which enhance membrane conductance to calcium ions. This would explain the immediate increase in cardiac action potentials and contractility when in the presence of these neurocrines.

THE MOLLUSCAN NEUROPEPTIDE, SCP_B, INCREASES THE RESPONSIVENESS OF THE FEEDING MOTOR PROGRAM OF LIMAX MAXIMUS. D.J. Prior, W.H. Watson and S.D. Hess. Univ. of Kentucky, Lexington, and Univ. of New Hampshire, Durham.

We have studied the effect of SCP_B on the fast salivary burster neuron (FSB) and the feeding motor program (FMP). When the isolated CNS is exposed to 2 μ M SCP_B there is a rapid 3 to 4 fold increase in the burst frequency of the FSB. The response is dose dependent with a threshold concentration of 2×10^{-8} M. The effect of SCP_B was reversed within 10 min by perfusion with 1.0X saline. The response of the FSB was sustained during longterm (20 min) exposure to SCP_B. The cyclical motor output of the FMP can be initiated by stimulation of a lip nerve. When the CNS was perfused with 2 μ M SCP_B a previously subthreshold stimulus could initiate a complete FMP. SCP_B-immunoreactive substance occurs in several groups of buccal ganglion neurons and in the neuropile. Thus an SCP_B-like substance appears capable of modulating the neural network that generates the feeding motor program in Limax.

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CHEMICAL MEDIATION OF SCAVENGING AND PREY SEARCH IN POST-LARVAL LOBSTERS (HOMARUS AMERICANUS). P.C. Daniel
Univ of Maine, Orono.

We determined whether lab-reared 4-7th stage lobsters are attracted to prey extracts and live prey leachates and attractant types using a rapid behavioral bioassay. Attraction to herring extract was confined to primary amine containing fractions after removal of peptides and proteins. Treatment of herring extract with a protease enhanced response. Similar responses were obtained to equimolar extracts of Asterias vulgaris, Mya arenaria, Mytilus edulis, and Cancer irroratus. Of the live prey soaks only full-strength Asterias vulgaris elicited a significant but weak response. Scavenging appears to be a "generalist" behavior probably mediated by amines/amino acids, while little chemical attraction to live prey occurs in recently settled cryptic lobsters unlike older field-collected lobsters. Increase in chemoattraction to live prey may be through predatory experience or development.

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DIETARY PROTEIN SELECTION BY THE DEER MOUSE, PEROMYSCUS MANICULATUS.

L. DeLuca, Clemson University, S.C.

To determine the effects of cold temperature and short photoperiod on protein intake, dietary self-selection patterns were studied in 2.5 to 4 month old laboratory-reared P. maniculatus maintained at either 12°C (8L:16D) or 23°C (13L:11D). Mice were permitted to select freely from isocaloric diets of low (5%) or high (45%) protein content, and their protein intake and total caloric intake (per gram body weight) were monitored for two weeks. Compared to females at 23°C, females at 12°C selected a higher percentage of energy as protein (%PE). Males at 12°C, however, selected a lower %PE than their 23°C counterparts. Although all mice consumed significantly more energy at 12°C, the differences in the %PE were reflected primarily in the amount of high protein diet selected whereas the differences in the total energy intake were more apparent as increases in the amount of low protein diet selected. This study was conducted as part of an effort to assess the importance of winter protein restrictions to daily torpor of P. maniculatus.

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GROWTH AND BLOOD CHEMISTRY OF DUCKLINGS REARED ON ACIDIFIED WETLANDS. B. Rattner, G. Haramis*, G. Linder and D. Chu*.
Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, Laurel, MD.

Acid deposition is one factor that may be responsible for the decline of some waterfowl populations. Growth and physiological condition were monitored in captive-reared black ducks (Anas rubripes) exposed for 10-day trials (day 11-20 of life) on control (pH 6.8) and acidified (pH 5.0) man-made emergent wetlands. Impaired growth (body weight, culmen and tarsus length) and increased mortality (50%) were apparent in broods (hen + 4 ducklings) reared on acidified wetlands. Ducklings exhibiting poor growth had reduced hematocrit, plasma protein and cholesterol levels. This subset of birds had elevated plasma uric acid concentration and creatine kinase activity (perhaps due to enhanced protein and nucleotide catabolism), and elevated plasma K⁺ levels. Based upon overt appearance, growth and blood chemistry, ducklings exposed to acidified wetlands were concluded to be in poorer condition than those exposed on circumneutral pH wetlands.

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SEMILUNAR SPawning CYCLES OF THE GULF KILLIFISH, FUNDULUS GRANDIS, IN CLOSED CIRCULATION SYSTEMS. Shyh-Min Hsiao* and Albert H. Meier. Louisiana State Univ., Baton Rouge.

Gulf killifish, Fundulus grandis, spawned daily in aquaria of closed circulation systems held on 12-hour daylengths and 23°C. However, the number of eggs spawned during a 24-hour period varied greatly from one day to another. Statistical analyses of the data revealed the presence of 13-day cycles of spawning in 5 of 7 aquaria that persisted for as long as 4 months without obvious external synchronization. Because each aquarium usually held 21 females, the existence of 13-day cycles indicates that there was synchronization within each group. There was also synchronization of 13-day cycles among aquarium groups that had a common recirculating water supply. Although the 13-day cycle may be essentially an endogenous free-running semilunar rhythm, exogenous timing of this cycle is supported by its precision over a long period and by a strong coherence of the spawning cycles and high tide cycles on the Louisiana Gulf coast.

THE RESPONSE OF WORKERS TO THERMAL STRESS IN HONEYBEE COLONY THERMOREGULATION. F.D. Vogt and B. Heinrich. SUNY, Plattsburgh and Univ. of VT, Burlington.

Do workers respond behaviorally to change in body temperature or to change in hive temperature? The thoracic temperature (T_{th}) of workers in an observation hive were taken when various areas of the hive were heated or cooled. The temperature of the brood at the periphery of the hive (T_{per}) ranged from 32-38°C as the air temperature surrounding the hive was increased from 10-41°C. The T_{th} of bees at the periphery approximately equalled T_{per} despite locally heating or cooling other areas of the hive. When T_{per} was locally increased, the incidence of thermoregulatory behavior increased until workers abandoned the heated area at $T_{per} > 46°C$. At $T_{per} = 41-44°C$, the T_{th} of bees which continuously performed thermoregulatory behaviors were typically 1-2°C higher than those bees which performed no prolonged bouts of thermoregulatory behavior. These findings suggest that thermoregulatory behavior is cued by local thermal conditions. However, changes in behavior may be influenced by body temperature. Supported by NYS/UUP PDQWL New Faculty Development Award and NSF grant DEB-816662.

INCUBATION TEMPERATURE AFFECTS THERMAL SELECTION OF HATCHLING CROCODILES.

J.W. Lang. University of North Dakota, Grand Forks, N.D. 58202

Eggs of Crocodylus siamensis were incubated at constant temperatures of 32.5 and 28°C. The two groups of hatchlings were housed in separate but identical thermal gradients (land-water 20-40°C continuous; 12L:12D) for 30 days, then placed together in the same gradient for 60 days. Hatchlings were not fed, then fed for alternating 10 day periods. Body temperatures (T_b s) were monitored at intervals each day (40 T_b s/animal/10 day). In comparison with alligators, hatchling Siamese crocodiles selected high T_b s and did not respond to feeding with higher T_b s as alligators did. Crocodiles incubated at 32.5° selected significantly higher T_b s than did those incubated at 28° (whether each group was housed alone or together). These hatchlings were siblings, but differed in sex (32.5° produces males; 28° produces females). Thus, incubation temperature determined hatchling sex; and incubation temperature and/or sex influenced their subsequent thermal selection. The thermal regime during incubation may affect various physiological parameters of the hatchlings in addition to determining sex.

HYDRIC CONDITIONS DURING INCUBATION INFLUENCE LOCOMOTOR PERFORMANCE OF HATCHLING SNAPPING TURTLES.

K. Miller, G. C. Packard, and M. J. Packard. Franklin and Marshall College, Lancaster, PA and Colorado State Univ., Fort Collins.

Locomotor performance of hatchling snapping turtles (Chelydra serpentina) was assessed while turtles were running on land and swimming in water. Turtles from eggs incubated on a relatively wet substrate were faster, on both absolute and relative scales, than those from eggs incubated on a relatively dry substrate. The improved locomotor performance of hatchlings from eggs incubated on the wet substrate was beyond that expected from their larger size. The improved performance persisted after turtles from both groups were fully hydrated, indicating that it was not the result of differential dehydration. Turtles from eggs incubated on the relatively wet substrate, despite moving more quickly, accumulated lactate more slowly than turtles from eggs incubated on the dry substrate. These observations may provide a physiological basis for the improved survivorship of larger reptile hatchlings.

(Supported by NSF DCB-8308555)

ACTIVATION OF CYTOCHROME OXIDASE BY PHOSPHOLIPIDS FROM THERMALLY ACCLIMATED CRAYFISH. G. L. Hodge* and N. P. Neas. Colgate Univ., Hamilton, NY.

The fatty acyl moieties of most membrane phosphatides from hepatopancreas tissue of both winter-active (Cambarus bartoni) and winter-quiescent (Orconectes propinquus) crayfish become more unsaturated following acclimation to 5° (CA) vs 20° C (WA). In both species, cardiolipin (CL), a phosphatide confined to the inner mitochondrial membrane and an essential cofactor for mammalian cytochrome oxidases (CO), exhibits the opposite trend becoming more saturated following cold acclimation. The role of CL in activating crayfish CO was investigated by assaying the enzyme isolated from WA or CA crayfish in both a lipid-depleted form (acetone powder) and following addition of different lipid fractions from acclimated crayfish. In lipid-depleted form, CO activity is low (velocity constant, $K \sim 0.03$ [mg·min]⁻¹). CL enhanced CO activity from WA and CA animals in both winter-active and winter-quiescent species, with CL from CA animals more effective than CL from WA animals. Total phospholipid extracts and phosphatidylcholine extracts had little effect on CO activity. Thus, temperature-induced restructuring of CL may reflect its role as a cofactor for membrane-bound enzymes as opposed to a homeoviscous adaptation.

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TEMPERATURE, pH AND PRESSURE EFFECTS ON LACTATE DEHYDROGENASES OF VERTICALLY MIGRATING MIDWATER FISHES. P.H. Yancey, W. Bement* and M. Maier*. Whitman College, Walla Walla, WA.

Many species of mesopelagic fishes are known to migrate into surface waters at dusk and to depths of 400-800m at dawn, thus undergoing large temperature and pressure changes in a short period. M_4 -lactate dehydrogenases (LDH) were purified from muscles of 3 species of migrators: the lanternfishes (Myctophidae) Tarletonbeania crenularis and Stenobranchius leucopsarus, and the viperfish Chauliodus macouni (Chauliodontidae) (smaller individuals of which migrate). The apparent pyruvate K_m values of all 3 species were found to be insensitive to hydrostatic pressure from 0-200 atm, but those of T. crenularis rise above this, a response not before seen in studies of LDHs and pressure. In addition, pyruvate K_m values show little or no change with temperature (5-17°C) in imidazole buffer, in contrast to LDHs of all other vertebrates (15 spp.) examined (only in constant-pH buffer do these LDHs behave as do other vertebrate LDHs in imidazole). If these fish exhibit "alphastat" pH regulation (mimicked by imidazole), LDH function in vivo may be constant during migration.

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ABSENCE OF RESONANCE MODULATION IN NON-HUMAN VOICES. Abbot S. Gaunt & Thomas E. Hetherington. Ohio State Univ., Columbus.

The modulations of human voice that produce the different vowel sounds are effected by changing the shape, hence the resonant properties, of the vocal tract. In contrast, avian voices are modulated by changing the properties of the vocal organ. If humans change the resonance of the vocal tract by breathing He/O_2 , their voices are dramatically altered, and lip whistling is difficult, but the calls and whistles of birds are scarcely affected by helium. For a lark, we tested some amphibians and mammals. The voices of Hyla crucifer and Felis catus were not altered by helium. The clicks, whistles and lowings of the dolphin, Tursiops truncatus, are also unaffected (Ridgeway & Evans, pers. comm.). Observed changes in the calls of Hyla versicolor could not be definitely attributed to helium.

If resonance modulation should be generally absent from non-human tetrapods, especially mammals, then human voice is more peculiar than generally supposed, and the evolution of human languages, with all their cultural import, even more intriguing.

Research continues even as this abstract is submitted.

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EVOLUTION AND MORPHOLOGICAL DIVERSITY OF THE LATERAL LINE SYSTEM IN FISHES. J.F. Webb. Boston University, Boston, MA.

The morphological diversity of the mechanoreceptive lateral line system was examined by surveying the systematic literature. Gross morphological features were superimposed on established systematic schemes in order to determine the contribution of phylogenetic and developmental constraint to morphological diversity. The cephalic lateral line canals show four evolutionary trends: highly ramified branching (hypothesized primitive osteichthyan character), canal reduction and replacement by superficial neuromasts (via paedomorphosis, in 10 euteleostean lineages), widening of the canals, and sinus formation with the loss of pores (unique to Osteoglossomorpha). Trunk canal patterns fall into 5 categories: complete, incomplete, disjunct, multiple and absent. The taxonomic distribution of these patterns suggests pathways along which they could have been derived. Functional hypotheses generated as a result of this survey indicate that the head canal and trunk canal morphologies may be subject to different selection pressures: increased sensitivity to stimuli originating from prey or predators and precise detection of hydrodynamic stimuli in actively swimming fishes, respectively.

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DISTRIBUTION OF MUSCLE FIBER TYPES IN THE AVIAN PECTORALIS. B.W.C. Rosser and J.C. George. Univ. of Guelph, Guelph, Ontario.

The distribution of fiber types in the pectoralis muscle (PM) of 45 species of carinate birds and two species of ratites is described. The carinate PM consists almost entirely (99-100%) of red (aerobic) and/or white (anaerobic) fast-twitch fiber types. Slow fiber types are rare, and are restricted to the deepest craniodistal fasciculi. In those carinates having both red and white fibers, there is a higher proportion of red fibers in the deeper areas of the PM. This distribution is comparable to that of other vertebrate locomotory muscles, and is an adaptation for flapping flight. A deep belly of the PM has been found in cathartid vultures (Fisher 1946). This belly consists entirely of slow fibers, and is an adaptation for soaring flight. In the ratite PM, slow fibers are widely distributed in large numbers (< 39%). This could represent the ancestral avian PM, neoteny or an effect of flightlessness. Extensive anaerobic areas of the ostrich PM are probably utilized during behavioural displays. (Supported by NSERC of Canada).

ACETYLCHOLINESTERASE AND THE ZONAL ORGANIZATION OF THE CEREBELLUM. B.L. Brown (intro. by J. Besharse). Emory Univ., Atlanta.

Voogd (1964,1969) has suggested that mammalian cerebellar cortex can be subdivided into parasagittally oriented zones. Each zone receives climbing fiber input from a unique part of the inferior olivary complex and projects to a single cerebellar nucleus. Brown and Graybiel (1983) have shown that boundaries visible in acetylcholinesterase (AChE)-stained sections of cat cerebellum mark edges of certain connectional zones. Sections from the cerebella of various species were AChE-stained to determine whether AChE is present in a zone-like pattern. Although there are marked variations in the laminar distribution of AChE between species, in all mammalian species examined to date (chimpanzee, squirrel monkey, rhesus monkey, rabbit, rat, guinea pig, hamster, and mouse) there is some indication of zonality in the distribution of AChE-positive elements. Determination of whether this zone-like distribution of AChE staining marks boundaries of connectional zones in species other than cat will require use of tract-tracing methods combined with AChE staining. Supported by a grant from the Emory University Research Committee.

DEVELOPMENT OF ZONAL ORGANIZATION IN THE CEREBELLUM OF THE SYRIAN HAMSTER. R.P. Ierardi and B.L. Brown (intro. by S. Herring). Emory Univ., Atlanta.

The experiments reported here are part of a study designed to investigate the factors which produce the zonal pattern of connectivity in mammalian cerebella. Hamsters were used because of their short gestation period (16 days), resulting in cerebella which are very immature at birth. Cell-stained sections through the cerebella of animals sacrificed at various postnatal ages were examined, with particular attention being paid to indicators of zonal organization. At the time of birth (P0) the hamster cerebellum is unfoliated, and prospective Purkinje cells (PCs) and deep nuclear neurons are still partially intermingled. However, there is already some hint of zone-like PC clustering which persists through P1, when the developing PC layer is clearly demarcated from the deep nuclear mass. Prior reports (Oster-Granite and Herndon, 1976) suggest that afferent fibers may not arrive in the cerebellum until P2, raising the possibility that the initial events leading to formation of cerebellar zones take place in an uninnervated cerebellum. Supported by a grant from the Emory University Research Committee.

LOCALIZATION AND HISTOLOGY OF THE OVIDUCTAL SPERM-STORAGE TUBULES (SST) IN THE AMERICAN KESTREL. M. R. Bakst and D. M. Bird (intro. by G. Gee). USDA, Agricultural Research Service, Beltsville, MD, and McGill Univ., Quebec.

Although oviductal SST have been investigated in domesticated birds, the presence of SST in nondomesticated birds has been questioned. By adapting techniques used for the localization and histological preparation of turkey SST, we have localized and histologically characterized the SST of the American kestrel. The SST were located at the anterior end of the vagina and appeared as tubular structures. The SST epithelium was nonciliated and possessed secretory capability as indicated by a moderately positive PAS reaction product. Infundibular glandular grooves and tubular invaginations, known secondary sperm-storage sites in the anterior-end of the turkey oviduct, were present in the kestrel. Because the kestrel exhibits a high copulation rate during the breeding season, the precise role of the SST is unclear. However, as artificially inseminated females remain fertile for about 8 days, we assume sperm are maintained in the SST.

CRANIAL KINESIS IN NILE MONITOR FEEDING. K. Condon. University of Illinois at Chicago.

Cineradiographic studies by various authors find no evidence of movement within the dermatocranium of the potentially kinetic lizard skull. However, this technique has limited resolution and its use has been restricted to the ingestion phase of feeding. In this study, slotted mounts were affixed to the parietal and frontal bones of a 1.5 kg Nile monitor. Flexible extensions which exaggerate the relative movement of the bones were attached to the mounts. All phases of feeding on a laboratory mouse were filmed. Prior to the strike and concomitant with jaw opening, the muzzle is slightly elevated (2-3 degrees). During the strike both jaws are adducted simultaneously. Immediately after the strike the muzzle is ventroflexed 5 degrees past the resting position. Ventroflexion is maintained throughout the prehension and ingestion of the mouse. Only after the prey item has passed into the esophagus do the cranial elements return to their resting position. Mesokinesis does occur in the Nile monitor and involves movement of the palato-maxillary unit relative to the parietals.

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METAMORPHIC DEVELOPMENT OF THE AMPHIBIAN MIDDLE EAR: FUNCTIONAL IMPLICATIONS. T.E. Hetherington, Ohio State Univ., Columbus.

Several functions have been proposed for the opercularis system (otic operculum and opercularis muscle) of the amphibian ear. Two major hypotheses are: 1) modulation of responsiveness of the tympanum-stapes complex of the middle ear to aerial sound, and 2) involvement in seismic reception. The development of both systems was studied in 8 species of frogs of 3 families (Bufonidae, Hylidae, and Ranidae). In all species the opercularis system is fully developed by the time of emergence of the forelimbs, a general indication of the onset of terrestrial activity. Timing of development of the tympanum-stapes complex is variable and corresponds with body size. Only in the largest ranids were the tympanum and stapes fully developed by the end of metamorphosis. In the remaining species this complex completed development after varying periods of time and significant increases in body size. The tympanic ear of smaller hylids was complete in frogs approaching adult body sizes. The developmental independence of the opercularis system and tympanum-stapes complex suggests functional independence. Supported by NIH grant 1-R23-NS21998.

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INTRASPECIFIC VARIATION IN THE HINDLIMB MUSCULATURE OF THE HOUSE SPARROW. S.L. Berman, M. Cibischino*, P. Dellaripa*, L. Montren*. College of the Holy Cross, Worcester, MA.

How confident can we be in the accuracy of anatomical descriptions based on the dissection of only a few specimens? There is abundant evidence from anatomical teaching labs that it is not uncommon to find specimens that differ from the condition described for that species. As time constraints and availability of specimens usually preclude the use of large sample sizes by morphologists, there is always the possibility that a species has been characterized by an anomalous specimen. We dissected the hindlimb muscles of 40 English Sparrows. Among the variations were: (1) *M. iliofemoralis*, normally absent in passerines, present in 1 specimen; (2) *M. puboischiofemoralis* had an "extra" head in 10 of the 40 specimens; (3) *M. flexor hallucis longus* had 3, as opposed to 2, heads in 22 specimens; (4) 1 specimen had an unusual relationship between tendons of *Mm. fibularis longus* and *flexor perforatus digiti III*. It is doubtful that such results will promote use of larger sample sizes in anatomical studies, but they may foster an awareness that such variation exists.

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DISTRIBUTION OF CATECHOLAMINES IN THE BRAIN OF THE GOLDFISH, *CARRASSIUS AURATUS*: AN IMMUNOCYTOCHEMICAL STUDY USING ANTIBODIES TO TYROSINE HYDROXYLASE. P.J. Hornby, D.T. Piekut* and L.S. Demski Univ. of Rochester, N.Y., and Univ. of Kentucky, Lexington.

Catecholamine distribution was demonstrated using antibodies to tyrosine hydroxylase and the Avidin-Biotin-Peroxidase (ABC) method of immunocytochemistry. This enabled direct visualization of the dark brown immunoreactive product within cell bodies and fibers. In brainstem small bipolar cells were clustered in the central medulla at the level of the commissural nucleus of Cajal; scattered cells lay close to the vagal motor nucleus. In hypothalamus larger dark-staining cells were concentrated along the third ventricle, many within the anterior tuberal nucleus. Fibers ran parallel to the third ventricle. Dark-staining cells were found throughout the periventricular preoptic nuclei, fibers could be traced laterally into the telencephalon. The distribution is consistent with that found in other teleosts using the less sensitive Falck-Hillarp histofluorescence method (Parent, 1983).

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HISTOCHEMISTRY OF THE FLIGHT MUSCLES IN A PHYLLOSTOMID BAT. J.W. Hermanson and R.C. Foehring, Emory Univ., Atlanta, GA. and Univ. of Florida, Gainesville.

Previous studies on flight muscles in free-tailed bats (*Tadarida brasiliensis*) have indicated that the primary muscle powering the downstroke, the pectoralis, is composed entirely of fast-twitch oxidative fibers. To examine functional specialization in a bat exhibiting different flight behaviors and with a different wing morphology, we studied fiber type composition of the primary flight muscles in a fruit-eating bat, *Artibeus jamaicensis*. We assessed histochemical staining properties for myosin ATPase, α -GPD, and NADH-TR. In the pectoralis of *Artibeus*, two fast-twitch fiber types were indicated by the acid preincubation protocols for myosin ATPase. All fibers exhibited high staining levels for NADH-TR, and relatively low staining levels for α -GPD. We conclude that the pectoralis muscle of *Artibeus* has two motor unit populations that may be recruited independently and/or in combination and permit a finer degree of motor control than is possible in the fast flying *Tadarida*. Supported in part by an Emory Univ. Research Award and by NINCDS NS15913.

THE CORRELATION OF EXPERIMENTALLY APPLIED LOADS WITH THE ARCHITECTURE OF CANCELLOUS BONE IN THE FEMUR OF DEVELOPING MICE. K.R. GORDON. Florida International Univ.

Experimentally applied loads changed the size, shape, and location of trabeculae in the proximal femur of actively growing mice. Tensile and compressive loads were applied at age 21 days for a period of at least 30 days. Tensile loads were applied to the femur by attaching to the ankle a weight cuff of approximately 50% of the normal compressive support load. Compressive loads were applied in two ways. The first was by exposing the mice to 2X normal gravity in a hypergravity chamber for one hour/day (10 min. x 6 episodes). The second was by attaching a cuff to one leg which caused the mice to favor the opposite leg for support. On initial examination with the scanning electron microscope tensile loading caused an increase in size of an obliquely patterned series of trabeculae on the medial aspect of the proximal one third of the shaft. Compressive loading caused a dramatic increase in size and numbers of trabeculae traversing the lateral shaft of the femur. It appears that with this latter configuration of trabeculae the shaft under compression would resist buckling to a greater degree than the controls.

PROXIMAL CAUSES OF NATAL DISPERSAL IN BELDING'S GROUND SQUIRRELS. K. E. Holekamp. University of California, Berkeley.

I tested nine hypotheses, each suggesting a different social, ecological, or ontogenetic factor as a proximal cause of natal dispersal behavior in two California populations of Spermophilus beldingi. The data failed to support hypotheses suggesting resource shortage, ectoparasite load, population density, social facilitation, conspecific aggression, or avoidance by conspecifics as proximal causes of natal dispersal in this species. The data supported an "ontogenetic switch" hypothesis which suggests that natal dispersal by male S. beldingi is triggered by attainment of a particular body weight, body composition, or some combination of these two variables.

PHOTOPERIODIC RESPONSES IN LACTATING VOLES AND DEVELOPING PUPS. T.M. Lee, L. Smale, J. Dark*, and I. Zucker*. Univ. of California, Berkeley.

Several studies tested the hypothesis that pregnancy and lactation ameliorate the effects of short daylengths on energy balance of voles. Lactation and gestation prevented the weight losses, food intake decreases and appearance of the winter pelage in Microtus pennsylvanicus housed in short photoperiods. Litter weight, but not number of pups was decreased for females kept in a short daylength for 2 wks prior to mating. The pregnancy rate was decreased by 50% for females housed in short days for 8 wks prior to mating. Pups born to females housed in short days displayed delayed puberty, reduced body size, increased nest size and increased pelage development. The normal winter pelage development of female voles housed in short days was blocked by PRL injections; therefore, effects seen in lactating voles may be due to high PRL levels induced by suckling young.

PATTERNS OF HOUSE OCCUPANCY IN WOODRATS: EFFECTS OF SEX AND AGE. M.A. NEWTON. ARIZONA STATE UNIVERSITY, TEMPE.

I examined patterns of house placement and occupancy by woodrats (Neotoma albigula) on a 9.9 ha site in the Upper Sonoran desert for 2 years. Nearest-neighbor analysis of 132 active and 15 inactive woodrat-houses indicated that nonrandom placement of houses was mostly explained by environmental heterogeneity. House occupancy and visitations by other woodrats were documented by trapping. While characteristics of residents appear to have some effect on house placement, they exert a strong influence on patterns of house occupancy. Adult males were separated by greater distances than were females or heterosexual pairs. Houses separated by very small distances were occupied by young and putative mothers. These data imply a polygynous mating system for N. albigula. Visitation data is consistent with predictions from this hypothesis. Adult males visit females of reproductive age. Mature females seldom visit the houses of adult males, but instead are often found at homes of juveniles. In this species, patterns of house occupation by sex and age groups probably reflect male competition for mates and extended maternal care.

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TERRITORIALITY AND MATING SYSTEM OF CALIFORNIA VOLES, MICROTUS CALIFORNICUS. R.S. Ostfeld. Univ. of California, Berkeley.

Radiotelemetry was used to examine space use by California voles before and after the provision of supplemental food. Experiments were performed at high and low population density. The sexes had similar home range core areas, but males had larger peripheral areas. Home ranges of females, but not of males, shrank after food provisioning. Some females shifted their home ranges to encompass more of the provisioned area. Home ranges of males, but not of females, were smaller during high than low density. Home ranges of females often overlapped extensively with each other, and nest-sharing was observed. Supplemental food induced overlap between females that had not previously overlapped. Males showed very little overlap with each other, and this was not affected by the addition of food. Males rapidly occupied home ranges abandoned by adjacent males. Males and females overlapped with each other extensively, but access to females was unequal. I conclude that male M. californicus are strongly territorial, but that females are non-territorial. Mating is probably polygynous, and the most likely mode is female defense.

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MOTHER-OFFSPRING DYNAMICS IN THREE GROUND SQUIRREL SPECIES. L.S. Rayor. Univ. of Kansas, Lawrence.

This study describes, quantifies, and comparatively analyses changes in the mother-offspring relationship during the first summer of life in the Gunnison's prairie dog (Cynomys gunnisoni), and the Columbian and 13-lined ground squirrels (Spermophilus columbianus, S. tridecemlineatus). C. gunnisoni adult males and females are amicable, interactive, tolerant, and in close association with their offspring, and other intraharem young, throughout the summer. Litters within a harem readily intermingle. Mothers and young share the natal burrow through the summer, and sometimes into the yearling summer. S. columbianus maternal-offspring interactions are infrequent, but mostly amicable. Adult male interactions with young were rare. Litters mingle, but interaction and play markedly decline by mid-summer. Young often move out of the maternal burrow. S. tridecemlineatus lives in aggregations, but it is essentially asocial. Mothers actively avoid their young, which disperse 2 to 3 weeks after weaning. My data support current hypotheses which suggest that increased sociality is a means of investing in offspring by promoting cohesion, which is a proximal factor in delaying dispersal.

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DEVELOPMENT OF DIAPTOMUS SHOSHONE NAUPLII (CALANOIDA; COPEPODA) ON A VARIETY OF ALGAL FOODS. N.M. Butler, University of British Columbia, Vancouver.

A population of Diaptomus shoshone in a Colorado alpine lake was observed to have a distinct separation into adult and nauplii swarms positioned in different areas of the lake. It appeared that the location of adult swarms was related to the algal-rich meltwaters from shoreline snow banks and that adults utilized snow algae as a supplemental food source. However, nauplii did not appear to position swarms in meltwater areas, raising the question as to whether nauplii recognized and could utilize snow algae as a food source.

To test this hypothesis, nauplii hatched in the lab from resting eggs were raised under 4 separate food treatments: no food (starvation), snow algae (Chlamydomonas nivalis), and either of 2 planktonic algae (C. reinhardtii and Cryptomonas reflexa). Rate of growth, time in each instar, lipid content, and mortality were compared between treatments. Starved nauplii grew to N-3 stage with rapid depletion of lipid reserves. Fed nauplii developed into the copepodite phase. Size of fed nauplii differed between treatments, while lipid content, growth rate, and mortality were similar. Implications of the findings to oligotrophic alpine ecosystems will be discussed.

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RAINFOREST LEAF-LEACHATE TOXICITY AND SURVIVORSHIP OF STREAM-DWELLING ATYID SHRIMP IN EL VERDE, PUERTO RICO. A.P. Covich. Univ. of Oklahoma, Norman.

Leaf leachates caused differences in mortality of Xiphocaris elongata and Atya lanipes in lab and field tests. Seven of 12 tree species resulted in 40 to 100% mortality of Xiphocaris whereas only two (Homalium and Nectandra) caused high mortality in Atya. Xiphocaris displayed an increased jumping/leaping behavior and attempts to leave the water. During prolonged dryness leaf fall increases in some tree species that have toxic secondary compounds (i.e. alkaloids) in their leaves. When stream pools are reduced in water volume and flow these inputs result in low levels of oxygen and high levels of toxic chemical compounds. Inputs from fruits and seeds also may selectively eliminate some species of crustaceans and other arthropods in first- and second-order streams that drain areas with a closed-forest canopy. Recolonization of these pools would be influenced by timing of heavy rains that dilute toxins and increase dissolved oxygen.

COMPARATIVE POPULATION ECOLOGY OF AN INSECT FROM ALKALINE SALT LAKES. D.B. Herbst. Oregon State Univ., Corvallis.

Surveys of salt lakes have in general shown species diversity declines as salinity increases, while productivity is highest at moderate salinity. Abundance is supposed reduced above physiologically limiting high salinities, and at dilute salinities where ecological limitations are imposed on salt-tolerant species by interactions with a more diverse biota. To examine the associations of salinity and biotic diversity with abundance of a halotolerant osmoregulator, populations of the alkali fly *Ephydra hians* (Diptera: Ephydriidae) were compared between two Great Basin lakes. Abert Lake is a low salinity lake (20-30 g/l TDS) with more co-inhabiting species than the high salinity Mono Lake (75-90 g/l). Decreasing salinity in both lakes over the period of study coincided with relative abundance decreasing at Abert and increasing at Mono. These results conform to the hypothesis that abundance of salt-tolerant species will be maximum at intermediate salinity. Experimental exposures to increased salinity or limited food supply produced low survival, reduced body size, and prolonged development. Alkali fly dynamics may thus be partially regulated by salinity effects on life history traits.

FACTORS CONTROLLING NATURAL INFECTION LEVELS OF FRESHWATER SNAILS BY LARVAL TREMATODES. Kenneth M. Brown*, E. K. Leathers† and D. Minchella*. Louisiana State Univ., Baton Rouge, Univ. Illinois, Champaign, and Purdue U., West Lafayette (intro. by W. Stickle). We suggest factors determining infection rates in natural populations, and present survey data supporting our predictions. Assuming infection by miracidia is random, probability of infection should increase with

(1) snail age and life cycle length, (2) declining resource levels, (3) individual shell size, and (4) snail density. A survey of populations of *Lymnaea elodes* did show higher infection levels where snails had longer life cycles due to lower food levels. Comparing across species, snails with longer life cycles and greater shell lengths usually have higher infection levels when present in the same area, as we predict.

SEASONAL PATTERNS OF TISSUE ACCUMULATION AND RESORPTION IN THE ASIATIC CLAM, *CORBICULA FLUMINEA*. F.G. Doherty. Virginia Polytechnic Institute and State University, Blacksburg.

Adult and juvenile *Corbicula fluminea* (n=100) were collected once each month from the New River in southwestern Virginia. Data recorded for each individual included shell dimensions and visceral wet and dry weights. Results indicate high degrees of correlation among shell dimensions, between shell dimensions and cube roots of tissue weights, and between tissue weights ($r > 90\%$) within monthly samples. Comparisons between samples reveal seasonal changes in visceral weight relative to shell dimensions and percent body water content. Individuals showed an 81.5% increase in visceral weight over a two month span (February to April) with all size classes demonstrating similar percentage changes in weight. Conversely, percent body water content peaked in February at 88.7% and declined steadily through May to 84.4% of total body weight in adults. These trends developed at a time when water temperatures were rapidly increasing. Both changes are thought to be associated with the commencement of reproductive activities.

CRUSHING STRENGTHS OF AGGLUTINATED AND CALCAREOUS TESTS OF BENTHIC FORAMINIFERA. K.L. Wetmore. Johns Hopkins Univ., Baltimore, Md.

Some species of benthic foraminifera secrete calcite tests while others cement sediment particles together to build their tests. The proportion of calcareous species has increased over time. One hypothesized reason for this increase is that evolution of a calcareous test permitted construction of stronger, lighter tests. Crushing strengths of individual tests were measured to examine possible correlations between test strength, habitat, and test composition. Crushing strengths of calcareous species were greater in high-energy habitats than in low-energy habitats. Also, within species, populations from high-energy habitats had stronger tests. Within the low-energy habitats there was no significant difference in test strength or weight between agglutinated species and most calcareous species. Thus, construction of a calcareous rather than an agglutinated test does not necessarily result in a stronger, lighter test.

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FLOW EFFECTS ON GAS EXCHANGE IN SOME CNIDARIANS. M.R. Patterson. Northeastern Univ., Nahant, MA.

Boundary layer thickness over aquatic organisms is modulated by flow speed. It is an important component of the diffusion path for gas exchange in invertebrates without circulatory systems. Gas exchange experiments were conducted at different flow speeds in recirculating flow respirometers using the symbiotic coral, *Montastrea annularis* in situ and the boreal sea anemone, *Metridium senile*, and octocoral, *Alcyonium siderium*, in the laboratory. Respiration rates increased with increasing flow speed in these species. The increase in respiration was related directly to the decrease in the boundary layer thickness. Production in *M.annularis* also increased with flow speed, but not proportionately as much as dark respiration. Since boundary layer thickness scales as the inverse square root of flow speed, flow-modulated gas exchange will be most important for aquatic organisms in relatively stagnant habitats subject to periodic increases in flow. Supported by NOAA Hydrolab missions 84-7 and 85-7 and by the National Science Foundation.

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SWASH-RIDING: WAVE-PROPELLED LOCOMOTION IN THE COQUINA CLAM *DONAX VARIABILIS*. O. Ellers. Duke Univ., Durham, NC.

Swash-riding animals allow themselves to be propelled shoreward or seaward by the upwash or backwash which results when a wave breaks onto the beach. Several crustaceans, gastropods, and bivalves do it. In the migrating coquina clam this movement depends on the clam's behavior, its special shape and unusually high density ($1.7-2.7 \times 10^3 \text{ Kg m}^{-3}$), and the wave flow. In accelerating flows of low turbulence this clam slides stably with the anterior (foot end) upstream. In contrast, models of other shapes (including bivalves which do not swash-ride) tumble, roll, or slide faster in varying orientations. The stability of *Donax variabilis* in flow can assure it control over where it burrows, and hence also over how far it moves. Control is crucial since forces tending to wash the clam seaward peak at 2 N and the forces tending to wash the clam out of the sand peak at 0.5 N, while a clam can only pull itself into the sand with its foot with a peak force of 0.2 N.

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FLOW-ASSISTED REFILLING OF SQUID MANTLE CAVITY. S. Vogel. Duke Univ., Durham NC

As a consequence of Bernoulli's principle, pressure is subambient lateral to a body moving through a fluid. The resulting pressure difference across the mantle of a rapidly-jetting squid will expand the mantle cavity and, by such supercharging, should increase the rate of refilling. Is the phenomenon quantitatively significant? When stationary, squid refill mainly by thinning the mantle via radial muscle contraction, producing pressure differences of about 1200-1500 Pa (from either existing estimates and measurements or my estimates based on muscle mass). A swimming speed of 4 m s^{-1} will yield as much pressure again. Since pressure difference is proportional to velocity squared, higher speeds will give much higher flow-generated pressures. Swimming speeds of at least 9 m s^{-1} are implied by anecdotal reports of predator-pursued squid landing on the decks of ships; under such extreme conditions flow-generated pressure will be the predominant agency of refilling.

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Kinematics of Forward Flight in Bumblebees. Robert Dudley Univ. of Cambridge, England.

Bumblebees in controlled free flight were filmed with a high speed camera at 5000 frames per second. An optomotor device was used to position the insects in the jet of a wind tunnel, which was operated over a range of forward velocities. Kinematics of the wing beat, including angle of the stroke plane, position of the wing tip, and oscillations of the body were calculated from a three-dimensional reconstruction of the two-dimensional film image. The variation of kinematic parameters with forward velocity and insect size was determined. Such results, in conjunction with lift and drag measurements on isolated bumblebee wings and fuselages, yield considerable insight into the aerodynamic mechanisms and power requirements of forward flight in insects.

ANTLION PIT STRUCTURE AND THE BEHAVIOR OF PREY. JR Lucas. College of William & Mary, Williamsburg, VA.

Two factors influence capture success of antlion pits: slope and grain size. The pit wall slope is asymmetric and this asymmetry is actively maintained by the orientation of the antlion; the wall behind the antlion is significantly shallower than the facing wall. This design compensates for an orientational asymmetry in the efficiency of prey capture. Antlions are more efficient catching prey that escape to the rear of the pit, while the pit is most efficient at deterring prey escaping to the front of the pit. Due to the physical properties of sand, particle size increases on shallow slopes. Antlions compensate for this by lining the rear of the pit with fine sand after the pit is excavated. The behavior of ants escaping from antlions is analyzed with respect to pit structure.

ELECTROPHORETIC COMPARISON OF REPTILIAN VITELLOGENINS. J. Zimochow and R.E. Bast, Cleveland State Univ., OH.

We analyzed by electrophoresis, plasma samples from untreated and estrogen treated animals under denatured, or denatured and reduced conditions. By comparing banding patterns of samples from treated or untreated animals we identified tentatively the constituent polypeptides of vitellogenins (Vgs) from 20 different reptilian species representing 4 of the 5 extant orders. By comparing reduced and nonreduced samples we determined the role of disulfide bonds in Vg structure. The Vgs of turtles and crocodiles are composed of at least two large polypeptides with no apparent role for interpolypeptide chain disulfide bonds. Vgs of snakes are composed of 3 to 5 polypeptides, several of which form dimers connected by disulfide bonds. Generally, the Vgs of lizards are composed of a complex set of polypeptides with one or two dimeric subunits linked by disulfide bonds. Reptilian Vgs will be compared to amphibian and avian Vgs.

RELEASE OF PROTEIN FROM ISOLATED YOLK PLATELETS OF ARTEMIA CYSTS DURING PH TRANSITIONS IN VITRO. P.J. Utterback and S.C. Hand. Univ. of Southwestern Louisiana, Lafayette.

Yolk platelets rapidly release protein (up to 9 mg/10⁹ platelets) upon alkalization of a platelet suspension from pH 6.3 to 8.0. Protein levels in both the platelets and incubation medium reach steady-state values 40-50 minutes after a pH change. The exponential release can be stopped, but not reversed, by reacidification. Plotting protein liberated versus pH gives a sigmoidal titration curve, with an inflection point at pH 7.2 and maximal release (80% of total platelet protein) at pH 8.0 to 8.4. Temporally associated with this biochemical change is a reduction in platelet dry weight from 7.5 mg/10⁹ platelets at pH 6.3 to 3.3 mg at pH 8.6 (51% reduction). Diameter decreases from 2.40 ± 0.05 μm (SE, n=346) at pH 6.3 to 1.89 ± 0.06 μm (n=342) at pH 8.0, representing a 51% volume change. Since the transition from anaerobic dormancy to aerobic development in Artemia is promoted by alkalization of intracellular pH, protein mobilization from yolk platelets may be a feature of this activation event. Supported by NSF Grant DCB-8316711

ISOLATION AND CHARACTERIZATION OF SNAKE VITELLOGENIN. B.F. McArdle and R.E. Bast (intro. by F.P. Doerder). Cleveland State Univ., OH.

The yolk protein precursor, vitellogenin (Vg), was purified from plasma of the common garter snake, Thamnophis sirtalis, by ultracentrifugation, Mg-ion precipitation, and ion exchange chromatography. Vg was obtained with no detectable impurities. Vg and each of its constituent polypeptides were injected into rabbits. Antiserum to Vg was used on Western immunoblots of denatured plasma samples to identify Vg polypeptides. Four polypeptides reacted with the antiserum. The polypeptides are of very different molecular weights. Antisera to individual constituent polypeptide did not crossreact with other Vg polypeptides on immunoblots. We conclude that T. sirtalis Vg is composed of an unusual number of polypeptides of markedly different size, and that each of them is the product of a separate gene. A preliminary mechanism of how T. sirtalis Vg genes evolved will be presented.

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EGG AND HATCHLING COMPONENTS OF THE SNAPPING TURTLE (*CHELYDRA SERPENTINA*). D. C. Wilhoft, Rutgers University, Newark, N. J.

Whole eggs whose mean wet weight was 9.45g contained 72.6% H₂O and 12.38 Kcal of energy while egg components included by dry weight 29.8% shell, 33.8% lipid (43.6% higher than previously reported for this species) and 54.9% protein. Mean wet weight of hatchling yolk-sacs on the day of hatching was 0.16g and averaged 60.0% H₂O, 37.3% lipid, 58.2% protein and 6.0 Kcal of energy. The majority of yolk present at hatching was metabolized by day 18 of hatchling life. Mean hatchling, minus yolk-sacs, wet weight was 7.59g and averaged 82.1% H₂O, 19.7% lipid, 32.2% protein and 6.72 Kcal of energy. During development approximately 40% lipid, 53% protein and 40% energy were utilized the remaining portions stored in the hatchlings. Hatchling body separated from hatchling shell averaged 18.1% lipid, 24.4% protein; shell averaged 8.2% lipid and 21.2% protein. Protein percent by dry weight exceeded percent lipid by approximately 38% in both egg yolk and hatchlings but due to the different energy content in lipid and protein an equal energetic contribution was made.

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CONTROL OF POLYAMINE SYNTHESIS, AND ITS REQUIREMENT DURING VITELLOGENIN PRODUCTION IN THE MOSQUITO, *Aedes Aegypti*. P. H. Kogan* and H. H. Hagedorn, Cornell University, Ithaca, NY.

Polyamines -- amino acid derived cations -- are essential for many cellular functions, including optimal protein synthesis. Depletion of polyamines decreases protein production, most likely by affecting ribosomal and transfer RNA. Investigation of this problem is best in a defined system of massive protein synthesis. We are working with such a system -- vitellogenin synthesis in the mosquito, *Aedes aegypti*. After a blood meal as much as 10 ug of vitellogenin is made per hour. Among the earliest events after the meal is a rise in activity of ornithine decarboxylase (ODC), a rate-limiting enzyme in polyamine synthesis. ODC activity rises within a few hours after the blood meal and then falls. Activity then rises again during the period of continuous vitellogenin production. Labelled ornithine injected into blood fed mosquitoes is converted to polyamines in a pattern which correlates well with macromolecular syntheses. Inhibition of ODC with specific inhibitors disrupts digestion of the meal and decreases vitellogenin production. Thus, polyamines may be required for optimal vitellogenin synthesis.

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DOES BIOLUMINESCENCE IN THE COLONIAL RADIOLARIA ORIGINATE FROM ALGAL SYMBIANTS? M. I. Latz, University of California, Santa Barbara.

The bioluminescence of colonial radiolaria from the Sargasso Sea was examined with fast spectroscopy and photon counting techniques. Luminescence is readily elicited by mechanical stimuli and is blue in color ($\lambda_{max} = 450 - 460$ nm). Since colonies possess symbiotic algae containing dinoflagellate pigment, the characteristics of radiolarian luminescence were compared to those of free-living dinoflagellates to determine the source of light emission in the colonies. Luminescence of the radiolaria examined most likely does not originate from symbiotic dinoflagellates based on the following criteria: (1) emission spectra, (2) unresponsiveness to low pH stimulation, (3) flash kinetics, and (4) lack of light inhibition. High densities of radiolaria encountered in the Sargasso Sea suggest that they may be a significant source of in situ luminescence.

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EFFECT OF KETOSIS AT LOW BODY TEMPERATURE IN *SPERMOPHILUS BELDINGI*. B. L. Krilowicz, Univ. of Santa Clara, Santa Clara, CA.

Pectoral tissue removed from hibernating *S. beldingi* and incubated in media containing physiological concentrations of glucose and β -HB, responds to 1.0 mM β -HB by decreased glucose uptake ($P < 0.03$). Thus, glucose supplies all (132%) of the metabolism of the tissue when no β -HB is present and none when 1.0 mM β -HB is present. Pectoral muscle removed from fed animals does not alter glucose uptake or lactate release when exposed to β -HB. However, glucose uptake by the tissue is low even in the absence of β -HB; none of the metabolism is from glucose. Therefore, no further reduction in glucose utilization is predicted when β -HB is present. At an external β -HB concentration of 1.0 mM, β -HB metabolism accounts for 25% of the metabolic rate of tissue from fed animals. However, β -HB is not metabolized by tissue from hibernators. Ketosis during hibernation in *S. beldingi* leads to decreased glucose utilization by pectoral muscle at the low body temperature experienced during torpor. Coupled with a similar effect of β -HB at body temperatures experienced during arousal and homeothermy, ketosis during hibernation leads to a sparing of body protein.

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PHAGOCYTIIC DEPRESSION OF TROUT SPLEEN MACROPHAGES. Hugo C. Lang. Wake Forest Univ., Winston-Salem.

Five days after a 15% hemorrhage the serum of rebled rainbow trout reduced the number of yeast and bacilli phagocytosed by four-day adherent spleen cells maintained in L-15 culture medium supplemented with 0.2% glucose and 10% fetal bovine serum at 10 C. Both above and below 30,000MW blud serum fractions retained the capacity to reduce phagocytosis. SDS-PAGE showed that, relative to controls, protein bands from whole blud or fractionated blud sera were reduced or were missing. Nevertheless, the total protein concentration of the blud serum did not differ significantly from controls. HPLC showed that cortisol remained high in the serum of five-day blud animals. The relationship between these protein and steroid changes and phagocytic depression is presently under scrutiny.

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Bioenergetics of Callinectes sapidus exposed to South Louisiana crude oil. S.Y. Wang and W.B. Stickle. Louisiana State Univ., Baton Rouge.

Juvenile blue crabs were exposed to the water soluble fraction of South Louisiana crude oil (0, 0.866, 1.462 and 2.316 ppm) for 21 days. Crab feeding rates on fresh Palaemonetes pugio, absorption efficiencies, oxygen consumption and ammonia excretion rates were determined on days 0, 7, 14 and 21 of the exposure period. Feeding rate varied inversely with aromatic hydrocarbon concentration and was the primary determinant of crude oil effects on crab bioenergetics. Energy expenditure due to respiration and ammonia excretion was generally lower for crabs exposed to 0.866 and 1.462 ppm than control crabs and crabs exposed to 2.316 ppm. Percent caloric expenditure due to respiration ranged from 87.9-96.2% while that due to ammonia excretion ranged from 3.8-12.1%. The overall energy budget or Scope for Growth was significantly affected by aromatic hydrocarbon exposure, decreasing with both time and exposure level. The scope for growth of crabs exposed to 2.316 ppm was 28.5% of that of control crabs by day 21.

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THE EFFECT OF COCCIDIOSIS ON HEMATOLOGY OF LOHI Sheep. Zia-ur-Rahman, M. Ahmad and Sajjad-ur-Rahman. Univ. of Agri. Pakistan.

Hematological values of lohi sheep (a native breed of Pakistan) infected with pathogenic coccidiosis oocysts revealed the following: 1) 51% decrease of glucose from the healthy sheep value during the peak infection. 2) a 45% increase in potassium and 22% decrease in sodium contents were observed in the infected animals at the peak of infection and these values are significantly different ($P < 0.01$) from the healthy normal observation. 3) coccidiosis infected animals showed 26% decrease in total globulin which was the result of decrease in gamma globulin concentration. 4) packed cell volume decreased significantly ($P < 0.01$) at the peak of infection and almost return to normal after Amprolium treatment.

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HEMOLYMPH LIPIDS IN FORAGING HONEYBEES. J. M. Sidle. Ursinus College, Collegeville, PA.

Lipids detected by TLC in adult worker honeybee hemolymph are: phospholipids, monoglycerides, 1,2- and 1,3-diglycerides, tri-glycerides, free fatty acids, cholesterol, esterified cholesterol and hydrocarbons. Spectrophotometric total hemolymph lipid ranges 650-1090mg% but is similar in foragers and non-flying hive bees on any given day. Total glyceride concentration in adult workers is 200-350mg%. Total cholesterol concentration in adult workers is 13-24mg%. Drones have little or no hemolymph cholesterol. There is no detectable change in concentration of any of the lipid classes as a result of forager flight over distances up to 1000m. Adult workers show a gradual increase in total hemolymph lipid from March to mid-June and this change parallels local pollen availability.

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PROTEIN HYPERTROPHY IN LIVER AND HEART FOLLOWING COLD ACCLIMATIZATION AND ACCLIMATIZATION IN CHANNEL CATFISH (CCF). J.D. Kent and C.L. Prosser. Univ. Illinois, Urbana.

We have previously shown that total protein content doubled in liver of cold acclimated CCF (25 vs 15 C) coincident with a similar increase in HSI. In the present study, we consider changes in total protein content and HSI in summer, winter, fall, and spring acclimated CCF. Total protein content is increased by approximately 78% and HSI, 165% between summer (25-30 C) and fall (12-15 C) animals and remains elevated throughout the winter and spring. Glycogen is altered in the same direction. In contrast to the acclimated state, seasonally acclimated animals appear to exhibit variable amounts of total liver DNA and occur in the order: fall (36.62 ± 2.68 mg/TL) > summer (21.93 ± 1.26) > winter (17.27 ± 1.56) > spring ($12.09 \pm .49$). This suggests that a hyperplasia, in association with hypertrophy, may be important in the seasonal acclimatization of CCF.

Both cold (compared to warm) acclimated and winter and fall (compared to summer) acclimated CCF show heart mass and protein hypertrophy, suggesting that the hypertrophy phenomenon is a common strategy for achieving independence with respect to temperature in this species.

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HEXOSE-6-PHOSPHATE DEHYDROGENASE FROM THE FISH FUNDULUS HETEROCLITUS. I.J. Ropson* and D.A. Powers. Johns Hopkins Univ., Baltimore, MD

Hexose-6-Phosphate dehydrogenase, a microsomal liver enzyme, catalyzes reactions similar to those catalyzed by Glucose-6-Phosphate dehydrogenase. However, a broader range of substrates and coenzymes can participate. H6pdh is believed to have arisen from a G6pdh gene duplication event. Purification and characterization of H6pdh has been reported for a few mammalian systems, but little is known about this enzyme in lower vertebrates. We have purified H6pdh to homogeneity and found that it follows a random bisubstrate reaction mechanism. Glucose-6P, Galactose-6P, 2-Deoxyglucose-6P, and Glucose have been studied as substrates (K_m values: 5.5, 60, 200, and 100,000 μ M, respectively). NADP, deamino NADP, and 3-acetylpyridine NADP are coenzymes (K_m values: 1.2, 10, and 150 μ M, respectively). NAD is a coenzyme only when glucose is a substrate, acting as a competitive inhibitor for NADP in reactions with sugar-6P ($K_i=0.75$ μ M).

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ANALYSIS OF HEAT-SHOCK GENE EXPRESSION IN THE TELEOST FUNDULUS HETEROCLITUS. Michael Koban and Dennis Powers. Johns Hopkins University, Baltimore, MD 21218

We use the teleost, Fundulus heteroclitus, as a model to study organism-environment interactions at the molecular level. The heat-shock response is particularly appropriate because this fish is highly eurythermal. Thermally acclimated fish were heat stressed and RNA was isolated. Cell-free translation products were resolved on SDS gels. There was differential thermal sensitivity of individual tissues in heat-shock protein (hsp) synthesis, as well as tissue specificity in hsp Mws. Relative abundance of heat-shock transcripts was assayed by synthesis of cRNA from a trout heat-shock gene cloned into pSP6 plasmid. cRNA was used as a probe for Northern blot analysis of liver RNA of heat-stressed fish. Hybridization studies of control and heat-stressed fish suggest that two different heat-shock genes may be constitutively transcribed. However, as only one hsp was translated, the heat-shock response in Fundulus liver may be under stringent translational control.

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mtDNA POLYMORPHISMS IN POPULATIONS OF THE TELEOST FUNDULUS HETEROCLITUS. L.I. Gonzalez-Villaseñor* and D.A. Powers. The Johns Hopkins University, Baltimore, MD.

Individual fish from each of several different populations along the East Coast were analyzed for genetic diversity of their mtDNA restriction patterns. Cloned fish mtDNA was used as a hybridization probe to detect individual electromorphs generated by each of 18 restriction endonucleases. These mtDNA electromorphs reflected genetic variation between and within populations. The Southern most population (Georgia) showed larger (28%) genetic variability than the Northern most population (Maine) which has 5.5% variation. While 44% of the mtDNA patterns were different between these populations, the variability was due to single nucleotide changes. Populations geographically between the Northern and Southern extremes showed intermediate degrees of genetic variability. Low levels of mtDNA divergence as indicated by the nucleotide diversity index argues against different Fundulus species.

PHOSPHOFRUCTOKINASE FROM THE ADDUCTOR MUSCLE OF THE BAY SCALLOP. C.P. Chih and W.R. Ellington. Florida State Univ., Tallahassee.

Phosphofructokinase (PFK) from the phasic adductor muscle of the bay scallop Argopecten irradians concentricus was purified by ammonium sulfate precipitation, Cibacron blue Sepharose affinity chromatography and gel filtration using Sephadex G-200. The final specific activity was 55.6 EU/mg protein. Fructose-6-P saturation curves were sigmoidal at pH 7 ($n=2.8$) and below. Increased assay pH resulted in increase in enzyme activity as well as a decrease in the degree of sigmoidicity. At pH 7, the presence of AMP (0.1 mM), ADP (0.5 mM) or fructose-2,6-P (1 μ M) in the assay system resulted in hyperbolic F-6-P saturation kinetics. The activation curves of AMP and F-2,6-P were hyperbolic yielding K_m values of 22.0 μ M and 0.65 μ M, respectively. ATP saturation kinetic curves generated at pH 7 showed pronounced substrate inhibition which was relieved by AMP (0.1 mM). Inorganic phosphate, phosphoenolpyruvate and citrate were found to be inhibitory modulators while arginine-P appeared to have no effect on this enzyme. The properties of this enzyme show that it has a high potential for activation during burst muscle contraction. Supported by NSF grant PCM-8401258.

NADP-LINKED MALIC ENZYME FROM THE MITOCHONDRIA OF THE HEART OF THE WHELK BUSYCON CONTRARIUM. R.A. Graham and W.R. Ellington. Fla. State Univ., Tallahassee.

Malic enzyme (ME) was isolated from mitochondria of the heart of B. contrarium by HPLC with a TSK-3000 column. The isolated enzyme showed a specific activity of 5 EU/mg protein and was free of malate or lactate dehydrogenase and fumarase activities. The molecular weight, estimated from the TSK column, was 179,000. This ME was specific for NADP(H). At physiological pH, the decarboxylation reaction was the preferred direction. The saturation kinetics with respect to malate and pyruvate were sigmoidal. The $S_{1/2}$ for malate ranged from 0.3 to 3 mM; the $S_{1/2}$ for pyruvate was 6.5 mM. The apparent K_m 's for NADPH and NADP were 1.5 and 13 μ M respectively. NADPH inhibited malate decarboxylation at concentrations greater than 100 μ M. NADH, NAD, fumarate and succinate had no effect on enzyme activity. Hydroxymalonic acid was a potent inhibitor at sub mM concentrations. We conclude that the whelk heart ME appears to function in the decarboxylation of malate to provide an alternative source of intramitochondrial pyruvate. Supported by NSF Grant PCM-8202370.

ARACHIDONIC ACID METABOLISM BY GILL TISSUE OF THE FRESHWATER MUSSEL, LIGUMIA SUBROSTRATA. A.F. Hagar and T.H. Dietz. Louisiana State Univ., Baton Rouge.

Prostaglandin E_2 (PGE_2) has recently been shown to be a negative modulator of Na uptake in the freshwater mussel, Ligumia subrostrata. Thus the ability of gill tissue from this species to metabolize arachidonic acid (20:4n6) is of interest. Gill homogenates were incubated with 3H -20:4n6, and the reaction products were isolated by thin-layer chromatography (TLC). Three major radioactive peaks with R_f values of 0.0, 0.35, and 0.50 were localized and eluted from the TLC plate for further analysis. The metabolite with an R_f value of 0.35 appears to be PGE_2 because a PGE_2 standard had a similar R_f in this solvent system. Additionally, when the compound was rechromatographed in another solvent system, it again had an R_f value similar to the PGE_2 standard. The metabolite with an R_f value of 0.50 was analyzed by HPLC. It was identified as 5-hydroxyeicosatetraenoic acid (5-HETE) based upon an elution time that was identical to that of a 5-HETE standard. The metabolite with an R_f of 0.0 is a very polar compound and has not yet been identified. Supported by NSF grant DCB83-03789.

KETOGLUTARATE DEHYDROGENASE COMPLEX (KGDC) FROM A BIVALVE GILL TISSUE.

G. A. Karam, K. T. Paynter, S. H. Bishop, Iowa State Univ., Ames and R. Komuniecki, Univ. of Toledo, OH.

Transient proline accumulation in osmotically stressed ribbed mussel gill tissue may be due to a transient inhibition of the KGDC. KGDC activity was partially purified from gill tissue mitochondria by a combination of Triton-extraction, polyethylene glycol precipitation and differential ultracentrifugation. The activity showed sigmoidal (allosteric) kinetics with regard to α -ketoglutarate ($K_{0.5} = 54 \mu$ M) and little variation in activity between pH 6.5 and 8.5. No inhibition was observed with ATP, ATP analogs, or EDTA in the 1-10 mM range and there appeared to be no regulation by a protein kinase-phosphatase system. Other properties indicated a close similarity to KGDC from other animal tissues. If it occurs at all, transient inhibition of the KGDC during hyperosmotic stress appears to be due to transient changes in metabolite levels. (Supported by grants from the NSF.)

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REGULATION OF THE ASCARIS SUUM PYRUVATE DEHYDROGENASE KINASE. J. Thissen*, P. McCartney* and P. Komuniecki. University of Toledo, Toledo, Ohio

The pyruvate dehydrogenase complex (PDC) has been purified to apparent homogeneity in a fully active state from body wall muscle of the porcine nematode, Ascaris suum, in yields 20-fold greater than previously published procedures, using isolated mitochondria. This preparation contains an active PDK kinase, which catalyzes the ATP-dependent phosphorylation and subsequent inactivation of the PDC. A. suum PDK kinase is stimulated by elevated NADH/NAD⁺ ratios, in common with PDK kinases isolated from aerobic tissues. However, the ratio giving "half maximal stimulation" is more than an order of magnitude greater for the ascarid enzyme (1.1 vs. 0.03 or 0.05 for porcine liver or kidney, respectively.) In addition, physiological levels of two important intermediates of ascarid mitochondrial metabolism, pyruvate and propionate, also potentially inhibit kinase activity. These results may account for the observed activity of the PDC in intact muscle strips incubated anaerobically even in the presence of a relatively reduced mitochondrial pyridine nucleotide pool.

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EVALUATION OF SALINITY STRESS BY ATOMIC RATIO OF OXYGEN CONSUMED TO NITROGEN EXCRETED. M. Iamir*, S. Hajj*, M. Nuwayhid* and L. S. L. Young. Amer. Univ. of Beirut, LEBANON.

In preliminary observations, we found little variation in body water content for the intertidal hermit crab, Glibana ciliata erythroga Latreille 1818. Oxygen consumption over the first 96 h ranged between 0.75 and 2.01 ml/h for standard sized individuals of 0.0684 g afdw. Body water content varied between 62.9 to 64.2% of wet weight. We used the method of atomic ratio of oxygen consumed to nitrogen excreted for evaluating stress. Animals from an intertidal rocky beach demonstrated declining water content from 71 to 66% body water during the summer when exposed to 15 thru 50 ppt salinity. The environmental conditions were 40 ppt salinity and 28 °C. Respiration rates varied after two weeks acclimation from 1.6 to 2.9 ml/h for standard sized animals of 0.173 g wet weight. Gram-atomic nitrogen excreted varied from 222.3 to 554 ug-atom N/h for 0.173 g wet weight individuals. Atomic ratios varied between 313.8 and 869.6 without any clear pattern. We found assessment of stress by atomic ratios to be of limited value.

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PROPERTIES OF SINGLE CNIDOCYTES ISOLATED FROM SEA ANEMONES. M. C. McKay and P. A. V. Anderson. Intro by M. J. Greenberg. C. V. Whitney Laboratory, Univ. of Florida, St. Augustine.

Cnidocytes were isolated from the acrorhagi and tentacles of several species of sea anemones by enzymatic digestion with papain. The tissue digest was then centrifuged in a Percoll gradient to separate unwanted cells and debris from cnidocytes. Our method yields a relatively pure preparation of cnidocytes and can be applied to a variety of cnidarians. The electrical properties of the isolated, intact cnidocytes were examined using whole-cell patch clamp recording techniques. Isolated cnidocytes produced both inward and outward currents; however, capsule discharge does not depend upon a change in membrane potential. The responsiveness of in situ and isolated cnidocytes to discharge with different chemical stimuli was quite different. Isolated cnidocytes were less sensitive to stimuli than whole tentacle preparations. This may be due to dissociation of the cnidocytes from the accessory ciliary-cone sensory cells present in whole tentacles. Whole tentacles treated with papain for short times did not change in their responsiveness to chemical stimuli. Supported by NSF Grant No. BNS 82-09848

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AMILORIDE-SENSITIVE Na⁺/H⁺ EXCHANGE IN MEMBRANE VESICLES FROM CRAB (CALLINECTES SAPIDUS) GILL. D.W. Towle, Univ. of Richmond, VA and Mt. Desert Island Biol. Lab., Salsbury Cove, ME

Sodium uptake across gill epithelial cells is thought to depend on concerted action of basolateral Na⁺+K⁺-ATPase and apical Na⁺/H⁺ or Na⁺/NH₄⁺ exchange. Membrane vesicles from mitochondria-rich and -poor cells were prepared by density gradient centrifugation. Uptake of ²²Na⁺ into Na⁺-free vesicles was measured by rapid filtration, with and without amiloride (up to 1 mM). Amiloride-sensitive Na⁺ uptake was observed only in vesicles from mitochondria-rich cells. Imposition of a pH gradient (high internal H⁺) enhanced Na⁺ uptake, indicating the presence of Na⁺/H⁺ exchange. However, loading vesicles with 1 mM NH₄Cl produced no increase in amiloride-sensitive Na⁺ uptake. The kinetic effects of altering external Na⁺ indicated the existence of two routes of Na⁺ uptake, a saturable, amiloride-sensitive pathway, and a second, unsaturable pathway. Supported by National Science Foundation (DCB 8408510).

UPTAKE OF AMINO ACIDS VIA THE MANTLE OF THE MUSSEL, *MYTILUS EDULIS*. M. A. Rice and G. C. Stephens. University of California, Irvine.

Uptake of amino acids was monitored by following disappearance of substrate using both radiochemical and chemical techniques. Rates were compared in parallel observations on mussels from which the gills were removed and sham operated mussels (adductor muscle was cut). Distribution of amino acid supplied externally to selected internal tissues was determined and compared in these two preparations. On a surface area basis, internal distribution of substrate entering via the mantle tissue is quantitatively more important. The preparation was also used to test interactions between pairs of amino acids. There appear to be differences in specificity of carriers present in the epithelia of the gills and the mantle, particularly with respect to taurine. The data suggest that transepidermal transport via the mantle tissue may play an important role in amino acid uptake in *Mytilus*. This work was supported by NSF Grant PCM-8208185.

CARBONIC ANHYDRASE LOCALIZATION IN THE MIDGUT EPITHELIUM OF LARVAL *MANDUCA SEXTA* (INSECTA, LEPIDOPTERA). R.L. Ridgway and D.F. Moffett. Washington State Univ., Pullman.

Differences in the cytoarchitecture of columnar and goblet cells allow the midgut of larval *Manduca sexta* to be divided into anterior, middle, and posterior regions. The pH of the midgut contents rises from 5.5 in food to 11 in middle midgut, but falls to 8 in the posterior midgut, and to 4 in feces. These results suggested that the anterior and middle midgut are responsible for net carbonate secretion and that the posterior midgut may serve to reabsorb some of the secreted base.

Carbonic anhydrase is typically found in high levels at cellular sites of acid/base transport. We report here that acetazolamide-sensitive carbonic anhydrase activity, as determined by histochemistry, is primarily localized to the apical membrane of goblet cells in anterior and middle midgut, but to the brush border of columnar cells in posterior midgut. These results confirm different roles for the anterior and middle regions versus the posterior region in managing the alkalinity of larval midgut contents.

(Supported by NSF DCB 8315739 to DFM)

ISOZYMES OF MALATE DEHYDROGENASE (MDH) AND ASPARTATE AMINOTRANSFERASE (AAT) IN RIBBED MUSSEL GILL TISSUE. M. M. Brodey, A. McCormick, K. T. Paynter and S. H. Bishop. (intro. by S. S. Shen) Iowa State Univ., Ames.

Malate and aspartate (asp) metabolism appear to be metabolically coupled to changes in alanine levels in euryhaline bivalve gill tissue during osmotic stress. The cytosolic MDH (cMDH) activity consists of five electromorphs each having distinctive kinetic properties. The mitochondrial MDH (mMDH) activity consisted of two electromorphs. One mMDH was electrophoretically identical to one of the cMDHs. Kinetic properties of the mMDHs and cMDHs differed from each other. The purified cAAT and mAAT were dimers of identical subunits of MW 50K and both used cysteine sulfinic acid as a substrate in place of asp. The cAAT differs from all other known animal AATs by having a high K_m for asp (150 mM) and low K_m for OAA ($> 2 \mu M$) at low pH values (pH 6.5). The variable properties of the MDHs and AATs in the cytosolic and mitochondrial compartments may account for some of the unusual aspects of decarboxylic acid metabolism and amino acid accumulation in this tissue. (Supported by grants from the NSF.)

NEURAL PRODUCTS REDUCE THE EPITHELIAL WATER PERMEABILITY OF THE MUSSEL *GEUKENSIA DEMISSA*. L. E. Deaton. Whitney Laboratory, University of Florida, St. Augustine.

The diffusional water permeability (Pd) of mantles from *G. demissa* acclimated to 1000 and 500 mOsm seawater (SW), were, respectively, 10.6×10^{-5} cm/sec and 6.7×10^{-5} cm/sec. Incubation of mantles from 1000 mOsm-acclimated mussels in 1000 mOsm SW for 4 hours increased Pd by 1.0×10^{-5} cm/sec. Exposure to 500 or 250 mOsm for 4 hours decreased the Pd by 2.3 and 4.1×10^{-5} cm/sec, respectively. Acetone extracts of the pooled ganglia of mussels acclimated to 1000 mOsm, and of mantles from mussels acclimated to 500 mOsm significantly reduced the Pd of 1000 mOsm-acclimated mantles incubated in 1000 mOsm SW. Extracts of mantles and gills from mussels acclimated to 1000 mOsm had no effect. Prolactin (50 ug/ml) also decreased the Pd. Vasopressin, cortisol, amphoteracin B, serotonin, and FMRF-NH₂ had no effect. The results suggest that the epithelial water permeability of euryhaline bivalves decreases in hypoosmotic media, and that the permeability change is modulated by neurohormones.

Supported by NSF grant PCM 8309314

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ALLANTOIC FLUID REGULATION IN EMBRYONIC JAPANESE QUAIL. R.A. McNABB. Virginia Polytechnic Institute and State University, Blacksburg.

During embryonic development, allantoic fluid represents the shifting balance between renal excretion and allantoic reabsorption. Allantoic contents of Na, K, Cl, urate (UA), water and pH were followed for d 10-15 of the 16d incubation. Water volume was near 0.9 ml until d 13, then fell very rapidly. The pH fell more steadily, from 8 to 5.5. Contents of Na and Cl fell regularly to final values of 80-88% below d 10. The K content changed differently, and nearly doubled by d 13, but returned to d 10 values at the end. UA content rose until d 13, then fell suddenly to low values. This was due to abrupt precipitation of most UA into masses not sampled by our method; thus, after d 13, UA was underestimated (by 90-96%). Ion-binding by UA was low (3-10%) and nonspecific. The underestimate of UA means that in late incubation about one-third Na and 65-70% K and Cl are precipitated and do not appear in balance sheets of allantoic ions. These precipitated ions account for the significant Na and K that are left in the shell at hatching, but whose presence is not predicted by the analysis of allantoic fluid. (Supported by BRSG and NSF-PCM 8021881.)

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MAINTENANCE NITROGEN REQUIREMENT OF THE RACCOON, *PROCYON LOTOR*. J.N. Mugaas, K. Halama*, B. Lundrigan*, and J. Seidensticker*. W.V. School of Osteopathic Med., Lewisburg, and National Zoological Park, Washington, D.C.

Adult raccoons (4♂, and 3♀) in nonreproductive condition were fed purified diets containing 0.15, 0.525, and 1.51% nitrogen (N) [0.94, 3.28, and 9.44% crude protein, respectively]. Raccoons gained weight on all three diets (0.41 kg±0.34), but could only maintain positive N balance on 3.28 and 9.44% protein diets. Fecal N (gN/kg wet feed intake) as a function of dietary N (%) was described by $y = 1.523X + 0.461$, $r = 0.99$, which predicts a metabolic fecal N value of 0.461 gN/kg wet feed intake. Total N excretion (gNex/kg^{0.75} day) as a function of total N intake (gNi/kg^{0.75} day) was described by $y = 0.333X + 0.086$, $r = 0.92$. This predicts an endogenous urinary N excretion of 0.086 gN/kg^{0.75} day, and an EUN:BMR ratio of 1.21 mgN/kcal. The point at which N intake and N excretion were equal (0.12 gN/kg^{0.75} day) represents the necessary maintenance intake. Supported by WVSOM Faculty Research Grant, and Friends of the National Zoo.

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UREOTELISM IN THE PHYLUM ECHINODERMATA. W.B. Stickle. Louisiana State Univ., Baton Rouge.

Rates of nitrogen excretion and the percent composition of ammonia (N), urea (U) and primary amine (PA) nitrogen were determined in fifteen species of echinoderms at 30-35°C and ambient water temperature. The range of mean percent contribution attributable to three species of holothuroids was: N=33-96%; U=2-67% and PA=1-4%. Nitrogen excreted by a species of echinoid was partitioned as follows: N=93%; U=3% and PA=4%. The range of mean percent contribution attributable to eight species of asterooids was: N=21-87%; U=0-66% and PA=0-21%. Urea excretion was related to the arginine ingestion rate in one species but was synthesized endogenously in four species of asterooids starved prior to their use as experimental animals. The range of mean percent contribution of nitrogen attributable to three species of ophiurooids was: N=20-68%; U=3-76% and PA=0-29%. Eleven of the fifteen species are urogenic while six of them are urotelic. In light of these findings, the Baldwin-Needham hypothesis about the selective forces which modify the pattern of nitrogen excretion in echinoderms must be modified.

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PHOTOPERIODIC CONTROL OF THE PARR-SMOLT TRANSFORMATION IN ATLANTIC SALMON: CHANGES IN THYROID HORMONES, GILL Na⁺,K⁺-ATPase AND SALINITY TOLERANCE. S.D. McCORMICK, R.L. SAUNDERS*, E.B. HENDERSON* and P.R. HARMON*. Biological Station, St. Andrews, N.B.

Atlantic salmon (*Salmo salar*) reared under simulated natural photoperiod underwent concurrent increases in plasma thyroxine (T4), gill Na⁺,K⁺-ATPase activity and salinity tolerance in March-April. Exposure to continuous light completely inhibited increases in gill Na⁺,K⁺-ATPase and salinity tolerance and partially inhibited the rise in plasma T4. Replacement of continuous light with normal photoperiod, 3 and 5 months prior to normal smolting, resulted in normal and delayed increases, respectively, in gill Na⁺,K⁺-ATPase activity and salinity tolerance. The results indicate that photoperiod can act as both a zeitgeber and inhibitor of the parr-smolt transformation and that salinity tolerance, gill Na⁺,K⁺-ATPase and to a lesser extent plasma T4 are positively related during photoperiod manipulations.

FEMALE-SPECIFIC LIPOPROTEIN IN THE HEMOLYMPH OF THE BLUE CRAB, *CALLINECTES SAPIDUS*. R.F. Lee, Skidaway Inst. Oceanogr. Savannah, GA.

The hemolymph lipid in crustaceans is associated with lipoproteins in the high density class (1.07-1.21 g/ml). The objectives of the study were the isolation of hemolymph lipoproteins found in both male and female blue crabs, as well as any female specific lipoproteins. Two different lipoproteins were found with one appearing in female hemolymph soon after their molt to the adult form. Lipoprotein I was found at low concentrations (0.4 to 0.7 mg/ml) in both male and female blue crab. Lipoprotein II was found at high concentrations (up to 4 mg/ml) in sponging female crabs. The high density lipoprotein fractions were separated into ten fractions using isopycnic density gradient ultracentrifugation. Using these procedures the lipoproteins associated with two subfractions which were fraction 6 (density 7.123-1.142 g/ml) with lipoprotein I and fraction 9 (density 1.156-1.170 g/ml) with lipoprotein II. Different peptides were associated with each lipoprotein.

FOUR SPECTRAL CLASSES OF CONE IN THE RETINAS OF BIRDS. D.-M. Chen* and I.H. Goldsmith. Yale University, New Haven, CT.

The spectral sensitivity of 15 species of birds has been measured by recording transretinal voltages from opened eyecups. With suitable combinations of colored adapting lights, we find that a variety of passerines have four types of cone, with maximum sensitivities at 370, 450, 480, and 570 nm. Cones with maximum sensitivity at 510 nm are found in some species. The spectral sensitivity maxima are not altered by bathing the retina in 50 mM sodium aspartate, indicating that they reflect the properties of receptors and do not result from inhibitory interactions between retinal interneurons. Mathematical modeling of the data indicates that many of the cones that are maximally sensitive in the blue and violet must contain oil droplets that attenuate the deep violet and near uv.

ORIENTATION OF SOME VERTEBRATES INCLUDING MAN IN A SPATIAL DISTRIBUTION OF LIGHT OR OF CONTRASTS. F.J. Verheijen. State Univ. of Utrecht, The Netherlands.

Natural distributions of light or of contrasts were imitated in the laboratory. Fish, turtle and rabbit orient perfectly in the brightest direction of an anisotropic light field with two eyes, and equally well with one eye. This suggests that they perceive the angular gradient and determine the brightest direction with a multisensor system (raster). Two orientation mechanisms known in fish, viz. the dorsal light response (DLR) and the ventral substrate response (VSR) were studied in man. It was found that in a natural light distribution the direction of the major influx indicates above to human subjects; similarly below is indicated by the direction in which most contrasts are found. The DLR and the VSR might contribute to adaptation to microgravity in man. In addition the two responses might influence studies of posture and of visual monitoring of movement, the more so as the relevant optic variables - the spatial distributions of light and of contrasts - are conventionally not controlled.

ELECTROSENSORY NOVELTY DETECTORS IN THE MIDBRAIN OF PULSE-TYPE WEAKLY ELECTRIC FISH. H.J. Grau. Univ. of Oklahoma, Norman.

Pulse-type weakly electric fish generate an Electric Organ Discharge (EOD) that is brief relative to the inter-pulse interval. By means of a specialized electroreceptor system these fish can locate objects with conductivities differing from that of the environment, and can communicate with other weakly electric fish. In novel situations pulse-type fish will commonly raise their EOD rate. This Novelty Response (NR) behavior occurs by the detection of changes, or novelty, in successive EOD afferences. This study is a preliminary investigation into the mechanisms of electrosensory afference-difference detecting in these fish. Neural recordings were made from several electrosensory-processing brain regions of fish that were presented stimuli at various frequencies, representing various degrees of novelty. Whereas lower-order electrosensory-processing regions show only minor changes in response size to stimuli presented less frequently, the midbrain exhibits very strong novelty-related activity patterns. This novelty-related neural activity can be correlated with certain aspects of the fish's behavior (NR). Supported by NIH#NS12337.

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REGIONAL LOCALIZATION OF MUSCARINIC CHOLINERGIC AND α_2 -NORADRENERGIC RECEPTOR BINDING IN TWO SONGBIRD SPECIES USING TRITIUM-SENSITIVE FILM AUTORADIOGRAPHY. G.F. Ball, B. Nock*, J.C. Wingfield, and B.S. McEwen*. Rockefeller University, New York

To understand how environmental stimuli that control reproductive development are integrated by the neuroendocrine system we have begun mapping, using quantitative autoradiography, the distribution of neurotransmitter receptor binding sites. Subjects consist of males of two passerine species, the european starling (*Sturnus vulgaris*) and the song sparrow (*Melospiza melodia*). Frozen sections of brains were mounted onto gelatin-coated slides. Muscarinic receptors were labelled using (^3H) scopolamine and α_2 receptors using (^3H) p-aminoclonidine. In both species muscarinic binding was heaviest in the paleostriatal complex especially the paleostriatum augmentatum, the lobus parolfactorius (LPO), and area X. Binding for α_2 was also heavy in area X but not in LPO in both species. High binding for α_2 was found in the preoptic, the anterior and posterior hypothalamus, and in the dorsal portion of the archistriatum. The anatomical localization of these binding sites agrees, in general, with previous studies localizing neurotransmitter distribution.

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HOW DOES PROLACTIN MODIFY TESTOSTERONE FEEDBACK - A HYPOTHALAMIC SITE OF ACTION? K.S. Matt, R. Steger*, and A. Bartke*. Southern Illinois Univ., Carbondale.

In the golden hamster, changes in photoperiod result in altered responsiveness of the hypothalamic-pituitary axis to testosterone (T) negative feedback. Changes in plasma levels of prolactin (PRL) appear to be important in causing these changes in T effectiveness. The present study tests whether PRL modifies T feedback by acting at the hypothalamic level to alter neurotransmitter turnover rates. The results indicate T is much more effective in decreasing norepinephrine (NE) turnover and increasing dopamine (DA) turnover in animals on short days than in animals on long days. This is consistent with the ability of T to inhibit gonadotropins more effectively on short days. Elevation of plasma PRL with pituitary grafts in animals on short days decreases the suppressive effect of T on NE turnover, and the stimulatory effect of T on DA turnover. In conclusion, photoperiod causes a change in feedback sensitivity by altering plasma PRL, which then acts at the hypothalamic level to alter neurotransmitters.

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OVARIAN FOLLICULAR DEVELOPMENT IN VOLES FOLLOWING EXPOSURE TO MALES OR UNILATERAL OVARIECTOMY. T.H. Horton and N.B. Schwartz*. Northwestern University, Evanston, Illinois.

Montane voles exhibit reflex ovulation and no estrous cycles. We have initiated a study of environmental and internal feedback mechanisms regulating ovarian function in this species. Exp. 1: Virgin females housed in 16L:8D were exposed to males (EX) in partitioned cages or caged individually until sacrifice at 72 hrs. EX females exhibited increased uterine wet and dry weights, as observed in prairie voles (Hasler & Conaway. Biol. Reprod. 1973). Ovaries of EX females contain follicles with diameters greater than 500 μm , such follicles were absent from controls. Exp. 2: Females housed in 16L:8D were unilaterally ovariectomized, sham operated or unoperated to determine if compensatory ovarian hypertrophy, occurs in voles. No differences were seen in ovarian weight or follicle size-class distribution 72 hr after surgery. We hypothesize that recruitment of large follicles in voles occurs only following stimulation of the hypothalamic-pituitary axis by environmental factors, and is less dependent on changes in internal feedback signals.

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EFFECT OF ALGAL MEDIA ON BRINE SHRIMP GROWTH. P. Pendoley* and M. Landau, Florida Institute of Technology, Melbourne.

Little is known about how algal media affects the nutritional quality of algae fed to invertebrates. *Isochrysis* and *Dunaliella* were grown in four different media containing: (1) only macronutrients, (2) macronutrients and vitamins, (3) macronutrients and trace metals, and (4) macronutrients, vitamins, and trace metals. Algal cells were washed and fed to newly hatched nauplii of the brine shrimp, *Artemia* (San Francisco strain). Nauplii used were hatched simultaneously (maximum 90 minute variation in age). Results were similar for both species of algae; those grown in media which contained trace metals resulted in significantly better growth of the brine shrimp.

ECOLOGY AND FUNCTIONAL MORPHOLOGY OF SEVERAL PLANT-GRAZING TROPICAL DECAPOD CRUSTACEANS. L.D. Coen. Univ. of Maryland, College Park.

Decapod crustaceans constitute a diverse and widespread group in the tropics being found in most marine, freshwater and terrestrial habitats. However, there exists a paucity of detailed descriptive or functional information on their chelae, foreguts and associated masticatory structures. The natural history, feeding biology and morphology of several species of herbivorous crabs (Families Majidae, Grapsidae and Xanthidae) from Belize were examined using both experimental and observational methods. Structural details were further elaborated using both LM and SEM. Special attention was given to chelae, gastric mill teeth and mandibles, as they relate to feeding, wear and physical capacities. Diets were examined using an array of 7 plants in feeding experiments, complemented by gut analyses from day/night field collections. Feeding comparisons were made based on plant characteristics as well as herbivore morphology. Most crabs examined here were capable of directly consuming tough corticated and leathery macroalgae. (Research supported by Sigma Xi, the Lerner-Gray Fund for Marine Research and the Smithsonian's CCRE project.)

NITROGEN LIMITATION IN THE HERBIVOROUS LAND CRAB, CARDISOMA GUANHUMI. D. L. Wolcott and T. G. Wolcott. North Carolina State Univ., Raleigh.

The natural plant diet of C. guanhumi was supplemented with casein, and the nitrogen (N), fat, uric acid, and tissue content of supplemented and unsupplemented crabs compared to demonstrate N limitation in this species. Crabs were maintained in the lab with access to plants found in the field, and 10 min. exposure to tap water or 10% sea water daily. N-supplemented crabs also received casein-agar. N intake was calculated for crabs in each group, based on quantity eaten and N content of plant material. After 2 months, N-supplemented crabs contained more N, fat, uric acid, and tissue than unsupplemented laboratory controls or freshly collected field crabs. Analysis of gut passage time, feeding behavior, and gut volume revealed that crabs eating only plant material were both N and growth limited. Supported by NSF Grant PCM-83-10465 to the authors.

ONTOGENY OF THE GUT IN PENAEUS SETIFERUS. D.L. Lovett and D.L. Felder. Univ. of Southwestern Louisiana, Lafayette.

Ontogeny of foregut, midgut, and hepatopancreas was examined with light and electron microscopy in laboratory-reared Penaeus setiferus. Growth rate of foregut increases after metamorphosis. During postlarval development, the median tooth becomes armed with setae which subsequently develop into spines, then teeth. The number of ampullary channels in gland filter increases during development. Development of midgut structures is gradual, rather than punctuated at ecdysis. In larvae and early postlarvae the hepatopancreas exists as distinct lobes. In 14-day postlarvae the hepatopancreas consists of six pairs of lobes. In 21-day postlarvae lobes are no longer distinct because of ramification of lobes into tubules. The anterior diverticulum of midgut exists in larvae as a bilobed structure that extends anteriorly beyond foregut. After metamorphosis, the anterior diverticulum becomes rudimentary. The posterior diverticulum is not present during early postlarval ontogeny.

TEMPERATURE ECOLOGY OF HYDROTHERMAL VENT DECAPODS: APPLICATION OF STABLE ISOTOPE TECHNIQUES. C.L. Van Dover, Marine Biological Lab., Woods Hole, MA.

Two decapod crustaceans--a bresilliid shrimp and a galatheid squat lobster--were collected by the submersible ALVIN from the Rose Garden hydrothermal vent site. Standard analytical techniques were used to measure $\delta^{18}\text{O}$ values of the carapacial CaCO_3 from individual specimens. The shrimp $\delta^{18}\text{O}$ values were consistently lower (i.e., the CaCO_3 was precipitated in warmer water) than the galatheid $\delta^{18}\text{O}$ values. This agrees with photographic observations of the species' distributions in this vent area. A statistically significant negative correlation of $\delta^{18}\text{O}$ values with size was found in the galatheids; the significant correlation was positive in the shrimp. Sex- and reproductive state-dependent distributions were also detected in the galatheid population. Thus, in a surprisingly complex way, the decapod populations at hydrothermal vents seem to occupy various distinct temperature (and hence chemical) regimes. This will be an important consideration in any discussion of their physiology, ecology or evolution.

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VISUAL SPECTRAL SENSITIVITY IN A STOMATOPOD CRUSTACEAN MEASURED USING PSEUDOPUPIL SCATTERING CHANGES. T.W. Cronin. University of Maryland Baltimore County, Catonsville, MD.

The pseudopupil of a compound eye is the dark area observed within the eye due to the absorption of light from the direction of the observer. It has been known for some time that in the compound eyes of several insect orders, rapid changes in light scattering occur within the pseudopupil upon stimulation with light. These are due to movements of pigment granules in the retinular (receptor) cells. Such responses permit noninvasive measurements of various aspects of insect visual physiology, including spectral sensitivity. I have applied these techniques to the eyes of the stomatopod crustacean, *Gonodactylus oerstedii*, a visually active, shallow-water, predatory mantis shrimp. Its eyes have as many as 3 separate pseudopupils. The ommatidia giving rise to the lateral and medial pseudopupils have sensitivity maxima in the ultraviolet and the green, while those of the central band are maximally sensitive in the ultraviolet and blue. This could provide the sensory substrate for color vision.

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THE ONTOGENY OF OCULAR PIGMENT MIGRATIONS IN GRASS SHRIMP, *PALAEMONETES PUGIO*. J.K. Douglass. Duke Univ. Marine Laboratory, Beaufort, N.C.

Migrations of accessory screening and reflecting pigments are well-known for their role in light and dark adaptation in compound eyes. Adult crustaceans have been extensively studied, while larval and juvenile stages remain poorly understood in this regard. *P. pugio* larvae and postlarvae were light adapted (LA) or dark adapted (DA) prior to fixation for light microscopy and quantification of compound eye pigment distributions. Accessory pigments in both LA and DA larvae are distributed much like those of LA adult eyes. Large-scale pigment migrations commence abruptly at the time of metamorphosis to the postlarva. Still, in DA postlarvae the relationship between accessory pigment positions and rhabdoms differs considerably from the DA adult pattern. Full development of pigment migrations as a mechanism of light and dark adaptation thus appears to involve two phases. First, physiological mechanisms of pigment translocation become operational at metamorphosis. Subsequently, the extent of pigment migration and the relative positions of pigments and rhabdoms continue to develop as eye growth proceeds.

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MORPHOLOGY OF PUTATIVE SOUND-PRODUCING STRUCTURES IN FIDDLER CRABS OF SUBGENUS *CELUCA*. R.S. Kaufmann* and F.H. Barnwell. University of Minnesota, Minneapolis.

Several fiddler crabs, mostly of subgenus *CelUCA*, are suspected of producing acoustic signals with cuticular structures on the inner palm of the major cheliped and anterior face of the first walking leg. These surfaces were examined by scanning electron microscopy in 11 species. Nine species were distinguishable by patterns of tubercles. In particular, members of closely related species pairs could be readily separated; *UCA musica* possessed more striae on the cheliped than *terpsichores* and *panacea* had denser patches of tubercles on the leg than *pugilator*, as did *beebei* in comparison to *stenodactylus*. Distinctive tubercle patterns were obvious on *U. latimanus* and *inaequalis*, less so in *cumulanta*, and lacking in *deichmanni* and *uruguayensis*. Our morphological analysis has turned up useful taxonomic characters and, in addition, has provided a basis for predictions about acoustic mechanisms and signal properties that can be tested in future behavioral studies.

(Supported in part by a UROP grant from the University of Minnesota.)

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SALINITY PREFERENCE BEHAVIOR OF THE FIDDLER CRAB, *UCA MINAX*. N.A. McCarty, R.D. Roer and R.B. Hamm*. University of North Carolina at Wilmington.

Fiddler crabs of the genus *UCA* possess extensive osmoregulatory capabilities and can maintain tolerable blood concentrations from fresh water to hypersaline media. *UCA minax*, however, is generally found in the fresh water reaches of estuaries. We studied the frequency distribution of *UCA minax* in a salinity gradient apparatus in the laboratory to determine if the natural distribution of this species was based upon salinity preference and to determine the modality of osmoreception. Crabs were given access to 8 compartments of varying salinity (0-35ppt) or varying ionic and osmotic concentrations. Initial preference was dependent upon acclimation salinity, while the long-term preference behavior of crabs in dilutions of sea water demonstrated a choice for median (10-20ppt) salinities regardless of acclimation salinity. Salinity is thus not the primary factor determining the natural distribution of this species. Experiments are underway to determine the chemical basis for this behavior. (Partial funding by a Sigma Xi grant to N.A.M.)

DISTRIBUTION AND ULTRASTRUCTURE OF OSMOREGULATORY AND RESPIRATORY FILAMENTS IN THE GILLS OF THE CRAYFISH. J.S. Dickson and R.M. Dillaman. Institute for Marine Biomedical Research, Wilmington, N.C.

Gills of the freshwater crayfish, Procambarus clarkii, function as a site for both respiration and ion regulation. To determine if these functions are partitioned within or between individual gill filaments, live crayfish were placed briefly in a dilute AgNO_3 solution and the pattern of silver accumulation was fixed by a photographic developer. The consistent pattern was that of silver accumulation by the filaments in the center of the gill and none by the filaments at the margin. Electron microscopic examination of filaments that accumulated silver showed features consistent with ion transport: a highly interdigitated subcuticular epithelium rich in mitochondria. Filaments not accumulating silver and presumably respiratory had a thinner cuticle and a very scant subcuticular epithelium. Na, K-ATPase levels were also highest in the silver accumulating filaments. The observed anatomical partitioning of respiration and ion transport may permit differential regulation within the crayfish.

SEQUENTIAL EXPRESSION OF GERM-LAYER SPECIFIC MOLECULES IN THE SEA URCHIN EMBRYO. G.M. Wessel and D.R. McClay. Duke University, Durham, N.C.

Two germ-layer specific molecules appear coincident with the formation of two different cell lineages in the sea urchin embryo. Both antigens are identified by monoclonal antibodies, and are described by immunofluorescence and immunoelectron microscopy, and by pulse-chase immunoprecipitations. Mesol (380Kd) is first detected in mesenchyme cells as they delaminate from the wall of the blastula. The Mesol epitope is generated in trans golgi saccules and is concentrated throughout the mesodermal cell surfaces. Expression of the Mesol epitope appears to be regulated by post-translational modification(s) of a pre-existing polypeptide chain. Endol (320Kd), by contrast, is localized to the apical and basolateral cells surfaces of mid- and hindgut cells. The first evidence of Endol translation occurs at the onset of gastrulation. Therefore, de novo expression of these developmentally regulated molecules occurs via diverse mechanisms. Supported by Grant HD 14483 from NIH.

POSSIBLE INVOLVEMENT OF NERVE GROWTH FACTOR (NGF) IN NEURAL INDUCTION IN THE CHICK. H. Lee and R.G. Nagele*. Rutgers Univ. and UMDNJ-School of Osteopathic Med., Camden, N.J.

Our previous studies have suggested that neural induction may be mediated by NGF or a NGF-like substance. To further test the validity of this hypothesis, two experimental series were carried out. In the first series, explanted stage 3-5 chick embryos were exposed to ^{125}I -labeled NGF for 3-5 hours and radioautographed. Results showed that labeled materials were most concentrated on the surfaces of presumptive neural ectodermal cells during neural induction. In the second series, cultures of embryonic chick dorsal root ganglia (DRG) were treated with protein extracts from various regions of stage 3-5 chick embryos. Hensen's node extract from stage 3+ embryos was most effective in inducing neurite outgrowth from DRG explants, suggesting that it contained the highest amount of a NGF-like substance. The significance of these findings will be discussed.

ACTIN COLOCALIZES WITH MICROTUBULES IN ADULT RAT SCIATIC NERVE AXONS TREATED WITH β,β' -IMINODIPROPIONITRILE (IDPN). R.G. NAGELE*, M.C. KOSCIUK*, and H. LEE. UMDNJ-School of Osteopathic Med. and Rutgers Univ, Camden, NJ.

Evidence for the active participation of microtubules (MTs) in axonal transport has emerged from studies on the effects of IDPN on large peripheral nerves of rodents. In the present study, we examined the possibility that the mechanism of fast axonal transport is driven by an actin-myosin contractile system associated with MTs. Sciatic nerves were injected subepineurally with IDPN and prepared for electron microscopy or indirect immunofluorescence (IIF) using monoclonal anti-actin and anti-tubulin antibodies. IDPN was found to induce complete segregation of MTs from neurofilaments and the formation of MT clusters in axons within 2 h of injection. IIF revealed that actin redistributed in IDPN-treated axons and colocalized with tubulin (corresponding to MT clusters). This finding lends further support to the notion that fast axonal transport is driven by an actin-myosin contractile mechanism. Supported by UMDNJ Foundation, Busch and Kapnek Funds.

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POSTNATAL DEVELOPMENT OF MU OPIATE RECEPTORS IN FOREBRAIN REGIONS OF THE CHICK. R. Abdulla, K. Arouni*, Dr. McLean*, Dr. Hagan.

Opiate receptors are reported to be present in the chick brain (Bardo *et al* 1982). Using *in vitro* receptor autoradiography the neuroanatomical distribution of opiate receptors in the chick brain is examined. Briefly, the method used were as follows: brains from chicks 1,7,14,21 and 28 days of age were rapidly removed, frozen, mounted onto cyrostat chucks, cut, and thaw mounted onto subbed slides. The sections were incubated in 0.05M Tris buffer with 1.0nM (³H) dihydromorphine for 30 mins. at 25°C, and the incubation terminated by 5 sequentials in 0.05M Tris buffer. The slides were processed for emulsion autoradiography. The results indicate a heterogenous distribution of opiate receptors in the forebrain with limbic regions selectively enriched.

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METAMORPHOSIS OF OYSTER LARVAE IS MEDIATED BY PUTATIVE ALPHA₁-ADRENORECEPTORS. S.L. Coon, D.B. Bonar and R.M. Weiner. Univ. of Maryland. College Park.

Larvae of the Pacific oyster, *Crassostrea gigas*, can be efficiently induced (90%) to metamorphose, without settlement behavior, by 10⁻⁶M epinephrine or norepinephrine. These compounds show high activity with exposure times of less than 30 minutes. The putative adrenoreceptors mediating the induction of metamorphosis were pharmacologically characterized *in vivo* using selective adrenergic agonists (EC₅₀: epinephrine < phenylephrine < norepinephrine < isoproterenol < methoxamine ≈ clonidine) and antagonists (IC₅₀: prazosin < WB4101 < phentolamine < phenoxybenzamine < yohimbine < propranolol). Additionally, norepinephrine, but not epinephrine, has been found in competent oyster larvae using HPLC. These results support the hypothesis that the metamorphosis of *C. gigas* is mediated at some early stage by receptors similar to vertebrate alpha₁-adrenoreceptors and that metamorphosis is induced by an endogenous release of norepinephrine, or other catecholamine-mimetic molecule, during or after settlement.

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ELECTRON MICROSCOPY OF A SYMMETRICAL BIPOLAR GASTRODERMAL SENSORY CELL IN HYDRA. J.A. Westfall, D.T. Ensley* and D.C. Hancock.* Kansas State University, Manhattan, Kansas.

Previous scanning electron microscopy (SEM) of isolated gastrodermal sensory cells of *Hydra* revealed an 8-12 μm long apical cilium lying near the perikaryon of unipolar cells or at the end of a narrow neck region of asymmetrical bipolar cells. In this SEM study of macerated *Hydra* tissues we describe a third type of gastrodermal sensory cell which is triangular in shape with a short apical cilium and two symmetrical basal processes. This cell resembles in its shape and pair of oppositely directed basal neurites a previously described JDL+ bipolar sensory cell isolated from the epidermis. It differs from bipolar epidermal sensory cells by having a visible cilium approximately 3.5 μm in length. We classify this cell as a symmetrical bipolar gastrodermal sensory cell. The morphology of the perikaryon corresponds to a gastrodermal sensory cell with apical cilium observed in the budding region of *Hydra* by transmission electron microscopy (TEM). This is the first TEM report of a luminal apical cilium on a gastrodermal sensory cell.

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MONOCLONAL ANTIBODY TO THE NEUROPEPTIDE SCP_b DEFINES SIMPLE NEURONAL SYSTEM IN EMBRYOS AND LARVAE OF TRITONIA DIOMEDEA. S.C. Kempf and B. Masinovsky. Univ. of Washington. Seattle, WA.

SCP_b-like antigenicity is first present in small cells of the cerebral ganglia and a single axon crossing the cerebral commissure in 8 d old embryos. Other axons and neurons become antigenic as the larva develops. At 4-9 d after hatching 2 pairs of neurons are labeled. Axons extend from one pair to the left cerebral ganglion and from the other to the right. A second labeled axon is present across the cerebral commissure. In metamorphically competent larvae the cerebral and pedal neuropils, as well as two neurons in the buccal ganglia with axon(s) across the commissure, are antigenic. The position of the 2 neuron pairs suggests their possible involvement in larval feeding behavior. The change in antigenicity as the larva becomes competent is presumably preparatory for juvenile life. The labeled buccal neurons may be B12, which are known to function in adult feeding behavior.

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AVIAN EXTRAEMBRYONIC FLUIDS: A POSSIBLE SOURCE OF MAMMALIAN EMBRYOCULTURE MEDIA? M.J. Murphy. State University of New York @ Cobleskill, NY.

Allantoic (AF), amniotic (AM) and extracoelomic (EC) fluids were characterized by Lowry and polyacrylamide gel electrophoresis (PAGE); protein banding patterns were compared to those obtained from embryonic serum (SER). Day 12 embryos contain extraembryonic fluids with 11 distinct protein bands ranging in relative molecular mass from 16,000 to 200,000. These bands were represented in all three fluid types (AM, AF, EC) and comigrated with identical bands in SER. Protein concentration of day 12 fluids was 0.8 mg/ml in AL, 9.3 mg/ml in EC and 14.4 mg/ml in AM. No detectable levels of proteins were found in day 7 AM and AL. Day 7 SER and EC, however, exhibited banding patterns similar to day 12 fluids when characterized by PAGE.

AM and EC may be an excellent source of *in vitro* embryoculture media since they are nearly isotonic to embryonic serum, are maintained at near serum pH, and have the full complement of serum proteins. (Supported in part by a grant from United University Professions).

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FLUOROCHROME STAINING OF SUBAERIAL GREEN ALGAE. K.J. Boullion and R.L. Chapman*. Louisiana State Univ., Baton Rouge.

Several DNA and cell wall-specific fluorochromes were used in an investigation of the effects of different photoregimes on growth and cell division in Cephaleuros virescens and Trentepohlia sp., two subaerial green algae. The stains were mithramycin, DAPI, ethidium bromide, Hoechst 33342, and Cellufluor. The optimal combination of dyes for screening large numbers of cells and for simultaneous visualization of both mitotic events and early stages of crosswall formation was mithramycin in conjunction with Cellufluor. Nuclear staining with mithramycin was variable, especially in Trentepohlia sp., but the inconsistencies could usually be overcome by long-term staining at 4°C. None of the other nuclear dyes was as effective as mithramycin, either due to failure of nuclei to stain or to limitations inherent in the observation process (e.g., damage by ultraviolet light to living cells). Supported by a Sigma Xi grant to KJB and NSF grant BSR-8308420 to RLC.

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A MODEL TO EXPLAIN NEPHRIDIAL DIVERSITY IN ANIMALS. E. E. Ruppert and P. R. Smith. Clemson University, Clemson, S. C.

A phylogenetic model explaining nephridial diversity in animals was formulated by Goodrich (QJMS 1945). The general form of the model proposed that protonephridia are primitive to metanephridia, that protonephridia are mutually homologous organs, and that urogenital systems are derivatives of originally separate excretory and genital ducts. Our model argues that nephridia modify the composition of extracellular fluid (ECF) by filtration and selective reabsorption. In animals with metanephridia, vascular fluid is pressure-filtered into a coelomic cavity across the vascular extracellular matrix (ECM) and the primary urine is swept into the metanephridium for modification. In animals with protonephridia, a blood vascular system (BVS) is absent and ECF is filtered as it is pumped into the duct across the ECM of the terminal cell. Because the absence of a BVS can be explained by functional criteria related to small body size, flat shape, or lack of septal partitions, protonephridia can be viewed as the only nephridia that will work in these body plans; they need not be regarded as primitive excretory organs. Supported by NSF Grant No. BSR-8408500 to E. E. Ruppert.

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ULTRASTRUCTURE AND FUNCTION OF THE PROTONEPHRIDIUM OF GLYCERA DIBRANCHIATA (POLYCHAETA). P.R. Smith and E.E. Ruppert. Clemson Univ., Clemson, S.C.

G. dibranchiata has a reduced blood vascular system lacking podocytes and segmental nephridial complexes consisting of a protonephridium (PN), phagocytal sac (PS), and ciliated organ, an organization predicted by our model rationalizing nephridial diversity. The PN covers the coelomic surface of the PS and consists of a series of branched collecting ducts, made of ciliated transportive epithelia, opening into a common canal leading to the exterior. Solenocytes project from the collecting ducts into the coelom and each forms a filtration tube composed of cytoplasmic rods interconnected by extracellular matrix (ECM). Following intracoelomic injections of electron-dense tracers (iron dextran, dextrans, colloidal gold), they are observed within filtration tubes and collecting ducts. Duct cells concentrate tracers in large vesicles. Permeability of the ECM of the filtration tube is $\leq 2 \times 10^6$ MW and ≤ 32 nm. Results support a filtration/reabsorption function for the PN. The ciliated organ sweeps coelomocytes and foreign particles into the PS where they are phagocytosed by cells lining the sac. The PS is considered a spleen analogue. Supported by NSF Grant No. BSR-8408500 to E.E. Ruppert.

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ULTRASTRUCTURE AND FUNCTION OF THE PROTONEPHRIDIUM OF *Nephtys* (POLYCHAETA). E. M. Messinger, P. R. Smith, E. E. Ruppert. Clemson University, Clemson, SC.

Nephtyid polychaetes are unusual in having a well-developed vascular system and segmental protonephridia, an organization not predicted by our model rationalizing nephridial diversity. The terminal part of the nephridium consists of two clusters of solenocyte nuclei flanking a collecting duct made of ciliated transportive epithelial cells. A cell process from each nucleus projects into the coelom, bifurcates, and each fork produces a weir that rejoins the duct. Podocytes are absent from nephridial, gonadal, and major vessels. Intracoelomic injections of 10 μ l of ferritin and iron dextran were incubated for various times. After standard fixation and processing, both labels were observed in filtration tubes and collecting ducts. Duct cells concentrated labels in large vesicles. The results support a filtration/reabsorption function for protonephridia. Chromatographic analysis of coelomic fluid confirmed the presence of a large (3x10⁶ MW) hemoglobin (Hb). It is concluded that the exceptional occurrence of protonephridia in *nephtyids* may be an adaptation to retain a unique coelomic entity, the extracellular Hb. Supported by NSF Grant No. BSR-8408500 to E.E. Ruppert.

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NEPHRIDIA IN THE LARVAE OF ECHINODERMS AND HEMICHORDATES. E. E. Ruppert and E. J. Balser. Clemson University, Clemson, SC

Our model for nephridial design in animals predicts the occurrence of metanephridia in echinoderms and hemichordates correlated with the presence of a coelom and a blood vascular (=haemal) system (BVS). *Tornariae*(T) of *Schizocardium brasiliense* and *bipinnariae*(B) of *Asterias forbesi* were reared in the lab. Soon after coelom formation, a hydroporic canal joins the axocoel(T) or left axohydrocoel(B) to the hydropore. Most of the axocoel and canal (T) or part of the left axohydrocoel(B) are lined with ciliated podocytes separated from the blastocoel by a basal lamina (ECM). The distal part of the canal(T) or the entire canal(B) is lined with ciliated ectoderm structured as a transportive epithelium. Perfusion of the coelom with latex microbeads reveals a constant, ciliary-driven efflux of fluid from the pore (T,B). Presumably, blastocoelic fluid re-enters the coelom across the ECM between pedicels. The coelom-canal-hydropore unit can be considered a giant protonephridium. Later, as a pulsatile vesicle joins the canal-coelom junction(T,B), correlated with larval size increase and development of the BVS, a typical metanephridial system is formed. Supported by NSF Grant No. BSR-8408500 to E. E. Ruppert.

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ULTRASTRUCTURE AND FUNCTION OF THE PROBOSCIS COMPLEX OF *SACCOGLOSSUS* (ENTEROPNEUSTA). E.J. Balser. Clemson Univ., Clemson, SC.

The proboscis complex consists of the notochord(NC), pericardium(P), glomerulus(G), protocoeil(P), protocoeil duct (PD), and pore. The NC, a diverticulum of the gut, is characterized by vacuolated epithelial cells surrounded by basal lamina and connective tissue. The PC, a myoepithelium, lies dorsal to the heart sinus. The G is a mesh of podocytes and blood vessels, formed by an elaboration of the P lining overlying the heart. Much of the remainder of the P lining is transformed into muscle and connective tissue. Opening into the P and connecting with the outside via the proboscis pore is the PD, which is composed of multiciliated transportive epithelial cells. Perfusion of the dorsal blood vessel in the trunk with vital dyes reveals a rapid flow of blood into the glomerular vessels. The results suggest that vascular fluid is filtered by G, producing primary urine in the P which may be modified as it passes over the peritoneum, through the PD, and out of the pore. An examination of the permeability of the glomerulus and transport characteristics of the peritoneal and duct cells is in progress. Supported by NSF Grant No. BSR-8408500 to E.E. Ruppert.

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ULTRASTRUCTURE AND FUNCTION OF THE COLLAR DUCTS OF PTEROBRANCHS AND ENTEROPNEUSTS (HEMICHORDATA). S.M. Lester, E.E. Ruppert and E.J. Balser. Clemson University, Clemson, SC.

Adult hemichordates possess a pair of ciliated ducts extending from the mesocoel to the exterior in pterobranchs (P) and into the first gill pore in enteropneusts (E). Classical discussions of duct function argue for an efflux of fluid (excretion) or an influx of fluid associated with hydrostatics. In P, the duct is made of monociliated, cuboidal epithelial cells with apical microvilli and few cytoplasmic vesicles. A cross-striated dilator muscle and a well-developed blood sinus are associated with the duct. In E, collar ducts are composed of multiciliated cells with apical microvilli forming a complex epithelium with various cytoplasmic vesicles. The duct has a slit-like, C-shaped lumen in cross section which may collapse arresting flow when coelomic pressure is elevated. Perfusion of the mesocoel with particulate tracers indicates ciliary-driven efflux of fluid from the collar ducts. The results support the idea of the collar ducts as excretory organs perhaps augmenting renal function associated with the glomerular complex in the oral shield (P) or proboscis (E). Supported by NSF Grant No. BSR-8408500 to E.E. Ruppert.

URICASE ACTIVITY IN THE RENAL SAC ENDO-SYMBIONT *NEPHROMYCES*. M.B. Saffo, Univ of Calif. Santa Cruz.

Hypothesized roles of the ductless renal sac of molgulid tunicates have been based on the notion that the renal sac functions as an organ of "storage excretion", with its uric acid-containing "wastes" stored permanently as concretions in the renal sac lumen.

But uric acid is not a permanent deposit: there is substantial uricase activity in the renal sac. We have shown that this activity is localized not in *Molgula* tissue *per se*, but in the cells of its endosymbiont *Nephromyces*. In lab-raised, symbiont-infected *M. manhattensis*, uricase activity is present in *Nephromyces* and the ambient renal sac fluid, yet is absent from the renal sac wall. In uninfected lab-raised *Molgula*, uricase activity is absent from all renal sac tissue and contents. *Nephromyces'* uricase activity, coupled with the probably universal infection of molgulids by *Nephromyces* in nature, suggests a need for reassessment of renal sac function, with attention to its role as a habitat for *Nephromyces*. Our results suggest that *Nephromyces* has a profound effect on molgulid uric acid metabolism, which may be a metabolic basis of this apparently mutualistic symbiosis. Supported by NSF grant 8410107 and the Whitehall Foundation.

COMPOSITION OF *MERCENARIA MERCENARIA* (L.) BLOOD PLASMA AND PERICARDIAL FLUID: IMPLICATIONS FOR ULTRAFILTRATION AND THE ELIMINATION OF POLLUTANT METALS. W.E. Robinson and M.P. Morse. New England Aquarium, Boston, MA and Northeastern University, Boston, MA.

Ultrafiltration sites have been identified in electron micrographs of the pericardial glands of the bivalve *M. mercenaria*. The biochemical composition of pericardial fluid (primary urine) and blood plasma was investigated in order to better characterize this ultrafilter. Pericardial fluid glucose (20.5±12.7 ug/ml) and lipid (51.4±50.4 ug/ml) concentrations were similar to those found in the plasma (18.2±7.5 ug glucose/ml; 31.5±25.0 ug lipid/ml). Protein concentrations, however, were significantly lower in the pericardial fluid (617.6±537.7 ug/ml) than in the blood plasma (1525.3±531.5 ug/ml), although gel electrophoresis revealed that identical proteins are present in both fluids. In animals exposed to Cd or Ag, no consistent relationship between plasma and pericardial fluid metal levels was evident, even though most metal was associated with plasma proteins. (Funded by D.O.E. Contract DE-AC02-77EV04580).

INCORPORATING MORPHOLOGICAL DIVERGENCE IN PHYLOGENY: AN EXAMPLE WITH WATERSCORPIONS. D.V. Bennett. The Univ. of Connecticut, Storrs.

Many phylogeny construction techniques incorporate some measure of divergence between taxa. The graphical limitations of 2-dimensional methods in current use are evaluated, and a 3-dimensional alternative is shown. This new representation of phylogeny combines statistical measures of continuous morphological variation between taxa, with their cladistic relations derived from analysis of discrete morphological data. The technique is applied in an analysis of morphological divergence and sister group relationships of six North American waterscorpion species (a predaceous aquatic insect in the order Hemiptera). Five of the six species examined form a sibling species group. Statistical analyses of morphological variation over latitude and longitude show clinal relationships in predatory and locomotory structures of the sibling species. The sibling species show different degrees of habitat specialization. Speciation of the sibling species is effected by Pleistocene glaciations and the slow speciation and extinction rates of the ecologically plastic waterscorpions.

SEXUALLY DIMORPHIC CHARACTERS AS INDICATORS OF PHYLOGENY IN LETHAEINE SEED BUGS (INSECTA: HEMIPTERA) J. E. O'Donnell The University of Connecticut, Storrs.

In the Lethaeini, a worldwide tribe of ground-living, seed-eating lygaeid bugs, males exhibit unexpected, sometimes bizarre features not expressed in conspecific females. A cladistic analysis shows that while some of these characters, such as modified antennal tubercles or expanded fore tibiae, are autapomorphies at the specific level, other sexually dimorphic features establish phylogenetic relationships at higher taxonomic levels. For example, I hypothesize that the common presence of elaborate metathoracic scent gland peritremes in males of the Australian genus *Aristaenetus* and the Neotropical genus *Bubaces* is a synapomorphy. The sister group relationship thus proposed can be tested by examining additional data sets for congruence with morphological data. Behavioral and biochemical characters will determine whether a plausible scenario for speciation (cladogenesis) within this lineage involves the evolution of species-specific chemical cues as pre-mating isolating mechanisms through sexual selection.

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SPECIATION RATES IN THE HAWAIIAN TERRESTRIAL FAUNA. G. Paulay. Univ. of Washington, Seattle.

The terrestrial faunas of oceanic islands are characterized by very high levels of endemism on each separate island. Most oceanic islands are the results of short periods of intense volcanism, and their ages are known. I propose a simple model to calculate the average rates of speciation for taxa inhabiting young oceanic islands, by using the age of the island and the percentage of species endemic to it. After examining its assumptions and limitations, I use the model to calculate speciation rates for the terrestrial fauna of Hawaii Island. Average rates of speciation have the order of magnitude of 10^4 - 10^5 years per speciation event. Taxa undergoing very extensive adaptive radiation (with over 100 species derived from a single ancestral coloniser) speciate considerably faster than less diversified groups.

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EVOLUTIONARY SUCCESS: ADAPTATION OR ARTIFACT? Robert J. Baikow. University of Pittsburgh, Pennsylvania.

Evolutionary success, as measured by number of species, is often attributed to key innovations. Recognition of such may be flawed by circular reasoning or by the nonequivalence of categories for taxa in eclectic classifications. The Passeriformes, by far the most successful order of birds, appears to lack derived states with such key significance, although weak hypotheses may be suggested on the basis of feeding niche specificities, limited dispersibility, vocal organs and behavior, and foot structure. Some of these, however, rely on the summary effect of different key adaptations in passerine subgroups. Perhaps we ask the wrong question. Instead of wondering why there are so many kinds of passerine birds, we might better ask why we recognize this clade out of some 9,000 as a taxon. The answer may lie more in the history of taxonomic procedure than in the adaptive significance of specific passerine characters. Supported by N.S.F. grant BSR-8314729.

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RATIONALE FOR THE PROPOSED NATIONAL BIOLOGICAL SURVEY AND PROGRESS REPORT ON IT. M. Kosztarab. Virginia Polytechnic Inst. and State Univ., Blacksburg.

We are lacking basic taxonomic-ecologic information on the composition of the biota in North America. Less than 1/3 of the living organisms and their developmental stages have been described. U. S. A. is probably the only country without an inventory of our living natural resources, while the extinction rate of our animal and plant species doubled during the past 10 years. The effect on our biota of ozone, acidification, pesticides and industrial pollution was never adequately studied. A National Biological Survey (NABIS) project can remedy the present situation. Twenty-eight scientific organizations representing over 200,000 scientists, and a number of government agencies are endorsing the NABIS concept. We need help from every life scientist with the initiation effort of NABIS.

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THE USE OF ELECTROPHORETIC DATA IN TESTING CHROMOSOMAL AND MORPHOLOGICAL PHYLOGENIES OF GERBILLIDAE (MAMMALIA). M.B. Qumsiyeh. Texas Tech University, Lubbock.

A phylogeny for seven genera of gerbils was constructed by coding chromosomal rearrangements as evidenced by banding analysis in a binary system and analyzing the data using Farris's method for computing rooted Wagner trees. Electrophoresis was used as an independent test to resolve instances where the chromosomal and morphological (Pavlinov, 1982) data were inconclusive or incongruent. By the use of these three data sets, we can place more confidence in a phylogeny for gerbils which: 1) divides this family into three distinct groups, 2) assigns the genera Sekeetamys and Desmodillus to the Meriones group, and 3) recognizes Meriones as monophyletic. In addition to the obvious systematic implications, the use of three data sets allows for more confidence in assessing the number and types of chromosomal rearrangements incorporated during the course of evolution in this group.

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AN OPHIDIAN PALEOFAUNA FROM PIT 91, RANCHO LA BREA. T.C. LaDuke. City Univ. of New York.

New studies and improved micro-vertebrate collecting techniques have resulted in the addition of several species to the snake fauna of the Rancho La Brea asphalt deposits in Los Angeles, California. The present fauna results from a current, carefully controlled excavation of a single Rancho La Brea site. Fossils were identified by comparison with modern skeletal material, increasing the Rancho La Brea snake species list from four to twelve. Two of these species are new to the fossil record. The fauna is very similar to that of the Los Angeles region today but indicates a climate that was slightly more moist. It is suggested that the stability of the North American herpetofauna compared to the mammalian fauna may be related to the ability of small ectotherms to maintain viable populations in isolated refugia which will not support populations of large endotherms. The comparative method of identifying fossil snakes by their vertebrae is critiqued and it is suggested that a multivariate discriminant or regression analysis might prove more useful.

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A MIOCENE EOSUCHIAN - EXAMPLE OF THE LAZARUS EFFECT. M. HECHT. Queens College, Flushing, New York.

An eosuchian reptile was identified from the early Miocene (Aude, France); from a classic deposit associated with a well known biota. Eosuchia are paraphyletic lepidosaurs. The fossil is placed in the suborder Younginiformes, which appears in the Upper Permian and vanishes in the Lower Triassic. The postcranial skeleton is complete; the skull is incomplete. The fossil bears many primitive features as thecodont teeth, amphicoelous vertebrae, hooked fifth metatarsal, gastralia, etc. This specimen represents a primitive taxon which disappears in the early Mesozoic and reappears in the middle Cenozoic; this is called the Lazarus Effect.

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PLACENTATION IN THE ROUGH EARTH SNAKE, VIRGINIA STRIATULA (SERPENTES: COLUBRIDAE). J.R. Stewart. Univ. of Tulsa.

The morphology of the extraembryonic membranes of Virginia striatula suggests three structures as potential sites of maternal-fetal placental exchange. The first of these to develop, the choriovitelline placenta, is confined to the area above the sinus terminalis and consists of a vascularized trilaminar omphalopleure adjacent to a vascularized uterine epithelium. The choriovitelline membrane is transitory and is replaced by the chorioallantois. The chorioallantoic placenta, formed as the allantois expands to contact the chorion, is richly vascularized by both allantoic and uterine vessels. The formation of the isolated yolk mass, characteristic of squamate development, is associated with the third placental structure. The placenta of the isolated yolk mass forms as a non-vascular bilaminar omphalopleure. Both the chorioallantoic placenta and the placenta of the isolated yolk mass persist throughout development. The shell membrane is a prominent structure between extraembryonic membranes and the uterine epithelium in all regions. (Supported by a Cottrell College Science Grant from Research Corporation and a University of Tulsa faculty research grant).

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COMPARATIVE TONGUE AND ANTERIOR PROCESS HISTOLOGY IN FIVE COLUBRID SNAKES. G.R. Ten Eyck and James C. Gillingham. Central Michigan Univ., Mt. Pleasant, MI.

A histological examination was conducted on the ophidian olfactory transfer mechanism utilizing light and electron microscopy. Five colubrid species were studied: Opheodrys aestivus, Carphophis amoenus, Thamnophis sirtalis, Nerodia sipedon, Masticophis flagellum. Major differences were found between the dorsal and ventral epithelium of the tongue in all the species considered. The ventral surface was characterized by a thicker epithelium, which contacts the dorsal surface of the anterior processes. Even though tongue morphology displayed some interspecific differences the general histology remains similar. The anterior processes were chiefly composed of collagen fibers. The striking feature of the processes was an epithelium consisting of stratified squamous cells which varied in thickness according to where the tongue contacted them. Goblet cells and mucous glands provided the mechanism with lubrication and particle adherence. The overall histology and morphology displays a mechanism for enhanced chemical transfer from the environment to the ducts of Jacobson's organ. This study confirms the transfer mechanism proposed by Gillingham and Clark (1981).

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SNOUT MOBILITY IN SOME NATRICINE SNAKES. D. Cundall and J.S. Cundall*. Lehigh Univ., Bethlehem, PA, and Muhlenberg College, Allentown, PA.

It has long been assumed that the snout of snakes behaves as a single mechanical unit that moves only around the prokinetic joint between the snout and the braincase. Cinegraphic, radiographic and histological data for several natricine species suggest that the seven bones of the snout form four units (1-nasals, 2-right, and 3-left septomaxillary-vomerine complexes and 4-premaxilla) having limited independent mobility. Movement is permitted by structural relationships between the bony and cartilaginous elements, particularly the placement of the nasal septum between the septomaxillae and the separation of the septomaxillae from the premaxilla by the nasal capsules. Movement may be caused either by external forces or displacements of the underlying palatomaxillary apparatus. Based on morphological data, loosening of the snout may be characteristic of many advanced snakes and may enhance the functional independence of right and left palatomaxillary arches.

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MORPHOMETRIC ANALYSIS OF LIZARD SKULLS. R.T. Zanon. Univ. of Chicago, Chicago, IL.

Uni- and multivariate analyses were performed on a data set of fifteen whole-skull variables, reflecting functionally significant parameters. 141 species of lizards were included, representing five families: Anguidae, Iguanidae, Scincidae, Teiidae, and Varanidae. Variables were corrected for size using brain stem length. Univariate comparisons of family means suggest that varanids and teiids have relatively greater gape than the other lizards in the sample, and that each of these two families has corrected for an otherwise reduced bite force in a different way. In a principal components analysis, the first three components primarily reflect length, width, and height of skull respectively. There are no clean separations between either taxonomic or ecological groups, although certain trends are apparent.

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ON THE BEGINNINGS OF EXPERIMENTAL BIOLOGY-ABRAHAM TREMBLEY'S RESEARCH ON HYDRA. H.M. Lenhoff and S.G. Lenhoff*. University of California, Irvine.

In four short years Abraham Trembley startled a disbelieving world with his experiments demonstrating for the first time that: a) complete animals can regenerate from small cut pieces of those animals; b) animals can reproduce without the involvement of gonads; c) tissue sections from two different animals of the same species can be grafted to each other; and d) "eyeless" animals can exhibit a behavioral response to light. Trembley affords us insights into a remarkably attractive philosophy of experimental research as he presents the results of his experiments in his masterwork, the 1744 Mémoires on the fresh-water "polyp." (For an English translation, see S.G. Lenhoff and H.M. Lenhoff, Hydra and the Birth of Experimental Biology-1744; Abraham Trembley's Memoirs Concerning the Polyps, Boxwood Press, Palo Alto, CA.) Trembley's experiments and philosophy and methodology of experimental research, and references to them by several important American experimental biologist of the late 19th and early 20th centuries, will be the subject of our presentation.

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SOME EXPERIMENTAL BIOLOGY WITH BENJAMIN FRANKLIN. Brother C. Edward Quinn FSC, Manhattan Coll. New York, N.Y.

Among the American Founding Fathers, Benjamin Franklin was the only one with an international reputation as a scientist. The main source of Franklin's reputation was, of course, the experimental work he had done with electricity. But Franklin did some experimental biology too. He relates that his father induced alewives to spawn in a river where they had never spawned before. Perhaps this example prompted Franklin to test how ants inform their nestmates about the location of food. In addition, he was one of the first to apply statistics to problems like the effect of inoculation on smallpox mortality, and the role of lemon juice in reducing the incidence of shipboard scurvy. Franklin believed ideas should be tested, and he tested a few favorites of his time. For example, he showed why killing blackbirds was not an unmixed blessing for the farmer.

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IS DOWN SYNDROME A MODERN DISEASE?

E. Peter Volpe. Mercer Univ. School of Medicine, Macon, Ga.

Down syndrome is the most common congenital disorder associated with severe mental retardation. The anomaly is so common and so apparent clinically that it is surprising, if not startling, that the condition was recognized as a distinct entity only slightly more than a century ago. The first pictorial sketch in the medical literature of the facial features of a person with Down syndrome appeared in 1876. Did awareness of Down syndrome predate the medical reports of the late 1800s? A hypothesis is presented to explain what appears to have been a complete oversight of a very conspicuous disorder. A plausible explanation is that early physicians had confused the stunted, mentally retarded Down child with the dwarfed, mentally deficient cretin. Eventually, knowledge and understanding of Down syndrome became possible when this condition was divorced from cretinism.

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BIOLOGICAL LIFE ACCORDING TO PLATO AND ARISTOTLE. James A. Marcum. Harvard Medical School, Boston.

For Plato and Aristotle, a living entity is composed of a body as well as a soul. The relationship between these two components is important in understanding biological life. The body according to these peripatetics is composed of fundamental elements from which all material bodies are constructed. However, animate beings cannot be reduced to their physical components alone; rather, living organisms are a composite between the material elements and the soul. The soul serves as the principle of animation, imparting life to the body; it is the cause of life and is responsible for the function of bodily events. Biological life is an operational concept involving the direction of bodily processes. The actions of the body reflect, as it were, regulatory patterns of the soul itself, including generation, nutrition, motion, and sensation. The relationship of the soul to the body in a biological context is a balance between bodily processes and the homeostatic actions of the soul. Living beings are dependent upon hierarchical patterns which are essential for maintenance of bodily functions.

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METAPHORS AND ANALOGIES IN D'ARCY

THOMPSON'S ON GROWTH AND FORM. M. Bradie. Bowling Green State Univ., Bowling Green, Ohio.

D'Arcy Thompson's On Growth and Form is an important contribution to morphology and development. A central feature of the work is Thompson's explicit appeal to metaphors and analogies drawn from the physical sciences and applied to biological phenomena. The paper is divided into three parts. Part I is a brief description and assessment of Thompson's work in morphology and development. Part II develops a schema for the role of metaphors and analogy in scientific reasoning. Three central roles are distinguished: (1) the use of metaphors and analogies drawn from already developed theories in one field to suggest and validate new theories in the same or other fields; (2) the use of metaphors drawn from physical phenomena to suggest and validate theories; (3) the use of metaphors in applying theories to empirical phenomena. The general thesis argued for is that metaphors and analogies are cognitively significant tools for the validation of theories and are not merely heuristic. Part III is a discussion of some of the central metaphors and analogies in Thompson's work in the light of the above schema.

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SCIENTIFIC CREATIONISM: MYTHOLOGY IN THE MAKING. W.D. Hummon. Ohio Univ., Athens.

'Scientific' creationism is one of a host of recent reactions to a perceived 'profaning' of the universe by evolution/ secular humanism. These are equated & blamed for the evils of modernity. But, creationism itself has many characteristics of a mythology in the very process of formation and development. It is constrained both by a view of Biblical inerrancy & by the need to accept and incorporate into its new sacred view of history the unassailable findings of science. Its primordial event is not so much creation itself as the flood & a 'geologic/hydraulic' explanation in terms of a young earth. The spindle of the earth (axis mundi) is held to pierce the traditional Mt. Ararat. The geocentric, flat-earth/waters-of-the-firmament view becomes a heliocentric, round-earth/vapor-canopy view that is read back into Genesis. Creationists claim to have discovered both heliocentrism and natural selection. Adoption of their new cosmology (or even parity of time with the 'evolution model') will bestow upon it a divine origin and dimension. For myth once told establishes thenceforth for believers truth that is absolute & the nostalgia for paradise that led Morris from Genesis (1976) to Revelations (1983).

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CHARACTERIZATION OF RED CELL HEMOGLOBIN OF PHORONIS PSAMMOPHILA. T.L. Vandergon and J.M. Colacino. Clemson Univ., SC.

The circulating blood cells of *Phoronis* contain hemoglobin at an average heme concentration of 17.2 mM. The p50 for O₂ binding by Hb averages 1.26 mmHg *in vivo* and 1.01 mmHg *in vitro*. The pigment shows cooperative O₂ binding *in vivo* (Hill number = 3.4) but no significant Bohr effect ($\Delta \log p50/\Delta pH = -0.01$). *In vitro* stopped flow O₂ dissociation measurements at various wavelengths result in curves with three distinct phases with rates of approximately 14, 5 and 0.05 sec⁻¹. The first two rates, ascribed to O₂ dissociation, suggest a heterogeneous Hb. The third phase may result from an aggregation state change of the pigment following deoxygenation. The overall O₂ association rate of the pigment is $3.5 \times 10^6 M^{-1} sec^{-1}$, calculated from an overall dissociation rate (phases 1&2) and the steady state equilibrium value. Sephadex gel filtration of red cell lysate saturated with CO shows two components of very similar MW between 16 - 17,000. Neither gel filtration nor electrophoresis has yet shown a Hb component above a MW of approximately 16,000. Thanks are due to C. Bonaventura and J. Bonaventura (Duke Marine Lab) for the use of their equipment and their assistance with stopped flow kinetic measurements.

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RELATIONSHIP BETWEEN BLOOD VOLUME AND HB-O₂ AFFINITY. G. F. Birchard, Dept. of Physiology, Dartmouth Medical School, Hanover, NH 03756.

Increased blood volume (TBV) results in greater tolerance to experimental hypoxia. Since P₅₀ and tolerance of ambient hypoxia are inversely related we hypothesized that TBV and P₅₀ might also be inversely correlated. Data for P₅₀, hematocrit, plasma volume (PV) and TBV were gathered from the literature for 22 species and subjected to least squares regression analysis. The relationships found were: TBV=112.5-1.45(P₅₀), r²=0.37, p>.003 and PV=78.7-1.1(P₅₀), r²=0.37, p>.004. No relationship between P₅₀ and hematocrit was found. These relationships do not reflect the combination of correlations between body mass and P₅₀ and body mass and TBV. It is suggested that an increased blood volume may account in part for the increase in hypoxic tolerance of animals with low P₅₀s.

Supported by NIH grants HL02888 and HL07449. GFB is a fellow of the A.J. Ryan Foundation.

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SUBUNIT HETEROGENEITY OF THE BLUE CRAB (CALLINECTES SAPIDUS) HEMOCYANIN ALONG A SALINITY GRADIENT. J. Rainer, C. P. Mangum and G. Godette*, Col. Wm. & Mary, Williamsburg and Duke Univer. Mar. Lab, Beaufort, NC.

A salinity gradient was defined by the fresh water of the Pamunkey river down the increasingly saline water of the York river to the Chesapeake Bay and ending with the full strength saline water of the Atlantic ocean off the Virginia eastern shore. Populations of blue crabs were sampled at various points along this gradient. Blood was sampled from individual crabs and dialyzed to dissociate the hemocyanin subunits from their multimeric structures. The samples were then electrophoresed to distinguish the 6 different subunits as shown by the banding on the gel. Each band was densitometrically scanned to determine the various concentration of each subunit for each individual of each population sampled. The results obtained from the scans suggest that three of the six subunits change in concentration according to salinity.

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THE EFFECT OF CO₂ ON THE ADRENERGIC REGULATION OF BLOOD-OXYGEN AFFINITY IN THE TELEOST, FUNDULUS HETEROCLOLITUS. P.M. Dalessio, L. DiMichele, and D.A. Powers, George Washington Univ., Washington, DC and The Johns Hopkins Univ., Baltimore, MD.

Many studies have indicated that endogenous release of epinephrine in teleosts causes an increase in blood-oxygen affinity that is controlled by changes in intraerythrocytic pH and ion fluxes. We found that this response appears to be dependent on blood Pco₂ (HCO₃⁻). Epinephrine, whether injected into the fish or added to whole blood ameliorates both the hypocapnic increase in blood-oxygen affinity and the hypercapnic decrease in blood-oxygen affinity. At resting blood Pco₂, epinephrine has no effect on blood-oxygen affinity. From *in vitro* experiments we hypothesize that this phenomenon is attributable to a reversible proton channel whose status is neutral at resting pH and Pco₂. If correct, our hypothesis predicts that epinephrine's major role is to limit excessive changes in oxygen affinity at the onset of stress.

CHARACTERIZATION OF THE HEMOGLOBINS ISOLATED FROM HIBERNATORS OF THE GENERA CITELLUS AND MARMOTA. L.K. Duffy, C.T. Genau* and G.L. Florant.* Harvard Medical School, Boston, MA, Univ. of Alaska, Fairbanks, AK and Swarthmore College, Swarthmore, PA

Characterization of hemoglobins of winter-hibernating, winter-active and summer-active arctic ground squirrels (Citellus undulatus) by citrate agar electrophoresis and isoelectric focusing (IEF), pH 5.5-8.5, showed no differences in electrophoretic patterns. Previous studies showing alterations in hemoglobins were most likely the result of artifacts due to the use of whole blood. The arctic ground squirrel's hemoglobin amino terminal sequence was determined for each activity state and was identical in all cases.

The hemoglobins from Citellus undulatus will be compared with the hemoglobins from Citellus lateralis and Marmota flaviventris.

VARIATION IN THE OXIDATION OF GLUTAMATE AND GLUCOSE BY VERTEBRATE AND INVERTEBRATE ERYTHROCYTES. N.A. Mauro and R.E. Isaacks. Veterans Administration Medical Center, Miami, Fla.

With the exception of the lungfish, nucleated vertebrate erythrocytes (RBC) can clearly be differentiated metabolically from those of invertebrates. The lungfish RBCs like those of invertebrates demonstrate a greater oxidation of exogenous glutamate than RBCs from most vertebrates. In the lungfish, glutamate is oxidized 2.7 times more than glucose. The rate of glutamate oxidation in other species of fish, as well as other classes of vertebrates, is approximately equal to, or less than, that observed from glucose. These observations are surprising since RBC's of vertebrate, in general, are permeable to glutamate which is oxidized directly via the TCA cycle. Furthermore, these findings suggest a specialization of vertebrate RBCs toward carbohydrate oxidation.

HEMOLYMPH AND TISSUE ION AND ACID-BASE BALANCE IN CRAYFISH DURING CHRONIC EXPOSURE TO NITRIC ACID. B.R. McMahon and S.A. Stuart. Biology, U. of Calgary, Calgary, Alberta, Canada.

Adult Procambarus clarki, acclimated (14d) to soft water ($Ca^{++}0.22mM$) were exposed 21-60 days to pH 4.0 (HNO_3) in soft water. Hemolymph was sampled at 0,1,2, 7,14,21,60 d in acid and 1,2 and every 7d during recovery. Tissue ion contents were determined weekly. Exposure to HNO_3 caused an initial hemolymph acidosis, reduced PCO_2 and $[CO_2]$ and no increase in lactate. In chronic exposure, however, hemolymph acid-base status returned to normal. Hemolymph NO_3 increased significantly, but other hemolymph ions were significantly depleted at 7d acid exposure. $Na^+ Cl^- Ca^{++}$ (not K^+ or Mg^{++}) however, showed substantial recovery during chronic acid exposure. Tissue ion levels, in general, showed little recovery. In contrast with previous acute (H_2SO_4) studies, the results suggest some potential to compensate for and perhaps survive severe acid exposure in Procambarus. The extent to which the observed recovery results from uniqueness of either the species or acid employed is not known. Return to normal pH was associated with hemolymph alkalosis. Ion status recovered completely within 7d in hemolymph but more slowly in tissues.

RESPONSES OF BLUE CRABS TO NEUTRAL AND ACIDIC SEAWATER INJECTION. K.L. Gallagher* and P.L. deFur. George Mason Univ., Fairfax, VA.

Blue crabs (Callinectes sapidus) were injected with seawater (SW) at a pH the same as, or 1 unit lower than the pH of the hemolymph. In one set of experiments, arterial hemolymph pH, CO_2 content ($CaCO_2$), and CO_2 tensions ($PaCO_2$) were measured over a 4h period and at 24h. In a second set of experiments, the above variables and ventilatory flow (V_w) were measured over the same time period. pH decreased over 4h in all cases. At 24h post injection, pH was lowest in animals injected with acidic SW. Mean $CaCO_2$ decreased in all cases except during SW injection experiments in which V_w was monitored. Mean $PaCO_2$ cyclicly increased then decreased in all cases; the greatest increase occurring following SW injection. There were discrepancies between measured $PaCO_2$ values and those calculated using pK_1 values from the literature.

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INTRACELLULAR pH (pH_i) REGULATION IN FROG MUSCLE. Robert W. Putnam and Albert Roos*. Washington University School of Medicine, St. Louis.

Recovery of pH_i from acid loads (5% CO_2) was studied with microelectrodes in semitendinosus fibers from *Rana pipiens*. Recovery in resting fibers ($2.5K, V_m -90mV$) was $0.03 \pm 0.01 \Delta pH_i/h$ ($n=16$). It increased to 0.28 ± 0.02 ($n=42$) upon depolarization (50K, constant Cl , $V_m -20mV$), and was partly inhibited by $1mM$ amiloride (Na/H exchange) and partly by $0.5mM$ SITS (Na/HCO₃/Cl exchange). In resting fibers exposed to CO_2 , either $1mM$ amiloride or Na removal produced a slow acidification of 0.07, probably due to HCO₃ efflux. Recovery from an acidifying NH₄Cl prepulse (no CO_2), entirely due to Na/H exchange, was the same in resting 0.26 ± 0.04 ($n=10$) and depolarized fibers 0.29 ± 0.03 ($n=13$). Depolarization in constant Cl elevates Cl_i from 2 to $\sim 30mM$. Recovery from CO_2 was lower when depolarization (to $\sim 20mV$) was achieved without an increase in Cl_i : 0.21 ± 0.01 ($n=53$) in 50K, constant KxCl; and 0.14 ± 0.02 ($n=19$) in 2.5K, 5.9Cl, 0.5Ba. We propose that increased recovery with depolarization at constant Cl is partly due to the elimination of an acidifying HCO₃ efflux and partly to an increase in Cl_i . (NIH Grant HL-00082.)

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BUFFERING CAPACITIES AND LDH ACTIVITIES OF HEART AND SKELETAL MUSCLE OF A VERTEBRATE FACULTATIVE ANAEROBE. K.M. Crawford and J.M. Olson. Univ. of Michigan, Ann Arbor.

Aquatic turtles possess adaptations for long term submergence and anoxia tolerance unrivaled among air breathing vertebrates. The ability of tissues to buffer the acidic end products of anaerobic metabolism may be an important adaptation to maintain function during hypoxic conditions. We therefore measured *in vitro* non-bicarbonate buffering capacity (β) and lactate dehydrogenase (LDH) activity of pectoralis muscle (PM) and cardiac muscle (CM) homogenates of locally collected *Chrysemys picta*. β was significantly higher in PM than CM (40.3 and 27.0 slykes, respectively). These values are lower than those reported for fish white muscle. LDH activities of PM and CM were not significantly different at either 10°C (125.5 vs. 137.7 IU/g) or 25°C (354.4 vs. 343.2 IU/g). The Q_{10} for LDH activity was 2.03 for PM and 1.87 for CM. There appears to be no direct association between β and LDH activity for these tissues. This may reflect the need for a higher buffering capacity in skeletal muscle which may not be perfused during prolonged dives.

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DIFFERENTIAL EFFECTS OF Ca^{2+} -CHANNEL ANTAGONISTS ON CARDIAC ACTION POTENTIALS IN RAT AND GOLDFISH. John S. Cameron. Dept. of Biol. Sci., Wellesley College, MA 02181

The contribution of calcium currents to transmembrane action potential (AP) configuration in goldfish (*Carassius auratus*) myocardium was investigated and compared to that in mammals. Cellular electrophysiologic responses to varying concentrations of external Ca^{2+} (0.9-3.6 mM) and of the Ca^{2+} -channel blocking agents verapamil (V; 0.1-2.0 $\mu g/ml$) and Mn^{2+} (0.9-3.6 mM) were monitored with standard glass microelectrodes in isolated, superfused ventricles. Elevated $[Ca^{2+}]_i$ shortened the AP in endocardial muscle fibers of both rat (37°C) and goldfish (22°C), while decreased $[Ca^{2+}]_i$ lengthened it. In rat, V and Mn^{2+} reduced AP duration at 25% repolarization (APD_{25}), but prolonged APD_{50} ; AP amplitude (APA) and upstroke velocity (V_{max}) were unaffected. In contrast, goldfish APD_{25} , APD_{50} , APA and V_{max} decreased in response to V or Mn^{2+} , an effect prevented by isoproterenol ($10^{-6}M$). Ca^{2+} -mediated slow inward currents (I_{s_i}) may contribute more to ventricular depolarization in teleosts than in mammals; the relative role of I_{s_i} and Ca^{2+} -activated K^+ currents in AP plateau formation is uncertain. (NIH, NIRA HL-34672 and Brachman-Hoffman Fdn.)

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ACID-BASE CHARACTERISTICS OF THE UTERINE ENVIRONMENT FOR LATE GESTATION DOGFISH PUPS. G.A. Kormanik and D.H. Evans. Univ. North Carolina at Asheville, Univ. Florida, Gainesville and Mount Desert Isl. Biological Laboratory, Salsbury Cove.

Pups of the dogfish, *Squalus acanthias*, during late gestation, live in a uterine solution resembling sea water, at least with respect to the major ion concentrations. It is not clear what role the mother plays in supplying O_2 and removing CO_2 and waste products. We examined blood acid-base values for mothers and pups as well as the uterine sea water. Blood of the mothers and pups is not significantly different with respect to pH, CO_2 content, Na and urea. Pup blood ammonia was significantly higher (1160 vs. 334 μM) and PCO_2 slightly lower compared to the mother. Uterine sea water had an ammonia concentration of up to 22 mM and a pH as low as 5.4, thus the pups were living in ammonia concentrations ordinarily considered to be toxic to aquatic organisms. It would appear that the low pH protects the pups against the toxic NH_3 gas, since most ammonia is in the ionic form. The role of this accumulated ammonia is not yet clear. (Funded by NSF PCM 83-02621 to D.H.E. and an NSF-ROA to G.A.K.)

CALCIUM BINDING BY MOLLUSCAN ORGANIC MATRIX: EFFECTS OF IONIC STRENGTH AND RELEVANCE TO BIOMINERALIZATION.

A.P. Wheeler, K.W. Rusenko,* J.W. George* and C.S. Sikes.* Clemson Univ., SC and Univ. of South Alabama, Mobile.

Calcium association with fractions of organic matrix extracted from the shell of the oyster *Crassostrea virginica* and the clam *Mercenaria mercenaria* was determined at various concentrations of NaCl and other salts using calcium-specific electrodes and static and dynamic equilibrium dialysis. At NaCl concentrations approaching that of the mineralization medium for these molluscs, calcium binding was reduced to a level such that only static dialysis was sensitive enough for detection. Polyaspartate, an analogue of matrix, associates with calcium with approximately the same affinity and sensitivity to ionic strength as matrix. From these studies it is suggested that undue emphasis on calcium binding by organic matrix *in vitro* as indicative of its role in the initiation of biomineralization is unwarranted. The calcium associated with matrix may be inconsequential in the ionic environment in which nucleation of biomineral occurs. This research was supported in part by South Carolina Sea Grant Consortium grant SC 85-6.

QUATERNARY AMMONIUM SULFANILAMIDE: A NOVEL CARBONIC ANHYDRASE INHIBITOR. R.P. HENRY. AUBURN UNIV., AUBURN, AL.

The enzyme carbonic anhydrase (CA) has been shown to be associated with the plasma membrane of a number of tissues (e.g., vertebrate kidney and lung). Direct physiological studies of membrane-associated CA have been difficult because of the absence of a way to selectively inhibit the membrane-associated enzyme. In an attempt to develop a membrane-impermeant CA inhibitor the quaternary ammonium derivative of the CA inhibitor sulfanilamide was synthesized. Quaternary ammonium sulfanilamide (QAS) has a MW of 309, a melting point of 231.8 C, and gave one spot on TLC (Rf=0). The affinity constant (Ki) for QAS against pure Bovine CAII was between 1 and 10 μ M. An 18-oxygen/mass spectrometer CA assay was used to test the permeability of QAS to the cell membrane of intact erythrocytes (rbc's). After 24 hr of incubation in 5 mM QAS the rbc's showed no loss of intracellular CA activity; CA activity from lysed rbc's was immediately and completely inhibited by 5 mM QAS. This indicates that QAS is indeed membrane impermeant, and it is a useful tool for directly studying the physiology of membrane-associated CA in a variety of tissues. Supported by NSF DCB 84-17379.

pH-DEPENDENT ARRESTMENT OF CARBOHYDRATE METABOLISM DURING ANAEROBIC DORMANCY AND AEROBIC ACIDOSIS IN ARTEMIA CYSTS. J.F. Carpenter and S.C. Hand. Univ. of Southwestern Louisiana, Lafayette.

Mobilization of trehalose and synthesis of glycogen and glycerol are blocked during anaerobic dormancy (known to foster intracellular acidification), and adenylate energy charge (AEC) drops from 0.72 to 0.42. Glucose levels remain unchanged throughout anaerobic incubation while the glucose 6-P/glucose ratio drops from an aerobic, control value of 0.36 to 0.042. These findings indicate that trehalase and hexokinase (HK) are simultaneously inhibited. Inhibition of phosphofructokinase (PFK) is reflected in a decline of the fructose 1,6-P₂/fructose 6-P ratio from 2.77 to 0.94. The reactions catalyzed by trehalase, HK and PFK are displaced from equilibrium, with MAR/Keq values of 2.15×10^{-9} , 2.79×10^{-5} and 2.79×10^{-3} , respectively. Exposure of cysts to aerobic conditions known to artificially depress intracellular pH (60% CO₂: 40% O₂) leads to similar metabolic transitions (except that AEC only drops to 0.68) which can be fully reversed by return to control, aerobic incubation. Thus, it is concluded that hydrogen ion is a primary modulator of carbohydrate metabolism in *Artemia* cysts. Supported by NSF Grant DCB-8316711.

SPECIES AND STRAIN DIFFERENCES IN RBC GALACTOKINASE ACTIVITY. H.M. Kuerer*, L.-Y. Shih*, and O. Gona. Departments of Pediatrics and Anatomy, New Jersey Medical School, Newark, NJ 07103.

Abnormalities in galactose metabolism result in human cataract and high dietary galactose induces cataract development in mammals, including rat and rabbit but not mouse. We recently induced galactose cataracts in a strain of mice with low galactokinase activity. Because mice do not readily develop galactose cataracts, it was of interest to compare galactokinase activity in mouse with that in rat and human. Blood was collected from Sprague-Dawley rats (5-10 wks), C57BL and AJ mice (6-8 wks), and humans (various ages). RBC galactokinase activity was measured by the modified method of Beutler (1981) using a ¹⁴C-galactose substrate. Highest activity was in AJ mice (121 μ U/g Hb) and lowest in adult human (25 μ U). C57/BL mice, in which we induced cataracts by prenatal galactose exposure, had a 48 μ U/g Hb mean activity while that of Sprague-Dawley rats was 71 μ U Hb. The results do not support the hypothesis that susceptibility of humans and rats, and resistance of mice, to galactose cataract development is mainly due to RBC galactokinase activity.

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POSTPRANDIAL OXYGEN UPTAKE IN MYTILUS EDULIS L. RECOVERING FROM STARVATION. W.J. Diehl, P.M. Gaffney* and R.K. Koehn*. State Univ. New York, Stony Brook.

Mytilus edulis spat were grown singly in plastic racks in a tidal salt marsh for 10 weeks, starved in the laboratory for 19 weeks, then fed Isochrysis galbana in excess for 10 weeks. During this recovery, individuals returned to a mean 89% of their estimated dry weight prior to starvation, from a mean 53% after starvation. At weekly intervals during recovery, oxygen uptake was measured following a pulse of food until it returned to a basal rate; postprandial and basal volumes (ul at STP) of oxygen consumed (VO_{2pp} and VO_{2b} , respectively) were calculated. Both VO_{2pp} and VO_{2b} increased significantly during recovery; VO_{2pp} increased significantly from 15.2 to 23.2% of VO_{2b} . At the end of the recovery period, VO_{2pp}/VO_{2b} was independent of final dry weight but was significantly correlated with percent dry weight recovered ($r = 0.663$; $df = 11$; $P < 0.025$). We interpret the increase in VO_{2pp}/VO_{2b} to reflect increased utilization of food and its conversion to soma during recovery from starvation, as distinct from mechanical energy expenditure (feeding activity) following a meal.

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ADJUSTMENTS OF CARDIAC RATE TO CHANGES IN RESPIRATORY GASES BY A BIMODAL BREATHER, THE PANAMANIAN SWAMP EEL, SYNBRANCHUS MARMORATUS. J.L. Roberts and J.B. Graham, Univ. Massachusetts, Amherst, and Scripps Inst. Oceanography, La Jolla, Ca.

Extreme lability of heart frequency (fH) occurs during air breathing cycles of swamp eels. When a breath is taken into the air breathing organ by an eel, the fH rises sharply to >40 cpm from the low rate of 3 to 10 cpm found just after release of a prior air breath (AB). Just after filling of the air breathing organ (10 to 30 ml), fH declines slowly as O_2 is extracted, often dropping to about half the initial rate before breath release occurs. During rhythmic gill breathing in well-aerated water, fH remains comparable to the rate found after taking of an AB. When gill breathing ceases a marked bradycardia develops immediately, as when an AB is released. Atropine (1 mg/kg) blocks development of the bradycardia and stabilizes fH to ± 40 cpm or the maximum rate observed for a specific animal. Evidence obtained by artificial changes in volume and concentrations of O_2 and CO_2 present in the AB shows a fH dependency supporting the view that swamp eels monitor both volume and quality of air breaths.

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PERIODIC CO_2 RELEASE IN LAND SNAILS AND INSECTS: A COMPARISON. M.C. BARNHART, UNIV. OF CALGARY, CALGARY, ALTA.

Respiratory gas exchange of many dormant or resting insects and of dormant helioid land snails is characterized by alternating periods of CO_2 accumulation and release. In insects, CO_2 accumulation is attributed to subambient pressure in the tracheal system (suction ventilation). However, analysis of gas exchange in snails (Otala) shows that suction ventilation is not prerequisite for periodic CO_2 release. Regulation of low PO_2 in the tracheae or lung is associated with periodic CO_2 release in both systems, and may be possible only when metabolic rate is very low. The magnitude of fluctuations of body CO_2 content is about 30 times greater in Otala than in lepidopteran pupae of similar mass, due mainly to greater buffering capacity in the mollusc. In contrast to pupae, dormant Otala show periodic, sustained elevations (2 to 3 fold) of the rate of oxygen consumption. Periodic increase of oxygen consumption is closely correlated with decrease in whole-body CO_2 content (calculated from the respiratory quotient and continuous recording of respiratory exchange ratio).

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ONTOGENY OF HEART RATE REGULATION IN AMPHIBIANS. W. Burggren and M. Doyle. Univ. of Massachusetts, Amherst.

Little is known of the ontogeny of cardiovascular regulatory mechanisms in lower vertebrates. Consequently, heart rate was measured in six developmental stages of the bullfrog before and after acute hypoxia, exercise and treatment with cholinergic and adrenergic antagonists, to assess developmental changes in cardiac function. Resting heart rate was highest in newly hatched larvae, intermediate through the remainder of larval development, and lowest in adults. These developmental changes were due largely to changes in intrinsic properties of the cardiac pacemaker, rather than vagal or sympathetic influences. Hypoxia, exercise or drug treatment had no effect on heart rate of newly hatched larvae, but induced major changes in older larvae and adults. We conclude that the capability for cardiac regulation increases with development. However, intermediate and late larval stages show regulatory mechanisms different from, but no less complex, than those of post-metamorphic adults. Support by NSF grant #PCM-8309404.

NEURAL CORRELATES OF REVERSED VENTILATION IN THE SHORE CRAB. R.A. DiCaprio (intro. by M.H. Rowe) Ohio University, Coll. Osteo. Med., Athens.

Gill ventilation in decapod Crustacea is produced by the rhythmic dorsoventral movements of the scaphognathite (SG) or gill bailer of the second maxilla. Alteration of the recruitment sequence of the four major muscle subgroups controlling the SG allows water to be pumped in either of two directions, corresponding to forward and reversed ventilation. The ventilatory motor pattern is organized and controlled by non-spiking interneurons. A class of interneurons has been found which appear to play a fundamental role in the switch between forward and reversed ventilation. These cells fire a sustained burst of action potentials during reversed ventilation. Bouts of reversed ventilation can be elicited by depolarizing these neurons, and the reversed motor program is terminated when the current is turned off. The activity of motor pattern generator interneurons, frequency modulating interneurons and motor neurons during reversed ventilation will also be presented.

RESPONSES OF CONSCIOUS, DECEREBRATE AND ANESTHETIZED CATFISH TO HYPOXIA AND NaCN. M.L. BURLERSON AND N.J. SMATRESK. UNIV. OF TEXAS AT ARLINGTON.

To evaluate the effects of animal preparation on hypoxic reflexes, conscious, decerebrate and anesthetized Ictalurus punctatus were subjected to varying O₂ levels and NaCN (CN). All groups showed bradycardia, increased blood pressure, and increased ventilation rate and opercular pressure during hypoxia. 50ug NaCN given into the dorsal aorta increased ventilation frequency after a 30 sec delay, in all but decerebrate fish. Opercular pressure increased in all groups. Internal CN had no effect on heart rate. 500ug CN given externally immediately increased ventilation rate and opercular pressure, and caused bradycardia. Ventilatory responses to hypoxia and CN were attenuated in decerebrate fish. Conscious fish exhibited behavioral responses (bradycardia and apnea) to all manipulations. Anesthetized fish remained responsive to hypoxia and had no behavioral responses. CN experiments indicated that chemoreceptors which modulate heart rate are external whereas both external and internal receptors modulate ventilation. (Supported by NSF Grant PCM-8317914)

CHARACTERISTICS OF PULMONARY MECHANORECEPTORS IN THE AIR BREATHING FISH, LEPISOSTEUS OCVLATUS. N.J. Smatresk and S.Q. Azizi. Univ. of Texas at Arlington.

Ventilatory and cardiovascular reflexes associated with air breathing and lung deflation suggest the presence of mechanoreceptors in the air breathing organ of L. oculatus. Single fiber and whole nerve afferent activity was recorded from the pulmonary branch of the vagus nerve in response to step inflation, ramp inflation and inflation of the lung with 5 or 10% CO₂ in air. Slowly adapting receptors (SAR) were found which increased their tonic level of discharge above a threshold volume. SARs also showed rate sensitive responses to inflation and phasic inhibition of activity in response to lung deflation. Lung inflation with 5-10% CO₂ inhibited activity in some SARs, and had no effect on others. Rapidly adapting receptors (RAR) responded with a burst of activity, but ceased firing 1-2 sec after inflation or deflation. CO₂ had no effect on the response of RARs. Thus, L. oculatus have receptors that respond to both the volume and rate of inflation or deflation of the air breathing organ. (Supported by NSF Grant PCM-8317914)

ANTIBIOTIC SUBSTANCES FROM SEVERAL ANTARCTIC BRYOZOANS. R. Colon-Urban, L. Reyes*, J.E. Winston, SUNY, College at Old Westbury, New York and Amer. Nat. Hist. Museum of New York.

Several bryozoan species from Low Island Antarctica were examined for antibiotic activity. Aqueous methanol homogenates were prepared followed by chloroform extractions. Bioassays (disc diffusion method) were performed on the lipid soluble fractions using cultures of Staphylococcus aureus (ATCC-12600) at concentrations of 5 mg/ml, Himantozoum antarcticum and Cycli-copora polaris strongly inhibited the growth of S. aureus. Caberea darwini, Nematoflustra flagellata and Flustra thysanica were moderately inhibitory while extracts from Beania livingstonei were noninhibitory. None of the above extracts inhibited the growth of E. coli. These results confirmed earlier reports from our laboratories using temperate zone bryozoan species. These patterns may have ecological and/or morphological significance. Supported by NIH Grant No. RR-08180.

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THE EFFECT OF COMPETITION REDUCTION ON FORAGING DECISIONS. D. B. Campbell. Univ. of New Hampshire, Durham.

The blue mussel (*Mytilus edulis*) is the competitive dominant in the New England rocky subtidal and lower intertidal zones. Major predators of mussels include sea stars (*Asterias* spp.) and dogwhelks (*Thais lapillus*). Dogwhelks may also be eaten by sea stars, and are therefore both competitors and prey items of sea stars. Sea stars presumably get a double bonus by feeding on dogwhelks: energy gain and reduced competition for preferred prey (mussels). Feeding rates of sea stars are variable. Feeding studies showed that sea stars gained weight faster on a diet of mussels when feeding rates were low, but dogwhelks provide faster growth when feeding rates were high. Critical ratios of numbers of dogwhelks:mussels were determined which predicted the points at which a sea star should switch from mussels to dogwhelks if 1) gain in sea star biomass was the important variable and 2) competition reduction was also important. In this food web competition reduction was not a factor in foraging decisions; the switching point could be predicted on the basis of availability and prey value alone.

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ENERGY ALLOCATION AND REPRODUCTIVE STRATEGIES IN A MARINE GASTROPOD, *CREPIDULA CONVEXA* (SAY). P. AITKEN-ANDER. BROOKLYN COLLEGE (CUNY), NEW YORK, N.Y.

Crepidula convexa is a filter-feeding, protandric hermaphrodite which produces large, yolky eggs. During the annual reproductive season (May-Oct.) at Breezy Point, N.Y., females can lay 4-5 egg masses. Fecundity increases with female size (weight), and females continue to grow throughout the reproductive period. Allocating energy for growth allows the female to optimize brood size at each successive oviposition and to maximize her fecundity for the season. Although fecundity increases with female weight, egg output per unit weight decreases as the animals become larger. For each allocation of energy to growth (cost), the female derives less benefit (increased fecundity) as she continues to grow. Regression analysis of data for egg output (mg) and net production (mg) indicates that a 21 mm female must allocate approximately 100% of net production to egg output. Therefore, animals larger than 21 mm have little energy available for growth. Since specimens of *C. convexa* larger than 22 mm have not been collected at this site, the species may reach a maximum size determined by energetic factors at a given geographic location.

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GROWTH OF JUVENILE THREESPINE STICKLEBACKS (*GASTEROSTEUS ACULEATUS*) IN ROCKY TIDEPOLS. H. J. Weeks Cornell Univ., Ithaca, NY

Threespine sticklebacks enter marine rockpools of the upper intertidal and lower supralittoral of Appledore Island, Gulf of Maine. They reproduce successfully in some pools of undilute seawater, and the juveniles reside in natal tidepools for the first several weeks of life. Pools vary widely in levels of primary production, prey item abundance and density of juvenile sticklebacks. Growth rates of juveniles, calculated from regressions of standard length on age estimates from daily increment counts of the otoliths, are generally similar from pool to pool and year to year, and are comparable to estimates of maximum growth rates for juvenile sticklebacks reported in the literature. These results suggest rockpools are rich nurseries for juvenile sticklebacks; utilization of rockpools as breeding habitat by adults is not determined by trophic factors, but by disturbance due to wave action.

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SOMATIC-OTOLITH GROWTH COMPARISONS IN LARVAL AND JUVENILE STRIPED BASS AND SPOT. David H. Secor, John Mark Dean, and P.W. Haake. Belle W. Baruch Institute for Marine Biology and Coastal Research, Univ. of South Carolina, Columbia, SC 29208.

Otoliths are calcium concretions within the labyrinth of teleost fishes. Growth increments are a consistent feature of the microstructure of otoliths and form with a daily frequency in many species. Recent reports postulate a relationship between increment width and daily somatic growth of the fish. We investigated otolith and somatic growth in larval and juvenile striped bass (*Morone saxatilis*) and spot (*Leiostomus xanthurus*) from impounded and wild habitats. Daily increment formation has been verified for these species in complementary studies. Otolith size was highly correlated to fish length but within each species, this allometric relationship showed higher slopes for slower growing groups. Therefore the relationship between otolith and fish length is not necessarily species or population specific. Our experiments demonstrate a coupling of allometric relationship to growth rate of the fish. This implies that within a species, otolith-fish size comparisons might describe past growth. (Supported by South Carolina Sea Grant Consortium).

HATCHING PHENOLOGY OF THE DUSKY SALAMANDER DESMOGNATHUS FUSCUS. J. E. Juterbock. The Ohio State Univ., Lima.

Six Ohio and Kentucky populations of Desmognathus fuscus oviposited relatively synchronously only during July. Embryological development required approximately 46-61 days. Hatching occurred in late August and September and is not synchronous within a clutch. It required from 2-12 days for all eggs in a clutch to hatch. Hatching occurred over a wide range of developmental stages. The range of interpopulation variation in hatching was no greater than, and was similar to, intrapopulation variation. The latter involved variation in both the time of oviposition and the time required for embryological development. Since hatchlings leave the nest after a variable period of time, a more accurate picture of hatching phenology requires monitoring the entire season. Annual variation in hatching peaks was slightly greater than that of oviposition peaks, presumably due to temperature variation, which is known to influence developmental rates. However, no definite associations could be determined between temperature or moisture and oviposition or hatching peaks.

THE INSECT ASSEMBLAGE OF YUCCA IN SOUTHWEST FLORIDA. D.L. Matthews*. New College of USF., Sarasota.

Yucca supports a variety of insects, especially the larval stages of burrowing and saprophytic forms. Insects on Yucca aloifolia and Yucca filamentosa found along the southwestern Florida coast were observed in the field and laboratory. Three recurring species of the families Megathymidae (Lepidoptera), Curculionidae (Coleoptera), and Stratiomyidae (Diptera) were observed intensively. Examination of their life history strategies reveals the potential for direct and indirect interspecific interactions. A direct interaction between the Megathymidae and the Curculionidae is possible which may be competitive in nature. A direct interaction is also possible between the Curculionidae and the Stratiomyidae. Indirect interactions may exist between the Stratiomyidae and the Megathymidae.

MUSCLE STRESS IN THE LOCOMOTION OF THE WHITE RAT AND THE KANGAROO RAT. A.K. Perry*, R. Blickhan, and C.R. Taylor. C.F.S., Harvard University, Bedford, MA.

This study was designed to test the hypothesis that stress (force per cross-sectional area) in the locomotory muscles of terrestrial animals is the same in different animals running at an equivalent speed (e.g. gait transition speed, preferred speed within a gait, top speed). To test this hypothesis, we measured the peak locomotory stress at preferred speed in the ankle extensor group of two animals differing in mass and locomotory technique: the white rat, a quadrupedal galloper; and the kangaroo rat (Dipodomys spectabilis), a bipedal hopper. Locomotory stress was determined from film and force records obtained from the animals as they ran over a force platform. The two species showed similar values for stress at their preferred speeds, providing strong support to the hypothesis.

	White	Kangaroo	Both
Stress (kN/m ²)	57.8	71.8	64.8
95% conf.	+ 61.0	+ 58.0	+ 44.9

(Supported by NIH grant 2-R01-AM-18140)

MECHANICS OF HUMAN HOPPING: MODEL AND EXPERIMENTS. C.T. Farley*, R. Blickhan and C.R. Taylor. Concord Field Station, Harvard University, Bedford, MA. 01730.

Animals hop and gallop with constant frequencies through large speed ranges. These preferred frequencies only depend on body mass. For example, a human hopping on a treadmill chooses about the same frequency as a kangaroo of similar mass. For human hoppers, the preferred frequency is about 2 Hz. We undertook this study to determine how physiological and mechanical constraints limit hopping frequency. We used force platform and cinematographic data to explore the limits of hopping frequency and amplitude. We observed a sharp transition in the mechanics of hopping at about 1.6 Hz and a maximum frequency of about 5 Hz. Taking the experimental force-displacement ratio as a measure for spring stiffness, a linear spring-mass model can predict the dependence of peak ground reaction force, ground contact time and displacement on hopping frequency. The maximum whole body stiffness confines hopping frequency to a region close to the preferred frequency. (Supported by NIH grant # 2 R01 AM 18140)

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GHOST CRAB LOCOMOTION: MECHANICAL ENERGY CHANGES OF THE CENTER OF MASS. R. Blickhan and R. J. Full. Harvard Univ., C.F.S., Cambridge, Mass. and The Univ. of Chicago.

Two general mechanisms are used to conserve energy during bipedal and quadrupedal locomotion of birds and mammals: 1) pendulum type energy exchanges and 2) spring type energy storage. The purpose of this study was to investigate the mechanical mechanisms used by an invertebrate which travels sideways, the ghost crab, *Ocypode quadrata*, (30-90g). The speeds adopted by crabs ranged from 0.05 to 1.60 m.sec⁻¹. Instantaneous vertical displacement and horizontal velocity of the center of mass were calculated from the vertical and horizontal components of the ground reaction forces measured by a force platform. The ghost crabs used two gaits, a "walk" and a "run", which were mechanically similar to the walk and run of birds and mammals. We found that gravitational and kinetic energy were out of phase in a "walk" (50% energy exchange) and were in phase during a run. The equation relating the mechanical energy changes of the center of mass (\dot{E}_{cm} , W/kg) to the animal's speed (v , m/sec), $\dot{E}_{cm}/\text{Mass} = 0.9 v + 0.03$, applies to bipedal, quadrupedal and octapedal travellers. (Supported by NIH-grant 2R01 AM 1840-09.)

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GHOST CRAB LOCOMOTION: THE EFFICIENCY OF TRAVELING SIDEWAYS. R. J. Full and R. Blickhan. The Univ. of Chicago and Harvard Univ., C.F.S., Cambridge, Mass.

Ghost crabs (*Ocypode quadrata*, 25-80g) were exercised within a treadmill respirometer. Steady-state oxygen consumption was obtained by open flow respirometry at speeds (v) ranging from 0.06 to 0.17 m/sec. Metabolic power input (\dot{E}_{metab} , W/kg) increased linearly with speed. For crabs with a mean mass (M) of 0.026 kg, $\dot{E}_{metab}/M = 17.2 v + 1.0$, while for 0.074 kg crabs, $\dot{E}_{metab}/M = 9.8 v + 1.5$. Mechanical energy changes of the center of mass were determined by measuring ground reaction forces on a forceplate track. Mass-specific mechanical power output required to lift and accelerate the center of mass (\dot{E}_{cm}/M) increased linearly with speed ($\dot{E}_{cm}/M = 0.9 v + 0.03$) and was independent of mass over the range examined. The estimated gross efficiency of crab locomotion (mechanical power output / metabolic power input) ranged from 5 - 8%. Gross efficiency increased with an increase in the speed of locomotion and with an increase in body mass. Eight-legged, sideways travel appeared no less efficient than bipedal or quadrupedal locomotion. (Supported by NIH-grant 2R01 AM 1840-09.)

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THERMAL AND TEMPORAL STABILITY OF SPRINT SPEED IN A LIZARD (*SCELOPORUS MERRIAMII*). R. B. Huey and A. E. Dunham. Univ. of Washington, Seattle, and Univ. of Pennsylvania, Philadelphia.

The physiological capacities of animals are often measured, but the stability of those capacities is rarely established. We have studied the stability of maximum sprint speed in a lizard (*Sceloporus merriami*, Big Bend National Park) across temperature and over time. Absolute speed was influenced by temperature, but relative speed was independent of temperature at 28, 33, and 37 °C: individuals that were relatively fast at one temperature were fast at other temperatures. Maximum speed was also temporally stable: lizards that were fast when first measured in July 1984 were fast when reraced in July 1985. This demonstration that sprint speed is phenotypically stable facilitates microevolutionary studies of the adaptive significance of individual differences in this trait.

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POSSIBLE GENETIC BASIS FOR INDIVIDUAL VARIATION IN SPRINT SPEED IN HATCHLING LIZARDS (*SCELOPORUS OCCIDENTALIS*). F.H. van Berkum and J.S. Tsuji. Univ. of Washington, Seattle.

Hatchling (19-37 days old) *Sceloporus occidentalis* from the same dam were more similar in maximum sprint speed and body size than were hatchlings from different dams. Maximum sprint speed varied 6-fold (range .283 - 1.724 m/s) among the 99 hatchlings measured, but was uncorrelated with age or any measure of body size (range of body masses .400 - 1.308 g). Therefore differences in sprint speed among maternally related families of hatchlings were independent of family differences in size of hatchlings. Demonstration of family differences in sprint speed is an important first step towards demonstrating a genetic basis for individual variation in sprint speed. However, environmental factors common to maternally related sibs might also contribute to family differences in sprint speed.

ENERGY LEVELS AND ANAEROBIC ENDPRODUCTS IN THE BRAINS OF TWO SPECIES OF TELEOST FISH AT DEATH IN ANOXIC WATER. C.R. DiAngelo and A.G. Heath. Virginia Polytechnic Institute and State Univ., Blacksburg.

Brains from anoxia-exposed rainbow trout (*Salmo gairdneri*) and brown bullhead catfish (*Ictalurus nebulosus*) were analyzed using enzymatic assays and HPLC. Control catfish brains had higher concentrations of glycogen, ATP, CrP, and glucose than trout. Anoxic catfish showed a significant decrease in ATP, CrP, and glycogen with no change from controls noted for glucose. Exposed trout showed no change in ATP, CrP, or glucose but glycogen decreased significantly. Ketone bodies in exposed catfish did not change. Anoxic trout brains had higher levels of beta-hydroxybutyrate. In both species, there was no difference between anoxic and controls in the anaerobic endproducts alanine, ethanol, isobutyrate, isovalerate, propionate, or succinate. Lactic acid levels in both species were higher than their respective control brain and anoxic blood values. These results suggest the brain of both species uses classic glycolysis. Catfish survive anoxia 6X longer, perhaps due to greater fuel stores in the brain.

DENSITY OF ZOOXANTHELLAE IN A NUDIBRANCH : EFFECT ON ZOOXANTHELLAE CARBON BUDGETS. Ove Hoegh-Guldberg. Univ. of California, Los Angeles, CA.

Zooxanthellae provide host invertebrates with recent products of photosynthesis. This contribution has been viewed as constant. There is growing evidence however, that zooxanthellae vary their metabolism during the ontogeny of a symbiotic association. I chose to investigate the metabolism of zooxanthellae in the symbiotic nudibranch, *Pteraeolidia ianthina*. This animal is populated by zooxanthellae relatively late in its life and consequently is found with widely different densities of zooxanthellae. While there were no major differences in photosynthetic efficiency of zooxanthellae in high and low density populations, there were significant differences in the partitioning of recently synthesized organic carbon between symbiont and host. In high density population zooxanthellae, where specific growth rates were low (0.100 d^{-1}), zooxanthellae were potentially capable of supplying their own carbon requirement as well as 80 to 180 % of the host respiratory demand. Low density populations, however, were only able to supply the carbon necessary for their own rapid growth (0.399 d^{-1}) and were unable to supply any carbon for host respiration.

THE EVOLUTION OF VERTEBRATE GENE EXON AND INTRON ORGANIZATION. M.W. Smith. Johns Hopkins Univ., Baltimore, MD.

Hypotheses of independence of gene structural elements and intron origin were tested with 53 independent vertebrate genes. Structure was measured as the number of exons, percent introns, and the position of intron interruptions of the codon frame. Additional variables were the sizes and base pairs (bp) of the genes, introns, exons, intervening DNA (sum of introns), mRNA (sum of exons), and mRNA 5' and 3' untranslated regions. The intron-size frequency distribution was bell shaped with a second smaller mode and nearly truncated at under 80 bp. The exon distribution was comparatively very peaked, suggesting different size constraints. Significant positive relationships existed between intervening DNA and the mRNA sizes, and mRNA 5' and 3' untranslated region sizes. Intron interruptions of the codon frame between nucleotides 2 & 3 occurred infrequently (22%). Most interruptions in the untranslated mRNA sequences were in the 5' region (83%). If introns were inserted into the genes, this data indicates that successfully insertions occurred nonrandomly.

ANALYSIS AND FUNCTION OF ORGANIC MATRIX FROM SEA URCHIN TESTS. D.M. Swift. Clemson University, Clemson, S.C.

The organic matrix from sea urchin tests was analysed and compared to matrix from other known carbonate systems. The aqueous soluble component of molluscan systems has been shown by others to be both a mineral growth inhibitor and a mineral nucleator. Little work has been done on urchin matrix and none on its possible physiological functions. This study was designed to elucidate on the composition of organic matrix from sea urchin tests and explore its possible roles as a regulator of mineral growth. Organic matrix was extracted using 2% acetic acid. The tests contained 0.092% organic material by weight. This material was 81-85% protein, 14-19% carbohydrate, and 1% phosphate. The aqueous soluble (SM) and insoluble (IM) components constituted 17-24% and 76-83% of the whole matrix (WM) respectively. SM was 92% protein, 4% carbohydrate, and 4% PO_4 . IM was 11% carbohydrate, 88% protein, and 0.3% PO_4 . Urchin SM significantly inhibited spicule formation in urchin larvae at 10 $\mu\text{g/ml}$, whereas WM had no effect on spicule formation at that concentration. SM was capable of inhibiting *in vitro* crystallization in solutions supersaturated with Ca^{2+} and CO_3^{2-} .

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AN UNUSUAL BLUE PROTEIN FROM THE MANGROVE JELLYFISH *CASSIOPEA XAMACHANA*. R.S. Blanquet and M.A. Phelan. Georgetown Univ. and Food and Drug Administration, Washington, D.C.

Many specimens of the mangrove jellyfish *Cassiopea xamachana* contain a blue glycoprotein diffused within the acellular portion of the mesoglea of the oral appendages and bell. Within the bell mesoglea, both the pigment and endosymbiotic zooxanthellae are concentrated immediately beneath the ex- and sub-umbrellar epithelia. Analyses of this protein by chromatographic and acrylamide gel electrophoretic (PAGE) techniques have shown it to be highly oligomeric (mol.wt. $> 10^6$ daltons) and characterized by multiple isoelectric points. Denaturation with sodium dodecyl sulfate results in two major subunits of 36,000 and 38,000 daltons. The blue native protein shows multiple absorption peaks at 620,587,557 and 420 nm while the denatured protein is a pink color with a single absorption peak at 510 nm. The protein does not appear to contain a carotenoid or retinene prosthetic group. Amino acid analysis shows a significant cysteine content of 5.8 mole percent. The function of this protein is presently unknown.

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MOVEMENT OF MATERNAL CALCIUM INTO GLOCHIDIA IN A UNIONID. T.H. Dietz, H. Silverman, and W.L. Steffens. Louisiana State Univ., Baton Rouge.

The disappearance of calcium concretions from the gills of unionids during reproduction suggests maternal Ca passage to larvae developing in the gill water channel. To test this possibility *Anodonta grandis* ($n=50$) were injected with 2,000,000 CPM ^{45}Ca on August 1. Gill, gonad, kidney, blood, and shell were monitored for ^{45}Ca weekly for the duration of the study. Only gill and shell have any appreciable label after a month, and the gill label is largely accounted for by label found in isolated concretion material. Spawning occurs in late September and larval development occurs in October. Both scintillation data and autoradiography indicate the presence of ^{45}Ca in the shells of larvae developing in injected animals. No movement of ^{45}Ca to the gonads was detected during the period of study. Since only the maternal animal can be the source of label, Ca passage to the larvae is demonstrated. Passage of label occurs during the time when gill concretions disappear suggesting they are a major source of the transferred ^{45}Ca . Supported by NSF-DCB 83-03789.

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INTERCONVERSION BETWEEN MOLECULAR FORMS OF ARTEMIA CYST TREHALASE PROMOTED BY CHANGES IN pH. S.C. Hand and J.F. Carpenter. Univ. of Southwestern Louisiana, Lafayette.

Trehalase from brine shrimp cysts can exist in two forms which are distinguishable by electrophoretic mobility, kinetic properties and molecular weight. Dialysis of semipurified trehalase at pH 8.3 or higher fosters the formation of a fast-migrating species with a pH optimum of 7.0 and a molecular weight of 112,000 (as estimated by Sephacryl S-200 chromatography). Dialysis at pH 6.3 converts trehalase to a slow-migrating form of M_r 232,000, which exhibits a more alkaline pH optimum and acute inhibition by ATP. The interconversion is reversible and requires approximately one hour after a titration of solution pH. The molecular weight differences suggest a polymerization/depolymerization mechanism. Evidence is consistent with a model whereby intracellular acidification of *Artemia* cysts (which occurs upon entry into anaerobic dormancy) could shift trehalase to the ATP-inhibited form with the basic pH optimum, potentially stopping further trehalase mobilization. Supported by NSF grant DCB-8316711.

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PYRUVATE DEHYDROGENASE COMPLEX (PDC) FROM BIVALVE GILL TISSUE. K. T. Paynter, G. A. Karam and S. H. Bishop. Iowa State Univ., Ames and R. Komuniecki. Univ. of Toledo, OH

Acute regulation of the PDC seems to be involved in the control of tissue alanine levels during osmotic stress of this halotolerant bivalve. PDC was isolated by high speed differential centrifugation of lysed ribbed mussel (*Modiolus demissus*) gill mitochondria and by the Triton extraction-polyethylene glycol precipitation procedure (Stanley and Perham, *Biochem J.* 191, 147 (1980)). The kinetic properties and sub-unit structure are similar to PDC from other animals. The presence of a protein kinase-phosphatase system that operates on the 41Kd subunit of E, was demonstrated. Continuing studies indicate regulation of the catalytic activity by ATP, ATP analogs and the NAD/NADH ratio and of the kinase-phosphatase activities by Mg^{++} levels, pyruvate and thiamine pyrophosphate. PDC may be regulated by both changing metabolite levels and the protein phosphorylation-dephosphorylation system during osmotic stress. (Supported by grants from the NSF.)

THERMOREGULATION IN DESERT-ADAPTED RINGTAIL CATS (*BASSARISCUS ASTUTUS*). C.D. Chevalier. University of California, Irvine.

Oxygen consumption ($\dot{V}O_2$), total evaporative water loss (EWL), and body temperature (T_b ; rectal temperature at end of each run) were measured over the air temperature (T_a) range of 0 °C to 45 °C at 5 °C intervals. From these values minimal resting metabolism (0.429 ml O_2 /(g·h); body mass = 865 g), minimal thermal conductance (0.0296 ml O_2 /(g·h·°C)), and T_b (37.6 °C) across and below the thermal neutral zone (TNZ: 23.2–35.5 °C) were determined. $\dot{V}O_2$ increased with decreasing T_a below the TNZ according to the equation: $\dot{V}O_2$ (ml O_2 /(g·h)) = 1.0988 - 0.0288 T_a (°C) ($r = -0.93$). EWL was 0.77 mg H_2O /(g·h) below $T_a = 35$ °C, rising steadily to 8.76 mg H_2O /(g·h) at $T_a = 45$ °C. Evaporative heat loss (EHL) was 8.9% (1.86 J/(g·h)) of metabolic heat production (MHP) at $T_a = 0$ °C, 100% of MHP at $T_a = 40$ °C, and 172% (21.28 J/(g·h)) of MHP at $T_a = 45$ °C. Supported by NSF8102331 to A.F. Bennett, and Sigma XI.

THERMOREGULATORY BEHAVIOR OF BLACK AND TURKEY VULTURES AT A WINTER DAY-ROOST. D. Byman. Pennsylvania State Univ., Dunmore, PA.

The thermoregulatory behaviors of the Black (*Coragyps atratus*) and Turkey (*Cathartes aura*) Vultures were observed at a day-roost at the northern edge of the winter range of both species. If the wind speed at dawn was high (> 1.8 m s^{-1}), most of the Turkey Vultures and many of the Black Vultures in the night-roost would fly directly to forage and not go to the day-roost. At low wind speeds (< 1.8 m s^{-1}), vultures would fly from the night-roost to the day-roost and stay until the wind rose. At the day-roost, vultures moved from high limbs (> 10 m) to the ground by late morning. At low ambient temperatures (< 15 °C), the vultures covered the bare skin of the head and neck by raising the feathered skin up to the top of their heads. Vultures of both species would spread their wings when short wave (visible range) radiation was high (> 200 W m^{-2}). These behaviors on the day-roost are important mechanisms for energy conservation when foraging is uneconomical.

ENERGETICS OF EARED GREBES. H.I. Ellis, C. Comstock[†], H. Noskin[‡], and J.R. Jehl, Jr.[‡] Univ. of San Diego, CA 92110 and Hubbs Marine Research Institute, San Diego, CA 92109.

Oxygen consumption of 12 captive Eared Grebes (*Podiceps nigricollis*) was measured in dry air in 49 separate experiments at thermoneutrality (TNZ = 20.0 - 38.1 °C). Mass-specific basal metabolism (\dot{H}_b) throughout the TNZ was 1.160 ml O_2 /g·hr or about 126% of that predicted by the Lasiewski and Dawson (1967) allometric equation.

Mass varied considerably in these captive birds, as it does in the field, according to the time of year. In the experimental birds, mass was low in April (~250g) and could rise to >500g ($\bar{x} = 385$ g) in September, falling thereafter. In spite of changes in mass, due to large deposits of subcutaneous fat, \dot{H}_b (mass-specific) remained constant. In fact, \dot{H}_b does not significantly differ in these birds at any mass interval (either 100g or 150g) or at any time of year. Because absolute mass-specific \dot{H}_b is constant at all masses, it varies between 106% and 152% of predicted values. Therefore, using a predictive equation based on mass is not advisable in estimates of energetics for these grebes.

THERMAL STABILITY OF THE STRUCTURAL PROTEINS OF THE VERTEBRATE EYE LENS. M. J. McFall-Ngai, L. L. Ding* and J. Horwitz*. Univ. of California, Los Angeles.

The soluble proteins of the vertebrate eye lens, collectively referred to as the crystallins, are contained within fiber cells that shortly after development lose the organelles essential for renewal of cellular components. Because there is no protein turnover in these cells, the crystallins must be stable throughout the life history of the animal. In order to maintain lens function, it would be predicted that these structural proteins must be resistant to the specific set of environmental stresses experienced by any given animal species, in much the same way as has been noted for catalytic proteins. We characterized the thermal tolerance limits of purified lens crystallins, as reflected in changes in tertiary protein structure, employing the spectrophotometric methods of circular dichroism and fluorescence, and differential scanning calorimetry. Using a number of vertebrate species from different habitats, we find a highly significant correlation between the tolerance to heat or cold denaturation of the crystallins and the thermal environment in which the animals naturally occur.

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TEMPERATURE EFFECTS ON CHELA MUSCLE PERFORMANCE IN TWO DECAPOD SPECIES. Jay A. Blundon. University of Maryland, College Park.

Measurements of chela performance from live blue crabs (Callinectes sapidus) and stone crabs (Menippe mercenaria) show that within each species, northern and southern populations of crabs exert comparable amounts of force. However, muscle performance in southern (Florida) populations of these crabs is reduced at colder temperatures (8°C), even after weeks of acclimation. Northern populations of blue crabs (Chesapeake Bay) and stone crabs (Beaufort, NC) which annually experience temperatures as low as 2-4°C are more able to use their chela at colder temperatures.

This study investigates chela muscle fiber response to 1) axonal stimulation, 2) current injection and 3) neurotransmitter application in these two crab species taken from northern and southern populations and acclimated to warm and cold temperatures. To date, these differences in muscle fiber performance appear to be due to increased fiber membrane resistance at low temperatures found in the northern crabs but less so in the southern crabs.

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A CALCIUM PUMP IN THE HEATER TISSUE OF MARLINS AND SAILFISH. B. A. Block. Duke University, Durham, N. C.

The heat producing tissue that warms the brain and eyes in billfish is a modified eye muscle. A portion of this eye muscle remains intact and has the appearance of normal skeletal muscle. The heat producing portion of this muscle contains cells that have a high content of mitochondria and abundant smooth endoplasmic reticulum. The mitochondria rich cells lack contractile proteins, and production of ATP appears to be the main function. In this study, the smooth membranes were isolated from the heater tissue to determine if the membranes contain an ATP-dependent ion pump, capable of using the ATP for heat production. The close morphological relationship of the heater tissue to muscle has suggested that the endoplasmic reticulum might be similar to sarcoplasmic reticulum, and thus, rich in Ca-ATPase. The crude membrane preparations from heater tissue had about the same Ca-stimulated ATPase activity per gram protein as that from muscle. Ca uptake in the heater tissue ranged from 50 to 100% of the control eye muscle. In gel electrophoresis of tissue homogenates, the 105 kDa band corresponding to the Ca-ATPase, was more prominent in heater than in muscle tissue. Characteristic muscle proteins such as myosin are virtually absent in the heater tissue homogenates. This study suggests that Ca-ATPase is a very important component of the heater tissue.

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DISPERSAL OF HATCHED JUVENILES OF THE AMPHIPOD CRUSTACEAN MICRODEUTOPUS GRYLLOTALPA (COSTA) M. Kafka and B. Borowsky, Osborn Laboratories of Marine Sciences, Boardwalk & W. 8th St. Brooklyn, N.Y. 11224 and New York University, Washington Square, New York 10003

Most intertidal invertebrates have planktonic larval stages, which require many molts before the larva assume the adult form. A notable exception is the amphipod crustacea. Therefore, the mechanism of dispersal for one amphipod species was investigated in the laboratory. It was found that the newly hatched juveniles initially remain proximate to the maternal parent and then disperse gradually. This suggests that this amphipod does not disperse in the plankton.

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DIURNAL VERTICAL DISTRIBUTION OF DECAPOD LARVAE/POSTLARVAE IN THE CHESAPEAKE BAY, VIRGINIA, WITH EFFECTS ON DISPERSAL-RECRUITMENT MECHANISMS. R. C. Maris. Old Dominion Univ., Norfolk, VA.

The diurnal vertical distribution of 33 species of decapod crustacean larvae and postlarvae was studied from plankton samples collected at two stations located in the Chesapeake Bay, Virginia: bay mouth (36° 59'N, 76° 08'W) and York River mouth (37° 12'N, 76° 16'W). Neuston (0.10-0.15 m), 1 m, 3 m, 6 m and epibenthic (11 m) samples were collected at three hour intervals for 72 h, over six tidal cycles at each station. Both light and the tidal cycle were found to be important factors in vertical distribution, but temperature and salinity were not significant parameters. Most species concentrated at mid to lower depths during the day and exhibited various numbers in the upper depths at night according to species, stage of development and tidal phase. The estuarine species were classified as retained or expelled according to adult distribution and larval/postlarval vertical positioning. Interactions of distributional, dispersal and recruitment patterns are very complex with multiple factor effects, and not simply due to diurnal vertical migration or tidal rhythms.

ECOLOGY OF JUVENILE HERMIT CRAB SHELL USE: FIELD AND LAB COMPARISONS. S. Gilchrist. New College, Sarasota.

Though hermit crab ecology has been studied for many years, little is known of shell use and selection by newly settled and juvenile crabs. Field studies of 3 species of hermit crabs provide information on initial shell use by newly settled crabs. Newly settled crabs of all 3 species do not appear to have specific preferences for shell type. These crabs often settle among rubble or seagrass bases. Juvenile crabs also inhabit a variety of shell types and sizes. However, shape variables become important factors near the molt size for sexual maturity.

Laboratory tests suggest that juvenile crabs will select shells never encountered in natural selection pools for the crabs. Continued use of such shells will change shell selection for the crabs over time to include only natural shells similar to those offered in the laboratory. Thus, it appears that early shell experiences may be important in determining adult shell use.

ICONOGRAPHY IN THE COURTSHIP BEHAVIOR OF THE FIDDLER CRAB *UCA BEEBEI*. J.H. Christy. Smithsonian Tropical Research Institute, Apdo. 2072, Balboa, Republic of Panama.

Male *U. beebei* court from and defend burrows to which females come for mating. Males court by waving their single enlarged cheliped and, when a female is near, by raising it revealing its dark ventral surface as they enter their burrows. Most courting males construct arching pillars of mud about 2 cm high at their burrow entrances. Such structures may reduce overlap in the activity spaces of neighboring males and rates of aggressive interaction thereby providing each male more time to court and the opportunity to court without aggressive interference from its neighbor. Alternatively, pillars may function as visual guideposts that help females find a burrow entrance once a courting male has disappeared from the surface. Field observations of time budgets, space use, spacing and aggressive interactions among neighboring males and of the behavior of courting males and sexually receptive females support the latter explanation. Pillars appear to be icons of the visual image presented to females when a male raises its cheliped as it leads a female into its burrow.

RELATIVE GROWTH IN CRUSTACEANS. N. W. Blackstone. The Academy of Natural Sciences, Philadelphia.

Crustaceans continue to be the first choice for studies of relative growth because: (1) their external form is precise and easily measured, (2) exuviation allows longitudinal studies of undisturbed individuals, (3) relative growth of externally recognizable parts dominates their ontogenies, and (4) regeneration provides insight into the developmental integrity of each part. These characteristics make crustaceans ideal for relating patterns of relative growth to processes of development. In this regard, a specific growth rate (length increment per time increment per absolute length) is useful when calculated over an entire molt cycle. Comparisons of specific growth rates of different parts provides more insight into relative growth processes than comparisons of the logarithms of length measures because the former gives the absolute relationship of specific growth rates, while the latter only gives the relative relationship. These results suggest that bivariate and multivariate analyses of distance measures provide insight into patterns rather than processes of relative growth and should be interpreted accordingly.

GROWTH AND REPRODUCTION IN ADULT MALE STONE CRABS IN ON- AND OFFSHORE HABITATS. D. H. Wilber. Florida State Univ. Tallahassee.

On the northern gulf coast of Florida, offshore populations of adult stone crabs, *Menippe mercenaria* (Say), are comprised mainly of females (3.5F:1M) in the summer, whereas, concurrently on intertidal oyster reefs, males are predominant (1F:3M). Females spawn in the summer, however, molting (sexually receptive) females were observed offshore and were invariably guarded by a male. I examined the growth and reproductive states of males in the different habitats by determining their molt stages and sperm content levels.

Males occurring in offshore seagrass beds contained more sperm ($\bar{X} = 23.2 \times 10^6$ sperm/crab, $p < 0.0001$) than males on intertidal oyster reefs ($\bar{X} = 8.9 \times 10^6$). Sperm number was not correlated with crab size, however, adult males inshore were smaller ($\bar{X} = 79 + 13$ mm CW) than offshore males ($\bar{X} = 89 + 13$ mm CW, $p < 0.01$). Only 4.5% of the males at the offshore habitat were molting compared to 59.4% of the inshore males, a difference too large to be accounted for by the discrepancy in crab size alone. These data suggest an association between a male's reproductive state and proximity to potential mates may exist.

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INHIBITION OF LIMB REGENERATION AND ECDYSIS BY THE PARASITIC BARNACLE, *LOXOTHYLACUS PANOPAEI* IN THE MUD CRAB, *RITHROPANOP-EUS HARRISII*. J.J. O'Brien and D.M. Skinner. Biol. Div., ORNL, Oak Ridge, TN

Unparasitized (UNPZ) and parasitized (PZ) crabs were maintained on artificial seawater (20 ppt) at R.T.; their high survival rate makes them an excellent model system for use in labs without running seawater. UNPZ crabs of all sizes molted within 12-14 days following limb autotomy (LA; 6 walking legs); mean time to ecdysis for the control group was 40 days. This brings to 15 the number of crustaceans that have been induced to molt by LA. Data suggest that the 2nd molt following LA also occurred sooner. Since the largest UNPZ crabs formed limb-buds and molted following LA, it seems likely that there is no terminal anecdyosis in this species. Parasite prevalence decreased with increasing host size, a pattern observed in other sacculinid-host associations. PZ crabs bearing the external stage of the parasite did not molt nor form limb-buds. Given the cessation of molting by ovigerous UNPZ crabs, it would be of interest to compare the response of ovigerous females to LA. (Supported by Seed Money and by Martin Marietta Energy Systems, Inc with the USDOE.)

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SEASONAL VARIATION IN EGG PRODUCTION AMONG SAND CRABS (*EMERITA ANALOGA*). A. M. Wenner, J. Dugan*, and D. Hubbard*. Univ. of California, Santa Barbara.

Estimates of egg number per female were determined volumetrically (by means of calibrated pipettes) for various sizes and ages of sand crabs throughout the season at different localities to discern the degree of variation present. As with other animals which have indeterminate growth, egg production as a function of size exhibited great variation. Separation of animals into either size or age classes facilitated data interpretation. Egg production within each year class appeared to be a semi-logarithmic function on any one date. Egg production within any size or age class increased until about the first of August and then declined. Apparently females within any size/age group have experienced a specific exposure to environmental circumstances (e.g., temperature regime and/or food supply), which dictates the number of eggs possible under those circumstances.

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ADAPTATION TO EPHEMERAL PONDS IN THE CONCHOSTRACAN *EULIMNADIA TEXANA*. C. Sassaman and S. C. Weeks*. Univ. of California, Riverside.

Eulimnadia texana is often common in very transient ponds in the southwestern United States. Laboratory studies on its life history indicate adaptations for colonizing coupled with rapid subsequent population growth. At 24 °C, maturity is reached 7 days after hydration of the encysted embryos. Growth in carapace length ceases at about 10 days and survivorship is to 15-20 days. Clutch size is related to female length and ranges from 50-400. Maximum length is inversely related to population density. Sex ratios in adults are strongly female-biased (80-90% females) and females reared in isolation from the nauplius stage to maturity produce viable progeny. Nevertheless, natural populations harbor substantial amounts of genetic variation, although deficiencies of heterozygotes at several loci suggest strong inbreeding. The mechanism of facultative selfing is unknown, but its existence allows the propagation of populations from single colonists. This feature of the life history may, in part, explain the diversity of species in the genus and the remarkable endemism of some of their distributions.

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INTERSTITIAL CELLS ARE REQUIRED FOR POLYP MORPHOGENESIS DURING METAMORPHOSIS OF HYDROZOAN PLANULAE. V. J. Martin. Univ. of Notre Dame, IN.

The role of interstitial cells and their derivatives in attachment and metamorphosis of cnidarian planulae was examined using hydroxyurea. Hydroxyurea was used to selectively reduce the interstitial cell population. Eight hour embryos of the marine hydrozoan *Planaria tiarella* were cultured continuously for 1 to 7 days in 0.01 M hydroxyurea in seawater. Animals were processed for light microscopy at selected timed intervals and stained with Azure B. The number of interstitial cells, ganglionic cells, and nematoblasts was scored in treated animals and comparable controls. Embryos grown continuously in hydroxyurea remained healthy, attached, and underwent metamorphosis to form small upright partial polyps which lacked hypostomes, tentacles, and stolons. Upon removal of hydroxyurea the partial polyps developed within 2 days into normal primary polyps containing hypostomes, tentacles, and stolons. Hydroxyurea treatment reduced the interstitial cell and nematoblast population significantly in animals while the population of ganglionic cells was less affected. Treated planulae and partial polyps returned to normal seawater showed a recovery of all 3 cell types. The results from this study suggest that the interstitial cell population is required for primary polyp morphogenesis during metamorphosis of hydrozoan planulae, a role not previously reported in any cnidarian.

EVIDENCE OF A MICROTUBERCULAR CYTOSKELETAL LATTICE IN GLANDULAR CELLS OF HYDROZOAN PLANULAE. E.T. Walch and V.J. Martin, Univ. of Notre Dame, IN. Hydrozoan planulae of Pennaria tiarella and Podocoryne carnea were processed for transmission electron microscopy using diethylene glycol distearate (DGD). The DGD serves as a removable embedding medium to produce embedment-free sections of intact planulae. The technique allows for sections to be examined without the electron scattering effects of plastic embedding resins which often obscure thin fibrous elements within the cytoplasm of cells and also enables much thicker sections to be examined, thus providing a more 3-dimensional view of cellular contents. Images of glandular cells obtained using embedment-free sections were compared with those from conventional Spurr-embedded sections. In unembedded sections a large number of thin anastomosing fibers are observed throughout the cytoplasm of the glandular cell. Such fibers are not seen in Spurr-embedded sections. The fibers appear to coalesce in certain areas to form thick fibers that partition the glandular cytoplasm into spherical subunits. The lattice of fibers is 3-dimensional as evidenced by stereopairs. The lattice is composed of microtrabeculae, microfilaments, and intermediate filaments. Mitochondria are suspended within and attached to the network of fibers thus indicating the cytoskeletal role of the fibers. This study documents the presence of a cytoplasmic fiber system within cells of intact invertebrate larvae.

EFFECTS OF NICOTINE ON THE DEVELOPMENT OF A STEM CELL POPULATION IN HYDROZOAN PLANULA LARVAE. K.J.S. Kolberg and V.J. Martin, Univ. of Notre Dame, IN. Interstitial cells of cnidarians provide an ideal model system in which to examine the effects of toxic substances on cellular differentiation and development. Interstitial cells differentiate into nematoblasts and ganglionic cells and divide to replenish the stem cell population. The three cell types are easy to distinguish histologically. Embryos of Pennaria tiarella were exposed to three dosages of nicotine either at gastrulation or at 24 hours postfertilization. Animals were fixed immediately after treatment or after various recovery periods. Embryos were serially sectioned for light microscopy and stained with saure B. The number of ganglionic cells, interstitial cells, and nematoblasts were scored in treated and control planulae. The ratio of interstitial cells:ganglionic cells:nematoblasts was significantly different in treated planulae when compared with comparable controls. In treated embryos an increase in nematoblast differentiation was accompanied by a decrease in the interstitial stem cell population. The number of nematoblasts migrating from the endoderm to the ectoderm was increased in treated embryos. These data suggest that nicotine does affect stem cell differentiation during development. This study represents the first attempt to document the effects of nicotine on the differentiation and development of a stem cell population.

SECRETORY CELL RESYNTHESIS AND REPLACEMENT IN HYDRA FOLLOWED USING TRITIATED URIDINE AND TRITIATED THYMIDINE. I. Kessler, College of St. Elizabeth, Convent Station, N. J.

Population dynamics of secretory cells in Hydra were followed after being depleted by feeding. At various times after feeding animals were labeled with tritiated uridine or tritiated thymidine and fixed for histological study. The population sizes of labeled and unlabeled cells were determined for each stage of secretory cell development. A broad peak of uridine incorporation was observed between 3 and 6 hours after feeding. A smaller peak was found at 13 hours. Thymidine incorporation gradually increased to 15 hours then dropped off. A comparison of the magnitude of these cell populations indicate that resynthesis rather than replacement is the major pathway for reestablishing the mature secretory cell population after its depletion during feeding.

DEFINING COMMITMENT AND COMPETENCE IN LEPIDOPTERAN IMAGINAL DISKS BY HORMONAL TREATMENT. C. Kremen and H.F. Nijhout, Duke University, Durham, N.C.

Juvenile hormone (JH) maintains the imaginal disks of lepidopterans in an undifferentiated state during larval life; its absence during a critical period early in the last instar allows disks to become committed to metamorphose. Disk metamorphosis then occurs at the end of the instar in response to release of ecdysterone (EC). Only disks from late last instar larvae are competent to respond to EC. It is not known whether commitment, the irreversible restriction to a particular developmental fate, and competence, the ability to respond to a particular differentiative cue, are causally or temporally distinct phenomena in imaginal disks. To examine this issue, I applied either JH or EC to staged larvae of Manduca sexta and Precis coenia. When JH is applied to early last instar larvae, only disks which are already committed to pupal development initiate metamorphosis at the next molt. Similarly, EC injected into last instar larvae provokes a premature metamorphic molt, but only competent disks can participate in it. Thus the use of these hormones allows the definition of the critical periods for commitment and competence in imaginal disks.

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POPULATION DYNAMICS, DIET, AND MOVEMENT OF BLUE CRABS IN A SUBESTUARY OF CHESAPEAKE BAY. A.H. Hines and K.L. Comtois. Smithsonian Environmental Research Center, Edgewater, MD.

Abundance and population structure of *Callinectes sapidus* in 5 years of monthly otter trawls showed distinct seasonal cycles and significant annual variation. Crabs were abundant from June through September; size and sex composition changed during the season. Stomach contents indicate crabs prey primarily on infauna with a high percentage of clams; but contents were more diverse in June after infaunal recruitment than September indicating crabs also fed opportunistically. Exclusion of crabs by cages significantly increases clam survivorship. Speed and orientation of free-ranging crabs were tracked with ultrasonic telemetry. Mean speed was 15m/hr but ranged from 0-325 m/hr. Crabs spent about 2 weeks foraging haphazardly within the subestuary before moving rapidly back into the Bay. Male and juvenile crabs appear to move up into salt creeks to molt, while females remain in the subestuary for the pubertal molt. This study shows the importance of shallow embayments in the population biology of blue crabs.

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FORAGING BEHAVIOR IN BLUE CRABS: ULTRASONIC TELEMETRY OF FEEDING MOVEMENTS. T. G. Wolcott and A. H. Hines. NC State Univ., Raleigh, and Smithsonian Environmental Research Center, Edgewater, MD.

We have developed an ultrasonic transmitter to determine the timing and location of feeding by free-ranging blue crabs (*Callinectes sapidus*). We telemeter biopotentials of the mandibular musculature, an unequivocal indicator of mastication. Number of bites and length of feeding correlated roughly with size of prey items in laboratory tests. In a 4-day field trial, a crab released into a subestuary of the Chesapeake Bay was readily tracked and feeding easily quantified. No periodicity was distinguishable in either movement or feeding, and the number of bites per feeding bout followed a Poisson distribution, suggesting that foraging by the blue crab is highly opportunistic. This method can be adapted to telemeter any vertebrate or invertebrate behavior that can be linked to a specific muscle group.

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DIEL ACTIVITY AND FORAGING PATTERNS IN *HEMISQUILLA ENSIGERA CALIFORNIENSIS*. J.M. Engle¹ and L.V. Basch^{1,2}. Channel Islands Research Program, Avalon CA, and Ft. Loma Biology Laboratory, San Diego CA.

Hemisquilla ensigera californiensis is a large, highly active predator ranging from Southern California and the Channel Islands to Baja California Sur, Mexico. Preliminary studies indicate that *Hemisquilla* dwell in burrows in stable sand communities at depths from 5m to >30m. When open, burrows are often circled with invertebrate hard body parts. During inactive (=non-foraging) periods in one diel cycle, burrows were frequently capped with a 2-5cm thick sand plug. In one population (n=13) >50% of burrows were capped during daylight and ca. 100% were capped at night. Based on no. of open burrows, >50% of the population was active from 0400-0830h and from 1600-2000h. During the 2 crepuscular activity peaks, animals heads were often above the entrance observing the surround. Individuals forage throughout diel cycles but this activity peaks 1-2h prior to both sunrise and sunset. Foragers move to 60m from burrows and feed on >7 taxa. Foraging movement rates range from 1m to >7m·min⁻¹. Animals stop for prey locating, fossorial foraging, or for avoiding bioluminescence. Evidence suggests that *Hemisquilla* cause significant bioturbation and predation.

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SPATIAL AND TEMPORAL DISTRIBUTIONS OF GRASS SHRIMP LARVAE (*PALAEMONETES* SPP) IN A HIGH SALINITY SOUTHEASTERN ESTUARY. D.M. ALLEN AND D.L. BARKER*. UNIV OF SOUTH CAROLINA, GEORGETOWN.

Zooplankton collections were made in tidal creeks and coastal areas at North Inlet, SC to determine the lateral and vertical distribution of larval stages of *Palaemonetes pugio* and *P. vulgaris*. Throughout the spring and summer reproductive period first stage zoeae were most abundant near the surface and final stages (7 and 8) dominated near-bottom collections in shallow, well mixed, creeks. Intermediate stages rarely occurred anywhere within the estuary, but were present in the ocean. Short term studies to assess patterns of abundance as a function of tidal stage, time of day, and lunar phase indicated: (1) periodicity in the release of larvae, (2) a rapid movement of early stages to the ocean, and (3) a repenetration of late larvae to adult habitats in marsh creeks. The mechanism by which various stages move between the estuary and ocean probably involves stage specific behavioral responses to regular tidal patterns. This study is supported by the Long Term Ecological Research Program (NSF-DEB-8012165).

INVASIONS OF SOUTHERN MARINE FAUNA INTO CAPE ANN, MASS., DURING PERIODS OF WARMER SEA WATER. R.W. Dexter. Kent State Univ., Ohio.

Between 1952-64, 8 spp. of invertebrates and 12 spp. of fishes were found north of their usual range at times of warmer water at Cape Ann as follows: polychaete-Lepidametria commensalis; gastropods-Polinices duplicatus and Urosalpinx cinereus; amphipod-Orchestia uhleri; decapods-Callinectes sapidus, Ovalipes ocellatus and Uca pugnax; sea urchin-Cidaritis tribuloides; sea horse-Hippocampus hudsonius; rudder fish-Seriola zonata; mackerel scad-Decapterus macarellus; hardtail-Caranx crysos; Saurel-Trachurus trachurus; common sea robin-Prionotus carolinus; stripped sea robin-P. evolans; sea bass-Centropristis striatus; Kingfish-Menticirrhus saxatilis; leather-jacket-Oligophites saurus; shark sucker-Echeneis naucrates; and puffer fish-Sphaeroides maculata.

THE POPULATION STRUCTURE OF A TROPICAL MYTILID FROM TWO DIFFERENT INTERTIDAL ENVIRONMENTS. T.L. Smalley. Univ. Hawaii, Honolulu.

The population structure and dynamics of the mussel Brachidontes crebristriatus exhibits differences between two major intertidal habitat types: the shoreward margin of wide fringing reef flats and the protected backwaters of embayments. Population density, mean shell length, and flesh dry weight differ between populations from the two habitat types - being greater for bay populations. Furthermore, the 3-dimensional growth form of these populations differ between habitat types. On fringing reef flats individuals occur in a single layer, embedded in an algal turf. In bays individuals may occur in a single layer or hummock, forming sheets several individuals thick. Reproductive activity and recruitment occur throughout the year with at least one major peak from Dec. to Feb. Between habitat differences in reproductive activity and recruitment also occur - bay populations having a greater reproductive potential and greater recruitment. It is suggested that these differences can be explained by between site variability in environmental features such as food availability, wave impact, and structural features of the habitat.

CATASTROPHIC MORTALITY IN SUBTROPICAL LIMPETS. S. B. Cook and C. B. Cook, Bermuda Biological Station, Ferry Reach.

On sheltered shores, physical stresses during springtime low tides in Bermuda have dramatic effects on the demography of the pulmonate limpet Siphonaria alternata. In 1980 and 1985, one-half of a population at John Smith Bay vanished when daytime low tides coincided with stressful physical regimes (strong winds in April 1980; 2 weeks of very low tides and continual aerial exposure in May 1985). Death due to water loss at low tide was indicated by 1) desiccated and loosely attached animals and 2) earlier mortality in drier areas and among 3-5 mm. recruits. Size-frequency data from the intervening 4 years indicate that such spring-summer die-backs occur annually but vary in magnitude and timing. During "good years", clearcut evidence for catastrophic spring-summer declines was confined to the sheltered shore at Smith's Bay, but during the stressful periods of 1980 and 1985, increased mortality was also seen at Spittal Pond, a more wave-swept and wetter site. (Supported by the Center for Field Research and EPA grant R811318).

DESICCATION AND THERMAL STRESS AS A POSSIBLE EXPLANATION FOR THE SHIFT IN SHELL COLOR AMONG POPULATIONS OF THE INTERTIDAL SNAIL NUCELLA LAPILLUS DIFFERENTIALLY EXPOSED TO WAVE ACTION. R.J. Etter. Harvard Univ., Cambridge, MA.

The intertidal snail N. lapillus exhibits considerable variation in shell color among populations differentially exposed to wave action. Snails from shores of high wave energy are dominated by brown morphs and are highly polymorphic while those on protected shores are monomorphically white. Measures of tissue temperatures, rates of water loss and mortality on dark and white morphs indicated that white morphs had lower tissue temperatures, lost less water and experienced lower mortality than dark morphs. Since snails on protected shores tend to experience higher temperatures and greater desiccation, white morphs may be selectively favored on protected shores because they have a higher reflectance for incident solar radiation which may in turn reduce water loss and/or mortality.

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GEOGRAPHIC VARIATION IN INTERTIDAL EMERSION GRADIENTS AND SPECIES ZONATION PATTERNS. W. H. Brake. Loyola College, Baltimore, MD.

A computer program that predicts tides from published harmonic constants and compiles statistics on the duration and frequency of emersion as a function of elevation was developed for a detailed analysis of geographic variation in intertidal emersion gradients. One year of tide predictions (computed at 15-minute intervals) for 4 localities with tidal curves ranging from diurnal to mixed and to semidiurnal, were analyzed after elevations had been normalized to facilitate comparison. Mean emersion time and the number of dry intervals increased monotonically with increasing elevation for all locations. However, mean emersion time at any given standardized elevation varied as much as twofold among the locations. Graphs of the annual maximum emersion time as a function of elevation revealed sharp discontinuities that occurred at very different elevations depending on locality. The implications of these differences in emersion gradients for biogeographic trends in intertidal zonation require further investigation.

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FINE STRUCTURE OF THE REPRODUCTIVE CYST WALL OF HYALOPHYSA CHATTONI (CILIOPHORA, APOSTOMATIDA). N. RIVAUD. North Carolina State University, Raleigh.

Electron microscopy and cytochemistry were used to investigate the visible structure, components, and stages of secretion of the reproductive (tomont) cyst wall of Hyalophysa chattoni and compare them with the phoretic cyst wall of the same species and with other ciliate cyst walls. Initially, a thick amorphous cell cover appears on the precystic swimming ciliate. Layers of cyst wall are added to it as the organism settles. The mature cyst wall consists of an inner granular and an outer fibrillar layer. The outer is often subdivided into a more compact inner and an almost amorphous outer component. Material identified as mucopolysaccharide persists between the pellicle and the wall. Cilia remain throughout encystment, pressed against the surface and immobilized by pellicular folds. The cyst wall is not secreted by mucocysts as in some other ciliates. The tomont wall lacks the paracrystalline component of the phoront wall. Unlike the phoront, the tomont is immobile within its cyst wall. The cyst walls of Hyalophysa lack the well defined layers of hypotrich cyst walls. In this they resemble the cell cover of suctorians.

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A LIGHT AND ELECTRON MICROSCOPE STUDY OF EIMERIA NECATRIX. J. B. Mitchell and E. Sweterlitsch*, Moravian College and Thomas Jefferson University.

Both asexual and sexual stages were analyzed in this work. Large schizonts were located in the connective tissue of the small intestine of the bird. Microgamete development was first observed when peripheral nuclei and a small amount of cytoplasm protruded into a parasitophorous vacuole. Immature macrogametocytes also formed within a vacuole. Two types of wall-forming bodies were observed and their role in oocyst formation was studied.

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THE ULTRASTRUCTURE OF RESPIRATORY ORGANS OF JUMPING SPIDER, PLEXIPPUS PAYKULLI, AUDOVIN (ARANEAE, SALTICEDAE). S.M. Laliwala and A. B. Vyas. St. Xavier's College, Gujarat, India, and Rutgers' Univ., New Brunswick, N.J.

There is a great deal of variation in the respiratory structures of spiders. In Plexippus paykulli, these organs comprise a pair of book lungs and a pair of tracheae. The basic plan and functional morphology of book lungs of this spider, confirm with those observed in other species of spiders. Stereomicrographs by scanning electron microscopy of book lungs of P. paykulli clearly demonstrate communications of intralamellar space with haemolymphatic sinuses. The ultrastructure of the chitinization of the lamellar surface shows unique pattern for the species. Tracheal system on the other hand, is well developed and branched. Scanning electron micrographs reveal that tracheae have annulated structure.

A COMPARISON OF THE DISC AUTOTOMY REGIONS
IN FOUR SPECIES OF OPHIUROID ECHINODERM.

William E. Dobson, University of South
Carolina, Columbia.

Recent research indicates that echinoderm autotomy probably is effected by secretions from special juxtaligamental cells associated with the mutable collagenous tissues (MCT) of the autotomy region. The morphology, histology, and tissue ultrastructure of the disc autotomy regions of Micropholis gracillima and M. atra were compared to homologous regions in the non-autotomizing species Ophiothrix angulata and Hemopholis elongata, using light microscopy, TEM, and SEM. M. gracillima and M. atra have disc autotomy regions identical to those found in Ophiophragmus filigraneus (Dobson, 1983. Amer. Zool. 23: 1026), with thick MCT ligaments and associated juxtaligamental cell layers between each of the ten genital bars and their associated lateral arm plates. These tissues disintegrate during the autotomy process. The homologous regions of O. angulata and H. elongata contain thick connective tissue ligaments, but no juxtaligamental cells. The results indicate that juxtaligamental cells are found only in those species that can autotomize. These cells appear to be an integral part of the MCT. Supported by a G.I.A.R. from Sigma Xi, The Scientific Research Society

THE TUBE-BUILDING COPEPOD PSUEDOSTENHELIA
WELLSI: MORPHOLOGICAL STUDIES. J.

Williams-Howze, Louisiana State Univ.,
Baton Rouge.

Pseudostenhelia wellsii a meiobenthic harpacticoid builds tubes in estuarine sediments. The copepods' external and internal morphology is described with reference to tube building. Scanning electron microscopy (SEM) showed large pores on the last abdominal segment and caudal rami. These secretory pores are associated with regions of mucus and lipid storage as revealed by light microscopy. Large membrane bound storage "sacs" of lipid material are found in the abdominal segments, and acid mucopolysaccharide sacs (mucin) are found in the caudal rami. These appear to be the major storage sites of material used for tube-building. Transmission EM reveals multicellular glands, of secretory structure, enclosing the storage areas. PAS and lipid assay on the tube show that mucin and lipid are involved in tube construction. A comparison of P. wellsii and two confamilials, Stenhelia paulstris, another known tube-builder, and S. (D.) bifidia, a non-tube-builder, using SEM, is given. The tube builders have large pores, similar in size and placement, while the non-tube builder has few, tiny pores.

SHELL SHAPE AND LOCOMOTION IN GALAPAGOS
TORTOISES: AN EVOLUTIONARY MODEL. R.W.
Marlow, Dept. Medicine, Dalhousie Univ.,
Halifax, Nova Scotia, Canada.

Variation in shell shape among island populations of Galapagos tortoises, as an example of adaptive radiation has been an important and misunderstood case. Attempts to explain the pattern of shell shape variation have failed. Tortoises were filmed walking on even and uneven ground. Kinematic data converted to link-segment models demonstrate significant differences in the angular relationships of segments during a gait cycle between tortoises with small anterior openings (domes) and those with large openings (saddlebacks). Saddlebacks have a wider range of forelimb movement because of elevation of the anterior carapace and the resulting shift in orientation of the pectoral girdle. Mechanical energy analysis suggests that locomotion over open, even or uneven terrain is more efficient for saddlebacks than domes. Domes are more efficient in dense vegetation. This is consistent with a model of shell shape evolution favoring saddlebacks, or rapid evolution of that shape, as colonists of newly emergent volcanic islands (uneven ground, sparse vegetation) and domes on mature islands (even ground, dense vegetation).

MORPHOLOGICAL AND BEHAVIORAL ASPECTS OF
THE LOCOMOTION OF THE LIZARD OPHISAURUS
APODUS. C. Gans and J.-P. Gasc, Lab.
Anatomie Comparée, Mus. Nat. Hist. nat.
Paris, France.

Nine specimens of a 3:1 range of mass were filmed while being subjected to sequences in varying combinations of standardized locomotor tasks including passage of parallel-sided channels, substrates with varying coefficients of friction and smoothness and peg-fields of various spacings. The lizards traverse smooth surfaces utilizing variants of concertina (slow) and slide pushing (fast) movement. Peg spacings are traversed by variants of lateral undulant movements. Perfect lateral undulation occurs for a relatively limited range of peg spacings; wider spacings involve continuous change of the points d'appui utilized. The sliding friction of the substrate affect the sites against which the animal pushes. Parallel-sided tunnels are passed by a regular concertina with the curves starting at the neck and continuing onto the tail without interruption. Portions of the ventral armor may be depressed against the ground (in slide pushing) but (literature statements to the contrary) no horizontal movement is used to effect digging. Supported by NSF DEB 8121229.

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STRUCTURAL-FUNCTIONAL ASSOCIATIONS IN PROSIMIANS: LOCOMOTION, ENVIRONMENT AND DIET. C.E. Oxnard, R.H. Crompton*, and S.S. Lieberman. Univ. of Southern California, L.A., and Chinese Univ. of Hong Kong.

The relationship between structure and function in primates has often been investigated using complex morphometric analyses of structure but compared to only rather simple classifications of function. Attempts are made here to quantify aspects of function: locomotion, environment and diet in prosimians, and to use, on the resulting data, similar multivariate statistical methods. Though not so easy to measure, function is as easily analysed as is structure. Groups of species are readily recognized that make biological sense both from the functional standpoint itself, and when compared with appropriate morphometrics. For instance, the various tarsiers, indriids and lorises are each as clearly demarcated functionally as they are structurally. And within the groups identified, a spectrum of associations is evident that is related to smaller within-group functional and structural differences. Such studies allow the functional side of the functional-structural equation to be as fully understood as the structural. Supported by NIH BRSG and USC FRIF funds to CEO.

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KINKAJOU (POTOS FLAVUS) LOCOMOTION. Deedra McLearn. College of Veterinary Medicine, Cornell Univ., Ithaca. Light films were taken of two newly captured, freely-moving kinkajous. Light films and radiographic films were made of these animals and one other trained to run on a treadmill. Several distinctive features of kinkajou locomotion include: 1) use of a variety of footfall patterns (up to four) at walking speeds, with a predominance of a diagonal sequence, diagonal couplets gait (LH RF / RH LF); 2) lateral flexion and extension of the trunk; 3) rapid extension of the wrist and abduction of the digits just prior to forepaw contact with the ground; 4) restricted excursion of the tibia such that it does not swing out past the vertical plane. None of these characteristics is shared with other procyonids examined (coatis and raccoons), but may be seen in other highly arboreal animals; e.g., koalas, lemurs, silky anteaters, and Tamandua anteaters use the diagonal sequence, diagonal couplets gait at walking speeds. These data suggest that the kinkajou footfall pattern is not "hard-wired" neurally and, furthermore, that similar locomotor behaviors are more likely to be convergent with those of arboreal animals in other taxa rather than shared with more closely related carnivores. Supported by NSF DEB 79-09797 and NIH 5T 32 GM07117-05.

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FORELIMB MORPHOLOGY, LOCOMOTOR DIVERSIFICATION AND MORPHOLOGICAL CONSTRAINTS IN PANGOLINS. J. A. Sherman. U. of Chicago.

The forelimb morphology of pangolins was examined as part of an extensive morphometric study of edentates, pangolins and aardvark. The locomotor behavior of pangolins ranges from nearly totally arboreal for the smallest species to exclusively terrestrial for the largest species. Pangolins do not show any pattern of variation in their forelimb skeleton, independent of size, that can be related to differences in locomotor habits. Unlike edentates and other groups of mammals for which regular patterns of variation in the shape of limb elements, independent of body size, have been documented and related to locomotor habits, pangolins are arranged according to their locomotor behavior only when parameters which are highly correlated with body size (e.g., the first principal axis of analyses on log-transformed linear dimensions) are used. This suggests that the limb morphology of pangolins is versatile but may be subject to constraints not present in other groups of mammals, probably due to the (primitive) loss of the clavicle.

Supported, in part, by NSF.

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ENERGY OF THE OSCILLATING LEGS OF HORSES. M. Hildebrand. Univ. of California, Davis.

The average and maximum kinetic and potential energy of the legs was determined for two horses moving at a range of speeds for each natural gait. For the hind leg there is less energy in the system at the trot than at a walk of the same speed. No change in level of energy could be attributed to gait for the foreleg at the walk-trot transition, or for either leg at the trot-gallop transition. At the trot there is an arrest of the proximal segment of the foreleg midway in the fore swing which transfers angular velocity to the middle segment. The proximal segment reaccelerates as the extension of the middle segment nears completion.

BIOMECHANICAL IMPLICATIONS OF MAMMALIAN LOCOMOTOR-RESPIRATORY COUPLING. D.M. Bramble, Univ. of Utah, Salt Lake City.

That the locomotor and respiratory cycles of running mammals are tightly coupled (typically at a 1:1 ratio) has prompted a search for the structural/functional basis of such an integration. Preliminary findings indicate that by (1) linking respiratory frequency to stride frequency and (2) tidal volume to stride length, running mammals may have a simple strategy for accurately matching the level of lung ventilation to running speed and metabolic demand. Additionally, several mechanisms, not operative in the standing animal, are likely to contribute significantly to ventilatory mechanics. Among these are the inertial displacements of a "visceral piston" of which the liver is the dominant component. The existence of such a piston is suggested by anatomical detail, locomotor and respiratory dynamics and the allometric scaling relationships of both morphological and physiological variables. The operation of such a visceral piston could help to explain constraints on stride frequency in galloping mammals.

PHYLOGENY AND ONTOGENY OF GROSS SPINAL CORD MORPHOLOGY IN ANURAN LARVAE. K.C. Nishikawa and R.J. Wassersug, Dalhousie Univ., Halifax, N.S.

At metamorphosis, anurans undergo a profound change in mode of locomotion from axial, undulatory swimming to appendicular saltation. The spinal cord also changes ontogenetically; being elongate and fish-like in early development and shorter, with a cauda equina, in the adult. We examined the gross morphology of larval spinal cords from 28 anuran species (15 families), selected because of their phylogenetic and behavioral diversity. Prior to metamorphosis, tadpoles exhibit two major spinal cord patterns that follow recognized evolutionary grades in the Anura. Mature larvae of archaic families (e.g., Ascaphidae, Pipidae & Discoglossidae) have an elongate spinal cord extending far posterior into the tail. In contrast, comparably staged larvae from advanced families (e.g., Ranidae, Hylidae) have a cauda equina, like the adults, but with a longer *filum terminale*. There appears to be an evolutionary progression toward ontogenetically earlier appearance of the adult spinal cord pattern as one goes from generalized to derived Anura. [This research was supported by the Natural Science and Engineering Research Council of Canada.]

SNAKE PITUITARY IMMUNOCYTOCHEMISTRY. G.Z. Wurst and A.K. Pearson† Weber State College, Ogden, UT and Univ. of California, Berkeley.

Immunocytochemical methods accurately identify cellular origins of various substances, including pituitary hormones. The technique has been applied to some reptilian pituitaries, but snakes have received little attention. We investigated the distribution of pituitary cell types in the snake *Thamnophis* using immunocytochemical methods and have correlated our observations with previous tinctorial studies. The strongly-staining acidophilic cells in the anterior pars distalis include both adrenocorticotropes and lactotropes; the large areas of chromophobic cells in the posterior of the gland are primarily somatotropes. The basophilic glycoprotein hormone-producing cells (thyrotropes and gonadotropes) are distributed throughout the pars distalis in narrow bands which surround clusters of somatotropes in the posterior pars distalis and adrenocorticotropes and lactotropes in the anterior of the gland. This cellular organization of the basophils differs from that described in other reptiles.

BRAIN DISTRIBUTION OF GONADOTROPIN-RELEASING HORMONE (GnRH) CONTENT IN FEMALE GOLDFISH: SEASONAL VARIATION AND PERIOVULATORY CHANGES.

K.L. Yu, C.S. Nahornial*, R.E. Peter, A. Corrigan*, J.E. Rivier*, W.W. Vale*.

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Seasonal variation and perioovulatory changes in brain GnRH content of female goldfish were determined by a radioimmunoassay specific for salmon gonadotropin-releasing hormone (GnRH). Immunoreactive GnRH is widely distributed goldfish brain, the highest concentrations being in pituitary and olfactory bulbs. The GnRH content (pg GnRH/brain fragment/gonad-free body weight) in certain brain areas (olfactory bulbs, hypothalamus, optic tectum-thalamus, spinal cord and pituitary) varied with season and were highest during the time when the gonad was regressed (except for spinal cord). Significant differences in GnRH concentration of certain brain areas (olfactory bulbs, telecephalon, hypothalamus, optic tectum-thalamus and pituitary) between ovulatory and nonovulatory fish were found primarily before and shortly after (1-3 hrs.) ovulation. GnRH neuronal system may function as an integrated unit for the activation of pituitary gonadotrophs during ovulation in goldfish.

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OVARIAN MATURATION IN FUNDULUS HETEROCLITUS: PHOTOPERIOD AND LIGHT INTENSITY EFFECTS. M. H. Taylor, L. L. Hyde*, E. J. Platt and J. R. Day. Univ. of Delaware, Newark, Univ. of California, Berkeley and Univ. of California, Santa Cruz.

Long days are an effective stimulus for gonadal maturation in female Fundulus heteroclitus. As is typical of "photoperiodic" species, it is the timing rather than the duration of the light exposure which is critical to its effectiveness. Ovarian maturation was greater in fish receiving a maximum of six hours of light per day for six weeks in winter if the light was presented alternately in the subjective day and night of the fish. However, maturation was more complete in fish which received more frequent light exposure. The possibility that the amount of light received influenced maturation was tested by varying intensity and duration. Higher light intensities produced more effective maintenance of mature ovaries and more complete recrudescence of immature ovaries in fish exposed to LD 15:9. Ovulated eggs were found in fish maintained at intensities as low as 0.1 lu/m² but not in those maintained at 0.01 lu/m². Photoperiod lengths in excess of 12 hours are necessary for maintenance of ovarian maturation. This finding is in contrast with previous observations of recrudescence on shorter photoperiods.

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EFFECT OF STEROIDS ON FUNDULUS HETEROCLITUS FOLLICLE MATURATION IN VITRO. M.S. Greeley, Jr., D.R. Calder*, M.H. Taylor and R.A. Wallace. Univ. of Florida, Whitney Lab., St. Augustine, and Univ. of Delaware, Newark.

The effects of several steroids on F. heteroclitus follicle maturation in vitro are examined. At relatively high concentrations (1.0ug/ml) a number of steroids are able to effectively induce germinal vesicle breakdown in prematuration oocytes, including pregnenolone, corticosterone, cortisol, 11-deoxycorticosterone, 11-deoxycortisol, testosterone, progesterone, 17 α -hydroxyprogesterone, 20 β -dihydroprogesterone and 17 α -hydroxy-20 β -dihydroprogesterone. Cholesterol and 17 β -estradiol are ineffective. 11-Oxygenated steroids tend to be less effective than their 11-deoxysteroid counterparts. Steroids with a 20 β hydroxyl group (17 α -hydroxy-20 β -dihydroprogesterone and 20 β -dihydroprogesterone) are the most potent initiators of maturation, with partial activity at 1.0 ng/ml. These results suggest a possible physiological role for a 20 β -dihydroprogestin in the resumption of meiotic maturation in this teleost.

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THE RELATIONSHIP OF SOME STEROID HORMONES AND THEIR GLUCURONIDES TO THE TERMINAL STAGES OF OOCYTE MATURATION IN LANDLOCKED ATLANTIC SALMON. Y.P. SO* and D.R. Idler. Marine Sciences Research Laboratory, Memorial University of Newfoundland, Canada.

Peripheral serum levels of free and conjugated steroids were correlated with seven terminal stages of oocyte maturation in female salmon. 17 α ,20 β -dihydroxy-4-pregnen-3-one increased progressively from oocyte stage 1 to 6, with the glucuronide predominatively in stages 1 to 4 and the free steroid in stages 5 to 7. Pregnenolone levels were maximal at stage 1, followed by a surge in testosterone after initiation of germinal vesicle migration. Their glucuronides were always lower than the corresponding free forms. Progesterone, 17 α -hydroxy-pregnenolone, 5-pregnene-3 β ,17 α ,20 β -triol were not detected in the serum during final maturation. The present *in vivo* and *in vitro* study suggests that testosterone and its metabolites and pregnenolone stimulate germinal vesicle migration whereas 17 α ,20 β -P brings about germinal vesicle breakdown.

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OVARIAN CONTRACTIONS OF FUNDULUS HETEROCLITUS. S.M. Winner and M.H. Taylor. Univ. of Delaware, Newark.

Spontaneous contractions have been observed in ovaries of F. heteroclitus in vitro. These contractions have a frequency of 0.28 \pm 0.9/min (\bar{x} + SE, n=5) and amplitudes of 0.53 \pm .04 g (\bar{x} + SE, n=5). Acetylcholine (ACh), arginine vasotocin (AVT), oxytocin (OXY), and isotocin have been tested for ability to induce or modify ovarian contractions. Ovaries were suspended in a Ringer's-filled organ bath and connected to a strain gauge for tension measurements. ACh consistently resulted in dose-dependent (10⁻⁷ to 10⁻⁴ M) increases in tension. These contractions were not dependent on the reproductive state of the ovary. Contractions of lesser magnitude were seen with AVT and OXY but not with isotocin. AVT was effective in the range of 60.0 ng/ml to 1.2 ug/ml. OXY (0.01 IU/ml to 1.0 IU/ml) was less effective. None of the drugs tested modified spontaneous contractions. These contractions might facilitate egg release during spawning or function to move eggs within the ovary.

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AN INVESTIGATION OF ESTROGEN-BINDING ACTIVITY IN GOLDFISH LIVER AND PLASMA. J. Hannum and R. McPherson. Clarion University, Clarion, PA.

Estrogen-binding activity was investigated in nuclear salt extracts of liver from sexually mature female goldfish, Carassius auratus. Salt extracts of nuclei were found to contain high affinity ($K_d=3.42\text{ nM}$) and low capacity binding sites (.42 pM/g tissue). The binding sites were specific for estrogens, no significant competition by 5 α -DHT, progesterone, or cortisone was observed. A saturable binding component was also investigated in the plasma. This binder was found to have distinctive differences in regard to structural specificity compared to the estrogen-binding activity of the liver. It was found to have no affinity for DES while having affinity for both 5 α -DHT and progesterone. The goldfish liver estrogen-binding component was observed to have characteristics in common with estrogen receptors found in other vertebrates.

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EFFECTS OF PRL AND GH ON SECRETION OF PRL-SYNERGIZING ACTIVITY (SYNLACTIN) BY THE LIVER OF POSTMETAMORPHIC GRASS FROGS. B.C. Delidow and C.S. Nicoll. Univ. of California, Berkeley.

It has been shown that liver of bullfrog tadpoles releases prolactin-synergizing activity (synlactin), while that of adult frogs does not (Am. Zool. 24:117A). We investigated hepatic release of synlactin in young grass frogs (Rana pipiens) after treatment with PRL or GH. They were given daily injections of 10ug/g GH or 10ug/g PRL, or the solvent (0.1N NaHCO₃) for 10 days. Animals were killed 24hr after the last injection and the liver sliced, washed and incubated 3hr in 70% Medium 199. Liver incubation media (LIM) were dialysed and tested for PRL-synergizing activity in the pigeon crop-sac bioassay. Only GH increased shin length and body weight in frogs, but only LIM from PRL-treated frogs contained synlactin activity. We conclude that in young frogs PRL, but not GH, can stimulate the liver to secrete synlactin, though GH alone was able to promote growth. Similar experiments on R. pipiens tadpoles are in progress. Supported by NSF grant PCM 8203583 and NIH training grant T32-GM-7379.

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STRESS HORMONES AND TESTIS FUNCTION IN AN AMPHIBIAN. S.K. Boyd and F.L. Moore. Oregon State Univ., Corvallis.

To determine whether corticosterone (CS) directly modulates testis function, testes from Taricha granulosa were treated in vivo or in vitro with CS. In the first experiments, testes were incubated in vitro with various doses of CS and/or ovine LH. Measurements of androgen (T + DHT) in the medium indicated that LH-stimulated androgen synthesis was not affected by CS. In another experiment, males were injected ip with CS or saline or were untreated for 9 days. When testes from these males were incubated in vitro with ovine LH, it was found that testes from untreated males produced more androgen in response to LH than did testes from CS-injected males or saline-injected controls. Results of in vitro incubations, therefore, provide no evidence that CS directly inhibits testicular function. Some other unidentified stress hormone may act directly on the testis to suppress androgen production.

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INFLUENCE OF SOCIAL CUES ON THE TEMPORAL PATTERN OF TESTOSTERONE SECRETION IN MALE BROWN-HEADED COWBIRDS. A.M. Duffy, Jr. and J.C. Wingfield. Rockefeller Univ. Field Res Ctr., Millbrook, NY.

Brown-headed cowbirds (Molothrus ater) are brood parasites that exhibit no parental care and breed almost continuously for approximately 8 weeks in the summer. Males do not defend territories, but do guard females from the courtship activities of other males. Free-living males possess maximal levels of testosterone (T) when females arrive, and male-male competition is greatest. T levels are higher at that time in paired than in unpaired individuals. In the laboratory, dominant males have higher T levels than subordinates during hierarchy formation but not before or after. In addition, the onset of the seasonal rise in T is accelerated, and elevated T levels are maintained longer in photostimulated males paired with females than in similar males housed without females. Nonphotostimulated males show no such response to the presence of females. Thus, social interactions may play a major role in determining the pattern of plasma T in male cowbirds throughout the breeding season.

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EFFECT OF POULTS ON PLASMA PROLACTIN IN INCUBATING TURKEY HENS. H. Opel and J. A. Proudman*. USDA, Agricultural Research Service, Beltsville, MD

Turkey hens kept singly in 66 x 44 x 62 cm wire cages without eggs or nest materials exhibited incubation behavior accompanied by extremely high plasma prolactin (PRL) levels. The hens readily accepted artificially hatched poults. To provide adequate maternal care in a severely limited space, the hens typically spent 12-13 h of a 14 h light period sitting on the cage floor with wings slightly extended to cover the poults. Hen PRL levels fell sharply within 6 h of poult introduction, reached preincubation levels within 24 h and did not recover during 48 h after poults were removed. Incubating hens in adjacent cages, having visual and auditory contact, but no tactile contact with the poults showed no significant change in incubation behavior or in plasma PRL during the experimental period. Our results raise the possibility that tactile stimuli from hatchlings, rather than release of tactile stimuli from the eggs and/or the nest account for the sharp fall in PRL levels in incubating precocial birds at the time of hatch.

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PLASMA ANDROGEN DURING EMBRYONIC AND PERINATAL DEVELOPMENT IN MALE JAPANESE QUAIL M.A. Abdel Nabi and M.A. Ottinger, University of Maryland, College Park

Previous experiments in our laboratory have shown that endogenous steroid hormones change during development. The present experiment was designed to verify and extend these earlier results. Blood samples were collected from quail embryos and posthatch quail; plasma was pooled to allow measurement of androgen concentrations. Results were similar to those obtained previously. Androgen concentrations (ng/ml plasma \pm SE) were 2.7 ± 0.3 , 0.59 ± 0.1 , 0.58 ± 0.1 , and 1.10 ± 0.1 at 10, 12, 14 and 16 days of incubation respectively. Concentrations were still elevated at hatching (0.99 ± 0.4 ng/ml plasma) and at days 1 and 3, posthatch (2.58 ± 0.9 and 2.2 ± 0.9 ng/ml plasma, respectively). By 5 days, posthatch blood levels were declining. The timing of peaks in plasma androgen were similar to results from our earlier experiments. These results will also be related to neuroendocrine changes that occur during this period of development.

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NEONATAL ANDROGENIZATION IN GROUND SQUIRRELS. L. Smale, K. Pelz*, I. Zucker*, and P. Licht. Univ. California, Berkeley.

Male and female Spermophilus lateralis undergo circannual rhythms of body mass and reproduction but there are substantial sex differences in the seasonal pattern of weight gain and luteinizing hormone (LH) secretion. This study examined the effect of testosterone propionate (TP) injected on the day of birth on the development of these sex differences. Squirrels were gonadectomized at 47 days of age and then monitored for 1 year. Neonatally androgenized females attained peak body weights intermediate between those of oil-injected control females and control males. Trough body weights did not differ among the groups. Luteinizing hormone was detectable in all males and most TP-treated females but not in any control females during the first 4 months after gonadectomy. Other sexually dimorphic parameters of LH secretion were not affected by neonatal TP. These data support the hypothesis that testicular hormones secreted during the early postnatal period induce seasonally recurring sex differences in body mass and some aspects of LH secretion.

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ENDOCRINE AND ENVIRONMENTAL INFLUENCES ON COHO SALMON INTERRENAL ACTIVITY. Graham Young (assisted by G. Gottlieb), Univ. of California, Berkeley.

Increased in vitro sensitivity to ACTH and capacity for cortisol production by the interrenal of smoltifying coho salmon coincide with peak plasma thyroxine (T_4) levels and enhanced seawater (SW) adaptability. A role for cortisol in SW adaptation was suggested by short-term increases in plasma cortisol and interrenal sensitivity to ACTH after successful transfer of coho to SW; however, these increases may not be linked to osmoregulation but to non-specific stress (Young, Am. Zool. 24, 73A, 1984). In 1985, plasma cortisol levels and interrenal responsiveness to ACTH were assessed after transfer to SW of coho of optimal or of limited hypoosmoregulatory ability. The former group was characterized by relatively modest rises in plasma cortisol and enhanced interrenal responsiveness, whereas the latter displayed plasma cortisol increases and interrenal responses suggestive of "stress." Administration of T_4 in vivo or ovine growth hormone in vitro enhanced the sensitivity of the interrenal to ACTH in vitro; the action of T_4 appears to be indirect.

(Supported by UC Sea Grant R/F-101 and NSF grant PCM 84-05249 to H.A. Bern)

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ADRENAL STEROIDS REGULATE SERUM ELECTROLYTES IN BULLFROG TADPOLES. P.S. Brown, E.A. Horgan and P.A. Strempe. Siena College, Loudonville, NY.

Although adrenal steroids are known to be secreted by anuran larvae and have been shown to stimulate metamorphosis, there is little evidence for a direct osmoregulatory function for these hormones in anuran larvae. To investigate this possibility, Rana catesbeiana tadpoles (5.2±.7 g; TK stage 13.5) were treated with solvent, aminoglutethimide (AG), AG+corticosterone (B), AG+cortisol (F), or AG+aldosterone. AG decreased extracellular fluid (ECF) [Na] by 60% as well as plasma [Na] and [Cl]. Replacement with either B, F, or aldosterone maintained ECF and plasma electrolytes at control levels. Decreased [Na] in AG-treated tadpoles was not due to dilution since wet weight, body water and hematocrit were unchanged by AG treatment. Because no changes in metamorphic stage occurred during this 4 day experiment, these data suggest that adrenal hormones have a direct role in maintaining EC salts in prometamorphic bullfrog tadpoles that is not explained by their role in accelerating metamorphosis. Supported by NSF Grant PCM-83-02698 and a William and Flora Hewlett Foundation Grant of Research Corp.

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HORMONAL CONTROL OF TRANSDERMAL ION TRANSPORT IN NEWTS. S.C. Brown and L.M. Savage. SUNY @ Albany and Siena College, Loudonville, N.Y.

Voltage-clamped, *in vitro* ventral skin from Taricha granulosa and T. torosa was used to examine the electrophysiological consequences of: (1) *in vivo* salt depletion; (2) long-term *in vivo* treatment with prolactin (PRL) and human placental lactogen (HPL); and (3) short-term addition of AVT and aldosterone to the medium bathing the isolated skins. Plasma ions and osmolarity were significantly reduced in newts maintained in DW for 3 wks, whereas *in vitro* SCC was increased and R_e lowered. *In vivo* treatment with PRL or HPL significantly lowered *in vitro* TEP and SCC and significantly increased R_e . Addition of 10^{-9} AVT to the serosal bathing medium significantly increased SCC and TEP and lowered R_e with a mean maximum response time of 126±13 min. Addition of 3.5×10^{-6} M aldosterone to the serosal bathing medium caused a significantly increased SCC and TEP in experimental newt skin compared with a paired control from the same animal. The mean time to maximum response in aldosterone stimulated newt skin was 13.2±.8 hr. Supported in part by NSF Grant PCM-83-02698.

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IOPANOIC ACID AND THYROID HORMONES IN FISHES. Milwaukee Public Museum, Milwaukee, WI. R. Spieler, T. Noeske-Hallin, S. Yeo* and T. De Rosier*

In mammals, iopanoic acid (IOP) initially decreases circulating T3 and increases T4 (by blocking peripheral monodeiodination). In addition, IOP has a long half-life (2 wk in man) and low toxicity (LD₅₀ in mice = 9-14g/kg). Should these characteristics be similar in fishes, IOP could be a valuable tool for examining physiological effects of endogenous T3 in this class of animals. In 4 studies (2 with carp, 2 with rainbow trout) groups of fish were injected with one of several different doses of IOP (0, 0.25, 0.5, 1.0, 2.0 or 4.0 mg/fish; \bar{x} = 25g carp or 40g trout) or served as noninjected controls. Approximately 9 fish/group were sacrificed at different time intervals (days or weeks) after injection. Serum samples (N=1074) were assayed in duplicate for T3 and T4. Nonmortality was attributable to IOP dosage. IOP reduced T3 in all studies (as much as 40% in some cases). In general, maximum decrease occurred 7 days after injection. In some studies, however, there was a concomitant decrease in T4 (and a trend in T4 reduction in others). There were inconsistent differences in T3 and T4 levels both among and within treatments. The experimental design did not test if IOP is chronobiotic; phase shifts in diel rhythms of T3 and T4 might explain a large measure of the variance among and within treatments. This consideration notwithstanding, IOP does not appear at this time to have great potential as a tool for examining physiological differences in function of endogenous circulating T3 vs. T4 in fishes.

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TRIIODOTHYRONINE BINDING TO ISOLATED TILAPIA HEPATOCYTE AND BRAIN CELL NUCLEI. C.L. Brown. University of California, Berkeley, CA. RNA- and protein synthesis promoting actions of thyroid hormones in tilapia liver and muscle are reportedly maximal at or near 30°C, and this response is lost with age (Matty et al., 1982, Gen. Comp. Endocrinol., 47: 497-507). To elucidate mechanisms of temperature- and age-related changes in peripheral responses to thyroid hormones, we have studied the binding of T₃ to nuclei isolated from possible target tissues in adult and juvenile tilapia. Maximal specific binding (ca. 16%) was observed at 30°C (ambient temperature of the fish) and at pH 7.4; binding decreased sharply in incubations which were conducted at lower temperatures or at other pHs. Adults and juveniles showed similar binding both in the liver and in the brain. These results suggest that temperature-dependent differences in the anabolic effects of thyroid hormones may be due, in part, to altered hormone-receptor interaction but that the loss of response of older tilapia to thyroid hormones is not due to a loss of hormone-binding competence. (Aided by NSF grant PCM 84-05249 and NIH grant CA-09041 to H.A. Bern).

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PERTUSSIN TOXIN BLOCKS MELATONIN ACTION UPON AMPHIBIAN DERMAL MELANOPHORES. B.H. White, M.D. Rollag, and R.D. Sekura*. Uniformed Services University of the Health Sciences and NICHD, Bethesda, MD.

In order to elucidate a mechanism of action for the pineal hormone melatonin, forskolin and pertussis toxin were used to explore whether melatonin acts on hormone-sensitive adenylate cyclase. Melatonin exerts a powerful aggregation of melanosomes in dermal melanophores in tadpoles of *Xenopus laevis*. Meningeal explants of stage 52-54 tadpoles were used in a bioassay system to test whether pertussis toxin, which inactivates the inhibitory nucleotide coupling protein, Ni, blocks melatonin's contracting ability. We found that forskolin causes dispersion of melanosomes, melatonin reverses this forskolin-induced melanosome dispersion, and pertussis toxin blocks the effects of melatonin. A protein corresponding to the Ni alpha subunit was found after SDS gel electrophoresis of melanophore-rich meningeal homogenates. We conclude that melatonin acts to inhibit adenylate cyclase via the inhibitory coupling protein, Ni. Supported by USUHS Protocol C07049 to MDR.

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ULTRASTRUCTURE OF THE PARATHYROID GLANDS IN SHELL-LESS AND *IN OVO* CHICK EMBRYOS. M. B. Clark, Univ. of Connecticut, Storrs.

Chick embryos were grown *in ovo* or in shell-less culture for 12, 15 or 18 days. Blood calcium values were measured and the parathyroid glands removed for ultrastructural examination. Serum calcium values were consistently lower in the shell-less embryos compared to the *in ovo* controls. The parathyroid glands of the 12 day shell-less embryos were conspicuously more active in protein synthesis than controls, as evidenced by presence of more rough endoplasmic reticulum (RER), lipid droplets and dense secretory granules. The latter were not seen in controls. At 15 days of incubation, the *in ovo* glands appeared to be more active than at 12 days. However, the glands of shell-less embryos still were more active, containing a profusion of RER membranes and many mature secretory granules. At 18 days of incubation, the glands of the two groups were ultrastructurally similar, both appearing equally active in protein synthesis. Clearly shell-less culture stimulated early synthesis of parathyroid hormone, presumably in response to hypocalcemia that results from absence of the shell.

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EFFECTS OF GASTRIN AND CCK PEPTIDES ON PANCREATIC EXOCRINE SECRETION IN THE PAINTED TURTLE, *Chrysemys picta*. P. Bond* and D.A. Gapp, Hamilton Coll., Clinton NY

Relative potencies of gastrin family hormones on pancreatic protein secretion in *Chrysemys picta* were determined using an *in vitro* perfusion system. Minced pancreatic tissue was perfused with oxygenated medium (37°C) for a 40-minute period. Increasing concentrations of sulfated and unsulfated CCK, CCK10-20, caerulein, gastrin I and gastrin II were perfused and fractions collected at 4-minute intervals. Protein content of the perfusate was determined using a modified Lowry protein assay. The sulfated CCK8 and caerulein stimulated secretion much more strongly than the other analogues, suggesting a preference for a sulfated tyrosine residue at the 7th position from the C-terminal. The comparatively low potencies of gastrin II and unsulfated CCK8 are probably due to the presence of the tyrosine at the 6th position and the absence of the sulfate group, respectively. It appears that the exocrine pancreas of the painted turtle is more responsive to CCK-like than gastrin-like hormones.

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MOSQUITO DIURESIS: *IN VIVO* EFFECTS OF HEAD EXTRACT. G.D. WHEELOCK*, D.H. PETZEL and H.H. HAGEDORN. Cornell Univ., Ithaca, N.Y.

A new *in vivo* assay was developed to examine the effects of mosquito head extract on diuresis in blood fed *Aedes aegypti*. Females fed blood containing tritiated water (20 μ Ci/ml) were held in a vial for 30 min., removed and the radioactivity in the vial counted by liquid scintillation. Decapitation immediately after feeding resulted in only 8% of the urine output of intact females. Blood fed, decapitated females injected immediately with boiled extract increased urine output 5 fold compared to blood fed, decapitated, saline injected controls. Unboiled extract did not increase urine flow over controls. Sodium content of urine collected between 5 and 10 min. after injection of extract or saline was assayed by WDS electron probe analysis. Sodium concentration was the same in both groups. However, sodium excretion increased 4 fold in extract injected females due to increased urine flow. The requirement for boiling the extract, and the magnitude of change in fluid and Na secretion are similar to previous findings regarding the effects of head extract on isolated Malpighian tubules. Supported by NSF PCM8403305.

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HUMORAL INHIBITION OF JUVENILE HORMONE SYNTHESIS IN LARVAE OF THE COCKROACH DIPLOPTERA PUNCTATA. C.R. Paulson and B. Stay. University of Iowa, Iowa City.

Decline in juvenile hormone synthesis by the corpora allata which occurs prior to metamorphosis was investigated in male larvae to determine whether humoral inhibition of the corpora allata occurs in addition to nervous inhibition. Changes in corpus allatum activity resulting from *in vivo* manipulations were measured using an *in vitro* radiochemical assay for juvenile hormone synthesis. Humoral inhibition was shown by the observations that activity of larval corpora allata declined during the final stadium whether the glands were innervated or denervated, and that activity of adult female corpora allata declined similarly following implantation into late final-instar larvae. However, inhibition did not occur in adult corpora allata implanted into larval hosts which had been decapitated. Extract of larval brains inhibited corpus allatum activity *in vitro*. Inhibitory effect of extract was lost following treatment with trypsin. These results suggest that a factor in the haemolymph inhibits juvenile hormone synthesis during the final larval stadium, and that this factor is a brain peptide.

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REGULATION OF JUVENILE HORMONE LEVEL BY JUVENILE HORMONE ESTERASE AFTER A BLOOD MEAL IN THE ADULT FEMALE YELLOW FEVER MOSQUITO, AEDES AEGYPTI. A.B. Shapiro* and H.H. Hagedorn. Cornell University, Ithaca, NY.

Juvenile hormone (JH) plays several roles in the reproductive physiology of the female Aedes aegypti, and there are dramatic changes in the amount of JH present in the animal during the course of the reproductive cycle. Juvenile hormone esterase (JHE) initiates the catabolism of JH. Therefore, the level of activity of JHE could be important for the control of the JH level. JHE activity in hemolymph of female mosquitoes at several times after a blood meal was determined. The levels of JH after a blood meal correlate well with the levels of activity of JHE in the hemolymph: JHE activity rises as JH levels fall after the blood meal, until 36 hours, when JH levels rise again and JHE activity falls. A JH analog, methoprene, and a JHE inhibitor, BEPAT, were topically applied to mosquitoes at a time after the blood meal when the JH level is lowest and the JHE activity is highest. These treatments significantly reduced the percentage of fertile eggs, suggesting that the JH level must be low at this time, and that JHE is responsible for regulating it.

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JUVENILE HORMONE LEVELS DURING A REPRODUCTIVE CYCLE IN THE ADULT MOSQUITO AEDES AEGYPTI. H.H. Hagedorn, F.C. Baker* and D.A. Schooley*. Cornell University, Ithaca, NY, and Zoecon Laboratories, Palo Alto, CA.

Juvenile hormone (JH) has several roles to play during previtellogenic and vitellogenic growth of the oocyte in the mosquito A. aegypti. It stimulates behavioral and physiological events after emergence that prepare the animal for the blood meal. However, its role after a blood meal is incompletely understood. JH III is the only JH found in the mosquito. We measured JH III levels by coupled GC-mass spectrometry. The amount of JH rose over the first two days after emergence from 0.7 ng/g to 7.5 ng/g and then slowly fell over the next five days in females not given a blood meal. In females fed blood on the third day after emergence, JH levels fell during the first three hours to 2.3 ng/g. The rate of decline then slowed so that levels had reached their lowest point (0.4 ng/g) by 24 hours after the blood meal. By 48 hours, levels of JH started to rise again so that by 96 hours they were equivalent to pre-blood-meal levels. The fluctuations of JH and 20-hydroxyecdysone after a blood meal will be compared, and their role in egg development will be discussed.

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ALTERNATIVES TO MAMMALIAN ANTISERA IN THE EVALUATION/IDENTIFICATION OF HUMAN PROTEINS. A.C. Smith. Veterans Administration Medical Center, Bay Pines, FL.

A project was initiated to investigate the possibility of making available an entirely new class of reagents for use in laboratory diagnosis. The study made use of natural products from marine invertebrates, protochordates (tunicates), and fishes. It was hypothesized that (1) natural fluids of marine animals react with human molecules and cells, and so are potential screening reagents in the clinical laboratory; and (2) natural products of marine animals could be modified by simple procedures to induce specific reactivity for selected human molecules. Natural Fluids. The body fluids from several marine animals were found to produce sex-differentiating reactions with human erythrocytes. This finding demonstrates the value of a natural reagent in detecting a previously unknown (sex-specific) surface structure on human cells. Modified Natural Products. Lens reagents, produced entirely *in vitro* from fish lenses, differentiated hemoglobins A and S; human and bovine serum albumins; erythrocytes of the ABO blood group; and erythrocytes from human females and males (confirming the results of the studies with marine animal body fluids).

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ANTIGEN UPTAKE BY GILL CELLS OF ATLANTIC SALMON GIVEN BATH IMMUNIZATIONS WITH YERSINIA RUCKERI BACTERINS. D. P. Anderson, A. C. Zapata, and M. Wisniewski* National Fish Health Research Laboratory, Kearneysville, WV; Univ. Leon, Faculty of Biology, Leon, Spain; and Appalachian Fruit Research Station, Kearneysville, WV.

Atlantic salmon (Salmo salar) were given 2-min bath immunizations with Yersinia ruckeri O-antigen or formalin-killed cells. Gill samples taken immediately after treatment were fixed and later examined by light and electron microscopy. Effectivity of immunization was confirmed by testing the immune response 21 days after bacterin bath by the passive hemolytic plaque assay to enumerate numbers of splenic antibody-producing cells and by passive hemagglutination to determine humoral antibody titers. Bacterial cells were observed entering the gill cells in a phagocytic-like manner at different stages. The immune response could be reduced by first treating fish with low doses (10 ppm) of phenol for 5 min. The point of blockage of the immune system is speculated to be when bacterin enters the gill cells.

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MITOGENIC RESPONSIVENESS OF NEWT SPLENOCYTES DURING REGENERATION AND FOLLOWING NON-AMPUTATIONAL WOUNDING. R.E. Sicard, M.F. Lombard², J. Foley^{2*}, & M.D. Albert^{2*}. R.I. Hospital, Providence, ¹Regis Coll., Weston, MA, ²Boston Coll., Chestnut Hill, MA.

Immunological influence on regeneration has been proposed, but not experimentally supported. Past studies showed effects on regeneration of administered immunological agents, but did not document immune status. This study reports differences in splenocyte response to T- and B-cell mitogens [concanavalin A (conA) & bacterial lipopolysaccharide (LPS), respectively] between newts undergoing regeneration and those healing wounds caused by surgical removal of the humerus. Both operations increased mitogenic responses at 2 days posttrauma. During regeneration, no increase (vs control) was seen at 5, 8, or 20 days post amputation. However, response to conA was reduced at 12 days, but elevated at 16 days after amputation; while response to LPS was unchanged. Following dehumeralizing, response to conA and LPS increased at 8 days, but was reduced at all other times posttrauma. This is the first evidence of altered immune status during regeneration. These results are consistent with a role for the immune system in amphibian forelimb regeneration. However, further studies are required to prove this role and to suggest the nature of its action.

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KINETICS OF CHICKEN MACROPHAGE ACTIVATION: COMPARISON OF FUNCTIONAL ACTIVITY AND REACTIVITY WITH MONOCLONAL ANTIBODIES. Y. Chu*, K.A. Trembicki* and R.R. Dietert, Cornell Univ., Ithaca, NY.

Harvestable peritoneal macrophages elicited by Sephadex stimulation of 3.5-5 week old female K strain chickens were found to undergo a major shift in activation status during the course of the response to the irritant. Six hours after injection, most adherent macrophages were nonphagocytic, failed to form EA-rosettes, and failed to react with either of two macrophage-specific monoclonal antibodies, CMTD 1 and CMTD 2. In contrast, the majority of peritoneal macrophages isolated 42 or 52 hours after stimulation were phagocytic for sheep erythrocytes, formed EA-rosettes, and reacted with the CMTD 1 antibody. A subpopulation of these macrophages also reacted with the CMTD 2 antibody. Cells from intermediate timepoints possessed intermediate phenotypes. These results suggest that major phenotypic changes occur in the chicken macrophage population during the recruitment and response of the cells to an irritant. Supported by CU Biotechnology Grant 157302 and USDA NY(C) 157424.

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CHARACTERIZATION AND COMPARISON OF ADHERENT CELLS FROM THE RAT THYMUS AT THREE DIFFERENT STAGES OF THYMIC DEVELOPMENT. D.C. Tsui and M. Cook*. University of Cincinnati, Ohio.

Adherent cells (AC) from the rat thymus at the developing, fully developed and acute involution stages were characterized and compared for five phagocyte related enzymes, Fc receptors and their stimulation of syngeneic thymocytes. There are significant shifts in the enzymatic profiles of leucine aminopeptidase and 5'-nucleosidase in AC from the developing thymus to acute thymic involution. The number of esterase positive AC peaks at full thymic development. Though all stages contain acid phosphatase positive AC, there is no significant difference in their relative abundance. Peroxidase activity is negative at all three stages. The number of Fc receptor positive, phagocytosing AC diminishes with acute thymic involution. AC from the fully developed thymus have the highest stimulatory effect on syngeneic thymocytes, while those from the acutely involuted thymus exhibit minimal effect. This study indicates that thymic AC, which have properties similar to phagocytes, differentiate during thymic development, and these cells, from developing and fully developed thymuses, enhance the proliferation of thymocytes.

THE EFFECTS OF OPIATES ON ANTIBODY PRODUCTION IN VIVO. A.A. Hagan¹, A. Pert* and R.J. Weber*. American University, Washington, D.C., and NIMH, Bethesda, MD.

Opiates have been shown to alter a variety of immune functions in vitro and in vivo (Weber, R.J. and Pert, C.B., 1984). For example, heroin addicts are immunosuppressed, and immune parameters such as natural killer cell activity, and in vitro antibody production, can be modulated by opiates or opiate peptides. We examined the antibody response to trinitrophenyl¹⁴⁰-ovalbumin (TNP-OVA) in Balb/c mice which were chronically infused with morphine from an implanted source. Serum antibody levels to TNP were determined using an ELISA assay. Doses of 30 µg per hour for a period of one week had no significant effect on the primary or secondary responses to TNP-OVA. However, implantation of a 75 mg morphine pellet caused a suppression of antibody production to TNP. Therefore, the primary antibody response in vivo to a T-dependent antigen was suppressed by chronic infusion of opiates. ¹(Supported by the American University Faculty Research Grant.)

REPRODUCTIVE BEHAVIOR IN MALE LIZARDS TREATED WITH THE ANTIANDROGENS CYPROTERONE ACETATE AND FLUTAMIDE. R. R. Tokarz. Univ. of Miami, FL.

Cyproterone acetate (CA) has both antiandrogenic and antigonadotropic properties, whereas flutamide (F) has only antiandrogenic activity. The purpose of this study was to investigate the effects of CA and F on male reproductive behavior in the lizard Anolis sagrei. Reproductively active males were implanted with subcutaneous pellets containing either CA, F, or placebo (P). Pellets delivered CA and F at a constant rate of 0.1 mg per day. Behavioral tests were staged between treated males and stimulus males and females after three weeks of treatment. Aggressive and courtship behavior in CA-treated males, but not in F-treated males, was significantly less than in P-treated males. Thus antiandrogens with both antiandrogenic and antigonadotropic activity may effectively inhibit male reproductive behavior in lizards.

ANALYSIS OF A SEX ATTRACTANT PHEROMONE IN GARTER SNAKES. R.T. Mason and D. Crews Institute of Reproductive Biology, Univ. of Texas, Austin, TX.

Male red-sided garter snakes, Thamnophis sirtalis parietalis, detect unmated females by means of a sex attractant pheromone released from the female's dorsal surface. Pheromone samples were obtained in the field by washing the skin of females, males, and female-mimics with hexanes. These washes were biologically active eliciting courtship behavior from sexually active males in field tests. Males discriminated hexane washes of females and female mimics from washes of males. Pheromone samples were analyzed with a gas chromatograph/mass spectrometer. The chromatograms showed clear and distinct peaks that were compared to known traces from a gc/ms computer library. Supported by NIMH NRSA to RTM and NICHD 16687 and NIMH NRSA MH00135 to DC.

STERNAL GLAND SCENT COMMUNICATION IN THE RUFOUS ELEPHANT-SHREW, ELEPHANTULUS RUFESCENS. F. W. KOONTZ NEW YORK ZOOLOGICAL PARK, BRONX.

Sternal gland scent communication in captive Elephantulus rufescens was studied to determine its intraspecific communicatory function. The sternal gland, composed of holocrine sebaceous and apocrine glands, became active about 30 days after birth, however, marking was inhibited until after dispersal from the natal site. Among adults, males had larger glands and marked more often than females. Marking was not affected by either cage size or the female's estrous phase but marking did increase during agonistic encounters. Marking sites were concentrated at trail junctions. Sebum aged 120 days still elicited behavioral responses. Animals discriminated sebum on the basis of sex, individuality, and female reproductive state. Introduction of "deodorized animals" reduced sex-specific aggression levels. It was concluded that sternal gland scent communication facilitates social categorization, which is necessary for the regulation of agonistic behavior.

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THE ONTOGENY OF CONSTRICTING BEHAVIOR IN RAT SNAKES AND BOA CONSTRICTORS.

Mark A. Milostan and James C. Gillingham,
Central Michigan Univ., Mt. Pleasant, MI.

Literature is virtually nonexistent in regards to constricting behavior in neonate snakes. The objective of this study was to investigate the ontogeny of constriction in naive Elaphe obsoleta and Boa constrictor. Using mice as food, over 40 feedings were filmed per snake during a three year period. Discrete components of the constriction phase were identified and followed over time using cinematographic analysis. This made it possible to estimate and compare the ontogenetic stability of constricting patterns within and between species. Neonate boas did not show any significant differences in patterns from older, larger, and more experienced individuals. Conversely, Elaphe exhibited greater variation in patterns during early growth but became more stereotypic in older snakes. These results suggest that interspecific divergence in developmental patterns may have some ecological basis. Additional measurements also show that rat snakes significantly reduce handling time as they mature. Such an increase in efficiency was not observed in boas since they are proficient constrictors from the start.

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SOCIAL PLAY AND FACTORS PRECIPITATING ESCALATION INTO AGONISM IN JUVENILE PUNARÉS (THRICHOMYS APEREIOIDES). K.V. Thompson and J.A. Cranford. Virginia Polytechnic Inst. and State Univ., Blacksburg.

Differences in the content of social play with respect to genetic relatedness was investigated in juvenile punarés (Thrichomys apereoides). Family groups and unrelated dyads were observed, and the initiator, content, sequence and duration of social interactions were recorded. Play bouts between unrelated juveniles were shorter in duration and ended more frequently with one juvenile exhibiting avoidance behavior than those between littermates. Agonism, never observed among littermates, occurred in 12% of encounters between unrelated male juveniles when both had prior experience in the observation arena. All encounters which escalated incorporated play prior to the occurrence of agonism. Agonism was initiated by the subordinate juvenile immediately following performance of dominance reinforcement behaviors by the dominant juvenile. These results support hypotheses of the concurrent development of competitive social skills and dominant relationships through play.

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LIGHT SAMPLING BEHAVIOR IN PHOTOENTRAINMENT OF CIRCADIAN RHYTHMS. P. DeCoursey. Univ. South Carolina, Columbia.

These experiments examine the means by which a nocturnal hole-dwelling rodent, the flying squirrel, assesses the day-night regime in entraining its internal timer to a relevant time of day. Phase Response Curves as well as entrainment patterns of squirrels in wheel cages were first documented. Then, simulated den cages were constructed with a darkened nest box connected via a dark tunnel to a feeding-exercise area on a light-dark schedule, such that the interface of tunnel and outer area served as a port for inspection of the light schedule. Monitoring of movements of individual squirrels in den cages was carried out for periods up to 18 months by means of infrared photocells and a running wheel, in order to detect the time at which each squirrel tested the photoregime. A maximum of several minutes light per day was seen by squirrels on 12 hr L: 12 hr D schedules. When an animal's internal timer brought it to the light sampling port in advance of the light-dark transition, delay phase resetting of its clock took place; on succeeding days, the animal free-ran. These data form the basis for a model of circadian photoentrainment in nocturnal rodents.

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CIRCADIAN PHOTOENTRAINMENT: % OF LIGHT SCHEDULE VIEWED BY A NOCTURNAL RODENT. S.A. Menon. (intro. by S.E. Stancyk). Univ. of South Carolina, Columbia.

The hypothesis was tested that brief glimpses of light seen by a nocturnal, den-dwelling rodent at an appropriate time of day suffice to synchronize its daily activity-rest cycle with the environmental cycle. Simulated dens were designed and the activity of 4 flying squirrels (Glaucomys volans) and 1 deer mouse (Peromyscus leucopus) was individually recorded with infrared photocell monitors and a recording wheel, to determine time of checking light conditions and circadian phase of activity. Recordings of entrainment were made for at least 21 days. For the mouse, maximum amount of light seen was 2.1% (11 min of 9hr L: 15hr D) while minimum was 0.6% (3 min). For one squirrel, maximum light seen was 1.4% (8 min of 9hr L: 15hr D) while no light was seen on 12 of the 21 days. Light was usually seen near onset of activity time (CT 12) where it induced a delay phase shift of activity; subsequently, most animals free-ran for several days. The relevance of these data for transitional and proportional hypotheses of photoentrainment of circadian rhythms is discussed.

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THE NEXT EXPERIMENT: TEMPERATURE AS A ZEITGEBER FOR CIRCAANNUAL RHYTHMS. D.E. Davis. 777 Picacho Ln. Santa Barbara CA.

The Z for circannual rhythms of weight is not known. Squirrels (*Spermophilus beecheyi*) were caged individually. Fed ad lib, kept at either northern (NH) or southern hemisphere (SH) daylength and 20 C. or southern hemisphere (SH) temperature cycle. All sqs were 6 months old at the start. Expt I. Sqs on NH and 20 C had maximum weight in Sep. or Aug. for 7 years. Sqs on SH and 20 C ran freely, as did sqs on LD 12:12. Expt II. Sqs on NH and 20 C had maxima in Aug for 3 year but when switched to SH temp. advanced in 2 years to April. Sqs on SH and 20 C ran freely for 3 years but when switched to SH temp. kept their maxima at April for 2 years. Expt III. Sqs on NH day length and SH temp. advanced to July in 3 years while sqs on SH daylength and SH temp. advanced to June. Expt IV. Sqs on intens illumination (1000 lux) showed no difference in 5 years from those on weak (200). Expt V. Sqs started on SH daylength in Feb. showed no difference from those started in Sept. Next Exp*. Maintain sqs on constant daylength (LD 12:12), and SH temp. for 5-8 years. Entrinment for circannual rhythms may require 2 factors.

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CALLING SONG RECOGNITION AND PHONOTAXIS IN CRICKETS. L.A. Doherty. Cornell University, Ithaca, N.Y.

In the acoustic communication system of crickets, males produce calling songs that serve to attract conspecific females for mating. In some species of crickets, the recognition of male calling song and the elicitation of positive phonotaxis in receptive females involves the evaluation of several calling song temporal properties that appear to have different weightings in the recognition process. All of these properties, including pulse and chirp repetition rates and pulse and chirp durations, contribute to the total attractiveness of the acoustic signal. Some properties, such as pulse repetition rate, may have weightings that are much higher than those of other temporal properties, leading one to believe that these other properties are not essential for calling song recognition. However, when the attractiveness of the most potent properties are diminished, the effects of other less potent properties on triggering recognition and phonotaxis become more evident. In this paper I present results of ongoing phonotaxis studies that provide evidence for the existence of temporal property interactions and different weighting factors in the recognition of male calling song by females. The results of several phonotaxis assays are considered, including phonotaxis in arenas, in flight, and on a locomotion compensator. These results indicate that in addition to searching for necessity and sufficiency of temporal properties in communication systems, we should also consider how animals recognize and act upon particular combinations of signal properties. (Supported by the Max-Planck Society and an NIH postdoctoral fellowship).

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AVERSIVE STIMULI GENERALIZATION IN YOUNG AVIAN INSECTIVORES. D. L. Evans,† H. Badruddine, N. Castoriades. American Univ. of Beirut.

We presented sets of naive common quails with 6 different sequences of 3 similar aposematic insects. Our goal was to determine whether naive predators initially form a sharply defined aversive gestalt which would then stimulate an avoidance response only in the presence of that signal. These birds usually generalized the signals and did, indeed, reject later, similar but not identical, signals. Therefore, anti-predatory signs need not be identical to be mutually protective for prey organisms. Müllerian systems in nature can have variable components.

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ONTOGENY OF AVIAN ACTIVITY RHYTHMS. C.J. Fisher, D. Attai* and P.J. DeCoursey. Vassar College, Poughkeepsie, N.Y., and Univ. South Carolina, Columbia.

Shell-less culture of chick embryos facilitated direct observation of developing rhythmicity. Muscle activity was studied in White Leghorn chick embryos from the start of culture on day 3 of development to day 19, the limit of survival. Rates of amniotic (smooth) muscle and skeletal muscle contraction under constant lighting and temperature conditions were measured. Amniotic contraction commenced on day 4, increased through day 10, and then dropped off sharply. Skeletal muscle contractions, expressed as % time active, began about day 7, correlated with rapid limb growth, and continued as long as embryos survived. Neither individual data nor pooled means for data through day 12 of development suggested circadian rhythmicity. From days 13-17 small, short-term fluctuations in rate of skeletal muscle contraction were seen, which increased gradually in amplitude and period. On days 18-19, changes in activity rate from about 9% to 69% at approximately 12-hour intervals suggested incipient rhythms which may lengthen into circadian rhythms.

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HYPOPHYSES IN JUVENILE OSTEOGLOSSID TELEOSTS: UPDATE. S. Holtzman, NY College of Osteopathic Med, Old Westbury, and Brookhaven Nat'l Lab, Upton, NY

In 1968 Kerr described the characteristics of a hypothetical ancestral teleostean hypophysis. The glands in 2 juvenile silver arowanas, Osteoglossum bicirrhosum, were described by Holtzman et al at these meetings in 1981. The gross morphology of the glands appeared to fit Kerr's theory: the dorsal surface of the pars distalis is separated from the anterior surface of the infundibulum by a vascular membrane; the neurohypophysis interdigitates with the pars intermedia only. These observations have now been confirmed in 5 additional juvenile O. bicirrhosum and 2 juvenile black arowanas, O. ferrerei. Scott and Fuller (1976) described the hypophyses in the Malaysian osteoglossids, Scleropages formosus, in relation to reproductive development. The glands in juvenile scleropages appear to be similar to the glands in juvenile arowanas, supporting the concept that the developing hypophyses in osteoglossid teleosts represent extant examples of an early stage in the evolution of the teleostean hypophysis. (Supported in part by DOE contract No. DE-AC02-76CH00016).

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THE EFFECTS OF ESTRADIOL-17B AND THYROTROPIN-RELEASING HORMONE (TRH) ON PROLACTIN RELEASE FROM THE ROSTRAL PARS DISTALIS (RPD) OF THE TILAPIA, OREOCHROMIS MOSSAMBICUS IN VITRO I. E. Barry and E. G. Grau. Univ. of Hawaii, Honolulu.

Spontaneous prolactin (PRL) release increased in a dose-related manner following estradiol-17B (E_2) pretreatment. Thyrotropin-releasing hormone also stimulated a dose-related increase in PRL release from E_2 -preincubated RPDs, but had no effect on tissues not previously exposed to E_2 . The maximal PRL response, nearly 3X control release, occurred at 50 nM TRH. Higher doses of TRH were less effective in stimulating PRL release. These findings indicate that TRH may be an important hypothalamic prolactin-releasing factor in the tilapia. Furthermore, the potentiation of PRL cell responsiveness to TRH by E_2 suggests that the control of PRL secretion may shift with variations in the reproductive state of the tilapia. Supported by NSF Grant PCM-83-14294 and NOAA Sea Grant NA85AA-D-SG082-A/R-31 through the Hawaii Sea Grant College Program to E.G.G. and by a Sigma Xi Grant-In-Aid and East-West Center Fellowship to T.P.B.

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RAPID CHANGES IN PROLACTIN (PRL) RELEASE FROM THE PITUITARY OF THE TILAPIA, OREOCHROMIS MOSSAMBICUS. E. G. Grau, C. N. Ford, L. M. H. Helms, and S. K. Shimoda. University of Hawaii, Honolulu.

Rostral pars distalis tissue was placed in perfusion culture to investigate temporal patterns in the secretory responses of PRL cells. Release was quantified by measuring 3H -Leu-labeled PRL in the perfusate. Baseline release was established in hyperosmotic (HR) medium (355 mOsm) for 3 hrs. Upon exposure to hyposmotic (HO) medium (280 mOsm) PRL release increased rapidly within 10-30 min, and remained elevated for at least 3 hrs thereafter. Release remained at baseline during continued exposure to HR medium. Somatostatin (SRIF) both substantially blocked the stimulation of PRL release by HO medium and elicited a rapid reduction in release (within 10 min) from levels that were already elevated. The rapidity of these changes suggests that the actions of SRIF and reduced medium osmotic pressure on PRL secretion are at least partly independent of any potential effects on hormone synthesis. Supported by NSF Grant PCM-83-14294 and by NOAA Sea Grant NA85AA-D-SG082-A/R-31 through the Hawaii Sea Grant College Program.

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BIOCHEMICAL SEPARATION OF SALMON PITUITARY THYROTROPIN (TSH) AND GONADOTROPIN (GTH). P. Swanson, W.W. Dickhoff and A. Gorbman. Univ. of Washington, Seattle.

TSH and Gth were isolated from adult coho salmon pituitary glands. After final extraction in acidic alcohol, proteins were fractionated using gel filtration chromatography and chromatofocusing. TSH activity was measured *in vivo* in salmon parr. Gth (steroidogenic) activity was determined *in vitro* using cultures of adult salmon ovarian follicles. Biologically active proteins were examined for purity and subunit nature by gel electrophoresis. Antisera generated to the purified hormones was characterized immunostaining of Western blots. Using these procedures TSH activity eluted at pH 6.3 on chromatofocusing. Six protein peaks which eluted from pH 5.4 to 4.0 contained Gth activity. All hormones have an estimated molecular weight of 40 kilodaltons and consist of two subunits. Since microheterogeneity of pituitary glycoproteins is common, the multiple GTHs could represent isoforms of one Gth. (supported by NIH training grant 5T32-GM07270-10 and NSF grant DCB-8416224)

STRUCTURAL FEATURES OF HUMAN GROWTH HORMONE (hGH) AND PLACENTAL LACTOGEN (hPL) RELATED TO THEIR BIOLOGICAL PROPERTIES. C.S. Nicoll, G.L. Mayer* and S.M. Russell. Univ. of California, Berkeley.

Although the complete amino acid (a.a.) sequence of several GHs, PRLs and of hPL has been determined, little is known about the structural features responsible for their common or diverse bioactivities. hGH and hPL should be useful for providing clues to such features since they are structurally very similar (85% identical a.a. homology) but they are different biologically: they both have PRL activities but only hGH has GH activity. The a.a. sequences of hGH and hPL were compared with those of GHs from 8 other species and with PRLs from 7 species. hGH and hPL differ from other GHs in 50 and 60 residues, respectively. Among these residues, 12 in hGH and 13 in hPL are identical with corresponding residues in one or more of the PRLs. Using other information it is possible to reduce the number of critical residues associated with PRL activities of hGH and hPL to 8 and 9, respectively. hPL differs from hGH at 28 residues and 11 of these are in positions that are invariant in other GHs, but 6 of the 11 are conservative substitutions. Thus, hPL's lack of GH activity may be due to as few as 5 substituted residues. NSF grant 82-03583

Parrotfish Thyroid Ultrastructural Changes After *In Vitro* Bovine Thyrotropin (bTSH) Stimulation. C.J. Smith and E.G. Grau.

Six groups of thyroid glands of *Scarus dubius* were compared by electron microscopy after a 4 hour culture with bTSH. Three groups, 1) control, 2) tissues exposed to 1 mIU/ml bTSH, and 3) tissues exposed to 20 mIU/ml bTSH, did not differ from each other in relative surface density of rough endoplasmic reticulum (rER), or relative surface area of lysosomes and engulfed colloid droplets. Thyroids exposed to 5 mIU/ml bTSH showed an increase in microvilli, rER, engulfed colloid droplets, and lysosomes. Tissues exposed to 10 mIU/ml bTSH showed an even greater increase in these structures, with the apical portion bulging into the lumen. Most cells in tissue exposed to 20 mIU/ml were broken apart, but a few intact cells contained large engulfed colloid droplets extending from the apical to basal borders. This tissue's dose-response curve shows that thyroid hormone release peaks at exposure to 10 mIU/ml bTSH, and declines upon exposure to 20 mIU/ml bTSH. The decline may be due in part to the cell lysis seen in this group. The lysis may be the result of the engulfment of more colloid than the membranes could contain. Funding by: NSF Predoctoral Fellowship (Smith) NSF Grant PCM-83-14294 (Grau). U.H. Sea Grant NOAA NA 81AA-D-00070 (Fast and Grau).

CHANGES IN THYROIDAL RESPONSE TO BOVINE THYROTROPIN (bTSH) DURING THE PARR TO SMOLT TRANSFORMATION OF COHO SALMON (*Oncorhynchus kisutch*). W.W. Dickhoff and P. Swanson. Nat. Mar. Fish. Serv. and Univ. of Washington, Seattle.

The parr to smolt transformation (smoltification) of anadromous salmonids is associated with a surge in blood levels of thyroid hormones. A study of the elevation of blood thyroxine (T₄) in response to administered bTSH (0.2 to 7 mIU/g) in intact fish was conducted to evaluate thyroid sensitivity during smoltification. The thyroid was relatively insensitive to exogenous TSH in January and February. An increase in thyroid sensitivity was observed to occur in parr in late March. During the endogenous T₄ surge in April, there was no significant additional elevation in T₄ in response to exogenous TSH. Thyroid sensitivity remained high from May through July. These results indicate that the coho salmon thyroid is insensitive to bTSH in late winter but increases before and remains high after smoltification. Thus, smoltification cannot be defined by the increased sensitivity of the thyroid. (Supported by NSF DCB 8416224 and Wash. Sea Grant R/A-42).

THYROID HORMONES, GILL (Na⁺-K⁺)ATPase, AND SEAWATER TOLERANCE IN SALMON EMBRYOS. C.V. Sullivan and W.W. Dickhoff. Univ. of Washington and Nat. Mar. Fish. Serv., Seattle.

Increases in plasma thyroxine (T₄) and triiodothyronine (T₃) levels, gill Na⁺, K⁺-ATPase activity (ATPase), and seawater (SW) tolerance occur in juvenile salmon during smoltification. Smoltification occurs in embryos of some species. Plasma levels of thyroid hormones (TH), gill ATPase activities, and SW tolerance were evaluated in developing embryos of five salmon species in order to examine the relationship between thyroid function, osmoregulation, and embryonic development. In general, plasma T₄ levels (5-15 ng/ml) increased during development. Maximal T₄ levels usually coincided with completion of yolk-sac absorption. Plasma T₃ levels were low (0-3 ng/ml) during this time. In chum salmon embryos a maximum gill ATPase activity of 18 umoles ATP hydrolyzed·mg protein⁻¹·h⁻¹ (units) coincided with completion of yolk-sac adsorption and development of SW tolerance. Coho, chinook, sockeye, and Atlantic salmon embryos had lower gill ATPase activities (2-8 units) which changed little during development. There were differences between species in the pattern of development of SW tolerance, but no correlation between plasma TH levels, gill ATPase activities, or SW tolerance were noted. (supported by NSF DCB-8416224 and Wash. Sea Grant R/A-42)

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THE NATURE OF TSH EFFECTS ON THE THYROID GLAND (TG) IN DEVELOPING AND MATURE JAPANESE QUAIL. M.J. McNichols and F.M. Anne McNabb, Dept. of Biology, Virginia Tech, Blacksburg, VA 24061.

This study examined the nature and time course of TSH stimulation of TG function with respect to iodine (I) uptake, thyroid hormone (TH) production and release. The TG is responsive to a single TSH injection in embryos, chicks and adults as shown by increased TG-³²P uptakes (2 through 8 hrs) and increased serum TH (30 min through 8 hrs). However, TG-¹²⁵I uptakes were not increased by TSH exposures up to 24 hrs. A dual-label experiment in chicks using ³²P and ¹²⁵I verified the lack of an I response while confirming TG stimulation.

Chronic (> 1 wk) TSH injections resulted in elevated serum T4 concentrations, decreased TG-T4 content and increased TG-¹²⁵I uptakes. Manipulation of I availability demonstrated that the elevated TG-¹²⁵I uptakes with chronic TSH did not result merely from a TG-I deficiency caused by sustained high hormone release. Thus stimulation of TG-¹²⁵I uptake requires prolonged TSH exposure in contrast with the short-term effects of TSH on hormone release and hormone production (as shown by increased serum TH, increased ³²P uptake and hormone labelling within 6 hrs.) Supported by NIH RO1 28216.

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ENZYMATIC CHARACTERIZATION OF AVIAN HEPATIC 5'-MONODEIODINASE PATHWAYS. F.M.A. McNabb, L.J. Lyons and T.E. Hughes. Dept. of Biology, Virginia Tech, Blacksburg, VA 24061.

Two types of 5'-D from quail liver were characterized biochemically to compare their properties with those of mammalian (mml) enzymes. Type I activity, the fraction inhibited by propylthiouracil (PTU) and characteristic of mml liver, also predominates in avian liver. However, Type II (not inhibited by PTU) accounts for up to 50% of the activity. Iopanoic acid (IOP) inhibited all activity, demonstrating the enzymatic nature of activity measured in our *in vitro* system (assay for T₃ production by liver homogenates with abundant substrate and cofactor available). T₃ production from T₄ by both pathways increased progressively with increased enzyme concentrations, substrate concentrations, and incubation times. Enzyme activity for both pathways was maximal at 37°C and pH 6-8. Km values were 1.58 μM T₄ for Total and 0.90 nM T₄ for Type II activity, as are characteristic of the mml pathways. The effects of goitrogens were as on mml 5'-D: methimazole and thiourea were without effect, 2-thiouracil inhibited Type I but not Type II activity. Supported by NIH RO1 28216 and a BRSG grant.

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CORTICOSTERONE, LIPID STORES AND FORAGING IN DARK-EYED JUNCOS, JUNCO HYEMALIS. D. Yarian*, M. Ramenofsky and J.M. Gray*, Vassar College, Poughkeepsie, New York.

Stress-induced elevations of corticosterone (B) are well known. Ramifications of hormonal fluctuations are associated with promotion of gluconeogenesis and foraging in birds and mammals. We hypothesized that stress-induced increases in (B) would result in depletion of energy stores which, in turn, would stimulate foraging, thus replenishing utilized fuels. To test this hypothesis male juncos were administered B, metyrapone or control implants. Foraging behavior and measures of lipid metabolism (body weight, fat deposition, lipoprotein lipase activity (LPL) in muscle and fat) were monitored. Results indicate that B depletes muscle mass of the pectoralis-supracoracoideus complex while conserving lipid stores. LPL in muscle was elevated while that in adipose tissue remained unchanged. Although this mechanism is, at present, unclear, these intriguing results highlight a specificity of the catabolic action of B, which preserves lipid, a major fuel utilized by birds. (Funded by NSF grant BNS 84-03798).

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PLASMA CORTICOSTERONE:CORTISOL RATIOS IN SYRIAN HAMSTERS DECREASE WITH AGE AND HEART DISEASE. J.E. Ottenweller, W.N. Tapp* and B.H. Natelson*. VA Med. Ctr., East Orange, NJ.

Both corticosterone (B) and cortisol (F) contribute to total plasma glucocorticoid concentrations in hamsters. We measured B and F in young (3-5 mo.) and old (12-19 mo.) male hamsters, which had heart disease (BIO 14.6) or were healthy controls (F1B). Hamsters were kept on a 12:12 L:D schedule with food and water available *ad libitum* and were sacrificed by decapitation. Plasma hormone levels were determined by specific RIA's. B and F concentrations were similar in young animals of the two strains with the B:F ratio being 4:1 (B=2.0±0.2 and F=0.5±0.1 μg/dl). While B was higher than F in all groups, the ratio dropped to 2:1 in old controls (19 mo.) and sick (12 mo.) hamsters (P < 0.01). In heart failure, B=1.5±0.1 and F=1.2±0.1 μg/dl. In old controls, B=1.45±0.1 and F=0.9±0.1 μg/dl. These data suggest that species which secrete both B and F, such as man, may regulate adrenal 17-hydroxylase activity and/or clearance of B and F to alter the ratio of corticosterone to cortisol in plasma. Supported by VA Research Funds.

A HIGH AFFINITY CORTISOL RECEPTOR IN THE GILLS OF THE BROOK TROUT, SALVELINUS FONTINALIS. P. K. Chakraborti*, A. Chakraborti* and M. Weisbart. St. Francis Xavier Univ., Antigonish, Nova Scotia, Canada.

In vitro binding of [³H]cortisol (F) to gill cytosol preparation demonstrated high affinity (K_a $0.31 \pm 0.02 \times 10^7/M$, N_{max} 223.9 ± 22.8 fmoles/mg protein) and specific steroid binding. The kinetics of the binding at 0°C showed association and dissociation rate constants of 0.002 nM/min and 0.007 nM/min respectively and a half life of the receptor-ligand complex of 29.2 min. Competition studies with [³H]-labeled cortisol and different inert steroids showed the binding hierarchy as: dexamethasone > triamcinolone acetonide > 11-deoxycortisol > F > corticosterone > cortisone > progesterone > 17 β -estradiol > 17 α ,20 β -dihydroxyprogesterone > testosterone > pregnenolone. Gel filtration chromatography indicated a molecular weight of 326,000 Daltons and Stokes radius of 5.96 nm. Low levels of high affinity binding were also detectable in salt extracts of gill nuclei. (Supported by NSERC grant A0781 and RDG1405 to M.W.)

PANCREATIC ISLET HORMONES OF SALMON: PURIFICATION AND PRIMARY STRUCTURE. E. Plisetkaya, H.G. Pollock*, J.R. Kimmel* and A. Gorbman. University of Washington, Seattle and Veterans Administration Hospital, Kansas City, MO.

Insulin (INS), somatostatin (SS), glucagon (GLU), glucagon-related peptide (GLU RP), and pancreatic peptide (PP) have been isolated from principal pancreatic islets of 3000 coho salmon (Oncorhynchus kisutch) by gel filtration and reverse phase HPLC, and their amino acid sequences have been determined by J.B. Rouse and J.W. Hamilton (Veterans Administration Hospital, Kansas City) as follows: INS A-chain GIVEQ CCHKPCNIFDLQNYCN, B-chain AAAQHLGSHLVDALY LVCGEKGFYYPK; GLU HSECTFSNDYSKYQEERMAQDFV QWLMNS; GLU RP HADGTYTNSVSTYLQDQAAKDFVSWLK SGRA; SS-25 SVDNLPPRRKAGCKNFYWKGFSTC; SS-14 AGCKNFFWKTFTSC. Salmon PP seems to be a 36-amino acid peptide. The differences and similarities in structure as compared to mammalian and other fish islet hormones, as well as some biological activities of salmon islet peptides will be demonstrated. (Supported by NSF DCB-8415957 and NIH AM 0907219)

CARDIAC STIMULATORY EFFECTS OF ARGININE VASOTOCIN IN BULLFROG, Rana catesbiana. J.S.K. Sham and P.K.T. Pang. The Johns Hopkins University, Baltimore, and Texas Tech University, Lubbock.

The antidiuretic and vasopressor effects of arginine vasotocin (AVT) in bullfrog have been well documented. However, the cardiac stimulating effects of AVT is unknown. We found that AVT possesses positive chronotropic and inotropic effects in bullfrog *in vivo*, after the neural reflex has been blocked by atropine and propranolol. In isolated spontaneously beating frog atria, AVT increased the beating rate by 20% and the contractile force by 100%. The inotropic effect of AVT was also demonstrated in electrically driven atria and ventricles. Propranolol was found ineffective in blocking the cardiac effects of AVT. In conclusion, AVT stimulates cardiac beating rate and force in bullfrog, and is not act via cardiac β -adrenoceptors.

CRUSTACEAN CHROMATOPHOROTROPIC FACTORS FROM THE CRICKET, ACHETA. C. J. Mohrher and K. Ranga Rao. Univ. of West FL, Pensacola, FL.

Although analogs of crustacean red pigment concentrating hormone (RPCH) have been isolated from insect sources, less is known about the distribution of peptides related to crustacean pigment-dispersing hormones (PDHs). We found that extracts of whole heads and various components of the cephalic neuroendocrine system of the cricket, Acheta, elicit melanophore pigment dispersion and leucophore pigment concentration in destalked Uca pugilator. These activities are due to thermostable peptides. Upon gel filtration chromatography, the chromatophorotropins from Acheta emerge in two peaks. The first peak is chromatographically similar to the 1928-dalton PDH of Uca, and elicits chromatophore pigment dispersion. The second peak, apparently of lower molecular size component(s), elicits melanophore pigment dispersion and leucophore pigment concentration. Work is in progress to further purify and characterize these peptides. (Supported by NSF grant DCB-8314737)

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REDUCED RESPONSIVENESS OF STARFISH OOCYTES TO THE MEIOSIS-INDUCING HORMONE FOLLOWING AN EXTENDED EXPOSURE TO 1-METHYLADENINE AT HIGH PRESSURE. J. G. CLOUD. Univ. of Idaho, Moscow.

For immature starfish oocytes, the meiosis-inducing activity of 1-methyladenine (1-MA) is reversibly blocked by increasing ambient pressure during the hormone dependent period. Extending the incubation time with 1-MA at high pressure to twenty hours did not result in an increase in oocyte maturation but did result in a reduction in the percentage of oocytes that matured in response to 1-MA when subsequently incubated at atmospheric pressure. This reduced responsiveness of oocytes incubated with 1-MA (1 µg/ml) at high pressure (4500 psi) for twenty hours is not detectable in oocytes incubated under identical conditions in filtered seawater alone, cannot be attributed to the presence of an inhibitor substance, cannot be explained by a delay in the onset of germinal vesicle breakdown and is not reversed by maintaining the treated oocytes at atmospheric pressure for up to twelve hours before the addition of 1-MA.

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TREHALASE IN BEAN-SHAPED ACCESSORY GLAND AND SPERMATOPHORE OF TENEBRIO MOLITOR. T. Yaginuma and C.M. Happ. Univ. of Vermont, Burlington.

Trehalase activity was first examined in a reproductive system of 10 day-old male adults. In testis and tubular accessory gland (TAG), the activity was very low (1.5 nmol of glucose released/min/pair testes and 0.1 nmol/min/pair TAG) but in bean-shaped accessory gland (BAG), it was found to be 400 nmol/min/pair BAG. Trehalase in BAG was a soluble type and had an optimum pH of 5.7 and a Km value of 5.5 mM for trehalose. In BAG just after adult ecdysis, the activity was 4 nmol/min/pair BAG. From 1 day to 6 days, it increased linearly by 100 times and then reached a plateau. In specific activity, it increased by 20 times. In the deposited spermatophore, trehalase activity was found to be 13 nmol/min/spermatophore. In BAG of 4 day-old isolated abdomens which had been prepared just after adult ecdysis, the activity was similar to that in the same aged controls. These results suggest that trehalase is involved in the terminal differentiation of BAG and transferred into spermatophore and that an occurrence of the high activity in BAG does not require factor(s) from the brain, CC and CA. Supported by NIH AI-15662.

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NEUROHORMONAL AND HORMONAL STIMULATION OF ECDYSTEROID PRODUCTION BY TESTES OF THE TOBACCO BUDWORM, HELIOTHIS VIRESCENS. M.J. Loeb, E.P. Brandt and C.W. Woods. USDA, Insect Reproduction Lab., Beltsville, MD 20705.

Testes from late last larval instar and mid-pupal Heliothis virescens secrete ecdysteroids spontaneously *in vitro*. Testes from younger larvae can be stimulated to do so by Testis Ecdystiotropin (TE) from brains of late last instar and midpupal animals; early last instar testes are used to assay for TE activity. TE, a peptide of moderately low molecular weight, can be partially purified by HPLC. Although bioassay of ecdysteroid-free active fractions elicits response, 20-hydroxyecdysone in the incubation medium induces even more ecdysteroid. Testes producing ecdysteroid spontaneously release 2 to 200 times more detectable ecdysteroid in the presence of increasing titers of 20-hydroxyecdysone in the incubation medium. Thus 20-hydroxyecdysone provides positive feedback reinforcement for ecdysteroid synthetic activity by testes. Dual control of testis ecdysteroid production by TE and exogenous ecdysteroid is implied.

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ESTERASES AND PROTEASES IN MERCENARIA MERCENARIA HEMOCYTES. C.A. Moore and S.R. Gelder, Lasell College, MA, and Univ. of Maine, Presque Isle, ME.

Previous studies have identified numerous degradative enzymes within the hemocytes of M. mercenaria. Six acid hydrolases including indoxyl-acetate esterases -A, -B, and -C have been localized as primary and secondary lysosomes. Li et al. (1973) showed that esterases varied amongst types of human blood cells; they differentiated these esterases by comparing the results following the use of specific substrates. Three of these substrates (Naphthol AS-D choroacetate; Naphthol AS acetate; and δ-Naphthol acetate) were used to further characterize the esterases in Mercenaria hemocytes. As some esterases mimic the reactions of proteases, three representative peptidases were sought, DAP I, II, and IV. Since hemocytes incorporate proteinaceous materials of both external and internal origin, an array of protein degrading enzymes was predicted. Supported by NSF-PCM-8316396.

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IN VITRO RESPONSE OF NURSE SHARK LEUCOCYTES TO PORCINE C5a. S. Hyder Smith and S. Obenauf*. Florida International Univ. and Univ. of Miami, Florida.

The *in vitro* chemotactic response of nurse shark leucocytes to endotoxin-activated rat serum previously described was further examined to determine whether the cells were responding to C5a of activated serum (as in the case with mammalian cells). Purified porcine C5a was employed and a chemotactic response was observed. Optimal cell migration was obtained at C5a dilutions between 1:1000 and 1:2000. For comparative purposes activated guinea pig and human serum were assayed to determine whether these sera stimulate chemotactic migration. Although a migratory response was seen in response to guinea pig serum, human serum failed to stimulate a response. These results indicate that shark leucocytes may be capable of differential recognition of C5a from different species. Currently the response of shark leucocytes to sera from lower vertebrate species is being examined.

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GROWTH FACTOR IN CULTURES OF FISH EPITHELIAL CELLS. B. A. Hamby*, E. M. Huggins, Jr.* and M. M. Sigel. USC School of Medicine, Columbia.

The EPC line was initiated by Dr. N. Fijan and Dr. D. Sulimanovic in 1969 from carp epidermal herpes virus induced hyperplastic lesions. A subculture of these epithelial cells was kindly supplied to us by Dr. B. Lindgerding. The cells have been grown in Eagle's MEM containing 10% fetal bovine serum and 1% gentamicin at 23-24°C. Supernatants and extracts of these cells were tested for their effect on catfish peripheral blood lymphocytes and mouse thymocytes. Increased proliferation was observed with the fish lymphocytes in the presence of the supernatants and to a greater extent with the cell extracts. There was no stimulatory effect for mouse thymocytes and in fact the preparations caused an inhibition of proliferation especially in the presence of mitogens. The nature of the factor has not been determined and we are investigating the possibility that it may represent a cytokine in the family of interleukins. We have already demonstrated that catfish lymphocytes recognize and respond to human IL-1.

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LYMPHOID CELLS IN RANA PIPIENS: A TWO-COLOR IMMUNOFLOUORESCENCE STUDY OF SURFACE AND CYTOPLASMIC MARKERS. Leslie D. Zettergren and Barbara J. Fenn*. Carroll College, Waukesha, WI.

Fluorochrome-conjugated peanut agglutinin (PNA) and affinity-purified, fluorochrome-tagged F(ab')₂ antibody fragments specific for (i) IgM, (ii) nylon wool nonadherent splenocytes (NSS), and (iii) monoclonal antibodies were used in two-color staining combinations in order to define mononuclear cell populations (MNC) in larval liver, thymus and urogenital tissue (UGT). We found (i) 25-50% of MNC were surface (s)NSS⁺, (ii) 5-25% of MNC were sPNA⁺, and (iii) 5-15% of thymus MNC were sOKT-11⁺/sT-11⁺. Among sPNA⁺ UGT MNC, 5-20% contained cytoplasmic (c)IgM; while about one-third of sNSS⁺ MNC were cIgM⁺. These observations suggest that (i) heterogeneous MNC subpopulations may be simultaneously defined by fluorescence techniques in *Rana*, and (ii) the sites and patterns of MNC ontogeny and differentiation in frogs may be similar to those of birds and mammals. (Partially supported by a Hewlett Fdn. Grant of Research Corp. and the NIEHS Aquatic Biomedical Research Center of Med. College of Wisc. and Univ. of Wisc.-Milwaukee.)

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TRANSIENT DECLINE IN ADOPTIVE IMMUNITY IN NEONATAL CHICK HOSTS. F. Seto Univ. of Oklahoma, Norman.

The levels of acquired immunity in neonatal chick hosts were equal to or greater than those in embryo hosts when transferred cells were from B haplotype-matched donors. However, the adoptive immunity expressed by the grafted immune cells in B haplotype-mismatched neonatal chick hosts was greatly reduced and is believed to be the consequence of an incipient host allograft reaction that manifests itself at this age. In other experiments with 1 to 8-day old B haplotype-matched chick hosts, the immune level was consistently lower with 4 to 6 day hosts. This coincides approximately with the onset of immunocompetence to the test antigen. When the adoptive immune levels of 1 to 6 day chick hosts, pretreated earlier with cyclophosphamide (CY), were compared with those of untreated hosts of comparable ages, no consistent changes were observed, although slight reduction was detectable in older CY-treated hosts. The nature of the transient host decline in immunosupportive capacity is not clear but there is little direct evidence for an involvement of a suppressor cell system.

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DETECTION OF O-ACETYLATED (O-Ac+) SIALOCONJUGATES ON HUMAN MELANOMA BY CANCER ANTENNARIUS LECTIN (CaL). M.H. Ravindranath, J.C. Paulson,* E.L. Cooper, and R.F. Irie.* Division of Surgical Oncology, UCLA School of Medicine, Los Angeles, CA 90024

We tested iodinated Cancer antennarius Lectin (CaL) for its binding capacity to mammalian red blood cells (RBCs). Only O-Ac+ RBCs such as those of the equine and murine varieties showed strong cpm. I-125-CaL bound to RBCs was removed by EDTA and subjected to electrophoresis, and its homogeneity and molecular weight were confirmed. To establish sensitive methods for the detection of O-Ac+ sialoconjugates on human tumor cell membranes, two immunoassays were developed using melanoma cell lines rich in O-Ac+ gangliosides as targets. The first assay, the immunoadherence assay, involved adherence of human RBCs to CaL-anti-CaL-complement formed on O-Ac+ melanoma cells, and was sensitive when the anti-CaL was of IgM class. The other assay, which involved I-125-protein-A binding to CaL-anti-CaL complexed on cell membranes, was sensitive when the antibody was of IgG class. These assays will be useful in investigating O-Ac+ sialoconjugates on human tumor cells. (Supported by NCI Grants CA29605, CA12582, and CA30647, by NSF Grant DCB-85-10930, and by the Fulbright and the Ben and Joyce Eisenberg Foundations.)

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FRESHWATER SHRIMPS (DECAPODA: NANTIA) FROM VENEZUELA, AND THEIR BIOGEOGRAPHICAL RELATIONSHIPS. G.A. Pereira Univ. of Maryland, College Park.

A survey of Venezuelan freshwater shrimps was made during the last 4 years. 32 species were found, pertaining to the families Sergestidae (1), Atyidae (5), and Palaemonidae (26). The genus *Macrobrachium* is the most diverse and widespread, with 20 species. Ecologically, the species found can be arranged in two groups: those found in coastal rivers which require estuarine zones for reproduction, and those which live in inland waters, totally independent of estuaries. All 3 families are represented in the former group while only the Palaemonidae (and probably Sergestidae) are represented in the second group. Shrimps from group one are widely dispersed, and show close relation with the freshwater shrimp fauna of the West Indies and tropical eastern Atlantic drainages. While species in group 2 are not widely dispersed, they are found in both Amazon and Orinoco basin, including distinct groups of morphologically related species. Research funds by CONICIT S1-1259 and Univ. of Maryland.

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THE DISTRIBUTION AND ECOLOGY OF THE CRUSTACEAN CLASS REMIPEDIA. J. Yager. Old Dominion Univ., Norfolk, VA.

In 1979 an unusual troglolithic crustacean was discovered in an anchialine cave in the Bahamas. Due to the characters of this animal, a new class, Remipedia, was proposed. Since the discovery of the first remipede, *Speleonectes lucayensis*, additional representatives of the class have been found in anchialine caves throughout the West Indies and in the Canary Islands. Investigation of the physical environment indicates a complex vertical stratification of the water column. Most remipedes are found in polyhaline waters of long residence time, with low dissolved oxygen and often below a layer of hydrogen sulfide. Due to the abundance of several of the new species, more details concerning the functional morphology and general characteristics of the class are now available.

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SYSTEMATICS, ECOLOGY AND ZOOGEOGRAPHY OF THE EASTERN PACIFIC SPECIES OF ALPHEUS (CRUSTACEA, DECAPODA). W. Kim and L. G. Abele. Florida State University, Tallahassee.

A revision of the genus *Alpheus* revealed 53 nominal species reported from the eastern Pacific. Of these 23 are considered valid and an additional 22 new species are described, resulting in 45 eastern Pacific species. Morphological and possible subgeneric relationships among the species were examined using 67 characters. Phenetic and phylogenetic results were compared. The species occur in a variety of habitats including coral (18 species), rocky intertidal (29 species), mangroves (3 species) and sand-mud (21 species). Most species occur in several habitats while a few (e.g. *Alpheus lottini*) are only found in a single habitat. Seventy eight percent of the species are endemic to the eastern Pacific while 11% also occur on both coasts of the Atlantic. Four percent are shared with the Indo-West Pacific and 2% each with the western Atlantic, eastern Atlantic and Indo-West Pacific and all other regions.

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TWENTY-ONE SPECIES OF FIDDLER CRABS (GENUS UCA) FROM A SMALL TIDAL RIVER ON THE PACIFIC COAST OF COSTA RICA. F.H. Barnwell and W.A. Szelistowski. University of Minnesota, Minneapolis, and University of Southern California, Los Angeles.

The tropical eastern Pacific coastline of Central and northern South America has been identified as the center of species diversity for fiddler crabs but little information is available on details of regional and local distributions. We collected crabs along the Rio Lagarto from their farthest upstream occurrence to the mouth of the river near Punta Morales in the Gulf of Nicoya. Freshwater banks and brackish mangrove forest of the upper river yielded Uca ecuadoriensis, brevifrons, herradurensis, galapagensis, zaca, argillicola, festae and limicola while tidal mud and sand flats at the mouth provided U. heteropleura, stylifera, ornata, panamensis, batuenta, saltitanta, oerstedii, inaequalis, tomentosa, beebei, stenodactylus, deichmanni and terpsichores. This level of local diversity is unexceptional for the region but extraordinary when compared to 15 species reported for all of eastern North America between Massachusetts and Yucatan. Thus, the tropical Pacific coast offers a rich and accessible resource for comparative biological research on the genus Uca.

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KOREAN BARNACLES (CRUSTACEA, CIRRI-PEDIA, THORACICA). I.H. Kim and H.S. Kim. Kangreung National Univ. and Seoul National Univ., Korea.

The specimens were collected at 72 localities in South Korean waters. The majority were obtained from inshore and shallow water. In total, 51 species and 1 subspecies were identified and classified into 2 suborders (Lepadomorpha and Balanomorpha), 12 families and 27 genera. Among them one species of the genus Paralepas within the Heterolepadiidae, one of the genus Chirona (true brackish water species) and two species of Acasta within the Archaeobalanidae are new to science. In South Korean waters, 16 species were found from the Yellow Sea, 30 from the South Sea, 35 from the Cheju Island region and 23 from the East Sea. When these 52 species or subspecies are grouped into four climatic components, 14 species (27%) are tropical, 24 (46%) are temperate, 4 (8%) are boreal and 10 (19%) are worldwide; 22 of 24 temperate zone species appear to be endemic to Far East Sea. Balanus amphitrite, B. eburneus and B. improvisus have recently immigrated into Korean waters.

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PRELIMINARY SURVEY OF STOMATOPOD CRUSTACEA IN THE GULF OF NICOYA, COSTA RICA. A. Dittel. Universidad de Costa Rica, San Pedro

Stomatopod crustacea were sampled by trawl monthly at 8 stations and weekly at 4 stations in the Gulf of Nicoya, a tropical estuary in the Pacific coast of Costa Rica, Central America during 1981-1982. Four species of stomatopods were identified: Squilla parva, S. mantoidea, S. aculeata and S. panamensis. Differential patterns of distribution between the various species were observed. S. aculeata was found in most stations but was more abundant in the upper Gulf, while S. parva and S. mantoidea were found only in the lower Gulf. S. panamensis was uncommon. The association between the observed distributional patterns and the physico-chemical characteristics of the Gulf are discussed.

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DENSITY INFLUENCED DISPERSAL OF COPEPODS: IMPORTANCE OF SPECIES PATTERNS. S.K. Service, Univ. of South Florida, Tampa Fl.

The effects of increased meiofaunal abundance on harpacticoid copepod dispersal were experimentally investigated in a Florida intertidal sandflat habitat and in a laboratory experiment. In the field, ambient sediment was defaunated and then stocked with three levels of harpacticoid copepod densities. Dispersal of copepods, measured by decreasing sediment density, was monitored for all density treatments over a four hour period. Total copepods showed an increase in dispersal with increasing sediment density. Three species were selected for population-level examination of the density-dispersal relationship. Two of three species demonstrated the pattern of increased dispersal with increasing density. A laboratory experiment was conducted to further investigate this relationship. Total copepods again show the pattern of increased dispersal with increased density, however there is an overall reduction in numbers dispersing. Dispersal of harpacticoid copepods appears to be related to density and is species-specific.

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DISTRIBUTIONS OF CO-OCCURRING
CALLIANASSA CALIFORNIENSIS AND
C. GIGAS. D.P. Berschauer.

Univ. of California, Irvine.
 The deposit feeding mudshrimp, Callianassa californiensis and C. gigas are potential competitors and coexist in high densities in the mudflats in Bahia de San Quintin, Mexico. The hypothesis that they partition space vertically within the sediment, and/or by tidal height, was tested. No differences in the patterns of vertical distribution were found between the two species, however there was tidal height segregation in that C. californiensis inhabited the high intertidal zone and C. gigas inhabited the low intertidal zone. C. gigas is significantly larger at all tidal heights where it occurs alone than where it occurs with C. californiensis. C. californiensis is significantly smaller in lower tidal levels where it co-occurs with C. gigas. Size differences of species in allopatry vs. sympatry may be related to competitive interactions between the two species.

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INFAUNAL INTERACTIONS IN THE BAY OF FUNDY.
 W. Herbert Wilson, Jr. Dalhousie Univ.,
 Halifax, NS, and Northeastern Univ.,
 Boston, MA.

The infauna of the Minas Basin of the Bay of Fundy is dominated by the amphipod, Corophium volutator, with summer densities exceeding 50,000/m². To test for the importance of competition between Corophium and other infaunal species, sediment cores were taken from an upper intertidal area dominated by polychaetes and were maintained in running seawater in the laboratory. The mean field density of Corophium was added to half of the cores. A third treatment with Corophium maintained alone was also established. After five weeks, only the nephtyid polychaete, Aglaophamus neotenus, declined in abundance in the presence of Corophium. Polychaetes did not affect the abundance of adult Corophium but did significantly depress juvenile abundance. In late July, the intertidal site dominated by polychaetes was colonized by Corophium. Population changes are currently being monitored and will be reported.

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EFFECTS OF COMPETITION AND PREDATION ON
 THE DISTRIBUTION OF CREPIDULA SPECIES.
 M.A. Shenk. Univ. of Delaware, Newark.

The three Crepidula species are common epifaunal associates of hermit crabs along the Atlantic coast of North America. The species have limited microhabitat overlap within the hermit crab assemblage. Competition between Crepidula species, and predation are two alternative hypotheses to explain Crepidula distributions. Selective removal of presumed competitors from replicate sets of shells had no effect on Crepidula densities. Thus competition between Crepidula species does not explain the field distribution patterns. A manipulation of predator densities within enclosures had significant effects on Crepidula densities and distributions; each species occupies a refuge from predation on field shells. These findings indicate that predation, not competition, determines the microhabitat distributions of Crepidula species.

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CHEMICAL FEEDING DETERRENTS IN A MARINE
 ALGA: EFFECTS ON THREE SYMPATRIC
 HERBIVORES. J.E. Duffy and M.E. Hay*.
 Curriculum in Marine Science, Univ. of
 North Carolina, Chapel Hill.

The brown seaweed Dictyota dichotoma produces a diterpene alcohol, pachydictyol A, which we hypothesized might deter feeding by its common herbivores. Sea urchins (Arbacia punctulata), spot-tail pinfish (Diplodus holbrooki), and a mixture of amphipod species were offered portions of a palatable seaweed (Gracilaria foliifera) coated with either 1) crude organic extract of Dictyota dissolved in ether, 2) pachydictyol A in ether, or 3) pure ether as a control. Extracts were applied at concentrations naturally occurring in local Dictyota populations. Crude extract significantly reduced grazing by all three herbivores. Pachydictyol A was as effective as crude in deterring grazing by fish and amphipods but was ineffective against urchins. In preference experiments with several spp. of algae Dictyota ranks low for fish and urchins but high for amphipods, suggesting that amphipod feeding preferences are a complex function of plant chemistry and other characteristics such as plant morphology and predation risks associated with feeding on specific plants.

TROPHIC ROLES OF THE TROPICAL LIMPET-LIKE PREDATORY GASTROPOD, DRUPA. F.I.M. Thomas* and A.J. Kohn. University of Washington, Seattle.

Most limpet-like gastropods are herbivores or suspension-feeders, but *Drupa* (Neogastropoda: Thaididae) retains the predatory habit typical of its family. Gut contents of three *Drupa* species co-occurring on the windward, seaward reef platform of Enewetak Atoll were analyzed to identify prey species. The major food of *D. ricinus* was the vermetid gastropod *Dendropoma gregaria*. *D. arachnoides*, considered conspecific with *D. ricinus* by some workers, preyed almost exclusively on the nereid polychaete *Ceratonereis mirabilis*. The commonest prey of *D. morum*, the largest species, was the nereid *Perinereis singaporiensis*. Diets differed within species between exposed and protected portions of the reef. Prey size and predator size were positively correlated. The results are compared with data from studies of other predators of the same prey species at Enewetak, and with J.H. Taylor's data on the diets of *Drupa* species elsewhere in the Indo-West Pacific region. (Supported by NSF Grant DEB 81-17945.)

PREDATOR-PREY SIZE INTERACTION IN THE ENERGY BUDGET OF THE ESTUARINE GASTROPOD THAIS HAEMASTOMA. D.W. Garton. State University of New York at Stony Brook.

Energy budgets were determined for individual oyster drills fed diets restricted to either 1) hatchery-reared oyster spat 1-2 cm in length, or 2) wild-caught juvenile oysters 4-5 cm in length. Mean scope for growth was positive in both diet groups, however oyster drills fed small oysters had a mean scope for growth twice that of oyster drills fed large oysters (228.4 cal/day vs 107.0 cal/day, respectively). This was a consequence of the interaction of predator and prey size. Small oyster drills (<750 mg dry wt) fed large oysters had significantly lower weight standardized scope for growth than small oyster drills fed small oysters. Scope for growth of large oyster drills (>750 mg dry wt) was not affected by oyster size. Differences in metabolic energy losses did not contribute to differences in scope for growth. These results suggest that for a predatory gastropod there are considerable energetic benefits for selecting optimum size bivalve prey.

PREDATION BY STOMATOPOD CRUSTACEA ON MOBILE INVERTEBRATES IN TROPICAL THALASSIA-RUBBLE HABITATS. G.K. Roderick, S.M. Shuster, and R.L. Caldwell. University of California, Berkeley.

Stomatopod crustacea are abundant in many tropical and temperate marine communities, yet their importance as predators is not well understood. In a field study, we measured the intensity and effects of predation by the stomatopod, *Gonodactylus bredini*, on populations of mobile invertebrate prey in a *Thalassia*-rubble community on the Atlantic coast of Panama. We first document 65 acts of predation in the field by *G. bredini* in a range of sizes on several species of *Cerithium* gastropods (mainly *C. eburneum*) and on hermit crabs in *Cerithium* shells; stomatopod size and prey size were highly correlated. Secondly, in a multifactorial design with replication we used artificial cavities to manipulate local densities of stomatopods (35-45mm). Predation was intense only on smaller (less than 16mm) gastropods and hermit crabs, demonstrating size-specific vulnerability for prey. Also, predation varied seasonally, corresponding with gastropod recruitment. These results suggest that stomatopods may be important in structuring populations of their prey. (Supported by NSF BNS Grant 80-23414 to RLC.)

THE ORIGIN OF TROPHIC SPECIALIZATION IN WRASSES. S.L. Sanderson, Harvard Univ., Cambridge, MA

A number of morphologically specialized species in the marine teleost family Labridae have limited dietary breadths (e.g. *Cheilinus unifasciatus* and *Gomphosus varius*). Generalized species (e.g. *Thalassoma ballieui* and *T. duperrey*) have a typical percoid body shape, undifferentiated dentition, and a relatively broad diet. High-speed films of prey capture were digitized to provide plots of morphological parameters (e.g. gape and premaxillary protrusion) against time. To investigate the neuromuscular basis for these kinematics, electrodes were implanted in the major jaw abductors and adductors. The results suggest that radiation into various trophic niches has involved morphological and behavioral specialization rather than the acquisition of unique neuromuscular activity patterns. This is inconsistent with reports that specialized cichlids and centrarchids do possess unique patterns. An examination is needed of the constraints on the functioning of labrid oral jaws that could account for a different process of evolutionary diversification in the Labridae compared to the closely-related Cichlidae. Supported by an NSF Graduate Fellowship.

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AIR BREATHING AND RISK OF AQUATIC PREDATION IN THE DWARF GOURAMI, *COLISA LALIA*. N.G. Wolf. McGill Univ., Montreal, Que.

In a laboratory experiment examining aquatic predation as a potential factor selecting against the evolution and use of air breathing in fishes, dissolved O₂ concentration was used to manipulate the frequency of air breaths taken by dwarf gouramis. At low oxygen levels (0 and 1 ppm), the gouramis breathed air more frequently and spent more time out of cover (benthic vegetation) than they did at higher oxygen concentrations (3 and 8 ppm). When exposed to predation by snakeheads (*Channa* sp.), gouramis were caught more quickly at low oxygen levels. Most captures occurred when the gouramis were out of cover. These results indicate that the vulnerability of a bimodally breathing fish increases when it breathes air more frequently, leaving cover to go to the surface.

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MUCOUS SECRETIONS OF *CONVOLUTA* "PULCHRA": A FUNCTIONAL-ECOLOGICAL APPROACH. Klausner, M. D., Univ. of Maine, Orono.

The functional significance of the mucous secretions from the frontal organ and epidermal body glands of the acoel turbellarian *Convoluta* "pulchra" was determined in experiments that tested choice of the animals between sand previously exposed to C. "pulchra" (natural sand) and acid-cleaned sand, and experiments testing the effect of mucus on the growth rates of the acoel's food item, *Nitzschia curvilineata*. Since C. "pulchra" preferentially chose natural sand over acid-cleaned sand ($p < 0.05$; $z = 2.45$), it is proposed that mucus is involved in the gregarious spatial distribution of the animals by acting as an attractive signal to conspecifics. Secreted mucus also was found to enhance growth of the diatom, *N. curvilineata*. More than twice the initial diatom concentrations were found after the same time span in dishes containing mucus as compared to controls ($p < 0.05$; $U = 25$). In addition, it was found that these mucous secretions agglutinate sediment particles into an interstitial system of tunnels and trails, thus stabilizing the sediment. Supported by NSF grant BRS 81-16894.

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THE ROLE OF *NEPHTYS BUCERA* (POLYCHAETA) IN THE FOOD WEB OF THE SURF ZONE COMMUNITY. J.J. McDermott. Franklin and Marshall College, Lancaster, PA.

The population under study is located mainly below MLW of an exposed sandy beach at Avalon, New Jersey. *N. bucera* is the only large polychaete in the shallow surf, but it is subordinate in numbers and biomass to the smaller spionid *Scolelepis squamata*. Over 100 worms, ranging in wet weight from 0.2 to 2.7 g, were collected periodically from 1978-85. Food items found along their entire digestive tracts were identified and counted. *Donax variabilis* (juveniles), the most common prey, was ingested whole and thus digested in the shell. Next in importance was *Scolelepis*, but *Nephtys* can seldom take full advantage of this mid-intertidal species because their distributions overlap only slightly for most of the year. The amphipod *Amphiporeia virginiana* and the anomuran *Emerita talpoida* were eaten sporadically. Thus *N. bucera* is a predator of the most common benthic invertebrates of the surf zone community; these in turn play a major role in the nutrition of surf zone fishes. *Nephtys*, however, has never been identified in the gut contents of these fishes. (Supported in part by research grants from F and M College).

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ON THE BIOLOGY OF *METIS HOLOTHURIAE* IN SEAGRASS HABITATS, TAMPA BAY, FLORIDA. S.S. Bell and M.O. Hall*. University of South Florida, Tampa.

Metis holothuriae is a conspicuous harpacticoid copepod, distinguished by its red color and humpback morphology. Even though this copepod is easily identified and reported from phytal habitats around the world, virtually no information on the biology of this copepod exists. In Tampa Bay we have recorded large numbers of individuals of *Metis* on both seagrass blades and in sediments, especially during summer months. Although a distinct range of size classes has been recorded from field samples, no gravid females have been noted. Because members of the Metidae are distinct in having degenerate mouthparts, the mode of nutrition for *Metis* is particularly perplexing. Our observations in the laboratory indicate that the copepod browses among detrital flocs and algal epiphytes using first and second antennae and first pereopods to manipulate structure. *Metis* co-occurs in seagrass habitats with a host of other large, highly pigmented harpacticoids with good swimming ability.

THE INFLUENCE OF HYDROIDS ON THE RECRUITMENT OF FOULING ORGANISMS. Walter J. Lambert (intro. by L.G. Harris). Univ. of New Hampshire, Durham, NH.

Colonization in a fouling community was investigated to evaluate the role of hydroids in recruitment. Plexiglas panels were placed in Portsmouth Harbor, Portsmouth, NH and treated with $MgCl_2$ to remove micropredators. The presence of predators (particularly nudibranchs) in a hydroid community seems advantageous for the establishment of *Botrylloides aureum*. It is suggested that nudibranchs interfere with a hydroid community's defense against larval invasion. A comparison between predator recruitment and the sessile community suggests an attraction by nudibranchs to their preferred prey resource, *Obelia* or *Tubularia*. The presence of hydroids appears to benefit the recruitment of pycnogonids and caprellid amphipods by providing cryptic protection and to facilitate the establishment of the blue mussel, *Mytilus edulis*.

DAMSELFISH - SEA URCHIN COMMUNITY STRUCTURE OF A BACK REEF ENVIRONMENT AT MAGUEYES, PUERTO RICO. A. H. Williams, M. R. Garstka, K. Wasmund,* and D. L. West. Auburn Univ., Auburn, AL, and Univ. of Alabama in Huntsville.

The community of damselfish (Pomacentridae) and sea urchins occupying patches of staghorn coral (*Acropora cervicornis*) and coral heads (e.g. *Montastrea annularis*) in the sloping back reef of MARIO reef offshore from Magueyes Island was examined in September 1984 for comparison with similar communities off Jamaica. Four 25 m transect lines were laid perpendicular to the depth gradient at 3, 5, 8 and 10 m depth contours. Fish and urchin densities and coral and algal lawn dimensions were recorded. Twenty threespot damselfish (*Eupomacentrus planifrons*) were collected from both coral types for sex determination and gonadal analyses. Mean (\pm SE) damselfish, *Diadema antillarum*, and *Echinometra viridis* densities (no. inds. m^{-2}) along 3 transects were 0.14 ± 0.06 , 0.01 ± 0.01 , and 1.99 ± 0.46 , respectively. Within staghorn coral patches threespot and *Echinometra* densities (no. inds. m^{-3}) were higher (0.87 ± 0.48 and 29.89 ± 14.76 , respectively). Staghorn coral volume and algal lawn area averaged 0.30 ± 0.06 and 0.16 ± 0.04 along the transects. Mean threespot density was significantly higher along the 8 m transect, as compared to the 3 and 5 m depths. In staghorn coral, 78% of the fish were males with a mean total length (TL) of $76.3 \text{ mm} \pm 3.3$ and a mean sperm cyst length (SCL) of $0.06 \text{ mm} \pm 0.008$. Females from these patches were $74.7 \text{ mm} \pm 1.9$ TL and had a mean ovarian follicle length (OFL) of $0.09 \text{ mm} \pm 0.018$. Fish collected from head corals were 80% female, $76.44 \text{ mm} \pm 2.57$ TL, and had a mean OFL of $0.3 \text{ mm} \pm 0.05$. Males on these heads were smaller than all other groups but did not exhibit a significant difference in mean SCL. Females on head corals had significantly more mature follicles. Patterns of social organization within damselfish colonies appear to be consistent with similar communities in Jamaica.

EFFECTS OF SUSPENDED SEDIMENT AND BURIAL UPON SURVIVAL AND GROWTH OF GULF OF MEXICO CORALS. S.A. Rice. Univ. of Tampa, FL.

Laboratory experiments were employed to quantify the effects of high suspended sediment loads and total burial upon hard coral species from the central west coast of Florida. Eight species of corals were tested with survival and growth rates measured in suspended sediment tests and survival rates measured in burial tests. Coral growth rates were determined using the buoyant weight technique. Natural, unpolluted sediment from the Gulf of Mexico was used in all experiments. No significant differences between control and experimental treatments were found in 10 day survival rates, however growth rates were significantly lower in the experimental treatment exposed to an average suspended sediment load of 165 mg/l. Burial experiments were undertaken with seven of the coral species and produced LT_{50} values ranging from 7 to 15 days. *Scolymia lacera* was most sensitive to burial while *Solenastrea hyades* and *Stephanocoenia michelinii* were most tolerant to burial.

ORIGIN AND EVOLUTION OF EASTERN PACIFIC CORAL REEFS. R.H. Richmond. Smithsonian Tropical Research Institute, Panama.

The origin of the present coral fauna of the eastern Pacific has been an area of controversy and debate. Two theories proposed to explain the observed distribution of corals in this region are vicariance and long-distance dispersal of planula larvae. Experiments performed on the larvae of both *Pocillopora damicornis* and *Tubastrea aurea* indicate that planulae of these species remain competent for periods long enough to enable immigration from the central Pacific into the eastern Pacific. Major differences in life history characteristics have been observed between the geographically separated populations of *P. damicornis* from the eastern Pacific and Central Pacific Ocean. These include differences in fecundity, reproductive allocation, growth rate, age specific mortality, and interspecific competitive ability, and are hypothesized to be the result of divergent evolution via adaptation to local biotic and abiotic factors.

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EVOLUTIONARY DIVERGENCE OF POPULATIONS OF A MARINE ISOPOD IN PANAMA: BETWEEN OCEAN COMPARISONS. J.R. Weinberg, Woods Hole Oceanogr. Inst., MA.

Approximately 4 m y ago the Isthmus of Panama rose and split marine species into isolated, Caribbean and Pacific, populations. This barrier remained effective until at least 80 y ago, when the Canal was constructed. Excitrolana braziliensis is an abundant sand beach isopod occurring on both coasts of Panama. It was used to test whether interpopulational divergence was greater between- than within- oceans. Data were collected on morphological and genetic differences and reproductive isolation. Two morphs were discovered, but there was not one in each ocean, as expected if they were split by a landmass 4 m y ago. One morph occurs only in the Pacific. The other occurs in both oceans. The morph which only occurs in the Pacific differs greatly in morphology and genetic structure from the morph which occurs in both oceans. Taxonomists should split the morphs into two species. We do not know if the morph which occurs on both coasts has been split into Caribbean and Pacific populations for 4 m y or if interoceanic migration and breeding have occurred as a result of man's activities.

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"EGG-SHELL GRANULES IN SOME PRIMITIVE TURBELLARIA: MORE EVIDENCE FOR POLYPHYLY? M.B. Thomas, J.P.S. Smith, R. Chandler* and A. Barker*. Univ. of North Carolina, Charlotte and Univ. of Maine, Orono.

Mature oocytes (or vitellocytes, when present) of many turbellarians contain granules that react positively to histochemical tests for polyphenols. These "egg-shell" granules are released when the egg is laid, and participate in a quinone-tanning process that reinforces the egg shell. Mature oocytes of members of the turbellarian Orders Macrostomida, Acoela, and Nemertodermatida, and mature oocytes and vitellocytes of a member of the Order Prolecithophora were examined with the Fast Red Salt B test for polyphenols. Positively-staining granules were found in the oocytes and in the vitellocytes of the prolecithophoran, and in the oocytes of the macrostomids. No reaction for polyphenols was observed in the oocytes of the nemertodermatid or in those of the acoels. These histochemical differences are reinforced by preliminary ultrastructural studies, and we therefore conclude that the mode of egg-shell formation is yet another anatomical feature separating the Acoela and Nemertodermatida from the rest of the Turbellaria.

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PROTIST PHYLOGENY BASED ON SMALL SUBUNIT rRNA SEQUENCES. J.H. Gunderson, H.J. Elwood* and M.L. Sogin*, National Jewish Hospital, Denver, CO.

Comparisons of small subunit rRNA ("18S") gene sequences were used to determine phylogenetic relationships among the protists. The diversity observed within the protists is greater than that of the other three eukaryotic kingdoms combined. The deepest branchings among the protists examined so far are those of the euglenoids and kinetoplastids. These early events were followed by the divergence of the cellular slime molds, and then by a relatively recent period of intense protist evolutionary radiation during which the fungal, plant and animal lineages also appeared. The groups most closely related to these three kingdoms have not yet been identified, but the data refute the idea that metazoa arose from ciliates. These two groups are separated by plants, fungi and several other protist groups. Finally, our data suggest that the eukaryotic lineage is a very ancient one; the eukaryotic sequences don't converge on recognizably archaeobacterial or eubacterial groups.

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A PHYLOGENY OF PRIMITIVE FROGS (ANURA: ARCHAEOBATRACHIA). D.C. Cannatella. University of Kansas, Lawrence.

The phylogenetic relationships of 40 taxa of primitive frogs (suborder Archaeobatrachia) were resolved using more than 200 derived character-states of morphology. Each of the three superfamilies of archaeobatrachians (Discoglossoidae, Pipoidea, and Pelobatoidea) has been thought previously to be monophyletic. However, this study shows the discoglossoids to be a primitive grade. Within the Pipoidea, the Pipidae are the sister-group to the fossil family Palaeobatrachidae. The third pipoid family, Rhinophrynidae, is problematic in that although derived larval features ally it to the other pipoids, characters of the adult suggest a relationship to the Pelobatoidea. Within the family Pelobatidae, the Pelobatinae and Mego-phryinae are each monophyletic. (Supported by NSF grant DEB 8207681 to Linda Trueb.)

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PHYLOGENY OF OLD WORLD FRUIT BATS (MAMMALIA: CHIROPTERA): CONGRUENCE AMONG MOLECULAR, CHROMOSOMAL, AND MORPHOLOGICAL DATA SETS. C.S. Hood, Texas Tech Univ., Lubbock.

Phylogenetic relationships of the Old World nectar-feeding bats (Pteropodidae; Macroglorossinae) were assessed using data derived from histomorphology of the female reproductive tract. A cladistic analysis of the derived character states does not support the monophyly of the Macroglorossinae, if the African taxon Megaloglossus is included. The phylogenetic relationship of Megaloglossus to other pteropodid genera is not strongly supported, however, the female reproductive data support chromosomal and immunoelectrophoretic data that associate this nectar-feeder with the epomophorines. Taxonomic congruence among independent data sets shows that the subfamily Pteropodinae is a paraphyletic assemblage and that the systematic arrangement of macroglorossine bats should be reconsidered.

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ALLOZYMES AND THE BIOGEOGRAPHY OF THE LIZARDS OF THE GALAPAGOS ARCHIPELAGO. J. W. Wright and M. A. Simovich, Natural History Museum, Los Angeles, California.

Tissue samples representing the diversity of the lizards of the iguanid genus Tropidurus from the Galapagos Archipelago and mainland South America were subjected to allozyme electrophoresis. The allele distributions for genes coded by 32 loci were determined. These were treated both as genetic distance and character data and subjected to a battery of phenetic and phylogenetic analyses. The results provide significant new insights into the number and relative timing of founder events for the Galapagos populations and into the evolutionary histories and biogeography of the species and species groups on the mainland.

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THE PHYLOGENETIC RELATIONSHIPS OF BOLYERIID SNAKES: IMPLICATIONS FOR HIGHER LEVEL SNAKE SYSTEMATICS. F.J. Irish, Harvard University, Cambridge, MA.

Bolyeria and Casarea, now found only on tiny Round Island off the coast of Mauritius, form a monophyletic group characterized by the possession of an intramaxillary joint, a feature unique among amniote vertebrates. Their relationships to other snake lineages remain in dispute. Detailed anatomical studies of both preserved and osteological material reveal a combination of distinctly autapomorphic and apparently primitive characters. Derived features shared with advanced snake lineages may have been acquired independently through pedomorphosis. Critical examination of the latter hypothesis requires comparison with the supposed ancestral ontogeny, but identifying the appropriate primitive sister group is difficult. Snake evolution has proceeded largely by reduction and loss, and many primitive snakes are morphologically specialized, resembling members of similar habits in derived lineages. Thus recognition of primitive and derived character states is problematical, and most major snake lineages have not been adequately defined.

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XANTHINE DEHYDROGENASE ACTIVITY AS A MODULATOR OF PIGMENT CELL DIFFERENTIATION. S.K. Frost, M.E. Borchert*, S. Thorsteinsdottir* and S.J. Robinson*, University of Kansas, Lawrence.

Xanthine dehydrogenase (XDH) activity plays an integral role in the synthesis of purine (iridophore) and pteridine (xanthophore) pigments. In the Mexican axolotl several genes alter the types of pigment cells that differentiate in the skin: Melanoid axolotls have no iridophores, show a gradual (developmental) reduction in the number of xanthophores and an increase in melanophore number; axanthic axolotls lack both xanthophores and iridophores but have normal numbers of melanophores. XDH activity was assayed in skin and liver from wild type, melanoid and axanthic axolotls. Assays involved incubation of tissue extracts with pterin (XDH substrate) followed by separation of substrate and product (isoxanthopterin) by TLC and quantitation by scanning the TLC plate in a fluorometer. This technique revealed that levels of XDH are the same in axanthic and wild type tissues. In melanoids, however, XDH levels are substantially reduced. This and other biochemical and structural data suggest that melanoids result from defective XDH activity; axanthics do not.

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MECHANISMS OF MORPHOGENETIC SPECIFICATION IN SKULL DEVELOPMENT. P. Thorogood, Department of Biology, Southampton University, Southampton SO1 3TU, Britain.

The formation of cartilage and bone in vertebrate skull development is elicited by interactions between epithelia and mesenchyme derived either from the cephalic neural crest or from mesoderm. Transfilter culture and ultrastructural investigation have previously demonstrated that, in the avian embryo, chondrogenesis-promoting interactions are matrix-mediated. Immunohistochemical analysis has revealed a correlated compositional change in the extracellular matrix at the interface between such interacting tissues. Collagen type II is expressed in spatial and temporal patterns which i) map topographically with the sites of, and ii) correlate temporally with the duration of, chondrogenesis-promoting interactions which generate the cartilaginous neurocranium. A model will be introduced, proposing that the location and timing of collagen type II expression has a morphogenetic role by specifying, to a responsive mesenchyme, where and when a chondrogenesis-promoting interaction will take place.

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MORPHOLOGY AND DEVELOPMENT OF HEAD MESODERM IN EARLY EMBRYOS OF *SQUALUS ACANTHIAS*. E. H. Gilland, Harvard University, Cambridge, MA.

Embryos at stages from the first appearance of an embryonic thickening to well after the completion of neurulation were dissected and examined with SEM. The pro-otic mesoderm is organized into three regions corresponding to the classical hyoid, mandibular and premandibular "segments". However, the hyoid and mandibular regions are not simple, unitary structures; each comprises two somitomeres. The premandibular region derives from the prechordal plate. In *Squalus*, the prechordal plate is especially well differentiated from the anterior borders of the first pair of mandibular somitomeres and, unlike the condition in urodeles and amniotes, it is clearly a structural continuation of the notochord. Further development of the pro-otic mesoderm shows that the "head somites" of the Balfour-Goodrich segmentation scheme are secondary transformations of a greater number of earlier existing somitomeres and are therefore not serially homologous with trunk somites. A ventralward displacement of the somitomeres appears to give rise to the mesoderm of the mandibular and hyoid arches ("visceral tubes or stalks"), thus indicating that at least these two sets of branchial muscles may be somitic in nature. Supported by NIH GM-07598-07.

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VERTEBRAL DEVELOPMENT IN GYMNOPHIONE AMPHIBIANS: RESEGMENTATION AND HOMOLOGY. M. H. Wake and D. B. Wake. University of California, Berkeley.

A number of authors have argued recently that resegmentation, or the composition of vertebrae from anterior and posterior halves of adjacent segments, and thought to occur in all terrestrial vertebrates, does not in fact occur. Therefore the phylogeny of vertebrae and the homologies of vertebral elements cannot be traced in terms of resegmented blocks of tissue. We present evidence for resegmentation in gymnophiones, now a key taxon in this debate. Gymnophiones have abundant sclerotome tissue, in contrast to other amphibians. Individuals have large numbers of segments and a strong developmental gradient. We present evidence of a division of sclerotome into more dense posterior and less dense anterior sclerotomites, and of a sclerocoele continuous with myocoele and nephrococoele. Posterior sclerotomites give rise to the neural pedicel rudiment, and we observe these cells in an intersegmental position. However, observational techniques do not allow the tracing of cell movements. To us, resegmentation is a subtle phenomenon, largely dependent on cell size and number. Supported by NSF.

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MECHANISMS OF HETEROCHRONY IN FROGS.

S. Emerson and J. Travis*. Field Museum of Natural History, Chicago, Ill. and Florida State Univ., Tallahassee.

Frog species are often characterized by minor differences in relative hindlimb length. Heterochrony, or changes in developmental timing, can produce morphological differences in relative hindlimb length similar to those found among closely related species. The particular relationship between morphology and timing of development depends on which heterochronic mechanism is involved. Frogs raised under different environmental conditions show a negative phenotypic correlation between time to metamorphosis and relative hindlimb length. Relative hindlimb length and time to metamorphosis have a positive genetic correlation and no phenotypic correlation when frogs are raised under a single environmental regime. Consequently, selection on time to metamorphosis can result in a correlated response in relative hindlimb length because of the positive genetic correlation between the two variables. Supported by NSF Grants BSR83-05998 (SBE) and DEB81-02782 (JT).

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ONTOGENETIC REPATTERNING, A PROCESS UNDERLYING MORPHOLOGICAL TRANSITIONS IN THE EVOLUTION OF TERRESTRIAL SALAMANDERS. D. B. Wake and G. Roth*. Univ. of California, Berkeley, and Univ. Bremen, Bremen FRG.

The highly integrated feeding system of lungless salamanders (family Plethodontidae) has undergone dramatic change during the transition to complete terrestriality. The completely terrestrial Plethodontini has only modest abilities to feed by tongue projectility, and uses mainly tongue pad flipping. The equally terrestrial Bolitoglossini display extreme morphological and behavioral specialization for feeding using high speed, directional versatility, and long distance tongue projection. They differ from other plethodontids which use tongue projection, the *Eurycea* group, in many details. The *Eurycea* group is constrained in the degree of specialization for feeding by the existence of an aquatic larval stage and its development. The plethodontines, while lacking a larval stage, retain many of the developmental constraints and have evolved conservatively. By contrast, the bolitoglossines have experienced ontogenetic repatterning during the long embryonic period. Major differences are seen in eye frontality, in the development of the retinotectal projections, in the organization of the brain stem and spinal cord, and in the structure and functional morphology of the tongue skeleton and musculature. Ontogenetic repatterning counters the generally conservative nature of developmental systems and offers important opportunities for escape from systems of developmental and functional constraints on evolutionary transformations in morphology.

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MORPHOGENESIS OF THE CHELONIAN CARAPACE. A.C. Burke. Harvard University, Cambridge, MA.

The ribs and thoracic vertebrae of turtles are enclosed in a dermal carapace and are situated dorsal to the limb girdles. This situation is unique to turtles. The first appearance of the carapace is a thickening of the dermis which forms a ridge, dorsally circumscribing the trunk vertebrae of the otherwise typically vertebrate embryo. The dermal ridge forms a disc which grows radially, incorporating the ribs and overgrowing the scapula and ilium. Observations with light microscopy and SEM of cross sections through the incipient dermal ridge in embryos of *Chelydra*, *Chrysemys* and *Trionyx* show a relationship between ectoderm and mesoderm characteristic of epithelial-mesenchymal interaction. A marked thickening of the ectoderm overlies a condensation in the otherwise loose mesenchyme of the dispersing dermomyotome. This morphology is similar to that seen in the apical ectodermal ridge in the limb, which suggests a common mechanism of directional outgrowth. Thus a relatively simple developmental mechanism may be responsible for the radically altered chelonian *Bauplan*. Supported by NIH GM-07598-07

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ONTOGENETIC MODEL OF TOOTH MORPHOLOGY IN CARNIVORA.

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Because no cell resorption occurs during tooth ontogeny, a tooth documents the history of its growth. This research used the ontogenetic trajectory of a canine tooth as the basis of a morphologic model. This model consists of a specification of the initial numbers of cells and a set of equations describing the proliferation rate of these cells. Predictions from this model were made concerning relative shape during growth and the relationships that hold among adult teeth independent of size. These predictions were tested with 66 adult dog canine teeth and 40 incompletely formed teeth from dogs of known post natal age. The results indicate that the tooth shape can be defined by a single set of functions operating on species specific boundary conditions. The hypothesis that a common growth model exists for all Carnivora was tested using 30 species ranging in size from weasels to bears. The model that holds for dogs appears to be true for Carnivora, and differences in morphology are due to differences in the spatial distributions of cells prior to the start of growth.

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MORPHOLOGY AND HISTOCHEMISTRY OF GLYCOL METHACRYLATE EMBEDDED GRAVID MURINE UTERI. C.M. Conway, Y.S. Bilodeau*, and A.F. Conway. VA. Commonwealth Univ., Richmond, and Randolph-Macon College, Ashland, VA.

Gravid uteri, obtained from pregnant CD-1 mice on approximately day 10 of gestation, were fixed in cold buffered paraformaldehyde containing 2.5 mM calcium chloride and 0.1 M sucrose. Adjacent implantation sites were separated, dehydrated in glycol methacrylate, and subsequently embedded. Serial cross sections (2 μ) were stained for general morphology or according to histochemical protocols including periodic acid-Schiff (PAS), alpha naphthyl acetate esterase (ANAE), peroxidase-labelled goat antimouse IgG (P-GAM-IgG). Intracellular PAS positive material was present in some trophoblastic giant (TbG) cells located at the periphery of the developing placenta and in numerous large cells located in the decidua basalis (DB). These PAS positive decidual cells were in highest density near the developing placenta and near the myometrium. ANAE positive material appeared to be present in many of the TbG and decidual cells which were PAS positive. Staining with P-GAM-IgG was observed in the maternal blood spaces of the DB and decidua capsularis and between or on cells located in the DB.

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ANATOMY OF THE UPPER REPRODUCTIVE TRACT OF A PLANORBID FRESH WATER SNAIL. Nancy D. Green and A. F. Conway. Randolph-Macon Col., Ashland, Va.

Intact snails (Gyraulus sp.) were narcotized, fixed, decalcified, and embedded in Paraplast. Serial sections stained with Lillie's Azure-Eosin were used to reconstruct the structure of the reproductive tract. The gonad was an ovotestis composed of a series of anastomosing flattened hollow sacculles oriented perpendicularly to the axis of the gonad. Developing sperm were found throughout the wall of most gonadal units, but developing oocytes were usually near the outer surface of the gonad. The gonadal units were connected to anastomosing ducts which merged to form the hermaphrodite duct at the surface of the gonad. The hermaphrodite duct was highly coiled near the gonad, then followed a straight course along the right side of the first body coil to the carrefour area. A series of 5 groups of 4 alveolar seminal vesicles evaginated from the surface of the hermaphrodite duct near its midpoint. The structure of the upper reproductive tract of Gyraulus sp. therefore differs markedly from published descriptions of the equivalent structures in closely related genera.

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COMPARATIVE ULTRASTRUCTURE AND PROTEIN UPTAKE OF TROPHOTAENIAL CELLS OF TWO GOODEID FISHES. F. Hollenberg and J. P. Wourms. Clemson University, Clemson, S.C.

Trophotaeniae are placental structures in viviparous goodeid fishes. Morphologically they are small rosette- or long ribbon-like evaginations of the embryonic hindgut. The ultrastructure of trophotaenial absorptive cells was compared in the goodeids Allophorus robustus (ribbon) and Goodea atripinnis (rosette) by transmission electron microscopy. The absorptive cells of Allophorus are characterized by numerous endocytotic pits and a prominent apical canalicular system (ACS). The apical part of the cells contain large vesicles (presumably lysosomes) and relatively few mitochondria. In Goodea cells there are few endocytotic pits. The ACS is poorly developed. There are few or no lysosome-like structures. Mitochondria are abundant. Horseradish peroxidase (HRP) was used to examine protein uptake. HRP was demonstrable in the ACS, and in transport vesicles and lysosomes of Allophorus cells following a 30 minute incubation. Little uptake was demonstrable in Goodea and this appeared limited to the ACS. We suggest these results reflect the utilization of different nutrient substrates by embryos of these species *in vivo*.

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PROTOTYPIC TROPHOTAENIAE AND OTHER PLACENTAL STRUCTURES IN EMBRYOS OF THE PILE PERCH, RHACOCILLUS VACCA (EMBIOTOCIDAE). J. P. Wourms and J. Lombardi. Clemson Univ., S.C. and Univ. of North Carolina, Chapel Hill.

Mid-gestation embryos (45mm TL) possess a hypertrophied hindgut. Elongated intestinal villi extend through an enlarged anus and probably absorb nutrients. Externalized intestinal villi are a prototypic stage in the evolution of trophotaeniae, structures that occur in goodeids, ophidioids, and a parabrotulid. Trophotaeniae, belong to the enterotrophic class of embryonic placentae. Tips of the hypertrophied fins possess spatulate extensions, termed epaulettes whose epithelial cells have stubby microvilli. Fin epithelial cells only have micropliae. At 55mm, few vestiges of trophotaeniae remain. Epaulettes are larger. Their epithelial surfaces have both stubby microvilli and fragmentary micropliae. They possess a capillary plexus supplied by a large artery and vein that run along each fin ray. Epaulettes are dermotrophic placentae that probably function in respiration and nutrition. Late in gestation, association of ovigerous folds and embryonic gill filaments constitute a branchial placenta.

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INTERACTION OF STEROIDS WITH OVARIAN TISSUE *IN VIVO* AND *IN VITRO* DURING OOCYTE GROWTH AND MATURATION IN BROOK TROUT (SALVELINUS FONTINALIS). C. A. LESSMAN, H. R. HABIBI* and R. C. COCHRAN. St. Francis Xavier Univ., N.S., Canada; Johns Hopkins Univ., Chesapeake Bay Inst., Shady Side, Md.

The effects of 17 β -estradiol (E2) implants *in vivo* on trout ovarian development were assessed in a longitudinal study. Ovarian biopsies were removed from females at monthly intervals. The biopsies were measured for largest oocyte size class, and tested *in vitro* for progesterone-induced meiosis reinitiation. Plasma E2 levels were monitored by RIA throughout the study. The results indicate an increase in E2 levels with increasing oocyte size in controls while E2 implanted animals had smaller or delayed peaks of plasma E2 with varying levels of follicle atresia. Ovarian follicles and oocytes denuded of somatic cells were incubated with 3 different radiolabeled progesterones. At 0, 6, and 24 h the incubates were extracted; the resulting extracts run on HPLC. Radioactivity associated with either follicles or denuded oocytes was lower than that in media extracts, and between 49 and 97% of exogenous steroid was converted over time to compounds with different retention times. This research was funded by NSERC of Canada. We acknowledge a gift of tritiated DHP from Drs. Weisbart and Idler.

A BINDING SITE ON THE SPERM PLASMA MEMBRANE WHICH RECOGNIZES THE MURINE ZONA PELLUCIDA. R. Richardson*, R. Robinson*, K. Hinds* and G.R. Poirier*, University of Alabama at Birmingham, Birmingham, Alabama.

Capacitated murine sperm bind to cumulus-free, zona pellucida-intact eggs at the apical portion of the sperm head. Pretreatment of such eggs with a purified preparation of the seminal inhibitor binding component (acceptor) isolated from murine cauda epididymal sperm significantly reduces the number of sperm that bind. Treatment of cauda sperm, preincubated under conditions known to induce capacitation, with the seminal inhibitor also reduces the number of sperm able to bind. These data are interpreted to mean that the seminal inhibitor acceptor on the sperm surface functions in the binding of sperm to the zona pellucida. Furthermore it suggests that the seminal inhibitor, which binds to the sperm surface at ejaculation, may protect the binding site until capacitation when such inhibitors are usually removed.

PROPERTIES OF A SEMINAL INHIBITOR BINDING COMPONENT ON MURINE SPERMATOZOA. R. Robinson*, R. Richardson*, K. Hinds* and G.R. Poirier University of Alabama at Birmingham, Birmingham, Alabama.

Murine cauda epididymal sperm contain a binding site on the plasma membrane which recognizes both proteinase inhibitors and the zona pellucida. Few sperm from the upper regions of the epididymis are able to bind inhibitor while the majority of those from the lower regions readily do so. Cauda epididymal and ductus sperm do not lose their ability to bind inhibitor after a 4-hour incubation in a medium known to induce capacitation. The proportion of ejaculated sperm with the seminal inhibitor bound to their surface decreases to about 10 % after 4 hours post coitus. However, approximately 80 % of these sperm show positive immunofluorescence when given the opportunity to rebind the inhibitor. Ultrastructural observations of the 4-hour uterine sperm revealed that 75 to 90 % of these cells have an intact plasma membrane over the apical portion of the acrosome. These data suggest that the binding site for the seminal inhibitor becomes functional during the epididymal sojourn and that it is not lost during capacitation.

SPERM INCORPORATION INTO THE TELEOST EGG. J. Wolenski and N.H. Hart. Rutgers Univ., New Brunswick, N.J.

During teleost fertilization, a single sperm is incorporated into the egg cytoplasm at a predetermined site of sperm entry (SES). The SES of *Brachydanio*, located in the animal pole, was a circular tuft of 15-20 microvilli that extend into the micropyle of the chorion. Routine TEM of the unactivated egg showed an electron-dense band of "filamentous material" subjacent to the SES. However, the band was visualized as a meshwork of 60-70 A filaments in cells fixed with tannic acid and saponin, and postfixed with osmium containing $K_2Fe(CN)_6$. A fertilization cone was formed at the SES with sperm head and mid-piece being incorporated within 1-2 min of gamete binding. During sperm entry, the band of filaments insinuated itself between the sperm nucleus and the egg plasma membrane. Filaments were difficult to discern in the core of the fertilization cone. Vesiculation of the sperm nuclear membrane was initiated shortly after sperm entry into the cytoplasm. Eggs treated with cytochalasin B (10 ug/ml) bind sperm to the SES; however, sperm were not incorporated into the cytoplasm. This suggested indirectly that sperm incorporation was dependent upon polymerization of actin filaments. (NIH supported)

TEMPERATURE AND BICARBONATE REQUIREMENTS FOR POLAR BODY FORMATION DURING *IN VITRO* MATURATION OF PORCINE OOCYTES.

L.A. Eng and E.T. Kornegay*. Virginia Polytechnic Institute and State University, Blacksburg.

The effects of culture medium composition, incubation temperature, and buffering system on polar body formation during porcine oocyte maturation *in vitro* were examined. Oocytes cultured at 39°C had a higher percentage of polar body formation than those cultured at 37°C. A culture medium based on Medium 199 with Earle's salts and supplemented with 15% young barrow serum was found to be superior to a modified Krebs-Ringer Bicarbonate medium (Toyoda & Chang, J Reprod Fert, 36:9, 1974) and just as good as a more complex formulation which is commonly used (Tsafiriri & Channing, J Reprod Fert, 43:149, 1975). If the bicarbonate buffer system (Earle's salts) of Medium 199 was replaced with a phosphate buffer system (Hank's salts), the rate of polar body formation was decreased. When the Hank's based medium was supplemented with a bicarbonate buffer system, polar body formation was restored to the level in Earle's based medium. This suggests that CO_2 /bicarbonate may be important for the normal maturation of porcine oocytes.

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ULTRASTRUCTURAL STUDY OF PRIMARY SPERMATOGONIA AND OOGONIA OF THE PLATYFISH. J.A. Flores, J.R. Burns and K.D. Kallman. George Washington Univ., Washington, DC and New York Zoological Society, New York.

To evaluate their degree of differentiation, electron microscopic observations on type A spermatogonia and oogonia are described. Both cell types were round to oval. Nuclear chromatin was clear and homogeneous, while perichromatin granules were rare. One to two nucleoli were present with distinct granular and fibrillar components. The nuclear diameter was significantly larger in type A spermatogonia ($9.3 \pm 1.3 \mu\text{m}$) than in oogonia ($6.5 \pm 1.3 \mu\text{m}$). Mitochondria of both cell types were spherical or slightly elongated with a clear matrix and were usually located at one cellular pole, occasionally possessing electron-dense granules. Nuage was associated with nucleopores and groups of mitochondria. Annulate lamellae appeared as long sheets paralleling the plasma membrane or as shorter pieces among mitochondria. Ribosomes were abundant as rosettes or sometimes associated with annulate lamellae. The Golgi, although present, was not prominent. Endoplasmic reticulum was even less frequent. It is concluded that few ultrastructural differences exist between these two cell types.

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A NEW TYPE OF BARRIER TO PARACELLULAR MOVEMENT OF MACROMOLECULES IN INSECT TESTIS. K.M. Baldwin*, M.J. Loeb, and J.G. Riemann. Howard Univ., Washington, D.C., USDA, Beltsville, MD, and USDA, Fargo, ND.

In insect testis, the germ cells develop as clones with each clone surrounded by somatic cyst envelope cells. The cyst envelope cells form a barrier separating the developing germ cells from the fluid in the testicular lumen. Our studies have been directed at elucidating the nature of this barrier. In Heliothis virescens testis, movement of macromolecular tracers (horseradish peroxidase and ruthenium red) into the germ cell cysts is blocked by a structure at the outer edge of the septate junctions joining the cyst envelope cells. This structure appears as a P-face ridge or an E-face groove in freeze fracture replicas, similar to a single-stranded tight junction. Unlike tight junctions, however, there is no fusion of adjacent cell membranes in this location. We conclude that a new type of occluding junction acts as barrier to paracellular movement of macromolecules in Heliothis testis.

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A MONOCLONAL ANTIBODY TO A 9.6Kd DIFFERENTIATION-SPECIFIC PROTEIN IN BEETLE ACCESSORY GLANDS. K.A. Grimes, C.S. Bricker and G.M. Happ. Univ. of Vermont, Burlington.

Monoclonal antibodies were produced against secretory proteins (plugs) of the bean-shaped accessory gland of Tenebrio molitor. One antibody (PL6.3) recognized a 9.6 kd protein present only in BAGs, plugs and spermatophores. A second antigen (5.0 kd) was also recognized, and may be a breakdown product of the larger protein. Antigen PL6.3 first appeared in 8 day pupal glands and increased 40-fold by the 8 day adult stage. Analysis of glands cultured with/without 20-hydroxyecdysone showed that hormone is necessary for in vitro antigen production. Antigen was restricted to type 5 and 7 of the eight cell types present in BAG. Ultrastructural studies showed antigen was present within type 5 and 7 granules, but not found in surrounding cytoplasm. Within the spermatophore, antigen PL6.3 surrounded the lumen and was localized to the whorled membrane layer identifiable at the ultrastructural level. Antibody PL6.3 will facilitate structural biochemical, and developmental analysis of this model system.

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PRELIMINARY OBSERVATIONS ON CORTICAL GRANULE COMPOSITION IN EGGS OF BRACHYDANIO. K. DAS*, N.H. Hart and J. Wolenski, Rutgers Univ., New Brunswick, N.J.

Studies have been initiated on the composition of cortical granules (CGs) of Brachydanio (teleost) eggs to evaluate the potential role of cortical granule exocytosis in the development of the vertebrate egg. Histochemically, CG contents showed strong, positive reactions with toluidine blue, PAS and Alcian blue 8GS stains, indicating the presence of mucopolysaccharides. Weak responses were recorded with general protein stains. To further examine the proteins of CGs, a method was developed to collect cortical granule exudate from 10 min activated eggs. Exudate (with chorions) from 50-75 eggs was treated with 0.125 M Tris-HCl (pH 6.8), 4% SDS, 20% glycerol and 10% mercaptoethanol, centrifuged for 5 min at 5000 rpm, and the supernatant then analyzed by SDS-PAGE using a 4% stacking gel with a 10% running gel. Four major soluble proteins were detected with Coomassie blue R-250 stain and 12 proteins with silver stain (Biorad). Polypeptide molecular weights ranged from 29K to 120K. Since the chorion did not appear to be solubilized during buffer treatment, these proteins are probably sequestered inside the intact granules. (Supported by NIH).

SEM VISUALIZATION OF MORPHOGENESIS DURING GASTRULATION IN THE SEA URCHIN, LYTECHINUS VARIEGATUS. J. Morrill, L. Santos*, S. Doyle* and S. Doty*. New College-USF, Sarasota, FL.

The overt appearance of dorso-ventrality and bilaterality during gastrulation is accompanied by the differentiation of at least 11 cell compartments: ciliated, apical plate ectoderm; anterior-ventral ectoderm; posterior-dorsal ectoderm; ventral-vegetal plate ectoderm; endoderm; primary mesenchyme (PMC) ring cells; PMC lateral arm cells; PMC spicule forming cells; secondary mesenchyme cells (SMC) and migratory pigment cells. Ectoderm and endoderm cells are ciliated, secretory, epithelial cells; PMC and SMC are invasive cells that probably alter the extracellular matrix (ECM) of the blastocoelic jelly and basal lamina. Spatial and temporal patterns of the ECM of the blastocoel accompany changing cell patterns beginning with the Okazaki cell pattern of the mesenchyme blastula. Primary invagination involves infolding, increase in cell number and cell migration of the vegetal plate. Secondary invagination and elongation of the endoderm accompany a non-linear increase in blastocoelic volume.

COMPARATIVE DEVELOPMENT OF AMBYSTOMA LATERALE AND A. MACULATUM. K.A. Talentino and E.M. Landre*. Simmons College, Boston, and Massachusetts Audubon Society.

Larval development of these two mole salamander species was monitored during a three-year study in a breeding pond where they are sympatric. Number of eggs/mass, mortality, and developmental stage were recorded, in addition to certain physical parameters of the pond. Post-hatching development was followed by collecting larvae with a mesh dip net. Larvae were also maintained in the lab in order to follow specific individuals through metamorphosis. Preliminary analysis indicates that number of egg masses deposited varies significantly from year to year. Yearly mortality rate is rather consistent for a specific developmental stage, but may be affected considerably by unusual weather conditions. A. laterale reached specific developmental stages earlier and attained greater total length and snout/vent length than A. maculatum prior to metamorphosis. Population levels of the two species have fluctuated significantly during the past five years. Massachusetts Audubon Society provided access to the field site. The Simmons College Fund for Research provided financial assistance.

THE EFFECTS OF METHYLAZOXYMETHANOL ACETATE ON THE DEVELOPING CHICK EMBRYO. N.K. Farzaneh, A.A. Hagan and J. Hill*. The American University, Washington, D.C. and The National Institutes of Health, Bethesda, Maryland.

Methylazoxymethanol acetate (MAM) is an antimitotic, teratogenic agent which arrests cerebral development in mammals. To ascertain if MAM affects avian development, graduated doses of MAM were introduced into White Leghorn chicken eggs. Ninety eggs were injected with 0.20 cc saline, 10 mg/kg MAM or 20 mg/kg MAM dosages during days three, four or five of incubation. Factors used in assessing the effects of MAM were survivability of the eggs, brain and body weights, external brain measurements and histology of the forebrain. The study revealed that MAM has an effect on chick development. There were marked decreases in the overall size and weight of the bodies and brains of the MAM-treated chicks compared to the control chicks on the various days of treatment. The effect of MAM is dose-response and time related. The greatest reduction in brain size appeared on day three of incubation in the highest dosage group of MAM administration (20 mg/kg). Body weight was proportionally more reduced than brain weight on day three in the highest dose group.

DEVELOPMENT OF AXONAL PROJECTIONS FROM APPENDAGES TRANSPLANTED AT DIFFERENT ECTOPIC SITES IN AN INSECT. P. Sivasubramanian and D.R. Nässel*. University of New Brunswick, Fredericton, N.B., Canada, and University of Lund, Lund, Sweden.

Specificity of axonal pathfinding by growing neurons within the central nervous system (CNS) was studied in the fleshfly, Sarcophaga bullata. The axons were forced to enter the CNS at inappropriate sites by transplanting various organ primordia (leg, wing or haltere imaginal discs) at ectopic sites into host prepupae. Upon completion of metamorphosis, the sensory projections from these supernumerary appendages were examined by horseradish peroxidase tracing techniques. Although the majority of the ectopic neurons entered the CNS via one of the host's abdominal nerves, the halteres and wings projected almost always into their appropriate dorsal neuropil by following their specific pathways. This was true even if they were transplanted at ventral locations. However, no such specificity was noticed with ectopic legs. While the supernumerary legs developing at ventral and lateral sites projected into the leg (ventral) neuropil, most of the dorsally transplanted legs projected into inappropriate sites namely, dorsal neuropil. Why ectopic legs from dorsal sites innervate inappropriate neuropil whereas the ectopic haltere and wing neurons from ventral sites manage to find their specific projection sites is highly speculative at this time. Perhaps, the difference lies in the different types of sensillae present in these appendages.

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ETHANOL INFLUENCE ON GROWTH IN CHICK NEURAL RETINA CELLS. G. W. Kalmus, D. L. Lee*, and S. N. Pennington*. East Carolina Univ., Greenville, N. C.

It is proposed that ethanol reduces growth of an organism via a cyclic 3', 5' adenosine monophosphate (cAMP) mechanism. Growth and cAMP concentrations were measured in response to varying ethanol dosage in cultured chick neural retina cells. Ethanol alone (50 mg/dl) did not significantly reduce the total protein and did not appear to affect the DNA content of the cells. However, when a phosphodiesterase inhibitor was added at low concentrations (11.5 ug/ml of 1-methyl, 3-isobutylxanthine, MIX) to the ethanol sample, protein and DNA content was significantly reduced. Total protein content in the ethanol samples supplemented with MIX were reduced 19% compared to the vehicle values. Cyclic-AMP values for the ethanol samples alone were 20% higher than the controls while the ethanol plus MIX group was 24% higher than the vehicle group. This data suggests that although ethanol increases cAMP values, a phosphodiesterase inhibitor is necessary to maintain the higher cAMP concentrations, thus eliciting a cAMP mediated response that affects growth.

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THE BINDING OF MANNOSE TO CHICK CORNEAL EPITHELIAL CELLS IS IMPLICATED IN CELL ADHESION AND DESMOSOME FORMATION. M. McKisic* and J. Overton. Univ. of Chicago, Chicago, IL.

Cell adhesion and desmosome formation were studied in 11 and 15-1/2 day chick corneal epithelial cells by investigating cell interactions involving surface sugars and carbohydrate binding molecules. Older cells, which have a higher frequency of desmosomes, aggregated at a faster rate and formed more rosettes. Adhesive cell interactions involving 15-1/2 day cells, but not 11 day cells, appeared to be altered by mannose and its derivatives. Also, the aggregation of older cells was partially inhibited by cleaving high mannose groups from surface glycoproteins with the glycosidase endo-B-N-acetylglucosaminidase (Endo H), but was not affected by neuraminidase (NANase). The binding of labeled mannose to 11 and 15-1/2 day cells indicated that a greater number of high affinity, $K_D 4.4 \times 10^{-9} M$, binding sites were present on older cells. Furthermore, 15-1/2 day cells aggregated in the presence of Endo H or NANase formed fewer desmosomes, compared to the controls. These results suggest that the interactions between endogenous sugar residues and specific carbohydrate binding sites mediates cell adhesion and desmosome formation. Supported by NSF PCM 8316412.

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IN-VITRO RESPONSE OF PALATAL EPITHELIUM FROM THE EMBRYONIC MOUSE TO DIFFERENT EXTRACELLULAR MATRICES. M.S. Tyler, S. Tyler, and R.M. Pratt. Univ. of Maine, Orono, and NIEHS, Res. Tri. Pk., NC.

Palatal epithelium isolated enzymatically from 13-day embryonic mice was grown in primary culture to determine specificity of response to two extracellular matrices (ECMs): one (HR9-ECM) produced by a mouse-derived endodermal cell line, PF-HR-9, and one (CE-ECM) produced by bovine corneal endothelial cells. Results were analyzed using autoradiography of [³H]thymidine-labelled cultures and electron microscopy. On HR9-ECM, attachment was poor. Addition of cholera toxin (1ug/ml) and epidermal growth factor (EGF, 20ng/ml) together, but not individually, enhanced attachment. On CE-ECM, the epithelium attached, and spreading was enhanced by addition of EGF. EGF caused the medial epithelium to be maintained and promoted proliferation of oral but not nasal epithelium. Keratinocytes developed in the oral region, and squamous as well as ciliated rounded cells appeared in the nasal region. Palatal epithelium, therefore, was specific in its response to different ECM's. Supported by NIH Grant DE-04859. ECMs courtesy of D. Gospodarowicz, UCSF.

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DEVELOPMENT OF THE URINARY BLADDER IN RANA CATESBIANA TADPOLES. T.L. Powell and J.J. Just. Univ. of Ky., Lexington.

Growth and differentiation of the urinary bladder were examined at various stages of metamorphosis (Taylor-Kollros). Bladder weight (mg) per animal weight (g) at stage XVI was 0.054 ± 0.03 mg/g and increased to 1.13 ± 0.04 mg/g at stage XXIV. Two week froglets were not significantly different from adults at 1.44 ± 0.21 mg/g. A saline column, 0.4 cm in diameter, was used to fill the bladder through a cannula secured in the cloaca. Volumes were determined at a minimum of three hydrostatic pressures. Maximum volumes were reached at filling pressures of 10 to 30 cm saline and ranged from 0.33 ± 0.16 ml at stage XX to 1.80 ± 0.78 ml at stage XXIV. Maximum volumes were 4, 13, 22, and 28 percent of total body weight at stage XX, stage XXIV, two week froglets, and adults, respectively. Light microscope examination, using H & E staining on 12 μ sections, revealed initial appearance of the bladder at stage XII. Cells comprising the bladder appear the same at all stages. Electron microscope studies and bladder development during thyroxine induced metamorphosis are currently being conducted. Two other species of anurans have been examined and similar patterns of urinary bladder development are indicated.

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PEROXISOMAL B-OXIDATION IN BROWN FAT OF PERINATAL RABBITS. LP MANGURIAN AND RP DONALDSON*. George Washington Univ. Wash. D.C. Peroxisomes were isolated from brown fat of perinatal rabbits, not cold acclimated. Overall B-oxidation as well as the individual enzymes, acyl-CoA oxidase, hydratase, hydroxyl acyl-CoA dehydrogenase and thiolase, were measured. Acyl CoA oxidase is the rate limiting enzyme. The specific activities of catalase and acyl CoA oxidase were highest in 25 day old fetuses and then decreased progressively in postnatal rabbits. Mitochondrial cytochrome c oxidase on the other hand was greatest in newborns. Electron micrographs corroborate these findings. Densely packed mitochondria were seen in the newborns in contrast to less densely packed mitochondria in 25 day fetus. Visually, peroxisomes were more dense in fetuses compared to older rabbits. We have also found in purified peroxisomal fractions palmitoyl-CoA dependent cytochrome c reductase activity insensitive to Antimycin A and KCN. This activity is not present in mitochondrial fractions. We suggest the possibility of an electron transport system in the peroxisome which might channel reducing equivalents produced during peroxisomal fatty acid oxidation.

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STUDIES ON THE EXTRACELLULAR MATRIX IN REGENERATING LIMBS OF LARVAL URODELES. C. Cox and A. Mescher. I.U. Bloomington.

Amphibian limb regeneration is nerve-dependent and involves complete remodeling of the extracellular matrix (ECM) in the stump tissues. These changes in the ECM include synthesis and accumulation of hyaluronate. Since a hyaluronate-rich matrix is characteristic of several embryonic tissues in which cell migration and proliferation are active, this change in the ECM of the limb stump may be of key importance for the cellular events leading to limb regeneration. To ascertain whether the neural influence affects production of hyaluronate, we examined by histochemistry and microspectrophotometry the ECM in denervated limb stumps of *Ambystoma* larvae as they became reinnervated and began to regenerate. Such limb stumps show dedifferentiation and increased cell density in distal areas. Upon reinnervation, cell density is reduced and active cell proliferation begins. The decrease in cell density is accompanied by accumulation of extracellular hyaluronate. Stimulation of hyaluronate synthesis by the dedifferentiated cells may therefore be part of the growth-promoting effect of nerves in limb regeneration.

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PIGMENTARY PATTERN FORMATION INDUCED BY AUTOGRAFTED ERYTHROPHORES IN THE NEWT. Robert A. Zaccaria. Lycoming College, Williamsport, Pa.

Chromatophores of the black-ringed red spots in the red-spotted newt (Forbes, Zaccaria, and Dent, 1973) and of the black-bordered stripes in the broken-striped newt (unpub. obs.) constitute a dermo-epidermal chromatophore unit. The spots or stripes consist of epidermal erythrophores underlaid with dermal iridophores and are bordered by dermal melanophores. The maintenance of the pigmentary pattern as well as its reformation following partial surgical disruption was shown to be dependent on the presence of the erythrophores (Zaccaria, 77). In the present study, following the removal of the skin between two spots or stripes, an erythrophore-bearing wound epithelium developed. The epithelium was then auto-grafted to a recipient site which had been denuded of whole skin. At this site, iridophores from the surrounding dermis migrated under the transplanted erythrophores, and eventually, scattered dermal melanophores aggregated at the periphery of this pigmentary unit. The erythrophores thus induce the ectopic and *de novo* development of a highly organized pigmentary pattern.

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THE MESOGLEA OF HYDRA IS SYNTHESIZED BY BOTH ECTODERM AND ENDODERM. L. Epp., I. Smid* and P. Tardent.* Mount Union College Alliance, Ohio and University of Zurich, Switzerland.

Synthesis of hydra mesoglea was investigated in "reassembled" hydra, i.e. hydra regenerating from previously isolated and then recombined ectoderm and endoderm. Mesoglea remains adherent to the endoderm after tissue separation. TEM indicates that after reassembly "old" mesoglea is digested within the endoderm and a "new" mesoglea is synthesized. New mesoglea is first visible with TEM about 12 hours after tissue reassembly. The mesoglea has a normal appearance after about 48 hours. Ultrastructurally, it appears that both ectoderm and endoderm contribute to mesoglea synthesis. This was confirmed by autoradiography after individually labelling either ectoderm or endoderm with tritiated amino acids prior to tissue reassembly. Other autoradiographic studies, using intact hydra, indicate very rapid initial incorporation (5-6 hours) and long residence time (more than 2 weeks) of amino acids within the mesoglea.

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THE EFFECTS OF X-IRRADIATION ON THE METAMORPHOSIS AND BUDDING OF *AURELIA AURITA*. M.J. Prokopchak*, D.B. Spangenberg and J. Shaeffer*. Eastern Virginia Medical School, Norfolk, Va.

With the aid of the *Aurelia* Metamorphosis Test System, the acute and subtle morphological and behavioral effects of irradiation on the Norfolk *Aurelia aurita* was described and the sensitivity to X-irradiation of those organisms receiving thyroxine and those not receiving thyroxine was compared. Levels of radiation were 0 (control), 5,000, 10,000, 15,000, 20,000 and 40,000 rads. Morphology of the ephyrae, including statolith and rhopalia numbers, were recorded using the light microscope. Developmental abnormalities of the scyphistomae and ephyrae were recorded with the scanning electron microscope and light microscope. Major findings from this investigation were the absence of rhopalia and statoliths following exposure with 15,000 and 20,000 rads, the decrease in pulse rate of developed ephyrae, and the development of two-bodied scyphistomae.

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STRUCTURAL AND FUNCTIONAL ORGANIZATION OF THE NERVOUS SYSTEM IN HYDRA: I. FEEDING BEHAVIOR RECOVERY DURING REPOPULATION OF NERVE-FREE HYDRA. B.A. Marcum and D.A. Clark*. California State Univ., Chico.

Hydra possess a diffuse nervous system composed of different nerve cell types arranged in a loose network. This nervous system coordinates complex behavioral patterns including the feeding response. At least 3 processes, tentacle waving, tentacle ball formation and mouth opening, comprise the feeding response; and each can be elicited by distinct chemical stimuli (Koizumi, *et al*, 1983). Reduced glutathione (GSH) stimulates the entire feeding response and has been shown to be the normal feeding behavior activator (Lenhoff, 1961). Experimentally produced nerve-free hydra display no spontaneous behavior nor do they respond to GSH. This study used nerve-free hydra, grafting techniques, and a GSH assay to characterize the functional reorganization and restoration of the nervous system. Homografts and heterografts of *H. attenuata* and *H. oligactis* were monitored daily for GSH sensitivity. In all cases the 3 distinct behavioral components, tentacle waving, tentacle ball formation and mouth opening returned sequentially rather than simultaneously. This gradual recovery coincided with a gradual increase in nerve cell numbers.

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A MORPHOLOGICAL VARIANT OF THE CHRYSAORA POLYP (CNIDARIA, SCYPHOZOA). R. E. Black. College of William and Mary, Williamsburg.

A clone of polyps having reduced tentacle number and greatly exaggerated, stolon-like basal structures has been maintained asexually through 15 passages over five years. No spontaneous strobilation has been seen, but strobilation can be induced in a low percentage by cold conditioning. Ephyrae are abnormal in form and nearly nonmotile. Cross-sections of the polyp show that cells of the epiderm are much more densely packed and columnar than normal. Chimaeras made from reaggregates of normal and abnormal cells are intermediate in form at first but resemble only the aberrant form after several weeks. The unusual form of the polyp could be produced by rapid cell division in the gastric region, with too few tentacle-forming sites, forcing cell movement toward the basal end. The possible action of morphogens has not been investigated.

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NUCLEOCYTOPLASMIC INTERACTION IN THE DE NOVO BIOGENESIS OF PLANARIAN MITOCHONDRIA. M. Morita, FL. Hall, and JB. Best. Colo State Univ, Ft Collins, CO

The historic conception of the mitochondrion as an acquired endosymbiont is challenged by a variety of evidence, which tends to replace the notion of mitochondrial autonomy with the demonstration of profound nuclear control. Certain nuclear emissions, referred to as chromatoid bodies in oocytes and as nuclear satellite material (NSM) in planarian stem cells, appear to be intimately associated with mitochondria. This nucleocytoplasmic interaction was investigated with electron microscopy in the totipotent planarian neoblast, and in a chemically transformed planarian cancer cell which displayed an exaggerated production of both NSM and mitochondria, and revealed a sequence of mitochondriogenesis which had remained hitherto obscure. The emission of precursor material from nuclear pores during a brief "critical period" prior to cellular differentiation, followed by a series of intermediate morphogenic stages, characterize the assembly of new mitochondria. These results suggest de novo assembly from NSM as the ultimate origin of the mitochondrion, with subsequent replication as penultimate biogenesis.

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THE SOFT TISSUE-BONE INTERFACE: HOW DO ATTACHMENTS OF MUSCLES, TENDONS AND LIGAMENTS CHANGE WITH AGE? A LIGHT MICROSCOPY STUDY. J.R. Hurov. Univ. of Texas, Austin.

Attachments of the popliteus muscle, semitendinosus tendon, medial collateral knee ligament and extensor retinaculum were studied histologically in rabbits aged 2-60 days. Soft structures inserted principally into fibrous periosteum or perichondrium in the age range studied. An extensive collagen fiber framework in cellular periosteum, present by at least 2 days of age, linked fibrous periosteum to subjacent skeletal connective tissue matrices. Maturation of soft tissue-bone interfaces was viewed from 2 related perspectives; 1) temporal patterns of skeletal connective differentiation and 2) incorporation of attachments into skeletal connective tissue matrices during growth and remodeling. Skeletal connective tissue differentiation and remodeling varied between attachment regions of single muscles and ligaments. Insertion regions were characterized by coarse-fibered periosteal bone and chondroid bone, both morphologically intermediate between cartilage and lamellar bone. Supported by PHS AML9632 and DE07047.

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EFFECTS OF DOPAMINE AND NEUROPEPTIDES ON THE ISOLATED EYESTALK OF THE FIDDLER CRAB. T.A. Butler and M. Fingerman. Tulane Univ., New Orleans, LA.

The neuroendocrine system of the eyestalk of the fiddler crab, Uca pugnator, releases pigmentary hormones. Eyestalk ganglia were bathed in transmitter- or neuropeptide-containing solutions. The resulting superfusates were then assayed in isolated legs for chromatophoretropic activity. Eyestalks bathed in dopamine (DA) (10^{-5} to 10^{-4} M) released both black and red pigment concentrating hormones. Haloperidol (10^{-6} M), a DA antagonist, blocked this release. Met-enkephalin (Met-Enk) (10^{-10} to 10^{-4} M) also elicited the release of both hormones, and its action was blocked by naloxone (10^{-6} M). FMRFamide (10^{-11} to 10^{-5} M) released red, but not black, pigment concentrating hormone. Naloxone (10^{-6} M) had no effect on the action of FMRFamide. When injected directly into isolated legs, neither Met-Enk nor FMRFamide produced pigment concentration. Supported by NSF Grant PCM-8300064.

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VERIFICATION OF THE MAJOR FORM OF PIGMENT-DISPERSING HORMONE IN THE EYESTALKS OF UCA PUGILATOR. C. A. Zahn and K. Ranga Rao. Univ. of West FL, Pensacola, FL.

Crustacean pigment-dispersing/light-adapting hormones occur in multiple forms. The first characterized hormone (DRPH, α -PDH), NSGMINSILGIPRVMTAAamide, was identified as the major form in the eyestalks of the prawn Pandalus borealis (Fernlund, 1971, 1976). Recently a novel form of this hormone (β -PDH), NSELINSILGLPKVMNDAAamide has been characterized as the major form of PDH in the fiddler crab Uca pugnator (Rao et al., 1985). The extraction procedures employed in these two studies were different. In order to determine whether these procedures contributed to differential extraction of the multiple forms of PDH, the Uca PDH was re-extracted and chromatographed according to the procedure for Pandalus. β -PDH was found to elute at about 1 column volume on cation-exchange chromatography and account for 91% of the recovered activity. A peak corresponding to α -PDH was absent in Uca. This shows that regardless of the extraction procedure, β -PDH is the major form of this hormone in eyestalks of Uca. (Supported by NSF grant DCB-8314737)

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C-TERMINAL DELETION ANALOGS OF A CRUSTACEAN PIGMENT DISPERSING HORMONE. J. P. Riehm* and K. Ranga Rao. Univ. of West FL, Pensacola, FL.

This study deals with the effect of deamidation and C-terminal truncation on the potency of Pandalus DRPH (α -PDH): Asn-Ser-Gly-Met-Ile-Asn-Ser-Ile-Leu-Gly-Ile-Pro-Arg-Val-Met-Thr-Glu-Ala-NH₂. Bioassay of synthetic analogs for melanophore pigment dispersion in destalked fiddler crabs (Uca pugnator) showed that deamidation causes a 300-fold decrease in potency. The analogs 1-17-NH₂ and 1-16-NH₂ were about 3 times more potent than 1-18-OH. Further truncation led to decreases in potency, with the peptide 1-9-NH₂ being the smallest C-terminal deletion analog to display activity (0.001% potency). Smaller analogs (1-8-NH₂, 1-6-NH₂ and 1-4-NH₂) were inactive when tested in doses as high as 500 nmoles/crab. These results along with work on N-terminal deletion analogs are expected to help identify the core sequence important for PDH action. (Supported by NSF grant DCB-8314737)

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THE EFFECT OF VIBRATION, CENTRIFUGATION, AND LIMB AUTOTOMY ON CHROMATOPHORES IN UCA PUGILATOR. R. E. Weinstein*, J. M. Roberts*, and C. F. Herreid II. SUNY/Bufalo.

Exercise in fiddler crabs promotes a color change: melanophores show pigment concentration, erythrophores and leucophores show pigment dispersion. Blood removed from the exercised crabs and injected into isolated Uca pugilator leg segments causes similar changes, suggesting the presence of a blood-borne factor. In an effort to see if other stresses cause chromatophore changes we subjected Uca pugilator to high frequency mechanical vibration in a sonic cleaner and observed melanophore pigment concentration and erythrophore and leucophore pigment dispersion. Blood drawn from crabs subjected to vibration caused similar chromatophore changes in isolated leg segments. In experiments involving gravitational stress, where Uca pugilator were spun in a centrifuge at 1,500 RPM, again chromatophores altered as they did in both exercise and vibration. Similar results seen in the exercise, vibration, and centrifugation experiments suggest that stress in general causes the presence of a blood-borne factor which induces chromatophore responses. Autotomy did not induce any changes in chromatophores.

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HORMONAL MODULATION OF PHEROMONE-MEDIATED BEHAVIOR IN A CRUSTACEAN. R. A. Gleeson, M. A. Adams* and A. B. Smith III*. C. V. Whitney Laboratory, Univ. of Florida and Monell Chemical Senses Center, Phila.

Courtship display behavior in the male blue crab, Callinectes sapidus, is normally triggered by a pheromone which is present in the urine of pubertal females. Recently it was discovered that with bilateral ligation of the eyestalks of males, frequent bouts of spontaneous display behavior are induced within a few days. The objective of this study was to determine whether the induction of this behavior is due to a loss of neural input from the eyestalk ganglia, or from the absence of a hormonal factor(s) elaborated and/or released in the eyestalk. In experimental males the optic nerves were cut using a procedure which did not disrupt hemolymph flow to the eyestalks. Spontaneous display behavior was virtually absent in the experimental group relative to controls. These results indicate the presence of an eyestalk hormone which modulates the activity of CNS pathways organizing the behavior. A positive correlation with hypertrophic changes in the androgenic glands and display activity suggests a possible role of androgenic hormone(s) in the regulation of this behavior. [Supported by NSF grant #PCM-8308776].

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JUVENILE HORMONE-LIKE COMPOUNDS IN LIBINIA EMARGINATA. H. Laufer, D.W. Borst, F.C. Baker*, and D.A. Schooley*. Univ. of Connecticut, Storrs, Illinois State Univ., Normal, and Zoecon Corp., Palo Alto, CA.

JH-like compounds may have important roles in the regulation of crustacean reproduction and larval development. To determine the presence of such compounds in Libinia, we analyzed its hemolymph by GC/MS procedures. Both methyl farnesoate (MF) and JHIII were detected at concentrations of 10-50 ng/ml and 3-30 pg/ml, respectively. We also examined several tissues for the secretion of these compounds during incubation with methyl-radiolabeled methionine. Only mandibular organs (MOs) secreted material that co-eluted on HPLC with MF and JHIII, with rates of synthesis from 1-20 ng and 1-10 pg/gland/hr, respectively. The identity of both compounds was further confirmed by GC/MS. However, the low levels of JHIII detected in both hemolymph and culture medium appear to reflect the non-specific chemical oxidation of MF during analysis. Therefore, our data suggest that MF may be a crustacean JH or a prohormone that is converted by peripheral tissues to some other active compound (such as JHIII). (Supported in part by Sea Grant NA82AA-D-00018 and NSF grant PCM82-08665).

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METHYL FARNESOATE PRODUCTION BY THE CRUSTACEAN MANDIBULAR ORGAN. D.W. Borst, M. Sinkus*, and H. Laufer. Illinois State Univ., Normal, and Univ. of Connecticut, Storrs.

We have recently reported that methyl farnesoate (MF) is secreted by the mandibular organs (MOs) of Libinia emarginata. To determine the generality of this observation, we analyzed the secretory products of MOs from several other crustaceans, including Cancer borealis, Callinectes sapidus, Cambarus bartonii, and Homarus americanus. MF was secreted by MOs from males and females of these species. Rates of MF secretion varied considerably between individuals of each species, but were generally higher in Brachyurans (up to 33 ng/mg gland/hr) than in Macrurans (up to 0.1 ng/mg/hr). The secretory rate of MOs from females appeared to be correlated with vitellogenesis in some species. In Libinia, MOs from non-vitellogenic juvenile females secreted low levels of MF (<0.1 ng/gland/hr) while adult females secreted higher amounts (3-38 ng/gland/hr). Likewise, MF secretion by MOs from female Homarus was highest in vitellogenic individuals. Our data suggest that MF is a common product of the crustacean MOs and may be involved in the regulation of vitellogenesis in the female. (Supported in part by Sea Grant NA82AA-D-00018).

EXTRACTS OF EYESTALKS FROM FIDDLER CRABS CONTAIN HIGH LEVELS OF ECDYSTEROIDS. P.M. Hopkins. Univ. of Oklahoma, Norman.

Eyestalks were removed from recently collected fiddler crabs, *Uca pugilator*, at the Florida State Univ. Marine Lab during the summer. The eyestalks were frozen and lyophilized at the station and returned to Oklahoma for bioassay. Eyestalks were extracted in deionized, distilled water, sonicated for 60 secs, put in a boiling water bath for 10 mins and centrifuged at 15K X g for 3 mins. The precipitate was discarded and the supernatant was applied to an HPLC Bio-Sil TSK 250 column (BioRad). The effluent was monitored at 280 nm. A large peak at the tailing end of the effluent had very high ecdysteroid-like RIA activity. Other extraction protocols plus RIA, HPLC-TSK 125 separation, C-18 reversed phase HPLC separation, thin-layer chromatography and mass spectrometry substantiated that the compounds extracted from the eyestalks were, indeed, a mixture of ecdysone, 20-hydroxyecdysone and other metabolites of ecdysone. Levels of ecdysteroid extracted were as high as 2000 pg per single eyestalk. The ratio of ecdysone to 20-hydroxyecdysone was 8:1. The implications of these results in light of much earlier reports of high titers of juvenile hormone in the crustacean eyestalk and of ecdysones in other anterior segments of crustaceans will be discussed.

ECDYSTEROIDOGENESIS BY CRAB Y-ORGANS IN VITRO: CALCIUM ANTAGONIZES cAMP-MEDIATED INHIBITION BY MIH. M.P. Mattson and E. Spaziani. Dept. of Biology, University of Iowa, Iowa City, Iowa 52242.

The eyestalk putative neuropeptide, molt-inhibiting hormone (MIH), suppresses Y-organ ecdysteroid secretion by raising cAMP. Basal secretion was enhanced by external Ca; MIH suppression did not require ext. Ca but its action was blunted by high ext. Ca. Inhibitors of Ca transport mimicked, and enhanced, MIH action, whereas a Ca ionophore raised basal secretion 3-fold and completely blocked MIH action, even in 0 ext. Ca. Effects on secretion by forskolin or dbcAMP, which mimic MIH, were inhibited by ext. Ca but an MIH-mimicking inhibitor of phosphodiesterase activity (IBMX) was not affected. Ext. Ca or ionophore lowered cAMP; MIH or IBMX increased cAMP, effects which were blunted by raising ext. Ca. A calmodulin blocker (TFP) depressed ecdysteroid secretion, increased cAMP and dramatically enhanced the action of MIH or forskolin in raising cellular cAMP. Phosphodiesterase activity, measured directly, increased linearly with ext. Ca and was lowered by TFP. Apparently, Ca, released intracellularly, counters MIH action by decreasing cAMP through a calmodulin-linked rise in phosphodiesterase activity.

CELLULAR CONTRIBUTION TO THE REGENERATION BLASTEMA IN THE AXOLOTL. K. Muneoka, University of California, Irvine.

The cellular contribution to the blastema from three different tissues of the limb stump has been analyzed using the triploid/diploid cell marker in the axolotl. Grafts of full skin, cartilage and nerve sheath were made from triploid donors into diploid hosts. Quantitative data for the percent contribution to the medium bud blastema from these tissues was gathered from histological sections of experimental chimeric blastemas as compared to control triploid blastemas. The cellular contribution from dermal tissues was found to be strikingly high; ranging as high as 78% of the blastemal cells with a mean of 46%. The dermis itself was found to represent only about 19% of the stump cells thus indicating that the dermis overcontributes by greater than 2 fold to the blastema. Conversely, both the cartilage and the nerve sheath undercontribute relative to the percent of cells they represent in the stump. These data correlate with the influence these various tissues have on the formation of the limb pattern during regeneration. Supported by NIH Grant HD 06082.

PATTERN ONTOGENY OF CHROMATOPHORE ORGANS IN THE SKIN OF CEPHALOPOD MOLLUSCS. R.T. Hanlon. Marine Biomedical Inst., Univ. Texas Medical Branch, Galveston.

Squids and octopuses use complex body patterns to communicate. The basic elements of this system are pigmented, neurally controlled chromatophores in the dermis. To observe morphological pattern formation, 6 octopuses (*O. joubini*) and 14 squids (*Sepioloa robusta*, *S. affinis*) were reared from hatching through 3 months, and photomicrographs were made of the dorsal mantle skin every 2 weeks. These species have a simple pattern repertoire and only yellow and brown chromatophores. The standard morphological array is non-random, consisting of larger brown chromatophores interspersed with smaller yellow chromatophores; mean density of chromatophores is 6 per mm² in *Sepioloa*. During ontogeny, some yellow chromatophores develop into browns in as little as 6 days. There appears to be a zone of lateral inhibition around all chromatophores, resulting in new yellows developing in unoccupied spaces of the skin. The rate of recruitment of new chromatophores is about 0.8 chromatophores per mm² per week in *Sepioloa*. Since each chromatophore is large, highly visible and controlled neurally, cephalopods may be useful in studying positional information at the organ level.

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ENVIRONMENTAL INFLUENCES ON OVUM SIZE IN A LABORATORY POPULATION OF THE FROG, BOMBINA ORIENTALIS. R. H. Kaplan. Reed College, Portland, OR.

Thirteen individual oriental fire-bellied toads, Bombina orientalis, were each bred four times. Prior to breeding an individual was kept for a minimum of eight weeks at either 24°C or 16°C with food ad libitum or at a reduced level. Breeding was induced with human chorionic gonadotropin after which the female was transferred in a random fashion to one of the remaining four treatments. All of the ova of a clutch were measured to the nearest 0.01 mm. It was found that single females can produce viable ova of very different sizes at different times. The mean values for an individual ranged from 2.25 to 1.95 mm. The amount of food provided had the greatest effect with decreased food resulting in a significant decrease in ovum size. A significant food x temperature interaction indicated that this effect was greater at the warmer temperature. These data are the first to show that the natural variation in ovum size and the consequences of such variation in amphibian populations may be primarily due to the plasticity of the vitellogenic process within a given individual.

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VARIATION IN RELATIVE CLUTCH MASS IN SNAKES AMONG AND WITHIN SPECIES. R. A. Seigel*, N. B. Ford, and H. S. Fitch*. Savannah River Ecology Laboratory, Univ. of Texas-Tyler, and Univ. of Kansas.

We examined the relationship between relative clutch mass (RCM) and female body size (SVL) both within and among different species of snakes. In 10 of 12 within-species comparisons, RCM varied independently of SVL. We suggest that this independence of body size and RCM is explainable on ecological grounds alone. In among-species comparisons, RCM decreased with increasing body size in both viviparous colubrids and viviparous viperids, but only the colubrid sample was statistically significant. In 20 egg-laying colubrids, RCM increased slightly (but not significantly) with increasing female SVL. We suggest that the differences in the SVL/RCM relationship between reproductive modes is related to the increased costs of viviparity resulting from long gestation times.

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CLONAL REPRODUCTION IN HYBRIDS OF THE CYPRINID FISHES PHOXINUS EOS AND P. NEOGAEUS. K.A. Goddard, R.M. Dawley, and R.J. Schultz.* Univ. of Connecticut, Storrs, and Cornell Univ., Ithaca, N.Y.

Phoxinus eos x neogaeus hybrids are widespread and abundant throughout North America. They are generally female and can exist in the absence of one or both parent species. These features are indicators of clonal reproduction by some unusual meiotic mechanism such as parthenogenesis or gynogenesis. Diploid hybrids collected at one New Hampshire site accept tissue grafts from each other, indicating that these individuals are genetically identical, and thus reproduce clonally. Triploid hybrids, identified by chromosome counts and electrophoresis, are as abundant as the diploids at this site and others nearby. While some triploids accept grafts from the diploids, others do not. Preliminary fin graft analyses, chromosome counts and electrophoretic analyses indicate that similar hybrid communities exist in New York, Maine and eastern Canada. Diploid P. eos x neogaeus hybrids appear capable of reproducing partially or completely independently of the parent species by parthenogenesis or gynogenesis, while the triploids apparently are produced by a more complex mechanism.

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POPULATION DIFFERENCES IN ENERGY UTILIZATION IN GROWTH AND REPRODUCTION IN THE MARINE SHORE FISH, HYPSOBLENNIUS JENKINSI. T.M.C. Present. Scripps Inst. Ocean., La Jolla, CA.

Local populations of Hypsoblennius jenkinsi are found in a diversity of habitats and are subject to a wide range of survivorship conditions. Life history theory predicts that as adult survivorship decreases relative to juvenile survivorship, there is a selective advantage for organisms to increase reproductive effort or the proportion of available energy used in reproduction rather than growth. To determine if patterns of energy use in H. jenkinsi are consistent with a model of adaptation to local survivorship conditions, estimates were made of the relative amounts of energy used in growth and reproduction over a single annual cycle by one-year-old females in two populations that experience very different survivorship conditions. Results indicate that, contrary to the predictions of life history theory, individuals exposed to higher mortality risks do not devote a lesser proportion of available energy to growth. Population differences in energy use can be explained as representing responses to different food supplies rather than as adaptations to different survivorship conditions.

AGE AND GROWTH OF THE LEMON SHARK, NEGAPRION BREVIROSTRIS (POEY), AS DETERMINED BY MARK/RECAPTURE DATA AND THE EXAMINATION OF TETRACYCLINE LABELLED VERTEBRAL CENTRA. S.H. Gruber, C.A. Brown, and A.D. Henningsen. RSMAS, University of Miami, Miami, Florida.

A multiple mark tagging program involving two lemon shark populations was conducted from 1979 to the present. In the Florida Keys, 1935 sharks were marked with a variety of tags, injected with tetracycline HCl, and released, as were 280 sharks in Bimini, Bahamas. There were 123 Keys recaptures and 92 in Bimini. Time at large and lengths at release and recapture were utilized in a least squares method estimating von Bertalanffy growth curve parameters of $L_{\infty} = 303.8\text{cm}$, $K = 0.05$, and $t_0 = -3.17$, predicting maturity near age 14 and 95% L_{∞} after 55 years. Vertebral centra were removed from 56 recaptures and ground along a frontal plane. Annual bands and circulus formation occurring every 28 days were validated using the tetracycline marker. Estimated ages from circulus counts describe a growth curve with $L_{\infty} = 310.6\text{cm}$, $K = 0.06$, $t_0 = -2.28$, predicting maturity near age 12 and 95% L_{∞} after 50 years. Results agree that this shark is slow growing and long-lived.

CHARACTERIZATION OF LOGGERHEAD AND GREEN TURTLE POPULATIONS IN THE INDIAN RIVER LAGOON SYSTEM, FLORIDA, WITH COMMENTS ON USE OF THE TERMS, "JUVENILE" AND "SUB-ADULT." L.M. Ehrhart. Univ. of Central Florida, Orlando.

Mendonca and Ehrhart (1982) and Ehrhart (1983) have shown that loggerhead and green turtle populations of the northern region of the Indian River are composed of immature individuals and that size structures of the populations are very different. Purported differences in growth rates suggested that the age structures might, however, be similar. In the summers of 1982 through 1985 turtles of both species were live-captured in nets in the central region of the Indian River. As in the northern region, loggerheads (CLs Range: 43-80 cm) are about twice as large as green turtles (CLs Range: 28-64 cm). Recent evidence suggests that growth rates and maturation times are similar in green turtles and loggerheads (Frazer and Ehrhart, 1985). This implies that age structures of the two Indian River populations are quite different and that the ecologic geography of the species can be used to define life history stages ("juvenile" and "subadult") that are biologically more meaningful than those previously defined arbitrarily.

EFFERENT PROJECTIONS OF THE OLFACTORY BULBS IN THE PACIFIC HAGFISH. R. G. Northcutt. Univ. of Michigan, Ann Arbor.

The telencephalon in Pacific hagfish, Eptatretus stouti, is large and the pallium laminated, perhaps due to hypertrophy of olfactory and/or tactile inputs. To examine the first possibility, HRP (Sigma, Type VI) was injected unilaterally into the olfactory bulbs of six adult Pacific hagfish. Following survival times of 10-14 days at 12°C, brains were processed by a Hanker-Yates protocol. Lateral and medial olfactory tracts exit the bulb. The lateral tract runs dorsomedially within the hemisphere and gives rise to superficial and deep subdivisions. The superficial subdivision terminates throughout the extent of pallial lamina 1, whereas the deep subdivision terminates throughout laminae 4 and 5. Fibers also decussate in the anterior and habenular commissures to terminate in the contralateral pallium as well as bilaterally in the hypothalamus. A medial olfactory tract terminates in the rostral ventromedial hemisphere. Pallial lamination is related to olfactory hypertrophy, but not all laminae receive direct olfactory input. (Supported by NIH grants EY02485 and NS11006.)

SECONDARY MECHANOSENSORY LATERAL LINE PATHWAYS OF THE SPINY DOGFISH. R.L. Boord and R.G. Northcutt. Univ. of Delaware, Newark, and Univ. of Michigan, Ann Arbor.

The medial octavolateralis nucleus (MON) is a primary medullary center that receives information from peripheral lateral line and octaval mechanoreceptors as well as from central nervous system sources. Anterograde transport of horseradish peroxidase injected into MON of 5 juvenile spiny dogfish Squalus acanthias, reveals that most MON efferents project directly, as commissural fibers, to the contralateral MON, and to the midbrain via ipsilateral and contralateral lemnisci. The ipsilateral lemniscus is situated, at medullary levels, dorsal and lateral to the contralateral lemniscus but both ascend to mesencephalic levels parallel to the electrosensory pathways and terminate within the optic tectum and, lateral to the torus semicircularis, within the medial part of the lateral mesencephalic nucleus (LMN). Ipsilateral fibers appear to terminate in a paratrigenial nucleus as they ascend so that the larger number of fibers to LMN is contralateral. The mechanosensory part of LMN of primitive squalomorph sharks is the apparent homologue of the dorsomedial subdivision of the LMN complex of those elasmobranchs that possess a hypertrophied midbrain roof, e.g., skates. Supported by NIH grants.

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DEVELOPMENT OF THE THERMORECEPTIVE PIT ORGANS IN THE BOID SNAKE PYTHON REGIUS. A. H. Savitzky, Old Dominion Univ., Norfolk, VA.

A series of embryos of Python regius permits the first study of development of the thermoreceptive pit organs in a boid snake. Embryos were sequentially removed from eggs, fixed in phosphate buffered formalin, and the heads serially sectioned and stained. Difficulty was encountered in applying existing staging criteria for colubrid snakes to the embryos of P. regius. Pit organs are first evident externally at a stage approximately equivalent to Zehr Stage 30-33. The supralabial pits invaginate in series from anterior to posterior. Thus, the pits which are deepest in the adult are the earliest to form. As in pit vipers, the pit organs of boids arise much later in embryonic development than do the primary cephalic sense organs. Nevertheless, their development begins quite early relative to the total period of embryonic development, prior to the appearance of cephalic scales or pigment. (Supported by NSF Grant No. BSR-8415752).

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TERMINAL NERVE OF ODONTOCETE WHALES L.S. Demski, S.H. Ridgway,* J.H. Bullock and M. Schwanzel-Fukuda*. Univ. of Kentucky, Lexington; NOSC, San Diego; UCSD, La Jolla; and Rockefeller Univ., New York.

In dolphins (Pacific bottlenosed, common and Pacific whitesided), the TN is characterized by many osmium stained strands running parallel in the pia on the ventromedial surface of the frontal lobe. In larger whales (killer and beluga), the TN is primarily a single trunk (several mm) in the midline between the hemispheres. In both types, the fibers enter the cranium from paired medial foramina located dorsal to the frontal lobes. In Tursiops, TN bundles enter the brain in the anterior perforated substance or run along the optic chiasma or branches of the anterior cerebral arteries. In Delphinus, ganglia are distributed along the TN with the largest situated at the point of cranial entry. The latter contains many (>1000) round cells (30µm) and a lesser number of smaller LHRH-immunoreactive fusiform neurons. The TN of all forms examined is mostly, if not entirely myelinated (fibers up to 5µm). The functional significance of the well-developed TN in mammals which have lost the olfactory system will be considered. Supported by the NIH, NSF and NOSC.

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THE RECOGNITION OF HOMOLOGOUS NEURONS IN THE OPTIC TECTUM: A DISCUSSION OF METHOD. Thomas E. Hughes. Duke Univ., Durham, North Carolina

In comparative neuroanatomy, as in other comparative sciences, various criteria have been proposed to be the most useful for recognizing homologous relationships. A historical review of the comparative study of the optic tectum reveals that researchers using different criteria for homology - such as cell position, dendritic morphology, or axonal connections - have proposed very different hypotheses about which neurons are homologous in the optic tectum. This disparity can provide useful insight into comparative neuro-anatomical method. For example, if cell position is used as a criterion for homology, then cells in the same position are thought homologous while their dendritic arbors, axonal connections, or both, are inferred to have changed. Conversely, if dendritic morphology is thought to reveal homology, similar looking cells are sought regardless of other criteria such as position. The use of any one or two criteria limits the data collected, precludes certain hypotheses of homology from consideration, and is an assumption about what does, and does not, change during evolution.

566

COMPARTMENTALIZATION OF RAT LATERAL GASTROCNEMIUS MUSCLE A.W. English, S. Donahue, and O.I. Weeks, Emory University, Atlanta, GA

The anatomy, innervation patterns, and histochemical composition of the lateral gastrocnemius (LG) muscle were examined in adult rats. Primary branches of the nerve to LG were stimulated to deplete muscle muscle glycogen. Sections of muscle stained for glycogen were used to visualize these innervation territories. Adjacent sections were reacted for demonstration of myosin ATPase and succinate dehydrogenase. Fibers were classified using these stains as types FG, FOG, or SO. Rat LG consists of three heads, organized about two tendons of origin and single tendon of insertion. The nerve to LG divides into four naturally occurring branches which each innervates a distinct muscular volume. These four compartments have a distinct relationship to the three heads. The medial head contains mostly type FG and very few type SO fibers. The distal part of the intermediate head contains a large number of type SO fibers and many fewer type FG fibers. Thus the organization of LG in rats is strikingly similar to that of cats and other mammals, suggesting that such an organizational pattern may be a widespread phenomenon.

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SYNAPSE ELIMINATION AND THE ESTABLISHMENT OF NEUROMUSCULAR COMPARTMENTS. S. Donahue and A. English (intro. by L. Wineski). In adult rats, the lateral gastrocnemius (LG) muscle is compartmentalized about its primary muscle nerve branches. At birth all LG fibers are innervated by more than one axon but later all but one of these synapses is eliminated. To determine the role of synapse elimination in the establishment of LG compartments, innervation patterns were examined using selective EMG techniques. In pups older than five days, stimulation of single LG nerve branches evoked EMG activity only in parts of the muscle corresponding to adult innervation territories. No EMG activity was observed in other parts of LG or in medial gastrocnemius (MG). In younger pups, nerve branch stimulation produced EMG activity which was more widespread, involving adjacent but denervated compartments but not MG. The amplitude and reliability of evoked cross-compartmental potentials was quite variable, suggesting that they result from activation of synapses already targeted for elimination. Thus immature innervation patterns do cross compartmental boundaries, but probably not to the extent that synapse elimination could be considered compartment-specific.

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COPULATORY EXHAUSTION: MODIFICATION OF ENDOGENOUS OPIOID FUNCTION RENEWS SEXUAL PERFORMANCE. S.J. Bauman*, R.B. Pitkin, and J.D. Cross*. Allegheny College, Meadville, PA.

The present investigation explored the role of endogenous opioids in the "Coolidge Effect" - renewal of copulatory behavior in sexually satiated male rats when presented with a novel female. Tail-flick latencies of male rats were measured prior to and following copulatory exhaustion (30 min. without mount attempt) to measure changes in endogenous opioids. The latencies increased significantly indicating an increase in opioids. Sated males were then exposed to one of five post-exhaustion treatments: novel estrus female; odor of novel estrus female; non-estrus female, naloxone injection (opioid antagonist); empty arena and tail-flick latencies measured again. Significant declines in tail-flick latencies were observed for the novel estrus female, odor of novel estrus female and naloxone treatment. These results confirm that endogenous opioids play a role in male satiation and suggests an interaction between pheromone perception and endogenous opioids and the possibility of an endogenous, fast-acting opioid antagonist.

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REPRODUCTIVE SUCCESS IS DEPENDENT ON FIRST ESTABLISHING HIGH RANK IN FEMALE WILD HOUSE MICE. P. Franks and S. Lenington*. Univ. of Wisconsin, Madison and Institute of Animal Behavior, Rutgers Univ., Newark, NJ.

F₁ and F₂ generation house mice were studied in a semi-natural environment to determine dominance and reproductive success correlated with T Locus genotype. Groups of 2 to 4 males and 4 to 6 females were placed into a 6 by 12 ft room for 20 days on a reversed day-night light cycle. The males were not related to any other mouse in the group, but females could have been related to each other. Social interactions such as approaches and attacks, and time spent together, were recorded during 1 h daily observation periods. 20 groups were observed. Dominance rank was established before behavioral estrus occurred. Those females who were top ranked had a greater probability of coming into behavioral estrus than did lower ranking females. Top ranked females also had a greater probability of producing young than did lower ranked females.

577

VISUAL CUES FOR PREY SELECTION BY FORAGING TREEFROGS. A.N. Freed. Johns Hopkins Univ., Baltimore.

Do visual cues aid treefrogs (Rhyla cinerea) in the discrimination and selection of prey? I examined feeding response times of treefrogs in relation to the visual cues provided by natural prey. Simple linear regression indicates that prey size (length and dorsal surface area), perceived prey size (i.e., subtended visual angle), shape (length/width ratio), crawling speed, the rate at which prey are perceived to move (i.e., subtended angular velocity), and the distance of prey from the predator at the time of prey detection significantly influence the response time of foraging frogs. Multiple linear regression indicates that treefrogs respond more slowly to distant items and more quickly to prey that exhibit large visual angles (i.e., large and nearby items), large length/width ratios (i.e., elongate items), and high crawling speeds. All but one prey species elicits response times that are significantly different from the reference species (Musca domestica). Treefrogs consistently discriminate among prey that are morphologically and behaviorally similar regardless of their phylogenetic relationship (closely-related vs. unrelated).

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INCREASE IN VISUAL SENSITIVITY AND BIOLUMINESCENT FLASHING ACTIVITY IN FIREFLIES. A. B. Lall and S. Supattapone* The Johns Hopkins University, Baltimore, MD 21218

North American fireflies can be divided into two groups: a) those which restrict their luminescent activity to a short period at twilight (twilight active) and b) those which are active all night (dark active). Threshold sensitivity of the compound eyes was monitored over long periods by recording ERGs. In dark active fireflies of genus Photuris visual sensitivity increased dramatically (1000-10,000 X) between 1830-2100 hrs. This increase in sensitivity occurred only when the insects were maintained under strict natural ambient illumination diurnal rhythm. When fireflies were placed in total darkness, the increase in sensitivity was not synchronized with evening hours. Twilight active fireflies of genus Photinus showed only slight increase in visual sensitivity over the same period. Supported by BNS 8311127

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AN INVESTIGATION INTO INDIVIDUAL RECOGNITION IN THE BLACK-BILLED MAGPIE (PICA PICA). L. Reed. Idaho State Univ., Pocatello.

In a preliminary investigation using operant two-choice techniques, Black-billed magpies spent significantly more time near one of two conspecifics. This indication of preference (and recognition) was maintained through position reversals of the conspecifics. Little has been reported about visual cues controlling individual recognition. Magpies possess several physical features which may act as cues, with potentially the most salient being a white wing patch. This patch is more variable in juveniles than in adults and less variable among sibs than among non-sibs. In this ongoing investigation, magpies are trained to make simultaneous discriminations among photographs of wing patches (s^d) and the same photos with altered areas of white (s^A). It is hypothesized that magpies can discriminate between original and altered photos when the variability of the alteration is equal to or greater than the variation found among sibs.

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CORTICOSTERONE AND NALOXONE EFFECTS ON PREENING BEHAVIOR IN DOMESTIC CHICKENS. S. Williams and Lisa Tiberi*. Simmons College, Boston, MA.

Excessive grooming behavior has been documented in birds as a result of stress and intraventricular administration of ACTH and ACTH₁₋₂₄. Naloxone has been shown to decrease preening behavior in stressed birds. Increased ACTH leads to higher levels of corticosterone which influence energy production that may be used in stressful situations.

In the present study, two doses of corticosterone (0.002mg/kg and 0.02mg/kg) and one of naloxone (3.2mg/kg) plus oil and saline controls were injected s.c. into four-month-old, heavy-hybrid chickens in random order in double blind methods. Behavior was observed for 15 min. and recorded for 30-sec. intervals. Neither corticosterone nor naloxone significantly affected the preening behavior of chickens.

581

WHETHER TO FEED OR FLEE: CHEMICAL CONTROL OF CRUSTACEAN BEHAVIOR. R.K. Zimmer-Faust. Univ. of Cal., Santa Barbara.

Feeding responses were initiated in 5 species of bathypelagic and littoral crustacea in laboratory experiments, using single amino acids occurring abundantly in natural prey. Escape responses were elicited in bathypelagic species by ammonia, a non-nutritive substance produced in copious amounts during bacterial degradation, and both feeding and fleeing were suppressed by an amino acid - ammonia mixture. Ammonia suppressed responses by littoral species to amino acids, but was otherwise ineffective. Chemical analytical procedures (HPLC and flow injection) coupled with computer simulations were used to estimate limits of behavioral detection. Concentrations deviating <5% above ambient seawater levels were detected, while concentrations of >0.5 log unit above ambient caused feeding or fleeing. Dose - response curves were typically hyperbolic, an observation agreeing with previous citations for insects and vertebrates. Results show that: (1) low molecular weight compounds induce or inhibit crustacean behavior at environmentally relevant concentrations, and (2) the decisions to feed or flee are mutually exclusive and under simple chemical control.

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STRUCTURE OF THE PEDAL APERTURE GLANDS IN *MYA ARENARIA*. Jon L. Norenburg. Mt. Desert Isl. Biol. Lab., Salsbury Cove, ME.

Vlès (1909, Mem. Soc. Zool. Fr. 22:90-141) observed in *Mya arenaria* a pair of "corps brun, organe glandulaire de l'orifice de sortie du pied." These pedal aperture glands are not described and are not mentioned in recent anatomical studies, including those on pedal function in *Mya*. Each gland lies along the internal edge of the aperture and is apposed to the foot during its protrusion. The gland is dominated by deep (up to 1.5mm), flask-shaped mucus cells with necks opening in the surface epithelium. The cell appears to contain two types of inclusion. One is relatively amorphous, consists of fine granular material in highly distended cisternae (RER?), and is positive for sulfated and non-sulfated mucosubstances (NSM). The other consists of strongly refringent granules (1x4um) which stain for NSM only and weakly for protein. The granule is a vesicle with a peripheral coiled array of electron-dense, paracrystalline fibers surrounding an electron-lucent core. This appears to be the dominant secretion at the gland's surface. Sediment does not adhere readily to the foot, hence, these granules may lubricate the foot, or they may aid in sealing the pedal aperture or in consolidating burrow sediments.

583

A COMPARATIVE ANALYSIS OF SERTOLI-LIKE CELLS OF SOME MOLLUSCS AND ECHINODERMS. John Buckland-Nicks and Fu-Shiang Chia, Univ. of Alberta, Edmonton, Canada.

In prosobranch molluscs the Sertoli-like cells are modified columnar epithelial cells that maintain continuous contact with the basal lamina and extend from it to the lumen of the seminiferous tubule. Spermatogenesis takes place between adjacent Sertoli-like cells, but a continuous layer of cytoplasm separates the germ cells from the basal lamina. Thus there is no basal compartment and substances traversing from the interstitium must pass either through the Sertoli-like cells, or between them. However, between the cells, a junctional complex acts as a blood-testis barrier that blocks the passage of substances, such as the tracer lanthanum nitrate. Sertoli-like cells of prosobranchs readily phagocytize waste sperm and in most other aspects of their morphology they are analogous to the Sertoli cells of vertebrates.

In the echinoderms we have studied the Sertoli-like cells have a quite different morphology and might best be described as "pluripotent interstitial cells". Following ejaculation they can leave the basal lamina and behave like wandering amoebocytes, phagocytizing waste sperm in the lumen. There is no blood-testis barrier. Substances traversing from the genital haemal sinus can reach the spermatogonia directly or can pass unimpeded between adjacent Sertoli-like cells, as there is no junctional complex to prevent them. We suggest that the Sertoli-like cells in the testis of echinoderms are not true Sertoli cells and may have a completely different origin. Supported by an N.S.E.R.C. of Canada grant to F-S.C.

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FINE STRUCTURE OF THE LARVAL MIDGUT IN THE MOSQUITO, *Aedes aegypti*. Maira Cioffi. Temple Univ., Philadelphia, PA.

The midgut of larval *A. aegypti* was examined using light microscopy and transmission electron microscopy. The midgut is a simple uncoiled tube one cell layer thick, with a cluster of anterior caecae. The cecal and posterior midgut cells have a structure typical of digestive tissue, with a brush border of microvilli and cytoplasm packed with mitochondria, rough endoplasmic reticulum, Golgi complexes, lysosomes, and protein storage granules. However the cells forming the anterior one quarter of the midgut lack a brush border as well as ribosomes and other protein synthesizing machinery. Mitochondria are located at the apical and basal regions of the cell, and the bulk of the cytoplasm is filled with small vesicles. The basal plasma membrane is infolded to form a branching system of tubules closely associated with mitochondria, an organization typical of ion transporting cells. In addition, the cytoplasmic side of this membrane is studded with small particles characteristic of transporting membranes in insect epithelia. Therefore the ultrastructural evidence suggests that while the caecae and posterior midgut function in digestive processes, the anterior midgut is specialized for ion regulation.

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THE REPRODUCTIVE CYCLE OF *MYA ARENARIA* FROM LONG ISLAND SOUND AND RARITAN BAY. A. Cristini, E. Saiff, M. Schneider. * Ramapo College of New Jersey, Mahwah.

The state of the gonads of the bivalve *Mya arenaria* was monitored in natural populations from Raritan Bay and Long Island Sound and in clams from Long Island Sound caged in Raritan Bay for 11 months. The water temperature, Adenylate Energy Charge (AEC), lipid and glycogen content of tissues was measured and correlated to the condition of the gonad. All of the animals, natural populations as well as caged, were observed to spawn in March and in June. The spring spawning occurred when the water temperature was between 5-12°C, the early summer peak occurred when surface temperature ranged between 18-24°C. The AEC values were lower for animals from Long Island Sound caged in Raritan Bay, however, their reproductive cycle was not affected by the alteration of their adenylate pools. The concentration of lipids in the tissues of all the clams decreased prior to both spawning periods. The glycogen content in all the animals was high from October-December and exhibited a gradual decline from January-August during gamete development and release.

586

SALINITY EFFECTS ON THE TOLERANCE AND DEVELOPMENTAL RATE OF THE SEA URCHIN, LYTECHINUS VARIEGATUS (ECHINODERMATA: ECHINOIDEA) R.A. Roller and W.B. Stickle. Louisiana State University, Baton Rouge.

Tolerance and developmental rates of the larvae of Lytechinus variegatus was examined as a function of salinity. Adults were induced to spawn and fertilization and subsequent development were followed in the laboratory (25°C) at the following salinities: 35, 30, 27.5, 25, 20, 15, and 10‰. The developmental rate varied directly with salinity for this species. There was an observed increase in the number of abnormal plutei and a decrease in survival at salinities below 35‰. Cell volume varied indirectly with salinity during early development (ANOVA). (Supported by a grant from the Petroleum Refiners Environmental Council of Louisiana).

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THE ENERGETIC CONTRIBUTION OF GLUCOSE AND GLYCINE TAKEN UP FROM NATURAL SEAWATER BY ADULT MARINE MUSSELS. W. T. Gorham. Univ. of Southern California, Los Angeles.

The removal of glycine and glucose by freshly collected adult Mytilus edulis was determined using radiolabeled substances added to ambient concentrations of dissolved organic materials in freshly collected natural sea water. Calculated uptake rates were estimated for substrate concentrations of 0.5 μM glycine and 1.0 μM glucose and were compared with the animals' energy and nitrogen demands as measured by oxygen consumption and ammonia excretion rates respectively. Respiration rates and ammonia excretion rates as well as either glucine or glucose removal were all determined for the same animals. The calculated uptake rates could have contributed roughly 13% to 14% of the mussels' energy requirements or 10% of the mussels' nitrogen requirements assuming a 0.5 μMolar concentration of free amino acids, a 1.0 μMolar concentration of simple sugars, uptake of total amino acids at a rate equal to that of glycine, and uptake of simple sugars at a rate equal to that of glucose.

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EFFECTS OF IONS ON NEMATOCYSTS ISOLATED FROM ACONTIA OF A SEA ANEMONE BY DIFFERENT METHODS. M. Hidaka and R.N. Mariscal. Florida State University, Tallahassee, FL.

We examined effects of Ca²⁺ and some other agents on nematocysts isolated from acontia of Calliactis tricolor by different methods. Undischarged nematocysts were isolated by immersing the acontia in (1) distilled water (DW) or (2) 1 M sucrose, or by squashing them in (3) 1 M Na citrate or (4) artificial sea water (ASW). Nematocysts isolated by different methods responded to various agents differently. Nematocysts isolated in ASW discharged in DW and 5 mM EGTA, but did not discharge in Ca-free ASW or 50 mM CaCl₂. Nematocysts isolated in citrate discharged when treated with any of the above solutions. Nematocysts isolated in DW and sucrose discharged only in EGTA after a latent period. Nematocysts isolated in ASW are considered to be closer to *in situ* nematocysts than others. Failure of Ca-free ASW to induce discharge in nematocysts isolated in ASW is not consistent with the recently proposed hypothesis that Ca-removal dissociates macromolecules to increase osmotically active particles and results in nematocyst discharge.

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EVIDENCE FOR TWO VISUAL PIGMENTS IN A DEEP-SEA MYSID. T.M. Frank. Univ. of California, Santa Barbara.

The spectral sensitivity of the bioluminescent mysid, Gnathophausia ingens, was determined by recording the electroretinogram from eyes of live, intact animals. The action spectrum (determined by utilizing a response criterion of 50 μV) exhibits a broad peak from 430nm to 550nm, suggesting the presence of more than one visual pigment. Chromatic adaptation experiments with both broadband and monochromatic light alter the shape of the spectral sensitivity curve, resulting in peaks at 450nm and 530nm. This selective bleaching, as well as waveform differences between responses to long wavelength and short wavelength light, also suggests the presence of two visual pigments. This is the first reported occurrence of possible multiple visual pigments in a deep-living crustacean. The presence of a 530nm pigment is completely unexpected in such an animal living below the photic zone at depths where the major known light source is blue bioluminescence (450-490nm).

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PRELIMINARY STUDIES ON KIDNEY ULTRASTRUCTURE IN THE BIVALVE *MYA ARENARIA* WITH OBSERVATIONS ON ORGANISMS FROM A POLLUTED SITE. G. Seiler and M.P. Morse. Bio.Dept., Marine Sci. Lab., Northeastern Univ., Nahant, Mass.

The pericardial gland-kidney complex forms the excretory system in *Mya arenaria*. Paired kidneys drain the pericardial cavity via ciliated renopericardial ducts. The kidney is differentiated by light microscopical observations into two distinct areas; the small proximal region and the enlarged distal region. The proximal region consists of columnar epithelial cells with an apical border of microvilli characteristic of reabsorptive surfaces. The majority of the organ consists of a distal secretory area made up of an extensively folded epithelium of cells with expanded apical tips. Beneath this layer are blood spaces filled numerous amoebocytes that are characterized by dense nuclei. In animals collected from polluted sediments (New Bedford, Mass.), the amoebocytes contain numerous inclusions. Similar granular materials are seen within the epithelial layer suggesting a possible sinus-to-lumen transport of waste materials.

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EMERGENCE OF LARVAL FLUKES FROM THE SNAIL, *Coniobasis semicarinata*: CONTRASTING RESPONSES OF CONGENERS TO L/D CYCLES. M.C. Lewis, I.G. Welsford, and G.L. Uglem. University of Kentucky, Lexington.

Proterometra macrostoma and *P. edneyi* (Digenea) require the same snail host, but different fish hosts in their life cycles. Larvae (cercariae) emerging from snails must be ingested by specific fish hosts to complete development. When infected snails were exposed to artificial L/D cycles at constant temperature (20C) *P. edneyi* emerged during photophase (85%:102/120), but *P. macrostoma* emerged during scotophase (72%:84/117). When the L/D regime was shifted relative to natural L/D cycle, peak emergence of both species was shifted with the new L/D regime. After 72 h in constant light or dark, emergence was no longer rhythmic in either species. Thus, L/D cycling appears to be important in timing the emergence of both species. These data suggest underlying circadian rhythms which would allow peak emergence of cercariae to coincide with the feeding periods of the fish hosts.

Supported by NSF grant PCM 8203378.

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EUSTRONGYLIDES TUBIFEX IN THE NORTHERN WATER SNAKE, *NERODIA SIPEDON*. C.R. BURSEY. Penn State Univ., Sharon.

Migratory and encysted nematodes, *Eustrongylides tubifex*, were found in northern water snakes, *Nerodia sipedon*. Encysted nematodes occurred in three forms: recently encapsulated, degenerating, and hyalinized; and were found in mesenteries, muscles, and subcutaneous tissue. Encystment was associated with hypotrophy, fibroplasia and eosinophilia. Migratory nematodes occurred within muscles, subcutaneous tissue and the coelom. Eggs were found within one nematode.

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THE JUMPING SPIDER (ARANEAE: SALTICIDAE) SUBFAMILY THIODININAE. R.J. Wolff. Trinity Christian College, Palos Heights, IL.

The jumping spiders in the subfamily Thiodininae sensu stricto are distinguished by two pairs of bulbous setae on the tibia of leg pair I. There are 17 species described in *Thiodina* and three new species. These occur throughout the neotropics with three species extending into the nearctic. There is also a *Thiodina* from Dominican amber which indicates a possible dispersal route through the Caribbean for the related North American *Thiodina puerpera*. *Parathiodina* from Haiti is considered a valid genus based on width of the third eye row, leg lengths, shape, and spination. The placement of *Cotinusa* and *Banksetosa* species with the bulbous setae is problematic. The posterior cheliceral teeth are useful for species identification (they could fit into all of the classical subfamilies based on cheliceral teeth).

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CONTRIBUTION OF EXCHANGE-DIFFUSION TO Na AND Cl FLUXES IN THE MANGROVE CRAB GONIOPSIS CRUENTATA. I.P. Zanders and M-J. Martelo. IVIC, Caracas, Venezuela.

The sodium and chloride fluxes between blood and medium were determined in crabs acclimated to 150, 100, 75, 50 or 25% seawater. The fluxes of ^{22}Na and ^{36}Cl were 3.8 and 2.1 mmol/hr x 100g, respectively, in crabs from 150% SW but both fluxes were considerably lower (about 0.6 mmol/hr) in those acclimated to 50% SW and below. The fluxes measured in the latter were completely accounted for by diffusive gains and losses between blood and medium, urinary losses and active uptake or excretion through the gills or other pathways. However, in 150% SW at least two-thirds of the measured fluxes remained unexplained. Replacing 500 mM sodium in 150% SW by isosmotic substitution with TRIS-chloride (=low Na-150% SW), brought about an immediate reduction of Na fluxes, from 3.7 to 0.6 mmol/hr. At the same time the Cl fluxes also decreased, but only from 1.9 to 1.5 mmol/hr. The results strongly suggest that the reduction of the Na (or Cl) fluxes observed in G. cruentata on acclimation to dilute media is caused by the disappearance of large components of exchange-diffusion and not by changes of the animals' permeability to these ions.

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ORGANISMAL RESPIRATORY RESPONSES OF FAIRY SHRIMP, STREPTOCEPHALUS SEALI, TO ENVIRONMENTAL HYPOXIA. G. Anderson. Univ. of Southern Mississippi, Hattiesburg.

Oxygen uptake rates and phyllopod beating frequencies were determined simultaneously for anostracans, Streptocephalus seali, subjected to normoxic and hypoxic conditions. Preliminary results demonstrate that unlike the oxygen regulator, Branchinecta mackini (Eriksen and Brown, 1980, Crustaceana 39:11-21), S. seali is an oxyconformer. At 26°C, oxygen consumption rate is near 0.8 mg O_2 /g/hr at $\text{PO}_2=154$ mm Hg and less than 0.1 mg O_2 /g/hr at $\text{PO}_2=10$ mm Hg. In contrast, ventilation frequency is nearly constant from $\text{PO}_2=154$ mm Hg to 11 mm Hg (3.4 ± 0.05 bps) but decreases sharply to less than 3 bps at $\text{PO}_2=10$ mm Hg. Shrimp exhibiting minimal ventilation (ca. 1.5 bps @ $\text{PO}_2 \leq 2$ mm Hg) recovered when returned to normoxic conditions. Spectrophotometric analysis of hemolymph revealed weak absorption peaks at 540 and 580 nm indicative of the respiratory pigment, hemoglobin. At present, work is underway to evaluate the effects of sex and life cycle stage on physiological responses to hypoxia.

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THE ROLE OF VISION IN CRAYFISH COMMUNICATION. C.A. Bruski and D.W. Dunham. Dept. Zoology, University of Toronto.

The effect of altered light level on the form and efficiency of agonistic communication was investigated in the crayfish Orconectes rusticus, a species normally active over a broad range of ambient light conditions. Isosexual pairs of males and females were observed interacting under moderate ambient light and in complete darkness (using infra-red video), in the laboratory. Type and frequency of behaviours, bout durations, and the sequential structure of interactions were analyzed. In the absence of light, bouts were fewer in number and longer in duration, and information transmission was lower than in the presence of light. Eventual losers of bouts had smaller behaviour repertoires than did winners under all lighting conditions, and the sequencing of behaviour in losers was more strongly influenced by altered light level than was that of eventual winners. The results suggest that visual input is an important permissive variable for efficient interaction in this species.

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LABORATORY STUDIES OF OLFACTION AND TASTE IN LAND HERMIT CRABS COENOBITA RUGOSIS. Dan Rittachof, Laura Barlow* and Alva R. Schmidt*. Duke Univ. Marine Laboratory, Beaufort, N.C.

Field and laboratory studies were performed to examine chemoreception in land hermit crabs C. rugosis. Crabs were collected on the Pacific Coast of Costa Rica as part of field studies and transported to the Duke University Marine Laboratory. Responses of crabs in the field were used to develop laboratory assays. Modifications of the assays used in the field tests were effective in assaying olfaction and taste. Field results showing attractive odors from horse feces, fruit, and fish were confirmed. Fasting and prior dietary history were important to assay responses. Pure volatile organic components of feces, rotting flesh, and fruits were tested with mixed success. Skatole (3-methylindole) was attractive to crabs but did not induce feeding responses. Feeding was stimulated by contact with nonvolatile compounds (such as sucrose). Land hermit crabs are basically ten-legged flies with respect to their responses to feces, fruit and carion. Supported by ONR contract #319-4002.

FACTORS INFLUENCING HABITAT SELECTION OF YOUNG JUVENILE SPINY LOBSTERS, *PANULIRUS ARGUS*. R.A. Tankersley, W.F. Herrkind, and M. Butler. Florida State Univ., Tallahassee.

The effects of sediment and food abundance on selection of the red algae, *Laurencia* spp., as primary habitat by newly settled juvenile spiny lobsters, *Panulirus argus*, were studied using field and laboratory experiments. Juvenile lobster recruitment and settlement in areas containing sedimented and unsedimented *Laurencia* were estimated using artificial habitats and bottom censuses. Significantly greater numbers of juveniles inhabited unsedimented algae despite high levels of recruitment in the sedimented area. Lobsters introduced to aquaria containing sedimented and unsedimented *Laurencia* clumps consistently resided in the unsedimented algae. Algae sediment from both sites differed in amount and particle frequency distribution. Additionally, the abundance of potential epifaunal prey contained within *Laurencia* from both areas were determined and compared with food preference tests.

DIFFERENCES IN EFFECTS OF MERCURY ON PREDATOR AVOIDANCE IN TWO POPULATIONS OF THE GRASS SHRIMP, *Palaemonetes pugio*. D.B. Kraus and M.L. Kraus*. Dept. of Psychiatry, Univ. of Medicine and Dentistry, Newark, NJ and Dept. of Ecology, Rutgers Univ., Piscataway, NJ.

Adult *Palaemonetes pugio* were collected from two tidal creek systems, Piles Creek (PC), a mercury polluted estuary, and Big Sheepshead Creek (BSC), a relatively pristine creek. Adult killifish (*Fundulus heteroclitus*), a natural predator of *P. pugio*, were obtained from BSC. For each test, 10 dosed (0.01 mg/l mercuric chloride (HgCl) or 0.01 mg/l methylmercury (MeHg)), or control shrimp were introduced into a tank containing 3 fish. The time between capture of the first and second BSC dosed (HgCl) shrimp was significantly faster ($p < .05$) than that of controls. There were also significantly more ($p < .05$) BSC dosed (HgCl) shrimp captured after 2 hrs than controls. There were no significant differences for PC shrimp. Similar results were obtained using MeHg. These data suggest that PC shrimp may be physiologically adapted to mercury.

INTRINSIC MUSCULATURE OF THE DIGESTIVE SYSTEM OF THE BRINE SHRIMP: SCANNING ELECTRON MICROSCOPY OF THE INTESTINE. G. E. Tyson and D. S. Lyon*. Electron Microscope Center, Mississippi State Univ.

The alimentary canal of the adult brine shrimp (*Artemia* sp.) consists of (1) a short esophagus or foregut, (2) a long midgut comprised of a pair of globular ceca and a simple, straight intestine, and (3) a short rectum or hindgut (Reeve, 1963; Snyder and Wolfe, 1980). Scanning electron microscopy (SEM) was used to observe the external surface of the tubular intestine (exposed by dissecting away the body wall and adjacent organs) and revealed regularly arranged, discrete bands of circular muscle. Near the junction with the rectum, slender, widely spaced, longitudinal muscle strands were also present external to the circular muscle and were continuous with longitudinal muscle of the rectum. Also studied by SEM were features of the midgut ceca, intestinal epithelial cells, and peritrophic membrane. (Supported in part by Office of Graduate Studies and Research, Mississippi State University)

HORMONAL REGULATION OF REPRODUCTIVE BEHAVIOR DURING MATURATION. C.S. Rawlings and M.A. Ottinger. University of Maryland, College Park.

Experiments were designed to study effects of graded levels of testosterone on behavioral induction in castrates, efficacy of exogenous testosterone in castrates at different ages, time required for response, and effect of time between castration and implantation. In experiment 1, 30 birds, castrated at 3 weeks of age, were given implants of either 10, 20 or 30 mm in length. Behavior was observed for 2-16 days. Results showed no difference between the treatment groups. In experiment 2, 40 birds, castrated at 2 weeks of age, received 20 mm implants at either 3, 4, 5 or 6 weeks of age. Behavior was observed from 2-16 days, post-implantation. No response was observed in the 3 week group, most the 4 week group showed reproductive behavior, while a portion of the 5 and 6 week group showed reproductive behavior. Based on these data, it appears that the mechanism responsible for the elicitation of reproductive behavior may not be available prior to 4 weeks of age and a time lag of 3 weeks following castration may have negative effects on behavioral recovery.

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PLASMA STEROID HORMONES IN THE SEX ROLE REVERSED WILSON'S PHALAROPE. A.J. Fivizzani, M.A. Colwell and L.W. Oring. Univ. of North Dakota, Grand Forks.

The Wilson's phalarope, Phalaropus tricolor, is an excellent example of sex role reversal of avian reproductive behavior in that females compete intensely for males and males provide all parental care. Blood samples were obtained from Wilson's phalaropes during the reproductive season and analyzed for testosterone (T), dihydrotestosterone (DHT), estradiol-17 β (E) and progesterone (P) via RIA. During pairing and egg laying T levels in males were tenfold greater than in females. During incubation male T and DHT levels declined to levels similar to those of females prior to incubation. Levels of E were greater in pairing and laying females than in incubating males and similar to values reported for other avian species. Levels of P were significantly greater in females than in incubating males. These results indicate that the reversal of the typical avian reproductive behavior characteristic of this species is not based upon a reversal of androgen and estrogen levels in males and females but may be based upon differences in neural receptivity to typical hormone values. Supported by NSF Grant PCM 8315758.

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SUBCELLULAR DISTRIBUTION OF AROMATASE IN QUAIL BRAIN. Barney A. Schlinger and Gloria V. Callard. Boston University, Boston, MA.

It is recognized that several actions of testosterone on the central nervous system are mediated by conversion to estrogenic metabolites in target tissue. In the bird, estrogens participate in the organization and activation of singing, aggressive and copulatory behaviors. The purpose of this investigation was to ascertain the subcellular distribution of aromatase on the Coturnix quail hypothalamus-preoptic area. After homogenization in sucrose phosphate buffer (250-50 mM), aromatase was enriched 8-fold in the microsomal subfraction (100,000g pellet) and 2-fold in the 11,000g pellet comprised mainly of synaptosomes (pinched-off nerve terminals). 5 β -reductase was enriched in the cytosolic (100,000g supernatant) subfraction. Although aromatase is considered a microsomal enzyme in non-nervous tissue, the dual subcellular localization of aromatase in the avian brain suggests that elevated concentrations of estrogens may occur at the synapse and may independently influence synaptic function in parallel with classical estrogen action on the genome. (Supported by NSF DCB 82-08248).

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INFLUENCE OF NON-AROMATIZABLE ANDROGENS AND AROMATASE INHIBITION ON SEX DETERMINATION IN CHANNEL CATFISH. K.B. Davis, B.A. Simco, C.A. Coudie and R. Snellgrove*. Memphis State Univ., Memphis, TN and U.S. Fish and Wildlife Srv., SFCL, Marion, AL

Oral administration of 17-alpha ethynyltestosterone (17ET) or 17-beta-estradiol to sexually indifferent channel catfish produced all female progeny. The sex reversal is complete and functional since these fish spawned and produced a 3:1, male:female, sex ratio. This sex ratio is compatible with a normal homogametic female genotype (XX) with YY animals surviving and having a male phenotype. It was proposed that the androgen used was converted to a molecule with estrogenic properties by endogenous aromatase enzymes. We have tested two non-aromatizable androgens, dihydrotestosterone (DHT) and 11-ketotestosterone (11KT), and an aromatase inhibitor, norethindrone (NE), alone and in combination with aromatizable 17ET. The sex ratios as a percent female were: DHT=76; 11KT=61; 17ET, NE and NE plus 17ET all three gave 100% female progeny. It does not appear that endogenous aromatase conversion of exogenous androgens is responsible for feminization, and that NE has a feminizing effect.

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IDENTIFICATION AND CHARACTERIZATION OF AN ANDROGEN RECEPTOR IN THE BRAIN OF GOLDFISH (CARASSIUS AURATUS). M. Pasmanik and G. Callard. Boston University, Boston, MA.

Testosterone (T) is metabolized to estradiol (E) and 5 α -dihydrotestosterone (DHT) in the brain of numerous vertebrates including the goldfish. In order to understand the relationship between locally synthesized hormone and activation of a biological response, we have initiated studies of steroid receptors in goldfish brain. We report here the identification of an androgen receptor (AR) present in both cytosolic and nuclear extracts of brain homogenates. Using Sephadex LH-20 and DNA-cellulose affinity chromatography, this AR can be distinguished from a non-receptor androgen binding component also present in brain cytosol and from a sex hormone binding protein in the serum. It had a high affinity ($K_D=10^{-9}$ M) and limited capacity for androgen, bound T and DHT equally well but did not bind 11-ketotestosterone, estrogens or progesterone. The AR-ligand complex exhibited a very low rate of dissociation ($t_{1/2}=100$ min at 22 C; 6 h at 4 C). It was DNA adhering and eluted between 0.1-0.2 M NaCl. These characteristics resemble those of classical mammalian AR. This is the first report of an AR in fish, suggesting that AR, like ER, are ancient molecules. (NSF PCM 82-08248).

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HORMONAL MEDIATION OF MALE- AND FEMALE-LIKE BEHAVIORS IN AN ALL-FEMALE LIZARD SPECIES. M. Grassman and D. Crews. Univ. of Texas, Austin, TX.

Individuals of all-female lizard species exhibit copulatory-like behaviors that are correlated with the ovarian hormonal cycle. Here we report on the hormonal bases of these behaviors. Parthenogenetic Cnemidophorus uniparens were ovariectomized, and given silastic implants containing either progesterone (P) or estradiol (E); controls received blank implants (B). Ten pairs of the following combinations were observed: P females paired with E females, P females paired with B females, and B females paired with E females. Each pair was observed at regular intervals four hours a day for six days. P and E animals pseudocopulated more frequently than either P and B or B and E pairs ($P < 0.05$). Further, P animals consistently assumed the male-like role while E females were female-like in their behavior ($P < 0.05$). These data suggest that the postovulatory surge in P mediates male-typical behaviors and the preovulatory surge in E mediates female-like receptivity in C. uniparens. Supported in part by NIH NRSA 1F32HD06618-02 to MG, and NSF BNS 8202531 and NIMH NRSA to DC.

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Control of Sexual Behavior in Male Cnemidophorus inornatus. Jonathan Lindzey and David Crews; Institute of Reproductive Biology, University of Texas at Austin.

Individuals of the parthenogenetic species Cnemidophorus uniparens exhibit male-like behavior during the post-ovulatory portion of the ovarian cycle. As part of ongoing studies into the evolution of hormone-brain-behavior relationships, experiments were conducted to determine the hormonal control of sexual behavior in male Cnemidophorus inornatus, one of the direct sexual ancestors of Cnemidophorus uniparens. Castrated males courted significantly less than did intact and control males. Castrates given silastic implants containing dihydrotestosterone (DHT) resumed courtship if the plasma androgen concentrations reach physiological levels. (Average physiological levels of DHT and T range from 9.8 to 17.4 and from 2.4 to 7.5 ng/ml, respectively.) These findings support the hypothesis that Cnemidophorus uniparens has modified the ancestral hormone-brain-behavior mechanism regulating male courtship and copulatory behavior. Supported in part by NSF BNS 8202531 and NIMH RSVA MH00135.

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PROSTAGLANDINS AND MATING BEHAVIOR IN FEMALE GARTER SNAKES. J.M. Whittier and D. Crews, Inst. Reproductive Biol., Univ. of Texas, Austin.

This study suggests that mating-induced declines of sexual attractivity and receptivity in female red-sided garter snakes (Thamnophis sirtalis parietalis) are mediated by prostaglandins. Females injected IP with 5 ug/g BW PGF₂^α became unreceptive (8/9) to males when compared with saline-injected, unmated control females (1/10). Further, these PGF₂^α-treated females were significantly less attractive to males 24 hr after treatment. Lower doses of PGF₂^α (1.0 and 0.5 ug/g BW) also inhibited receptive behavior; the latency to mating of females treated with these doses was threefold longer than controls. No significant changes in plasma levels of progesterone, testosterone, or estradiol were observed 24 hr after treatment with PGF₂^α. In addition, ovarian responses of the PGF₂^α- and saline-treated females were monitored for 6 wks. No alterations in frequency of post-treatment or post-mating ovarian growth were observed at any dose. These data suggest that while PGF₂^α can induce changes in sexual behavior that simulate the effect of mating, ovarian responses after mating are mediated by a separate mechanism.

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STRESS AND GONADAL STEROID SECRETION IN MALE ALLIGATORS. V. A. LANCE, Tulane University School of Medicine, New Orleans.

It is well known that environmental stress causes reproductive failure in domestic farm animals, and that stress-induced or pharmacologically induced increases in plasma corticoids in man and a number of mammalian species result in a rapid decline in plasma testosterone. The effect of the stress of captivity on gonadal steroid secretion in reptiles has however, generally been ignored. In order to test the effect of stress on gonadal hormone secretion in reptiles six mature male alligators were captured during April when plasma testosterone levels are maximum and a blood sample was taken within 5 min of captivity. Additional blood samples were taken at 4 hr intervals for up to 40 hr and plasma testosterone and corticosterone assayed by radioimmunoassay. Testosterone levels declined to 50% of the initial value by 4 hr and dropped to less than 10% of initial by 24 hr. Plasma corticosterone increased during the first 12 hr then declined at 24 hr and rose again at 40 hr. These results demonstrate that stress appears to have a rapid and dramatic effect on plasma testosterone in these reptiles, and that studies on reproductive cycles of non-mammalian vertebrates must take into account the effect of stress.

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HORMONAL REGULATION OF MYOMETRIAL ACTIVITY IN THE TURTLE, CHRYSEMYS PICTA. I.P. Callard and V. Abrams-Motz. Boston University, Boston.

Precise regulation of myometrial activity in vertebrates is important in the timing of egg retention, egg laying and parturition. Earlier studies from this laboratory established that estrogen and progesterone modify the inherent rhythmicity of the oviduct of Chrysemys picta *in vitro* and the current studies sought to examine the effect of progesterone (P), pretreatment on both *in vivo* and *in vitro* oviductal responses to the peptides arginine vasotocin (AVT), and relaxin (RLX). In post-ovulatory turtles, P treatment significantly decreased the number of eggs laid in response to a 10 ng injection of AVT. *In vitro*, myometrial strips from P-treated turtles were ten times less sensitive to AVT than control tissues, and the slowing effect of RLX on myometrial activity was inhibited. These results suggest that progesterone is an important modulator of myometrial responsiveness to AVT/RLX. In this way P determines the duration of egg retention and the timing of oviposition.

Supported by NSF PCM 81-04144

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FLUID MECHANICAL VALVING OF AIR FLOW IN BIRD LUNGS. D.O. Kuethe Duke University, Durham, NC.

Air flows in only one direction through the gas exchange passages in bird lungs, despite the fact that there are no mechanical valves in any of the bronchi.

In order to find out why the flow nevertheless is unidirectional, I took advantage of features of the gas exchanging bronchi which lend them to be calibrated as a flow meter. Using fixed duck lungs, I then experimentally manipulated the pressures of the air sacs. With these techniques, I demonstrated that certain features of the geometry of the large bronchi as well as certain air sac pressure differences are necessary for the natural flow pattern.

Further work with clear plastic models suggests that these necessary conditions are sufficient for the flow pattern under steady flow conditions. I have also found a physical explanation for how these conditions cause the fluid mechanical valving.

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RESPIRATORY AND CARDIAC RESPONSES OF RAINBOW TROUT AND BROWN BULLHEAD CATFISH TO WATERBORNE CYANIDE. P.L. Sawyer and A.G. Heath. Virginia Polytechnic Institute and State Univ., Blacksburg.

Changes in routine oxygen consumption (\dot{V}_{O_2}), heart rate (HR) and ventilatory frequency (V_f) and amplitude (V_{amp}) were recorded in rainbow trout (RT) and brown bullhead catfish (BBC) exposed to a gradually increasing cyanide concentration, selected to produce death in 8-9 hours in each species. Lethal cyanide concentration for BBC was an order of magnitude higher than for RT. RT showed gradually increasing bradycardia throughout the exposure period; BBC showed initial tachycardia followed by gradual bradycardia. Atropine injection suggests that bradycardia was in part due to vagal inhibition in both species. V_f and V_{amp} of RT was elevated throughout 95% of the exposure period and abruptly dropped; BBC showed a rapid increase in V_f with a dramatic increase in V_{amp} followed by a gradual decrease of both. \dot{V}_{O_2} changes paralleled ventilatory changes in both species. These results are similar to those seen during hypoxia in RT but not BBC, possibly due to a stress response produced by stimulation of gustatory and olfactory neurons of the BBC by cyanide.

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THE EFFECT OF FEEDING ON METABOLIC RATE AND SELECTED BLOOD PARAMETERS OF THE CHANNEL CATFISH, ICTALURUS PUNCTATUS. C.R. Brown and J.N. Cameron. Univ. of Texas Marine Science Institute, Port Aransas.

Specific dynamic action (SDA) refers to the increase in metabolic rate following the ingestion of a ration. The physiological changes associated with SDA were investigated using chronically catheterized catfish, fed various ration levels. The rate of oxygen consumption was elevated for approximately 24 hours after feeding, with a peak occurring at 4 hours. Plasma amino acid levels increased following feeding, reaching maximum levels at 4 hours. The essential amino acids showed the greatest degree of increase. Plasma ammonia and glucose levels also increased, while plasma protein levels showed no significant variation. The correlation between metabolic rate and amino acid levels suggests that increased metabolic rate may be due to the process of amino acid incorporation.

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POSTSYNAPTIC POTENTIALS IN CARDIAC MUSCLE OF THE DESERT SCORPION, *PARUROCTONIS MESAENSIS*. Roger D. Farley. University of California, Riverside.

The pacemaker ganglion in the dorsal midline of the scorpion heart elicits graded PSPs in the cardiac muscle. The muscle cells have resting potentials 30-45 mV, and the PSPs vary in amplitude from 10 to 40 mV, with duration as much as 0.2 sec. Simultaneous recordings from the posterior and anterior ends of the heart show that the PSPs at the posterior end usually precede those at the anterior end, causing a similar pattern of contraction with movement of blood anteriorly. The PSPs vary in amplitude and duration as the scorpion modulates heart activity in response to stimuli. The heart is stopped for brief periods or accelerated with the segmental nerves from the subesophageal and first three abdominal ganglia. Small pieces of heart with a length of cardiac ganglion contract rhythmically, suggesting that in the intact ganglion, the pacemaker cells are the neurons with the fastest frequency.

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CIRCULATORY FUNCTION DURING EXPANSION IN THE MOON SNAIL, *POLINICES LEWISII*.

G. B. Bourne, Univ. Calgary, Alberta and Bamfield Marine Station, British Columbia.

Following anesthesia in solutions of Althesin or xylazine (Veliger 26: 327), two sets of pressure catheters and impedance conversion electrodes were implanted into moon snails. The catheters were used to measure pressure simultaneously in the aorta and the aquiferous system while impedance conversion monitored all body movement within the shell and also gross movement of the shell (i.e., locomotion). Once sufficiently recovered, snails were caused to retract wholly or partially into the shell. Results indicate that during some phases of the expansion process, activity of the circulatory system is marked by periods of acardia when the heart stops and misses several beats. At these times, other body muscles are responsible for the pressure in the circulatory system which now functions hydraulically in the expansion process. There are indications that at these times no circulation of hemolymph occurs. Thus in the moon snail the hydraulic and transport functions of the circulation appear to be decoupled at certain phases of the expansion process.

(Supported by N.S.E.R.C., Canada)

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DEVELOPMENT IN LOW OXYGEN: MORPHOLOGICAL AND PHYSIOLOGICAL CONSEQUENCES IN THE BEETLE LARVA *TENEBRIO MOLITOR*. C. Loudon. Duke Univ., Durham, N.C.

Many insects developing in grain, rotting logs, stagnant water and soil may be exposed to gas mixtures significantly different from well-mixed air. In some insects, the ambient gas composition during development affects tracheal morphology. In order to investigate this phenomenon and to measure how tracheal geometry in turn influences relative gas exchange, *Tenebrio molitor* larvae (mealworms) were reared from eggs in constant oxygen concentrations of 21%, 15% or 10.5%. Larvae reared in lower oxygen concentrations had greater mortality, slower development and larger tracheae than larvae reared in higher oxygen concentrations. Oxygen uptake and tracheal water loss were measured for the different groups to evaluate the effect of tracheal diameter on gas movement.

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THE EFFECT OF TEMPERATURE ON HEMOLYMPH pH IN THE AMERICAN LOCUST. J.M. Harrison. Univ. of Colorado, Boulder.

Acid-base balance is poorly understood in insects. This study tested the effect of temperature on hemolymph pH in female *Schistocerca nitens*. Locusts reared with a photothermal gradient of 25-40°C were exposed to test temperatures for 24 h. Hemolymph was sampled quickly (11.6 ± .20 s) without CO₂ loss. Hemolymph pH varied with temperature:

	10°	25°	30°	35°
x	7.119	7.087	7.013	6.919
S.E.	.014	.018	.007	.008
n	10	8	9	10
dPH/dT	<.0021> <.0148> <.0188>			

The dissociation of protein imidazole groups and relative alkalinity were conserved at normally experienced body temperatures (25-35°C), but varied substantially at a colder temperature (10°C). Supported by a Sigma Xi grant and NIH AM31243 to T.T. Gleeson.

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UNUSUAL OXYGEN BINDING PROPERTIES IN THE BLOOD OF THE DEEP SEA HYDROTHERMAL VENT CRAB BYTHOGRAEA THERMYDRON. N.K. Sanders and J.J. Childress. Univ. of California, Santa Barbara.

Oxygen binding properties of hemocyanin were examined for fresh and frozen blood samples from the deep sea hydrothermal vent crab Bythograea therymydron. This brachyuran crab lives in an extremely variable environment and can experience drastic changes in physical and chemical parameters within distances of a few centimeters; previous work (Arp and Childress, 1981) indicated that O₂ binding in the whole blood of Bythograea was temperature independent. In the present study, the effects of temperature and pH on O₂ binding were examined for blood samples dialyzed against a physiological saline buffered with 0.05M Tris Maleate. Experimental temperatures ranged from 2°C-20°C at pH values of 7.4, 7.7, and 8.01. O₂ affinity was greatest at 10°C at all pH's, with higher numerical values of P₅₀ (lower affinity) at temperatures above and below 10°C; pH effected O₂ binding at all experimental temperatures, shown by normal Bohr effects. It appears that Bythograea therymydron, an animal living in a thermally unique environment, has evolved a hemocyanin with unusual oxygen binding properties.

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CO₂ SENSITIVITY OF THE HEMOCYANINS (Hcs) AND HEMERYTHRINS (Hrs). C.P. Mangum and L.E. Burnett. Col. of William & Mary, Williamsburg, Va.

H⁺ and Ca/Mg²⁺ bind to the same site and stabilize different conformations of many Hcs. It has been suggested that Cl⁻ and HCO₃⁻ act similarly. If so, sensitivity to the two should be invariably coupled. However we found all possible combinations. Some Hcs are sensitive only to Cl⁻, some only to CO₂/HCO₃⁻, some to both and some to neither. As suggested earlier, CO₂/HCO₃⁻ sensitivity of Hcs with reversed Ca/Mg²⁺ shifts can be explained in part or in full by the effect of HCO₃⁻/CO₂ on ion activity. Since Ca/Mg²⁺ lower O₂ affinity, ion immobilization raises O₂ affinity and thus the CO₂/HCO₃⁻ effect is greatest at high pH. CO₂/HCO₃⁻ also raise the O₂ affinity of at least one Hc with a normal Ca/Mg²⁺ shift and the effect is pH independent; in this case the effect must be direct.

A variety of monovalent anions influence H₂O₂ binding. Moreover sipunculid coelomic cells have the highest carbonic anhydrase activities of any blood cells outside of the vertebrates. Nonetheless coelomic H₂O₂ binding is not sensitive to CO₂.

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OXYGEN STORAGE BY HEMOGLOBIN. J.M. Colacino, J.R. Brannan* and M.A. Fields*. Clemson Univ., Clemson, SC.

An oxygen store can be characterized as a cell, tissue or compartment which contains oxyhemoglobin and which is surrounded by a diffusion barrier. A model is presented which predicts the rate and manner of oxygen release from such a store when the store is exposed to a zero oxygen environment. The environment is any region surrounding the store including external media and oxygen-consuming tissue. The model is defined by two non-linear, ordinary differential equations which take in to account hemoglobin concentration, store volume, store geometry, diffusion resistance and the rate constants for the reaction between hemoglobin and oxygen. A simple approximate solution to the model equations was obtained with singular perturbation techniques. The solution indicates that biologically realistic storage is predominately diffusion-limited, that storage times ranging from milliseconds to thousands of seconds are feasible, and that long duration oxygen storage can be achieved even at microscopic dimensions.

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ROUTES OF SLOW AND FAST FLEXOR MOTOR NEURONS THROUGH CRAYFISH GANGLIA ARE SEGREGATED. E.M. Leise and B. Mulloney. University of California, Davis.

The two sets of flexor muscles in the crayfish abdomen participate in different behaviors. The fast flexors generate the power-stroke for the tailflip escape response. The slow flexors help maintain bodily posture. To determine which ganglionic structures are important to the control of these activities, we studied a series of cobalt backfills of the flexor nerves and a set of horseradish peroxidase intracellular fills of flexor motor neurons. From serial thick sections we traced the routes of the filled cells through the axonal tracts, commissures and neuropils of the abdominal ganglia. Fast flexor motor neurons bypass the large, ventral horseshoe neuropil (HN) and the lateral neuropils (LN), but branch in the dorsal tracts and commissures. In contrast, the slow flexors branch in the HN and LN, and in more layers of dorsal tracts and commissures than the fast flexors. We conclude that both sets of motor neurons receive command input from axons in the most dorsal tracts, and that the more extensive branching of slow flexor motor neurons is a reflection of their participation in more behavioral activities.

INDUCED CHANGE IN AXONAL SETS IN A NERVE OF *DROSOPHILA*, SHIBIRE. M.R. Hummon and W.J. Costello, COM, Ohio Univ., Athens.

A peripheral nerve, PDMN, innervates targets of the giant fiber pathway (GFP), including jump muscle (TTM) and an indirect flight muscle (DLM). We find that timing of onset of a 6h heat pulse (HP)(30C) during pupal development of the temperature-sensitive mutant *shibire* (*shi*) differentially affects PDMN components. In wild-type or non-HP *shi*, the adult PDMN includes identified (d~2-10µm) neurons of the GFP: motoneurons TTMn and 5 DLMn and interneuron PSI. There are also ~15 medium axons (d~1.0µm) and ~100 small axons (d~0.1-0.3µm), probably sensory. PDMN of adult *shi* flies is unaffected by HP (18-117h onset, 22C, ~12-80h, 25C) with respect to presence of TTMn, 5 DLMn and ~15 medium axons. Yet PSI is absent or severely altered with HP onset at 18-90h; such flies also show altered DLM electrophysiology. The number of small axons is ~200 in flies with 18h HP onset, but is the normal ~400 if HP onset is at 66-117h. Thus there is a critical period during development when the number of small axons in PDMN can be altered by exposure to HP. The *shi* defect may prevent normal cell death or induce extra divisions in formation of these axons. Supported by Musc. Dys. Assoc.

CYTOCHEMICAL OBSERVATIONS ON THE STRIATED MUSCLE OF *LIMULUS*. M. Dewey*, F. Anapol and M. Srivatsan*. SUNY, Stony Brook, NY and Univ. of Illinois, Chicago.

The physiological properties of individual muscle fibers of *Limulus* have not been analyzed. The muscle fibers are unusual; they exhibit A-band and thick filament shortening upon sarcomere shortening below rest length and are triply regulated by Ca²⁺ (myosin heavy chain, light chain kinase and thin filament). Cytochemically the fibers fall into three general classes based on the Ca²⁺ ATPase activity in the absence of Mg²⁺, i.e. dark, intermediate and light staining fibers. Analysis of fiber diameters, cross-sectional areas and fiber cross-sectional shapes by image processing (Tracor 5500 SIA) showed that the fibers were graded and did not fall into discrete morphological classes. However, the staining intensity ranged from large, dark to small, light staining fibers. Acid reversal was apparent. Myosin ATPase activity in the presence of Mg²⁺ was similar but acid reversal did not occur. SDH and NADH stained smallest fibers most intensely while intermediate and larger fibers stained predominately in the periphery. The staining patterns for SDH and DPNH were not completely coincident.

MULTIPLE VARIANTS OF MYOFIBRILLAR PROTEINS IN CRUSTACEAN MUSCLES: EVIDENCE FOR TWO SLOW FIBER TYPES. D. L. Mykles. Biol. Div., Oak Ridge Natl. Lab., TN

Glycerinated muscle fibers from lobster, *Homarus americanus*, and land crab, *Gecarcinus lateralis*, have been analyzed by SDS-PAGE. In lobster, a total of two isoforms of paramyosin (P), three of troponin-T (TNT), five of TNI, three of TNC, three of myosin alpha light chain (αLC) and two of βLC were found in six muscles of the claws and abdomen. In both species only P showed a pattern completely consistent with fiber type: slow fibers contained a variant smaller (105 kD) than the major variant (110 kD) in fast fibers. More than one variant of a myofibrillar protein can be expressed in a single fiber, forming unique assemblages by which subgroups can be discriminated within the broader categories of fast and slow fibers. Two types of slow fibers, which differed in the variants of TNI and TNT, were found in the claw closer muscles of both crab and lobster. The minor (10-15% of muscle mass) type shared TN variants with lobster abdominal superficial fibers, suggesting they have similar contractile properties. (Operated by Martin Marietta Energy Systems, Inc. with the U.S. Department of Energy.)

AVIAN SLOW SKELETAL MUSCLE DIMORPHISM: SLOW TWITCH AND SLOW TONIC TYPES. R. S. Hikida. Ohio University, Athens.

Experimental studies using avian fast and slow skeletal muscles often yield results that may or may not coincide with mammalian fast and slow muscles. Avian slow muscles have been thought to be slow tonic, as in lower vertebrates, while most mammalian slow muscles are slow twitch. By using a technique that allows ultrastructural analysis of histochemically-identified muscle fiber types, we show that slow fibers in the avian mixed muscles have twitch type characteristics, indicated by the Z-line structure and sarcotubular system. A comparison of these slow fibers with the classic slow tonic anterior latissimus dorsi and the fast twitch fibers indicated that these fibers are quantitatively intermediate in their sarcotubular content. The anterior latissimus dorsi consists of fibers with only a slow tonic morphology. Both slow fiber types contain multiple innervation. We conclude that avian muscles contain two slow muscle fiber types, one similar to the lower vertebrates, and the other similar to the mammals.

Supported by Grant AM 26922 from NIH.

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ELECTROMYOGRAPHIC AND HISTOCHEMICAL DIVERSITY WITHIN PIG MASSETER MUSCLE.

F.C. Anapol. Univ. of Illinois, Chicago.

Electromyographic (EMG) activity was recorded from deep and superficial levels of m. masseter during pig mastication. Following the shift from soft (pelleted pig chow) to hard (cracked corn) food, EMG activity in the superficial regions increased a significantly greater amount than in the deeper portions of the muscle. The effect was more consistent on the balancing than on the working side of the jaw. Pig masseter is homogeneously comprised of moderately high oxidative (NADH, SDH) muscle fibers. Approximately two-thirds of these exhibit alkaline-stable/acid-labile ("fast") myosin adenosine triphosphatase activity. However, the percentage of fast fibers decreases from superficial to deep as the percentage of acid-stable/alkaline-labile ("slow") fibers increases. These results suggest that for chewing harder foods, additional motor units are recruited progressively from deep to superficial and that the burden of force may be shifted from slower contracting units to faster units. This pattern of neural organization is well suited for rapid and sustained masticatory behavior required by the diverse omnivorous diet of pigs.

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MORPHOLOGIC CHANGES INDUCED BY EXERCISE IN ZUCKER RAT SKELETAL MUSCLES.

(intro. by J.W. Lynn) L. Gilloteaux, J. Bissler, W. Payne, and N. Paradise. Northeastern Ohio Univ. College of Medicine, Rootstown, OH.

Skeletal muscle fibers from genetically obese (fa/fa) and non-obese (Fa/-) soleus (S) and tibialis anterior (TA) present several of the characteristics of human mitochondrial myopathy of the hypothyroidism type. Following a morphometric analysis, we found that fast glycolytic (FG), fast oxidative glycolytic (FOG) as well as slow oxidative (SO) fibers present a marked hypertrophy in both S and TA of Fa/- rats compared to the same muscles of the fa/fa rats ($p \leq .05$). Heavier muscle mass previously reported for Fa/- can therefore be confirmed by our findings. As a result of a 5 week treadmill exercise program, the Fa/- rats decrease FG fiber diameter ($p < .05$) while the obese rats present fiber hypertrophy. This finding can be explained by denervation which usually precedes fiber atrophy. Following exercise, the original fa/fa weakly stained histochemical pattern for oxidative metabolism is replaced by a stronger checkerboard histochemical pattern. Supported by NEOUCOM Biomedical grant PHS-SO-7R058005-05 from NEOUCOM.

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CIRCADIAN AND SEASONAL VARIATIONS OF PLASMA INSULIN CONCENTRATION IN THE SYRIAN HAMSTER (*Mesocricetus auratus*).

C.J. de Souza* and A.H. Meier. Louisiana State Univ., Baton Rouge, LA.

Insulin concentrations varied considerably during the day and the phases of the rhythms varied with season, daylength and body weights. Cortisol concentrations also varied during the day but the phases remained unchanged. Glucose concentrations varied little during the day and were not synchronized with either hormone. Furthermore, the daily pattern of feeding (greatest during the scotophase) did not account for the insulin rhythms. The results suggest that the circadian rhythms of cortisol and insulin concentrations are regulated by different circadian pacemakers. Changes in the phase relations of these two circadian systems may have a role in the determination of seasonal metabolic conditions.

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HORMONAL CONTROL OF DROSOPHILA VITELLOGENESIS WITH HYBRIDOMA ANTIBODIES AS SPECIFIC PROBES. S-J.

Wu, J. Zhang* and M. Ma. Univ. of Maryland, College Park, MD.

Hybridoma antibodies to *Drosophila* soluble yolk protein (YP) were developed by both in vitro and in vivo immunizations followed by cell fusions for hybridoma production. The binding sites of these antibodies towards different YP components were identified with a combination of gel electrophoresis, electro-transfer blotting and immunohistochemical staining. A sensitive and specific enzyme-linked immunosorbent assay (ELISA) was developed utilizing characterized hybridoma antibodies as specific probes for monitoring *Drosophila* yolk polypeptides. The roles of juvenile hormone and 20-hydroxyecdysone in the control of yolk polypeptide synthesis and uptake will be elucidated by both in vitro organ culture and hormonal replacement therapy.

¹³C-NMR ANALYSIS OF SNAKE SKIN LIPIDS
P.J. Weldon and F.M. Schell*, Texas
A&M Univ., College Station, and Univ.
of Tennessee, Knoxville.

Snake skin lipids contribute to homeostasis by retarding transepidermal water loss, and they act as behavioral releasers in intra- and interspecific interactions. ¹³C-NMR was used to examine methylene chloride extracts of shed skins from snakes in the families Boidae, Colubridae, Elapidae, and Viperidae. Resonances consistent with cholesterol, sterol esters, triglycerides, and other lipids are observed. Interspecific variation exists in the degree of unsaturation of long chain hydrocarbon groups and in the presence of certain lipid classes.

A NEW LOOK AT ENZYME TEMPERATURE COMPENSATION. D.A. Powers. Johns Hopkins Univ., Baltimore, MD.

Thermal compensation of several enzymes were studied. Values were determined for the energy of activation to the transition state, the energy of bond-making and breaking, and the energy of substrate and cofactor binding. Values for their associated enthalpy and entropy parameters were also determined. Comparisons were made for: (1) homologous enzymes between species, (2) multilocus isozymes within an individual, and (3) allelic isozymes between individuals of the same species. These results reveal three general strategies of thermal compensation at the molecular level. Examples of each strategy have been studied. Experimental and calculation methods for determining these energy relationships, as well as the associated statistical problems have been explored. Our findings will be discussed in the context of the technical, conceptual, and paradoxical problems associated with the literature.

THERMAL ACCLIMATION OR DIFFERENTIAL REGULATION? D. L. Crawford*, A. Place*, R. Cashon*, D.A. Powers. Johns Hopkins Univ., Baltimore MD.

Specific activity of LDH & MDH from unacclimated fish, *Fundulus heteroclitus*, from Maine and Georgia were significantly different. Activities were approximately twice as great for Maine fish than those from Georgia. Purified enzymes from both populations indicate that the catalytic rate constants (k_{cat}) are identical. Since, specific activity is dependent on enzyme concentration and k_{cat} , it follows that Maine fish must have a higher enzyme concentration. To test whether this could be explained by thermal acclimation, *Fundulus* from a central location, Chesapeake Bay, were acclimated to 5, 10, 22, and 30C. After 30 days of acclimation, specific activities were not significantly different between thermal regimes. These results suggest that the intrinsic mechanism of regulation is different between the two populations.

SEXUAL AND TEMPORAL DIFFERENCES IN THE MIXED FUNCTION OXIDASE ENZYME SYSTEM IN *FUNDULUS HETEROCLITUS*. D.C. Sauer. Univ. of South Carolina, Columbia.

Experiments were designed to test for seasonal variability in the mixed function oxidase enzyme system and its relationship to changes in reproductive condition. Fish were sacrificed at the calendar full moon of each lunar cycle from March, 1984 through April, 1985. Hepatic microsomal tissue was assayed for aryl hydrocarbon hydroxylase and NADPH cytochrome-c reductase activities, and specific contents of cytochromes P-450 and b₅. Gonad somatic indices were also determined. Significant seasonal fluctuations were observed for all parameters measured. Low specific activities and contents were observed in the spring and summer followed by an increase coinciding with autumn gonad regression. High values were observed in the autumn and winter followed by a decrease coinciding with the onset of reproductive activity in the spring.

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ASPECTS OF THE ECOPHYSIOLOGY OF TERRESTRIALITY IN ALICUS KIRKI, THE ROCKSKIPPER BLENNY OF THE RED SEA. M.S. Gordon, H.G. Chin* and K.L. Martin. Univ. of California, Los Angeles.

A. kirki is a highly terrestrial amphibious fish. Common in the upper parts of many rocky intertidal areas around the Red Sea, it tolerates extremely hot, dry summer climate conditions. Field (Sinai, Egypt) and lab (Los Angeles) observations show that it is diurnal and spends over 80% of its time out of water. It grazes for long periods on tough algal mats exposed to full sun and wind. It uses behavioral microhabitat selection to moderate thermal and evaporative stresses. In the field most feeding occurs close to the water's edge, with fish frequently moistened by wavelets. Feeding areas shift tidally. Field body temperatures in winter are close to simultaneous water temperatures. During low tide intervals in hot weather they often hide in damp rock crevices and empty barnacle shells. Aerobic metabolic rates in and out of water are similar.

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FISH PREDATION ON GASTROPODS ON THE PACIFIC COAST OF COSTA RICA. S. Ortega. Univ. of South Carolina, Columbia.

The intensity of fish predation was measured by comparing loss of gastropod shells at four shores in the intertidal zone on the Pacific Coast of Costa Rica. Fish had little effect on shell disappearance of gastropods although some shell crushing occurred. Fish predation intensity in Costa Rica was variable in space and time and was lower than in Panama. Loss rate of gastropods in Costa Rica was as low as that documented for temperate regions, suggesting that variation among latitudes (temperate vs tropical) was no higher than variation at similar latitudes (Panama vs Costa Rica). Local variation within each region should be considered when temperate-tropical comparisons are made.

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VERTICAL DISTRIBUTION OF THE NEOGASTROPOD ILYANASSA OBSOLETA AFFECTED BY A LARVAL TREMATODE. L.A. Curtis. University of Delaware, Newark, DE 19716.

Larval trematodes in Ilyanassa obsoleta collected from different vertical positions along the shores of two Delaware estuaries were determined by dissection. Comparisons of samples show that beachface snails were often (70%+) infected with Gynaecotyla adunca whereas few (10%-) from below the beachface were so infected. Since uninfected snails did not distribute this way results indicate that the snail's behavior is altered by the parasite. This suggested a snail removal experiment to see how long it took to generate the observed pattern. The experiment was run on a Cape Henlopen sandbar inhabited mostly (80%+) by G. adunca-infected snails. Snails were removed from a 3X5m plot near the sandbar top on each of a series of low tides in July 1984. Among snails that repopulated the plot between tides 271 were examined and 86% had G. adunca. Thus the observed pattern is generated and maintained on a tidal basis. The next parasite host is the beach-hopper (Talorchestia longicornis), which occurs mainly high on beaches. An attractive hypothesis to explain results is that snail distribution is parasite-altered to facilitate cerariae finding the next host.

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EVIDENCE THAT FEMALE CONTACT PHEROMONES INFLUENCE THE MALES' REPRODUCTIVE BEHAVIORS IN THE AMPHIPOD CRUSTACEAN GAMMARUS PALUSTRIS. B. Borowsky and R. Borowsky, Osborn Laboratories of Marine Sciences, Boardwalk at West 8th Street, Brooklyn, New York 11224 & New York University, Washington Square, New York 10003

The reproductive behavior of males of this species may be divided into three sequential stages: 1) males travel to receptive females; 2) males pick up females and begin to carry them about (precopulation). Precopulation continues for a few days until the female molts, when 3) copulation occurs. The first stage is influenced by water-borne secretions from receptive females. In contrast, the second and third stages are apparently unaffected by this attractant. Instead, the evidence suggests that contact pheromones on the females' exoskeleton are the principal stimuli of precopulation and copulation. In addition, the males' performance of these behaviors is aided by the females' behaviors; receptive females orient their bodies in one way to facilitate the males' initiation of precopulation, and newly molted females orient their bodies in another way to facilitate copulation. The existence of several distinct stimuli for each of the males' behaviors may be an adaptation for the severe time constraints imposed by the females' reproductive physiology.

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ROLE OF PROTEIN AND FREE AMINO ACID POOLS IN THE SHORT-TERM SALINITY ACCLIMATION RESPONSE OF *CALLINECTES SAPIDUS*. S. Sanzone. Univ. of South Carolina, Columbia.

Levels of muscle fiber protein and hydration, and hemolymph protein, free amino acids (FAA) and ammonia were followed over a 72 hr exposure to reduced salinity. Adult male blue crabs acclimated to 30 ppt were transferred directly to 10 ppt. At 6, 12, 24 and 72 hr, comparisons were made between treatment and control groups for all parameters measured. Exposure to reduced salinity resulted in a rapid decrease in hemolymph osmolality by 6 hr. Cell protein content was significantly increased in the low salinity group by 12 hr. The treatment resulted in elevated levels of ammonia and major FAA in the hemolymph. Hemolymph protein was reduced in the low salinity group at 12 hr. In agreement with previous studies, these results suggest that FAA lost from the tissues during hypo-osmotic stress may be accounted for by catabolism and loss to the extracellular fluid. However, incorporation of FAA into cell protein is also implicated as a storage mechanism. Data do not suggest storage of cell FAA as hemolymph protein during the short-term salinity acclimation response.

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CALCIFICATION IN THE CRAB *CARCINUS* AS REDOX CELL ACTIVITY. F. S. B. Digby. McGill University, Montreal, Canada.

Earlier demonstration of electrical conduction in cuticle suggested that calcification in crustaceans might involve or arise from an electrode process, driven by small potentials generated across the cuticle. But normally *Carcinus* cuticle is 1.0 pH unit alkaline to its blood; if this difference is produced, Ca salts deposit. For this pH difference, potentials as measured through KCl bridges are clearly inadequate. Crab blood and cuticle are however reducing and platinum electrode potential differences between blood and seawater are equivalent to the difference in pH. Furthermore it can readily be shown that oxidation of reduced cuticle by air or oxygen produces base. It is suggested therefore that the calcifying regions correspond to the cathodic side of a redox cell, the electronic conducting part of the circuit being the quinonoid complexes with associated terminal oxidase activity. It is suggested that calcification arose following the development of quinone-tanned complexes for strength and protection; copper in the blood led to the formation of enzymes with terminal oxidase activity, producing alkalinity and calcification at the outer surface. (Canadian N.S.E.R.C. grants A4687, E1831)

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ADAPTATIONAL DIVERGENCE IN VOLUME REGULATION IN TRANS-ISTHMIAN *PACHYGRAPSUS TRANSVERSUS*. Joan D. Ferraris and Joanna E. Roth*. Mt. Desert Island Biological Laboratory, Salsbury Cove, ME. and Univ. of Alaska, Fairbanks.

Panamanian cognate species of marine decapod crabs have been geographically isolated from each other since the emergence of the Isthmus separated the Pacific and Atlantic Oceans. Due to upwelling, which occurs only on the Pacific coast, Pacific crabs normally experience lower and more variable temperatures than do Atlantic crabs. Correspondingly, during exposure to low temperature cycles [28 C (control) + 21 C (24 h) + 28 C (24 h) + repeat] at constant salinity, Pacific crabs maintained a stable total claw water Na, K, and Cl content (g H₂O or µM/g solute free ash free dry wt) while Atlantic crabs did not. Atlantic crabs increased (P < 0.05) in water, Na, and Cl content with each exposure to low temperature. In contrast, during exposure to high temperature cycles (control = 28 C; high = 35 C) Pacific crabs were unable to maintain stable water and ion content while Atlantic crabs did. These results may indicate that adaptation to low temperature cycles in Pacific crabs has reduced their ability to regulate volume in high temperatures. Supported by the Whitehall Foundation.

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COMPARATIVE MORPHOLOGY, CLASSIFICATION, AND PHYLOGENY OF THE DECAPODA. L. G. Abele and B. E. Felgenhauer. Florida State Univ., Tallahassee.

There is considerable disagreement over the internal classification of the Decapoda. Current suggestions include subdividing the group into two (Dendrobranchiata, Pleocyemata), three (Dendrobranchiata, Caridea, Reptantia), or four (Dendrobranchiata, Caridea, Stenopodidea, Reptantia) suborders. Each of the above classifications has been based on relatively few characters. These three hypotheses and some additional ones are examined through an analysis of approximately 60 characters, including some not previously considered. The analyses suggest several different classifications and phylogenies. The differences depend, in part, on the interpretation of branchial and foregut morphology.

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SIGNIFICANCE OF SPERM TRANSFER COMPLEXITY IN DECAPOD CRUSTACEANS. R.T. Bauer, Univ. of Puerto Rico, Rio Piedras

Anterior pleopods of many male decapods are modified for transferring a spermatophore onto the female's ventral surface or into a seminal receptacle. Little modification is observed in carideans, palinurids, stenopodids, and anomurans. Complex male gonopods and female spermathecae occur in dendrobranchiate shrimps, most astacidean crayfish and lobsters, and brachyurans. Relationships among female molting, mating, postmating interval, oviposition, and embryo incubation are quite variable and not easily related to sperm transfer complexity. There appears to be a phylogenetic pattern to sperm transfer and storage if the dendrobranchiate-pleocyemate view of decapod evolution is accepted. A gradient of increasing complexity of insemination method can be constructed with the Infraorders Caridea, Astacidea, and Brachyura. Within the Brachyura, the primitive Dromiacea and Archaeobrachyura have spermathecae separate from oviducts while the two structures are intimately linked in advanced Brachyura (definite internal fertilization, no loss of sperm at molting). All dendrobranchiates have specialized transfer but inefficient storage.

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THE NATURE OF THE CRETACEOUS DECAPOD RECORD OF NORTH AMERICA. G. A. Bishop*, Georgia Southern College, Statesboro.

The fossil record of the decapod crustaceans is sparse and fragmentary. Cretaceous North American fossil decapods comprise 90 taxa. One-third of the taxa are represented by one specimen, two-thirds by fewer than 8 specimens, and only 5 by more than 100 specimens. Differential fossilization selectively preserves some taxa and parts of some taxa (eg. carapaces and claws). Taphonomic analysis often allows differentiation of remains into detritus, exuviae, or corpses. Remains are commonly preserved in concretions composed of the minerals calcite, hematite, or apatite. Patterns of distribution, faunal similarity, and similarity of preservation suggest many of these fossil decapod assemblages are preserved community fractions. Although sparse and fragmentary this record is the primary data source for the interpretation of the evolution of the evolution of the decapod crustaceans.

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SYSTEMATICS AND ECOLOGY OF THE SNAPPING SHRIMP SYNALPHEUS SCAPHOCERIS COUETIERE, 1910 (DECAPODA: ALPHEIDAE). M. R. Dardeau. Dauphin Island Sea Lab, Alabama.

Many subspecies of Synalpheus described at the turn of the century have since proved to be based on specimens representing extremes of a wide range of variation in the nominate subspecies. Synalpheus scaphoceris, originally described as a subspecies of S. townsendi, is an exception. Synalpheus scaphoceris can be distinguished from the morphologically similar S. townsendi by a distinctive spotted color pattern, the strongly produced ventral rostral process, the blunt dorsodistal process of major pereopod 1, and the absence of appendices internae on the pleopods of the male. Male-female pairs of S. scaphoceris were associated only with large individuals of Madracis decactis (Lyman, 1857), a scleratinian coral, in samples from the Florida Middle Ground. Oviparous females were present in fall and summer but not winter samples. Juveniles were present in fall and winter but not summer samples. Synalpheus scaphoceris occurred less frequently, in fewer numbers and at much lower densities than did Synalpheus townsendi in samples of the host coral.

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TWO NEW COMMENSAL ALPHEID SHRIMPS FROM SOUTH FLORIDA. D.L. Felder and R.B. Manning. Univ. Southwestern Louisiana, Lafayette, and Smithsonian Institution, Washington.

A survey of infaunal decapods using a yabby pump to sample shallow water habitats in the Indian River near Fort Pierce, Florida, has yielded material of Leptalpheus forceps Williams and two undescribed alpheid shrimps that also carry their chelae flexed against their merus. These shrimps are commensals, living in burrows of stomatopods, decapods, and other macroinvertebrates.

A PRELIMINARY ANALYSIS OF THE INTER-GENERIC RELATIONSHIPS OF STENOPODIDEAN SHRIMPS. J. W. Goy. Texas A&M Univ., College Station.

Phylogenetic relationships are presented for the nine genera of stenopodidean shrimps based on examination of a variety of morphometric, meristic, and two-state characters. Some of these characters, such as branchial formulae, are of high reliability in the cladistic analysis. The genus Stenopus seems to be ancestral with two genera (Microprosthema and Odontozona) diverging in the same ecological zone, live tropical coral reefs above 50m. The remaining six genera are deep water forms, five of which are known commensals of Hexactinellid sponges living below 165m. Extreme variability of certain characters in all genera and possible convergence of characters for commensal genera makes interpretation of intergeneric relationships difficult. This analysis is offered as the first step in a better understanding of the phylogeny of the Stenopodidea. Further examination of genera presently represented by only a few specimens and incorporation of more characters in the analysis, will lead to improvements on this preliminary analysis of the infraorder.

TWO NEW CARIDEAN SHRIMPS FROM MARINE CAVES OF WESTERN ATLANTIC ISLANDS. C.W. Hart, Jr. and Raymond B. Manning. National Museum of Natural History, Smithsonian Institution, Washington, D.C.

A shrimp belonging to a new family has been found in submerged caves in the Bahamas and the Turks and Caicos islands, and a third species of the genus Procaris (Procarididae) has been found in a cave on Bermuda. The new family may have affinities with shrimps recently found in the Galapagos Rift the new Procaris is closely related to those species previously described from Ascension and Hawaii.

A NEW GENUS AND SPECIES OF PROCARIDID SHRIMP FROM HAWAII. B. Kensley and D. Williams† Smithsonian Institution, Washington, D.C., and Freeport, Bahamas.

A new genus and species of procaridid shrimp is described from a pool on Hawaii Island. The new genus is characterized by the possession of appendices internae on the posterior three pairs of pleopods, by relatively elongate dactyls on all five pairs of pereopods, and by two arthrobranches on the third maxilliped and first three pairs of pereopods, and a single arthrobranch on the fourth pereopod. It is suggested that the new genus is more primitive than Procaris, the only other genus in the family. The diagnoses of the superfamily Procaridoidea and the family Procarididae are revised. The features of the new genus suggest that the procaridids may be more closely related to the Caridea than was originally thought. Some of the organisms co-occurring with the new shrimp including Procaris hawaiiensis and Halocaridina sp. are discussed in relation to food webs.

A SHELF ASSEMBLAGE OF XANTHOID CRABS IN THE NORTHERN GULF OF MEXICO. D.L. Felder and N.N. Rabalais. Univ. of Southwestern Louisiana, Lafayette, and Louisiana Univ. Marine Consortium, Chauvin.

During the last ten years, studies of benthos on the broad continental shelf of the northern Gulf of Mexico have added appreciably to specimen holdings of decapod crustaceans. This wealth of material has permitted detailed systematic studies of several poorly known reptant groups, including a rich and relatively unknown assemblage of largely infaunal xanthoid crabs. Part of this assemblage was originally described on the basis of very limited specimen materials, and little was known of depth ranges and substrate preferences that are clarified by our studies. The known outer continental shelf xanthoid assemblage does not necessarily demonstrate a strong tendency for endemism, such as is evident in coastal brachyuran assemblages of the northern and western Gulf. However, the prevalence of previously unreported or undescribed species among shelf xanthoid materials suggests that this group is overall too poorly known in the western Atlantic to, at present, lend to zoogeographic syntheses. Descriptions and redescriptions based upon studies of present Gulf materials and re-examination of type specimens are essential to future zoogeographic comparisons.

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PHYLOGENETIC RELATIONSHIPS OF THE GENUS *AEGLA* (DECAPODA, ANOMURA, AEGLIDAE). J. W. Martin. Florida State Univ., Tallahassee.

Freshwater anomuran crabs of the genus *Aegla* are endemic to temperate South America. Traditional classifications of the Decapoda group aeglids with galatheids, porcellanids, and chirostylids in the superfamily Galatheoidea. However, several characters of the carapace and pereopods would seem to ally aeglids with the hermit crab families. These characters are described using light and electron microscopy. For 11 decapod families that are now or were previously placed in the Anomura I examined 43 characters. A preliminary phenetic analysis does not closely group aeglids and galatheids, but does indicate a closer relationship between *Aegla* and the superfamily Galatheoidea than between *Aegla* and the hermit crabs. Phenetic and phylogenetic analyses of the Anomura are compared.

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THE EFFECTS OF FEEDING AND STARVATION ON THE LEVEL AND CONTENT OF NUCLEIC ACIDS IN THE GUT TISSUES OF *LYTECHINUS VARIEGATUS* (LAMARCK) (ECHINODERMATA: ECHINODEA). T.S. Klinger, S.A. Watts, and D. Forcucci*. Bloomsburg Univ., Penn., and Univ. of South Florida, Tampa.

Maximum gut indices of individuals fed *ad libitum* over a four-week period were 2.7 fold higher than those of individuals starved over the same period. The concentration of DNA in the gut tissue was 1.3 fold lower and total DNA was 2.3 fold higher in fed individuals than in starved individuals. The concentration of RNA in the gut tissue was the same in fed and starved individuals. RNA:DNA ratios were 2.2 and 1.5 in fed and starved individuals, respectively. Changes in the size of the gut during feeding or starvation are the result of changes in both cell size and number. Maximum changes in the synthetic capacity of the gut tissue (RNA:DNA) occurred within 1 week. Maximum changes in the size of the gut occurred within 3 weeks.

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ALLOCATION OF NUTRIENT RESOURCES IN THE REGENERATING ASTEROID *LUIDIA CLATHRATA*.

J.M. Lawrence, T.S. Klinger, J.B. McClintock, S.A. Watts, C.-P. Chen, A. Marsh, L. Smith. Dept. of Biology, Univ. South Florida, Tampa 33620.

Intact individuals and individuals with two adjacent arms amputated were fed or starved for 3 months during the gametogenic period. The radius of the arms did not change in any of the groups. The radius and amount (g dry weight) of regenerating arms of fed individuals were twice as great as those of starved individuals. The amount of body wall, pyloric caeca, and gonad in an arm increased in fed individuals and decreased in starved ones independently of regeneration. The amount of pyloric caeca in an arm increased more in fed, regenerating individuals than in fed, intact individuals; the total amount of increase in the pyloric caeca was equivalent in the two groups. Absorbed nutrients are allocated primarily to growth of the intact arms and the pyloric caeca and gonads which they contain, and secondarily to regeneration. This increase in functional capacity in terms of nutrient storage (pyloric caeca) and reproduction (gonads) is greater than if the absorbed nutrients were allocated primarily to regeneration.

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EVIDENCE OF THE NUTRITIONAL ROLE OF DISSOLVED ORGANIC MATERIAL DURING REGENERATION BY AN AMPHIURID BRITTLESTAR. L.A.J. Clements, Univ. of South Carolina, Columbia, S.C.

Disc loss by amphiuroid brittlestars precludes feeding on particles. The only nutrients available for regeneration are dissolved organic material (DOM) or material already stored in tissues. To test the hypothesis that DOM (amino acids) has an effect on the rate of disc regeneration by the brittlestar *Micropholis gracillima*, ten animals were incubated for 14 days in seawater media with various levels of amino acids added. Animals in all treatments regenerated disc tissue. Those in artificial seawater with no DOM added showed the slowest rate of regeneration. Animals in low DOM media (2.5 $\mu\text{mol/liter}$) and those in natural seawater had similar rates of regeneration; those in high DOM media (25 $\mu\text{mol/liter}$) showed accelerated regeneration. Increasing the concentration of DOM in seawater increased the rate of regeneration. This is the first experimental demonstration that dissolved amino acids can be used as a food source during regeneration.

RELATIONSHIP BETWEEN EGG VOLUME AND ENERGY CONTENT WITHIN A SINGLE SPAWN OF THE STARFISH PTERASTER TESSELATUS. Larry R. McEdward and Louise K. Coulter*, Department of Zoology, University of Alberta, Edmonton.

Pteraster tesselatus produces large (1.22 mm diameter), buoyant, orange eggs that develop into pelagic lecithotrophic larvae. A sample of 44 eggs from a natural spawning had a mean volume of 0.95 mm^3 (SE = 0.01; range = 0.83-1.08). The mean energy content of individual eggs was 351 joules (SE = 0.04; range = 2.52-3.98). Energetic density ranged from 2.52 to 4.50 joules mm^{-3} (mean = 3.70; SE = 0.05). Although there is considerable variation in egg volume and energy content (ranges vary from 27-53% of mean value), energy content is not significantly correlated with egg volume ($r = 0.25$; $p > 0.05$). Energetic density was inversely correlated with volume ($r = -0.39$; $p < 0.05$). It is not known whether the variations in egg size and energy content are evolved, adaptive responses to variation in the larval environment or are a necessary result of imprecision inherent in oogenesis. Variation in egg volume might result from differences in hydration. The lack of correlation means that egg dimensions are poor predictors of differences in energy content among eggs within a spawn. Therefore it will be difficult to examine the consequences of differences in parental investment of materials and energy among sibling offspring.

UPTAKE AND METABOLISM OF ^{14}C -GLYCINE BY LARVAE OF CREPIDULA FORNICATA (MOLLUSCA: GASTROPODA) A. Lord, Tufts Univ. Medford Mass.

Larvae of the marine gastropod Crepidula fornicata take up ^{14}C -glycine from concentrations of 0.17-10.2 μM . Uptake is linear from 2 to 100 minutes. The transport constant, K_t and maximum rate of uptake, J_{max} are 7.7 μM and 22 ng/larva/hr for larvae fed normally before experiments and 6.38 μM and 17 ng/larva/hr for larvae starved 48 before experiments. Both fed and starved larvae metabolize ^{14}C -glycine, catabolizing it to $^{14}\text{CO}_2$ or incorporating it into protein within 10 minutes after exposure begins. All experiments were done in .22 μm filtered, autoclaved seawater. Although fed and starved larvae take up ^{14}C -glycine at similar rates (2149 pg/larva/100 min vs. 2062 pg/larva/100 min) from 1.02 μM concentrations, starved larvae respire significantly more glycine as $^{14}\text{CO}_2$ and incorporate significantly less into protein (one way analysis of variance $p < 0.05$). These experiments indicate that fed and starved larvae may use dissolved glycine in different ways, with starved larvae catabolizing glycine for immediate energy needs, and fed larvae storing it in protein.

THE INFLUENCE OF ELEVATED KCl ON METAMORPHOSIS OF LARVAL CREPIDULA FORNICATA (MOLLUSCA: GASTROPODA). J.A. Pechenik and W. Heyman*. Tufts Univ., Medford, MA.

Measuring the length of time that metamorphosis can be delayed by marine invertebrate larvae deprived of suitable adult habitat requires that the time at which larvae become competent to metamorphose be determined. We have studied the potential use of KCl, NaCl, CaCl_2 , and GABA for testing competence in larvae of the marine gastropod Crepidula fornicata. GABA (10^{-7} - 10^{-6}M) and CaCl_2 (20 mM additions) did not elicit metamorphosis, but 100% metamorphosis was typically obtained within 8 h by increasing the KCl concentration of seawater by 20 mM. The effect was not due to increased osmotic concentration of the medium; a much lower response was obtained by elevating NaCl levels by 20 mM. Larvae first became responsive to the added KCl at shell lengths of about 800 μm , approximately the size at which larvae of this species can first be induced naturally. Juvenile growth following natural induction of metamorphosis is not significantly different ($P > 0.10$), for at least the first 5 days, from that following induction by elevated KCl. (NSF OCE-8500857)

THE EFFECTS OF CADMIUM EXPOSURES ON GROWTH OF LARVAE OF AN HAWAIIAN BIVALVE, ISOGNOMON CALIFORNICUM. Amy Huffman Ringwood. Univ. of Hawaii, Honolulu.

Three-day-old bivalve larvae were exposed to a series of Cd concentrations (from 2 to 50 ppb) for 14 days. The cultures were then subdivided and some larvae were exposed to Cd for an additional 14 days while others were ongrown in clean seawater. The effects of Cd on growth (shell dimensions, and shell and tissue weight) were determined. Although size is commonly used to evaluate the effects of toxic substances on growth, weight was found to be a more sensitive indicator. Both shell and tissue weight were affected. Growth was reduced during the first 7 days of exposure at all Cd concentrations, but partial recovery was observed during the second week, suggesting that larvae possess Cd-sequestering or detoxifying mechanisms with an activation lag phase of at least 7 days. With continued exposure, recovery was sustained in the low Cd concentrations, while at high concentrations inhibition of growth prevailed. At the highest concentration, morphological abnormalities of the velum occurred. During the ongrown period, recovery was observed in the lowest concentrations only.

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ONTOGENETIC LOSS OF ARENOPHILIC MANTLE GLANDS IN ENTODESMID BIVALVES. R.S. Prezant, Univ. of Southern Mississippi, Hattiesburg.

Juvenile members of the marine, crevice dwelling bivalves Entodesma saxicola and E. cuneata, possess numerous small multicellular glands along their mantle edge that secrete an adhesive mucin through and over their periostracum. This mucin serves to attach foreign particles to the outside of the thin juvenile shell. The outer extraneous cover helps protect and stabilize the juveniles in their then oversized crevice homes. With growth the bivalves gain stronger byssal attachments, become tightly wedged in crevices, and develop thicker, stronger shells. With the gradual attainment of the latter attributes the bivalves show a concomitant loss in the number of arenophilic mantle glands as the role of the adhesive mucin is replaced by adult features.

696

EARLY REGENERATIVE EVENTS IN THE COELOMIC LINING OF THE STARFISH TUBEFoot. M. J. Cavey and R. L. M. Marsden*. Univ. of Calgary, Alberta, Canada.

The coelomic lining in the tubefoot of Pisaster ochraceus is a complex myoepithelium consisting of adluminal cells and retractor cells. The early regenerative responses of the myoepithelial cells have been studied by light and electron microscopy in the stumps of amputated tubefoots. Organizational differences quickly develop between adluminal cells in the terminal and subterminal sectors of the stump. Terminal cells lose anchorages to the myoepithelial basal lamina and form a flattened layer over the severed ends of the underlying retractor cells. Subterminal cells, retaining connections to the basal lamina, appear in a conspicuously folded layer that is indented by the adjacent retractor cells. The removal of damaged retractor cells is a principal activity during the first 24 hours of regeneration. Fragments of retractor cells are basally engulfed by the adluminal cells and transported in vacuoles to the apical cytoplasm, where they are released, either unaltered or as lysosomal residual bodies, into the water vascular canal. Transcellular clearance of the damaged retractor cells preserves the junctional complexes between the adluminal cells.

697

SWIMMING OF CILIATED MARINE INVERTEBRATE LARVAE: RELATIONSHIP BETWEEN SPEED AND MORPHOLOGY. H. Lee. Wellesley College, MA.

For ciliated organisms, a consideration of the propulsive and drag forces involved in swimming gives rise to a model that relates speed with several morphological parameters. The present study investigates this relationship among 64 developmental stages of 30 species of marine invertebrate larvae. Results include: a) speed and body size were not correlated; b) speed increased significantly with the length of larval cilia; and c) larvae with transverse ciliary bands generally swam faster, while larvae with convoluted bands swam uniformly slowly.

698

DOES MORPHOLOGY PREDICT ECOLOGY? HYPOTHESIS TESTING WITHIN A FRESH WATER FISH COMMUNITY. Michael E. Douglas and William J. Matthews. Oklahoma State University and University of Oklahoma.

Can morphometric data serve as an index of niche width or community structure? Only if phenotypic measurements are significantly related to habitat, for this is how species segregate in both terrestrial and aquatic communities. To test this ecomorphological hypothesis, we generated pair-wise taxonomic distances between 17 freshwater fish species (in 8 genera and 4 families) using the following data: (1) various transformations of 41 phenetic measures; (2) the % occurrence of 23 food items in gut analyses; and (3) 25 microhabitat measures. Matrix comparisons were performed using the Mantel Test. When comparisons were made within a family of fishes, morphology and microhabitat were found to be significantly related. However, the niche/phenotype relationship breaks down when analyses are performed over several different families (the usual situation for community assays).

699

SYMMETRIC RESPIRATORY CURRENTS OF FLATFISHES. K.F. Liem, S. Kehl and E. Brainerd. Harvard Univ., Cambridge, MA and Friday Harbor Laboratories, WA.

Previous studies hypothesized that flatfishes (Pleuronectidae) breathe asymmetrically by exhaling from the eyed-side only. Our experiments show that various pleuronectid species generate symmetrical pressures in both opercular cavities, resulting in symmetrical exhalent currents as elucidated by cineradiography and the movements of dyes.

Symmetrical respiratory currents are made possible by the presence of an interconnecting channel between the two opercular cavities. The interconnecting channel, which is formed by a notch in the urohyal, plays a key role in equalizing the pressures of the two opercular cavities thereby ensuring the maintenance of symmetrical respiratory currents under varying environmental conditions. Experimental blockage of the channel results in unequal pressures and asymmetrical currents. Electromyographic data also show symmetrical activity in the major respiratory muscles. (Supported by NSF DCB 85-00585 to K.F. Liem).

700

COLORIMETRIC ANALYSIS OF THE PHARYNGEAL MUSCLES OF THE PARROTFISH, GENUS SCARUS. K. W. Gobalet. Loyola University, New Orleans, Louisiana.

Muscle color has been used to interpret the function of the muscles of the pharyngeal mill of parrotfish. The six pairs of muscles (L.EXT. 4, L. POST., R. DORS., OBL.D., AD. 5, TR.V.) that adduct or produce shear between the pharyngeals are red indicating endurance related activity for grinding algae and abrasive material. This color contrasts with the muscles of fishes that don't triturate their food. Six muscles used in respiration (STH., A 3, A.A.P., A.O., G.H., L.A.P.) show remarkable constancy in their color patterns. In over 20 species examined, there are distinctive white and pink to red regions. The pink to red regions are interpreted to correspond to aerobically active regions used during normal respiration. The white regions are probably recruited during feeding, forced respiration and the "cough."

701

EFFECTS OF FASTING ON THE FISH INTESTINE AND ITS DIVERTICULAE. A. Hossain and H. M. Dutta, Biological Sciences, Kent State University, Kent, OH

Light and electron microscopes were used to investigate the effect of fasting on the fish intestine and diverticulae. In a laboratory designed experiment, bluegills were forced-fasted for 100 days. A comparison was made with well nourished bluegills. Health reports were prepared. Gross and microscopic anatomy were evaluated both qualitatively and quantitatively by applying histological as well as histochemical techniques. Behaviour of goblet cells in both intestine and diverticulae were recorded by both light and electron microscopic study. The effect of fasting was more prominent in intestine than its diverticulae. Mucosal surface area was reduced upto 45% in intestine while the reduction did not exceed even 25% in caeca. Electron microscopic search revealed several changes among which the destruction of microvilli and macrophagic infiltration in the intestinal enterocytes were very common. Unlike mammals fish appear to be very tolerant to fasting.

702

VARIATION IN SECONDARY SEXUAL CHARACTERS IN Leptodactylus pentadactylus (ANURA: LEPTODACTYLIDAE). A.P. Jaslow. Rhodes College, Memphis, TN.

Several physical characters relating to male breeding behavior and fighting are found in Leptodactylus pentadactylus. These include large keratinized chest spines, one or two keratin-covered bony wrist spines, and hypertrophied arms. Variation in these characters was correlated with animal size and season. The three keratinized structures showed a hierarchical pattern of occurrence. Snout-vent length explained some of this pattern as well as some of the variation within these characters. Structures lost through injury were regrown during the breeding season in some males. Although previously thought to be permanent in L. pentadactylus, these characters were lost after the distinct breeding season seen in Panama. The upper arm of L. pentadactylus had a greater girth than the lower arm, and was much larger than those of females. This sexual dimorphism is supported by a dramatic difference in humeral structure. Beyond this skeletal dimorphism, male L. pentadactylus gain additional upper arm muscle girth during the breeding season.

703

GROWTH RATES AND PATTERNS OF SEXUAL DIMORPHISM IN ANEIDES FLAVIPUNCTATUS.
N.L. Staub, Univ. of California, Berkeley.

The plethodontid salamander Aneides flavipunctatus is sexually dimorphic: adult males have significantly broader heads than females. To determine how this dimorphism arises ontogenetically, a mark-recapture study was undertaken in Mendocino County, CA. 67 out of 348 marked salamanders were recaptured between November 1984 and April 1985. Head dimorphism is not explained by differences between males and females in body length or growth rates. Heads of males and females that reached sexual maturity during the 1984-85 season grew in width more rapidly than in juveniles and older adults, with males exhibiting this change more dramatically than females. This sexual difference in head growth rate accounts for the head dimorphism observed in adult A. flavipunctatus. A von Bertalanffy growth curve was fit to these recapture data to provide estimates of salamander age. Sexual maturity is reached during the third year, and large adults (>80mm) are approximately 7 years old. The evolution of sexual dimorphism in the genus Aneides will be examined using ontogenetic information.

704a

CUTANEOUS MUSCULATURE ASSOCIATED WITH THE PELVIC "SEAT PATCH" IN BUFONID ANURANS.
R. M. Winokur and S. D. Hillyard. Univ. of Nevada, Las Vegas.

Epidermal sculpturing of the pelvic skin or "seat patch" of Bufonids has been shown to facilitate the adsorption of soil particles to the skin and to enhance substrate moisture absorption (Hillyard, S.D., Copeia 1976:314-320). Dissections of B. woodhousei and B. marinus reveal that fibers from the gracilis minor muscle attach via numerous bundles to the dermal surface of the seat patch. These attachments have long been known but their potential relationship to the function of the seat patch has gone unnoticed. A small integumentary muscle takes its origin from paired triangular muscle masses ventral to the cloaca and has fibers extending longitudinally into the seat patch where they attach to the dermis. Fibers from these two muscles thus form a complex trabecular latticework and attach to each other as well as to the skin. Histological examination and direct electrical stimulation demonstrate that these muscles can significantly modify the pattern of epidermal sculpturing of the skin and may play a role in optimizing the uptake of substrate moisture. S.D.H. was supported in part by N.S.F. #Int 83 111 87.

704b

DIFFERENCES BETWEEN ONTOGENETIC AND REGENERATIVE CARPAL PATTERNING IN THE RED-BACKED SALAMANDER, Plethodon cinereus. C.E. Dinsmore and J. Hanken. Rush Medical College, Chicago and Univ. Colorado, Boulder.

We have examined two geographically isolated populations of Plethodon cinereus to determine the relationship between native and regenerate carpal patterning. Native limbs were amputated and whole mount stained for limb skeletal pattern analysis. The regenerates were subsequently removed and similarly analyzed. We have not found any correlation between native and regenerate carpal patterns on the same individuals. Furthermore, inter-element fusions are at much higher frequency in regenerates and differ qualitatively from native variant fusion patterns suggesting a differential responsiveness to epigenetic constraints during embryonic development versus adult limb regeneration. Supported by the Dahlgren Fund (CED) and NIH 1 R23 DE07190-01 (JH).

720

NUTRITION AND PHOTIC HISTORY MODIFIES PHOTOPERIODIC RESPONSES OF THE FEMALE GOLDEN HAMSTER. L.B. Johnson, R.A. Hoffman. (Intro. by C. Beuchat). Colgate Univ. Hamilton, N.Y.

In a recent paper (Johnson & Hoffman, in review), we demonstrated that a commercial diet supplemented with seeds enhanced growth rates and inhibited (delayed?) reproductive atrophy in hamsters. In other work (Hoffman & Johnson, 1985), photic history was found to modify reproductive responses and growth. We now report results of a study on the combined effects of photic history and nutrition on golden hamsters exposed to short photoperiods. Eight weeks after exposure to a short photoperiod (LD 8:16 hrs) the standard commercial pellet diet was supplemented with seeds/nuts or 20% sucrose. At autopsy five weeks later, all but 3 hamsters in the pellet and sucrose-supplemented groups possessed nonfunctional ovaries and atrophied uteri, while only 1 of 13 in the seed-supplemented group was so affected. Animals born in the dark were heavier than those born in colony conditions, but photic history had no effect on the reproductive system.

Partially supported by the Lighting Research Institute.

TERMINATION OF GONADAL REFRACTORINESS IN TURKISH HAMSTERS. S.M. Hong and M.H. Stetson. University of Delaware, Newark.

Photorefractoriness to short days is terminated by about 11 wks of long day treatment in golden hamsters. To determine the duration of long day treatment necessary to terminate refractoriness in Turkish hamsters, refractory hamsters were subjected to LD16:8 for 5, 10, 15, or 20 wks and then returned to LD12:12. Ten wks of long day exposure was sufficient to restore sensitivity to short days. Photoperiods of longer than 17 hrs of light cause gonadal regression in Turkish hamsters. We tested whether these very long days (LD20:4) can terminate refractoriness also. Refractory females were exposed to LD16:8 or LD20:4 for 15 wks. Upon return to LD12:12, 70% of both groups became anestrus after 15 wks. These results indicate that a) as in golden hamsters, refractoriness to short photoperiods in Turkish hamsters can be terminated 10 or more wks of long day exposure, and b) very long days (LD20:4) terminate refractoriness, even though they induce gonadal regression in reproductively active animals.

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CIRCADIAN RHYTHM OF LIPOGENIC RESPONSIVENESS TO INSULIN AND PROLACTIN IN PRIMARY CULTURE OF HEPATOCYTES. A.H. Cincotta* and A.H. Meier. Louisiana State Univ., Baton Rouge, LA.

Hepatocytes from male golden hamsters held on LD 14:10 (lights on 0800) were cultured in monolayer. The culture medium (supplemented Waymouth's also containing 3.5×10^{-10} M bovine insulin) was changed every 4 h over the course of the experiment. Lipogenesis (14 C-acetate incorporation into total cell lipid) was assayed at 4-h intervals during a 48-h period (day 2 and 3 of culture). Dramatic circadian variations were observed with peak lipogenic activity at 2400 and 0800 on both days. Prolactin almost doubled lipogenesis, only if assayed at 2400 and 0800 and only when added to culture 20 h before these times. Lipogenesis is the net consequence of a circadian rhythm of sensitivity to insulin which in turn is augmented by prolactin at a specific temporal relation to the sensitive interval.

REGULATION OF THE ANNUAL BREEDING CYCLE OF MALE MUMMICHOGS, FUNDULUS HETEROCALITUS. R.C. Cochran. Ches. Bay Inst., Johns Hopkins Univ., Shadyside, Md.

Sperm production by a field population of *F. h.* was monitored with a sperm index during 1983-85. Significant changes in the index were seen denoting seasonal, monthly, and diurnal rhythms in sperm production. These rhythms were correlated with changes in the serum concentrations of 3 androgens, listed in order of predominance- 11B-hydroxytestosterone, 11-ketotestosterone, and testosterone. Serum androgen levels were determined by RIA following ether extraction and HPLC resolution of the steroids from a uBondapak C18 column using methanol-water (56:44) for isocratic elution.

DIFFERENTIAL REGULATION OF GONADOTROPIN SECRETION IN THE RAT: DYNAMIC PERFUSION OF ANTERIOR PITUITARY GLAND FRAGMENTS. E.S. Hiatt, N. Guttman* and N.B. Schwartz* Northwestern University, Evanston, IL

In rats, ovariectomy (OVAX) leads to a doubling of serum FSH by 6h with no significant rise in LH until 4 days later. This dramatic difference in response to removal of gonadal feedback suggests differences in mechanisms regulating LH and FSH secretion. An automated dynamic perfusion system (AcusystTM) was used to examine basal and GnRH-stimulated LH and FSH secretion by individual ant. pit. glands removed on the AM of metestrus (Od), or on the 2nd or 6th day post-OVAX. The glands were quartered and placed into individual chambers for a 6h perfusion (10 ml/h) in MED 199. After 4h, all chambers received 2 15-min pulses of a long-acting GnRH agonist (15 nmol/ml) at 1 pulse/hour. By 2d post-OVAX, basal secretion of FSH was elevated significantly, while LH was only slightly increased over Od levels; both LH and FSH were highest at 6d. Response to agonist was greatest at Od, but much reduced by 2d and 6d post-OVAX. These data suggest that the rise in serum LH and FSH levels after OVAX may be due to temporally distinct elevations of basal secretion rates rather than increased pituitary responsiveness or increased hypothalamic "drive".

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GONADAL STEROID SECRETION FOLLOWING STIMULATION OF THE HYPOTHALAMIC-PITUITARY-TESTICULAR AXIS IN BROWN BULLHEADS, ICTALURUS NEBULOSUS. P.M. Rosenblum and I.P. Callard. Boston University, MA.

In order to investigate the regulation of the teleost hypothalamic-pituitary-testicular axis, I. nebulosus were treated with salmon gonadotropin (SG-G100), salmon gonadotropin-releasing hormone (sGnRH) or an opioid antagonist, naloxone (NAL). Plasma testosterone (T), 11-ketotestosterone (KT) and estradiol-17 β (E2) were measured following treatment. SG-G100 elicited parallel time-dependent increases in T and KT, however a higher dose was required to elicit KT secretion. No effect on E2 secretion was seen. After sGnRH, T and KT were increased, with a more prolonged secretion of KT. A slight increase in E2 was seen. No clear dose response to sGnRH was observed. NAL did not increase steroids in these animals. The effects of these treatments varied during the annual cycle, with maximal T and KT responses to SG-G100 and sGnRH in the spring. sGnRH also induced E2 secretion at this time. In animals near spawning, NAL induced E2 secretion. These data suggest the involvement of GnRH and endogenous opioids in the secretion of gonadotropin(s) in this species.

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GONADAL CHANGES FOLLOWING OLFACTORY-BRAIN AXIS INTERRUPTION IN PLATYFISH.

M.P. Schreiberman, H. Margolis-Nunno, L. Halpern-Sebold, F. Caracheo* and S.L. Weiner*. Brooklyn College, New York.

Structural and functional links exist between the olfactory system and the nucleus olfactoryretinalis (NOR), an LHRH containing brain area important in reproductive system physiology (Brain Res., 302 (1984): 180-183). In this study the NOR was bilaterally lesioned (NORX) or the olfactory epithelium (OE) surgically removed (OEX) in mature fish. 3-5 wks after surgery, the OE in NORX fish is convoluted, has fewer apical projections, decreased vascularity, and more pyknotic nuclei. In OEX fish, ir-LHRH is intensified in NOR cell bodies and processes. In NORX and OEX males Leydig and Sertoli cells are frequently enlarged and spermatogenesis is active; however most sperm packets are in the efferent ducts. Advanced stages of oogenesis also appear discharged into ducts; yolk eggs are generally fewer or absent.

Our observations suggest that following NORX or OEX, gametes are actively produced and released without storage. It appears, too, that information transfer between the NOR and OE is bidirectional. (Supported by NIA-AGO 1938 and PSC-CUNY.)

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INDUCTION OF OOCYTE MATURATION IN THE MARINE TELEOSTS, ATLANTIC CROAKER (MICROPOGONIAS UNDULATUS) AND SPOTTED SEATROUT (CYNOSCIION NEBULOSUS). J.M. TRANT and P. THOMAS. University of Texas Marine Lab, Port Aransas.

Final oocyte maturation (FOM) in Atlantic croaker and spotted seatrout is induced in vitro by an ovarian steroid of unknown identity. The potency of a variety of steroids in inducing FOM was examined in an in vitro bioassay. Hydroxyl groups at positions 17 α , 21, and 20 β increased FOM-inducing activity of the progesterone and pregnenolone steroid nuclei. However, hydroxylation at the 11 β position was strongly inhibitory. In addition, hydroxylations at 3 α , 18, 19 positions decreased activity. The 3 β HSD inhibitors, cyanoketone and epotane, did not block GtH-induced FOM, whereas the 17 α hydroxylase inhibitor, SU10603, blocked FOM. This indicates the natural maturation inducing steroid (MIS) is not a 3 keto, Δ 4 steroid, but it does contain a 17 α hydroxyl group. The steroid produced by maturing oocytes were fractionated by HPLC and assayed for FOM activity. A fraction which had considerable FOM activity did not co-chromatograph with any of the MIS's proposed in teleosts.

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BIOASSAY FOR FUNDULUS GONADOTROPIN(S): IN VITRO OOCYTE MATURATION & STEROID PRODUCTION BY ISOLATED OVARIAN FOLLICLES. Y-W.P. Lin, M.J. LaMarca* and R.A. Wallace. Univ. of Florida, Whitney Lab., St. Augustine.

Isolated ovarian follicles from several species were cultured in order to develop an in vitro bioassay system for Fundulus gonadotropin (GTH). An homogenate of frozen Fundulus pituitary (FP), when tested in the heterologous systems using follicles from Rana, Xenopus and Carassius was strikingly ineffective in provoking either germinal vesicle breakdown (GVBD) or steroid production. In the homologous system using Fundulus follicles, FP was capable of inducing both GVBD and steroid production in a dose-dependent fashion. Testosterone, progesterone and 17 α ,20 β diOH prog. were detected by RIA in the culture media after FP stimulation. There was however, a marked seasonal sensitivity of the Fundulus follicles to FP stimulation in vitro. Follicles obtained from fishes outside of the breeding season were unresponsive to stimulation by LH or FP. These same preparations of FP were capable of provoking GVBD in follicles obtained in May. In conclusion, Fundulus GTH shows a stringent species specificity and the Fundulus follicles exhibit a seasonal-dependent responsiveness to its own gonadotropin(s).

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INFLUENCE OF WATER POTENTIAL AND TEMPERATURE ON EGGS OF SNAPPING TURTLES (*CHELYDRA SERPENTINA*) INCUBATING ON DIFFERENT TYPES OF SUBSTRATES. G.C. Packard, M.J. Packard, K. Miller and T.J. Boardman*. Colorado State Univ., Fort Collins, and Franklin & Marshall Coll., Lancaster, PA.

Flexible-shelled eggs of snapping turtles were incubated on sand and on vermiculite to determine whether responses of eggs and embryos to environmental temperature and water potential are affected by characteristics of the substrate. Both temperature and water potential had major effects on duration of incubation, hatching success, and size of hatchlings. In general, incubation was longer, hatching success was higher, and hatchlings were larger at low temperatures (26.0 C) and at high water potentials (-150 kPa) than they were at high temperatures (28.5, 31.0 C) and at low water potentials (-550, -950 kPa). Despite major differences in physical characteristics of sand and vermiculite, however, only minor variation in the data was introduced by incubating eggs on the different substrates. Also, patterns of response were similar on sand and vermiculite, so no major conclusion would have been affected by selecting one medium over the other for use in this investigation.

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EFFECT OF VARIATION IN WATER BALANCE OF EGGS ON CALCIUM MOBILIZATION AND GROWTH BY EMBRYONIC PAINTED TURTLES (*CHRYSEMYS PICTA*). M. J. Packard and G. C. Packard. Colorado State University, Fort Collins.

Painted turtle eggs exposed to wet environments absorb more water, incubate longer, and produce larger hatchlings than do eggs exposed to drier conditions. Embryos in wet environments also grow faster and accumulate more calcium than do embryos in dry environments. Young from eggs incubated on wet substrates contain less residual yolk than do those from eggs on dry substrates, but calcium content is similar in the two groups. Yolk calcium is reduced to levels that preclude use of residual yolk for post-hatching growth. Hatchlings from eggs in wet settings obtain 56% of their calcium from the eggshell but those from eggs in dry settings obtain only 40% of their calcium from that source. Thus, the hydric environment to which eggs are exposed has subtle effects on both growth and calcium mobilization of embryonic painted turtles.

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EFFECT OF DIETARY SALT ON GROWTH AND DEVELOPMENT IN WHITE IBIS NESTLINGS. J.W. Johnston and K.L. Bildstein*. Winthrop College, Rock Hill, SC, and Baruch Inst., Univ. of South Carolina, Columbia.

21-24 day old white ibis (*Eudocimus albus*) nestlings were hand-reared on an ad lib diet of crayfish (*Procambarus* sp., 535 mOSM)(N=12) or on a saltwater diet of fiddler crabs (*Uca* spp., 1080 mOSM)(N=12). A third group (N=4) was fed crayfish "spiked" with a salt load equal to that of fiddler crabs. Brackish-water (480 mOSM), collected at the nesting colony, was provided to all three groups. Growth rate (tarsi length, toe pad, culmen, 2nd primary and middle rectrix), weight, and apparent metabolizable energy were followed for 3 weeks. Birds raised on crayfish grew and developed at rates equal to those of wild nestlings. Birds raised on fiddler crabs or "salty" crayfish lost >3% of their body weight/day, even though they produced a hyperosmotic nasal gland fluid (1325 mOSM). When switched from brackish-water to freshwater, the birds on a fiddler crab diet began gaining weight immediately. Supported by Winthrop College grants to JWJ and KLB and by an NSF-LTER grant to KLB.

732

GnRH INDUCES FERTILE MATINGS IN *Iguana iguana* DURING THEIR REFRACTORY PHASE. J.A. Phillips, B.L. Lasley*, and F. Frye*. Zool. Society of San Diego, California.

An agonist of avian GnRH (d-Arg⁶ chicken II) was administered via intraperitoneal osmotic pumps to female green iguanas to evaluate its effect on behavior and gonadal function. Seven days post-implant the GnRH induced territorial and courtship behavior in untreated male cagemates. Within 10 days mating occurred. The pumps were depleted after 14 days and courtship behavior ceased soon after. Six weeks post-implant a second courtship/mating period was observed between the hormone-treated females and their mates. Mating was successful and females oviposited 2-2.5 months later. Control pairs did not exhibit courtship/mating behavior until approximately four months later, the normal date for these events. The results suggest that GnRH can elicit a proximal behavioral response as well as an ultimate gonadal effect in reptiles. This type of therapy may help increase reproductive rates in endangered species.

This research was supported by an Endangered Species Research grant from Kaiser Development Corporation.

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IN SITU ENERGETICS OF CORAL REEF BRITTLE STARS (OPHIUROIDEA) DURING ORAL DISC AND ARM REGENERATION. K.M. Sullivan. Univ. of Miami, Coral Gables, Fla.

Four species of coral reef brittle stars were collected off reefs in the Dry Tortugas and Key Largo, Fla. Intact individuals were held in closed and circulating respiration chambers moored in situ for monitoring oxygen consumption and ammonia/urea excretion. After 12 hours, arms were autonomized and energetics experiments again conducted. Respiration rates (using ash-free dry weights) ranged from 0.25-0.76 mg.O₂ g⁻¹ h⁻¹ in intact animals and 0.11-0.22 in autonomized individuals. Ammonia was the primary nitrogenous waste in intact animals, while urea was the primary nitrogenous waste in regenerating brittle stars for up to 24 hours after losing an arm. Possible energy sources for regeneration are free amino acids or soluble proteins. Glycogen and lipid content analysis of brittle stars indicated insufficient energy stores for arm regeneration.

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ULTRASTRUCTURAL AND BIOCHEMICAL CHARACTERIZATION OF MINERALIZING AVIAN LEG TENDON. L.S. Eyster and W.J. Landis*. Harvard Medical School and Children's Hospital, Boston, MA.

Calcifying leg tendons from two avian species have been studied by transmission electron microscopy and gel electrophoresis to characterize structural and chemical changes in this tissue during mineralization. Gastrocnemius tendons from domestic turkeys 7-15 wks old were x-rayed for localization of mineral. Uncalcified, newly calcifying, and calcified regions from the same tendons were examined with TEM; ultrastructural comparison of the three regions showed differences in cell size and shape, development of collagen fibrillogenesis, and presence of extracellular vesicles possibly involved in tendon mineralization. Polyacrylamide gel patterns of the non-collagenous proteins from mineralized and unmineralized leg tendons as well as neck tendons (which never mineralize) from turkeys and chickens (19-28 wks old) indicated distinct differences. These results reflect temporal and spatial elaboration of matrix in an avian model of vertebrate calcification. Supported by NIH grants AM07112 and AM34078.

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PATTERN OF FEED RESTRICTION DELAYS FIRST BREEDING IN MICROTUS OCHROGASTER. G. Linder, J. Bauer,* and C. Morrell.* Cornell University, Ithaca, N.Y.

Work relating nutrition and reproductive success in small mammals indicates the pattern of feed restriction elicits different responses in laboratory-housed M. ochrogaster. Daily feed consumption was measured (=baseline), then one feed-restriction regimen was allowed a 60% baseline feed ration over 10-d, while another was offered variably increasing feed quantities. After the 10-d feeding trial, animals were returned to an ad libitum diet and breeding pairs were established within feed-restriction groups. Reproductive effects were then evaluated on criteria of time to first litter, for example, and morphological and physiological measures, e.g., testicular sperm counts and functional enzymes. Mated-pairs fed a 60% ration had reproductive success not unlike ad libitum fed controls; mated-pairs offered variably increasing quantities of feed had delayed times to first litter. These results suggest future work regarding nutritional effects potentially altering small mammal population dynamics.

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A PROTEINASE THAT DEGRADES CRUSTACEAN EXOSKELETON. J.J. O'Brien and D. M. Skinner. Biol. Div., ORNL, Oak Ridge, TN

The separation of epidermis from the membranous layer (ML) of the crustacean exoskeleton (apolysis) occurs early in proecdysis. "Forced apolysis" (FA; induced by chilling for >30 minutes) was observed in anecdysis, very early in proecdysis, and in metecdysis in the land crab, Gecarcinus lateralis. It was also found in all brachyurans tested (7 families). Extracts of G. lateralis branchiostegite epidermis contained both cathepsin D and alkaline cysteine proteinase (ACP) activities whether or not they were obtained from crabs which had undergone FA. FA was not detected in an astacuran (H. americanus) nor was ACP activity, although cathepsin D activity was, arguing against enzyme inactivation. ACP ranged in size from 53-67 kD (gel filtration) and 61 kD (SDS-PAGE). Autoradiography showed ACP hydrolyzed specific ML proteins as well as casein, the commonly used substrate. Optimal conditions for ACP activity mimic those seen in apolysis; ACP may function in apolysis. (Supported by the Seed Money Program and Martin Marietta Energy Systems, Inc. with the U.S. Department of Energy.)

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METABOLISM OF ECDYSONE BY TESTES OF THE EUROPEAN CORN BORER, OSTRINIA NUBILALIS (HUBNER). D.B. Gelman, C.W. Woods* and A.B. Borkovec*. IRL, ARS, USDA, Beltsville, Md.

Testes from European corn borer last stage larvae, pupae and pharate adults cultured in vitro in the presence of (³H)-ecdysone were found to convert ecdysone primarily to 20-hydroxyecdysone. Conversion was localized in testis sheaths. Rates of conversion were maximum in testes of wandering larvae (just prior to testis fusion), a time when hemolymph titres of ecdysone and 20-hydroxyecdysone peak. Conversion dropped considerably in pupal testes and was maintained at a low level throughout pharate adult development. Therefore, the conversion of ecdysone to 20-hydroxyecdysone that occurs in the corn borer just prior to pharate adult formation was not mirrored by similar activity in the testes. Interestingly, previously determined ecdysteroid profiles of larval testes revealed an absence of ecdysone, while those from pupal testes showed that ecdysone peaked just prior to pharate adult formation. Relative rates of conversion, then, correlated well with previously determined concentrations of ecdysone and 20-hydroxyecdysone in testes, concentrations that do not necessarily mirror hemolymph ecdysteroid levels.

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DOES THERMAL ACCLIMATION AID AMPHIBIANS? ACCLIMATION OF LOCOMOTOR METABOLISM AND PERFORMANCE IN SALAMANDERS. M.E. Feder. The University of Chicago.

Phylogenetic and allometric variation in the minimum metabolic rate (SMR) has predictable consequences for activity metabolism and locomotor performance in vertebrates. To test whether similar consequences attend variation in SMR due to thermal acclimation, two species of salamanders were exercised at controlled speeds (0-47 cm/min) in an exercise wheel while their oxygen consumption was measured. The working hypothesis was that acclimatory variation in activity metabolism and locomotor performance should parallel acclimatory variation in the SMR. The first species, *Desmognathus ochrophaeus*, undergoes a decline in SMR upon warm acclimation. Warm acclimation likewise reduced oxygen consumption during locomotion at 13 C in *Desmognathus*, but did not affect the maximum sustainable speed. At 21 C, warm acclimation improved stamina but did not affect oxygen consumption during locomotion. In *Bolitoglossa subpalmata*, a second species that undergoes no acclimation of the SMR, acclimation affected neither oxygen consumption nor maximum sustainable speed during locomotion at 13 C. However, at 21 C, acclimation affected both oxygen consumption and stamina, despite no variation in the SMR. These contradictory results suggest a critical reassessment of the adaptive significance of metabolic acclimation for amphibians.

Supported by NSF Grant BSR83-07089.

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METABOLIC COMPENSATION TO TEMPERATURE IN SALAMANDER EMBRYOS. Allan W. Smits. Univ. of Massachusetts, Amherst.

Metabolic compensation is well-known for adult amphibians, however, it seems strangely unknown or untested in amphibian embryos which must develop within sedentary egg masses, without the benefit of body temperature regulation. Metabolic acclimation was tested in salamander (*Ambystoma maculatum*) embryos in seven developmental stages from neurulation through post-hatching. Rates of O₂ uptake in cold-reared (12 C) embryos measured at 12 and 22 C exceeded those of warm-reared (22 C) embryos by two-fold throughout pre-hatching development. Metabolic rates of both groups tripled at hatching (Stage 40 for warm-reared, Stage 46 for cold-reared), despite concomitant decreases in body mass. No differences in embryo stage, dry body mass or embryonic protein content (minus yolk) existed between acclimation groups to account for their metabolic dissimilarity. The biochemical capacities permitting thermal acclimation are apparently present even in the earliest stages of the amphibian life cycle. (Supported as a Parker B. Francis Fellow of the Puritan-Bennett Foundation)

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SEASONAL CHANGES IN STANDARD METABOLISM AND HABITAT TEMPERATURES OF SCOLOPORUS OCCIDENTALIS LIZARDS. J.S. Tsuji. Univ. of Washington, Seattle.

O₂ consumption rates (V_{O2}) of *Sceloporus occidentalis* from southern California were measured throughout the year at their activity temperature (35°C) and two inactivity temperatures (16 & 10°C). V_{O2} at all test temperatures were highest in spring when lizards are the most active, decreased during summer, and were lowest in late-summer when habitat temperatures were hottest. V_{O2} of lizards in fall and winter were intermediate between spring and summer rates. In fall and winter, lizards experience the coolest temperatures, and consequently, are active only on warmer days. These results suggest that: (1) these lizards may lower metabolic rates to compensate for higher body temperatures and water stress during warm seasons; and that (2) these lizards raise metabolic rates more in response to increased activity in spring, rather than in compensation for the depressing effect of cooler temperatures on V_{O2} in winter. Comparative results from a northern population in Washington will be discussed.

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THE INFLUENCE OF EMBRYONIC DEVELOPMENTAL TEMPERATURE ON THERMAL TOLERANCE OF TADPOLES OF THE EASTERN SPADEFOOT TOAD, *SCAPHIOPUS HOLBROOKI*. Paul V. Cupp, Jr. Eastern Kentucky University, Richmond.

Critical thermal maxima (CTM) were determined for tadpoles of *S. holbrooki* reared at different temperatures from early cleavage through hatching and then acclimated at 20°C. In an initial study, *S. holbrooki* larvae of developmental stage 28 (after Gosner) that had hatched at 30°C had a significantly higher CTM than those that had developed and hatched at 25, 20 and 15°C. When the study was repeated, *S. holbrooki* larvae that had hatched at 30°C had a significantly higher CTM than those that hatched at 15 and 10°C, and those larvae that had hatched at 20°C had a significantly higher CTM than those hatched at 10°C. These data indicate that early thermal experience, possibly during a critical developmental period, may bring about significant changes in the thermal tolerance of an organism. This may prepare the larvae for survival at temperatures that occur in their shallow breeding pools. Also, effects of early thermal experience may contribute to differences in thermal tolerance sometimes observed between local populations.

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THE EFFECT OF DEHYDRATION ON ENERGY METABOLISM OF A TERRESTRIAL SALAMANDER. M. Stefanski, R.E. Gatten and E.H. Pough. Cornell Univ., Ithaca, N.Y., and Univ. of North Carolina, Greensboro.

We determined the oxygen consumption (VO₂) and whole body lactate (WBL) content of *Plethodon jordani* during rest and activity at 15°C and 25°C when animals were fully hydrated and dehydrated to 85% body mass. For activity measurements, salamanders were manually stimulated to locomote continuously for 5 min on dry circular tracks (circumference = 20.5 cm) within air-tight chambers. Running speeds were .036 km/hr at 15°C and .054 km/hr at 25°C. These were determined to be the fastest speeds for which both hydrated and dehydrated animals consistently completed 5 min of exercise at the respective temperatures. VO₂ was measured by analysis of gas samples withdrawn from the chambers. VO₂ and WBL increased significantly with activity for both hydrated and dehydrated animals at both temperatures. Resting VO₂ tended to be greater for dehydrated vs. hydrated animals, but other metabolic differences between these two groups were not pronounced. Substantial dehydrational stress seems to have a minimal impact on the short-term activity metabolism of this species. (Supported by McIntire-Stennis Project #564).

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AEROBIC AND ANAEROBIC METABOLISM IN CALLING FROGS: THE EFFECT OF TEMPERATURE. T.L. Taigen and K.D. Wells. Univ. of Connecticut, Storrs.

Vocal advertisement by male spring peepers (*Hyla crucifer*) to attract females begins early in the spring and continues for 6-8 weeks. During this period, calling frogs experience body temperatures ranging from 5 to 25°C. We investigated the vocal behavior and energetics of sound production in these animals at 7, 10, 15, 19, and 23°C. With decreasing temperature, calling rate declines, while call duration increases. At each of the five experimental temperatures, metabolic rates during sustained calling were 15-20 times resting metabolism. Metabolic rates in calling frogs also exceeded those attained during exhaustive locomotor exercise at all temperatures. A multiple regression analysis of our pooled results identified calling rate, body mass, and temperature as significant determinants of oxygen consumption. These variables accounted for 82%, 7%, and 2%, respectively, of the total variance in calling metabolism. Lactate levels in calling and noncalling frogs, measured at 10 and 19°C, were not significantly different. It appears that the energetic cost of producing a single call is relatively constant, and independent of temperature.

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SEXUAL COMPETITION AND CALLING ENERGETICS IN TREEFROGS. K. D. Wells and T. L. Taigen. Univ. of Connecticut, Storrs.

The effect of sexual competition on the energetic cost of calling was investigated in *Hyla versicolor*. Oxygen consumption of males increased with calling rate and call duration, reaching a peak of about 1.7 cc O₂/(g·h) at 19°C, one of the highest levels measured in an ectothermic vertebrate. Both call duration and calling rate were influenced by chorus density. Males in a dense chorus gave longer but less frequent calls than isolated males; estimated oxygen consumption remained relatively constant. Playbacks of calls of different durations and rates caused males to increase call duration and decrease calling rate, but again rates of oxygen consumption remained about the same. Hence, males adjust their vocal signals according to social context, but this has little influence on the energetic cost of calling. The calling effort of most males appears to be near the maximum level they can sustain, regardless of the level of vocal competition in the chorus. We found no evidence of seasonal changes in calling effort, despite the fact that females appeared to be less common late in the season.

POWER INPUT AND OUTPUT DURING CALLING IN HYLID FROGS. K. N. Prestwich, K. E. Brugger* and M. Topping* College of the Holy Cross, Worcester, MA and Univ. Florida, Gainesville.

We measured rates of oxygen consumption ($\dot{V}O_2$) and sound fields of north Florida hylids with different sizes and calling behaviors. At 29°C, Hyla gratiosa's (12.5g) peak calling $\dot{V}O_2$ was 1.21 mL O_2 /(g*h) at 3600 calls/h, duration ca. 0.2 s at a mean sound pressure level (SPL) of 91 dB (at 50 cm). At 27°C, in H. squirella (2.2 g), calling $\dot{V}O_2$ reached 2.1 (much higher than previously reported) at calling rates of 6000 calls/h, mean call duration of 0.18 s. and 88 dB mean SPL. Mean $\dot{V}O_2$ for maximal locomotory activity was 1.25 (H. gratiosa, 27°C) and 1.79 (H. squirella, 28°C).

Sound fields were essentially omni-directional. Sound-production efficiencies (P_{out}/P_{in}) in hylids are all less than 1% and are similar to calling insects. Estimation of calling energetics from analysis of the call will be discussed.

CATALASE ACTIVITIES IN TISSUES OF THE SOUTHERN LEOPARD FROG, Rana utricularia. F.E. Friedl and M.A. Vitale. Univ. of South Florida, Tampa.

As part of a comparative study on hydroperoxide metabolism, catalase (EC 1.11.1.6) was estimated in liver, kidney, heart, and lung homogenates of R. utricularia. The decrease in H_2O_2 substrate absorbance at 230 nm was recorded using a stopped-flow method. Reactions at 24.5°C were buffered at pH 7.1 and contained 1 mM H_2O_2 . Activities are expressed as an overall rate constant referenced to homogenate protein concentration (sec⁻¹·microgram protein⁻¹·ml⁻¹). The rate constant is demonstrably proportional to catalase content. It was found that activities followed the order liver > kidney > lung ≈ heart with values of 0.00156, 0.00032, 0.00006 and 0.00006 respectively. Although comparison of absolute values is difficult, our data agree with the order liver > kidney > heart found for R. ridibunda by Barja de Quiroga et al. (Comp. Biochem. Physiol. 80B:853, 1985)

STIMULATION OF DIURESIS IN THE HOUSE CRICKET BY A FACTOR FROM THE CORPUS CARDIACUM. J.H. Spring and S.R. Hazelton. Univ. of Southwestern Louisiana, Lafayette.

The Malpighian tubule system of the cricket can be maintained in an active state *in vitro* for upwards of six hours. Initial secretion rate is nearly 4 μ l.h⁻¹, declining to 1.5 μ l.h⁻¹ by hour 5. As determined by X-ray microanalysis, the major anions in the urine are chloride (72 mM) and sulphate (34 mM) and the cations are potassium (28 mM), sodium (16 mM), magnesium (13 mM) and calcium (6 mM). One pair of corpora cardiaca (CC) added to the saline bath (2.0 ml volume) doubles the secretion rate of the tubules. Higher concentrations of CC cause no further increase, and doses as low as 0.01 CC measurably affect secretion rate. The increased rate of urine formation does not appear to be caused by an increase in potassium transport, as the concentrations of this cation in the urine remain unchanged or only slightly elevated during stimulation. Sodium (peak value 50 mM) and chloride (peak value 110 mM) both increase significantly during stimulation, while the concentrations of all the other ions decrease. Whether this decrease is due to decreased transport or increased reabsorption by the ampulla is not yet clear. Supported by NSF grant DCB84-16829.

Na,K-ATPase ACTIVITY AND HYPOSMOREGULATION IN THE BRINE SHRIMP, ARTEMIA SALINA. C.W. Holliday. Lafayette College, Easton, PA.

Brine shrimp are strong hypoosmoregulators over a wide range of salinities. Changes in Na,K-ATPase enzyme specific activity (ESA) in phyllopods, metepipodites, phyllopods minus metepipodites, guts, heads, bodies and maxillary glands were measured in brine shrimp acclimated 21-30d in 50%, 100%, 200% and 400% sea water (SW, 100% SW = 1000 mOsm). ESA in phyllopods, metepipodites, guts, heads, and maxillary glands increased significantly (X 1.6-2.3) with salinity over the range tested. ESA in bodies and phyllopods minus metepipodites did not change significantly. ESA in metepipodites was high and increased with increasing salinity from 8% to 25% of total body ESA, strongly implicating these organs in salt transport out of the animal in concentrated media. ESA in guts, heads and maxillary glands was lower, but showed similar increases, also implicating these organs in salt transport.

Supported by Research Corporation.

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CL/HCO₃ ANTIPORT BY BASOLATERAL MEMBRANE VESICLES OF LOBSTER HEPATOPANCREATIC EPITHELIAL CELLS. G. A. Ahearn, M.L. Grover*, and R. T. Tsuji*. University of Hawaii, Honolulu, Hawaii 96822.

Purified epithelial basolateral membrane vesicles were prepared from lobster hepatopancreas using sorbitol gradient centrifugation. ³⁶Cl influx (4 sec uptake) was a hyperbolic function of [HCO₃]_i suggesting the occurrence of carrier-mediated anion antiport. ³⁶Cl influx was stimulated in decreasing order by the following intravesicular anions: Cl⁻ > NO₃⁻ > HCO₃⁻ > SO₄²⁻ > HPO₄²⁻. Vesicles preloaded with HCO₃ illustrated greater ³⁶Cl uptake rates in the presence of a transmembrane pH gradient (pHi > pHo) than those vesicles having bilaterally equal pH values. Cl/HCO₃ exchange was shown to be electrogenic by a valinomycin-induced K diffusion potential (inside -) in the presence of a transmembrane proton gradient (pHi > pHo). ³⁶Cl influx was a biphasic function of [Cl]_o, exhibiting both carrier-mediated and diffusional transport components. ³⁶Cl influx was a sigmoidal function of pHo, suggesting that more than one H⁺ may be cotransported across the membrane with each Cl⁻. The data support a model of basolateral HCl/HCO₃ antiport. Supported by NSF Grant No. PCM81-18366.

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DIVALENT CATION BINDING BY EXTRACELLULAR CONCRETIONS FROM THE GILLS OF UNIONIDS. J.W. McNeil and H. Silverman. Louisiana State Univ., Baton Rouge.

Binding of divalent cations by concretions from *Anodonta grandis* was studied both *in vivo* and *in vitro*. Animals exposed to Zn, Cd, and Mn for several weeks showed little binding of the metals to concretions. Eight hr after injection of ⁴⁵Ca or ⁶⁵Zn, concretions bound 1000X more Ca than Zn per mg of concretion. Further, the presence of ⁶⁵Zn in mussel tissues, gonad, kidney, mantle, and gill is two-fold greater/mg than found in the concretions, indicating no specific Zn incorporation. In contrast, ⁴⁵Ca in concretions was 3-4 fold higher than in any of the tissues. *In vitro* studies on isolated concretions indicate 80-85% binding of ⁴⁵Ca, while Zn is bound only 60% under similar conditions. These data suggest metal binding to concretions *in vivo* is specific for calcium and can occur extracellularly, but is carefully regulated. Further, it is unlikely that these concretions serve as part of a detoxification system. Supported by NSF-DCB 83-03789.

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PARTICIPATION OF CHLORIDE IONS IN FLUID RESPONSES OF THE BODY WALL OF THE LAND SLUG, *ARIOLIMAX COLUMBIANUS*. I. Deyrup-Olsen and A.W.Martin. Univ. of Washington Seattle.

The body wall of *Ariolimax* responds to mechanical stimulation by releasing mucus vesicles and fluid. The latter is formed as an ultrafiltrate of blood modified in composition as it traverses the specialized channel cells of the body wall. Na and Cl ions are conserved, whereas the levels of K and HCO₃ ions are significantly higher in the fluid emerging through the body wall than in the blood (Martin and Deyrup-Olsen, 1985, Fed. Proc. 44: 998). The processes whereby these modifications take place are blocked by transport and permeability modifying agents including ouabain, amiloride, furosemide, SITS, and 9-anthracenecarboxylic acid. In the case of the body wall *in vitro* (sac preparation) furosemide, alone among these agents, failed to block if the sac was filled initially with Ringer solution in which Cl was replaced with NO₃ or gluconate. The results suggest that Cl ions participate in body wall responses in 2 distinct ways: (1) excitation of the channel cells; (2) exchange of Cl for HCO₃ (Cl reabsorbed from the ultrafiltrate).

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THE EFFECT OF HEAVY METALS AND METABOLIC INHIBITORS ON CALCIUM UPTAKE IN *FUNDULUS HETEROCLITUS*. G.R. Sauer. Univ. of South Carolina, Columbia.

Zinc and cadmium have been shown to reduce calcium uptake by regenerating fish scales. Since the gills are thought to be the major site of calcium uptake, the toxic action of metals on this tissue could explain these results. The uptake of calcium-45 from environmental water was determined after 2, 12, 24 and 48 hours in the gills, blood, and regenerating scales of control and metal-exposed fish. Cadmium reduced calcium uptake in all three tissues while zinc reduced uptake by the scales only, suggesting that the metals influence calcium uptake by different mechanisms. Calcium-45 uptake experiments were performed with isolated gill tissues in the presence of zinc and cadmium, a calcium-binding antagonist, lanthanum, a calmodulin blocker, trifluoperazine, and the ATPase inhibitors ouabain and quercetin. Lanthanum significantly reduced calcium uptake by the gills suggesting that calcium may be taken up by fish gills via a facilitated diffusion process.

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CALMODULIN MAY BE INVOLVED IN CELL VOLUME REGULATION IN RESPONSE TO LOW SALINITY. S.K. Pierce, D.L. Cronkite, and L.H. Smith. Univ. of Maryland, College Park, and Hope College, Holland, MI.

Previously we have shown that cell volume recovery in isolated blood cells of Noetia ponderosa exposed to a hypoosmotic stress is sensitive to external Ca^{2+} . In addition, Ca^{2+} influx into Noetia blood cells occurs immediately following hypoosmotic stress. The calmodulin inhibitors trifluoperazine and chlorpromazine, alter cell volume regulation in the clam blood cells. We have now tested Noetia blood cells for the presence of calmodulin. A cell lysate was chromatographed on DEAE-cellulose and phenyl-sepharose. A protein was purified which bound to phenyl-sepharose in the presence of Ca^{2+} and eluted with EGTA. The protein comigrates with bovine calmodulin on a C-18 reverse phase HPLC column and on SDS-polyacrylamide gels. These results indicate that calmodulin is present in Noetia blood cells and, in company with our previous work, suggests that calmodulin is involved in cell volume regulation. (Supported by NIH #GM23731 and TS&GCMB, INC.)

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A PEPTIDE WITH EFFECTS ON THE CHLORIDE SHUNT PERMEABILITY OF MALPIGHIAN TUBULES. D.H. PETZEL, C.J. PROSPER* and K.W. BEYENBACH. Cornell Univ., Ithaca, N.Y.

Of the three peptides which we have isolated by HPLC from a saline extract of Aedes aegypti mosquito heads, two peptides cause increases in secretion rates of fluid, Na and Cl by Malpighian tubules (MT), while the other, Peptide I (PI) does not affect the rate of fluid secretion nor the ionic composition of the secreted fluid. However perfusion of Aedes MT with symmetrical Ringers solutions followed by bath addition of PI results in a depolarization of the transepithelial voltage (V_t) from 52mV to 11mV (lumen positive) and a 4-fold decrease in transepithelial resistance (R_t). These results are similar to those previously observed with the saline extract which was shown to be dependent on bath Cl. Under perfusion conditions when the transepithelial Nernst potential for Cl is equal to V_t (bath=157mM, lumen=20mM) addition of PI results in no change in V_t but a 2-fold reduction in R_t . These results are consistent with the notion that one of the effects of PI is to increase the Cl permeability of the shunt pathway while not affecting fluid secretion. Supported by NSF PCM8403305.

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Ca^{2+} ENTERS HYPOOSMOTICALLY STRESSED GLYCERA DIBRANCHIATA RED COELOMOCYTES AND INFLUENCES CELL VOLUME RECOVERY. A. D. Politis and S. K. Pierce. U. of Maryland, College Park, MD.

Volume recovery of Glycera red coelomocytes exposed to hypoosmotic media requires the presence of external Ca^{2+} . The site of Ca^{2+} action is unknown. A net ^{45}Ca influx occurs in these cells following media dilution (930-480 mosm). The ^{45}Ca influx occurs within seconds after the hypoosmotic exposure and the increased ^{45}Ca levels remain constant for at least 10 minutes. ^{45}Ca influx does not occur in cells exposed to media ionically equivalent to 480 mosm but osmotically equivalent (with sucrose) to 930 mosm. Therefore, the ^{45}Ca influx is triggered by an osmotic stimulus. The Ca^{2+} ionophore A2318, potentiates both cell volume recovery and net ^{45}Ca influx during hypoosmotic stress. These results suggest that the site of Ca^{2+} action during cell volume recovery is intracellular. (Supported by NIH GM-23731, Sigma Xi, and TS&GCMB)

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MORPHOLOGICAL VARIATIONS IN THE PARAPAGURUS PILOSIMANUS COMPLEX (CRUSTACEA, PAGUROIDEA, PARAPAGURIDAE). R. Lemaître, Univ. of Miami, Florida.

A worldwide review of Parapagurus hermit crabs has shown that 12 of the taxa assigned to this genus represent a group of closely related forms defined as the Parapagurus pilosimanus complex. In the western Atlantic the complex is represented by five species: P. pilosimanus, P. nudus, P. scaber, P. n. sp. A, and P. n. sp. B. The morphological variations exhibited by these species have been studied in detail based on the examination of nearly 3500 specimens. Two factors have been found to be primarily responsible for the great intraspecific variation and interspecific overlap of character ranges displayed, i.e., relative growth, and sexual dimorphism. The range of variations observed in continuous or discontinuous characters of diagnostic importance are described, quantified, and fully illustrated. The variations described herein can be considered indicative of the variations that could be expected in the complex in general. The results of this study will be used to evaluate the remaining members of this characteristically variable group of deep-water paguroids.

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SQUAT LOBSTERS, *Munidopsis*, ASSOCIATED WITH MESH ENCLOSED WOOD PANELS SUBMERGED IN THE DEEP SEA. A. B. Williams and R. D. Turner, NMFS, Systematics Lab., USNM, Washington, D.C., and MCZ, Harvard Univ., Cambridge, MA.

Squat lobsters, *Munidopsis crassa* and *M. nitida* were retrieved with the aid of the deep submersible ALVIN from 5 X 10 mm mesh bags containing experimental wood panels after 11 to 46 months of submergence in the Western Atlantic Ocean at depths of 1830 to 4000 m. Changes in carapace dimensions from megalopa to adult were determined for each species from specimens in this series. Largest *M. crassa* had a mean carapace width of 20.8 mm in bags submerged a mean 18 months. If these animals entered the bags at a maximum of 10 mm carapace width, it is conservatively estimated that they increased in carapace width at a mean 0.59 mm/month during residence in the bags. *M. nitida*, rarely exceeding 11 mm in carapace width, would not be trapped by the mesh.

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FEEDING BIOLOGY AND MOUTHPART MORPHOLOGY OF THREE SPECIES OF CORAL GALL-CRABS (DECAPODA, CRYPTOCHIRIDAE). R.K. Kropp, Univ. of Maryland, College Park.

The results of this study challenge the long-standing hypothesis that coral gall-crabs are filter feeders. I studied three species of gall-crabs, *Hapalocarcinus marsupialis*, *Utinomia dimorpha*, and *Favicola rugosa*. Feeding behavior of each species was observed in the laboratory. All three species were seen to ingest coral mucus. *Hapalocarcinus* collected mucus by fanning the third maxillipeds or by scratching the coral surface with the legs. *Utinomia* used chelipeds to collect mucus and other debris, or to snip pieces of coral polyp tissue. *Favicola* used mouthparts to make a mucous ball which then was swept along the coral surface to pick up mucus and debris. SEM photographs of each species' mouthparts show setae ill-suited for filter feeding, but useful for collecting coral mucus. Metabolic studies of *Hapalocarcinus* and *Utinomia* suggested each had a relatively high carbohydrate diet. In conclusion, coral gall-crabs are not filter feeders, but feed on mucus produced by the coral host.

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CARRYING BEHAVIOR IN BRACHYURAN CRABS. M.K. Wicksten, Texas A&M Univ., College Station.

Carrying is a behavior in which the last pereopods of a crab are used to lift and hold an object dorsally over the crab. This behavior is found in the families Homolidae, Dromiidae, Tylolidae and Dorippidae. These crabs have subdorsal pereopods ending in hooks, subchelae, spines or curved dactyls. Similar modifications are found in the Latreillidae and Homolodromiidae. All of the families that carry except for the Dorippidae have been classified in the section Dromiacea. I suggest that carrying is a conservative feature that should be used in defining this section. It is noteworthy that the extinct Eocarcinidae, among the oldest known brachyurans, had subdorsal pereopods. Were the earliest crabs carriers?

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SUPERIOR OBLIQUE MUSCLE REGENERATION PATTERNS FOLLOWING MUSCLE SECTIONING IN THE XENOPUS TADPOLE. R.F. Fangboner, Trenton State College, N.J.

Completely severed superior oblique muscles (SOM) in tadpoles of stage 53 regenerated over a period of 18 days. The pattern of regeneration was influenced by the placement of the cut and the condition of the distal trochlear nerve (NIV) sheaths. NIV was cut in all animals and four surgical formats were followed. In some animals A) the SOM was cut so that the distal NIV sheaths retracted toward the origin of the SOM, B) the SOM was cut so that the distal sheaths retracted toward the insertion, C) the distal sheaths were destroyed and then the SOM was cut, and D) the SOM was cut so that the sheaths retracted toward the origin and then the distal sheaths were removed. A portion of the animals were observed at 6, 12 and 18 days using methylene blue *in vivo* and histological techniques. Series "A" was the most successful with 100% showing nearly normal SOM by 18 days. Series "B" and "C" were less successful, 23% and 20% respectively. Series "D" had a number of animals showing no regenerative activity. Series "B" and "C" frequently showed a misdirection of muscle fibers. SOM regeneration seems to be more effective when regenerating from the muscle's origin.

MACROPHAGE MOBILIZATION DURING LENS REGENERATION FROM THE IRIS IN NEWTS.
R.W. Reyer, West Virginia Univ., Morgantown.

Studies already published, using TEM, have demonstrated that depigmentation of the dorsal iris epithelium during initial stages of lens regeneration involves the invasion of this epithelium by macrophages. By means of scanning electron microscopy, the mobilization of these cells on the surface of the iris facing the vitreous has been observed. They appeared by 6 days after lentiectomy and subsequently increased in number so that, in some cases, the macrophages appeared to be closely packed together. Many of these cells exhibited large lamellipodia while others had only low ridges or small protruding blebs on their surface. The iris epithelium itself was smooth with low ridges or, in other cases, it was covered by small tubular, spherical or cup-shaped bodies. In cryo-fractured preparations, macrophage invasion of the posterior iris epithelium was occasionally observed. It is concluded that mobilization of many macrophages occurs during dedifferentiation of iris epithelium. (Supported by WVU Med. Corp. and NIH Grants 5 S07-RR05433-18, 2 S07-RR054433-22).

REGULATION OF SPERM MOTILITY IN THE NEWT

M.P. Hardy and J.N. Dent.

Dept. of Biology, Univ. of Virginia, Charlottesville

We examined sperm motility in the red-spotted newt *in vivo*. Sperm were motile within the spermatothore, but quiescent within spermatic fluid (the sperm-bearing fluid of the vasa deferentia), and the spermatheca. The effects of changes in osmolality, specific osmolyte concentrations, and pH on sperm motility were examined *in vitro*. The osmolality of the spermatic fluid was 110 mOsm per Kg. Less than 50% of sperm were motile in saline media isosmotic with spermatic fluid, whereas more than 90% of sperm became motile when immersed in hypotonic media with osmolalities near that of pond water (less than 10 mOsm per Kg). Motility in isosmotic solutions persisted beyond 12 hours, whereas in hypotonic solutions it declined sharply and ceased by 6 hours. Sperm stored *in vitro* for 5 days at 4 deg in iso- and hyperosmotic media retained fertilizing capacity but those in hypotonic media did not. Increases in levels of potassium, in comparison with calcium and sodium, stimulated sperm motility most noticeably at osmolalities between 110 and 215 mOsm per Kg. Extremes of pH reduced or prevented motility within 12 hours, but at physiological levels (pH 7 to 8) sperm motility persisted beyond 12 hours. We infer a major role of osmolality in the enforced quiescence of sperm during storage in the vas deferens and the spermatheca, and in the activation of sperm upon discharge from the vas deferens into pond water before entrance into the cloaca of the female.

TWO DISTINCT MOTILE FORMS UTILIZED BY THE AFLAGELLATE SPERMATOZOON OF MACROSTOMUM TUBUM IN ACHIEVING TRANSLATION.
L. A. Mink* and W. D. Newton. Arkansas State University, Jonesboro.

Phase contrast observation and video tape records of the motility exhibited by free swimming spermatozoa released by macerated live specimen of *M. tubum* show two distinct methods for achieving rapid translation: a three-dimensional helical "propeller-like" rotation of the functional posterior end and a different 3-D "brace-and-bit" auger-like rotation of the entire cell. The presence of cortical singlet micro-tubules in the form of two sheets (Newton, W. D. (1980) *J. Ultrastruct. Res.* 73:318-330) suggests that motility is achieved by the curling or twisting of these sheets.

REGULATION OF SPERM MOTILITY BY A PHOSPHORYLCREATINE SHUTTLE. Robert M. Tombes, Charles J. Brokaw and Bennett W. Shapiro.* Univ. of Washington, Seattle and Cal.Tech., Pasadena.

Sea urchin sperm contain two isozymes of creatine kinase (CrK) by immunological and enzymatic criteria, located, respectively, at the mitochondrion and along the flagellum as termini of a proposed phosphorylcreatine shuttle (Cell 41:325, 1985). When whole sperm CrK is specifically inhibited, coupled but not uncoupled respiration is depressed and motility patterns are affected. Flagellar waves are initiated at normal frequency and wavelength, but attenuate in amplitude along the flagellum; attenuation is proportional to the degree of CrK inhibition. Attenuation is not observed, however, in CrK-inhibited, ATP-reactivated permeable sperm. Phosphagen kinases are found in other primitive sperm which rely solely upon energy produced at the base of the head, but not in modified sperm, which have an extended midpiece and shorter tails. Thus, a phosphorylcreatine shuttle appears to be responsible for energy transport from mitochondrion to tail in sperm with spatially separated sites of ATP production and utilization. Supported by NIH grants GM23910, GM18711 and HD0 7183-06.

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MEIOFAUNA SEE THE LIGHT? PHOTOBHAVIOR OF HARPACTICOID COPEPODS. K. Walters.

Univ. of South Florida, Tampa.

Active movement of meiobenthic copepods from subtidal sediments into the water column occurs nightly in both sand and seagrass subtropical habitats. The relationship between harpacticoid vertical movement and light intensity was examined on nine dates in the field. Light levels were recorded at water and sediment surface and copepod movement determined with an emergence trap over two hour intervals bracketing sunset and sunrise. Maximum vertical movement occurs during the two hours just after sunset on 8 of 9 dates, however some species can be found to ascend throughout the night. This post-sunset period does not represent the time of maximum absolute or relative decrease in light intensity. Either an absolute quantal intensity, e.g. threshold, or a lag in the response of harpacticoids to changing intensities may be responsible for initiating upward movement. Relative increases in light intensity were not always responsible for a cessation in upward movement either. Species identification, ontogenetic stage, sex and even sediment densities modify the overall pattern and role of light intensity in harpacticoid vertical movement.

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EFFECTS OF LIGHT AND DARK ON EYES OF THE POLYCHAETE NEREIS LIMNICOLA. R. M. Eakin and J. L. Brandenburger.* Univ. of California, Berkeley.

Electron microscopy of eyes of Nereis limnicola revealed profound damage to the photoreceptor microvilli when the worms were illuminated by a weak light for 24 h. The microvilli regenerated when the worms were returned to darkness for three h. No observable effects on other parts of the sensory cells or any part of a supportive cell were seen as a result of exposure to light. The breakdown products from microvillar degradation were removed from the opticoels by phagocytosis and pinocytosis by both sensory and supportive cells. The phagosomes and pinosomes then fused with primary lysosomes of GERL origin. Digestion probably took place in the lysosomes. Lysosomes were identified by the presence of the digestive enzyme acid phosphatase, using a cytologic stain combined with EM. Regeneration of the microvilli involved a formation of new submicrovillar ER and its fusion with the cell membrane from which a basal regrowth of the microvilli occurred. Although a circadian turnover of photoreceptor membrane has been demonstrated in other invertebrates this is the first report of the cycle in an annelid. Supported by NIH grant GM 28778.

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FIRST DESCRIPTION OF A BRITTLESTAR PHOTORECEPTOR SYSTEM. G. Hendler and M. Byrne. Los Angeles County Museum, and Harbor Branch Foundation, Inc., Ft. Pierce, FL.

The internal radial nerve of a brittlestar generates impulses in response to light/dark stimuli, but pigmentation and the crystallographic properties of the brittlestar skeleton shield the nerve from external illumination. SEM results show that the skeletal plates of Ophiocoma wendti bear microscopic glassy calcite tubercles that can channel light through the skeletal stereom. TEM results show that large nerve fibers within the skeleton lie beneath the glassy tubercles. Furthermore, thick sections show that the chromatophores responsible for the diel color-change cycle of O. wendti migrate through the skeletal stereom to expose the glassy tubercles or shield them from light. We propose that the glassy tubercles, intraskeletal nerve fibers, and chromatophores are a functional unit that allows O. wendti to respond to light and shadow under varying levels of ambient illumination.

768

IMMUNOHISTOCHEMICAL LOCALIZATION OF NEUROTRANSMITTERS IN THE NERVOUS SYSTEM OF THE PLUTEUS LARVA OF STRONGYLOCENTROTUS DROEBACHIENSIS. B.W. Bisgrove. Univ. of Victoria, Victoria, B.C., Canada.

Fixed, whole-mount preparations of S. droebachiensis larvae were stained by indirect immunofluorescence using polyclonal antibodies against serotonin, dopamine and gamma-aminobutyric acid (GABA). In eight-armed larvae serotonergic cell bodies and cell processes are concentrated in the apical region of the oral hood between the anterolateral arms. Serotonergic axons are also associated with the ciliary bands. The dopaminergic component of the nervous system includes an oral ganglion and neuropile associated with the lower lip of the larval mouth. As well, tracts of axons which arise from ganglia located at the base of the postoral arms run basally along the entire ciliary band. GABAergic neurons are associated with the upper lip and give rise to axons that encircle the mouth. The esophagus is also innervated by GABAergic neurons located on the dorsal surface of the upper esophagus. Serotonergic cells first appear in gastrulae and dopaminergic and GABAergic components are present in prism stage larvae. The development of the nervous system appears to continue throughout larval life. (Funded by an NSERC grant to R.D. Burke).

769

EVAPORATIVE COOLING IN THE DESERT CICADA, *DICEROPROCTA APACHE*. E. C. Toolson. Univ. of New Mexico, Albuquerque, NM 87131.

Heath and Wilkin (1970) reported that thoracic temperatures of *D. apache* measured in the field were 2 - 5°C below an ambient temperature of 44.5°C. They attributed the temperature difference to the ability of the cicadas to locate cool microhabitats in the mesquite trees that they occupy. However, when exposed to moving dry air (rh less than 5%) at 45.5°C in the laboratory, *D. apache* can maintain its thoracic and abdominal temperatures from 2 to 5°C below ambient for at least an hour without access to drinking water. The temperature difference rapidly disappears when the cicadas are transferred to an rh of 100%. The reduced body temperatures result from very high rates of evaporative water loss; at 45.5°C, *D. apache* loses 12 - 18% of its body mass per hour. The ability to evaporatively cool may be crucial when cicadas are unable to locate or occupy cool microhabitats.

770

THE ROLE OF CARBONIC ANHYDRASE IN CALCIFICATION IN THE GORGONIAN *LEPTOGORGIA VIRGULATA* (OCTOCORALLIA, GORGONACEA). R.J. Kingsley and N. Watabe. Duke Univ., Durham, N.C., and Univ. South Carolina, Columbia.

The enzyme carbonic anhydrase has been found to be involved in the calcification process in the gorgonian *Leptogorgia virgulata*. The mesoglea of this octocoral contains minute calcitic spicules. In addition, there are amorphous calcium carbonate granules found in the central axis of each of its branches. Carbonic anhydrase activity in the tissue is exceptionally high. The enzyme has been localized at both the light and electron microscope levels in the axis, axial epithelium and scleroblasts. Calcium uptake studies using the carbonic anhydrase inhibitor, Diamox, show significantly greater uptake of calcium in axes and spicules subjected to the inhibitor. These results contrast the findings of other calcifying organisms where Diamox reduced calcium uptake. The present results support and elaborate upon previous data which indicate that the axis as well as the scleroblasts of *L. virgulata* are actively involved in the calcification process.

771

CRYSTALS IN THE PENIS OF LAND SNAILS OF THE GENUS *ANGUISPIRA*. J. W. ATKINSON AND K. E. H. ATKINSON. MICHIGAN STATE UNIVERSITY, EAST LANSING.

Crystals have been observed in the lumen of a series of diverticula in the inner wall of the penis of *Anguispira alternata* and *A. kochi*. These structures have been found in all examined specimens of both fixed and unfixed tissue. Light microscope study of sectioned material reveals crystals which range in size from 1 µm to 25 µm and are shaped as three-pointed "jacks" in *A. kochi* but as equilateral triangles in *A. alternata*. When viewed with scanning electron microscopy, *A. alternata* crystals appear as tetrahedral structures. Similarity of chemical composition and/or structure between penis crystals and the radula of *A. alternata* may exist since preliminary histochemical analysis with light microscopy indicates sulfhydryl groups and calcium in both. SEM X-ray microanalysis indicates that crystals of *A. alternata* contain high concentrations of sulfur and calcium. The function of the penis crystals is unknown. Supported in part by BRSG Grant #2-S07 RR07049-15 awarded by the Biomedical Research Support Grant Program, Division of Research Resources, National Institutes of Health.

772

ULTRASTRUCTURE OF THE TRANSRECTAL COELOMODUCTS OF A SEA CUCUMBER (ECHINODERMATA; HOLOTHUROIDEA). G.L. Shinn. Harbor Branch Institution, Ft. Pierce, FL.

The perivisceral coelom of *Stichopus californicus* is connected to the lumen of the hindgut by up to two hundred short transrectal ducts. The ducts have a pseudostratified epithelium composed of monociliated tonofilament-containing cells, myoepithelial cells, gland cells, and bundles of nerve cell-like processes. The duct lumina are bordered, in most places, by the tonofilament containing cells. The myoepithelial cells are predominately circular in orientation; they are arranged in a layer among the bases of the tonofilament containing cells. Some of the myoepithelial cells border the duct lumen; their contractile projections parallel the duct axes. Functions of the ducts will be discussed. The duct epithelium is composed of the same cell types as is the peritoneum and the ducts appear to develop by evagination of the peritoneum. The ducts are thus "coelomoducts" *sensu* Goodrich. It is hypothesized that myoepithelial coelomoducts are pleisomorphic among coelomate organisms, and that, primitively, coelomoducts provided a mechanism for controlling the volume of the coelomic fluid.

773

MECHANICAL ASPECTS OF THE EVOLUTION OF THE MAMMALIAN SECONDARY PALATE. A.P. Russell and J.J. Thomason. University of Calgary, Canada and Ohio University, Athens.

Closure of the secondary palate occurred independently in several groups of mammal-like reptiles, and preceded a variety of changes in the head skeleton that have been associated with the emergence of the mammalian masticatory syndrome. Previous attempts to explain the origin of the secondary palate have concentrated on the emergent properties that accrue from its completion, and not upon the sequence of changes leading to its completion. We argue here, from a mechanical viewpoint, that the formation of the palate, in all of its incipient stages, provided structural buttressing for the rostrum as stress patterns altered with changes in mastication. We have employed a theoretical model on which our postulations are based. This model has been the subject of a series of static and dynamic tests, using the virginia opossum, to record stress patterns in vivo and in vitro.

774

SEXUAL DIMORPHISM IN THE DENTITION OF FOSSIL HOMINIDS: A MULTIVARIATE APPROACH. S.S. Lieberman and C.E. Oxnard. University of Southern Calif., Los Angeles.

Univariate studies of dental dimensions in fossil hominids have shown that several patterns of sexual dimorphism exist. This study places the various fossil hominids in relation to extant species, by interpolating data for the fossils into multivariate (canonical variates) analyses that were generated for the extant species. Lengths and breadths of teeth for 307 specimens of Pan, Pongo, Gorilla and Homo form the reference population. The fossils used are Ramapithecus, Sivapithecus, Gigantopithecus, Australopithecus (robustus, boisei, afarensis, africanus), Homo habilis, Homo erectus, and Homo sapiens neanderthalensis. The data for the fossils are the modes for both putative females and putative males, of the lengths and breadths of the incisors, canine, premolars, and first two molars, for both the mandible and the maxilla. In extant and fossil hominids, sexual dimorphism is not a feature of size only, but is represented by several complex patterns. Of the 13 species studied, at least 8 different patterns of sexual dimorphism are elucidated. These patterns are graphically illustrated using Andrews high-dimensional plots of the canonical variates. These findings have direct implications on both the evolution of sexual dimorphism in hominids in general and on the evolution of structural sexual dimorphism in modern Homo.

775

AN EVALUATION OF EPIPUBIC BONE FUNCTION: SCALING THEORY AND THE MARSUPIUM SUPPORT HYPOTHESIS. Thomas D. White. Univ. of California, Los Angeles.

Epipubic bone lengths and widths were scaled to body mass using data transformed to logarithms and the least-squares method of regression. Analysis of covariance was used to compare slopes between sexes and between groups possessing the marsupium and those without. Epipubic structure in taxa without a marsupium was found to scale as if it were related to litter mass. In taxa with a marsupium, epipubic structure is dimorphic, but the results indicated that the epipubic bones of females are more likely to fail mechanically than those of males given equal loading. Epipubic bone length (l) in taxa with a marsupium scaled significantly greater than geometric similarity ($l \propto Mb$, where $b = 0.440 \pm 0.028$, $N = 72$, $r^2 = 0.932$), implying that epipubic bone structure is suited to a function or functions other than support of a marsupium. This result is not inconsistent with the hypothesis that epipubic bones function in locomotion.

776

GEOMETRIC FORMS OF MAMMALIAN CLAWS. S.O. Landry. State Univ. of New York, Binghamton.

Since claws, like rodent incisors, consist of a hard upper layer, the nail, plate, and a softer lower layer, the sole, (Boas, 1931) continuously extruded in circular form, claws might be expected to show the same structural relations to the forces impinging on them as incisors. Not so. The soft, sole material is almost completely enclosed by the plate material which comes down over the sides of the nail, to give a V-shaped or U-shaped cross section. It is this side wall that must absorb the tensile forces acting on the tip of the nail when it is providing traction as the animal moves over the ground. This is presumably the primitive function of nails. The shape of the nail is approximated by 90° arcs of two circles of different diameters, with different centers, the larger circle being the upper curvature. The meaning of this in functional terms, is obscure.

777

FORM AND POSSIBLE FUNCTION OF THE COLLAGEN LAYER UNDERLYING CETACEAN BLUBBER. S.A. Wainwright, D.A. Pabst and P.F. Brodie.* Duke Univ., Durham, N.C. and Bedford Inst., Canada.

Beneath the cetacean blubber layer lies a wrapper of collagen fibers that are wound in right and left helices around the body. These fibers are tightly interwoven in the tail stock. We have seen this fiber sheath in animals from both suborders of Cetacea, including five species from three families of odontocetes, and one baleenopterid. A sheath of crossed helical fibers around cylindrical animals allows the body to bend in locomotion and not wrinkle. This morphology suggests the structure is functioning as a tension resisting member of a pressurized hydrostatic skeleton. It may be, as it is in other undulatory swimmers, a mechanism for storing elastic energy.

778

ALLOMETRY OF SKULL PROPORTIONS IN THE CAPRINAE (BOVIDAE: MAMMALIA). C.B. Ranzulli. Univ. of Chicago, IL.

The head-to-head collisions (clashes) of some male Caprinae load considerable forces on the skulls of these animals, and may generate torques which would tend to rotate their heads about the occipital condyles. These species would be expected to have specializations of the skull and the neck muscles to resist these forces compared to other Caprinae which do not clash. Features estimating functionally important characteristics of the cranium and the neck musculature were measured on the skulls of male Caprinae ranging from the small-horned Rupicaprini (chamois, serow, etc.) to the large-horned Caprini (sheep, ibex, etc.). Regressions were done to determine the interspecific allometric relationships of these cranial features with respect to basicranial axis length. Most of these measurements scaled isometrically, and rarely were any species outside the 95% confidence limits. These results suggest that some of the differences in skull shape among the Caprinae may be the result of scaling relationships and not associated with different methods of fighting.

779

RELATIVE MUSCLE FORCE CONTRIBUTIONS TO TMJ LOAD IN PIGS AND HUMANS. G.S. Throckmorton. Univ. Texas Health Sci. Ctr., Dallas.

In mammals, three muscles (Temporalis, Masseter, Medial Pterygoid) generate most of the reaction forces at the teeth and at the temporomandibular (TMJ) joint. The effect of each muscle on the TMJ reaction force is influenced by the muscle force magnitude, direction, and moment arm length relative to those of the resultant muscle force. Differences among species produce different effects on TMJ load. Comparison between humans and pigs (pig data supplied by Dr. S.W. Herring) was made using a 2-dimensional computer model for calculations of the direction, θ , and magnitude, FJ, of the TMJ reaction force during isometric bites at various bite positions. Differences between pigs and humans include: 1) At equivalent bite positions (8.0 cm) FJ is lower in pigs. 2) In humans Temporalis and Medial Pterygoid magnitude had the least effects on FJ and θ respectively; in pigs Masseter magnitude had the least effect on FJ and θ . 3) Increasing Temporalis magnitude in pigs or Medial Pterygoid magnitude in humans increased FJ.

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1

ROLE OF ODORS IN PREY LOCATION AND PREDATOR AVOIDANCE IN AQUATIC INSECTS. R. D. Soucek. Texas A&M Univ., College Station.

An observation system consisting of a behavioral chamber, video camera, Apple IIe computer, and electronic valve interface system has been developed. The apparatus has been used to determine the role of olfaction in the predator-prey relationships that exist among aquatic organisms, especially insects. Predators include the hemipterans Lethocerus, Belostoma, Ranatra, Buena, Notonecta, the beetle Dytiscus, and the mosquito fish Gambusia. Prey groups include the hemipterans Trichocorixa and the larval mosquitos Culex and Psorophora.

2

EARTHWORM LOCATION BY FORAGING GARTER SNAKES, THAMNOPHIS SIRTALIS. J.C. Gillingham and M.A. Weins.* Central Michigan University, Mt. Pleasant, MI.

A north temperate population of eastern garter snakes, Thamnophis sirtalis, was studied to ascertain the search pattern and cues involved in their location of earthworm prey. Snakes were observed under natural conditions from an elevated scaffolding using portable event recorders and photographic equipment. The garter snakes studied used an active foraging pattern and were capable of locating earthworms at a top observed rate of 13/hr with the maximum number of worms in any one snake being 24. Prior to earthworm capture garter snakes demonstrated an elevated tongue-flick rate followed by a shallow lunge into the soil and subsequent worm retrieval. Tests run in the laboratory showed that fresh-captured garter snakes could distinguish earthworm castings from ordinary soil and other substrate material. A significant preference was shown for castings less than 24 hrs old. Eastern garter snakes are apparently capable of successful foraging using earthworm castings as location cues.

3

THE MEASUREMENT OF INDIVIDUAL ASSOCIATION. S.J. Cairns and S.J. Schwager*.

A variety of indices of association are currently in use in field studies of animal behavior. Two of the most common ones are borrowed from ecological studies of species association and may not be the best choice for the measurement of individual association. The behavior of these and other indices is compared using simulations and analytic techniques. Several models of individual association are proposed, and the maximum likelihood estimator for p , the proportion of time spent together by two animals, is derived. Simulations based on these models clarify the effect of sampling bias on the different indices and show the maximum likelihood estimators to be more accurate and precise than the species-association indices. The results clearly indicate which indices are more accurate when specific types of bias occur during sampling, and suggest the possibility of improving on these indices.

4

STATISTICAL METHODS FOR DETECTING MULTIPLE PATERNITY AND QUANTIFYING SPERM COMPETITION. D. G. Heckel. Clemson Univ., S. C.

When data are available on genotypes of mothers and their offspring, it is possible to test hypotheses concerning the population's mating system. A general method based on likelihood ratio tests is presented which allows a hierarchy of such hypotheses to be examined. These include random vs. non random mating with respect to genotype, single vs. multiple mating of females, and equal mixing vs. prior- or latter-sperm-preference patterns. This approach is valid for two or more alleles at each genetic locus, and hence combines the advantages of multiallelic methods of detecting three or more paternal alleles in progeny, and the "analysis of variance" method of Wilson (*Evolution* 35: 664) which is restricted to biallelic loci. The approach is most powerful when relatively large broods can be analyzed. Supported by Grant # BSR-8415756 from NSF.

5

VARIATION IN MALE MATING STRATEGIES OF THE CARPENTER FROG, RANA VIRGATIPES. M.F. Given. Univ. of Connecticut, Storrs.

A hypothesis is proposed suggesting that in prolonged breeding anurans, selection has favored small males investing most of their energy in growth if male reproductive success is strongly influenced by body size. A population of 75 adults was studied 1983-85 at Cedar Run Lake, Medford, N.J. Males are territorial and use physical interactions and vocalizations to defend calling sites. Variability in male behavior is apparent when 48mm snout-vent length is used as a criterion for division, the point beyond which peak intensity of vocalizations is constant. Small males differ from large males in that they a) have calls of lower intensity and higher dominant frequency, b) are more likely to retreat or be silent in response to playback stimuli, c) are more likely to adopt a satellite posture, and d) grow faster than larger males. In a playback experiment using stimuli of a small vs. large male, males responded to the call of the smaller male with more total notes and aggressive calls. Focal animal data suggest a trade-off between calling activity and growth.

6

WHISTLE REPERTOIRES OF TWO BOTTLENOSED DOLPHINS, Tursiops truncatus: MIMICRY OF SIGNATURE WHISTLES? Tyack, Peter L. Woods Hole Oceanographic Institution, Woods Hole MA 02543

The whistle vocalizations of two bottlenosed dolphins, Tursiops truncatus, were recorded at the Sealand Aquarium in Brewster, MA. A telemetry device, called a vocalight, was developed for this study to identify which dolphin within the group produced a vocalization. The vocalight is attached to a dolphin's head with a suction cup and it lights up a variable number of light emitting diodes depending upon the loudness of sounds produced by the dolphin.

77% of the identified whistles (219 out of 284) fell into two primary categories, type 1 and type 2. The remaining 23% of whistles fell into five secondary categories. Of the primary whistles produced by one dolphin, 78% were of type 1 (22% type 2), while 69% of primary whistles from the other dolphin were of type 2 (31% type 1). The result that each of the dolphins favored a different primary whistle supports the signature whistle hypothesis of Caldwell and Caldwell. But in the present study, both dolphins produced both primary whistle types. This may represent mimicry of signature whistles.

7

THE FUNCTION OF VOCAL DUETTING IN THE BAY WREN (THRYOTHORUS NIGRICAPILLUS). R.N. Levin. Cornell University, Ithaca, NY.

Many hypotheses proposed for the function of duetting suggest that duets are a signal between members of a mated pair of birds and therefore assume both long term mate fidelity and that learning is required for pairs to sing precisely. Bay wrens in Panama do not consistently exhibit long term pair bonds and in experiments where one member of a pair was removed from a territory, newly formed pairs sang well-coordinated duets within minutes of the arrival of the new bird on the territory. Experimental exchanges of birds between territories demonstrate that these results are not due to prior learning of residents' songs by floaters. Thus, duets must be signals from a mated pair to conspecifics outside of the pair bond. However, the most likely "outside of pair" hypothesis, territory defense, does not seem to be supported in bay wrens. Duets are not critical to successful territory defense; birds whose mate was removed did not lose their territories. Remaining hypotheses are being tested through playback and muting experiments. Results of this study suggest that male and female bay wrens are sending very different signals within their well-coordinated songs.

8

EFFECTS OF ANDROGEN AND ANTI-ANDROGEN ON THE BEHAVIOR AND REPRODUCTION OF FREE-LIVING HOUSE SPARROWS, PASSER DOMESTICUS. Robert E. Hegner and John C. Wingfield, Rockefeller University Field Research Center, Millbrook, NY 12545.

Plasma levels of testosterone in male House Sparrows are maximal during egg-laying, decline during incubation and the first 2/3 of the nestling stage, and rise again during the last 1/3 of the nestling stage. This pattern was altered by giving silastic implants of testosterone (T), the anti-androgen flutamide (F), or empty implants as controls (C) to males feeding nestlings. Feeding rates of the C-treated males declined significantly as plasma levels of T began to rise. Feeding rates of the T-treated males declined more rapidly, while those of the F-treated males continued to remain high throughout the nestling stage. As a consequence, the F-treated males fledged significantly more of their nestlings than did the T-implanted males. These results support previous suggestions that (1) high plasma levels of T inhibit parental behavior and (2) prolonged high levels of T reduce reproductive success in species with bi-parental care.

NEURAL CONTROL OF COURTSHIP BEHAVIOR IN MALE GARTER SNAKES. R.W. Krohmer and D. Crews. Inst. Reproductive Biol., Univ. of Texas, Austin.

Warm temperatures following a prolonged low temperature dormancy activates courtship behavior in adult male red-sided garter snakes (*Thamnophis sirtalis parietalis*). Male snakes exhibited varying degrees of courtship behavior in response to brain lesions received prior to hibernation. Animals failing to thermoregulate were found to have lesions in the anterior hypothalamus-preoptic area (AH-POA). Furthermore, snakes with a bilateral lesion in the medial preoptic area (MPOA) or AH-POA showed no courtship activity upon emergence. Males that received sham lesions or lesions outside of the AH-POA courted normally. Other reproductive measures were not altered by lesion placement. These findings suggest that perception of external temperature is important in the activation of courtship behavior and that the AH-POA is essential for the integration of this information. Supported in part by HD 07264, HD 16687 and RSDA MH00135.

COMMUNICATION ABOUT SHELL CONDITION DURING HERMIT CRAB SHELL EXCHANGES.

Brian A. Hazlett, Univ. Michigan, Ann Arbor

Individuals of *Clibanarius antillensis* usually exchange shells only when both individuals gain in shell adequacy. To investigate the mechanisms involved in this process, in 100 shell exchange interactions, the shell of the initiator was altered following a natural interaction in such a way as to try to change the outcome of the interaction. When only weight of the initiator's shell was altered, the outcome was not different in the second interaction if the shell was a *Nerita* or a *Cerithium*. When the internal volume of the initiator's shell was manipulated, the outcome changed in about 70% of the cases for all 3 shell species tested (a shell exchange became a non-exchange, a non-exchange became an exchange). When the shell was that of a *Cantharus* sp., either weight or volume manipulations altered the outcome of the interaction. The results suggest that during shell rapping by the initiating crab, the non-initiating crab gains information about the other crab's shell via vibratory signals which are correlated with shell internal volume.

INTRASPECIFIC VARIABILITY AND BEHAVIORAL CHANGES IN HERMIT CRABS IN ASSOCIATION WITH A SEA ANEMONE. W.R. BROOKS AND R.N. MARISCAL. AUBURN UNIV. AT MONTGOMERY, ALABAMA, AND FLORIDA STATE UNIV., TALLAHASSEE.

Two populations of the hermit crab *Pagurus pollicaris* Say were behaviorally distinct in that one population transferred more anemones (*Calliactis tricolor* (Lesueur)) to their gastropod shells than did the other. Both populations of *P. pollicaris* and one population of another hermit crab, *P. impressus* (Benedict), transferred fewer *C. tricolor* after four weeks in an aquarium than they did in their first week. The chemical presence of the octopus *Octopus joubini* Robson, however, increased the number of anemone transfers by both species of hermit crab. The more active anemone-transferring population of *P. pollicaris* was collected from an area with a greater density of *O. joubini* than the area of the less-active population. Therefore, the differences between the two populations of *P. pollicaris* may have been due in part to differences in predation pressure by *O. joubini* or other predators.

AXONAL BASIS IN THE DETERMINATION OF DIFFERENCES IN PIGMENT PATTERN BETWEEN BLACK AND WHITE AXOLOTLIS. G. Vlasto* and I. Brick. Univ. of Conn., Stamford, and New York Univ., New York.

Relative adhesive strength of subepidermal and somite surfaces was assayed by observing the degree of axonal branching on these surfaces. It is known that axons tend to branch more often on strong adhesive surfaces rather than on weak ones. Our results showed that in the black axolotl, its axons tended to branch more on these surfaces than those seen in the white, suggesting that black surfaces tend to be more adhesive than white ones. This could facilitate melanoblast migration in black animals. SEM observations showed a close association of black melanoblasts with their axons more so than seen in white axolotls. These observations along neural tube transplants suggests that black melanoblasts may use axons as additional substrate for migration. Skin grafts showed that white melanoblasts under black tissues have more extensive axon branching on their surfaces than black melanoblasts under black tissues suggest inherent differences between black and white melanoblasts. Graft results also show that black axons fail to enter the white tissues.

13

ULTRASTRUCTURAL EXAMINATION OF RANA PIIPIENS GASTRULATION. J. LeBlanc, M. Yoder*, and I. Brick. The College of Staten Island, CUNY, S.I., N.Y. and New York University, N.Y.

Rana pipiens embryos from late blastula through late gastrula are being examined utilizing scanning and transmission electron microscopy. During gastrulation, the body plan of the amphibian embryo is established. Gastrular movements appear associated with specific changes in shape and arrangement of cells. In early R. pipiens gastrulation, translocating cells proximal to the blastopore project extensive contacts to the dorsal and lateral blastocoel lining. Leading-edge cells of the advancing mesoderm/endoderm fold positioned against the dorsal blastocoel lining during gastrulation exhibit filopodia and lamellipodia extending to the blastocoel wall. Often, these processes appear to be making or to have made contact with processes from the cells of the blastocoel lining. The area of the inner ectodermal surface anterior to the mesoderm/endoderm fold exhibits apparently long cell processes.

14

LITHIUM CHLORIDE (LiCl) RESCUES ULTRAVIOLET LIGHT (UV)-INDUCED AXIS-DEFICIENT XENOPUS LAEVIS EMBRYOS. Kenneth Kao, Richard Elinson*, and Yoshio Masui., Dept. of Zoology, Univ. of Toronto, Canada.

The embryonic axis in frogs is determined by a cytoplasmic rearrangement before first cleavage of the egg. It is possible to prevent this rearrangement and subsequent axis development by using UV-light. When fertilised Xenopus laevis eggs are UV-irradiated before axis determination, they develop into radially symmetric embryos. We have found that brief treatment of these embryos with LiCl during cleavage rescues axial structures. The type of rescue depends on concentration and duration of exposure to LiCl. UV-irradiated, axis-deficient embryos exposed to low doses of LiCl develop axes consisting of somites but lacking head structures. With higher doses, they become anteriorised, forming only head structures. Embryos treated only with low doses of LiCl show slight abnormalities such as a curved axis. With greater exposure to LiCl, they develop only anterior structures. The rescue of anterior and dorsal structures indicates that LiCl is activating dorsal differentiation which is not otherwise expressed.

This work was supported by a grant from NSERC, Canada.

15

CHEMICAL INDUCTION OF A BLASTOPORE-LIKE STRUCTURE IN THE UNFERTILIZED, UNACTIVATED EGG OF RANA PIIPIENS. I.D. Zimmerman (intro. by M. DiBerardino). The Medical College of Pennsylvania, Phila.

Incubation of the unfertilized, unactivated egg of the frog Rana pipiens in a 10% amphibian Ringer's solution containing 1.64 μ M 12-O-tetradecanoyl phorbol acetate (TPA) induces the formation of a dorsal lip in the previously radially symmetrical cell. The dorsal lip appears precociously in about 2 hours or so and is followed in many eggs (50%) by the formation of lateral and ventral lips and a disappearance of the yolk laden vegetal region in imitation of the latter stages of gastrulation. Control eggs show no changes. The symmetry-breaking evidenced by the formation of the blastopore lip is an organizing event. It is hypothesized to result from a chemical reaction in a "far-from-equilibrium" system of the sort known as a "dissipative structure." TPA is assumed to trigger the reaction by virtue of its ability to stimulate protein kinase C.

16

ABERRANT PATTERNS OF ENZYME LOCUS EXPRESSION IN HYBRID BARBS. J.S. Frankel. Howard Univ., Washington, D.C.

The expression of isozymal subunits, encoded at 14 structural loci, was investigated in hybrid fishes from the teleost genus Barbus (Cyprinidae) resulting from parentals of increasing degrees of taxonomic (genetic) distance. The developmental schedules of isozyme expression were normalized for all intraspecific embryos and compared with those of interspecific embryos at corresponding stages of development. Taxonomic distance between parentals was determined by analyses of allelic frequencies. With increasing genetic distance between parentals, allelic expression was altered from synchronous expression to synchronous delay or precocious expression of embryonic genes as compared with that in intraspecific embryos. These observations support the hypothesis that structural gene expression is initially regulated by a pool of effector molecules whose concentration and increasing rates of synthesis are under maternal control and, therefore, species specific.

DEVELOPMENTAL EVIDENCE FOR AMPHIBIAN ORIGINS. J. Hanken. Univ. of Colorado, Boulder.

Contrasting patterns of early development among various species of frogs, salamanders, and caecilians have been cited as evidence of a polyphyletic origin of amphibians, and thus tetrapods, from fishes. I evaluated seven such characters with respect to their validity in phylogenetic analysis and their implications for the origins of Recent amphibians. For three characters--mesoderm, notochord, and somite formation, supposedly fundamental differences among the orders are based on consideration of relatively few species and may be blurred by a diversity of developmental patterns within orders, particularly the Anura. Four characters--block to polyspermy, primary germ cell formation, apical ectodermal ridge, and prechondrogenic limb condensations--do reveal consistent differences between at least two of the orders. In the absence of comparable data from putative ancestral taxa and other outgroups, however, it is inappropriate to interpret these differences solely as evidence of polyphyly. Available data do not provide unequivocal proof of any hypothesis of amphibian origins. Supported by NIH grant 1 R23 DE07190-01.

ULTRASTRUCTURE OF EXCRETORY SYSTEM MODIFICATIONS IN THE HOUSE CRICKET (ACHETA DOMESTICUS). S.W. Parker and J.H. Spring. Univ. of Southwestern Louisiana, Lafayette.

The excretory system of the cricket is unique in that the approximately 110 Malpighian tubules empty into a common ampulla which is completely separate from the gut, linked to the lower hindgut by a single ureter. This system has been investigated using light, scanning and transmission electron microscopy. Five bands of smooth muscle spiral the length of each tubule, which has two morphologically distinct regions. The distal 18% of the tubule is transparent and consists of squamous cells with nuclei about one-half the size of those in the rest of the system. The remainder of the tubule is twice the diameter of the distal tip and consists of pigmented cuboidal cells. Cell number increases dramatically as the tubule transitions into the ampulla, which is composed of a single layer of columnar cells. A brush border of densely-packed microvilli lines the entire length of the tubule and the ampulla. The valved, muscular ureter, of ectodermal origin, actively pumps fluid from the ampulla into the hindgut. The production of hyposmotic urine when the system is stimulated *in vitro* is consistent with a reabsorptive function for the ampulla. Supported by NSF grant DCB84-16829.

EFFECTS OF UNRESPONSIVE, A TRANSIENT MUSCLE DYSFUNCTION MUTATION OF XENOPUS LAEVIS, ON THE EXTRACELLULAR MATRIX. J. Tompkins*, Y. Tai*, Q. Le*, C. Olsen*, J. Fuseler*, C. Kaye, R. Tompkins. Tulane University, New Orleans.

Homozygous *unresponsive* embryos show delayed muscle function during embryogenesis. Mutant nerve function and electrophysiological responses of mutant muscle cells are normal. Mutant muscles contract normally in response to caffeine and the calcium ionophore A23187 during the affected stages, despite myofilament disorganization. Chlorotetracycline fluorescence was used to assess calcium localizations in living muscle blocks. Calcium is confined to terminal vesicles in mutant muscle cells during affected stages; many normal embryonic muscle cells and mutant cells after recovery show calcium accumulation in the myoplasm. Mutant animals have reduced collagen deposits in most tissues and electrophoretic analysis of purified collagens showed that one collagen monomer and one dimer were not present in detectable quantities in mutant animals. These results, along with previous work showing that mutant muscle cells can recover normal function following association with normal tissues, suggest that the extracellular matrix plays an important role in embryonic muscle function.

EXPRESSION AND CURE OF CALCIUM METABOLISM ABNORMALITY IN CULTURED UNRESPONSIVE XENOPUS LAEVIS CELLS. P. Kelly*, K. Hanft*, J. Fuseler*, D. Reinschmidt*, R. Tompkins. Tulane University, New Orleans.

Normal and mutant *unresponsive* stage 22 to 25 muscle blocks were dissociated and cultured in modified L-15 medium. Chlorotetracycline fluorescence was used to assess the calcium content of cultured cells. Three day cultured mutant cells were less fluorescent than normal cells, paralleling the results observed *in vivo*. Cultured mutant muscle cells do not recover normal calcium levels within 10 days as they do *in vivo*. Since interaction with normal cells causes early recovery *in vivo*, the effects of culture medium from normal three day cultures on similar mutant cultures was tested. Such treatment, as well as treatment with extracts of normal embryos, caused recovery within 12 hours. These results support the hypothesis that extracellular material produced by normal cells is defective or absent in mutant cultures and that this material is essential for normal calcium metabolism during embryogenesis.

Supported by NSF grant BNS 84-17818

21

COINCIDENT PEAKS IN SERUM OSMOLALITY AND HEAT TOLERANCE RHYTHMS IN SEAWATER-ACCLIMATED KILLIFISH (FUNDULUS HETEROCLITUS). A.J. Bulger. Univ. of Virginia, Charlottesville.

Killifish (Fundulus heteroclitus) maintained in seawater (33 ppt S) at constant temperature (27°C) under a LD 14:10 photoperiod showed daily rhythms in both serum osmolality and heat tolerance (critical thermal maximum). The two rhythms appear to be in phase, each with a single peak at midday. A model is proposed which links the two rhythms functionally, and relates these phenomena to data on fresh- and brackish water-acclimated fish.

22

THE PHYSIOLOGICAL AND ECOLOGICAL CONSEQUENCES OF BURROW-DWELLING TO THE GREEN IGUANA (IGUANA IGUANA). D.G. Brust. University of Arizona, Tucson.

Most adult green iguanas (Iguana iguana) select sleeping sites high in trees. I have been studying a group of iguanas that, in contrast, regularly uses ground burrows as sleeping sites. By overwintering underground, the animals maintain nighttime body temperatures 8-10°C warmer than tree-dwellers. I compared the effects of a high nighttime body temperature on the ecology and digestive physiology of both groups. Burrow-dwellers have a longer activity period than tree-dwellers and allocate less time to basking before beginning other activities. Even during the non-breeding season, burrow-dwellers regularly return to the same sleeping sites and defend them against other iguanas; tree-dwellers do not. Burrow-dwellers also process food faster than tree-dwellers (passage time - 5.5 vs 6.7 days) and may be digesting food more efficiently. Sleeping in burrows may enable iguanas to have higher rates of energy acquisition, and thus enhance growth rates and reproductive success.

23

GEOGRAPHIC VARIATION IN THE RACCOON (PROCYON LOTOR) AND ITS RELATIONSHIP TO ENVIRONMENT. Mark E. Ritke and Michael L. Kennedy*. Memphis State University, TN.

Geographic variation in the raccoon (Procyon lotor) was assessed using univariate and multivariate analyses of twenty-two cranial characters. All characters showed significant interlocality variation for both sexes. Principal component I (a size factor) revealed longitudinal patterns of size variation for both sexes with larger individuals occurring in the western United States and Mexico and smaller in the southeastern United States and Florida. Larger size was positively associated with climatic variables expressing seasonality; smaller body size was negatively associated with evapotranspiration, temperature, precipitation, and humidity. Patterns of interlocality heterogeneity in eastern North America agree with several biological explanations of size variation proposed for homeotherms.

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TEMPERATURE EFFECTS ON WIND TUNNEL FLIGHT OF FRUIT BATS. R.E. Carpenter (intro by W.J. Wilson). San Diego State Univ., CA

Metabolic measurements on flying bats show that they produce heat at 15-20 X their resting rates, with a strong correlation between ambient temperature (T_a) and body temperature (T_b) in flight. Unlike birds, which increase pulmonary ventilation and evaporative water loss (EWL) at high T_a , bats have coupled respiratory and wingbeat cycles, so that EWL is limited to about 10% of heat production. Continuous measurement of foot temperatures (T_f) showed that at $T_a > 15^\circ\text{C}$, blood flow to feet and wings was increased for heat loss. This response was less effective at high T_a , when ($T_b - T_a$) became too small. Bats could not continue flight at $T_a > 25-30^\circ\text{C}$. At $T_a < 15^\circ\text{C}$, heat was conserved by minimizing blood flow to the wings. At $T_a < 10^\circ\text{C}$, wings often became too chilled to function properly, and bats crashed even when $T_a > 37^\circ\text{C}$. Thus, bat flight is more thermally restricted than bird flight by decreased convective cooling when hyperthermic, and a lack of insulation to preserve wing coordination at low T_a . This pattern is associated with absence of daytime flight and the reduction of bat activity during winter in temperature zones.

MAXIMAL RUNNING SPEEDS OF BIPEDAL AND QUADRUPEDAL RODENTS: RELEVANCE FOR COEXISTENCE? M. Dawdan and I. Garland*, University of California, Irvine.

Maximal sprint speeds of nocturnal desert rodents measured in the laboratory on a photocell-timed track were:

Species	n	\bar{x} Mass (g)	Speed (km/h)
			mean \pm SD, high
<u>Perognathus</u>			
<u>baileyi</u>	9	39.1	12.4 \pm 1.33, 14.9
<u>fallax</u>	12	18.0	12.8 \pm 0.91, 14.2
<u>longimembris</u>	13	8.9	9.9 \pm 0.74, 11.7
<u>parvus</u>	9	24.4	12.5 \pm 1.57, 14.6
<u>Microdipodops megacephalus</u>			
	8	12.3	10.9 \pm 1.59, 14.2
<u>Peromyscus</u>			
<u>crinitus</u>	14	13.7	11.4 \pm 0.82, 12.5
<u>eremicus</u>	7	19.8	13.1 \pm 1.05, 14.2
<u>maniculatus</u>	5	20.0	12.7 \pm 1.04, 13.8
<u>truei</u>	2	19.3	14.3 \pm 0.16, 14.4
<u>Onychomys torridus</u>			
	4	19.4	10.6 \pm 0.41, 11.0
<u>Neotoma lepida</u>	10	110.6	17.1 \pm 1.28, 19.1

All are lower than maximal field speeds of Dipodomys deserti (112 g, 30 km/h, our observations), D. merriami (35 g, 26 km/h; cf. 32 km/h, Kenagy, 1973, Ecology), and D. microps (56 g, 21 km/h, Kenagy, *ibid.*). Higher sprint speeds may facilitate predator avoidance and allow Kangaroo rats to exploit open microhabitats.

BEHAVIORAL RESPONSES DURING STAGED ENCOUNTERS BETWEEN THE SUSPECTED LIZARD COMPETITORS ANOLIS SAGREI AND ANOLIS CAROLINENSIS. R.R. Tokarz and J.W. Beck, Jr.* University of Miami, FL.

Intra- and interspecific encounters were staged with adult A. sagrei and A. carolinensis, two species believed to be in competition in southern Florida. The agonistic behavior of resident males toward heterospecific intruders was much less intense than that of resident males toward conspecific intruders, suggesting that behavioral interference is unlikely to be an important factor in competition between these two species. In staged encounters between males and females, courtship was usually and copulation invariably limited to the conspecific encounters, suggesting that sexual interactions between these species are not important under natural conditions.

FORAGING SUCCESS AND SPATIAL PREFERENCES OF INDIVIDUAL BROWN CAPUCHIN MONKEYS.

C. H. Janson, Department of Ecology and Evolution, SUNY, Stony Brook, NY 11794.

In the wild, individual brown capuchin monkeys (Cebus apella) spend very different amounts of time in different spatial positions within their group. An individual's foraging success depends both on its spatial position in the group and on its social status. Individuals of high dominance rank occupy the areas of highest foraging success, but these same areas yield little to subordinates, which are frequently displaced from food trees. Subordinates actually maximize their food intake by choosing areas of lower absolute foraging success away from the dominant group members. Thus, spatial structure in brown capuchin groups seems to arise from individual efforts to increase foraging success within the constraint of a 'despotic' social system.

FEEDING PREFERENCES OF FERAL BURROS IN A TROPICAL ECOSYSTEM. R. Rudman, A.B. Swanbeck* and D.W. Nellis*. Cornell Univ., Ithaca, NY and Division of Fish & Wildlife, St. Thomas, USVI.

The burro (Equus asinus) evolved in the arid regions of northern Africa, and thriving feral populations have caused problems in the desert American southwest. Concern over the effects of a growing feral burro population on St. John, USVI, prompted a study of burro ecology here. Two methods were employed to study feeding preferences. Direct observations of feral animals and also of a tamed burro captured for this purpose were conducted. Analysis of fecal samples collected monthly also provided information on feeding habits. Both methods indicated that, even in a tropical forest ecosystem, grasses are the preferred food item, followed by legumes, then other forb and browse species. Preferences for specific plant species may significantly alter the structure of the island vegetation, either by eventual elimination of the preferred plants or by enhanced seed distribution of certain species.

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ON THE RELATIONSHIP BETWEEN FIRE PERIODICITY, PLANT STRUCTURE AND HERPETOFAUNAL COMMUNITIES IN FLORIDA. H.R. Mushinsky and E.D. McCoy. Univ. of South Florida, Tampa.

Amphibians and reptiles were collected continuously by an array of drift fences and pitfall traps. Four plots of land (app. 1 ha each) have been burned on 1 yr, 2 yr and 7 yr cycles (since 1976); or protected from fire to serve as a control plot (cp). The structure of the plant community at ground level was assessed. Estimates of bare ground, leaf litter and overstory (up to 30cm above ground) taken on each plot in 1983 and 1985, and counts of herbs and grasses were used to construct a height-density vegetation profile. Herpetofaunal communities appear to respond to changes in the herb/grass layer. Cp had sparse herbs and grasses, a thick layer of litter and few animals. Also the dense herbs/grasses on the 2 yr plot prohibited herpetofaunal residency. Burning yearly reduced both litter and grasses, leaving an open habitat that supported a dense population of *Cnemidophorus sexlineatus*. The 7 yr plot, which resembled cp prior to burning, was temporarily opened by the fire, and had the greatest herpetofaunal diversity.

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PLANT-ANIMAL POLLINATION SYSTEMS 2. FEWER POLLINATOR THAN PLANT SPECIES. H. Wells. Univ. of Tulsa, OK.

A differential equation model was used to study the effects of pollinator individual-constancy foraging behavior on a plant-pollinator system. Individuals of a single pollinator species or population (e.g., bees from a hive) visited two plant taxa (species, varieties or morphs) but any individual was relatively constant to one of the plant taxa. Analyses examined conditions for equilibria, and stability as pollinator individual constancy increased in a two-plant one-pollinator system. Individual constancy reduced the probability of plant minority taxon extinction, and increased the likelihood of a stable system equilibrium involving more plant species than pollinator species.

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STUDIES OF DAMSELFISH GARDEN COMMUNITIES ASSOCIATED WITH ACROPORA COLONIES ON THE GREAT BARRIER REEF. L.G. Harris and A.W.D. Larkum. Univ. of New Hampshire, Durham, and Univ. of Sydney, Sydney.

Comparisons were made of the fauna inhabiting the gardens of three species of damselfish with that associated with dead *Acropora* skeletons outside damselfish territories. Gardens were sampled at One Tree Island and Lizard Island on the Great Barrier Reef. The gardens were produced by *Dischistodus perspicillatus*, *Eupomacentrus nigricans* and *Hemiglyphidodon plagiometapon*. Animals were extracted with a 6% solution of MgCl₂ in seawater. The density of the fauna was related to algal biomass. An experiment was run to compare early community development on newly killed coral skeletons placed inside and outside damselfish territories. The density of invertebrates was significantly higher inside damselfish gardens than on coral skeletons exposed to fish grazing. Copepods comprised the dominant group in the gardens of all three fish species. Community development on newly cleaned coral skeletons was similar, but certain algal species grew much faster when damselfish had direct physical contact with the substrates, suggesting a possible role for the fish in the earliest stages of garden development.

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LET US NOT FORGET THE PAST: FUNCTIONAL ANALYSIS OF A TROPHIC ASSEMBLAGE. L. Kaufman.

New England Aquarium, Boston. The Great Barrier Reef is inhabited by hundreds of planktivorous fishes, of which 50 or more species can occur at any one site. Models for species coexistence are reexamined here in light of new data on distribution, functional morphology, feeding kinematics and behavior of planktivores. The diurnal planktivore guild, if it can be called one, is composed of distinct species subgroups. Species segregate by position on the continental shelf, zone on a reef, microhabitat within a zone, and feeding height in the water column. They vary in mouth size, jaw protrusibility, feeding velocity, body form, and color pattern. Similar species differ in feeding plasticity when from different clades. Where differences were expected they were not found: individuals tended to associate in large schools with conspecifics or the next most similar species. Where differences were found they were not expected: functional variation was often tied to primitive characters of a genus or family unrelated to present patterns of resource utilization. Great care must be taken before testing competition theory on a system so rich in historical peculiarities and selective forces other than competition.

BENTHIC FAUNAL ZONATION AT A SUBTIDAL ROCK LEDGE IN THE CENTRAL GULF OF MAINE. J.D. Witman and K.P. Sebens. Mar. Sci. Lab. Northeastern University, Nahant, MA.

The abundance and distribution of benthic macroinvertebrates at Cashes Ledge was determined by quantitative photography from the Johnson Sea-Link submersible. Three faunal zones were observed. Zone 1 extends from the top of the ledge at 28 m to 40 m depth and is characterized by sheet-like sponges (Halichondria panicea) and dense aggregations of anemones (Metridium senile). A striking increase in invertebrate species richness at 40 to 48 m depth marked the beginning of Zone 2. The most conspicuous macrofauna in Zone 2 (~45-70 m depth) were upright and mounding sponges, anemones (Tealia crassicornis, Bolocera tuediae), comatulid crinoids, brachiopods, and ascidians. Zone 3 is a soft substratum assemblage extending from 70 m to at least 100 m depth. Polychaetes (Myxicola infundibulum) and cerianthid anemones (Cerianthus borealis) attained high densities in Zone 3. Experimental manipulations were established to test the role of predation and recruitment in maintaining depth zonation on hard substrata.

(Supported by the National Undersea Research Program, NOAA.)

THE ROLE OF BRYOZOANS IN THE BENTHIC COMMUNITY AT LOW ISLAND, ANTARCTICA. J. E. Winston and B. F. Heimberg. American Museum of Nat. Hist., New York.

In the primarily suspension-feeding community in 80-100 m at Low Island (So. Shetland Islands) the four most abundant bryozoan species have bushy erect colonies that may comprise a third of the benthic biomass. Trawl samples taken over the course of the austral summer and fall showed that the most common species, Carbasea ovoidea, is an annual, with high fecundity over a short reproductive season. The other species are perennials, showing yearly growth bands and lower fecundities over more extended reproductive periods. Colonies provide shelter for numerous motile invertebrates fed upon by demersal fish. Bryozoans suffer little predation from fish, but are found in stomach contents of echinoids and the large isopod Glyptonotus. Analysis of bryozoan gut contents showed that they ingest primarily small diatoms (under 40 μm in size) and thick-walled cysts (under 10 μm in size) that may be diatom resting stages.

DESCRIPTION OF A HYDROCARBON-SEEP COMMUNITY ON THE LOUISIANA SLOPE. G.J. Denoux, M.C. Kennicutt, II, R.R. Bidigare, J.M. Brooks, R.R. Fay, Texas A&M Univ., College Station, M.L. Jones, Smithsonian Inst., Washington, D.C., and R.D. Turner, Harvard Univ., Cambridge, MA.

Fourteen separate trawls in areas of known hydrocarbon seepage in the Gulf of Mexico indicate that chemosynthetic, vent-type taxa are important components of Gulf of Mexico deep-sea ecosystems. Initial analyses show that the taxonomic composition of the communities associated with these hydrocarbon seep sites (an area of at least several hundred square miles) is similar to those found at hydrothermal vents and the hypersaline, cold water, hydrogen sulfide seep at the Florida Escarpment. Associated with the chemosynthetic, vent-type taxa is an abundance of non-chemosynthetic species. The communities include vestimentiferan tubeworms, bivalves, mytilids, neogastropods, archeogastropods, decapods, barnacles, octacorals, ophiuroids and fish. The general nature of the mechanism of enrichment (areally and with time) and the enhanced community diversity suggest the possibility that these oil seep communities may indeed be the progenitors of the deep-water vent sites.

THE EFFECT OF SUMMER HYPOXIA ON PLANKTON DENSITY AND COMMUNITY STRUCTURE OFF THE LOUISIANA COAST. T.L. Boullion. Seafood Division, Louisiana Dept. Wildlife and Fisheries, Baton Rouge.

As part of LDWF's ongoing program of monitoring of the Louisiana Offshore Oil Port (LOOP) Project, zooplankton was collected monthly from 8 stations in Louisiana coastal waters. Environmental parameters were measured using a Martek Mark 6 CTD system, and included salinity, conductivity, temperature, and dissolved oxygen. Periodic hypoxia is common in the summer months in the northern Gulf of Mexico, and occurs mainly in the bottom two meters of the water column. A sharp gradient is found between the hypoxic (0.5 to 1.0) and the saturated (5.0 to 7.0) levels, forming an interface as narrow as 1 meter in depth. At these interfaces, zooplankton aggregations with densities as high as 200,000/m³ can be found. Calanoid copepods (especially Acartia tonsa and Labidocera aestiva) dominated most of these communities, except where chaetognaths (Sagitta spp.) and sergestids (Acetes americanus and Lucifer faxoni) were significant. Hypoxic waters yielded very low densities, consisting mainly of the calanoid copepods Acartia tonsa and Eucalanus pileatus. Saturated waters were dominated by hydrozoans, ctenophores, and larvaceans.

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THE ORGANIZATION OF AN ECOLOGICALLY SIMPLE ASSEMBLAGE: THE EPIFAUNAL NEMATODES OF BAY SCALLOPS. Kevin M. Sherman Florida State University, Tallahassee, FL

The fauna and flora of bay scallops was examined from twenty-five consecutive monthly collections. Comparisons with sediments and seagrasses showed that the scallop-shell nematode fauna was unique in that it had much lower diversity and was dominated by three species, *Viscosia macramphida* (V), *Chromadora nudicapitata* (C), and *Syringolaimus striatocaudatus* (S). These species accounted for 74% of the nematodes on scallops. This simplicity was exploited in field and laboratory experiments designed to uncover the ecological factors responsible for the temporal variation of the dominant species.

V is most abundant on scallop shells in late summer, coinciding with a peak in diatom abundance, its preferred food. C is abundant in spring on young scallops that have recently detached from *Thalassia testudinum* blades. At that time, C is the most abundant nematode on the blades, so its abundance on newly settled scallops is a reflection of the recent history of the shell. S was the overall dominant on scallop shells once C populations declined. A laboratory culture experiment showed that S could outcompete but not eliminate C under natural conditions.

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USE OF PRESENCE-ABSENCE DATA IN THE STUDY OF COMMUNITY STRUCTURE AMONG MARINE GASTROTRICHA. W.D. Hummon, Ohio Univ., Athens.

Presence-absence data, like hydrogen bonds, may be weak individually, but in aggregate can show strength and properties not otherwise seen. Eighty spp. of gastrotrichs were found in 52 intertidal beaches sampled around the coastline of the British Isles. Coefficients of association were calculated for permutation pairs of the 17 most commonly encountered spp. All spp. were found on between 15 and 42 beaches. On average, each sp. was involved in 3 sig. pos. associations (+A's) and 1 sig. neg. association (-A), for a Total (TA) of 4. The dispersion of +A's among spp. was regular but not sig.; that of -A's was aggregated but not sig.; though that of TA's (+A's + -A's) was both regular and sig. This indicates that spp. with many +A's had none to few -A's and that spp. with few +A's tended to have more -A's. Secondly, whereas naive competition theory has held that non-congeners should show +A's more often than congeners and that congeners should show -A's more often than non-congeners, here the opposite was the case, and significantly so. This indicates that accommodation between congeners was more common in these animals than exclusion.

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PREDICTING KEY SPECIES INTERACTIONS IN GUILDS OF PREDATORS WITH SIZE-STRUCTURED POPULATIONS. S.A. Wissinger, Purdue University, West Lafayette, IN.

Overlap indices which describe the potential for predation vs. competition were used to identify the subset of possible interactions most likely to affect coexistence among 14 species of dragonfly larvae (Anisoptera:Odonata). Detailed study of the spatial and temporal distribution of larvae in a small Indiana pond revealed that many species which overlap extensively have highly size-structured populations. Because dragonfly larvae are dietary generalists, similarly sized instars which co-occur in time and space are potential competitors, whereas disparately sized instars should interact as predators and prey. An index was developed to calculate the proportion of all encounters between pairs of species which are potentially predatory or competitive by accounting for both the densities and size ratios of all co-occurring instars. Predictions are made about which species interact most frequently, the relative occurrence of predation and competition, and how intensities of interactions vary during development. Such information is useful for designing manipulative experiments with dragonfly larvae or any other taxa with size-structured populations.

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A METHOD FOR OPTIMIZING SAMPLE SIZE. W.E. BROS AND B.C. COWELL*. UNIV. OF SOUTH Florida, Tampa.

The appropriate sample size (number of replicates) for an experiment is a function of sample precision and sample effort. Sample precision refers to the ability to detect differences between treatments and sample effort refers to the cost in time or money required to achieve a particular level of sample precision. As sample size increases, both sample precision and sample effort increase. Here we present a graphic method for simultaneously determining the effects of sample size on sample precision and sample effort. The method provides the investigator with information needed to choose an appropriate sample size.

The method involves the generation and interpretation of the functions, sample precision versus sample size and sample effort versus sample size, from a preliminary sample collection. Two techniques are described and compared for extracting a range of sample sizes from a preliminary sample collection. The standard error is used as an estimate for sample precision, while sample effort is measured by the factor which imposes the greatest limitations on sample size (e.g. cost of sample processing).

ELEPHANT TRUNKS: MORPHOLOGY AND MOTION. L.J. Croner and S.A. Wainwright. Duke University, Durham, N.C.

Soft tissue appendages are bio-mechanically interesting because they utilize mechanical principles different from those used in appendages with bony frameworks, and because they are versatile. An elephant's trunk is a long tapering structure, nearly circular in cross-section, pierced by two nostrils running up its center, and consisting entirely of soft tissue. Investigation of an embalmed trunk of an Asian elephant confirms that it has four distinct muscle masses--a radial, a longitudinal, and two oblique layers. Analysis of films taken of an elephant as it lifted a payload with the tip of its trunk indicates that the trunk is capable of shortening at least 30% of its maximum length, and that it has three sections, each of which shortens at a predictable time during a lift. Work in progress analyzes the sequential strain patterns at different parts of a trunk during the performance of other tasks.

TOUGHNESS IN HORSE HOOF KERATIN: A KEY PROPERTY IN THIS STRUCTURAL BIOMATERIAL. J.E.A. Bertram. Univ. of Chicago.

An engineering fracture mechanics approach was used to quantify the fracture resistance of equine hoof wall. The effect of morphological organization and hydration level were investigated. Tensile tests were also conducted.

Hoof wall has greatest fracture resistance for cracks running vertically, parallel to the tubular component. The toughness in this direction was nearly 3 times greater than the weakest direction, in which the crack ran parallel to the material between the tubules. The tubules of the wall appear to reinforce against fracture along the weak plane (parallel to the intertubular keratin) and the entire wall organization provides the means to limit and control fracture in this tissue.

Horse hoof keratin proved to be more responsive to variations in hydration level than other hard keratins, the stiffness increased approximately thirty times from saturation to dehydration. Fracture toughness was maximum at an intermediate hydration level which corresponds to that under which the majority of the hoof wall operates *in vivo*.

INFLUENCE OF LOAD CARRYING ON BONE MODELING DURING GROWTH. A.A. Biewener and J. Bertram. Univ. of Chicago, Chicago, IL

The purpose of this study was to test the hypothesis that increased bone loading stimulates increased bone mass during growth to maintain peak bone strain similar to unloaded animals. Growing chicks were trained to carry 20% of their body mass while running at 60% of their top speed. *In vivo* strains were recorded from strain gages at six sites on the tibiotarsus at 4, 8, and 12 wks of age. Peak strains recorded at each site were 1.17 ± 0.03 times greater when the animals carried a load, reflecting the 20% increase in mass. Peak strains at 60% top speed, carrying a load; however, were greater (1.27 ± 0.59 times) than those recorded from chicks that had been previously exercised at 35% of top speed unloaded. Indeed, comparison of peak strain at the same speeds (unloaded) in the two exercise groups indicated no difference ($p > 0.05$) in peak strain levels. These data show no adaptive increase in bone mass during growth in response to increased load bearing by the tibiotarsus of this species. This finding conflicts with data for mature sheep and pigs, and does not support our hypothesis. (Supported by The Whitaker Foundation).

THE INVASION OF THE PERIOSTEUM. S.F. Tarsitano and B.W. Oelofsen. Queens College of CUNY, New York and Univ. of Stellenbosch, Stellenbosch.

Although there have been many explanations as to the reasons behind fenestration of the tetrapod skull, none have a basis in either bone or muscle function. It is our contention that all striated muscle attaching to bone must do so at very low angles of insertion. In this way the periosteum can best resist the applied tension of the contracting muscle. We have tested this hypothesis by studying jaw adductor and hindlimb muscles of turtles, lizards, crocodilians and birds by dissection and through the use of the scanning electron microscope. We have found that virtually all muscles studied invade the periosteum at less than twenty degrees. Thus, the doming of the cotylosaur skull led to the medial migration of the jaw articulation, generating greater torque. However, this migration also caused the *M. pseudotemporalis* and *M. adductor externus* to invade the periosteum at high angles. This dilemma necessitated the fenestration of the temporal region, thus affording the muscles a low insertion angle on the rim of the fenestra.

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SWIMMING DYNAMICS OF A SMALL SEMI-AQUATIC MAMMAL. F.E. Fish. West Chester Univ., West Chester, PA.

The surface swimming of rice rats (*Oryzomys palustris*) was examined by film analysis of individual animals locomoting at various velocities. Thrust was produced by alternate strokes of the hindfeet in the paddling mode. The propulsive cycle was found to remain constant at 5 Hz over the range of velocities. The paddling mode was divided asymmetrically into power and recovery phases, representing 42 and 58 percent of the total cycle. Both phases were characterized by high angular velocities, but the hindfeet during the power phase showed a long radius of rotation in conjunction with increased surface area for effective thrust production. The energy expended in paddling was calculated from a hydrodynamic model using blade-element theory. The mean mechanical efficiency was 0.25. Substantial energy losses were incurred due to the recovery phase and acceleration of the hindfeet and entrained water mass. In comparison to other swimming vertebrates, energy utilization was low due to a lack of specific morphological adaptations for swimming.

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EVALUATING MECHANISMS OF UNDULATORY LOCOMOTION. K.S. Hoff, Dalhousie Univ., Halifax, N.S.

Most aquatic vertebrates use lateral undulation for propulsion. This requires that waves of bending travel along the body from anterior to posterior. Travelling waves of bending can be produced by three patterns of muscular contraction: 1) waves of contraction can travel from anterior to posterior, 2) all the axial muscle on one side can contract simultaneously, alternating with the other side, or 3) waves can be generated by contraction of only the anterior axial muscles and then passively transmitted posteriorly. Several methods were employed to distinguish among these mechanisms using anuran larvae. The body was treated as a variably flexible beam, and predictions of wave form were made on the basis of the three patterns of muscle contraction. Kinematic data from high-speed cine of normal swimming and mechanical oscillation of anaesthetized and curarized animals were used to test the predictions. Analyses were compared to EMG recordings. This study of anuran larvae shows that the pattern of muscle contraction during undulatory swimming varies among species and also within species at different swimming speeds.

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WHALE BLUBBER ELASTICITY. L.S. Orton and P.E. Brodie.* Duke Univ., Durham, N.C., and Bedford Inst., Canada.

We simulated swimming in a dead fin whale, 20 m long, by bending it with steam winches and showed that the blubber stretches and compresses longitudinally by +/-10-15%. Fin whale blubber is fat plus 25+% by volume collagen in an oriented array. In biaxial tension tests, 1 m² blubber samples demonstrate standard J-shaped stress/strain and elastic recovery curves. Our evidence suggests that the low modulus is related to fiber rearrangement within the blubber, and the high modulus is related to the compression resistance of a constant volume tissue.

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SUSPENSORY SUPPORT AND SKELETAL LOADING: AN IN VIVO BONE STRAIN ANALYSIS OF TWO-TOED SLOTHS. S.M. Swartz. University of Chicago.

Suspension of an animal's body by its limbs during support and locomotion creates a mechanical environment for the limb skeleton which is fundamentally different from that imposed on the limb by standing, walking, etc. An *in vivo* bone strain analysis of the forelimb of the habitually suspensory two-toed sloth (*Choloepus hoffmani*) was carried out to determine the patterns of bone loading associated with this unique form of locomotion. Rosette and single element strain gauges were attached to sites on the humerus, ulna and radius, and strain recordings were coordinated with films of the animal's movements. Strain values indicate that sloth limb bones are loaded in bending, with either tension or compression superimposed on the bending in some trials. The peak strain magnitudes were found to be far lower than those recorded from other mammals. Further, the orientation of principle strains demonstrates that largely off-axis principle strains predominate, even during quiescent hanging.

PREY AND PREY PROCESSING IN BLIND SNAKES OF THE GENUS *TYPHLOPS*. Richard Thomas. Univ. of Puerto Rico, Rio Piedras.

Typhlops richardi, studied at a site in Puerto Rico, fed principally on ants of certain species and secondarily on termites. Similar prey was taken by other Antillean species. Feeding by captive snakes showed very rapid sequential processing of the small prey. X-rays of the excursions of the maxillo-pterygoid linkage along with feeding observations demonstrate the mechanism for rapid ingestion of prey.

FREQUENCY RESPONSE CHARACTERISTICS OF NEURONS IN THE MEDULLARY ELECTROSENSORY NUCLEUS OF THE LITTLE SKATE. J. G. New, Dept. of Biology, Wesleyan University, Middletown, CT 06457

Single units within the dorsal octavolateralis nucleus (DON) were studied to determine the response of specific cell classes to electric stimuli of different frequencies. Mature specimens of the little skate, *Raja erinacea*, were anesthetized, decerebrated, and immobilized with tubocurarine chloride. Units recorded within the DON were classified as efferent fibers of the anterior lateral line nerve (ALLN), neurons ascending from DON to the lateral mesencephalic nucleus (LMN) or provisional interneurons, by their responses to anti- and orthodromic stimulation from ALLN and LMN. Tuning curves were generated for cells by measuring maximum firing rate (minimum interspike interval) through a range of frequencies (0.1-25 Hz) at given stimulus intensities. Stimuli were presented via a local dipole in the receptive field of the cell studied. All cell types studied showed a gradual increase in maximum firing rate from 0.1 through 5.0 Hz. The responses dropped rapidly from 10-15 Hz, the cell following the stimuli with 1-2 spikes/cycle. No responses above resting activity were seen above 20 Hz. The similarity in frequency response characteristics among primary ALLN efferents, interneurons, and ascending DON efferents make it appear unlikely that cells within DON selectively filter specific frequencies of behavioral significance to the skate.

ATROPHY OF MUSCLES PROXIMAL TO AUTOTOMIZED LIMB STUMPS IN CRABS. Stacia Moffett. Washington State University, Pullman.

In crabs, leg injury often evokes autotomy, the discarding of the distal part of the limb at a fracture plane near the base. Subsequently, the leg muscles proximal to the fracture plane undergo pronounced atrophy. I quantified the atrophy of these muscles by comparing the wet weights of individual muscles from an intact limb and the corresponding, contralateral muscles of an autotomized limb. For the crab *Uca pugnator*, 32 muscle pairs from 8 crabs were weighed. Muscles proximal to the limb stumps weighed an average of 69% of the contralateral, control muscle weights. For the crab *Carcinus maenas*, muscles proximal to limb stumps averaged 53% of the weight of contralateral, control muscles in 75 muscle pairs from 17 crabs. The degree of atrophy is correlated with time since autotomy (or growth of the limb bud) and with number of limbs autotomized. Factors which could contribute to this atrophy include disuse and/or catabolism to satisfy the protein requirement of the regenerating limb buds.

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COMPARISONS OF ENDOTHERMIC AND ECTOTHERMIC SCOMBRID FISHES: MUSCLE METABOLIC CAPACITY. K. A. Dickson. Scripps Inst. Oceanography, UCSD, La Jolla, CA.

As part of an investigation of the consequences and advantages of endothermy in tuna fishes (Family Scombridae), biochemical indices of red (RM) and white (WM) skeletal muscle aerobic and anaerobic metabolic potential were measured in five tuna species and in four species of ectothermic scombrids (mackerel and bonito). Activities of enzymes of aerobic respiration (citrate synthase) and of anaerobic glycolysis (pyruvate kinase and lactate dehydrogenase) in RM and WM are generally higher in endotherms than in ectotherms. In WM, but not in RM, intracellular buffering capacity is greater in endotherms, due to greater concentrations of low molecular weight (< 2000 daltons) buffering compounds. These differences suggest that endothermic fishes have a greater capacity to produce energy by both aerobic and anaerobic pathways. Thus, endothermy may enhance muscle function and swimming performance in tuna fishes.

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ULTRASTRUCTURE OF AUTOTOMY-INDUCED MUSCLE ATROPHY IN THE CRUSTACEAN CARCINUS MAENAS. D.L. Schmiede and Stacia Moffett. Washington State Univ., Pullman.

The autotomy response to limb injury is mediated by the anterior levator muscle in C. maenas. Muscles proximal to the fracture plane atrophy before regeneration of the limb at a subsequent molt. We have studied the ultrastructural changes associated with atrophy in the nine fibers of the coxal head of the anterior levator. All of these fibers appear to be phasic. The fibers of atrophied muscles can still contract and organelles such as nuclei and mitochondria appear unchanged. However, we observe a decrease in fiber diameter, an increase in thick filament packing density, and isolated areas of myofibril erosion. Our findings thus far indicate similarities between the autotomy-induced atrophy observed here and the molt-induced atrophy of Gecarcinus lateralis claw closer muscle described by Mykles and Skinner (J. Ultrastruct. Res. 75:314-325, 1981).

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ELECTRICAL AND MECHANICAL RESPONSES OF A MOLLUSCAN MUSCLE TO FMRFamide. R.B. Hill and P. Langton*. Univ. of Rhode Island, Kingston and Univ. of Lancaster, U.K.

Auxotonic contractions of the radular protractor muscle (RPM) of Busycon contrarium have often been used for bioassay of FMRFamide (Fa). However, until now sucrose gap recording of electrical responses of the RPM of Busycon canaliculatum has been accompanied by isometric recording of contractions. In a comparison of electrical, auxotonic, and isometric Fa-responses of the RPMs, we have discovered that Fa-responses are accompanied by relatively little depolarization compared to ACh- or K-responses. Although with isometric recording even 10^{-6} M Fa induced only very weak slow rhythmic contraction in the RPM of B. canaliculatum, with auxotonic recording threshold responses were obtained at about 5×10^{-9} M and contractions 4 orders of magnitude greater at 10^{-6} M. Depolarization only increased slightly over the whole range. Auxotonic and depolarization responses of the RPM of B. contrarium were consistently more sensitive to low concentrations of Fa. Contractions typically show a long latency followed by irregular rhythmicity superimposed on a contraction. Depolarization and contraction are Ca-dependent.

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CHEMICAL SENSITIVITY OF ARIOLIMAX COLUMBIANUS

D. M. Stewart* and A. W. Martin, Univ. of Baltimore and Univ. of Washington, Seattle.

Chemical stimulation elicits responses of skin cells in headless, eviscerated preparations. Stimulation was applied by immersion of the posterior chamber in a vial containing the agent in solution. Immersion in slug Ringer produced no fluid output, and in the range of 2/3 to 1 1/3 X tonicity the changes were negligible. Normal blood pH is 8.8. Very acid or very alkaline solutions stimulated production of much fluid, with graded intermediate responses. Geraniol was without significant effect but eugenol (0.01 M) stimulated measurable fluid output. An extract of garlic buds (5×10^{-3} g/ml) evoked a considerable response, but a solution of allyl sulfide, at the same dilution, did not. The responses to chemical stimulation resembled those to mechanical stimulation in that the channel cells ceased to respond after one to three minutes while the mucus response continued longer. The chemical response was somewhat inhibited by 5HT (10^{-3} M).

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LOCALIZATION OF FMRFamide-RELATED PEPTIDES IN THE SLUG, LIMAX MAXIMUS, AND THEIR EFFECTS ON THE ISOLATED CROP AND PENIS. K.G. Krajniak, M.J. Greenberg, K.E. Doble* and D.A. Price*. Whitney Lab., Univ. of Florida, St. Augustine.

Both FMRFamide (Fa) and pyroGlu-Asp-Pro-FMRFamide (pQDP-Fa) were identified in extracts of slug brain by RIA and by HPLC elution-time. Neurons containing immunoreactive Fa were demonstrated in the brain, crop and penis by immunohistochemistry; the density of fluorescent fibers was especially high in the crop. The spontaneous activity of the isolated, perfused crop was inhibited by both Fa and pQDP-Fa, and by ACh and low doses of 5HT; only the peptide SCP_B augmented tone and rhythmicity. The isolated penis was usually quiescent, but rhythmical contractions could be induced by 5HT, Fa or pQDP-Fa. The two peptides modulated 5HT-induced motility, but the effects were phasic and variable. Low doses of SCP_B inhibited penile contractions. These data and others suggest that the Fa-like peptides may have the role of suppressing digestive motility and behavior while stimulating male reproduction. Moreover, SCP_B seems to have an opposite action. These relationships are likely to be characteristic of pulmonate snails in general. Supported by NIH grant HL 28440 to MJG.)

COMPARISON OF MYOTUBE AND MYOFIBRILAR PROTEINS FROM AXOLOTL, NEWT, XENOPUS, AND CHICKEN. R.N. Fontaine*, A.R. Hilgers*, and J.A. Cameron. Univ. Illinois, Urbana.

We obtained muscle proteins from adult muscle, or from myotubes and fibroblasts cultured *in vitro* from three amphibians: larval axolotl, *Ambystoma mexicanum*; adult newt, *Notophthalmus viridescens*; and larval *Xenopus laevis*. Proteins were electrophoresed on SDS gels along with chicken myofibrillar proteins and MW standards. Myosin and actin were the predominant proteins. Proteins migrating with chicken C-protein and small amounts of filamin were also present. Proteins in axolotl, newt, and *Xenopus* migrated near chicken tropomyosin and they also stained a characteristic olive green with silver stain. However, while there was more of the 35Kd band in chicken myofibrils, the 32Kd band predominated over the 35Kd band in the axolotl. The single green band from the *Xenopus* migrated slightly faster than the 32Kd band in chicken myofibrils. α -actinin, desmin and proteins more than 250Kd were present in all three amphibians. The myotubes which developed from the primary cultures also had proteins which migrated with proteins described above. In conclusion, muscle from the three amphibians and the chicken have similar quantities and distribution of proteins.

CLOSER MUSCLE APODEME TENSION RECEPTORS IN THE BLUE CRAB *CALLINECTES SAPIDUS*: H. B. Hartman and B. A. Moulton*. Texas Tech Univ., Lubbock.

Receptors responsive to muscle tension have been located on the closer muscle apodemes of the walking and swimming legs, and the chelipeds of the blue crab *Callinectes sapidus*. Those of the walking legs have been investigated in detail using neurophysiologic techniques. That they signal tension information is supported by observations that the receptors 1) are unresponsive to passive unopposed movements of the dactyl, 2) respond to isotonic contractions when the dactyl is lifting a load, 3) fire during isometric contractions, 4) abruptly cease firing when isometric contraction is halted by quick release to allow muscle shortening against no load. Individual units show a variety of thresholds including some which respond to tensions of less than one gram. Cobalt backfilling of the tension nerve reveals 25-35 bipolar cells whose cell bodies measure between 25-60 μ m. The axons form a discrete nerve which joins the PD organ nerve. Reflexes evoked during walking and originally attributed to PD organ input alone will probably require reevaluation.

LANTHANUM BLOCKS EXCITATION BY FMRFAMIDE AND 5HT IN THE VENTRICLE OF BIVALVE, *MERCENARIA MERCENARIA*. C.L. Devlin. Univ. of Rhode Island, Kingston.

The mechanism of cardioexcitation in the bivalve heart by molluscan neurocrines, FMRFamide and 5HT was investigated using intracellular electrodes and sucrose gap techniques. These neurocrines enhanced the amplitude and frequency of cardiac action potentials and coupled force in a dose-dependent manner. Both substances affected the ventricles at parallel concentrations. Spike potentials were especially sensitive to changes in extracellular calcium, more so than other ions. 27 mM calcium slightly potentiated the amplitude of the spike potential, while calcium-free salines caused the cessation of all electrical and mechanical activity of the hearts. 10^{-3} M lanthanum blocked excitation as typically induced by FMRFamide and 5HT; this block was partially overcome by increasing extracellular calcium. This data indicates that FMRFamide and 5HT may activate receptors of the ventricle which enhance membrane conductance to calcium ions. This would explain the immediate increase in cardiac action potentials and contractility when in the presence of these neurocrines.

THE MOLLUSCAN NEUROPEPTIDE, SCP_B, INCREASES THE RESPONSIVENESS OF THE FEEDING MOTOR PROGRAM OF *LIMAX MAXIMUS*. D.J. Prior, W.H. Watson and S.D. Hess. Univ. of Kentucky, Lexington, and Univ. of New Hampshire, Durham.

We have studied the effect of SCP_B on the fast salivary burster neuron (FSB) and the feeding motor program (FMP). When the isolated CNS is exposed to 2 μ M SCP_B there is a rapid 3 to 4 fold increase in the burst frequency of the FSB. The response is dose dependent with a threshold concentration of 2×10^{-8} M. The effect of SCP_B was reversed within 10 min by perfusion with 1.0X saline. The response of the FSB was sustained during longterm (20 min) exposure to SCP_B. The cyclical motor output of the FMP can be initiated by stimulation of a lip nerve. When the CNS was perfused with 2 μ M SCP_B a previously subthreshold stimulus could initiate a complete FMP. SCP_B-immunoreactive substance occurs in several groups of buccal ganglion neurons and in the neuropile. Thus an SCP_B-like substance appears capable of modulating the neural network that generates the feeding motor program in *Limax*.

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CHEMICAL MEDIATION OF SCAVENGING AND PREY SEARCH IN POST-LARVAL LOBSTERS (HOMARUS AMERICANUS). P.C. Daniel
Univ of Maine, Orono.

We determined whether lab-reared 4-7th stage lobsters are attracted to prey extracts and live prey leachates and attractant types using a rapid behavioral bioassay. Attraction to herring extract was confined to primary amine containing fractions after removal of peptides and proteins. Treatment of herring extract with a protease enhanced response. Similar responses were obtained to equimolar extracts of Asterias vulgaris, Mya arenaria, Mytilus edulis, and Cancer irroratus. Of the live prey soaks only full-strength Asterias vulgaris elicited a significant but weak response. Scavenging appears to be a "generalist" behavior probably mediated by amines/amino acids, while little chemical attraction to live prey occurs in recently settled cryptic lobsters unlike older field-collected lobsters. Increase in chemoattraction to live prey may be through predatory experience or development.

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DIETARY PROTEIN SELECTION BY THE DEER MOUSE, PEROMYSCUS MANICULATUS.

L. DeLuca, Clemson University, S.C.

To determine the effects of cold temperature and short photoperiod on protein intake, dietary self-selection patterns were studied in 2.5 to 4 month old laboratory-reared P. maniculatus maintained at either 12°C (8L:16D) or 23°C (13L:11D). Mice were permitted to select freely from isocaloric diets of low (5%) or high (45%) protein content, and their protein intake and total caloric intake (per gram body weight) were monitored for two weeks. Compared to females at 23°C, females at 12°C selected a higher percentage of energy as protein (%PE). Males at 12°C, however, selected a lower %PE than their 23°C counterparts. Although all mice consumed significantly more energy at 12°C, the differences in the %PE were reflected primarily in the amount of high protein diet selected whereas the differences in the total energy intake were more apparent as increases in the amount of low protein diet selected. This study was conducted as part of an effort to assess the importance of winter protein restrictions to daily torpor of P. maniculatus.

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GROWTH AND BLOOD CHEMISTRY OF DUCKLINGS REARED ON ACIDIFIED WETLANDS. B. Rattner, G. Haramis*, G. Linder and D. Chu*.
Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service, Laurel, MD.

Acid deposition is one factor that may be responsible for the decline of some waterfowl populations. Growth and physiological condition were monitored in captive-reared black ducks (Anas rubripes) exposed for 10-day trials (day 11-20 of life) on control (pH 6.8) and acidified (pH 5.0) man-made emergent wetlands. Impaired growth (body weight, culmen and tarsus length) and increased mortality (50%) were apparent in broods (hen + 4 ducklings) reared on acidified wetlands. Ducklings exhibiting poor growth had reduced hematocrit, plasma protein and cholesterol levels. This subset of birds had elevated plasma uric acid concentration and creatine kinase activity (perhaps due to enhanced protein and nucleotide catabolism), and elevated plasma K⁺ levels. Based upon overt appearance, growth and blood chemistry, ducklings exposed to acidified wetlands were concluded to be in poorer condition than those exposed on circumneutral pH wetlands.

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SEMILUNAR SPAWNING CYCLES OF THE GULF KILLIFISH, FUNDULUS GRANDIS, IN CLOSED CIRCULATION SYSTEMS. Shyh-Min Hsiao* and Albert H. Meier. Louisiana State Univ., Baton Rouge.

Gulf killifish, Fundulus grandis, spawned daily in aquaria of closed circulation systems held on 12-hour daylengths and 23°C. However, the number of eggs spawned during a 24-hour period varied greatly from one day to another. Statistical analyses of the data revealed the presence of 13-day cycles of spawning in 5 of 7 aquaria that persisted for as long as 4 months without obvious external synchronization. Because each aquarium usually held 21 females, the existence of 13-day cycles indicates that there was synchronization within each group. There was also synchronization of 13-day cycles among aquarium groups that had a common recirculating water supply. Although the 13-day cycle may be essentially an endogenous free-running semilunar rhythm, exogenous timing of this cycle is supported by its precision over a long period and by a strong coherence of the spawning cycles and high tide cycles on the Louisiana Gulf coast.

THE RESPONSE OF WORKERS TO THERMAL STRESS IN HONEYBEE COLONY THERMOREGULATION. F.D. Vogt and B. Heinrich. SUNY, Plattsburgh and Univ. of VT, Burlington.

Do workers respond behaviorally to change in body temperature or to change in hive temperature? The thoracic temperature (T_{th}) of workers in an observation hive were taken when various areas of the hive were heated or cooled. The temperature of the brood at the periphery of the hive (T_{per}) ranged from 32-38°C as the air temperature surrounding the hive was increased from 10-41°C. The T_{th} of bees at the periphery approximately equalled T_{per} despite locally heating or cooling other areas of the hive. When T_{per} was locally increased, the incidence of thermoregulatory behavior increased until workers abandoned the heated area at $T_{per} > 46°C$. At $T_{per} = 41-44°C$, the T_{th} of bees which continuously performed thermoregulatory behaviors were typically 1-2°C higher than those bees which performed no prolonged bouts of thermoregulatory behavior. These findings suggest that thermoregulatory behavior is cued by local thermal conditions. However, changes in behavior may be influenced by body temperature. Supported by NYS/UUP PDQWL New Faculty Development Award and NSF grant DEB-816662.

INCUBATION TEMPERATURE AFFECTS THERMAL SELECTION OF HATCHLING CROCODILES.

J.W. Lang. University of North Dakota, Grand Forks, N.D. 58202

Eggs of Crocodylus siamensis were incubated at constant temperatures of 32.5 and 28°C. The two groups of hatchlings were housed in separate but identical thermal gradients (land-water 20-40°C continuous; 12L:12D) for 30 days, then placed together in the same gradient for 60 days. Hatchlings were not fed, then fed for alternating 10 day periods. Body temperatures (T_b s) were monitored at intervals each day (40 T_b s/animal/10 day). In comparison with alligators, hatchling Siamese crocodiles selected high T_b s and did not respond to feeding with higher T_b s as alligators did. Crocodiles incubated at 32.5° selected significantly higher T_b s than did those incubated at 28° (whether each group was housed alone or together). These hatchlings were siblings, but differed in sex (32.5° produces males; 28° produces females). Thus, incubation temperature determined hatchling sex; and incubation temperature and/or sex influenced their subsequent thermal selection. The thermal regime during incubation may affect various physiological parameters of the hatchlings in addition to determining sex.

HYDRIC CONDITIONS DURING INCUBATION INFLUENCE LOCOMOTOR PERFORMANCE OF HATCHLING SNAPPING TURTLES.

K. Miller, G. C. Packard, and M. J. Packard. Franklin and Marshall College, Lancaster, PA and Colorado State Univ., Fort Collins.

Locomotor performance of hatchling snapping turtles (Chelydra serpentina) was assessed while turtles were running on land and swimming in water. Turtles from eggs incubated on a relatively wet substrate were faster, on both absolute and relative scales, than those from eggs incubated on a relatively dry substrate. The improved locomotor performance of hatchlings from eggs incubated on the wet substrate was beyond that expected from their larger size. The improved performance persisted after turtles from both groups were fully hydrated, indicating that it was not the result of differential dehydration. Turtles from eggs incubated on the relatively wet substrate, despite moving more quickly, accumulated lactate more slowly than turtles from eggs incubated on the dry substrate. These observations may provide a physiological basis for the improved survivorship of larger reptile hatchlings.

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ACTIVATION OF CYTOCHROME OXIDASE BY PHOSPHOLIPIDS FROM THERMALLY ACCLIMATED CRAYFISH. G. L. Hodge* and N. P. Neas. Colgate Univ., Hamilton, NY.

The fatty acyl moieties of most membrane phosphatides from hepatopancreas tissue of both winter-active (Cambarus bartoni) and winter-quiescent (Orconectes propinquus) crayfish become more unsaturated following acclimation to 5° (CA) vs 20° C (WA). In both species, cardiolipin (CL), a phosphatide confined to the inner mitochondrial membrane and an essential cofactor for mammalian cytochrome oxidases (CO), exhibits the opposite trend becoming more saturated following cold acclimation. The role of CL in activating crayfish CO was investigated by assaying the enzyme isolated from WA or CA crayfish in both a lipid-depleted form (acetone powder) and following addition of different lipid fractions from acclimated crayfish. In lipid-depleted form, CO activity is low (velocity constant, $K \sim 0.03$ [mg·min]⁻¹). CL enhanced CO activity from WA and CA animals in both winter-active and winter-quiescent species, with CL from CA animals more effective than CL from WA animals. Total phospholipid extracts and phosphatidylcholine extracts had little effect on CO activity. Thus, temperature-induced restructuring of CL may reflect its role as a cofactor for membrane-bound enzymes as opposed to a homeoviscous adaptation.

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TEMPERATURE, pH AND PRESSURE EFFECTS ON LACTATE DEHYDROGENASES OF VERTICALLY MIGRATING MIDWATER FISHES. P.H. Yancey, W. Bement* and M. Maier*. Whitman College, Walla Walla, WA.

Many species of mesopelagic fishes are known to migrate into surface waters at dusk and to depths of 400-800m at dawn, thus undergoing large temperature and pressure changes in a short period. M_4 -lactate dehydrogenases (LDH) were purified from muscles of 3 species of migrators: the lanternfishes (Myctophidae) Tarletonbeania crenularis and Stenobranchius leucopsarus, and the viperfish Chauliodus macouni (Chauliodontidae) (smaller individuals of which migrate). The apparent pyruvate K_m values of all 3 species were found to be insensitive to hydrostatic pressure from 0-200 atm, but those of T. crenularis rise above this, a response not before seen in studies of LDHs and pressure. In addition, pyruvate K_m values show little or no change with temperature (5-17°C) in imidazole buffer, in contrast to LDHs of all other vertebrates (15 spp.) examined (only in constant-pH buffer do these LDHs behave as do other vertebrate LDHs in imidazole). If these fish exhibit "alphastat" pH regulation (mimicked by imidazole), LDH function in vivo may be constant during migration.

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ABSENCE OF RESONANCE MODULATION IN NON-HUMAN VOICES. Abbot S. Gaunt & Thomas E. Hetherington. Ohio State Univ., Columbus.

The modulations of human voice that produce the different vowel sounds are effected by changing the shape, hence the resonant properties, of the vocal tract. In contrast, avian voices are modulated by changing the properties of the vocal organ. If humans change the resonance of the vocal tract by breathing He/O_2 , their voices are dramatically altered, and lip whistling is difficult, but the calls and whistles of birds are scarcely affected by helium. For a lark, we tested some amphibians and mammals. The voices of Hyla crucifer and Felis catus were not altered by helium. The clicks, whistles and lowings of the dolphin, Tursiops truncatus, are also unaffected (Ridgeway & Evans, pers. comm.). Observed changes in the calls of Hyla versicolor could not be definitely attributed to helium.

If resonance modulation should be generally absent from non-human tetrapods, especially mammals, then human voice is more peculiar than generally supposed, and the evolution of human languages, with all their cultural import, even more intriguing.

Research continues even as this abstract is submitted.

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EVOLUTION AND MORPHOLOGICAL DIVERSITY OF THE LATERAL LINE SYSTEM IN FISHES. J.F. Webb. Boston University, Boston, MA.

The morphological diversity of the mechanoreceptive lateral line system was examined by surveying the systematic literature. Gross morphological features were superimposed on established systematic schemes in order to determine the contribution of phylogenetic and developmental constraint to morphological diversity. The cephalic lateral line canals show four evolutionary trends: highly ramified branching (hypothesized primitive osteichthyan character), canal reduction and replacement by superficial neuromasts (via paedomorphosis, in 10 euteleostean lineages), widening of the canals, and sinus formation with the loss of pores (unique to Osteoglossomorpha). Trunk canal patterns fall into 5 categories: complete, incomplete, disjunct, multiple and absent. The taxonomic distribution of these patterns suggests pathways along which they could have been derived. Functional hypotheses generated as a result of this survey indicate that the head canal and trunk canal morphologies may be subject to different selection pressures: increased sensitivity to stimuli originating from prey or predators and precise detection of hydrodynamic stimuli in actively swimming fishes, respectively.

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DISTRIBUTION OF MUSCLE FIBER TYPES IN THE AVIAN PECTORALIS. B.W.C. Rosser and J.C. George. Univ. of Guelph, Guelph, Ontario.

The distribution of fiber types in the pectoralis muscle (PM) of 45 species of carinate birds and two species of ratites is described. The carinate PM consists almost entirely (99-100%) of red (aerobic) and/or white (anaerobic) fast-twitch fiber types. Slow fiber types are rare, and are restricted to the deepest craniodistal fasciculi. In those carinates having both red and white fibers, there is a higher proportion of red fibers in the deeper areas of the PM. This distribution is comparable to that of other vertebrate locomotory muscles, and is an adaptation for flapping flight. A deep belly of the PM has been found in cathartid vultures (Fisher 1946). This belly consists entirely of slow fibers, and is an adaptation for soaring flight. In the ratite PM, slow fibers are widely distributed in large numbers (< 39%). This could represent the ancestral avian PM, neoteny or an effect of flightlessness. Extensive anaerobic areas of the ostrich PM are probably utilized during behavioural displays. (Supported by NSERC of Canada).

ACETYLCHOLINESTERASE AND THE ZONAL ORGANIZATION OF THE CEREBELLUM. B.L. Brown (intro. by J. Besharse). Emory Univ., Atlanta.

Voogd (1964,1969) has suggested that mammalian cerebellar cortex can be subdivided into parasagittally oriented zones. Each zone receives climbing fiber input from a unique part of the inferior olivary complex and projects to a single cerebellar nucleus. Brown and Graybiel (1983) have shown that boundaries visible in acetylcholinesterase (AChE)-stained sections of cat cerebellum mark edges of certain connectional zones. Sections from the cerebella of various species were AChE-stained to determine whether AChE is present in a zone-like pattern. Although there are marked variations in the laminar distribution of AChE between species, in all mammalian species examined to date (chimpanzee, squirrel monkey, rhesus monkey, rabbit, rat, guinea pig, hamster, and mouse) there is some indication of zonality in the distribution of AChE-positive elements. Determination of whether this zone-like distribution of AChE staining marks boundaries of connectional zones in species other than cat will require use of tract-tracing methods combined with AChE staining. Supported by a grant from the Emory University Research Committee.

DEVELOPMENT OF ZONAL ORGANIZATION IN THE CEREBELLUM OF THE SYRIAN HAMSTER. R.P. Ierardi and B.L. Brown (intro. by S. Herring). Emory Univ., Atlanta.

The experiments reported here are part of a study designed to investigate the factors which produce the zonal pattern of connectivity in mammalian cerebella. Hamsters were used because of their short gestation period (16 days), resulting in cerebella which are very immature at birth. Cell-stained sections through the cerebella of animals sacrificed at various postnatal ages were examined, with particular attention being paid to indicators of zonal organization. At the time of birth (P0) the hamster cerebellum is unfoliated, and prospective Purkinje cells (PCs) and deep nuclear neurons are still partially intermingled. However, there is already some hint of zone-like PC clustering which persists through P1, when the developing PC layer is clearly demarcated from the deep nuclear mass. Prior reports (Oster-Granite and Herndon, 1976) suggest that afferent fibers may not arrive in the cerebellum until P2, raising the possibility that the initial events leading to formation of cerebellar zones take place in an uninnervated cerebellum. Supported by a grant from the Emory University Research Committee.

LOCALIZATION AND HISTOLOGY OF THE OVIDUCTAL SPERM-STORAGE TUBULES (SST) IN THE AMERICAN KESTREL. M. R. Bakst and D. M. Bird (intro. by G. Gee). USDA, Agricultural Research Service, Beltsville, MD, and McGill Univ., Quebec.

Although oviductal SST have been investigated in domesticated birds, the presence of SST in nondomesticated birds has been questioned. By adapting techniques used for the localization and histological preparation of turkey SST, we have localized and histologically characterized the SST of the American kestrel. The SST were located at the anterior end of the vagina and appeared as tubular structures. The SST epithelium was nonciliated and possessed secretory capability as indicated by a moderately positive PAS reaction product. Infundibular glandular grooves and tubular invaginations, known secondary sperm-storage sites in the anterior-end of the turkey oviduct, were present in the kestrel. Because the kestrel exhibits a high copulation rate during the breeding season, the precise role of the SST is unclear. However, as artificially inseminated females remain fertile for about 8 days, we assume sperm are maintained in the SST.

CRANIAL KINESIS IN NILE MONITOR FEEDING. K. Condon. University of Illinois at Chicago.

Cineradiographic studies by various authors find no evidence of movement within the dermatocranium of the potentially kinetic lizard skull. However, this technique has limited resolution and its use has been restricted to the ingestion phase of feeding. In this study, slotted mounts were affixed to the parietal and frontal bones of a 1.5 kg Nile monitor. Flexible extensions which exaggerate the relative movement of the bones were attached to the mounts. All phases of feeding on a laboratory mouse were filmed. Prior to the strike and concomitant with jaw opening, the muzzle is slightly elevated (2-3 degrees). During the strike both jaws are adducted simultaneously. Immediately after the strike the muzzle is ventroflexed 5 degrees past the resting position. Ventroflexion is maintained throughout the prehension and ingestion of the mouse. Only after the prey item has passed into the esophagus do the cranial elements return to their resting position. Mesokinesis does occur in the Nile monitor and involves movement of the palato-maxillary unit relative to the parietals.

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METAMORPHIC DEVELOPMENT OF THE AMPHIBIAN MIDDLE EAR: FUNCTIONAL IMPLICATIONS. T.E. Hetherington, Ohio State Univ., Columbus.

Several functions have been proposed for the opercularis system (otic operculum and opercularis muscle) of the amphibian ear. Two major hypotheses are: 1) modulation of responsiveness of the tympanum-stapes complex of the middle ear to aerial sound, and 2) involvement in seismic reception. The development of both systems was studied in 8 species of frogs of 3 families (Bufonidae, Hylidae, and Ranidae). In all species the opercularis system is fully developed by the time of emergence of the forelimbs, a general indication of the onset of terrestrial activity. Timing of development of the tympanum-stapes complex is variable and corresponds with body size. Only in the largest ranids were the tympanum and stapes fully developed by the end of metamorphosis. In the remaining species this complex completed development after varying periods of time and significant increases in body size. The tympanic ear of smaller hylids was complete in frogs approaching adult body sizes. The developmental independence of the opercularis system and tympanum-stapes complex suggests functional independence. Supported by NIH grant 1-R23-NS21998.

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INTRASPECIFIC VARIATION IN THE HINDLIMB MUSCULATURE OF THE HOUSE SPARROW. S.L. Berman, M. Cibischino*, P. Dellaripa*, L. Montren*. College of the Holy Cross, Worcester, MA.

How confident can we be in the accuracy of anatomical descriptions based on the dissection of only a few specimens? There is abundant evidence from anatomical teaching labs that it is not uncommon to find specimens that differ from the condition described for that species. As time constraints and availability of specimens usually preclude the use of large sample sizes by morphologists, there is always the possibility that a species has been characterized by an anomalous specimen. We dissected the hindlimb muscles of 40 English Sparrows. Among the variations were: (1) *M. iliofemoralis*, normally absent in passerines, present in 1 specimen; (2) *M. puboischiofemoralis* had an "extra" head in 10 of the 40 specimens; (3) *M. flexor hallucis longus* had 3, as opposed to 2, heads in 22 specimens; (4) 1 specimen had an unusual relationship between tendons of *Mm. fibularis longus* and *flexor perforatus digiti III*. It is doubtful that such results will promote use of larger sample sizes in anatomical studies, but they may foster an awareness that such variation exists.

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DISTRIBUTION OF CATECHOLAMINES IN THE BRAIN OF THE GOLDFISH, *CARRASSIUS AURATUS*: AN IMMUNOCYTOCHEMICAL STUDY USING ANTIBODIES TO TYROSINE HYDROXYLASE. P.J. Hornby, D.T. Piekut* and L.S. Demski Univ. of Rochester, N.Y., and Univ. of Kentucky, Lexington.

Catecholamine distribution was demonstrated using antibodies to tyrosine hydroxylase and the Avidin-Biotin-Peroxidase (ABC) method of immunocytochemistry. This enabled direct visualization of the dark brown immunoreactive product within cell bodies and fibers. In brainstem small bipolar cells were clustered in the central medulla at the level of the commissural nucleus of Cajal; scattered cells lay close to the vagal motor nucleus. In hypothalamus larger dark-staining cells were concentrated along the third ventricle, many within the anterior tuberal nucleus. Fibers ran parallel to the third ventricle. Dark-staining cells were found throughout the periventricular preoptic nuclei, fibers could be traced laterally into the telencephalon. The distribution is consistent with that found in other teleosts using the less sensitive Falck-Hillarp histofluorescence method (Parent, 1983).

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HISTOCHEMISTRY OF THE FLIGHT MUSCLES IN A PHYLLOSTOMID BAT. J.W. Hermanson and R.C. Foehring, Emory Univ., Atlanta, GA. and Univ. of Florida, Gainesville.

Previous studies on flight muscles in free-tailed bats (*Tadarida brasiliensis*) have indicated that the primary muscle powering the downstroke, the pectoralis, is composed entirely of fast-twitch oxidative fibers. To examine functional specialization in a bat exhibiting different flight behaviors and with a different wing morphology, we studied fiber type composition of the primary flight muscles in a fruit-eating bat, *Artibeus jamaicensis*. We assessed histochemical staining properties for myosin ATPase, α -GPD, and NADH-TR. In the pectoralis of *Artibeus*, two fast-twitch fiber types were indicated by the acid preincubation protocols for myosin ATPase. All fibers exhibited high staining levels for NADH-TR, and relatively low staining levels for α -GPD. We conclude that the pectoralis muscle of *Artibeus* has two motor unit populations that may be recruited independently and/or in combination and permit a finer degree of motor control than is possible in the fast flying *Tadarida*. Supported in part by an Emory Univ. Research Award and by NINCDS NS15913.

THE CORRELATION OF EXPERIMENTALLY APPLIED LOADS WITH THE ARCHITECTURE OF CANCELLOUS BONE IN THE FEMUR OF DEVELOPING MICE. K.R. GORDON. Florida International Univ.

Experimentally applied loads changed the size, shape, and location of trabeculae in the proximal femur of actively growing mice. Tensile and compressive loads were applied at age 21 days for a period of at least 30 days. Tensile loads were applied to the femur by attaching to the ankle a weight cuff of approximately 50% of the normal compressive support load. Compressive loads were applied in two ways. The first was by exposing the mice to 2X normal gravity in a hypergravity chamber for one hour/day (10 min. x 6 episodes). The second was by attaching a cuff to one leg which caused the mice to favor the opposite leg for support. On initial examination with the scanning electron microscope tensile loading caused an increase in size of an obliquely patterned series of trabeculae on the medial aspect of the proximal one third of the shaft. Compressive loading caused a dramatic increase in size and numbers of trabeculae traversing the lateral shaft of the femur. It appears that with this latter configuration of trabeculae the shaft under compression would resist buckling to a greater degree than the controls.

PROXIMAL CAUSES OF NATAL DISPERSAL IN BELDING'S GROUND SQUIRRELS. K. E. Holekamp. University of California, Berkeley.

I tested nine hypotheses, each suggesting a different social, ecological, or ontogenetic factor as a proximal cause of natal dispersal behavior in two California populations of Spermophilus beldingi. The data failed to support hypotheses suggesting resource shortage, ectoparasite load, population density, social facilitation, conspecific aggression, or avoidance by conspecifics as proximal causes of natal dispersal in this species. The data supported an "ontogenetic switch" hypothesis which suggests that natal dispersal by male S. beldingi is triggered by attainment of a particular body weight, body composition, or some combination of these two variables.

PHOTOPERIODIC RESPONSES IN LACTATING VOLES AND DEVELOPING PUPS. T.M. Lee, L. Smale, J. Dark*, and I. Zucker*. Univ. of California, Berkeley.

Several studies tested the hypothesis that pregnancy and lactation ameliorate the effects of short daylengths on energy balance of voles. Lactation and gestation prevented the weight losses, food intake decreases and appearance of the winter pelage in Microtus pennsylvanicus housed in short photoperiods. Litter weight, but not number of pups was decreased for females kept in a short daylength for 2 wks prior to mating. The pregnancy rate was decreased by 50% for females housed in short days for 8 wks prior to mating. Pups born to females housed in short days displayed delayed puberty, reduced body size, increased nest size and increased pelage development. The normal winter pelage development of female voles housed in short days was blocked by PRL injections; therefore, effects seen in lactating voles may be due to high PRL levels induced by suckling young.

PATTERNS OF HOUSE OCCUPANCY IN WOODRATS: EFFECTS OF SEX AND AGE. M.A. NEWTON. ARIZONA STATE UNIVERSITY, TEMPE.

I examined patterns of house placement and occupancy by woodrats (Neotoma albigula) on a 9.9 ha site in the Upper Sonoran desert for 2 years. Nearest-neighbor analysis of 132 active and 15 inactive woodrat-houses indicated that nonrandom placement of houses was mostly explained by environmental heterogeneity. House occupancy and visitations by other woodrats were documented by trapping. While characteristics of residents appear to have some effect on house placement, they exert a strong influence on patterns of house occupancy. Adult males were separated by greater distances than were females or heterosexual pairs. Houses separated by very small distances were occupied by young and putative mothers. These data imply a polygynous mating system for N. albigula. Visitation data is consistent with predictions from this hypothesis. Adult males visit females of reproductive age. Mature females seldom visit the houses of adult males, but instead are often found at homes of juveniles. In this species, patterns of house occupation by sex and age groups probably reflect male competition for mates and extended maternal care.

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TERRITORIALITY AND MATING SYSTEM OF CALIFORNIA VOLES, MICROTUS CALIFORNICUS. R.S. Ostfeld. Univ. of California, Berkeley.

Radiotelemetry was used to examine space use by California voles before and after the provision of supplemental food. Experiments were performed at high and low population density. The sexes had similar home range core areas, but males had larger peripheral areas. Home ranges of females, but not of males, shrank after food provisioning. Some females shifted their home ranges to encompass more of the provisioned area. Home ranges of males, but not of females, were smaller during high than low density. Home ranges of females often overlapped extensively with each other, and nest-sharing was observed. Supplemental food induced overlap between females that had not previously overlapped. Males showed very little overlap with each other, and this was not affected by the addition of food. Males rapidly occupied home ranges abandoned by adjacent males. Males and females overlapped with each other extensively, but access to females was unequal. I conclude that male M. californicus are strongly territorial, but that females are non-territorial. Mating is probably polygynous, and the most likely mode is female defense.

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MOTHER-OFFSPRING DYNAMICS IN THREE GROUND SQUIRREL SPECIES. L.S. Rayor. Univ. of Kansas, Lawrence.

This study describes, quantifies, and comparatively analyses changes in the mother-offspring relationship during the first summer of life in the Gunnison's prairie dog (Cynomys gunnisoni), and the Columbian and 13-lined ground squirrels (Spermophilus columbianus, S. tridecemlineatus). C. gunnisoni adult males and females are amicable, interactive, tolerant, and in close association with their offspring, and other intraharem young, throughout the summer. Litters within a harem readily intermingle. Mothers and young share the natal burrow through the summer, and sometimes into the yearling summer. S. columbianus maternal-offspring interactions are infrequent, but mostly amicable. Adult male interactions with young were rare. Litters mingle, but interaction and play markedly decline by mid-summer. Young often move out of the maternal burrow. S. tridecemlineatus lives in aggregations, but it is essentially asocial. Mothers actively avoid their young, which disperse 2 to 3 weeks after weaning. My data support current hypotheses which suggest that increased sociality is a means of investing in offspring by promoting cohesion, which is a proximal factor in delaying dispersal.

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DEVELOPMENT OF DIAPTOMUS SHOSHONE NAUPLII (CALANOIDA; COPEPODA) ON A VARIETY OF ALGAL FOODS. N.M. Butler, University of British Columbia, Vancouver.

A population of Diaptomus shoshone in a Colorado alpine lake was observed to have a distinct separation into adult and nauplii swarms positioned in different areas of the lake. It appeared that the location of adult swarms was related to the algal-rich meltwaters from shoreline snow banks and that adults utilized snow algae as a supplemental food source. However, nauplii did not appear to position swarms in meltwater areas, raising the question as to whether nauplii recognized and could utilize snow algae as a food source.

To test this hypothesis, nauplii hatched in the lab from resting eggs were raised under 4 separate food treatments: no food (starvation), snow algae (Chlamydomonas nivalis), and either of 2 planktonic algae (C. reinhardtii and Cryptomonas reflexa). Rate of growth, time in each instar, lipid content, and mortality were compared between treatments. Starved nauplii grew to N-3 stage with rapid depletion of lipid reserves. Fed nauplii developed into the copepodite phase. Size of fed nauplii differed between treatments, while lipid content, growth rate, and mortality were similar. Implications of the findings to oligotrophic alpine ecosystems will be discussed.

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RAINFOREST LEAF-LEACHATE TOXICITY AND SURVIVORSHIP OF STREAM-DWELLING ATYID SHRIMP IN EL VERDE, PUERTO RICO. A.P. Covich. Univ. of Oklahoma, Norman.

Leaf leachates caused differences in mortality of Xiphocaris elongata and Atya lanipes in lab and field tests. Seven of 12 tree species resulted in 40 to 100% mortality of Xiphocaris whereas only two (Homalium and Nectandra) caused high mortality in Atya. Xiphocaris displayed an increased jumping/leaping behavior and attempts to leave the water. During prolonged dryness leaf fall increases in some tree species that have toxic secondary compounds (i.e. alkaloids) in their leaves. When stream pools are reduced in water volume and flow these inputs result in low levels of oxygen and high levels of toxic chemical compounds. Inputs from fruits and seeds also may selectively eliminate some species of crustaceans and other arthropods in first- and second-order streams that drain areas with a closed-forest canopy. Recolonization of these pools would be influenced by timing of heavy rains that dilute toxins and increase dissolved oxygen.

COMPARATIVE POPULATION ECOLOGY OF AN INSECT FROM ALKALINE SALT LAKES. D.B. Herbst. Oregon State Univ., Corvallis.

Surveys of salt lakes have in general shown species diversity declines as salinity increases, while productivity is highest at moderate salinity. Abundance is supposed reduced above physiologically limiting high salinities, and at dilute salinities where ecological limitations are imposed on salt-tolerant species by interactions with a more diverse biota. To examine the associations of salinity and biotic diversity with abundance of a halotolerant osmoregulator, populations of the alkali fly *Ephydra hians* (Diptera: Ephydriidae) were compared between two Great Basin lakes. Abert Lake is a low salinity lake (20-30 g/l TDS) with more co-inhabiting species than the high salinity Mono Lake (75-90 g/l). Decreasing salinity in both lakes over the period of study coincided with relative abundance decreasing at Abert and increasing at Mono. These results conform to the hypothesis that abundance of salt-tolerant species will be maximum at intermediate salinity. Experimental exposures to increased salinity or limited food supply produced low survival, reduced body size, and prolonged development. Alkali fly dynamics may thus be partially regulated by salinity effects on life history traits.

FACTORS CONTROLLING NATURAL INFECTION LEVELS OF FRESHWATER SNAILS BY LARVAL TREMATODES. Kenneth M. Brown*, E. K. Leathers† and D. Minchella*. Louisiana State Univ., Baton Rouge, Univ. Illinois, Champaign, and Purdue U., West Lafayette (intro. by W. Stickle). We

suggest factors determining infection rates in natural populations, and present survey data supporting our predictions. Assuming infection by miracidia is random, probability of infection should increase with (1) snail age and life cycle length, (2) declining resource levels, (3) individual shell size, and (4) snail density. A survey of populations of *Lymnaea elodes* did show higher infection levels where snails had longer life cycles due to lower food levels. Comparing across species, snails with longer life cycles and greater shell lengths usually have higher infection levels when present in the same area, as we predict.

SEASONAL PATTERNS OF TISSUE ACCUMULATION AND RESORPTION IN THE ASIATIC CLAM, *CORBICULA FLUMINEA*. F.G. Doherty. Virginia Polytechnic Institute and State University, Blacksburg.

Adult and juvenile *Corbicula fluminea* (n=100) were collected once each month from the New River in southwestern Virginia. Data recorded for each individual included shell dimensions and visceral wet and dry weights. Results indicate high degrees of correlation among shell dimensions, between shell dimensions and cube roots of tissue weights, and between tissue weights ($r > 90\%$) within monthly samples. Comparisons between samples reveal seasonal changes in visceral weight relative to shell dimensions and percent body water content. Individuals showed an 81.5% increase in visceral weight over a two month span (February to April) with all size classes demonstrating similar percentage changes in weight. Conversely, percent body water content peaked in February at 88.7% and declined steadily through May to 84.4% of total body weight in adults. These trends developed at a time when water temperatures were rapidly increasing. Both changes are thought to be associated with the commencement of reproductive activities.

CRUSHING STRENGTHS OF AGGLUTINATED AND CALCAREOUS TESTS OF BENTHIC FORAMINIFERA. K.L. Wetmore. Johns Hopkins Univ., Baltimore, Md.

Some species of benthic foraminifera secrete calcite tests while others cement sediment particles together to build their tests. The proportion of calcareous species has increased over time. One hypothesized reason for this increase is that evolution of a calcareous test permitted construction of stronger, lighter tests. Crushing strengths of individual tests were measured to examine possible correlations between test strength, habitat, and test composition. Crushing strengths of calcareous species were greater in high-energy habitats than in low-energy habitats. Also, within species, populations from high-energy habitats had stronger tests. Within the low-energy habitats there was no significant difference in test strength or weight between agglutinated species and most calcareous species. Thus, construction of a calcareous rather than an agglutinated test does not necessarily result in a stronger, lighter test.

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FLOW EFFECTS ON GAS EXCHANGE IN SOME CNIDARIANS. M.R. Patterson. Northeastern Univ., Nahant, MA.

Boundary layer thickness over aquatic organisms is modulated by flow speed. It is an important component of the diffusion path for gas exchange in invertebrates without circulatory systems. Gas exchange experiments were conducted at different flow speeds in recirculating flow respirometers using the symbiotic coral, *Montastrea annularis* in situ and the boreal sea anemone, *Metridium senile*, and octocoral, *Alcyonium siderium*, in the laboratory. Respiration rates increased with increasing flow speed in these species. The increase in respiration was related directly to the decrease in the boundary layer thickness. Production in *M.annularis* also increased with flow speed, but not proportionately as much as dark respiration. Since boundary layer thickness scales as the inverse square root of flow speed, flow-modulated gas exchange will be most important for aquatic organisms in relatively stagnant habitats subject to periodic increases in flow. Supported by NOAA Hydrolab missions 84-7 and 85-7 and by the National Science Foundation.

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SWASH-RIDING: WAVE-PROPELLED LOCOMOTION IN THE COQUINA CLAM *DONAX VARIABILIS*. O. Ellers. Duke Univ., Durham, NC.

Swash-riding animals allow themselves to be propelled shoreward or seaward by the upwash or backwash which results when a wave breaks onto the beach. Several crustaceans, gastropods, and bivalves do it. In the migrating coquina clam this movement depends on the clam's behavior, its special shape and unusually high density ($1.7-2.7 \times 10^3 \text{ Kg m}^{-3}$), and the wave flow. In accelerating flows of low turbulence this clam slides stably with the anterior (foot end) upstream. In contrast, models of other shapes (including bivalves which do not swash-ride) tumble, roll, or slide faster in varying orientations. The stability of *Donax variabilis* in flow can assure it control over where it burrows, and hence also over how far it moves. Control is crucial since forces tending to wash the clam seaward peak at 2 N and the forces tending to wash the clam out of the sand peak at 0.5 N, while a clam can only pull itself into the sand with its foot with a peak force of 0.2 N.

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FLOW-ASSISTED REFILLING OF SQUID MANTLE CAVITY. S. Vogel. Duke Univ., Durham NC

As a consequence of Bernoulli's principle, pressure is subambient lateral to a body moving through a fluid. The resulting pressure difference across the mantle of a rapidly-jetting squid will expand the mantle cavity and, by such supercharging, should increase the rate of refilling. Is the phenomenon quantitatively significant? When stationary, squid refill mainly by thinning the mantle via radial muscle contraction, producing pressure differences of about 1200-1500 Pa (from either existing estimates and measurements or my estimates based on muscle mass). A swimming speed of 4 m s^{-1} will yield as much pressure again. Since pressure difference is proportional to velocity squared, higher speeds will give much higher flow-generated pressures. Swimming speeds of at least 9 m s^{-1} are implied by anecdotal reports of predator-pursued squid landing on the decks of ships; under such extreme conditions flow-generated pressure will be the predominant agency of refilling.

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Kinematics of Forward Flight in Bumblebees. Robert Dudley Univ. of Cambridge, England.

Bumblebees in controlled free flight were filmed with a high speed camera at 5000 frames per second. An optomotor device was used to position the insects in the jet of a wind tunnel, which was operated over a range of forward velocities. Kinematics of the wing beat, including angle of the stroke plane, position of the wing tip, and oscillations of the body were calculated from a three-dimensional reconstruction of the two-dimensional film image. The variation of kinematic parameters with forward velocity and insect size was determined. Such results, in conjunction with lift and drag measurements on isolated bumblebee wings and fuselages, yield considerable insight into the aerodynamic mechanisms and power requirements of forward flight in insects.

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ANTLION PIT STRUCTURE AND THE BEHAVIOR OF PREY. JR Lucas. College of William & Mary, Williamsburg, VA.

Two factors influence capture success of antlion pits: slope and grain size. The pit wall slope is asymmetric and this asymmetry is actively maintained by the orientation of the antlion; the wall behind the antlion is significantly shallower than the facing wall. This design compensates for an orientational asymmetry in the efficiency of prey capture. Antlions are more efficient catching prey that escape to the rear of the pit, while the pit is most efficient at deterring prey escaping to the front of the pit. Due to the physical properties of sand, particle size increases on shallow slopes. Antlions compensate for this by lining the rear of the pit with fine sand after the pit is excavated. The behavior of ants escaping from antlions is analyzed with respect to pit structure.

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ELECTROPHORETIC COMPARISON OF REPTILIAN VITELLOGENINS. J. Zimochow and R.E. Bast, Cleveland State Univ., OH.

We analyzed by electrophoresis, plasma samples from untreated and estrogen treated animals under denatured, or denatured and reduced conditions. By comparing banding patterns of samples from treated or untreated animals we identified tentatively the constituent polypeptides of vitellogenins (Vgs) from 20 different reptilian species representing 4 of the 5 extant orders. By comparing reduced and nonreduced samples we determined the role of disulfide bonds in Vg structure. The Vgs of turtles and crocodiles are composed of at least two large polypeptides with no apparent role for interpolypeptide chain disulfide bonds. Vgs of snakes are composed of 3 to 5 polypeptides, several of which form dimers connected by disulfide bonds. Generally, the Vgs of lizards are composed of a complex set of polypeptides with one or two dimeric subunits linked by disulfide bonds. Reptilian Vgs will be compared to amphibian and avian Vgs.

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RELEASE OF PROTEIN FROM ISOLATED YOLK PLATELETS OF ARTEMIA CYSTS DURING PH TRANSITIONS IN VITRO. P.J. Utterback and S.C. Hand. Univ. of Southwestern Louisiana, Lafayette.

Yolk platelets rapidly release protein (up to 9 mg/10⁹ platelets) upon alkalization of a platelet suspension from pH 6.3 to 8.0. Protein levels in both the platelets and incubation medium reach steady-state values 40-50 minutes after a pH change. The exponential release can be stopped, but not reversed, by reacidification. Plotting protein liberated versus pH gives a sigmoidal titration curve, with an inflection point at pH 7.2 and maximal release (80% of total platelet protein) at pH 8.0 to 8.4. Temporally associated with this biochemical change is a reduction in platelet dry weight from 7.5 mg/10⁹ platelets at pH 6.3 to 3.3 mg at pH 8.6 (51% reduction). Diameter decreases from 2.40 ± 0.05 μm (SE, n=346) at pH 6.3 to 1.89 ± 0.06 μm (n=342) at pH 8.0, representing a 51% volume change. Since the transition from anaerobic dormancy to aerobic development in Artemia is promoted by alkalization of intracellular pH, protein mobilization from yolk platelets may be a feature of this activation event. Supported by NSF Grant DCB-8316711

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ISOLATION AND CHARACTERIZATION OF SNAKE VITELLOGENIN. B.F. McArdle and R.E. Bast (intro. by F.P. Doerder). Cleveland State Univ., OH.

The yolk protein precursor, vitellogenin (Vg), was purified from plasma of the common garter snake, Thamnophis sirtalis, by ultracentrifugation, Mg-ion precipitation, and ion exchange chromatography. Vg was obtained with no detectable impurities. Vg and each of its constituent polypeptides were injected into rabbits. Antiserum to Vg was used on Western immunoblots of denatured plasma samples to identify Vg polypeptides. Four polypeptides reacted with the antiserum. The polypeptides are of very different molecular weights. Antisera to individual constituent polypeptide did not crossreact with other Vg polypeptides on immunoblots. We conclude that T. sirtalis Vg is composed of an unusual number of polypeptides of markedly different size, and that each of them is the product of a separate gene. A preliminary mechanism of how T. sirtalis Vg genes evolved will be presented.

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EGG AND HATCHLING COMPONENTS OF THE SNAPPING TURTLE (*CHELYDRA SERPENTINA*). D. C. Wilhoft, Rutgers University, Newark, N. J.

Whole eggs whose mean wet weight was 9.45g contained 72.6% H₂O and 12.38 Kcal of energy while egg components included by dry weight 29.8% shell, 33.8% lipid (43.6% higher than previously reported for this species) and 54.9% protein. Mean wet weight of hatchling yolk-sacs on the day of hatching was 0.16g and averaged 60.0% H₂O, 37.3% lipid, 58.2% protein and 6.0 Kcal of energy. The majority of yolk present at hatching was metabolized by day 18 of hatchling life. Mean hatchling, minus yolk-sacs, wet weight was 7.59g and averaged 82.1% H₂O, 19.7% lipid, 32.2% protein and 6.72 Kcal of energy. During development approximately 40% lipid, 53% protein and 40% energy were utilized the remaining portions stored in the hatchlings. Hatchling body separated from hatchling shell averaged 18.1% lipid, 24.4% protein; shell averaged 8.2% lipid and 21.2% protein. Protein percent by dry weight exceeded percent lipid by approximately 38% in both egg yolk and hatchlings but due to the different energy content in lipid and protein an equal energetic contribution was made.

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CONTROL OF POLYAMINE SYNTHESIS, AND ITS REQUIREMENT DURING VITELLOGENIN PRODUCTION IN THE MOSQUITO, *Aedes Aegypti*. P. H. Kogan* and H. H. Hagedorn, Cornell University, Ithaca, NY.

Polyamines -- amino acid derived cations -- are essential for many cellular functions, including optimal protein synthesis. Depletion of polyamines decreases protein production, most likely by affecting ribosomal and transfer RNA. Investigation of this problem is best in a defined system of massive protein synthesis. We are working with such a system -- vitellogenin synthesis in the mosquito, *Aedes aegypti*. After a blood meal as much as 10 ug of vitellogenin is made per hour. Among the earliest events after the meal is a rise in activity of ornithine decarboxylase (ODC), a rate-limiting enzyme in polyamine synthesis. ODC activity rises within a few hours after the blood meal and then falls. Activity then rises again during the period of continuous vitellogenin production. Labelled ornithine injected into blood fed mosquitoes is converted to polyamines in a pattern which correlates well with macromolecular syntheses. Inhibition of ODC with specific inhibitors disrupts digestion of the meal and decreases vitellogenin production. Thus, polyamines may be required for optimal vitellogenin synthesis.

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DOES BIOLUMINESCENCE IN THE COLONIAL RADIOLARIA ORIGINATE FROM ALGAL SYMBIANTS? M. I. Latz, University of California, Santa Barbara.

The bioluminescence of colonial radiolaria from the Sargasso Sea was examined with fast spectroscopy and photon counting techniques. Luminescence is readily elicited by mechanical stimuli and is blue in color ($\lambda_{max} = 450 - 460$ nm). Since colonies possess symbiotic algae containing dinoflagellate pigment, the characteristics of radiolarian luminescence were compared to those of free-living dinoflagellates to determine the source of light emission in the colonies. Luminescence of the radiolaria examined most likely does not originate from symbiotic dinoflagellates based on the following criteria: (1) emission spectra, (2) unresponsiveness to low pH stimulation, (3) flash kinetics, and (4) lack of light inhibition. High densities of radiolaria encountered in the Sargasso Sea suggest that they may be a significant source of in situ luminescence.

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EFFECT OF KETOSIS AT LOW BODY TEMPERATURE IN *SPERMOPHILUS BELDINGI*. B. L. Krilowicz, Univ. of Santa Clara, Santa Clara, CA.

Pectoral tissue removed from hibernating *S. beldingi* and incubated in media containing physiological concentrations of glucose and β -HB, responds to 1.0 mM β -HB by decreased glucose uptake ($P < 0.03$). Thus, glucose supplies all (132%) of the metabolism of the tissue when no β -HB is present and none when 1.0 mM β -HB is present. Pectoral muscle removed from fed animals does not alter glucose uptake or lactate release when exposed to β -HB. However, glucose uptake by the tissue is low even in the absence of β -HB; none of the metabolism is from glucose. Therefore, no further reduction in glucose utilization is predicted when β -HB is present. At an external β -HB concentration of 1.0 mM, β -HB metabolism accounts for 25% of the metabolic rate of tissue from fed animals. However, β -HB is not metabolized by tissue from hibernators. Ketosis during hibernation in *S. beldingi* leads to decreased glucose utilization by pectoral muscle at the low body temperature experienced during torpor. Coupled with a similar effect of β -HB at body temperatures experienced during arousal and homeothermy, ketosis during hibernation leads to a sparing of body protein.

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PHAGOCYTIIC DEPRESSION OF TROUT SPLEEN MACROPHAGES. Hugo C. Lang. Wake Forest Univ., Winston-Salem.

Five days after a 15% hemorrhage the serum of rebled rainbow trout reduced the number of yeast and bacilli phagocytosed by four-day adherent spleen cells maintained in L-15 culture medium supplemented with 0.2% glucose and 10% fetal bovine serum at 10 C. Both above and below 30,000MW blud serum fractions retained the capacity to reduce phagocytosis. SDS-PAGE showed that, relative to controls, protein bands from whole blud or fractionated blud sera were reduced or were missing. Nevertheless, the total protein concentration of the blud serum did not differ significantly from controls. HPLC showed that cortisol remained high in the serum of five-day blud animals. The relationship between these protein and steroid changes and phagocytic depression is presently under scrutiny.

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Bioenergetics of Callinectes sapidus exposed to South Louisiana crude oil. S.Y. Wang and W.B. Stickle. Louisiana State Univ., Baton Rouge.

Juvenile blue crabs were exposed to the water soluble fraction of South Louisiana crude oil (0, 0.866, 1.462 and 2.316 ppm) for 21 days. Crab feeding rates on fresh Palaemonetes pugio, absorption efficiencies, oxygen consumption and ammonia excretion rates were determined on days 0, 7, 14 and 21 of the exposure period. Feeding rate varied inversely with aromatic hydrocarbon concentration and was the primary determinant of crude oil effects on crab bioenergetics. Energy expenditure due to respiration and ammonia excretion was generally lower for crabs exposed to 0.866 and 1.462 ppm than control crabs and crabs exposed to 2.316 ppm. Percent caloric expenditure due to respiration ranged from 87.9-96.2% while that due to ammonia excretion ranged from 3.8-12.1%. The overall energy budget or Scope for Growth was significantly affected by aromatic hydrocarbon exposure, decreasing with both time and exposure level. The scope for growth of crabs exposed to 2.316 ppm was 28.5% of that of control crabs by day 21.

Supported by an LSU Mineral Resources Research Institute Fellowship.

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THE EFFECT OF COCCIDIOSIS ON HEMATOLOGY OF LOHI Sheep. Zia-ur-Rahman, M. Ahmad and Sajjad-ur-Rahman. Univ. of Agri. Pakistan.

Hematological values of lohi sheep (a native breed of Pakistan) infected with pathogenic coccidiosis oocysts revealed the following: 1) 51% decrease of glucose from the healthy sheep value during the peak infection. 2) a 45% increase in potassium and 22% decrease in sodium contents were observed in the infected animals at the peak of infection and these values are significantly different ($P < 0.01$) from the healthy normal observation. 3) coccidiosis infected animals showed 26% decrease in total globulin which was the result of decrease in gamma globulin concentration. 4) packed cell volume decreased significantly ($P < 0.01$) at the peak of infection and almost return to normal after Amprolium treatment.

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HEMOLYMPH LIPIDS IN FORAGING HONEYBEES. J. M. Sidle. Ursinus College, Collegeville, PA.

Lipids detected by TLC in adult worker honeybee hemolymph are: phospholipids, monoglycerides, 1,2- and 1,3-diglycerides, tri-glycerides, free fatty acids, cholesterol, esterified cholesterol and hydrocarbons. Spectrophotometric total hemolymph lipid ranges 650-1090mg% but is similar in foragers and non-flying hive bees on any given day. Total glyceride concentration in adult workers is 200-350mg%. Total cholesterol concentration in adult workers is 13-24mg%. Drones have little or no hemolymph cholesterol. There is no detectable change in concentration of any of the lipid classes as a result of forager flight over distances up to 1000m. Adult workers show a gradual increase in total hemolymph lipid from March to mid-June and this change parallels local pollen availability.

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PROTEIN HYPERTROPHY IN LIVER AND HEART FOLLOWING COLD ACCLIMATIZATION AND ACCLIMATIZATION IN CHANNEL CATFISH (CCF). J.D. Kent and C.L. Prosser. Univ. Illinois, Urbana.

We have previously shown that total protein content doubled in liver of cold acclimated CCF (25 vs 15 C) coincident with a similar increase in HSI. In the present study, we consider changes in total protein content and HSI in summer, winter, fall, and spring acclimated CCF. Total protein content is increased by approximately 78% and HSI, 165% between summer (25-30 C) and fall (12-15 C) animals and remains elevated throughout the winter and spring. Glycogen is altered in the same direction. In contrast to the acclimated state, seasonally acclimated animals appear to exhibit variable amounts of total liver DNA and occur in the order: fall (36.62 ± 2.68 mg/TL) > summer (21.93 ± 1.26) > winter (17.27 ± 1.56) > spring ($12.09 \pm .49$). This suggests that a hyperplasia, in association with hypertrophy, may be important in the seasonal acclimatization of CCF.

Both cold (compared to warm) acclimated and winter and fall (compared to summer) acclimated CCF show heart mass and protein hypertrophy, suggesting that the hypertrophy phenomenon is a common strategy for achieving independence with respect to temperature in this species.

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HEXOSE-6-PHOSPHATE DEHYDROGENASE FROM THE FISH FUNDULUS HETEROCLITUS. I.J. Ropson* and D.A. Powers. Johns Hopkins Univ., Baltimore, MD

Hexose-6-Phosphate dehydrogenase, a microsomal liver enzyme, catalyzes reactions similar to those catalyzed by Glucose-6-Phosphate dehydrogenase. However, a broader range of substrates and coenzymes can participate. H6pdh is believed to have arisen from a G6pdh gene duplication event. Purification and characterization of H6pdh has been reported for a few mammalian systems, but little is known about this enzyme in lower vertebrates. We have purified H6pdh to homogeneity and found that it follows a random bisubstrate reaction mechanism. Glucose-6P, Galactose-6P, 2-Deoxyglucose-6P, and Glucose have been studied as substrates (K_m values: 5.5, 60, 200, and 100,000 μ M, respectively). NADP, deamino NADP, and 3-acetylpyridine NADP are coenzymes (K_m values: 1.2, 10, and 150 μ M, respectively). NAD is a coenzyme only when glucose is a substrate, acting as a competitive inhibitor for NADP in reactions with sugar-6P ($K_i=0.75$ μ M).

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ANALYSIS OF HEAT-SHOCK GENE EXPRESSION IN THE TELEOST FUNDULUS HETEROCLITUS. Michael Koban and Dennis Powers. Johns Hopkins University, Baltimore, MD 21218

We use the teleost, Fundulus heteroclitus, as a model to study organism-environment interactions at the molecular level. The heat-shock response is particularly appropriate because this fish is highly eurythermal. Thermally acclimated fish were heat stressed and RNA was isolated. Cell-free translation products were resolved on SDS gels. There was differential thermal sensitivity of individual tissues in heat-shock protein (hsp) synthesis, as well as tissue specificity in hsp Mws. Relative abundance of heat-shock transcripts was assayed by synthesis of cRNA from a trout heat-shock gene cloned into pSP6 plasmid. cRNA was used as a probe for Northern blot analysis of liver RNA of heat-stressed fish. Hybridization studies of control and heat-stressed fish suggest that two different heat-shock genes may be constitutively transcribed. However, as only one hsp was translated, the heat-shock response in Fundulus liver may be under stringent translational control.

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mtDNA POLYMORPHISMS IN POPULATIONS OF THE TELEOST FUNDULUS HETEROCLITUS. L.I. Gonzalez-Villaseñor* and D.A. Powers. The Johns Hopkins University, Baltimore, MD.

Individual fish from each of several different populations along the East Coast were analyzed for genetic diversity of their mtDNA restriction patterns. Cloned fish mtDNA was used as a hybridization probe to detect individual electromorphs generated by each of 18 restriction endonucleases. These mtDNA electromorphs reflected genetic variation between and within populations. The Southern most population (Georgia) showed larger (28%) genetic variability than the Northern most population (Maine) which has 5.5% variation. While 44% of the mtDNA patterns were different between these populations, the variability was due to single nucleotide changes. Populations geographically between the Northern and Southern extremes showed intermediate degrees of genetic variability. Low levels of mtDNA divergence as indicated by the nucleotide diversity index argues against different Fundulus species.

PHOSPHOFRUCTOKINASE FROM THE ADDUCTOR MUSCLE OF THE BAY SCALLOP. C.P. Chih and W.R. Ellington. Florida State Univ., Tallahassee.

Phosphofructokinase (PFK) from the phasic adductor muscle of the bay scallop Argopecten irradians concentricus was purified by ammonium sulfate precipitation, Cibacron blue Sepharose affinity chromatography and gel filtration using Sephadex G-200. The final specific activity was 55.6 EU/mg protein. Fructose-6-P saturation curves were sigmoidal at pH 7 ($n=2.8$) and below. Increased assay pH resulted in increase in enzyme activity as well as a decrease in the degree of sigmoidicity. At pH 7, the presence of AMP (0.1 mM), ADP (0.5 mM) or fructose-2,6-P (1 μ M) in the assay system resulted in hyperbolic F-6-P saturation kinetics. The activation curves of AMP and F-2,6-P were hyperbolic yielding K_m values of 22.0 μ M and 0.65 μ M, respectively. ATP saturation kinetic curves generated at pH 7 showed pronounced substrate inhibition which was relieved by AMP (0.1 mM). Inorganic phosphate, phosphoenolpyruvate and citrate were found to be inhibitory modulators while arginine-P appeared to have no effect on this enzyme. The properties of this enzyme show that it has a high potential for activation during burst muscle contraction. Supported by NSF grant PCM-8401258.

NADP-LINKED MALIC ENZYME FROM THE MITOCHONDRIA OF THE HEART OF THE WHELK BUSYCON CONTRARIUM. R.A. Graham and W.R. Ellington, Fla. State Univ., Tallahassee.

Malic enzyme (ME) was isolated from mitochondria of the heart of B. contrarium by HPLC with a TSK-3000 column. The isolated enzyme showed a specific activity of 5 EU/mg protein and was free of malate or lactate dehydrogenase and fumarase activities. The molecular weight, estimated from the TSK column, was 179,000. This ME was specific for NADP(H). At physiological pH, the decarboxylation reaction was the preferred direction. The saturation kinetics with respect to malate and pyruvate were sigmoidal. The $S_{1/2}$ for malate ranged from 0.3 to 3 mM; the $S_{1/2}$ for pyruvate was 6.5 mM. The apparent K_m 's for NADPH and NADP were 1.5 and 13 μ M respectively. NADPH inhibited malate decarboxylation at concentrations greater than 100 μ M. NADH, NAD, fumarate and succinate had no effect on enzyme activity. Hydroxymalonic acid was a potent inhibitor at sub mM concentrations. We conclude that the whelk heart ME appears to function in the decarboxylation of malate to provide an alternative source of intramitochondrial pyruvate. Supported by NSF Grant PCM-8202370.

ARACHIDONIC ACID METABOLISM BY GILL TISSUE OF THE FRESHWATER MUSSEL, LIGUMIA SUBROSTRATA. A.F. Hagar and T.H. Dietz. Louisiana State Univ., Baton Rouge.

Prostaglandin E_2 (PGE_2) has recently been shown to be a negative modulator of Na uptake in the freshwater mussel, Ligumia subrostrata. Thus the ability of gill tissue from this species to metabolize arachidonic acid (20:4n6) is of interest. Gill homogenates were incubated with 3H -20:4n6, and the reaction products were isolated by thin-layer chromatography (TLC). Three major radioactive peaks with R_f values of 0.0, 0.35, and 0.50 were localized and eluted from the TLC plate for further analysis. The metabolite with an R_f value of 0.35 appears to be PGE_2 because a PGE_2 standard had a similar R_f in this solvent system. Additionally, when the compound was rechromatographed in another solvent system, it again had an R_f value similar to the PGE_2 standard. The metabolite with an R_f value of 0.50 was analyzed by HPLC. It was identified as 5-hydroxyeicosatetraenoic acid (5-HETE) based upon an elution time that was identical to that of a 5-HETE standard. The metabolite with an R_f of 0.0 is a very polar compound and has not yet been identified. Supported by NSF grant DCB83-03789.

KETOGLUTARATE DEHYDROGENASE COMPLEX (KGDC) FROM A BIVALVE GILL TISSUE.

G. A. Karam, K. T. Paynter, S. H. Bishop, Iowa State Univ., Ames and R. Komuniecki, Univ. of Toledo, OH.

Transient proline accumulation in osmotically stressed ribbed mussel gill tissue may be due to a transient inhibition of the KGDC. KGDC activity was partially purified from gill tissue mitochondria by a combination of Triton-extraction, polyethylene glycol precipitation and differential ultracentrifugation. The activity showed sigmoidal (allosteric) kinetics with regard to α -ketoglutarate ($K_{0.5} = 54 \mu$ M) and little variation in activity between pH 6.5 and 8.5. No inhibition was observed with ATP, ATP analogs, or EDTA in the 1-10 mM range and there appeared to be no regulation by a protein kinase-phosphatase system. Other properties indicated a close similarity to KGDC from other animal tissues. If it occurs at all, transient inhibition of the KGDC during hyperosmotic stress appears to be due to transient changes in metabolite levels. (Supported by grants from the NSF.)

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REGULATION OF THE ASCARIS SUUM PYRUVATE DEHYDROGENASE KINASE. J. Thissen*, P. McCartney* and P. Komuniecki. University of Toledo, Toledo, Ohio

The pyruvate dehydrogenase complex (PDC) has been purified to apparent homogeneity in a fully active state from body wall muscle of the porcine nematode, Ascaris suum, in yields 20-fold greater than previously published procedures, using isolated mitochondria. This preparation contains an active PDK kinase, which catalyzes the ATP-dependent phosphorylation and subsequent inactivation of the PDC. A. suum PDK kinase is stimulated by elevated NADH/NAD⁺ ratios, in common with PDK kinases isolated from aerobic tissues. However, the ratio giving "half maximal stimulation" is more than an order of magnitude greater for the ascarid enzyme (1.1 vs. 0.03 or 0.05 for porcine liver or kidney, respectively.) In addition, physiological levels of two important intermediates of ascarid mitochondrial metabolism, pyruvate and propionate, also potentially inhibit kinase activity. These results may account for the observed activity of the PDC in intact muscle strips incubated anaerobically even in the presence of a relatively reduced mitochondrial pyridine nucleotide pool.

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EVALUATION OF SALINITY STRESS BY ATOMIC RATIO OF OXYGEN CONSUMED TO NITROGEN EXCRETED. M. Iamir*, S. Hajj*, M. Nuwayhid* and L. S. L. Young. Amer. Univ. of Beirut, LEBANON.

In preliminary observations, we found little variation in body water content for the intertidal hermit crab, Glibana ciliata erythroga Latreille 1818. Oxygen consumption over the first 96 h ranged between 0.75 and 2.01 ml/h for standard sized individuals of 0.0684 g afdw. Body water content varied between 62.9 to 64.2% of wet weight. We used the method of atomic ratio of oxygen consumed to nitrogen excreted for evaluating stress. Animals from an intertidal rocky beach demonstrated declining water content from 71 to 66% body water during the summer when exposed to 15 thru 50 ppt salinity. The environmental conditions were 40 ppt salinity and 28 °C. Respiration rates varied after two weeks acclimation from 1.6 to 2.9 ml/h for standard sized animals of 0.173 g wet weight. Gram-atomic nitrogen excreted varied from 222.3 to 554 ug-atom N/h for 0.173 g wet weight individuals. Atomic ratios varied between 313.8 and 869.6 without any clear pattern. We found assessment of stress by atomic ratios to be of limited value.

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PROPERTIES OF SINGLE CNIDOCYTES ISOLATED FROM SEA ANEMONES. M. C. McKay and P. A. V. Anderson. Intro by M. J. Greenberg. C. V. Whitney Laboratory, Univ. of Florida, St. Augustine.

Cnidocytes were isolated from the acrorhagi and tentacles of several species of sea anemones by enzymatic digestion with papain. The tissue digest was then centrifuged in a Percoll gradient to separate unwanted cells and debris from cnidocytes. Our method yields a relatively pure preparation of cnidocytes and can be applied to a variety of cnidarians. The electrical properties of the isolated, intact cnidocytes were examined using whole-cell patch clamp recording techniques. Isolated cnidocytes produced both inward and outward currents; however, capsule discharge does not depend upon a change in membrane potential. The responsiveness of in situ and isolated cnidocytes to discharge with different chemical stimuli was quite different. Isolated cnidocytes were less sensitive to stimuli than whole tentacle preparations. This may be due to dissociation of the cnidocytes from the accessory ciliary-cone sensory cells present in whole tentacles. Whole tentacles treated with papain for short times did not change in their responsiveness to chemical stimuli. Supported by NSF Grant No. BNS 82-09848

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AMILORIDE-SENSITIVE Na⁺/H⁺ EXCHANGE IN MEMBRANE VESICLES FROM CRAB (CALLINECTES SAPIDUS) GILL. D.W. Towle, Univ. of Richmond, VA and Mt. Desert Island Biol. Lab., Salsbury Cove, ME

Sodium uptake across gill epithelial cells is thought to depend on concerted action of basolateral Na⁺+K⁺-ATPase and apical Na⁺/H⁺ or Na⁺/NH₄⁺ exchange. Membrane vesicles from mitochondria-rich and -poor cells were prepared by density gradient centrifugation. Uptake of ²²Na⁺ into Na⁺-free vesicles was measured by rapid filtration, with and without amiloride (up to 1 mM). Amiloride-sensitive Na⁺ uptake was observed only in vesicles from mitochondria-rich cells. Imposition of a pH gradient (high internal H⁺) enhanced Na⁺ uptake, indicating the presence of Na⁺/H⁺ exchange. However, loading vesicles with 1 mM NH₄Cl produced no increase in amiloride-sensitive Na⁺ uptake. The kinetic effects of altering external Na⁺ indicated the existence of two routes of Na⁺ uptake, a saturable, amiloride-sensitive pathway, and a second, unsaturable pathway. Supported by National Science Foundation (DCB 8408510).

UPTAKE OF AMINO ACIDS VIA THE MANTLE OF THE MUSSEL, *MYTILUS EDULIS*. M. A. Rice and G. C. Stephens. University of California, Irvine.

Uptake of amino acids was monitored by following disappearance of substrate using both radiochemical and chemical techniques. Rates were compared in parallel observations on mussels from which the gills were removed and sham operated mussels (adductor muscle was cut). Distribution of amino acid supplied externally to selected internal tissues was determined and compared in these two preparations. On a surface area basis, internal distribution of substrate entering via the mantle tissue is quantitatively more important. The preparation was also used to test interactions between pairs of amino acids. There appear to be differences in specificity of carriers present in the epithelia of the gills and the mantle, particularly with respect to taurine. The data suggest that transepidermal transport via the mantle tissue may play an important role in amino acid uptake in *Mytilus*. This work was supported by NSF Grant PCM-8208185.

CARBONIC ANHYDRASE LOCALIZATION IN THE MIDGUT EPITHELIUM OF LARVAL *MANDUCA SEXTA* (INSECTA, LEPIDOPTERA). R.L. Ridgway and D.F. Moffett. Washington State Univ., Pullman.

Differences in the cytoarchitecture of columnar and goblet cells allow the midgut of larval *Manduca sexta* to be divided into anterior, middle, and posterior regions. The pH of the midgut contents rises from 5.5 in food to 11 in middle midgut, but falls to 8 in the posterior midgut, and to 4 in feces. These results suggested that the anterior and middle midgut are responsible for net carbonate secretion and that the posterior midgut may serve to reabsorb some of the secreted base.

Carbonic anhydrase is typically found in high levels at cellular sites of acid/base transport. We report here that acetazolamide-sensitive carbonic anhydrase activity, as determined by histochemistry, is primarily localized to the apical membrane of goblet cells in anterior and middle midgut, but to the brush border of columnar cells in posterior midgut. These results confirm different roles for the anterior and middle regions versus the posterior region in managing the alkalinity of larval midgut contents.

(Supported by NSF DCB 8315739 to DFM)

ISOZYMES OF MALATE DEHYDROGENASE (MDH) AND ASPARTATE AMINOTRANSFERASE (AAT) IN RIBBED MUSSEL GILL TISSUE. M. M. Brodey, A. McCormick, K. T. Paynter and S. H. Bishop. (intro. by S. S. Shen) Iowa State Univ., Ames.

Malate and aspartate (asp) metabolism appear to be metabolically coupled to changes in alanine levels in euryhaline bivalve gill tissue during osmotic stress. The cytosolic MDH (cMDH) activity consists of five electromorphs each having distinctive kinetic properties. The mitochondrial MDH (mMDH) activity consisted of two electromorphs. One mMDH was electrophoretically identical to one of the cMDHs. Kinetic properties of the mMDHs and cMDHs differed from each other. The purified cAAT and mAAT were dimers of identical subunits of MW 50K and both used cysteine sulfinic acid as a substrate in place of asp. The cAAT differs from all other known animal AATs by having a high K_m for asp (150 mM) and low K_m for OAA ($> 2 \mu M$) at low pH values (pH 6.5). The variable properties of the MDHs and AATs in the cytosolic and mitochondrial compartments may account for some of the unusual aspects of decarboxylic acid metabolism and amino acid accumulation in this tissue. (Supported by grants from the NSF.)

NEURAL PRODUCTS REDUCE THE EPITHELIAL WATER PERMEABILITY OF THE MUSSEL *GEUKENSIA DEMISSA*. L. E. Deaton. Whitney Laboratory, University of Florida, St. Augustine.

The diffusional water permeability (Pd) of mantles from *G. demissa* acclimated to 1000 and 500 mOsm seawater (SW), were, respectively, 10.6×10^{-5} cm/sec and 6.7×10^{-5} cm/sec. Incubation of mantles from 1000 mOsm-acclimated mussels in 1000 mOsm SW for 4 hours increased Pd by 1.0×10^{-5} cm/sec. Exposure to 500 or 250 mOsm for 4 hours decreased the Pd by 2.3 and 4.1×10^{-5} cm/sec, respectively. Acetone extracts of the pooled ganglia of mussels acclimated to 1000 mOsm, and of mantles from mussels acclimated to 500 mOsm significantly reduced the Pd of 1000 mOsm-acclimated mantles incubated in 1000 mOsm SW. Extracts of mantles and gills from mussels acclimated to 1000 mOsm had no effect. Prolactin (50 $\mu g/ml$) also decreased the Pd. Vasopressin, cortisol, amphoteracin B, serotonin, and FMRF-NH₂ had no effect. The results suggest that the epithelial water permeability of euryhaline bivalves decreases in hypoosmotic media, and that the permeability change is modulated by neurohormones.

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ALLANTOIC FLUID REGULATION IN EMBRYONIC JAPANESE QUAIL. R.A. McNABB. Virginia Polytechnic Institute and State University, Blacksburg.

During embryonic development, allantoic fluid represents the shifting balance between renal excretion and allantoic reabsorption. Allantoic contents of Na, K, Cl, urate (UA), water and pH were followed for d 10-15 of the 16d incubation. Water volume was near 0.9 ml until d 13, then fell very rapidly. The pH fell more steadily, from 8 to 5.5. Contents of Na and Cl fell regularly to final values of 80-88% below d 10. The K content changed differently, and nearly doubled by d 13, but returned to d 10 values at the end. UA content rose until d 13, then fell suddenly to low values. This was due to abrupt precipitation of most UA into masses not sampled by our method; thus, after d 13, UA was underestimated (by 90-96%). Ion-binding by UA was low (3-10%) and nonspecific. The underestimate of UA means that in late incubation about one-third Na and 65-70% K and Cl are precipitated and do not appear in balance sheets of allantoic ions. These precipitated ions account for the significant Na and K that are left in the shell at hatching, but whose presence is not predicted by the analysis of allantoic fluid. (Supported by BRSG and NSF-PCM 8021881.)

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MAINTENANCE NITROGEN REQUIREMENT OF THE RACCOON, *PROCYON LOTOR*. J.N. Mugaas, K. Halama*, B. Lundrigan*, and J. Seidensticker*. W.V. School of Osteopathic Med., Lewisburg, and National Zoological Park, Washington, D.C.

Adult raccoons (4♂, and 3♀) in nonreproductive condition were fed purified diets containing 0.15, 0.525, and 1.51% nitrogen (N) [0.94, 3.28, and 9.44% crude protein, respectively]. Raccoons gained weight on all three diets (0.41 kg±0.34), but could only maintain positive N balance on 3.28 and 9.44% protein diets. Fecal N (gN/kg wet feed intake) as a function of dietary N (%) was described by $y = 1.523X + 0.461$, $r = 0.99$, which predicts a metabolic fecal N value of 0.461 gN/kg wet feed intake. Total N excretion (gNex/kg^{0.75} day) as a function of total N intake (gNi/kg^{0.75} day) was described by $y = 0.333X + 0.086$, $r = 0.92$. This predicts an endogenous urinary N excretion of 0.086 gN/kg^{0.75} day, and an EUN:BMR ratio of 1.21 mgN/kcal. The point at which N intake and N excretion were equal (0.12 gN/kg^{0.75} day) represents the necessary maintenance intake. Supported by WVSOM Faculty Research Grant, and Friends of the National Zoo.

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UREOTELISM IN THE PHYLUM ECHINODERMATA. W.B. Stickle. Louisiana State Univ., Baton Rouge.

Rates of nitrogen excretion and the percent composition of ammonia (N), urea (U) and primary amine (PA) nitrogen were determined in fifteen species of echinoderms at 30-35°C and ambient water temperature. The range of mean percent contribution attributable to three species of holothuroids was: N=33-96%; U=2-67% and PA=1-4%. Nitrogen excreted by a species of echinoid was partitioned as follows: N=93%; U=3% and PA=4%. The range of mean percent contribution attributable to eight species of asterooids was: N=21-87%; U=0-66% and PA=0-21%. Urea excretion was related to the arginine ingestion rate in one species but was synthesized endogenously in four species of asterooids starved prior to their use as experimental animals. The range of mean percent contribution of nitrogen attributable to three species of ophiurooids was: N=20-68%; U=3-76% and PA=0-29%. Eleven of the fifteen species are urogenic while six of them are urotelic. In light of these findings, the Baldwin-Needham hypothesis about the selective forces which modify the pattern of nitrogen excretion in echinoderms must be modified.

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PHOTOPERIODIC CONTROL OF THE PARR-SMOLT TRANSFORMATION IN ATLANTIC SALMON: CHANGES IN THYROID HORMONES, GILL Na⁺,K⁺-ATPase AND SALINITY TOLERANCE. S.D. McCORMICK, R.L. SAUNDERS*, E.B. HENDERSON* and P.R. HARMON*. Biological Station, St. Andrews, N.B.

Atlantic salmon (*Salmo salar*) reared under simulated natural photoperiod underwent concurrent increases in plasma thyroxine (T4), gill Na⁺,K⁺-ATPase activity and salinity tolerance in March-April. Exposure to continuous light completely inhibited increases in gill Na⁺,K⁺-ATPase and salinity tolerance and partially inhibited the rise in plasma T4. Replacement of continuous light with normal photoperiod, 3 and 5 months prior to normal smolting, resulted in normal and delayed increases, respectively, in gill Na⁺,K⁺-ATPase activity and salinity tolerance. The results indicate that photoperiod can act as both a zeitgeber and inhibitor of the parr-smolt transformation and that salinity tolerance, gill Na⁺,K⁺-ATPase and to a lesser extent plasma T4 are positively related during photoperiod manipulations.

FEMALE-SPECIFIC LIPOPROTEIN IN THE HEMOLYMPH OF THE BLUE CRAB, *CALLINECTES SAPIDUS*. R.F. Lee, Skidaway Inst. Oceanogr. Savannah, GA.

The hemolymph lipid in crustaceans is associated with lipoproteins in the high density class (1.07-1.21 g/ml). The objectives of the study were the isolation of hemolymph lipoproteins found in both male and female blue crabs, as well as any female specific lipoproteins. Two different lipoproteins were found with one appearing in female hemolymph soon after their molt to the adult form. Lipoprotein I was found at low concentrations (0.4 to 0.7 mg/ml) in both male and female blue crab. Lipoprotein II was found at high concentrations (up to 4 mg/ml) in sponging female crabs. The high density lipoprotein fractions were separated into ten fractions using isopycnic density gradient ultracentrifugation. Using these procedures the lipoproteins associated with two subfractions which were fraction 6 (density 7.123-1.142 g/ml) with lipoprotein I and fraction 9 (density 1.156-1.170 g/ml) with lipoprotein II. Different peptides were associated with each lipoprotein.

FOUR SPECTRAL CLASSES OF CONE IN THE RETINAS OF BIRDS. D.-M. Chen* and I.H. Goldsmith. Yale University, New Haven, CT.

The spectral sensitivity of 15 species of birds has been measured by recording transretinal voltages from opened eyecups. With suitable combinations of colored adapting lights, we find that a variety of passerines have four types of cone, with maximum sensitivities at 370, 450, 480, and 570 nm. Cones with maximum sensitivity at 510 nm are found in some species. The spectral sensitivity maxima are not altered by bathing the retina in 50 mM sodium aspartate, indicating that they reflect the properties of receptors and do not result from inhibitory interactions between retinal interneurons. Mathematical modeling of the data indicates that many of the cones that are maximally sensitive in the blue and violet must contain oil droplets that attenuate the deep violet and near uv.

ORIENTATION OF SOME VERTEBRATES INCLUDING MAN IN A SPATIAL DISTRIBUTION OF LIGHT OR OF CONTRASTS. F.J. Verheijen. State Univ. of Utrecht, The Netherlands.

Natural distributions of light or of contrasts were imitated in the laboratory. Fish, turtle and rabbit orient perfectly in the brightest direction of an anisotropic light field with two eyes, and equally well with one eye. This suggests that they perceive the angular gradient and determine the brightest direction with a multisensor system (raster). Two orientation mechanisms known in fish, viz. the dorsal light response (DLR) and the ventral substrate response (VSR) were studied in man. It was found that in a natural light distribution the direction of the major influx indicates above to human subjects; similarly below is indicated by the direction in which most contrasts are found. The DLR and the VSR might contribute to adaptation to microgravity in man. In addition the two responses might influence studies of posture and of visual monitoring of movement, the more so as the relevant optic variables - the spatial distributions of light and of contrasts - are conventionally not controlled.

ELECTROSENSORY NOVELTY DETECTORS IN THE MIDBRAIN OF PULSE-TYPE WEAKLY ELECTRIC FISH. H.J. Grau. Univ. of Oklahoma, Norman.

Pulse-type weakly electric fish generate an Electric Organ Discharge (EOD) that is brief relative to the inter-pulse interval. By means of a specialized electroreceptor system these fish can locate objects with conductivities differing from that of the environment, and can communicate with other weakly electric fish. In novel situations pulse-type fish will commonly raise their EOD rate. This Novelty Response (NR) behavior occurs by the detection of changes, or novelty, in successive EOD afferences. This study is a preliminary investigation into the mechanisms of electrosensory afference-difference detecting in these fish. Neural recordings were made from several electrosensory-processing brain regions of fish that were presented stimuli at various frequencies, representing various degrees of novelty. Whereas lower-order electrosensory-processing regions show only minor changes in response size to stimuli presented less frequently, the midbrain exhibits very strong novelty-related activity patterns. This novelty-related neural activity can be correlated with certain aspects of the fish's behavior (NR). Supported by NIH#NS12337.

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REGIONAL LOCALIZATION OF MUSCARINIC CHOLINERGIC AND α_2 -NORADRENERGIC RECEPTOR BINDING IN TWO SONGBIRD SPECIES USING TRITIUM-SENSITIVE FILM AUTORADIOGRAPHY. G.F. Ball, B. Nock*, J.C. Wingfield, and B.S. McEwen*. Rockefeller University, New York

To understand how environmental stimuli that control reproductive development are integrated by the neuroendocrine system we have begun mapping, using quantitative autoradiography, the distribution of neurotransmitter receptor binding sites. Subjects consist of males of two passerine species, the european starling (Sturnus vulgaris) and the song sparrow (Melospiza melodia). Frozen sections of brains were mounted onto gelatin-coated slides. Muscarinic receptors were labelled using (3H) scopolamine and α_2 receptors using (3H) p-aminoclonidine. In both species muscarinic binding was heaviest in the paleostriatal complex especially the paleostriatum augmentatum, the lobus parolfactorius (LPO), and area X. Binding for α_2 was also heavy in area X but not in LPO in both species. High binding for α_2 was found in the preoptic, the anterior and posterior hypothalamus, and in the dorsal portion of the archistriatum. The anatomical localization of these binding sites agrees, in general, with previous studies localizing neurotransmitter distribution.

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HOW DOES PROLACTIN MODIFY TESTOSTERONE FEEDBACK - A HYPOTHALAMIC SITE OF ACTION? K.S. Matt, R. Steger*, and A. Bartke*. Southern Illinois Univ., Carbondale.

In the golden hamster, changes in photoperiod result in altered responsiveness of the hypothalamic-pituitary axis to testosterone (T) negative feedback. Changes in plasma levels of prolactin (PRL) appear to be important in causing these changes in T effectiveness. The present study tests whether PRL modifies T feedback by acting at the hypothalamic level to alter neurotransmitter turnover rates. The results indicate T is much more effective in decreasing norepinephrine (NE) turnover and increasing dopamine (DA) turnover in animals on short days than in animals on long days. This is consistent with the ability of T to inhibit gonadotropins more effectively on short days. Elevation of plasma PRL with pituitary grafts in animals on short days decreases the suppressive effect of T on NE turnover, and the stimulatory effect of T on DA turnover. In conclusion, photoperiod causes a change in feedback sensitivity by altering plasma PRL, which then acts at the hypothalamic level to alter neurotransmitters.

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OVARIAN FOLLICULAR DEVELOPMENT IN VOLES FOLLOWING EXPOSURE TO MALES OR UNILATERAL OVARIECTOMY. T.H. Horton and N.B. Schwartz*. Northwestern University, Evanston, Illinois.

Montane voles exhibit reflex ovulation and no estrous cycles. We have initiated a study of environmental and internal feedback mechanisms regulating ovarian function in this species. Exp. 1: Virgin females housed in 16L:8D were exposed to males (EX) in partitioned cages or caged individually until sacrifice at 72 hrs. EX females exhibited increased uterine wet and dry weights, as observed in prairie voles (Hasler & Conaway. Biol. Reprod. 1973). Ovaries of EX females contain follicles with diameters greater than 500 μ m, such follicles were absent from controls. Exp. 2: Females housed in 16L:8D were unilaterally ovariectomized, sham operated or unoperated to determine if compensatory ovarian hypertrophy, occurs in voles. No differences were seen in ovarian weight or follicle size-class distribution 72 hr after surgery. We hypothesize that recruitment of large follicles in voles occurs only following stimulation of the hypothalamic-pituitary axis by environmental factors, and is less dependent on changes in internal feedback signals.

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EFFECT OF ALGAL MEDIA ON BRINE SHRIMP GROWTH. P. Pendoley* and M. Landau, Florida Institute of Technology, Melbourne.

Little is known about how algal media affects the nutritional quality of algae fed to invertebrates. Isochrysis and Dunaliella were grown in four different media containing: (1) only macronutrients, (2) macronutrients and vitamins, (3) macronutrients and trace metals, and (4) macronutrients, vitamins, and trace metals. Algal cells were washed and fed to newly hatched nauplii of the brine shrimp, Artemia (San Francisco strain). Nauplii used were hatched simultaneously (maximum 90 minute variation in age). Results were similar for both species of algae; those grown in media which contained trace metals resulted in significantly better growth of the brine shrimp.

ECOLOGY AND FUNCTIONAL MORPHOLOGY OF SEVERAL PLANT-GRAZING TROPICAL DECAPOD CRUSTACEANS. L.D. Coen. Univ. of Maryland, College Park.

Decapod crustaceans constitute a diverse and widespread group in the tropics being found in most marine, freshwater and terrestrial habitats. However, there exists a paucity of detailed descriptive or functional information on their chelae, foreguts and associated masticatory structures. The natural history, feeding biology and morphology of several species of herbivorous crabs (Families Majidae, Grapsidae and Xanthidae) from Belize were examined using both experimental and observational methods. Structural details were further elaborated using both LM and SEM. Special attention was given to chelae, gastric mill teeth and mandibles, as they relate to feeding, wear and physical capacities. Diets were examined using an array of 7 plants in feeding experiments, complemented by gut analyses from day/night field collections. Feeding comparisons were made based on plant characteristics as well as herbivore morphology. Most crabs examined here were capable of directly consuming tough corticated and leathery macroalgae. (Research supported by Sigma Xi, the Lerner-Gray Fund for Marine Research and the Smithsonian's CCRE project.)

NITROGEN LIMITATION IN THE HERBIVOROUS LAND CRAB, CARDISOMA GUANHUMI. D. L. Wolcott and T. G. Wolcott. North Carolina State Univ., Raleigh.

The natural plant diet of C. guanhumi was supplemented with casein, and the nitrogen (N), fat, uric acid, and tissue content of supplemented and unsupplemented crabs compared to demonstrate N limitation in this species. Crabs were maintained in the lab with access to plants found in the field, and 10 min. exposure to tap water or 10% sea water daily. N-supplemented crabs also received casein-agar. N intake was calculated for crabs in each group, based on quantity eaten and N content of plant material. After 2 months, N-supplemented crabs contained more N, fat, uric acid, and tissue than unsupplemented laboratory controls or freshly collected field crabs. Analysis of gut passage time, feeding behavior, and gut volume revealed that crabs eating only plant material were both N and growth limited. Supported by NSF Grant PCM-83-10465 to the authors.

ONTOGENY OF THE GUT IN PENAEUS SETIFERUS. D.L. Lovett and D.L. Felder. Univ. of Southwestern Louisiana, Lafayette.

Ontogeny of foregut, midgut, and hepatopancreas was examined with light and electron microscopy in laboratory-reared Penaeus setiferus. Growth rate of foregut increases after metamorphosis. During postlarval development, the median tooth becomes armed with setae which subsequently develop into spines, then teeth. The number of ampullary channels in gland filter increases during development. Development of midgut structures is gradual, rather than punctuated at ecdysis. In larvae and early postlarvae the hepatopancreas exists as distinct lobes. In 14-day postlarvae the hepatopancreas consists of six pairs of lobes. In 21-day postlarvae lobes are no longer distinct because of ramification of lobes into tubules. The anterior diverticulum of midgut exists in larvae as a bilobed structure that extends anteriorly beyond foregut. After metamorphosis, the anterior diverticulum becomes rudimentary. The posterior diverticulum is not present during early postlarval ontogeny.

TEMPERATURE ECOLOGY OF HYDROTHERMAL VENT DECAPODS: APPLICATION OF STABLE ISOTOPE TECHNIQUES. C.L. Van Dover, Marine Biological Lab., Woods Hole, MA.

Two decapod crustaceans--a bresilliid shrimp and a galatheid squat lobster--were collected by the submersible ALVIN from the Rose Garden hydrothermal vent site. Standard analytical techniques were used to measure $\delta^{18}\text{O}$ values of the carapacial CaCO_3 from individual specimens. The shrimp $\delta^{18}\text{O}$ values were consistently lower (i.e., the CaCO_3 was precipitated in warmer water) than the galatheid $\delta^{18}\text{O}$ values. This agrees with photographic observations of the species' distributions in this vent area. A statistically significant negative correlation of $\delta^{18}\text{O}$ values with size was found in the galatheids; the significant correlation was positive in the shrimp. Sex- and reproductive state-dependent distributions were also detected in the galatheid population. Thus, in a surprisingly complex way, the decapod populations at hydrothermal vents seem to occupy various distinct temperature (and hence chemical) regimes. This will be an important consideration in any discussion of their physiology, ecology or evolution.

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VISUAL SPECTRAL SENSITIVITY IN A STOMATOPOD CRUSTACEAN MEASURED USING PSEUDOPUPIL SCATTERING CHANGES. T.W. Cronin. University of Maryland Baltimore County, Catonsville, MD.

The pseudopupil of a compound eye is the dark area observed within the eye due to the absorption of light from the direction of the observer. It has been known for some time that in the compound eyes of several insect orders, rapid changes in light scattering occur within the pseudopupil upon stimulation with light. These are due to movements of pigment granules in the retinular (receptor) cells. Such responses permit noninvasive measurements of various aspects of insect visual physiology, including spectral sensitivity. I have applied these techniques to the eyes of the stomatopod crustacean, *Gonodactylus oerstedii*, a visually active, shallow-water, predatory mantis shrimp. Its eyes have as many as 3 separate pseudopupils. The ommatidia giving rise to the lateral and medial pseudopupils have sensitivity maxima in the ultraviolet and the green, while those of the central band are maximally sensitive in the ultraviolet and blue. This could provide the sensory substrate for color vision.

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THE ONTOGENY OF OCULAR PIGMENT MIGRATIONS IN GRASS SHRIMP, *PALAEMONETES PUGIO*. J.K. Douglass. Duke Univ. Marine Laboratory, Beaufort, N.C.

Migrations of accessory screening and reflecting pigments are well-known for their role in light and dark adaptation in compound eyes. Adult crustaceans have been extensively studied, while larval and juvenile stages remain poorly understood in this regard. *P. pugio* larvae and postlarvae were light adapted (LA) or dark adapted (DA) prior to fixation for light microscopy and quantification of compound eye pigment distributions. Accessory pigments in both LA and DA larvae are distributed much like those of LA adult eyes. Large-scale pigment migrations commence abruptly at the time of metamorphosis to the postlarva. Still, in DA postlarvae the relationship between accessory pigment positions and rhabdoms differs considerably from the DA adult pattern. Full development of pigment migrations as a mechanism of light and dark adaptation thus appears to involve two phases. First, physiological mechanisms of pigment translocation become operational at metamorphosis. Subsequently, the extent of pigment migration and the relative positions of pigments and rhabdoms continue to develop as eye growth proceeds.

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MORPHOLOGY OF PUTATIVE SOUND-PRODUCING STRUCTURES IN FIDDLER CRABS OF SUBGENUS *CELUCA*. R.S. Kaufmann* and F.H. Barnwell. University of Minnesota, Minneapolis.

Several fiddler crabs, mostly of subgenus *CelUCA*, are suspected of producing acoustic signals with cuticular structures on the inner palm of the major cheliped and anterior face of the first walking leg. These surfaces were examined by scanning electron microscopy in 11 species. Nine species were distinguishable by patterns of tubercles. In particular, members of closely related species pairs could be readily separated; *UCA musica* possessed more striae on the cheliped than *terpsichores* and *panacea* had denser patches of tubercles on the leg than *pugilator*, as did *beebei* in comparison to *stenodactylus*. Distinctive tubercle patterns were obvious on *U. latimanus* and *inaequalis*, less so in *cumulanta*, and lacking in *deichmanni* and *uruguayensis*. Our morphological analysis has turned up useful taxonomic characters and, in addition, has provided a basis for predictions about acoustic mechanisms and signal properties that can be tested in future behavioral studies.

(Supported in part by a UROP grant from the University of Minnesota.)

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SALINITY PREFERENCE BEHAVIOR OF THE FIDDLER CRAB, *UCA MINAX*. N.A. McCarty, R.D. Roer and R.B. Hamm*. University of North Carolina at Wilmington.

Fiddler crabs of the genus *UCA* possess extensive osmoregulatory capabilities and can maintain tolerable blood concentrations from fresh water to hypersaline media. *UCA minax*, however, is generally found in the fresh water reaches of estuaries. We studied the frequency distribution of *UCA minax* in a salinity gradient apparatus in the laboratory to determine if the natural distribution of this species was based upon salinity preference and to determine the modality of osmoreception. Crabs were given access to 8 compartments of varying salinity (0-35ppt) or varying ionic and osmotic concentrations. Initial preference was dependent upon acclimation salinity, while the long-term preference behavior of crabs in dilutions of sea water demonstrated a choice for median (10-20ppt) salinities regardless of acclimation salinity. Salinity is thus not the primary factor determining the natural distribution of this species. Experiments are underway to determine the chemical basis for this behavior. (Partial funding by a Sigma Xi grant to N.A.M.)

DISTRIBUTION AND ULTRASTRUCTURE OF OSMOREGULATORY AND RESPIRATORY FILAMENTS IN THE GILLS OF THE CRAYFISH. J.S. Dickson and R.M. Dillaman. Institute for Marine Biomedical Research, Wilmington, N.C.

Gills of the freshwater crayfish, Procambarus clarkii, function as a site for both respiration and ion regulation. To determine if these functions are partitioned within or between individual gill filaments, live crayfish were placed briefly in a dilute AgNO_3 solution and the pattern of silver accumulation was fixed by a photographic developer. The consistent pattern was that of silver accumulation by the filaments in the center of the gill and none by the filaments at the margin. Electron microscopic examination of filaments that accumulated silver showed features consistent with ion transport: a highly interdigitated subcuticular epithelium rich in mitochondria. Filaments not accumulating silver and presumably respiratory had a thinner cuticle and a very scant subcuticular epithelium. Na, K-ATPase levels were also highest in the silver accumulating filaments. The observed anatomical partitioning of respiration and ion transport may permit differential regulation within the crayfish.

SEQUENTIAL EXPRESSION OF GERM-LAYER SPECIFIC MOLECULES IN THE SEA URCHIN EMBRYO. G.M. Wessel and D.R. McClay. Duke University, Durham, N.C.

Two germ-layer specific molecules appear coincident with the formation of two different cell lineages in the sea urchin embryo. Both antigens are identified by monoclonal antibodies, and are described by immunofluorescence and immunoelectron microscopy, and by pulse-chase immunoprecipitations. Mesol (380Kd) is first detected in mesenchyme cells as they delaminate from the wall of the blastula. The Mesol epitope is generated in trans golgi saccules and is concentrated throughout the mesodermal cell surfaces. Expression of the Mesol epitope appears to be regulated by post-translational modification(s) of a pre-existing polypeptide chain. Endol (320Kd), by contrast, is localized to the apical and basolateral cells surfaces of mid- and hindgut cells. The first evidence of Endol translation occurs at the onset of gastrulation. Therefore, de novo expression of these developmentally regulated molecules occurs via diverse mechanisms. Supported by Grant HD 14483 from NIH.

POSSIBLE INVOLVEMENT OF NERVE GROWTH FACTOR (NGF) IN NEURAL INDUCTION IN THE CHICK. H. Lee and R.G. Nagele*. Rutgers Univ. and UMDNJ-School of Osteopathic Med., Camden, N.J.

Our previous studies have suggested that neural induction may be mediated by NGF or a NGF-like substance. To further test the validity of this hypothesis, two experimental series were carried out. In the first series, explanted stage 3-5 chick embryos were exposed to ^{125}I -labeled NGF for 3-5 hours and radioautographed. Results showed that labeled materials were most concentrated on the surfaces of presumptive neural ectodermal cells during neural induction. In the second series, cultures of embryonic chick dorsal root ganglia (DRG) were treated with protein extracts from various regions of stage 3-5 chick embryos. Hensen's node extract from stage 3+ embryos was most effective in inducing neurite outgrowth from DRG explants, suggesting that it contained the highest amount of a NGF-like substance. The significance of these findings will be discussed.

ACTIN COLOCALIZES WITH MICROTUBULES IN ADULT RAT SCIATIC NERVE AXONS TREATED WITH β,β' -IMINODIPROPIONITRILE (IDPN). R.G. NAGELE*, M.C. KOSCIUK*, and H. LEE. UMDNJ-School of Osteopathic Med. and Rutgers Univ, Camden, NJ.

Evidence for the active participation of microtubules (MTs) in axonal transport has emerged from studies on the effects of IDPN on large peripheral nerves of rodents. In the present study, we examined the possibility that the mechanism of fast axonal transport is driven by an actin-myosin contractile system associated with MTs. Sciatic nerves were injected subepineurally with IDPN and prepared for electron microscopy or indirect immunofluorescence (IIF) using monoclonal anti-actin and anti-tubulin antibodies. IDPN was found to induce complete segregation of MTs from neurofilaments and the formation of MT clusters in axons within 2 h of injection. IIF revealed that actin redistributed in IDPN-treated axons and colocalized with tubulin (corresponding to MT clusters). This finding lends further support to the notion that fast axonal transport is driven by an actin-myosin contractile mechanism. Supported by UMDNJ Foundation, Busch and Kapnek Funds.

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POSTNATAL DEVELOPMENT OF MU OPIATE RECEPTORS IN FOREBRAIN REGIONS OF THE CHICK. R. Abdulla, K. Arouni*, Dr. McLean*, Dr. Hagan.

Opiate receptors are reported to be present in the chick brain (Bardo *et al* 1982). Using *in vitro* receptor autoradiography the neuroanatomical distribution of opiate receptors in the chick brain is examined. Briefly, the method used were as follows: brains from chicks 1,7,14,21 and 28 days of age were rapidly removed, frozen, mounted onto cyrostat chucks, cut, and thaw mounted onto subbed slides. The sections were incubated in 0.05M Tris buffer with 1.0nM (³H) dihydromorphine for 30 mins. at 25°C, and the incubation terminated by 5 sequentials in 0.05M Tris buffer. The slides were processed for emulsion autoradiography. The results indicate a heterogenous distribution of opiate receptors in the forebrain with limbic regions selectively enriched.

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METAMORPHOSIS OF OYSTER LARVAE IS MEDIATED BY PUTATIVE ALPHA₁-ADRENORECEPTORS. S.L. Coon, D.B. Bonar and R.M. Weiner. Univ. of Maryland. College Park.

Larvae of the Pacific oyster, *Crassostrea gigas*, can be efficiently induced (90%) to metamorphose, without settlement behavior, by 10⁻⁶M epinephrine or norepinephrine. These compounds show high activity with exposure times of less than 30 minutes. The putative adrenoreceptors mediating the induction of metamorphosis were pharmacologically characterized *in vivo* using selective adrenergic agonists (EC₅₀: epinephrine < phenylephrine < norepinephrine < isoproterenol < methoxamine = clonidine) and antagonists (IC₅₀: prazosin < WB4101 < phentolamine < phenoxybenzamine < yohimbine < propranolol). Additionally, norepinephrine, but not epinephrine, has been found in competent oyster larvae using HPLC. These results support the hypothesis that the metamorphosis of *C. gigas* is mediated at some early stage by receptors similar to vertebrate alpha₁-adrenoreceptors and that metamorphosis is induced by an endogenous release of norepinephrine, or other catecholamine-mimetic molecule, during or after settlement.

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ELECTRON MICROSCOPY OF A SYMMETRICAL BIPOLAR GASTRODERMAL SENSORY CELL IN HYDRA. J.A. Westfall, D.T. Ensley* and D.C. Hancock.* Kansas State University, Manhattan, Kansas.

Previous scanning electron microscopy (SEM) of isolated gastrodermal sensory cells of *Hydra* revealed an 8-12 μm long apical cilium lying near the perikaryon of unipolar cells or at the end of a narrow neck region of asymmetrical bipolar cells. In this SEM study of macerated *Hydra* tissues we describe a third type of gastrodermal sensory cell which is triangular in shape with a short apical cilium and two symmetrical basal processes. This cell resembles in its shape and pair of oppositely directed basal neurites a previously described JDL+ bipolar sensory cell isolated from the epidermis. It differs from bipolar epidermal sensory cells by having a visible cilium approximately 3.5 μm in length. We classify this cell as a symmetrical bipolar gastrodermal sensory cell. The morphology of the perikaryon corresponds to a gastrodermal sensory cell with apical cilium observed in the budding region of *Hydra* by transmission electron microscopy (TEM). This is the first TEM report of a luminal apical cilium on a gastrodermal sensory cell.

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MONOCLONAL ANTIBODY TO THE NEUROPEPTIDE SCP_B DEFINES SIMPLE NEURONAL SYSTEM IN EMBRYOS AND LARVAE OF TRITONIA DIOMEDEA. S.C. Kempf and B. Masinovsky. Univ. of Washington. Seattle, WA.

SCP_B-like antigenicity is first present in small cells of the cerebral ganglia and a single axon crossing the cerebral commissure in 8 d old embryos. Other axons and neurons become antigenic as the larva develops. At 4-9 d after hatching 2 pairs of neurons are labeled. Axons extend from one pair to the left cerebral ganglion and from the other to the right. A second labeled axon is present across the cerebral commissure. In metamorphically competent larvae the cerebral and pedal neuropils, as well as two neurons in the buccal ganglia with axon(s) across the commissure, are antigenic. The position of the 2 neuron pairs suggests their possible involvement in larval feeding behavior. The change in antigenicity as the larva becomes competent is presumably preparatory for juvenile life. The labeled buccal neurons may be B12, which are known to function in adult feeding behavior.

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AVIAN EXTRAEMBRYONIC FLUIDS: A POSSIBLE SOURCE OF MAMMALIAN EMBRYOCULTURE MEDIA? M.J. Murphy. State University of New York @ Cobleskill, NY.

Allantoic (AF), amniotic (AM) and extracoelomic (EC) fluids were characterized by Lowry and polyacrylamide gel electrophoresis (PAGE); protein banding patterns were compared to those obtained from embryonic serum (SER). Day 12 embryos contain extraembryonic fluids with 11 distinct protein bands ranging in relative molecular mass from 16,000 to 200,000. These bands were represented in all three fluid types (AM, AF, EC) and comigrated with identical bands in SER. Protein concentration of day 12 fluids was 0.8 mg/ml in AL, 9.3 mg/ml in EC and 14.4 mg/ml in AM. No detectable levels of proteins were found in day 7 AM and AL. Day 7 SER and EC, however, exhibited banding patterns similar to day 12 fluids when characterized by PAGE.

AM and EC may be an excellent source of *in vitro* embryoculture media since they are nearly isotonic to embryonic serum, are maintained at near serum pH, and have the full complement of serum proteins. (Supported in part by a grant from United University Professions).

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FLUOROCHROME STAINING OF SUBAERIAL GREEN ALGAE. K.J. Bouillion and R.L. Chapman*. Louisiana State Univ., Baton Rouge.

Several DNA and cell wall-specific fluorochromes were used in an investigation of the effects of different photoregimes on growth and cell division in Cephaleuros virescens and Trentepohlia sp., two subaerial green algae. The stains were mithramycin, DAPI, ethidium bromide, Hoechst 33342, and Cellufluor. The optimal combination of dyes for screening large numbers of cells and for simultaneous visualization of both mitotic events and early stages of crosswall formation was mithramycin in conjunction with Cellufluor. Nuclear staining with mithramycin was variable, especially in Trentepohlia sp., but the inconsistencies could usually be overcome by long-term staining at 4°C. None of the other nuclear dyes was as effective as mithramycin, either due to failure of nuclei to stain or to limitations inherent in the observation process (e.g., damage by ultraviolet light to living cells). Supported by a Sigma Xi grant to KJB and NSF grant BSR-8308420 to RLC.

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A MODEL TO EXPLAIN NEPHRIDIAL DIVERSITY IN ANIMALS. E. E. Ruppert and P. R. Smith. Clemson University, Clemson, S. C.

A phylogenetic model explaining nephridial diversity in animals was formulated by Goodrich (QJMS 1945). The general form of the model proposed that protonephridia are primitive to metanephridia, that protonephridia are mutually homologous organs, and that urogenital systems are derivatives of originally separate excretory and genital ducts. Our model argues that nephridia modify the composition of extracellular fluid (ECF) by filtration and selective reabsorption. In animals with metanephridia, vascular fluid is pressure-filtered into a coelomic cavity across the vascular extracellular matrix (ECM) and the primary urine is swept into the metanephridium for modification. In animals with protonephridia, a blood vascular system (BVS) is absent and ECF is filtered as it is pumped into the duct across the ECM of the terminal cell. Because the absence of a BVS can be explained by functional criteria related to small body size, flat shape, or lack of septal partitions, protonephridia can be viewed as the only nephridia that will work in these body plans; they need not be regarded as primitive excretory organs. Supported by NSF Grant No. BSR-8408500 to E. E. Ruppert.

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ULTRASTRUCTURE AND FUNCTION OF THE PROTONEPHRIDIUM OF GLYCERA DIBRANCHIATA (POLYCHAETA). P.R. Smith and E.E. Ruppert. Clemson Univ., Clemson, S.C.

G. dibranchiata has a reduced blood vascular system lacking podocytes and segmental nephridial complexes consisting of a protonephridium (PN), phagocytal sac (PS), and ciliated organ, an organization predicted by our model rationalizing nephridial diversity. The PN covers the coelomic surface of the PS and consists of a series of branched collecting ducts, made of ciliated transportive epithelia, opening into a common canal leading to the exterior. Solenocytes project from the collecting ducts into the coelom and each forms a filtration tube composed of cytoplasmic rods interconnected by extracellular matrix (ECM). Following intracoelomic injections of electron-dense tracers (iron dextran, dextrans, colloidal gold), they are observed within filtration tubes and collecting ducts. Duct cells concentrate tracers in large vesicles. Permeability of the ECM of the filtration tube is $\leq 2 \times 10^6$ MW and ≤ 32 nm. Results support a filtration/reabsorption function for the PN. The ciliated organ sweeps coelomocytes and foreign particles into the PS where they are phagocytosed by cells lining the sac. The PS is considered a spleen analogue. Supported by NSF Grant No. BSR-8408500 to E.E. Ruppert.

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ULTRASTRUCTURE AND FUNCTION OF THE PROTONEPHRIDIUM OF *Nephtys* (POLYCHAETA). E. M. Messinger, P. R. Smith, E. E. Ruppert. Clemson University, Clemson, SC.

Nephtyid polychaetes are unusual in having a well-developed vascular system and segmental protonephridia, an organization not predicted by our model rationalizing nephridial diversity. The terminal part of the nephridium consists of two clusters of solenocyte nuclei flanking a collecting duct made of ciliated transportive epithelial cells. A cell process from each nucleus projects into the coelom, bifurcates, and each fork produces a weir that rejoins the duct. Podocytes are absent from nephridial, gonadal, and major vessels. Intracoelomic injections of 10 μ l of ferritin and iron dextran were incubated for various times. After standard fixation and processing, both labels were observed in filtration tubes and collecting ducts. Duct cells concentrated labels in large vesicles. The results support a filtration/reabsorption function for protonephridia. Chromatographic analysis of coelomic fluid confirmed the presence of a large (3x10⁶ MW) hemoglobin (Hb). It is concluded that the exceptional occurrence of protonephridia in nephtyids may be an adaptation to retain a unique coelomic entity, the extracellular Hb. Supported by NSF Grant No. BSR-8408500 to E.E. Ruppert.

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NEPHRIDIA IN THE LARVAE OF ECHINODERMS AND HEMICHORDATES. E. E. Ruppert and E. J. Balser. Clemson University, Clemson, SC

Our model for nephridial design in animals predicts the occurrence of metanephridia in echinoderms and hemichordates correlated with the presence of a coelom and a blood vascular (=haemal) system (BVS). Tornariae (T) of *Schizocardium brasiliense* and bipinnariae (B) of *Asterias forbesi* were reared in the lab. Soon after coelom formation, a hydroporic canal joins the axocoel (T) or left axohydrocoel (B) to the hydropore. Most of the axocoel and canal (T) or part of the left axohydrocoel (B) are lined with ciliated podocytes separated from the blastocoel by a basal lamina (ECM). The distal part of the canal (T) or the entire canal (B) is lined with ciliated ectoderm structured as a transportive epithelium. Perfusion of the coelom with latex microbeads reveals a constant, ciliary-driven efflux of fluid from the pore (T,B). Presumably, blastocoelic fluid re-enters the coelom across the ECM between pedicels. The coelom-canal-hydropore unit can be considered a giant protonephridium. Later, as a pulsatile vesicle joins the canal-coelom junction (T,B), correlated with larval size increase and development of the BVS, a typical metanephridial system is formed. Supported by NSF Grant No. BSR-8408500 to E. E. Ruppert.

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ULTRASTRUCTURE AND FUNCTION OF THE PROBOSCIS COMPLEX OF *SACCOGLOSSUS* (ENTEROPNEUSTA). E.J. Balser. Clemson Univ., Clemson, SC.

The proboscis complex consists of the notochord (NC), pericardium (P), glomerulus (G), protocoeil (P), protocoeil duct (PD), and pore. The NC, a diverticulum of the gut, is characterized by vacuolated epithelial cells surrounded by basal lamina and connective tissue. The P, a myoepithelium, lies dorsal to the heart sinus. The G is a mesh of podocytes and blood vessels, formed by an elaboration of the P lining overlying the heart. Much of the remainder of the P lining is transformed into muscle and connective tissue. Opening into the P and connecting with the outside via the proboscis pore is the PD, which is composed of multiciliated transportive epithelial cells. Perfusion of the dorsal blood vessel in the trunk with vital dyes reveals a rapid flow of blood into the glomerular vessels. The results suggest that vascular fluid is filtered by G, producing primary urine in the P which may be modified as it passes over the peritoneum, through the PD, and out of the pore. An examination of the permeability of the glomerulus and transport characteristics of the peritoneal and duct cells is in progress. Supported by NSF Grant No. BSR-8408500 to E.E. Ruppert.

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ULTRASTRUCTURE AND FUNCTION OF THE COLLAR DUCTS OF PTEROBRANCHS AND ENTEROPNEUSTS (HEMICHORDATA). S.M. Lester, E.E. Ruppert and E.J. Balser. Clemson University, Clemson, SC.

Adult hemichordates possess a pair of ciliated ducts extending from the mesocoel to the exterior in pterobranchs (P) and into the first gill pore in enteropneusts (E). Classical discussions of duct function argue for an efflux of fluid (excretion) or an influx of fluid associated with hydrostatics. In P, the duct is made of monociliated, cuboidal epithelial cells with apical microvilli and few cytoplasmic vesicles. A cross-striated dilator muscle and a well-developed blood sinus are associated with the duct. In E, collar ducts are composed of multiciliated cells with apical microvilli forming a complex epithelium with various cytoplasmic vesicles. The duct has a slit-like, C-shaped lumen in cross section which may collapse arresting flow when coelomic pressure is elevated. Perfusion of the mesocoel with particulate tracers indicates ciliary-driven efflux of fluid from the collar ducts. The results support the idea of the collar ducts as excretory organs perhaps augmenting renal function associated with the glomerular complex in the oral shield (P) or proboscis (E). Supported by NSF Grant No. BSR-8408500 to E.E. Ruppert.

URICASE ACTIVITY IN THE RENAL SAC ENDO-SYMBIONT NEPHROMYCES. M.B. Saffo. Univ of Calif. Santa Cruz.

Hypothesized roles of the ductless renal sac of molgulid tunicates have been based on the notion that the renal sac functions as an organ of "storage excretion", with its uric acid-containing "wastes" stored permanently as concretions in the renal sac lumen.

But uric acid is not a permanent deposit: there is substantial uricase activity in the renal sac. We have shown that this activity is localized not in Molgula tissue per se, but in the cells of its endosymbiont Nephromyces. In lab-raised, symbiont-infected M. manhattensis, uricase activity is present in Nephromyces and the ambient renal sac fluid, yet is absent from the renal sac wall. In uninfected lab-raised Molgula, uricase activity is absent from all renal sac tissue and contents. Nephromyces' uricase activity, coupled with the probably universal infection of molgulids by Nephromyces in nature, suggests a need for reassessment of renal sac function, with attention to its role as a habitat for Nephromyces. Our results suggest that Nephromyces has a profound effect on molgulid uric acid metabolism, which may be a metabolic basis of this apparently mutualistic symbiosis. Supported by NSF grant 8410107 and the Whitehall Foundation.

COMPOSITION OF MERCENARIA MERCENARIA (L.) BLOOD PLASMA AND PERICARDIAL FLUID: IMPLICATIONS FOR ULTRAFILTRATION AND THE ELIMINATION OF POLLUTANT METALS. W.E. Robinson and M.P. Morse. New England Aquarium, Boston, MA and Northeastern University, Boston, MA.

Ultrafiltration sites have been identified in electron micrographs of the pericardial glands of the bivalve M. mercenaria. The biochemical composition of pericardial fluid (primary urine) and blood plasma was investigated in order to better characterize this ultrafilter. Pericardial fluid glucose (20.5±12.7 ug/ml) and lipid (51.4±50.4 ug/ml) concentrations were similar to those found in the plasma (18.2±7.5 ug glucose/ml; 31.5±25.0 ug lipid/ml). Protein concentrations, however, were significantly lower in the pericardial fluid (617.6±537.7 ug/ml) than in the blood plasma (1525.3±531.5 ug/ml), although gel electrophoresis revealed that identical proteins are present in both fluids. In animals exposed to Cd or Ag, no consistent relationship between plasma and pericardial fluid metal levels was evident, even though most metal was associated with plasma proteins. (Funded by D.O.E. Contract DE-AC02-77EV04580).

INCORPORATING MORPHOLOGICAL DIVERGENCE IN PHYLOGENY: AN EXAMPLE WITH WATERSCORPIONS. D.V. Bennett. The Univ. of Connecticut, Storrs.

Many phylogeny construction techniques incorporate some measure of divergence between taxa. The graphical limitations of 2-dimensional methods in current use are evaluated, and a 3-dimensional alternative is shown. This new representation of phylogeny combines statistical measures of continuous morphological variation between taxa, with their cladistic relations derived from analysis of discrete morphological data. The technique is applied in an analysis of morphological divergence and sister group relationships of six North American waterscorpion species (a predaceous aquatic insect in the order Hemiptera). Five of the six species examined form a sibling species group. Statistical analyses of morphological variation over latitude and longitude show clinal relationships in predatory and locomotory structures of the sibling species. The sibling species show different degrees of habitat specialization. Speciation of the sibling species is effected by Pleistocene glaciations and the slow speciation and extinction rates of the ecologically plastic waterscorpions.

SEXUALLY DIMORPHIC CHARACTERS AS INDICATORS OF PHYLOGENY IN LETHAEINE SEED BUGS (INSECTA: HEMIPTERA) J. E. O'Donnell. The University of Connecticut, Storrs.

In the Lethaeini, a worldwide tribe of ground-living, seed-eating lygaeid bugs, males exhibit unexpected, sometimes bizarre features not expressed in conspecific females. A cladistic analysis shows that while some of these characters, such as modified antennal tubercles or expanded fore tibiae, are autapomorphies at the specific level, other sexually dimorphic features establish phylogenetic relationships at higher taxonomic levels. For example, I hypothesize that the common presence of elaborate metathoracic scent gland peritremes in males of the Australian genus Aristaenetus and the Neotropical genus Bubaces is a synapomorphy. The sister group relationship thus proposed can be tested by examining additional data sets for congruence with morphological data. Behavioral and biochemical characters will determine whether a plausible scenario for speciation (cladogenesis) within this lineage involves the evolution of species-specific chemical cues as pre-mating isolating mechanisms through sexual selection.

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SPECIATION RATES IN THE HAWAIIAN TERRESTRIAL FAUNA. G. Paulay. Univ. of Washington, Seattle.

The terrestrial faunas of oceanic islands are characterized by very high levels of endemism on each separate island. Most oceanic islands are the results of short periods of intense volcanism, and their ages are known. I propose a simple model to calculate the average rates of speciation for taxa inhabiting young oceanic islands, by using the age of the island and the percentage of species endemic to it. After examining its assumptions and limitations, I use the model to calculate speciation rates for the terrestrial fauna of Hawaii Island. Average rates of speciation have the order of magnitude of 10^4 - 10^5 years per speciation event. Taxa undergoing very extensive adaptive radiation (with over 100 species derived from a single ancestral coloniser) speciate considerably faster than less diversified groups.

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EVOLUTIONARY SUCCESS: ADAPTATION OR ARTIFACT? Robert J. Baikow. University of Pittsburgh, Pennsylvania.

Evolutionary success, as measured by number of species, is often attributed to key innovations. Recognition of such may be flawed by circular reasoning or by the nonequivalence of categories for taxa in eclectic classifications. The Passeriformes, by far the most successful order of birds, appears to lack derived states with such key significance, although weak hypotheses may be suggested on the basis of feeding niche specificities, limited dispersibility, vocal organs and behavior, and foot structure. Some of these, however, rely on the summary effect of different key adaptations in passerine subgroups. Perhaps we ask the wrong question. Instead of wondering why there are so many kinds of passerine birds, we might better ask why we recognize this clade out of some 9,000 as a taxon. The answer may lie more in the history of taxonomic procedure than in the adaptive significance of specific passerine characters. Supported by N.S.F. grant BSR-8314729.

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RATIONALE FOR THE PROPOSED NATIONAL BIOLOGICAL SURVEY AND PROGRESS REPORT ON IT. M. Kosztarab. Virginia Polytechnic Inst. and State Univ., Blacksburg.

We are lacking basic taxonomic-ecologic information on the composition of the biota in North America. Less than 1/3 of the living organisms and their developmental stages have been described. U. S. A. is probably the only country without an inventory of our living natural resources, while the extinction rate of our animal and plant species doubled during the past 10 years. The effect on our biota of ozone, acidification, pesticides and industrial pollution was never adequately studied. A National Biological Survey (NABIS) project can remedy the present situation. Twenty-eight scientific organizations representing over 200,000 scientists, and a number of government agencies are endorsing the NABIS concept. We need help from every life scientist with the initiation effort of NABIS.

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THE USE OF ELECTROPHORETIC DATA IN TESTING CHROMOSOMAL AND MORPHOLOGICAL PHYLOGENIES OF GERBILLIDAE (MAMMALIA). M.B. Qumsiyeh. Texas Tech University, Lubbock.

A phylogeny for seven genera of gerbils was constructed by coding chromosomal rearrangements as evidenced by banding analysis in a binary system and analyzing the data using Farris's method for computing rooted Wagner trees. Electrophoresis was used as an independent test to resolve instances where the chromosomal and morphological (Pavlinov, 1982) data were inconclusive or incongruent. By the use of these three data sets, we can place more confidence in a phylogeny for gerbils which: 1) divides this family into three distinct groups, 2) assigns the genera Sekeetamys and Desmodillus to the Meriones group, and 3) recognizes Meriones as monophyletic. In addition to the obvious systematic implications, the use of three data sets allows for more confidence in assessing the number and types of chromosomal rearrangements incorporated during the course of evolution in this group.

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AN OPHIDIAN PALEOFAUNA FROM PIT 91, RANCHO LA BREA. T.C. LaDuke. City Univ. of New York.

New studies and improved micro-vertebrate collecting techniques have resulted in the addition of several species to the snake fauna of the Rancho La Brea asphalt deposits in Los Angeles, California. The present fauna results from a current, carefully controlled excavation of a single Rancho La Brea site. Fossils were identified by comparison with modern skeletal material, increasing the Rancho La Brea snake species list from four to twelve. Two of these species are new to the fossil record. The fauna is very similar to that of the Los Angeles region today but indicates a climate that was slightly more moist. It is suggested that the stability of the North American herpetofauna compared to the mammalian fauna may be related to the ability of small ectotherms to maintain viable populations in isolated refugia which will not support populations of large endotherms. The comparative method of identifying fossil snakes by their vertebrae is critiqued and it is suggested that a multivariate discriminant or regression analysis might prove more useful.

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A MIOCENE EOSUCHIAN - EXAMPLE OF THE LAZARUS EFFECT. M. HECHT. Queens College, Flushing, New York.

An eosuchian reptile was identified from the early Miocene (Aude, France); from a classic deposit associated with a well known biota. Eosuchia are paraphyletic lepidosaurs. The fossil is placed in the suborder Younginiformes, which appears in the Upper Permian and vanishes in the Lower Triassic. The postcranial skeleton is complete; the skull is incomplete. The fossil bears many primitive features as thecodont teeth, amphicoelous vertebrae, hooked fifth metatarsal, gastralia, etc. This specimen represents a primitive taxon which disappears in the early Mesozoic and reappears in the middle Cenozoic; this is called the Lazarus Effect.

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PLACENTATION IN THE ROUGH EARTH SNAKE, VIRGINIA STRIATULA (SERPENTES: COLUBRIDAE). J.R. Stewart. Univ. of Tulsa.

The morphology of the extraembryonic membranes of Virginia striatula suggests three structures as potential sites of maternal-fetal placental exchange. The first of these to develop, the choriovitelline placenta, is confined to the area above the sinus terminalis and consists of a vascularized trilaminar omphalopleure adjacent to a vascularized uterine epithelium. The choriovitelline membrane is transitory and is replaced by the chorioallantois. The chorioallantoic placenta, formed as the allantois expands to contact the chorion, is richly vascularized by both allantoic and uterine vessels. The formation of the isolated yolk mass, characteristic of squamate development, is associated with the third placental structure. The placenta of the isolated yolk mass forms as a non-vascular bilaminar omphalopleure. Both the chorioallantoic placenta and the placenta of the isolated yolk mass persist throughout development. The shell membrane is a prominent structure between extraembryonic membranes and the uterine epithelium in all regions. (Supported by a Cottrell College Science Grant from Research Corporation and a University of Tulsa faculty research grant).

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COMPARATIVE TONGUE AND ANTERIOR PROCESS HISTOLOGY IN FIVE COLUBRID SNAKES. G.R. Ten Eyck and James C. Gillingham. Central Michigan Univ., Mt. Pleasant, MI.

A histological examination was conducted on the ophidian olfactory transfer mechanism utilizing light and electron microscopy. Five colubrid species were studied: Opheodrys aestivus, Carphophis amoenus, Thamnophis sirtalis, Nerodia sipedon, Masticophis flagellum. Major differences were found between the dorsal and ventral epithelium of the tongue in all the species considered. The ventral surface was characterized by a thicker epithelium, which contacts the dorsal surface of the anterior processes. Even though tongue morphology displayed some interspecific differences the general histology remains similar. The anterior processes were chiefly composed of collagen fibers. The striking feature of the processes was an epithelium consisting of stratified squamous cells which varied in thickness according to where the tongue contacted them. Goblet cells and mucous glands provided the mechanism with lubrication and particle adherence. The overall histology and morphology displays a mechanism for enhanced chemical transfer from the environment to the ducts of Jacobson's organ. This study confirms the transfer mechanism proposed by Gillingham and Clark (1981).

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SNOUT MOBILITY IN SOME NATRICINE SNAKES. D. Cundall and J.S. Cundall*. Lehigh Univ., Bethlehem, PA, and Muhlenberg College, Allentown, PA.

It has long been assumed that the snout of snakes behaves as a single mechanical unit that moves only around the prokinetic joint between the snout and the braincase. Cinegraphic, radiographic and histological data for several natricine species suggest that the seven bones of the snout form four units (1-nasals, 2-right, and 3-left septomaxillary-vomerine complexes and 4-premaxilla) having limited independent mobility. Movement is permitted by structural relationships between the bony and cartilaginous elements, particularly the placement of the nasal septum between the septomaxillae and the separation of the septomaxillae from the premaxilla by the nasal capsules. Movement may be caused either by external forces or displacements of the underlying palatomaxillary apparatus. Based on morphological data, loosening of the snout may be characteristic of many advanced snakes and may enhance the functional independence of right and left palatomaxillary arches.

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MORPHOMETRIC ANALYSIS OF LIZARD SKULLS. R.T. Zanon. Univ. of Chicago, Chicago, IL.

Uni- and multivariate analyses were performed on a data set of fifteen whole-skull variables, reflecting functionally significant parameters. 141 species of lizards were included, representing five families: Anguidae, Iguanidae, Scincidae, Teiidae, and Varanidae. Variables were corrected for size using brain stem length. Univariate comparisons of family means suggest that varanids and teiids have relatively greater gape than the other lizards in the sample, and that each of these two families has corrected for an otherwise reduced bite force in a different way. In a principal components analysis, the first three components primarily reflect length, width, and height of skull respectively. There are no clean separations between either taxonomic or ecological groups, although certain trends are apparent.

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ON THE BEGINNINGS OF EXPERIMENTAL BIOLOGY-ABRAHAM TREMBLEY'S RESEARCH ON HYDRA. H.M. Lenhoff and S.G. Lenhoff*. University of California, Irvine.

In four short years Abraham Trembley startled a disbelieving world with his experiments demonstrating for the first time that: a) complete animals can regenerate from small cut pieces of those animals; b) animals can reproduce without the involvement of gonads; c) tissue sections from two different animals of the same species can be grafted to each other; and d) "eyeless" animals can exhibit a behavioral response to light. Trembley affords us insights into a remarkably attractive philosophy of experimental research as he presents the results of his experiments in his masterwork, the 1744 Mémoires on the fresh-water "polyp." (For an English translation, see S.G. Lenhoff and H.M. Lenhoff, Hydra and the Birth of Experimental Biology-1744; Abraham Trembley's Memoirs Concerning the Polyps, Boxwood Press, Palo Alto, CA.) Trembley's experiments and philosophy and methodology of experimental research, and references to them by several important American experimental biologist of the late 19th and early 20th centuries, will be the subject of our presentation.

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SOME EXPERIMENTAL BIOLOGY WITH BENJAMIN FRANKLIN. Brother C. Edward Quinn FSC, Manhattan Coll. New York, N.Y.

Among the American Founding Fathers, Benjamin Franklin was the only one with an international reputation as a scientist. The main source of Franklin's reputation was, of course, the experimental work he had done with electricity. But Franklin did some experimental biology too. He relates that his father induced alewives to spawn in a river where they had never spawned before. Perhaps this example prompted Franklin to test how ants inform their nestmates about the location of food. In addition, he was one of the first to apply statistics to problems like the effect of inoculation on smallpox mortality, and the role of lemon juice in reducing the incidence of shipboard scurvy. Franklin believed ideas should be tested, and he tested a few favorites of his time. For example, he showed why killing blackbirds was not an unmixed blessing for the farmer.

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IS DOWN SYNDROME A MODERN DISEASE?

E. Peter Volpe. Mercer Univ. School of Medicine, Macon, Ga.

Down syndrome is the most common congenital disorder associated with severe mental retardation. The anomaly is so common and so apparent clinically that it is surprising, if not startling, that the condition was recognized as a distinct entity only slightly more than a century ago. The first pictorial sketch in the medical literature of the facial features of a person with Down syndrome appeared in 1876. Did awareness of Down syndrome predate the medical reports of the late 1800s? A hypothesis is presented to explain what appears to have been a complete oversight of a very conspicuous disorder. A plausible explanation is that early physicians had confused the stunted, mentally retarded Down child with the dwarfed, mentally deficient cretin. Eventually, knowledge and understanding of Down syndrome became possible when this condition was divorced from cretinism.

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BIOLOGICAL LIFE ACCORDING TO PLATO AND ARISTOTLE. James A. Marcum. Harvard Medical School, Boston.

For Plato and Aristotle, a living entity is composed of a body as well as a soul. The relationship between these two components is important in understanding biological life. The body according to these peripatetics is composed of fundamental elements from which all material bodies are constructed. However, animate beings cannot be reduced to their physical components alone; rather, living organisms are a composite between the material elements and the soul. The soul serves as the principle of animation, imparting life to the body; it is the cause of life and is responsible for the function of bodily events. Biological life is an operational concept involving the direction of bodily processes. The actions of the body reflect, as it were, regulatory patterns of the soul itself, including generation, nutrition, motion, and sensation. The relationship of the soul to the body in a biological context is a balance between bodily processes and the homeostatic actions of the soul. Living beings are dependent upon hierarchical patterns which are essential for maintenance of bodily functions.

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METAPHORS AND ANALOGIES IN D'ARCY

THOMPSON'S ON GROWTH AND FORM. M. Bradie. Bowling Green State Univ., Bowling Green, Ohio.

D'Arcy Thompson's On Growth and Form is an important contribution to morphology and development. A central feature of the work is Thompson's explicit appeal to metaphors and analogies drawn from the physical sciences and applied to biological phenomena. The paper is divided into three parts. Part I is a brief description and assessment of Thompson's work in morphology and development. Part II develops a schema for the role of metaphors and analogy in scientific reasoning. Three central roles are distinguished: (1) the use of metaphors and analogies drawn from already developed theories in one field to suggest and validate new theories in the same or other fields; (2) the use of metaphors drawn from physical phenomena to suggest and validate theories; (3) the use of metaphors in applying theories to empirical phenomena. The general thesis argued for is that metaphors and analogies are cognitively significant tools for the validation of theories and are not merely heuristic. Part III is a discussion of some of the central metaphors and analogies in Thompson's work in the light of the above schema.

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SCIENTIFIC CREATIONISM: MYTHOLOGY IN THE MAKING. W.D. Hummon. Ohio Univ., Athens.

'Scientific' creationism is one of a host of recent reactions to a perceived 'profaning' of the universe by evolution/ secular humanism. These are equated & blamed for the evils of modernity. But, creationism itself has many characteristics of a mythology in the very process of formation and development. It is constrained both by a view of Biblical inerrancy & by the need to accept and incorporate into its new sacred view of history the unassailable findings of science. Its primordial event is not so much creation itself as the flood & a 'geologic/hydraulic' explanation in terms of a young earth. The spindle of the earth (axis mundi) is held to pierce the traditional Mt. Ararat. The geocentric, flat-earth/waters-of-the-firmament view becomes a heliocentric, round-earth/vapor-canopy view that is read back into Genesis. Creationists claim to have discovered both heliocentrism and natural selection. Adoption of their new cosmology (or even parity of time with the 'evolution model') will bestow upon it a divine origin and dimension. For myth once told establishes thenceforth for believers truth that is absolute & the nostalgia for paradise that led Morris from Genesis (1976) to Revelations (1983).

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CHARACTERIZATION OF RED CELL HEMOGLOBIN OF PHORONIS PSAMMOPHILA. T.L. Vandergon and J.M. Colacino. Clemson Univ., SC.

The circulating blood cells of *Phoronis* contain hemoglobin at an average heme concentration of 17.2 mM. The p50 for O₂ binding by Hb averages 1.26 mmHg *in vivo* and 1.01 mmHg *in vitro*. The pigment shows cooperative O₂ binding *in vivo* (Hill number = 3.4) but no significant Bohr effect ($\Delta \log p50/\Delta pH = -0.01$). *In vitro* stopped flow O₂ dissociation measurements at various wavelengths result in curves with three distinct phases with rates of approximately 14, 5 and 0.05 sec⁻¹. The first two rates, ascribed to O₂ dissociation, suggest a heterogeneous Hb. The third phase may result from an aggregation state change of the pigment following deoxygenation. The overall O₂ association rate of the pigment is $3.5 \times 10^6 M^{-1} sec^{-1}$, calculated from an overall dissociation rate (phases 1&2) and the steady state equilibrium value. Sephadex gel filtration of red cell lysate saturated with CO shows two components of very similar MW between 16 - 17,000. Neither gel filtration nor electrophoresis has yet shown a Hb component above a MW of approximately 16,000. Thanks are due to C. Bonaventura and J. Bonaventura (Duke Marine Lab) for the use of their equipment and their assistance with stopped flow kinetic measurements.

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RELATIONSHIP BETWEEN BLOOD VOLUME AND HB-O₂ AFFINITY. G. F. Birchard, Dept. of Physiology, Dartmouth Medical School, Hanover, NH 03756.

Increased blood volume (TBV) results in greater tolerance to experimental hypoxia. Since P₅₀ and tolerance of ambient hypoxia are inversely related we hypothesized that TBV and P₅₀ might also be inversely correlated. Data for P₅₀, hematocrit, plasma volume (PV) and TBV were gathered from the literature for 22 species and subjected to least squares regression analysis. The relationships found were: TBV=112.5-1.45(P₅₀), r²=0.37, p>.003 and PV=78.7-1.1(P₅₀), r²=0.37, p>.004. No relationship between P₅₀ and hematocrit was found. These relationships do not reflect the combination of correlations between body mass and P₅₀ and body mass and TBV. It is suggested that an increased blood volume may account in part for the increase in hypoxic tolerance of animals with low P₅₀s.

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SUBUNIT HETEROGENEITY OF THE BLUE CRAB (CALLINECTES SAPIDUS) HEMOCYANIN ALONG A SALINITY GRADIENT. J. Rainer, C. P. Mangum and G. Godette*, Col. Wm. & Mary, Williamsburg and Duke Univer. Mar. Lab, Beaufort, NC.

A salinity gradient was defined by the fresh water of the Pamunkey river down the increasingly saline water of the York river to the Chesapeake Bay and ending with the full strength saline water of the Atlantic ocean off the Virginia eastern shore. Populations of blue crabs were sampled at various points along this gradient. Blood was sampled from individual crabs and dialyzed to dissociate the hemocyanin subunits from their multimeric structures. The samples were then electrophoresed to distinguish the 6 different subunits as shown by the banding on the gel. Each band was densitometrically scanned to determine the various concentration of each subunit for each individual of each population sampled. The results obtained from the scans suggest that three of the six subunits change in concentration according to salinity.

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THE EFFECT OF CO₂ ON THE ADRENERGIC REGULATION OF BLOOD-OXYGEN AFFINITY IN THE TELEOST, FUNDULUS HETEROCALITUS. P.M. Dalessio, L. DiMichele, and D.A. Powers, George Washington Univ., Washington, DC and The Johns Hopkins Univ., Baltimore, MD.

Many studies have indicated that endogenous release of epinephrine in teleosts causes an increase in blood-oxygen affinity that is controlled by changes in intraerythrocytic pH and ion fluxes. We found that this response appears to be dependent on blood Pco₂ (HCO₃⁻). Epinephrine, whether injected into the fish or added to whole blood ameliorates both the hypocapnic increase in blood-oxygen affinity and the hypercapnic decrease in blood-oxygen affinity. At resting blood Pco₂, epinephrine has no effect on blood-oxygen affinity. From *in vitro* experiments we hypothesize that this phenomenon is attributable to a reversible proton channel whose status is neutral at resting pH and Pco₂. If correct, our hypothesis predicts that epinephrine's major role is to limit excessive changes in oxygen affinity at the onset of stress.

CHARACTERIZATION OF THE HEMOGLOBINS ISOLATED FROM HIBERNATORS OF THE GENERA CITELLUS AND MARMOTA. L.K. Duffy, C.T. Genau* and G.L. Florant.* Harvard Medical School, Boston, MA, Univ. of Alaska, Fairbanks, AK and Swarthmore College, Swarthmore, PA

Characterization of hemoglobins of winter-hibernating, winter-active and summer-active arctic ground squirrels (Citellus undulatus) by citrate agar electrophoresis and isoelectric focusing (IEF), pH 5.5-8.5, showed no differences in electrophoretic patterns. Previous studies showing alterations in hemoglobins were most likely the result of artifacts due to the use of whole blood. The arctic ground squirrel's hemoglobin amino terminal sequence was determined for each activity state and was identical in all cases.

The hemoglobins from Citellus undulatus will be compared with the hemoglobins from Citellus lateralis and Marmota flaviventris.

VARIATION IN THE OXIDATION OF GLUTAMATE AND GLUCOSE BY VERTEBRATE AND INVERTEBRATE ERYTHROCYTES. N.A. Mauro and R.E. Isaacks. Veterans Administration Medical Center, Miami, Fla.

With the exception of the lungfish, nucleated vertebrate erythrocytes (RBC) can clearly be differentiated metabolically from those of invertebrates. The lungfish RBCs like those of invertebrates demonstrate a greater oxidation of exogenous glutamate than RBCs from most vertebrates. In the lungfish, glutamate is oxidized 2.7 times more than glucose. The rate of glutamate oxidation in other species of fish, as well as other classes of vertebrates, is approximately equal to, or less than, that observed from glucose. These observations are surprising since RBC's of vertebrate, in general, are permeable to glutamate which is oxidized directly via the TCA cycle. Furthermore, these findings suggest a specialization of vertebrate RBCs toward carbohydrate oxidation.

HEMOLYMPH AND TISSUE ION AND ACID-BASE BALANCE IN CRAYFISH DURING CHRONIC EXPOSURE TO NITRIC ACID. B.R. McMahon and S.A. Stuart. Biology, U. of Calgary, Calgary, Alberta, Canada.

Adult Procambarus clarki, acclimated (14d) to soft water ($Ca^{++}0.22mM$) were exposed 21-60 days to pH 4.0 (HNO_3) in soft water. Hemolymph was sampled at 0,1,2, 7,14,21,60 d in acid and 1,2 and every 7d during recovery. Tissue ion contents were determined weekly. Exposure to HNO_3 caused an initial hemolymph acidosis, reduced PCO_2 and $[CO_2]$ and no increase in lactate. In chronic exposure, however, hemolymph acid-base status returned to normal. Hemolymph NO_3 increased significantly, but other hemolymph ions were significantly depleted at 7d acid exposure. $Na^+ Cl^- Ca^{++}$ (not K^+ or Mg^{++}) however, showed substantial recovery during chronic acid exposure. Tissue ion levels, in general, showed little recovery. In contrast with previous acute (H_2SO_4) studies, the results suggest some potential to compensate for and perhaps survive severe acid exposure in Procambarus. The extent to which the observed recovery results from uniqueness of either the species or acid employed is not known. Return to normal pH was associated with hemolymph alkalosis. Ion status recovered completely within 7d in hemolymph but more slowly in tissues.

RESPONSES OF BLUE CRABS TO NEUTRAL AND ACIDIC SEAWATER INJECTION. K.L. Gallagher* and P.L. deFur. George Mason Univ., Fairfax, VA.

Blue crabs (Callinectes sapidus) were injected with seawater (SW) at a pH the same as, or 1 unit lower than the pH of the hemolymph. In one set of experiments, arterial hemolymph pH, CO_2 content ($CaCO_2$), and CO_2 tensions ($PaCO_2$) were measured over a 4h period and at 24h. In a second set of experiments, the above variables and ventilatory flow (V_w) were measured over the same time period. pH decreased over 4h in all cases. At 24h post injection, pH was lowest in animals injected with acidic SW. Mean $CaCO_2$ decreased in all cases except during SW injection experiments in which V_w was monitored. Mean $PaCO_2$ cyclicly increased then decreased in all cases; the greatest increase occurring following SW injection. There were discrepancies between measured $PaCO_2$ values and those calculated using pK_1 values from the literature.

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INTRACELLULAR pH (pH_i) REGULATION IN FROG MUSCLE. Robert W. Putnam and Albert Roos*. Washington University School of Medicine, St. Louis.

Recovery of pH_i from acid loads (5% CO_2) was studied with microelectrodes in semitendinosus fibers from *Rana pipiens*. Recovery in resting fibers ($2.5K, V_m -90mV$) was $0.03 \pm 0.01 \Delta pH_i/h$ ($n=16$). It increased to 0.28 ± 0.02 ($n=42$) upon depolarization (50K, constant Cl , $V_m -20mV$), and was partly inhibited by $1mM$ amiloride (Na/H exchange) and partly by $0.5mM$ SITS (Na/ HCO_3^-/Cl exchange). In resting fibers exposed to CO_2 , either $1mM$ amiloride or Na removal produced a slow acidification of 0.07, probably due to HCO_3^- efflux. Recovery from an acidifying NH_4Cl prepulse (no CO_2), entirely due to Na/H exchange, was the same in resting 0.26 ± 0.04 ($n=10$) and depolarized fibers 0.29 ± 0.03 ($n=13$). Depolarization in constant Cl elevates Cl_i from 2 to $\sim 30mM$. Recovery from CO_2 was lower when depolarization (to $\sim 20mV$) was achieved without an increase in Cl_i : 0.21 ± 0.01 ($n=53$) in 50K, constant $KxCl$; and 0.14 ± 0.02 ($n=19$) in 2.5K, 5.9Cl, 0.5Ba. We propose that increased recovery with depolarization at constant Cl is partly due to the elimination of an acidifying HCO_3^- efflux and partly to an increase in Cl_i . (NIH Grant HL-00082.)

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BUFFERING CAPACITIES AND LDH ACTIVITIES OF HEART AND SKELETAL MUSCLE OF A VERTEBRATE FACULTATIVE ANAEROBE. K.M. Crawford and J.M. Olson. Univ. of Michigan, Ann Arbor.

Aquatic turtles possess adaptations for long term submergence and anoxia tolerance unrivaled among air breathing vertebrates. The ability of tissues to buffer the acidic end products of anaerobic metabolism may be an important adaptation to maintain function during hypoxic conditions. We therefore measured *in vitro* non-bicarbonate buffering capacity (β) and lactate dehydrogenase (LDH) activity of pectoralis muscle (PM) and cardiac muscle (CM) homogenates of locally collected *Chrysemys picta*. β was significantly higher in PM than CM (40.3 and 27.0 slykes, respectively). These values are lower than those reported for fish white muscle. LDH activities of PM and CM were not significantly different at either $10^\circ C$ (125.5 vs. 137.7 IU/g) or $25^\circ C$ (354.4 vs. 343.2 IU/g). The Q_{10} for LDH activity was 2.03 for PM and 1.87 for CM. There appears to be no direct association between β and LDH activity for these tissues. This may reflect the need for a higher buffering capacity in skeletal muscle which may not be perfused during prolonged dives.

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DIFFERENTIAL EFFECTS OF Ca^{2+} -CHANNEL ANTAGONISTS ON CARDIAC ACTION POTENTIALS IN RAT AND GOLDFISH. John S. Cameron. Dept. of Biol. Sci., Wellesley College, MA 02181

The contribution of calcium currents to transmembrane action potential (AP) configuration in goldfish (*Carassius auratus*) myocardium was investigated and compared to that in mammals. Cellular electrophysiologic responses to varying concentrations of external Ca^{2+} (0.9-3.6 mM) and of the Ca^{2+} -channel blocking agents verapamil (V; 0.1-2.0 $\mu g/ml$) and Mn^{2+} (0.9-3.6 mM) were monitored with standard glass microelectrodes in isolated, superfused ventricles. Elevated $[Ca^{2+}]_i$ shortened the AP in endocardial muscle fibers of both rat ($37^\circ C$) and goldfish ($22^\circ C$), while decreased $[Ca^{2+}]_i$ lengthened it. In rat, V and Mn^{2+} reduced AP duration at 25% repolarization (APD_{25}), but prolonged APD_{50} ; AP amplitude (APA) and upstroke velocity (V_{max}) were unaffected. In contrast, goldfish APD_{25} , APD_{50} , APA and V_{max} decreased in response to V or Mn^{2+} , an effect prevented by isoproterenol ($10^{-6}M$). Ca^{2+} -mediated slow inward currents (I_{s_i}) may contribute more to ventricular depolarization in teleosts than in mammals; the relative role of I_{s_i} and Ca^{2+} -activated K^+ currents in AP plateau formation is uncertain. (NIH, NIRA HL-34672 and Brachman-Hoffman Fdn.)

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ACID-BASE CHARACTERISTICS OF THE UTERINE ENVIRONMENT FOR LATE GESTATION DOGFISH PUPS. G.A. Kormanik and D.H. Evans. Univ. North Carolina at Asheville, Univ. Florida, Gainesville and Mount Desert Isl. Biological Laboratory, Salsbury Cove.

Pups of the dogfish, *Squalus acanthias*, during late gestation, live in a uterine solution resembling sea water, at least with respect to the major ion concentrations. It is not clear what role the mother plays in supplying O_2 and removing CO_2 and waste products. We examined blood acid-base values for mothers and pups as well as the uterine sea water. Blood of the mothers and pups is not significantly different with respect to pH, CO_2 content, Na and urea. Pup blood ammonia was significantly higher (1160 vs. 334 μM) and PCO_2 slightly lower compared to the mother. Uterine sea water had an ammonia concentration of up to 22 mM and a pH as low as 5.4, thus the pups were living in ammonia concentrations ordinarily considered to be toxic to aquatic organisms. It would appear that the low pH protects the pups against the toxic NH_3 gas, since most ammonia is in the ionic form. The role of this accumulated ammonia is not yet clear. (Funded by NSF PCM 83-02621 to D.H.E. and an NSF-ROA to G.A.K.)

CALCIUM BINDING BY MOLLUSCAN ORGANIC MATRIX: EFFECTS OF IONIC STRENGTH AND RELEVANCE TO BIOMINERALIZATION. A.P. Wheeler, K.W. Rusenko,* J.W. George* and C.S. Sikes.* Clemson Univ., SC and Univ. of South Alabama, Mobile.

Calcium association with fractions of organic matrix extracted from the shell of the oyster Crassostrea virginica and the clam Mercenaria mercenaria was determined at various concentrations of NaCl and other salts using calcium-specific electrodes and static and dynamic equilibrium dialysis. At NaCl concentrations approaching that of the mineralization medium for these molluscs, calcium binding was reduced to a level such that only static dialysis was sensitive enough for detection. Polyaspartate, an analogue of matrix, associates with calcium with approximately the same affinity and sensitivity to ionic strength as matrix. From these studies it is suggested that undue emphasis on calcium binding by organic matrix in vitro as indicative of its role in the initiation of biomineralization is unwarranted. The calcium associated with matrix may be inconsequential in the ionic environment in which nucleation of biomineral occurs. This research was supported in part by South Carolina Sea Grant Consortium grant SC 85-6.

QUATERNARY AMMONIUM SULFANILAMIDE: A NOVEL CARBONIC ANHYDRASE INHIBITOR. R.P. Henry. AUBURN UNIV., AUBURN, AL.

The enzyme carbonic anhydrase (CA) has been shown to be associated with the plasma membrane of a number of tissues (e.g., vertebrate kidney and lung). Direct physiological studies of membrane-associated CA have been difficult because of the absence of a way to selectively inhibit the membrane-associated enzyme. In an attempt to develop a membrane-impermeant CA inhibitor the quaternary ammonium derivative of the CA inhibitor sulfanilamide was synthesized. Quaternary ammonium sulfanilamide (QAS) has a MW of 309, a melting point of 231.8 C, and gave one spot on TLC (Rf=0). The affinity constant (Ki) for QAS against pure Bovine CAII was between 1 and 10 μ M. An 18-oxygen/mass spectrometer CA assay was used to test the permeability of QAS to the cell membrane of intact erythrocytes (rbc's). After 24 hr of incubation in 5 mM QAS the rbc's showed no loss of intracellular CA activity; CA activity from lysed rbc's was immediately and completely inhibited by 5 mM QAS. This indicates that QAS is indeed membrane impermeant, and it is a useful tool for directly studying the physiology of membrane-associated CA in a variety of tissues. Supported by NSF DCB 84-17379.

pH-DEPENDENT ARRESTMENT OF CARBOHYDRATE METABOLISM DURING ANAEROBIC DORMANCY AND AEROBIC ACIDOSIS IN ARTEMIA CYSTS. J.F. Carpenter and S.C. Hand. Univ. of Southwestern Louisiana, Lafayette.

Mobilization of trehalose and synthesis of glycogen and glycerol are blocked during anaerobic dormancy (known to foster intracellular acidification), and adenylate energy charge (AEC) drops from 0.72 to 0.42. Glucose levels remain unchanged throughout anaerobic incubation while the glucose 6-P/glucose ratio drops from an aerobic, control value of 0.36 to 0.042. These findings indicate that trehalase and hexokinase (HK) are simultaneously inhibited. Inhibition of phosphofructokinase (PFK) is reflected in a decline of the fructose 1,6-P₂/fructose 6-P ratio from 2.77 to 0.94. The reactions catalyzed by trehalase, HK and PFK are displaced from equilibrium, with MAR/Keq values of 2.15×10^{-9} , 2.79×10^{-5} and 2.79×10^{-3} , respectively. Exposure of cysts to aerobic conditions known to artificially depress intracellular pH (60% CO₂: 40% O₂) leads to similar metabolic transitions (except that AEC only drops to 0.68) which can be fully reversed by return to control, aerobic incubation. Thus, it is concluded that hydrogen ion is a primary modulator of carbohydrate metabolism in Artemia cysts. Supported by NSF Grant DCB-8316711.

SPECIES AND STRAIN DIFFERENCES IN RBC GALACTOKINASE ACTIVITY. H.M. Kuerer*, L.-Y. Shih*, and O. Gona. Departments of Pediatrics and Anatomy, New Jersey Medical School, Newark, NJ 07103.

Abnormalities in galactose metabolism result in human cataract and high dietary galactose induces cataract development in mammals, including rat and rabbit but not mouse. We recently induced galactose cataracts in a strain of mice with low galactokinase activity. Because mice do not readily develop galactose cataracts, it was of interest to compare galactokinase activity in mouse with that in rat and human. Blood was collected from Sprague-Dawley rats (5-10 wks), C57BL and AJ mice (6-8 wks), and humans (various ages). RBC galactokinase activity was measured by the modified method of Beutler (1981) using a ¹⁴C-galactose substrate. Highest activity was in AJ mice (121 μ U/g Hb) and lowest in adult human (25 μ U). C57/BL mice, in which we induced cataracts by prenatal galactose exposure, had a 48 μ U/g Hb mean activity while that of Sprague-Dawley rats was 71 μ U Hb. The results do not support the hypothesis that susceptibility of humans and rats, and resistance of mice, to galactose cataract development is mainly due to RBC galactokinase activity.

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POSTPRANDIAL OXYGEN UPTAKE IN MYTILUS EDULIS L. RECOVERING FROM STARVATION. W.J. Diehl, P.M. Gaffney* and R.K. Koehn*. State Univ. New York, Stony Brook.

Mytilus edulis spat were grown singly in plastic racks in a tidal salt marsh for 10 weeks, starved in the laboratory for 19 weeks, then fed Isochrysis galbana in excess for 10 weeks. During this recovery, individuals returned to a mean 89% of their estimated dry weight prior to starvation, from a mean 53% after starvation. At weekly intervals during recovery, oxygen uptake was measured following a pulse of food until it returned to a basal rate; postprandial and basal volumes (ul at STP) of oxygen consumed (VO_{2pp} and VO_{2b} , respectively) were calculated. Both VO_{2pp} and VO_{2b} increased significantly during recovery; VO_{2pp} increased significantly from 15.2 to 23.2% of VO_{2b} . At the end of the recovery period, VO_{2pp}/VO_{2b} was independent of final dry weight but was significantly correlated with percent dry weight recovered ($r = 0.663$; $df = 11$; $P < 0.025$). We interpret the increase in VO_{2pp}/VO_{2b} to reflect increased utilization of food and its conversion to soma during recovery from starvation, as distinct from mechanical energy expenditure (feeding activity) following a meal.

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ADJUSTMENTS OF CARDIAC RATE TO CHANGES IN RESPIRATORY GASES BY A BIMODAL BREATHER, THE PANAMANIAN SWAMP EEL, SYNBRANCHUS MARMORATUS. J.L. Roberts and J.B. Graham, Univ. Massachusetts, Amherst, and Scripps Inst. Oceanography, La Jolla, Ca.

Extreme lability of heart frequency (fH) occurs during air breathing cycles of swamp eels. When a breath is taken into the air breathing organ by an eel, the fH rises sharply to >40 cpm from the low rate of 3 to 10 cpm found just after release of a prior air breath (AB). Just after filling of the air breathing organ (10 to 30 ml), fH declines slowly as O_2 is extracted, often dropping to about half the initial rate before breath release occurs. During rhythmic gill breathing in well-aerated water, fH remains comparable to the rate found after taking of an AB. When gill breathing ceases a marked bradycardia develops immediately, as when an AB is released. Atropine (1 mg/kg) blocks development of the bradycardia and stabilizes fH to ± 40 cpm or the maximum rate observed for a specific animal. Evidence obtained by artificial changes in volume and concentrations of O_2 and CO_2 present in the AB shows a fH dependency supporting the view that swamp eels monitor both volume and quality of air breaths.

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PERIODIC CO_2 RELEASE IN LAND SNAILS AND INSECTS: A COMPARISON. M.C. BARNHART, UNIV. OF CALGARY, CALGARY, ALTA.

Respiratory gas exchange of many dormant or resting insects and of dormant helioid land snails is characterized by alternating periods of CO_2 accumulation and release. In insects, CO_2 accumulation is attributed to subambient pressure in the tracheal system (suction ventilation). However, analysis of gas exchange in snails (Otala) shows that suction ventilation is not prerequisite for periodic CO_2 release. Regulation of low PO_2 in the tracheae or lung is associated with periodic CO_2 release in both systems, and may be possible only when metabolic rate is very low. The magnitude of fluctuations of body CO_2 content is about 30 times greater in Otala than in lepidopteran pupae of similar mass, due mainly to greater buffering capacity in the mollusc. In contrast to pupae, dormant Otala show periodic, sustained elevations (2 to 3 fold) of the rate of oxygen consumption. Periodic increase of oxygen consumption is closely correlated with decrease in whole-body CO_2 content (calculated from the respiratory quotient and continuous recording of respiratory exchange ratio).

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ONTOGENY OF HEART RATE REGULATION IN AMPHIBIANS. W. Burggren and M. Doyle. Univ. of Massachusetts, Amherst.

Little is known of the ontogeny of cardiovascular regulatory mechanisms in lower vertebrates. Consequently, heart rate was measured in six developmental stages of the bullfrog before and after acute hypoxia, exercise and treatment with cholinergic and adrenergic antagonists, to assess developmental changes in cardiac function. Resting heart rate was highest in newly hatched larvae, intermediate through the remainder of larval development, and lowest in adults. These developmental changes were due largely to changes in intrinsic properties of the cardiac pacemaker, rather than vagal or sympathetic influences. Hypoxia, exercise or drug treatment had no effect on heart rate of newly hatched larvae, but induced major changes in older larvae and adults. We conclude that the capability for cardiac regulation increases with development. However, intermediate and late larval stages show regulatory mechanisms different from, but no less complex, than those of post-metamorphic adults. Support by NSF grant #PCM-8309404.

NEURAL CORRELATES OF REVERSED VENTILATION IN THE SHORE CRAB. R.A. DiCaprio (intro. by M.H. Rowe) Ohio University, Coll. Osteo. Med., Athens.

Gill ventilation in decapod Crustacea is produced by the rhythmic dorsoventral movements of the scaphognathite (SG) or gill bailer of the second maxilla. Alteration of the recruitment sequence of the four major muscle subgroups controlling the SG allows water to be pumped in either of two directions, corresponding to forward and reversed ventilation. The ventilatory motor pattern is organized and controlled by non-spiking interneurons. A class of interneurons has been found which appear to play a fundamental role in the switch between forward and reversed ventilation. These cells fire a sustained burst of action potentials during reversed ventilation. Bouts of reversed ventilation can be elicited by depolarizing these neurons, and the reversed motor program is terminated when the current is turned off. The activity of motor pattern generator interneurons, frequency modulating interneurons and motor neurons during reversed ventilation will also be presented.

RESPONSES OF CONSCIOUS, DECEREBRATE AND ANESTHETIZED CATFISH TO HYPOXIA AND NaCN. M.L. BURLESON AND N.J. SMATRESK. UNIV. OF TEXAS AT ARLINGTON.

To evaluate the effects of animal preparation on hypoxic reflexes, conscious, decerebrate and anesthetized *Ictalurus punctatus* were subjected to varying O₂ levels and NaCN (CN). All groups showed bradycardia, increased blood pressure, and increased ventilation rate and opercular pressure during hypoxia. 50ug NaCN given into the dorsal aorta increased ventilation frequency after a 30 sec delay, in all but decerebrate fish. Opercular pressure increased in all groups. Internal CN had no effect on heart rate. 500ug CN given externally immediately increased ventilation rate and opercular pressure, and caused bradycardia. Ventilatory responses to hypoxia and CN were attenuated in decerebrate fish. Conscious fish exhibited behavioral responses (bradycardia and apnea) to all manipulations. Anesthetized fish remained responsive to hypoxia and had no behavioral responses. CN experiments indicated that chemoreceptors which modulate heart rate are external whereas both external and internal receptors modulate ventilation. (Supported by NSF Grant PCM-8317914)

CHARACTERISTICS OF PULMONARY MECHANORECEPTORS IN THE AIR BREATHING FISH, *LEPISOSTEUS OCULATUS*. N.J. Smatresk and S.Q. Azizi. Univ. of Texas at Arlington.

Ventilatory and cardiovascular reflexes associated with air breathing and lung deflation suggest the presence of mechanoreceptors in the air breathing organ of *L. oculatus*. Single fiber and whole nerve afferent activity was recorded from the pulmonary branch of the vagus nerve in response to step inflation, ramp inflation and inflation of the lung with 5 or 10% CO₂ in air. Slowly adapting receptors (SAR) were found which increased their tonic level of discharge above a threshold volume. SARs also showed rate sensitive responses to inflation and phasic inhibition of activity in response to lung deflation. Lung inflation with 5-10% CO₂ inhibited activity in some SARs, and had no effect on others. Rapidly adapting receptors (RAR) responded with a burst of activity, but ceased firing 1-2 sec after inflation or deflation. CO₂ had no effect on the response of RARs. Thus, *L. oculatus* have receptors that respond to both the volume and rate of inflation or deflation of the air breathing organ. (Supported by NSF Grant PCM-8317914)

ANTIBIOTIC SUBSTANCES FROM SEVERAL ANTARCTIC BRYOZOANS. R. Colon-Urban, L. Reyes*, J.E. Winston, SUNY, College at Old Westbury, New York and Amer. Nat. Hist. Museum of New York.

Several bryozoan species from Low Island Antarctica were examined for antibiotic activity. Aqueous methanol homogenates were prepared followed by chloroform extractions. Bioassays (disc diffusion method) were performed on the lipid soluble fractions using cultures of *Staphylococcus aureus* (ATCC-12600) at concentrations of 5 mg/ml, *Himantozoum antarcticum* and *Cycli-copora polaris* strongly inhibited the growth of *S. aureus*. *Caberea darwini*, *Nematoflustra flagellata* and *Flustra thysanica* were moderately inhibitory while extracts from *Beania livingstonei* were noninhibitory. None of the above extracts inhibited the growth of *E. coli*. These results confirmed earlier reports from our laboratories using temperate zone bryozoan species. These patterns may have ecological and/or morphological significance. Supported by NIH Grant No. RR-08180.

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THE EFFECT OF COMPETITION REDUCTION ON FORAGING DECISIONS. D. B. Campbell. Univ. of New Hampshire, Durham.

The blue mussel (*Mytilus edulis*) is the competitive dominant in the New England rocky subtidal and lower intertidal zones. Major predators of mussels include sea stars (*Asterias* spp.) and dogwhelks (*Thais lapillus*). Dogwhelks may also be eaten by sea stars, and are therefore both competitors and prey items of sea stars. Sea stars presumably get a double bonus by feeding on dogwhelks: energy gain and reduced competition for preferred prey (mussels). Feeding rates of sea stars are variable. Feeding studies showed that sea stars gained weight faster on a diet of mussels when feeding rates were low, but dogwhelks provide faster growth when feeding rates were high. Critical ratios of numbers of dogwhelks:mussels were determined which predicted the points at which a sea star should switch from mussels to dogwhelks if 1) gain in sea star biomass was the important variable and 2) competition reduction was also important. In this food web competition reduction was not a factor in foraging decisions; the switching point could be predicted on the basis of availability and prey value alone.

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ENERGY ALLOCATION AND REPRODUCTIVE STRATEGIES IN A MARINE GASTROPOD, *CREPIDULA CONVEXA* (SAY). P. AITKEN-ANDER. BROOKLYN COLLEGE (CUNY), NEW YORK, N.Y.

Crepidula convexa is a filter-feeding, protandric hermaphrodite which produces large, yolky eggs. During the annual reproductive season (May-Oct.) at Breezy Point, N.Y., females can lay 4-5 egg masses. Fecundity increases with female size (weight), and females continue to grow throughout the reproductive period. Allocating energy for growth allows the female to optimize brood size at each successive oviposition and to maximize her fecundity for the season. Although fecundity increases with female weight, egg output per unit weight decreases as the animals become larger. For each allocation of energy to growth (cost), the female derives less benefit (increased fecundity) as she continues to grow. Regression analysis of data for egg output (mg) and net production (mg) indicates that a 21 mm female must allocate approximately 100% of net production to egg output. Therefore, animals larger than 21 mm have little energy available for growth. Since specimens of *C. convexa* larger than 22 mm have not been collected at this site, the species may reach a maximum size determined by energetic factors at a given geographic location.

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GROWTH OF JUVENILE THREESPIKE STICKLEBACKS (*GASTEROSTEUS ACULEATUS*) IN ROCKY TIDEPOOLS. H. J. Weeks Cornell Univ., Ithaca, NY

Threespine sticklebacks enter marine rockpools of the upper intertidal and lower supralittoral of Appledore Island, Gulf of Maine. They reproduce successfully in some pools of undilute seawater, and the juveniles reside in natal tidepools for the first several weeks of life. Pools vary widely in levels of primary production, prey item abundance and density of juvenile sticklebacks. Growth rates of juveniles, calculated from regressions of standard length on age estimates from daily increment counts of the otoliths, are generally similar from pool to pool and year to year, and are comparable to estimates of maximum growth rates for juvenile sticklebacks reported in the literature. These results suggest rockpools are rich nurseries for juvenile sticklebacks; utilization of rockpools as breeding habitat by adults is not determined by trophic factors, but by disturbance due to wave action.

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SOMATIC-OTOLITH GROWTH COMPARISONS IN LARVAL AND JUVENILE STRIPED BASS AND SPOT. David H. Secor, John Mark Dean, and P.W. Haake. Belle W. Baruch Institute for Marine Biology and Coastal Research, Univ. of South Carolina, Columbia, SC 29208.

Otoliths are calcium concretions within the labyrinth of teleost fishes. Growth increments are a consistent feature of the microstructure of otoliths and form with a daily frequency in many species. Recent reports postulate a relationship between increment width and daily somatic growth of the fish. We investigated otolith and somatic growth in larval and juvenile striped bass (*Morone saxatilis*) and spot (*Leiostomus xanthurus*) from impounded and wild habitats. Daily increment formation has been verified for these species in complementary studies. Otolith size was highly correlated to fish length but within each species, this allometric relationship showed higher slopes for slower growing groups. Therefore the relationship between otolith and fish length is not necessarily species or population specific. Our experiments demonstrate a coupling of allometric relationship to growth rate of the fish. This implies that within a species, otolith-fish size comparisons might describe past growth. (Supported by South Carolina Sea Grant Consortium).

HATCHING PHENOLOGY OF THE DUSKY SALAMANDER DESMOGNATHUS FUSCUS. J. E. Juterbock. The Ohio State Univ., Lima.

Six Ohio and Kentucky populations of Desmognathus fuscus oviposited relatively synchronously only during July. Embryological development required approximately 46-61 days. Hatching occurred in late August and September and is not synchronous within a clutch. It required from 2-12 days for all eggs in a clutch to hatch. Hatching occurred over a wide range of developmental stages. The range of interpopulation variation in hatching was no greater than, and was similar to, intrapopulation variation. The latter involved variation in both the time of oviposition and the time required for embryological development. Since hatchlings leave the nest after a variable period of time, a more accurate picture of hatching phenology requires monitoring the entire season. Annual variation in hatching peaks was slightly greater than that of oviposition peaks, presumably due to temperature variation, which is known to influence developmental rates. However, no definite associations could be determined between temperature or moisture and oviposition or hatching peaks.

THE INSECT ASSEMBLAGE OF YUCCA IN SOUTHWEST FLORIDA. D.L. Matthews*. New College of USF., Sarasota.

Yucca supports a variety of insects, especially the larval stages of burrowing and saprophytic forms. Insects on Yucca aloifolia and Yucca filamentosa found along the southwestern Florida coast were observed in the field and laboratory. Three recurring species of the families Megathymidae (Lepidoptera), Curculionidae (Coleoptera), and Stratiomyidae (Diptera) were observed intensively. Examination of their life history strategies reveals the potential for direct and indirect interspecific interactions. A direct interaction between the Megathymidae and the Curculionidae is possible which may be competitive in nature. A direct interaction is also possible between the Curculionidae and the Stratiomyidae. Indirect interactions may exist between the Stratiomyidae and the Megathymidae.

MUSCLE STRESS IN THE LOCOMOTION OF THE WHITE RAT AND THE KANGAROO RAT. A.K. Perry*, R. Blickhan, and C.R. Taylor. C.F.S., Harvard University, Bedford, MA.

This study was designed to test the hypothesis that stress (force per cross-sectional area) in the locomotory muscles of terrestrial animals is the same in different animals running at an equivalent speed (e.g. gait transition speed, preferred speed within a gait, top speed). To test this hypothesis, we measured the peak locomotory stress at preferred speed in the ankle extensor group of two animals differing in mass and locomotory technique: the white rat, a quadrupedal galloper; and the kangaroo rat (Dipodomys spectabilis), a bipedal hopper. Locomotory stress was determined from film and force records obtained from the animals as they ran over a force platform. The two species showed similar values for stress at their preferred speeds, providing strong support to the hypothesis.

	White	Kangaroo	Both
Stress (kN/m ²)	57.8	71.8	64.8
95% conf.	+ 61.0	+ 58.0	+ 44.9

(Supported by NIH grant 2-R01-AM-18140)

MECHANICS OF HUMAN HOPPING: MODEL AND EXPERIMENTS. C.T. Farley*, R. Blickhan and C.R. Taylor. Concord Field Station, Harvard University, Bedford, MA. 01730.

Animals hop and gallop with constant frequencies through large speed ranges. These preferred frequencies only depend on body mass. For example, a human hopping on a treadmill chooses about the same frequency as a kangaroo of similar mass. For human hoppers, the preferred frequency is about 2 Hz. We undertook this study to determine how physiological and mechanical constraints limit hopping frequency. We used force platform and cinematographic data to explore the limits of hopping frequency and amplitude. We observed a sharp transition in the mechanics of hopping at about 1.6 Hz and a maximum frequency of about 5 Hz. Taking the experimental force-displacement ratio as a measure for spring stiffness, a linear spring-mass model can predict the dependence of peak ground reaction force, ground contact time and displacement on hopping frequency. The maximum whole body stiffness confines hopping frequency to a region close to the preferred frequency. (Supported by NIH grant # 2 R01 AM 18140)

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GHOST CRAB LOCOMOTION: MECHANICAL ENERGY CHANGES OF THE CENTER OF MASS. R. Blickhan and R. J. Full. Harvard Univ., C.F.S., Cambridge, Mass. and The Univ. of Chicago.

Two general mechanisms are used to conserve energy during bipedal and quadrupedal locomotion of birds and mammals: 1) pendulum type energy exchanges and 2) spring type energy storage. The purpose of this study was to investigate the mechanical mechanisms used by an invertebrate which travels sideways, the ghost crab, *Ocypode quadrata*, (30-90g). The speeds adopted by crabs ranged from 0.05 to 1.60 m.sec⁻¹. Instantaneous vertical displacement and horizontal velocity of the center of mass were calculated from the vertical and horizontal components of the ground reaction forces measured by a force platform. The ghost crabs used two gaits, a "walk" and a "run", which were mechanically similar to the walk and run of birds and mammals. We found that gravitational and kinetic energy were out of phase in a "walk" (50% energy exchange) and were in phase during a run. The equation relating the mechanical energy changes of the center of mass (\dot{E}_{cm} , W/kg) to the animal's speed (v , m/sec), $\dot{E}_{cm}/\text{Mass} = 0.9 v + 0.03$, applies to bipedal, quadrupedal and octapedal travellers. (Supported by NIH-grant 2R01 AM 1840-09.)

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GHOST CRAB LOCOMOTION: THE EFFICIENCY OF TRAVELING SIDEWAYS. R. J. Full and R. Blickhan. The Univ. of Chicago and Harvard Univ., C.F.S., Cambridge, Mass.

Ghost crabs (*Ocypode quadrata*, 25-80g) were exercised within a treadmill respirometer. Steady-state oxygen consumption was obtained by open flow respirometry at speeds (v) ranging from 0.06 to 0.17 m/sec. Metabolic power input (\dot{E}_{metab} , W/kg) increased linearly with speed. For crabs with a mean mass (M) of 0.026 kg, $\dot{E}_{\text{metab}}/M = 17.2 v + 1.0$, while for 0.074 kg crabs, $\dot{E}_{\text{metab}}/M = 9.8 v + 1.5$. Mechanical energy changes of the center of mass were determined by measuring ground reaction forces on a forceplate track. Mass-specific mechanical power output required to lift and accelerate the center of mass (\dot{E}_{cm}/M) increased linearly with speed ($\dot{E}_{cm}/M = 0.9 v + 0.03$) and was independent of mass over the range examined. The estimated gross efficiency of crab locomotion (mechanical power output / metabolic power input) ranged from 5 - 8%. Gross efficiency increased with an increase in the speed of locomotion and with an increase in body mass. Eight-legged, sideways travel appeared no less efficient than bipedal or quadrupedal locomotion. (Supported by NIH-grant 2R01 AM 1840-09.)

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THERMAL AND TEMPORAL STABILITY OF SPRINT SPEED IN A LIZARD (*SCELOPORUS MERRIAMII*). R. B. Huey and A. E. Dunham. Univ. of Washington, Seattle, and Univ. of Pennsylvania, Philadelphia.

The physiological capacities of animals are often measured, but the stability of those capacities is rarely established. We have studied the stability of maximum sprint speed in a lizard (*Sceloporus merriami*, Big Bend National Park) across temperature and over time. Absolute speed was influenced by temperature, but relative speed was independent of temperature at 28, 33, and 37 °C: individuals that were relatively fast at one temperature were fast at other temperatures. Maximum speed was also temporally stable: lizards that were fast when first measured in July 1984 were fast when reraced in July 1985. This demonstration that sprint speed is phenotypically stable facilitates microevolutionary studies of the adaptive significance of individual differences in this trait.

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POSSIBLE GENETIC BASIS FOR INDIVIDUAL VARIATION IN SPRINT SPEED IN HATCHLING LIZARDS (*SCELOPORUS OCCIDENTALIS*). F.H. van Berkum and J.S. Tsuji. Univ. of Washington, Seattle.

Hatchling (19-37 days old) *Sceloporus occidentalis* from the same dam were more similar in maximum sprint speed and body size than were hatchlings from different dams. Maximum sprint speed varied 6-fold (range .283 - 1.724 m/s) among the 99 hatchlings measured, but was uncorrelated with age or any measure of body size (range of body masses .400 - 1.308 g). Therefore differences in sprint speed among maternally related families of hatchlings were independent of family differences in size of hatchlings. Demonstration of family differences in sprint speed is an important first step towards demonstrating a genetic basis for individual variation in sprint speed. However, environmental factors common to maternally related sibs might also contribute to family differences in sprint speed.

ENERGY LEVELS AND ANAEROBIC ENDPRODUCTS IN THE BRAINS OF TWO SPECIES OF TELEOST FISH AT DEATH IN ANOXIC WATER. C.R. DiAngelo and A.G. Heath. Virginia Polytechnic Institute and State Univ., Blacksburg.

Brains from anoxia-exposed rainbow trout (*Salmo gairdneri*) and brown bullhead catfish (*Ictalurus nebulosus*) were analyzed using enzymatic assays and HPLC. Control catfish brains had higher concentrations of glycogen, ATP, CrP, and glucose than trout. Anoxic catfish showed a significant decrease in ATP, CrP, and glycogen with no change from controls noted for glucose. Exposed trout showed no change in ATP, CrP, or glucose but glycogen decreased significantly. Ketone bodies in exposed catfish did not change. Anoxic trout brains had higher levels of beta-hydroxybutyrate. In both species, there was no difference between anoxic and controls in the anaerobic endproducts alanine, ethanol, isobutyrate, isovalerate, propionate, or succinate. Lactic acid levels in both species were higher than their respective control brain and anoxic blood values. These results suggest the brain of both species uses classic glycolysis. Catfish survive anoxia 6X longer, perhaps due to greater fuel stores in the brain.

DENSITY OF ZOOXANTHELLAE IN A NUDIBRANCH : EFFECT ON ZOOXANTHELLAE CARBON BUDGETS. Ove Hoegh-Guldberg. Univ. of California, Los Angeles, CA.

Zooxanthellae provide host invertebrates with recent products of photosynthesis. This contribution has been viewed as constant. There is growing evidence however, that zooxanthellae vary their metabolism during the ontogeny of a symbiotic association. I chose to investigate the metabolism of zooxanthellae in the symbiotic nudibranch, *Pteraeolidia ianthina*. This animal is populated by zooxanthellae relatively late in its life and consequently is found with widely different densities of zooxanthellae. While there were no major differences in photosynthetic efficiency of zooxanthellae in high and low density populations, there were significant differences in the partitioning of recently synthesized organic carbon between symbiont and host. In high density population zooxanthellae, where specific growth rates were low (0.100 d^{-1}), zooxanthellae were potentially capable of supplying their own carbon requirement as well as 80 to 180 % of the host respiratory demand. Low density populations, however, were only able to supply the carbon necessary for their own rapid growth (0.399 d^{-1}) and were unable to supply any carbon for host respiration.

THE EVOLUTION OF VERTEBRATE GENE EXON AND INTRON ORGANIZATION. M.W. Smith. Johns Hopkins Univ., Baltimore, MD.

Hypotheses of independence of gene structural elements and intron origin were tested with 53 independent vertebrate genes. Structure was measured as the number of exons, percent introns, and the position of intron interruptions of the codon frame. Additional variables were the sizes and base pairs (bp) of the genes, introns, exons, intervening DNA (sum of introns), mRNA (sum of exons), and mRNA 5' and 3' untranslated regions. The intron-size frequency distribution was bell shaped with a second smaller mode and nearly truncated at under 80 bp. The exon distribution was comparatively very peaked, suggesting different size constraints. Significant positive relationships existed between intervening DNA and the mRNA sizes, and mRNA 5' and 3' untranslated region sizes. Intron interruptions of the codon frame between nucleotides 2 & 3 occurred infrequently (22%). Most interruptions in the untranslated mRNA sequences were in the 5' region (83%). If introns were inserted into the genes, this data indicates that successfully insertions occurred nonrandomly.

ANALYSIS AND FUNCTION OF ORGANIC MATRIX FROM SEA URCHIN TESTS. D.M. Swift. Clemson University, Clemson, S.C.

The organic matrix from sea urchin tests was analysed and compared to matrix from other known carbonate systems. The aqueous soluble component of molluscan systems has been shown by others to be both a mineral growth inhibitor and a mineral nucleator. Little work has been done on urchin matrix and none on its possible physiological functions. This study was designed to elucidate on the composition of organic matrix from sea urchin tests and explore its possible roles as a regulator of mineral growth. Organic matrix was extracted using 2% acetic acid. The tests contained 0.092% organic material by weight. This material was 81-85% protein, 14-19% carbohydrate, and 1% phosphate. The aqueous soluble (SM) and insoluble (IM) components constituted 17-24% and 76-83% of the whole matrix (WM) respectively. SM was 92% protein, 4% carbohydrate, and 4% PO_4 . IM was 11% carbohydrate, 88% protein, and 0.3% PO_4 . Urchin SM significantly inhibited spicule formation in urchin larvae at 10 $\mu\text{g/ml}$, whereas WM had no effect on spicule formation at that concentration. SM was capable of inhibiting *in vitro* crystallization in solutions supersaturated with Ca^{2+} and CO_3^{2-} .

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AN UNUSUAL BLUE PROTEIN FROM THE MANGROVE JELLYFISH *CASSIOPEA XAMACHANA*. R.S. Blanquet and M.A. Phelan. Georgetown Univ. and Food and Drug Administration, Washington, D.C.

Many specimens of the mangrove jellyfish *Cassiopea xamachana* contain a blue glycoprotein diffused within the acellular portion of the mesoglea of the oral appendages and bell. Within the bell mesoglea, both the pigment and endosymbiotic zooxanthellae are concentrated immediately beneath the ex- and sub-umbrellar epithelia. Analyses of this protein by chromatographic and acrylamide gel electrophoretic (PAGE) techniques have shown it to be highly oligomeric (mol.wt. > 10⁶ daltons) and characterized by multiple isoelectric points. Denaturation with sodium dodecyl sulfate results in two major subunits of 36,000 and 38,000 daltons. The blue native protein shows multiple absorption peaks at 620,587,557 and 420 nm while the denatured protein is a pink color with a single absorption peak at 510 nm. The protein does not appear to contain a carotenoid or retinene prosthetic group. Amino acid analysis shows a significant cysteine content of 5.8 mole percent. The function of this protein is presently unknown.

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MOVEMENT OF MATERNAL CALCIUM INTO GLOCHIDIA IN A UNIONID. T.H. Dietz, H. Silverman, and W.L. Steffens. Louisiana State Univ., Baton Rouge.

The disappearance of calcium concretions from the gills of unionids during reproduction suggests maternal Ca passage to larvae developing in the gill water channel. To test this possibility *Anodonta grandis* (n=50) were injected with 2,000,000 CPM ⁴⁵Ca on August 1. Gill, gonad, kidney, blood, and shell were monitored for ⁴⁵Ca weekly for the duration of the study. Only gill and shell have any appreciable label after a month, and the gill label is largely accounted for by label found in isolated concretion material. Spawning occurs in late September and larval development occurs in October. Both scintillation data and autoradiography indicate the presence of ⁴⁵Ca in the shells of larvae developing in injected animals. No movement of ⁴⁵Ca to the gonads was detected during the period of study. Since only the maternal animal can be the source of label, Ca passage to the larvae is demonstrated. Passage of label occurs during the time when gill concretions disappear suggesting they are a major source of the transferred ⁴⁵Ca. Supported by NSF-DCB 83-03789.

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INTERCONVERSION BETWEEN MOLECULAR FORMS OF ARTEMIA CYST TREHALASE PROMOTED BY CHANGES IN pH. S.C. Hand and J.F. Carpenter. Univ. of Southwestern Louisiana, Lafayette.

Trehalase from brine shrimp cysts can exist in two forms which are distinguishable by electrophoretic mobility, kinetic properties and molecular weight. Dialysis of semipurified trehalase at pH 8.3 or higher fosters the formation of a fast-migrating species with a pH optimum of 7.0 and a molecular weight of 112,000 (as estimated by Sephacryl S-200 chromatography). Dialysis at pH 6.3 converts trehalase to a slow-migrating form of M_r 232,000, which exhibits a more alkaline pH optimum and acute inhibition by ATP. The interconversion is reversible and requires approximately one hour after a titration of solution pH. The molecular weight differences suggest a polymerization/depolymerization mechanism. Evidence is consistent with a model whereby intracellular acidification of *Artemia* cysts (which occurs upon entry into anaerobic dormancy) could shift trehalase to the ATP-inhibited form with the basic pH optimum, potentially stopping further trehalase mobilization. Supported by NSF grant DCB-8316711.

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PYRUVATE DEHYDROGENASE COMPLEX (PDC) FROM BIVALVE GILL TISSUE. K. T. Paynter, G. A. Karam and S. H. Bishop. Iowa State Univ., Ames and R. Komuniecki. Univ. of Toledo, OH

Acute regulation of the PDC seems to be involved in the control of tissue alanine levels during osmotic stress of this halotolerant bivalve. PDC was isolated by high speed differential centrifugation of lysed ribbed mussel (*Modiolus demissus*) gill mitochondria and by the Triton extraction-polyethylene glycol precipitation procedure (Stanley and Perham, *Biochem J.* 191, 147 (1980)). The kinetic properties and sub-unit structure are similar to PDC from other animals. The presence of a protein kinase-phosphatase system that operates on the 41Kd subunit of E₁ was demonstrated. Continuing studies indicate regulation of the catalytic activity by ATP, ATP analogs and the NAD/NADH ratio and of the kinase-phosphatase activities by Mg⁺⁺ levels, pyruvate and thiamine pyrophosphate. PDC may be regulated by both changing metabolite levels and the protein phosphorylation-dephosphorylation system during osmotic stress. (Supported by grants from the NSF.)

THERMOREGULATION IN DESERT-ADAPTED RINGTAIL CATS (*BASSARISCUS ASTUTUS*). C.D. Chevalier. University of California, Irvine.

Oxygen consumption ($\dot{V}O_2$), total evaporative water loss (EWL), and body temperature (T_b ; rectal temperature at end of each run) were measured over the air temperature (T_a) range of 0 °C to 45 °C at 5 °C intervals. From these values minimal resting metabolism (0.429 ml O_2 /(g·h); body mass = 865 g), minimal thermal conductance (0.0296 ml O_2 /(g·h·°C)), and T_b (37.6 °C) across and below the thermal neutral zone (TNZ: 23.2–35.5 °C) were determined. $\dot{V}O_2$ increased with decreasing T_a below the TNZ according to the equation: $\dot{V}O_2$ (ml O_2 /(g·h)) = 1.0988 - 0.0288 T_a (°C) ($r = -0.93$). EWL was 0.77 mg H_2O /(g·h) below $T_a = 35$ °C, rising steadily to 8.76 mg H_2O /(g·h) at $T_a = 45$ °C. Evaporative heat loss (EHL) was 8.9% (1.86 J/(g·h)) of metabolic heat production (MHP) at $T_a = 0$ °C, 100% of MHP at $T_a = 40$ °C, and 172% (21.28 J/(g·h)) of MHP at $T_a = 45$ °C. Supported by NSF8102331 to A.F. Bennett, and Sigma XI.

THERMOREGULATORY BEHAVIOR OF BLACK AND TURKEY VULTURES AT A WINTER DAY-ROOST. D. Byman. Pennsylvania State Univ., Dunmore, PA.

The thermoregulatory behaviors of the Black (*Coragyps atratus*) and Turkey (*Cathartes aura*) Vultures were observed at a day-roost at the northern edge of the winter range of both species. If the wind speed at dawn was high (> 1.8 m s^{-1}), most of the Turkey Vultures and many of the Black Vultures in the night-roost would fly directly to forage and not go to the day-roost. At low wind speeds (< 1.8 m s^{-1}), vultures would fly from the night-roost to the day-roost and stay until the wind rose. At the day-roost, vultures moved from high limbs (> 10 m) to the ground by late morning. At low ambient temperatures (< 15 °C), the vultures covered the bare skin of the head and neck by raising the feathered skin up to the top of their heads. Vultures of both species would spread their wings when short wave (visible range) radiation was high (> 200 W m^{-2}). These behaviors on the day-roost are important mechanisms for energy conservation when foraging is uneconomical.

ENERGETICS OF EARED GREBES. H.I. Ellis, C. Comstock[†], H. Noskin[‡], and J.R. Jehl, Jr.[‡] Univ. of San Diego, CA 92110 and Hubbs Marine Research Institute, San Diego, CA 92109.

Oxygen consumption of 12 captive Eared Grebes (*Podiceps nigricollis*) was measured in dry air in 49 separate experiments at thermoneutrality (TNZ = 20.0 - 38.1 °C). Mass-specific basal metabolism (\dot{H}_b) throughout the TNZ was 1.160 ml O_2 /g·hr or about 126% of that predicted by the Lasiewski and Dawson (1967) allometric equation.

Mass varied considerably in these captive birds, as it does in the field, according to the time of year. In the experimental birds, mass was low in April (~250g) and could rise to >500g ($\bar{x} = 385$ g) in September, falling thereafter. In spite of changes in mass, due to large deposits of subcutaneous fat, \dot{H}_b (mass-specific) remained constant. In fact, \dot{H}_b does not significantly differ in these birds at any mass interval (either 100g or 150g) or at any time of year. Because absolute mass-specific \dot{H}_b is constant at all masses, it varies between 106% and 152% of predicted values. Therefore, using a predictive equation based on mass is not advisable in estimates of energetics for these grebes.

THERMAL STABILITY OF THE STRUCTURAL PROTEINS OF THE VERTEBRATE EYE LENS. M. J. McFall-Ngai, L. L. Ding* and J. Horwitz*. Univ. of California, Los Angeles.

The soluble proteins of the vertebrate eye lens, collectively referred to as the crystallins, are contained within fiber cells that shortly after development lose the organelles essential for renewal of cellular components. Because there is no protein turnover in these cells, the crystallins must be stable throughout the life history of the animal. In order to maintain lens function, it would be predicted that these structural proteins must be resistant to the specific set of environmental stresses experienced by any given animal species, in much the same way as has been noted for catalytic proteins. We characterized the thermal tolerance limits of purified lens crystallins, as reflected in changes in tertiary protein structure, employing the spectrophotometric methods of circular dichroism and fluorescence, and differential scanning calorimetry. Using a number of vertebrate species from different habitats, we find a highly significant correlation between the tolerance to heat or cold denaturation of the crystallins and the thermal environment in which the animals naturally occur.

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TEMPERATURE EFFECTS ON CHELA MUSCLE PERFORMANCE IN TWO DECAPOD SPECIES. Jay A. Blundon. University of Maryland, College Park.

Measurements of chela performance from live blue crabs (Callinectes sapidus) and stone crabs (Menippe mercenaria) show that within each species, northern and southern populations of crabs exert comparable amounts of force. However, muscle performance in southern (Florida) populations of these crabs is reduced at colder temperatures (8°C), even after weeks of acclimation. Northern populations of blue crabs (Chesapeake Bay) and stone crabs (Beaufort, NC) which annually experience temperatures as low as 2-4°C are more able to use their chela at colder temperatures.

This study investigates chela muscle fiber response to 1) axonal stimulation, 2) current injection and 3) neurotransmitter application in these two crab species taken from northern and southern populations and acclimated to warm and cold temperatures. To date, these differences in muscle fiber performance appear to be due to increased fiber membrane resistance at low temperatures found in the northern crabs but less so in the southern crabs.

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A CALCIUM PUMP IN THE HEATER TISSUE OF MARLINS AND SAILFISH. B. A. Block. Duke University, Durham, N. C.

The heat producing tissue that warms the brain and eyes in billfish is a modified eye muscle. A portion of this eye muscle remains intact and has the appearance of normal skeletal muscle. The heat producing portion of this muscle contains cells that have a high content of mitochondria and abundant smooth endoplasmic reticulum. The mitochondria rich cells lack contractile proteins, and production of ATP appears to be the main function. In this study, the smooth membranes were isolated from the heater tissue to determine if the membranes contain an ATP-dependent ion pump, capable of using the ATP for heat production. The close morphological relationship of the heater tissue to muscle has suggested that the endoplasmic reticulum might be similar to sarcoplasmic reticulum, and thus, rich in Ca-ATPase. The crude membrane preparations from heater tissue had about the same Ca-stimulated ATPase activity per gram protein as that from muscle. Ca uptake in the heater tissue ranged from 50 to 100% of the control eye muscle. In gel electrophoresis of tissue homogenates, the 105 kDa band corresponding to the Ca-ATPase, was more prominent in heater than in muscle tissue. Characteristic muscle proteins such as myosin are virtually absent in the heater tissue homogenates. This study suggests that Ca-ATPase is a very important component of the heater tissue.

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DISPERSAL OF HATCHED JUVENILES OF THE AMPHIPOD CRUSTACEAN MICRODEUTOPUS GRYLLOTALPA (COSTA) M. Kafka and B. Borowsky, Osborn Laboratories of Marine Sciences, Boardwalk & W. 8th St. Brooklyn, N.Y. 11224 and New York University, Washington Square, New York 10003

Most intertidal invertebrates have planktonic larval stages, which require many molts before the larva assume the adult form. A notable exception is the amphipod crustacea. Therefore, the mechanism of dispersal for one amphipod species was investigated in the laboratory. It was found that the newly hatched juveniles initially remain proximate to the maternal parent and then disperse gradually. This suggests that this amphipod does not disperse in the plankton.

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DIURNAL VERTICAL DISTRIBUTION OF DECAPOD LARVAE/POSTLARVAE IN THE CHESAPEAKE BAY, VIRGINIA, WITH EFFECTS ON DISPERSAL-RECRUITMENT MECHANISMS. R. C. Maris. Old Dominion Univ., Norfolk, VA.

The diurnal vertical distribution of 33 species of decapod crustacean larvae and postlarvae was studied from plankton samples collected at two stations located in the Chesapeake Bay, Virginia: bay mouth (36° 59'N, 76° 08'W) and York River mouth (37° 12'N, 76° 16'W). Neuston (0.10-0.15 m), 1 m, 3 m, 6 m and epibenthic (11 m) samples were collected at three hour intervals for 72 h, over six tidal cycles at each station. Both light and the tidal cycle were found to be important factors in vertical distribution, but temperature and salinity were not significant parameters. Most species concentrated at mid to lower depths during the day and exhibited various numbers in the upper depths at night according to species, stage of development and tidal phase. The estuarine species were classified as retained or expelled according to adult distribution and larval/postlarval vertical positioning. Interactions of distributional, dispersal and recruitment patterns are very complex with multiple factor effects, and not simply due to diurnal vertical migration or tidal rhythms.

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ECOLOGY OF JUVENILE HERMIT CRAB SHELL USE: FIELD AND LAB COMPARISONS. S. Gilchrist. New College, Sarasota.

Though hermit crab ecology has been studied for many years, little is known of shell use and selection by newly settled and juvenile crabs. Field studies of 3 species of hermit crabs provide information on initial shell use by newly settled crabs. Newly settled crabs of all 3 species do not appear to have specific preferences for shell type. These crabs often settle among rubble or seagrass bases. Juvenile crabs also inhabit a variety of shell types and sizes. However, shape variables become important factors near the molt size for sexual maturity.

Laboratory tests suggest that juvenile crabs will select shells never encountered in natural selection pools for the crabs. Continued use of such shells will change shell selection for the crabs over time to include only natural shells similar to those offered in the laboratory. Thus, it appears that early shell experiences may be important in determining adult shell use.

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ICONOGRAPHY IN THE COURTSHIP BEHAVIOR OF THE FIDDLER CRAB *UCA BEEBEI*. J.H. Christy. Smithsonian Tropical Research Institute, Apdo. 2072, Balboa, Republic of Panama.

Male *U. beebei* court from and defend burrows to which females come for mating. Males court by waving their single enlarged chelapod and, when a female is near, by raising it revealing its dark ventral surface as they enter their burrows. Most courting males construct arching pillars of mud about 2 cm high at their burrow entrances. Such structures may reduce overlap in the activity spaces of neighboring males and rates of aggressive interaction thereby providing each male more time to court and the opportunity to court without aggressive interference from its neighbor. Alternatively, pillars may function as visual guideposts that help females find a burrow entrance once a courting male has disappeared from the surface. Field observations of time budgets, space use, spacing and aggressive interactions among neighboring males and of the behavior of courting males and sexually receptive females support the latter explanation. Pillars appear to be icons of the visual image presented to females when a male raises its chelapod as it leads a female into its burrow.

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RELATIVE GROWTH IN CRUSTACEANS. N. W. Blackstone. The Academy of Natural Sciences, Philadelphia.

Crustaceans continue to be the first choice for studies of relative growth because: (1) their external form is precise and easily measured, (2) exuviation allows longitudinal studies of undisturbed individuals, (3) relative growth of externally recognizable parts dominates their ontogenies, and (4) regeneration provides insight into the developmental integrity of each part. These characteristics make crustaceans ideal for relating patterns of relative growth to processes of development. In this regard, a specific growth rate (length increment per time increment per absolute length) is useful when calculated over an entire molt cycle. Comparisons of specific growth rates of different parts provides more insight into relative growth processes than comparisons of the logarithms of length measures because the former gives the absolute relationship of specific growth rates, while the latter only gives the relative relationship. These results suggest that bivariate and multivariate analyses of distance measures provide insight into patterns rather than processes of relative growth and should be interpreted accordingly.

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GROWTH AND REPRODUCTION IN ADULT MALE STONE CRABS IN ON- AND OFFSHORE HABITATS. D. H. Wilber. Florida State Univ. Tallahassee.

On the northern gulf coast of Florida, offshore populations of adult stone crabs, *Menippe mercenaria* (Say), are comprised mainly of females (3.5F:1M) in the summer, whereas, concurrently on intertidal oyster reefs, males are predominant (1F:3M). Females spawn in the summer, however, molting (sexually receptive) females were observed offshore and were invariably guarded by a male. I examined the growth and reproductive states of males in the different habitats by determining their molt stages and sperm content levels.

Males occurring in offshore seagrass beds contained more sperm ($\bar{X} = 23.2 \times 10^6$ sperm/crab, $p < 0.0001$) than males on intertidal oyster reefs ($\bar{X} = 8.9 \times 10^6$). Sperm number was not correlated with crab size, however, adult males inshore were smaller ($\bar{X} = 79 + 13$ mm CW) than offshore males ($\bar{X} = 89 + 13$ mm CW, $p < 0.01$). Only 4.5% of the males at the offshore habitat were molting compared to 59.4% of the inshore males, a difference too large to be accounted for by the discrepancy in crab size alone. These data suggest an association between a male's reproductive state and proximity to potential mates may exist.

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INHIBITION OF LIMB REGENERATION AND ECDYSIS BY THE PARASITIC BARNACLE, *LOXOTHYLACUS PANOPAEI* IN THE MUD CRAB, *RITHROPANOP-EUS HARRISII*. J.J. O'Brien and D.M. Skinner. Biol. Div., ORNL, Oak Ridge, TN

Unparasitized (UNPZ) and parasitized (PZ) crabs were maintained on artificial seawater (20 ppt) at R.T.; their high survival rate makes them an excellent model system for use in labs without running seawater. UNPZ crabs of all sizes molted within 12-14 days following limb autotomy (LA; 6 walking legs); mean time to ecdysis for the control group was 40 days. This brings to 15 the number of crustaceans that have been induced to molt by LA. Data suggest that the 2nd molt following LA also occurred sooner. Since the largest UNPZ crabs formed limb-buds and molted following LA, it seems likely that there is no terminal ecdysis in this species. Parasite prevalence decreased with increasing host size, a pattern observed in other sacculinid-host associations. PZ crabs bearing the external stage of the parasite did not molt nor form limb-buds. Given the cessation of molting by ovigerous UNPZ crabs, it would be of interest to compare the response of ovigerous females to LA. (Supported by Seed Money and by Martin Marietta Energy Systems, Inc with the USDOE.)

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SEASONAL VARIATION IN EGG PRODUCTION AMONG SAND CRABS (*EMERITA ANALOGA*). A. M. Wenner, J. Dugan*, and D. Hubbard*. Univ. of California, Santa Barbara.

Estimates of egg number per female were determined volumetrically (by means of calibrated pipettes) for various sizes and ages of sand crabs throughout the season at different localities to discern the degree of variation present. As with other animals which have indeterminate growth, egg production as a function of size exhibited great variation. Separation of animals into either size or age classes facilitated data interpretation. Egg production within each year class appeared to be a semi-logarithmic function on any one date. Egg production within any size or age class increased until about the first of August and then declined. Apparently females within any size/age group have experienced a specific exposure to environmental circumstances (e.g., temperature regime and/or food supply), which dictates the number of eggs possible under those circumstances.

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ADAPTATION TO EPHEMERAL PONDS IN THE CONCHOSTRACAN *EULIMNADIA TEXANA*. C. Sassaman and S. C. Weeks*. Univ. of California, Riverside.

Eulimnadia texana is often common in very transient ponds in the southwestern United States. Laboratory studies on its life history indicate adaptations for colonizing coupled with rapid subsequent population growth. At 24 °C, maturity is reached 7 days after hydration of the encysted embryos. Growth in carapace length ceases at about 10 days and survivorship is to 15-20 days. Clutch size is related to female length and ranges from 50-400. Maximum length is inversely related to population density. Sex ratios in adults are strongly female-biased (80-90% females) and females reared in isolation from the nauplius stage to maturity produce viable progeny. Nevertheless, natural populations harbor substantial amounts of genetic variation, although deficiencies of heterozygotes at several loci suggest strong inbreeding. The mechanism of facultative selfing is unknown, but its existence allows the propagation of populations from single colonists. This feature of the life history may, in part, explain the diversity of species in the genus and the remarkable endemism of some of their distributions.

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INTERSTITIAL CELLS ARE REQUIRED FOR POLYP MORPHOGENESIS DURING METAMORPHOSIS OF HYDROZOAN PLANULAE. V. J. Martin. Univ. of Notre Dame, IN.

The role of interstitial cells and their derivatives in attachment and metamorphosis of cnidarian planulae was examined using hydroxyurea. Hydroxyurea was used to selectively reduce the interstitial cell population. Eight hour embryos of the marine hydrozoan *Paramecia tiarella* were cultured continuously for 1 to 7 days in 0.01 M hydroxyurea in seawater. Animals were processed for light microscopy at selected timed intervals and stained with Azure B. The number of interstitial cells, ganglionic cells, and nematoblasts was scored in treated animals and comparable controls. Embryos grown continuously in hydroxyurea remained healthy, attached, and underwent metamorphosis to form small upright partial polyps which lacked hypostomes, tentacles, and stolons. Upon removal of hydroxyurea the partial polyps developed within 2 days into normal primary polyps containing hypostomes, tentacles, and stolons. Hydroxyurea treatment reduced the interstitial cell and nematoblast population significantly in animals while the population of ganglionic cells was less affected. Treated planulae and partial polyps returned to normal seawater showed a recovery of all 3 cell types. The results from this study suggest that the interstitial cell population is required for primary polyp morphogenesis during metamorphosis of hydrozoan planulae, a role not previously reported in any cnidarian.

EVIDENCE OF A MICROTUBERCULAR CYTOSKELETAL LATTICE IN GLANDULAR CELLS OF HYDROZOAN PLANULAE. E.T. Walch and V.J. Martin, Univ. of Notre Dame, IN. Hydrozoan planulae of Pennaria tiarella and Podocoryne carnea were processed for transmission electron microscopy using diethylene glycol distearate (DGD). The DGD serves as a removable embedding medium to produce embedment-free sections of intact planulae. The technique allows for sections to be examined without the electron scattering effects of plastic embedding resins which often obscure thin fibrous elements within the cytoplasm of cells and also enables much thicker sections to be examined, thus providing a more 3-dimensional view of cellular contents. Images of glandular cells obtained using embedment-free sections were compared with those from conventional Spurr-embedded sections. In unembedded sections a large number of thin anastomosing fibers are observed throughout the cytoplasm of the glandular cell. Such fibers are not seen in Spurr-embedded sections. The fibers appear to coalesce in certain areas to form thick fibers that partition the glandular cytoplasm into spherical subunits. The lattice of fibers is 3-dimensional as evidenced by stereopairs. The lattice is composed of microtrabeculae, microfilaments, and intermediate filaments. Mitochondria are suspended within and attached to the network of fibers thus indicating the cytoskeletal role of the fibers. This study documents the presence of a cytoplasmic fiber system within cells of intact invertebrate larvae.

EFFECTS OF NICOTINE ON THE DEVELOPMENT OF A STEM CELL POPULATION IN HYDROZOAN PLANULA LARVAE. K.J.S. Kolberg and V.J. Martin, Univ. of Notre Dame, IN. Interstitial cells of cnidarians provide an ideal model system in which to examine the effects of toxic substances on cellular differentiation and development. Interstitial cells differentiate into nematoblasts and ganglionic cells and divide to replenish the stem cell population. The three cell types are easy to distinguish histologically. Embryos of Pennaria tiarella were exposed to three dosages of nicotine either at gastrulation or at 24 hours postfertilization. Animals were fixed immediately after treatment or after various recovery periods. Embryos were serially sectioned for light microscopy and stained with saure B. The number of ganglionic cells, interstitial cells, and nematoblasts were scored in treated and control planulae. The ratio of interstitial cells:ganglionic cells:nematoblasts was significantly different in treated planulae when compared with comparable controls. In treated embryos an increase in nematoblast differentiation was accompanied by a decrease in the interstitial stem cell population. The number of nematoblasts migrating from the endoderm to the ectoderm was increased in treated embryos. These data suggest that nicotine does affect stem cell differentiation during development. This study represents the first attempt to document the effects of nicotine on the differentiation and development of a stem cell population.

SECRETORY CELL RESYNTHESIS AND REPLACEMENT IN HYDRA FOLLOWED USING TRITIATED URIDINE AND TRITIATED THYMIDINE. I. Kessler, College of St. Elizabeth, Convent Station, N. J.

Population dynamics of secretory cells in Hydra were followed after being depleted by feeding. At various times after feeding animals were labeled with tritiated uridine or tritiated thymidine and fixed for histological study. The population sizes of labeled and unlabeled cells were determined for each stage of secretory cell development. A broad peak of uridine incorporation was observed between 3 and 6 hours after feeding. A smaller peak was found at 13 hours. Thymidine incorporation gradually increased to 15 hours then dropped off. A comparison of the magnitude of these cell populations indicate that resynthesis rather than replacement is the major pathway for reestablishing the mature secretory cell population after its depletion during feeding.

DEFINING COMMITMENT AND COMPETENCE IN LEPIDOPTERAN IMAGINAL DISKS BY HORMONAL TREATMENT. C. Kremen and H.F. Nijhout, Duke University, Durham, N.C.

Juvenile hormone (JH) maintains the imaginal disks of lepidopterans in an undifferentiated state during larval life; its absence during a critical period early in the last instar allows disks to become committed to metamorphose. Disk metamorphosis then occurs at the end of the instar in response to release of ecdysterone (EC). Only disks from late last instar larvae are competent to respond to EC. It is not known whether commitment, the irreversible restriction to a particular developmental fate, and competence, the ability to respond to a particular differentiative cue, are causally or temporally distinct phenomena in imaginal disks. To examine this issue, I applied either JH or EC to staged larvae of Manduca sexta and Precis coenia. When JH is applied to early last instar larvae, only disks which are already committed to pupal development initiate metamorphosis at the next molt. Similarly, EC injected into last instar larvae provokes a premature metamorphic molt, but only competent disks can participate in it. Thus the use of these hormones allows the definition of the critical periods for commitment and competence in imaginal disks.

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POPULATION DYNAMICS, DIET, AND MOVEMENT OF BLUE CRABS IN A SUBESTUARY OF CHESAPEAKE BAY. A.H. Hines and K.L. Comtois. Smithsonian Environmental Research Center, Edgewater, MD.

Abundance and population structure of *Callinectes sapidus* in 5 years of monthly otter trawls showed distinct seasonal cycles and significant annual variation. Crabs were abundant from June through September; size and sex composition changed during the season. Stomach contents indicate crabs prey primarily on infauna with a high percentage of clams; but contents were more diverse in June after infaunal recruitment than September indicating crabs also fed opportunistically. Exclusion of crabs by cages significantly increases clam survivorship. Speed and orientation of free-ranging crabs were tracked with ultrasonic telemetry. Mean speed was 15m/hr but ranged from 0-325 m/hr. Crabs spent about 2 weeks foraging haphazardly within the subestuary before moving rapidly back into the Bay. Male and juvenile crabs appear to move up into salt creeks to molt, while females remain in the subestuary for the pubertal molt. This study shows the importance of shallow embayments in the population biology of blue crabs.

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FORAGING BEHAVIOR IN BLUE CRABS: ULTRASONIC TELEMETRY OF FEEDING MOVEMENTS. T. G. Wolcott and A. H. Hines. NC State Univ., Raleigh, and Smithsonian Environmental Research Center, Edgewater, MD.

We have developed an ultrasonic transmitter to determine the timing and location of feeding by free-ranging blue crabs (*Callinectes sapidus*). We telemeter biopotentials of the mandibular musculature, an unequivocal indicator of mastication. Number of bites and length of feeding correlated roughly with size of prey items in laboratory tests. In a 4-day field trial, a crab released into a subestuary of the Chesapeake Bay was readily tracked and feeding easily quantified. No periodicity was distinguishable in either movement or feeding, and the number of bites per feeding bout followed a Poisson distribution, suggesting that foraging by the blue crab is highly opportunistic. This method can be adapted to telemeter any vertebrate or invertebrate behavior that can be linked to a specific muscle group.

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DIEL ACTIVITY AND FORAGING PATTERNS IN *HEMISQUILLA ENSIGERA CALIFORNIENSIS*. J.M. Engle¹ and L.V. Basch^{1,2}. Channel Islands Research Program, Avalon CA, and Ft. Loma Biology Laboratory, San Diego CA.

Hemisquilla ensigera californiensis is a large, highly active predator ranging from Southern California and the Channel Islands to Baja California Sur, Mexico. Preliminary studies indicate that *Hemisquilla* dwell in burrows in stable sand communities at depths from 5m to >30m. When open, burrows are often circled with invertebrate hard body parts. During inactive (=non-foraging) periods in one diel cycle, burrows were frequently capped with a 2-5cm thick sand plug. In one population (n=13) >50% of burrows were capped during daylight and ca. 100% were capped at night. Based on no. of open burrows, >50% of the population was active from 0400-0830h and from 1600-2000h. During the 2 crepuscular activity peaks, animals heads were often above the entrance observing the surround. Individuals forage throughout diel cycles but this activity peaks 1-2h prior to both sunrise and sunset. Foragers move to 60m from burrows and feed on >7 taxa. Foraging movement rates range from 1m to >7m·min⁻¹. Animals stop for prey locating, fossorial foraging, or for avoiding bioluminescence. Evidence suggests that *Hemisquilla* cause significant bioturbation and predation.

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SPATIAL AND TEMPORAL DISTRIBUTIONS OF GRASS SHRIMP LARVAE (*PALAEMONETES* SPP) IN A HIGH SALINITY SOUTHEASTERN ESTUARY. D.M. ALLEN AND D.L. BARKER*. UNIV OF SOUTH CAROLINA, GEORGETOWN.

Zooplankton collections were made in tidal creeks and coastal areas at North Inlet, SC to determine the lateral and vertical distribution of larval stages of *Palaemonetes pugio* and *P. vulgaris*. Throughout the spring and summer reproductive period first stage zoeae were most abundant near the surface and final stages (7 and 8) dominated near-bottom collections in shallow, well mixed, creeks. Intermediate stages rarely occurred anywhere within the estuary, but were present in the ocean. Short term studies to assess patterns of abundance as a function of tidal stage, time of day, and lunar phase indicated: (1) periodicity in the release of larvae, (2) a rapid movement of early stages to the ocean, and (3) a repenetration of late larvae to adult habitats in marsh creeks. The mechanism by which various stages move between the estuary and ocean probably involves stage specific behavioral responses to regular tidal patterns. This study is supported by the Long Term Ecological Research Program (NSF-DEB-8012165).

INVASIONS OF SOUTHERN MARINE FAUNA INTO CAPE ANN, MASS., DURING PERIODS OF WARMER SEA WATER. R.W. Dexter. Kent State Univ., Ohio.

Between 1952-64, 8 spp. of invertebrates and 12 spp. of fishes were found north of their usual range at times of warmer water at Cape Ann as follows: polychaete-Lepidametria commensalis; gastropods-Polinices duplicatus and Urosalpinx cinereus; amphipod-Orchestia uhleri; decapods-Callinectes sapidus, Ovalipes ocellatus and Uca pugnax; sea urchin-Cidaritis tribuloides; sea horse-Hippocampus hudsonius; rudder fish-Seriola zonata; mackerel scad-Decapterus macarellus; hardtail-Caranx crysos; Saurel-Trachurus trachurus; common sea robin-Prionotus carolinus; stripped sea robin-P. evolans; sea bass-Centropristis striatus; Kingfish-Menticirrhus saxatilis; leather-jacket-Oligophites saurus; shark sucker-Echeneis naucrates; and puffer fish-Sphaeroides maculata.

THE POPULATION STRUCTURE OF A TROPICAL MYTILID FROM TWO DIFFERENT INTERTIDAL ENVIRONMENTS. T.L. Smalley. Univ. Hawaii, Honolulu.

The population structure and dynamics of the mussel Brachidontes crebristriatus exhibits differences between two major intertidal habitat types: the shoreward margin of wide fringing reef flats and the protected backwaters of embayments. Population density, mean shell length, and flesh dry weight differ between populations from the two habitat types - being greater for bay populations. Furthermore, the 3-dimensional growth form of these populations differ between habitat types. On fringing reef flats individuals occur in a single layer, embedded in an algal turf. In bays individuals may occur in a single layer or hummock, forming sheets several individuals thick. Reproductive activity and recruitment occur throughout the year with at least one major peak from Dec. to Feb. Between habitat differences in reproductive activity and recruitment also occur - bay populations having a greater reproductive potential and greater recruitment. It is suggested that these differences can be explained by between site variability in environmental features such as food availability, wave impact, and structural features of the habitat.

CATASTROPHIC MORTALITY IN SUBTROPICAL LIMPETS. S. B. Cook and C. B. Cook, Bermuda Biological Station, Ferry Reach.

On sheltered shores, physical stresses during springtime low tides in Bermuda have dramatic effects on the demography of the pulmonate limpet Siphonaria alternata. In 1980 and 1985, one-half of a population at John Smith Bay vanished when daytime low tides coincided with stressful physical regimes (strong winds in April 1980; 2 weeks of very low tides and continual aerial exposure in May 1985). Death due to water loss at low tide was indicated by 1) desiccated and loosely attached animals and 2) earlier mortality in drier areas and among 3-5 mm. recruits. Size-frequency data from the intervening 4 years indicate that such spring-summer die-backs occur annually but vary in magnitude and timing. During "good years", clearcut evidence for catastrophic spring-summer declines was confined to the sheltered shore at Smith's Bay, but during the stressful periods of 1980 and 1985, increased mortality was also seen at Spittal Pond, a more wave-swept and wetter site. (Supported by the Center for Field Research and EPA grant R811318).

DESICCATION AND THERMAL STRESS AS A POSSIBLE EXPLANATION FOR THE SHIFT IN SHELL COLOR AMONG POPULATIONS OF THE INTERTIDAL SNAIL NUCELLA LAPILLUS DIFFERENTIALLY EXPOSED TO WAVE ACTION. R.J. Etter. Harvard Univ., Cambridge, MA.

The intertidal snail N. lapillus exhibits considerable variation in shell color among populations differentially exposed to wave action. Snails from shores of high wave energy are dominated by brown morphs and are highly polymorphic while those on protected shores are monomorphically white. Measures of tissue temperatures, rates of water loss and mortality on dark and white morphs indicated that white morphs had lower tissue temperatures, lost less water and experienced lower mortality than dark morphs. Since snails on protected shores tend to experience higher temperatures and greater desiccation, white morphs may be selectively favored on protected shores because they have a higher reflectance for incident solar radiation which may in turn reduce water loss and/or mortality.

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GEOGRAPHIC VARIATION IN INTERTIDAL EMERSION GRADIENTS AND SPECIES ZONATION PATTERNS. W. H. Brake. Loyola College, Baltimore, MD.

A computer program that predicts tides from published harmonic constants and compiles statistics on the duration and frequency of emersion as a function of elevation was developed for a detailed analysis of geographic variation in intertidal emersion gradients. One year of tide predictions (computed at 15-minute intervals) for 4 localities with tidal curves ranging from diurnal to mixed and to semidiurnal, were analyzed after elevations had been normalized to facilitate comparison. Mean emersion time and the number of dry intervals increased monotonically with increasing elevation for all locations. However, mean emersion time at any given standardized elevation varied as much as twofold among the locations. Graphs of the annual maximum emersion time as a function of elevation revealed sharp discontinuities that occurred at very different elevations depending on locality. The implications of these differences in emersion gradients for biogeographic trends in intertidal zonation require further investigation.

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FINE STRUCTURE OF THE REPRODUCTIVE CYST WALL OF HYALOPHYSA CHATTONI (CILIOPHORA, APOSTOMATIDA). N. RIVAUD. North Carolina State University, Raleigh.

Electron microscopy and cytochemistry were used to investigate the visible structure, components, and stages of secretion of the reproductive (tomont) cyst wall of Hyalophysa chattoni and compare them with the phoretic cyst wall of the same species and with other ciliate cyst walls. Initially, a thick amorphous cell cover appears on the precystic swimming ciliate. Layers of cyst wall are added to it as the organism settles. The mature cyst wall consists of an inner granular and an outer fibrillar layer. The outer is often subdivided into a more compact inner and an almost amorphous outer component. Material identified as mucopolysaccharide persists between the pellicle and the wall. Cilia remain throughout encystment, pressed against the surface and immobilized by pellicular folds. The cyst wall is not secreted by mucocysts as in some other ciliates. The tomont wall lacks the paracrystalline component of the phoront wall. Unlike the phoront, the tomont is immobile within its cyst wall. The cyst walls of Hyalophysa lack the well defined layers of hypotrich cyst walls. In this they resemble the cell cover of suctorians.

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A LIGHT AND ELECTRON MICROSCOPE STUDY OF EIMERIA NECATRIX. J. B. Mitchell and E. Sweterlitsch*, Moravian College and Thomas Jefferson University.

Both asexual and sexual stages were analyzed in this work. Large schizonts were located in the connective tissue of the small intestine of the bird. Microgamete development was first observed when peripheral nuclei and a small amount of cytoplasm protruded into a parasitophorous vacuole. Immature macrogametocytes also formed within a vacuole. Two types of wall-forming bodies were observed and their role in oocyst formation was studied.

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THE ULTRASTRUCTURE OF RESPIRATORY ORGANS OF JUMPING SPIDER, PLEXIPPUS PAYKULLI, AUDOVIN (ARANEAE, SALTICEDAE). S.M. Laliwala and A. B. Vyas. St. Xavier's College, Gujarat, India, and Rutgers' Univ., New Brunswick, N.J.

There is a great deal of variation in the respiratory structures of spiders. In Plexippus paykulli, these organs comprise a pair of book lungs and a pair of tracheae. The basic plan and functional morphology of book lungs of this spider, confirm with those observed in other species of spiders. Stereomicrographs by scanning electron microscopy of book lungs of P. paykulli clearly demonstrate communications of intralamellar space with haemolymphatic sinuses. The ultrastructure of the chitinization of the lamellar surface shows unique pattern for the species. Tracheal system on the other hand, is well developed and branched. Scanning electron micrographs reveal that tracheae have annulated structure.

A COMPARISON OF THE DISC AUTOTOMY REGIONS
IN FOUR SPECIES OF OPHIUROID ECHINODERM.

William E. Dobson, University of South
Carolina, Columbia.

Recent research indicates that echinoderm autotomy probably is effected by secretions from special juxtaligamental cells associated with the mutable collagenous tissues (MCT) of the autotomy region. The morphology, histology, and tissue ultrastructure of the disc autotomy regions of Micropholis gracillima and M. atra were compared to homologous regions in the non-autotomizing species Ophiothrix angulata and Hemopholis elongata, using light microscopy, TEM, and SEM. M. gracillima and M. atra have disc autotomy regions identical to those found in Ophiophragmus filigraneus (Dobson, 1983. Amer. Zool. 23: 1026), with thick MCT ligaments and associated juxtaligamental cell layers between each of the ten genital bars and their associated lateral arm plates. These tissues disintegrate during the autotomy process. The homologous regions of O. angulata and H. elongata contain thick connective tissue ligaments, but no juxtaligamental cells. The results indicate that juxtaligamental cells are found only in those species that can autotomize. These cells appear to be an integral part of the MCT. Supported by a G.I.A.R. from Sigma Xi, The Scientific Research Society

THE TUBE-BUILDING COPEPOD PSUEDOSTENHELIA
WELLSI: MORPHOLOGICAL STUDIES. J.

Williams-Howze, Louisiana State Univ.,
Baton Rouge.

Pseudostenhelia wellsii a meiobenthic harpacticoid builds tubes in estuarine sediments. The copepods' external and internal morphology is described with reference to tube building. Scanning electron microscopy (SEM) showed large pores on the last abdominal segment and caudal rami. These secretory pores are associated with regions of mucus and lipid storage as revealed by light microscopy. Large membrane bound storage "sacs" of lipid material are found in the abdominal segments, and acid mucopolysaccharide sacs (mucin) are found in the caudal rami. These appear to be the major storage sites of material used for tube-building. Transmission EM reveals multicellular glands, of secretory structure, enclosing the storage areas. PAS and lipid assay on the tube show that mucin and lipid are involved in tube construction. A comparison of P. wellsii and two confamilials, Stenhelia paulstris, another known tube-builder, and S. (D.) bifidia, a non-tube-builder, using SEM, is given. The tube builders have large pores, similar in size and placement, while the non-tube builder has few, tiny pores.

SHELL SHAPE AND LOCOMOTION IN GALAPAGOS
TORTOISES: AN EVOLUTIONARY MODEL. R.W.
Marlow, Dept. Medicine, Dalhousie Univ.,
Halifax, Nova Scotia, Canada.

Variation in shell shape among island populations of Galapagos tortoises, as an example of adaptive radiation has been an important and misunderstood case. Attempts to explain the pattern of shell shape variation have failed. Tortoises were filmed walking on even and uneven ground. Kinematic data converted to link-segment models demonstrate significant differences in the angular relationships of segments during a gait cycle between tortoises with small anterior openings (domes) and those with large openings (saddlebacks). Saddlebacks have a wider range of forelimb movement because of elevation of the anterior carapace and the resulting shift in orientation of the pectoral girdle. Mechanical energy analysis suggests that locomotion over open, even or uneven terrain is more efficient for saddlebacks than domes. Domes are more efficient in dense vegetation. This is consistent with a model of shell shape evolution favoring saddlebacks, or rapid evolution of that shape, as colonists of newly emergent volcanic islands (uneven ground, sparse vegetation) and domes on mature islands (even ground, dense vegetation).

MORPHOLOGICAL AND BEHAVIORAL ASPECTS OF
THE LOCOMOTION OF THE LIZARD OPHISAURUS
APODUS. C. Gans and J.-P. Gasc, Lab.
Anatomie Comparée, Mus. Nat. Hist. nat.
Paris, France.

Nine specimens of a 3:1 range of mass were filmed while being subjected to sequences in varying combinations of standardized locomotor tasks including passage of parallel-sided channels, substrates with varying coefficients of friction and smoothness and peg-fields of various spacings. The lizards traverse smooth surfaces utilizing variants of concertina (slow) and slide pushing (fast) movement. Peg spacings are traversed by variants of lateral undulant movements. Perfect lateral undulation occurs for a relatively limited range of peg spacings; wider spacings involve continuous change of the points d'appui utilized. The sliding friction of the substrate affect the sites against which the animal pushes. Parallel-sided tunnels are passed by a regular concertina with the curves starting at the neck and continuing onto the tail without interruption. Portions of the ventral armor may be depressed against the ground (in slide pushing) but (literature statements to the contrary) no horizontal movement is used to effect digging. Supported by NSF DEB 8121229.

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STRUCTURAL-FUNCTIONAL ASSOCIATIONS IN PROSIMIANS: LOCOMOTION, ENVIRONMENT AND DIET. C.E. Oxnard, R.H. Crompton*, and S.S. Lieberman. Univ. of Southern California, L.A., and Chinese Univ. of Hong Kong.

The relationship between structure and function in primates has often been investigated using complex morphometric analyses of structure but compared to only rather simple classifications of function. Attempts are made here to quantify aspects of function: locomotion, environment and diet in prosimians, and to use, on the resulting data, similar multivariate statistical methods. Though not so easy to measure, function is as easily analysed as is structure. Groups of species are readily recognized that make biological sense both from the functional standpoint itself, and when compared with appropriate morphometrics. For instance, the various tarsiers, indriids and lorises are each as clearly demarcated functionally as they are structurally. And within the groups identified, a spectrum of associations is evident that is related to smaller within-group functional and structural differences. Such studies allow the functional side of the functional-structural equation to be as fully understood as the structural. Supported by NIH BRSG and USC FRIF funds to CEO.

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KINKAJOU (POTOS FLAVUS) LOCOMOTION. Deedra McLearn. College of Veterinary Medicine, Cornell Univ., Ithaca. Light films were taken of two newly captured, freely-moving kinkajous. Light films and radiographic films were made of these animals and one other trained to run on a treadmill. Several distinctive features of kinkajou locomotion include: 1) use of a variety of footfall patterns (up to four) at walking speeds, with a predominance of a diagonal sequence, diagonal couplets gait (LH RF / RH LF); 2) lateral flexion and extension of the trunk; 3) rapid extension of the wrist and abduction of the digits just prior to forepaw contact with the ground; 4) restricted excursion of the tibia such that it does not swing out past the vertical plane. None of these characteristics is shared with other procyonids examined (coatis and raccoons), but may be seen in other highly arboreal animals; e.g., koalas, lemurs, silky anteaters, and Tamandua anteaters use the diagonal sequence, diagonal couplets gait at walking speeds. These data suggest that the kinkajou footfall pattern is not "hard-wired" neurally and, furthermore, that similar locomotor behaviors are more likely to be convergent with those of arboreal animals in other taxa rather than shared with more closely related carnivores. Supported by NSF DEB 79-09797 and NIH 5T 32 GM07117-05.

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FORELIMB MORPHOLOGY, LOCOMOTOR DIVERSIFICATION AND MORPHOLOGICAL CONSTRAINTS IN PANGOLINS. J. A. Sherman. U. of Chicago.

The forelimb morphology of pangolins was examined as part of an extensive morphometric study of edentates, pangolins and aardvark. The locomotor behavior of pangolins ranges from nearly totally arboreal for the smallest species to exclusively terrestrial for the largest species. Pangolins do not show any pattern of variation in their forelimb skeleton, independent of size, that can be related to differences in locomotor habits. Unlike edentates and other groups of mammals for which regular patterns of variation in the shape of limb elements, independent of body size, have been documented and related to locomotor habits, pangolins are arranged according to their locomotor behavior only when parameters which are highly correlated with body size (e.g., the first principal axis of analyses on log-transformed linear dimensions) are used. This suggests that the limb morphology of pangolins is versatile but may be subject to constraints not present in other groups of mammals, probably due to the (primitive) loss of the clavicle.

Supported, in part, by NSF.

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ENERGY OF THE OSCILLATING LEGS OF HORSES. M. Hildebrand. Univ. of California, Davis.

The average and maximum kinetic and potential energy of the legs was determined for two horses moving at a range of speeds for each natural gait. For the hind leg there is less energy in the system at the trot than at a walk of the same speed. No change in level of energy could be attributed to gait for the foreleg at the walk-trot transition, or for either leg at the trot-gallop transition. At the trot there is an arrest of the proximal segment of the foreleg midway in the fore swing which transfers angular velocity to the middle segment. The proximal segment reaccelerates as the extension of the middle segment nears completion.

BIOMECHANICAL IMPLICATIONS OF MAMMALIAN LOCOMOTOR-RESPIRATORY COUPLING. D.M. Bramble, Univ. of Utah, Salt Lake City.

That the locomotor and respiratory cycles of running mammals are tightly coupled (typically at a 1:1 ratio) has prompted a search for the structural/functional basis of such an integration. Preliminary findings indicate that by (1) linking respiratory frequency to stride frequency and (2) tidal volume to stride length, running mammals may have a simple strategy for accurately matching the level of lung ventilation to running speed and metabolic demand. Additionally, several mechanisms, not operative in the standing animal, are likely to contribute significantly to ventilatory mechanics. Among these are the inertial displacements of a "visceral piston" of which the liver is the dominant component. The existence of such a piston is suggested by anatomical detail, locomotor and respiratory dynamics and the allometric scaling relationships of both morphological and physiological variables. The operation of such a visceral piston could help to explain constraints on stride frequency in galloping mammals.

PHYLOGENY AND ONTOGENY OF GROSS SPINAL CORD MORPHOLOGY IN ANURAN LARVAE. K.C. Nishikawa and R.J. Wassersug, Dalhousie Univ., Halifax, N.S.

At metamorphosis, anurans undergo a profound change in mode of locomotion from axial, undulatory swimming to appendicular saltation. The spinal cord also changes ontogenetically; being elongate and fish-like in early development and shorter, with a cauda equina, in the adult. We examined the gross morphology of larval spinal cords from 28 anuran species (15 families), selected because of their phylogenetic and behavioral diversity. Prior to metamorphosis, tadpoles exhibit two major spinal cord patterns that follow recognized evolutionary grades in the Anura. Mature larvae of archaic families (e.g., Ascaphidae, Pipidae & Discoglossidae) have an elongate spinal cord extending far posterior into the tail. In contrast, comparably staged larvae from advanced families (e.g., Ranidae, Hylidae) have a cauda equina, like the adults, but with a longer *filum terminale*. There appears to be an evolutionary progression toward ontogenetically earlier appearance of the adult spinal cord pattern as one goes from generalized to derived Anura. [This research was supported by the Natural Science and Engineering Research Council of Canada.]

SNAKE PITUITARY IMMUNOCYTOCHEMISTRY. G.Z. Wurst and A.K. Pearson† Weber State College, Ogden, UT and Univ. of California, Berkeley.

Immunocytochemical methods accurately identify cellular origins of various substances, including pituitary hormones. The technique has been applied to some reptilian pituitaries, but snakes have received little attention. We investigated the distribution of pituitary cell types in the snake *Thamnophis* using immunocytochemical methods and have correlated our observations with previous tinctorial studies. The strongly-staining acidophilic cells in the anterior pars distalis include both adrenocorticotropes and lactotropes; the large areas of chromophobic cells in the posterior of the gland are primarily somatotropes. The basophilic glycoprotein hormone-producing cells (thyrotropes and gonadotropes) are distributed throughout the pars distalis in narrow bands which surround clusters of somatotropes in the posterior pars distalis and adrenocorticotropes and lactotropes in the anterior of the gland. This cellular organization of the basophils differs from that described in other reptiles.

BRAIN DISTRIBUTION OF GONADOTROPIN-RELEASING HORMONE (GnRH) CONTENT IN FEMALE GOLDFISH: SEASONAL VARIATION AND PERIOVULATORY CHANGES.

K.L. Yu, C.S. Nahornial*, R.E. Peter, A. Corrigan*, J.E. Rivier*, W.W. Vale*.

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Seasonal variation and perioovulatory changes in brain GnRH content of female goldfish were determined by a radioimmunoassay specific for salmon gonadotropin-releasing hormone (GnRH). Immunoreactive GnRH is widely distributed goldfish brain, the highest concentrations being in pituitary and olfactory bulbs. The GnRH content (pg GnRH/brain fragment/gonad-free body weight) in certain brain areas (olfactory bulbs, hypothalamus, optic tectum-thalamus, spinal cord and pituitary) varied with season and were highest during the time when the gonad was regressed (except for spinal cord). Significant differences in GnRH concentration of certain brain areas (olfactory bulbs, telecephalon, hypothalamus, optic tectum-thalamus and pituitary) between ovulatory and nonovulatory fish were found primarily before and shortly after (1-3 hrs.) ovulation. GnRH neuronal system may function as an integrated unit for the activation of pituitary gonadotrophs during ovulation in goldfish.

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OVARIAN MATURATION IN FUNDULUS HETEROCLITUS: PHOTOPERIOD AND LIGHT INTENSITY EFFECTS. M. H. Taylor, L. L. Hyde*, E. J. Platt and J. R. Day. Univ. of Delaware, Newark, Univ. of California, Berkeley and Univ. of California, Santa Cruz.

Long days are an effective stimulus for gonadal maturation in female Fundulus heteroclitus. As is typical of "photoperiodic" species, it is the timing rather than the duration of the light exposure which is critical to its effectiveness. Ovarian maturation was greater in fish receiving a maximum of six hours of light per day for six weeks in winter if the light was presented alternately in the subjective day and night of the fish. However, maturation was more complete in fish which received more frequent light exposure. The possibility that the amount of light received influenced maturation was tested by varying intensity and duration. Higher light intensities produced more effective maintenance of mature ovaries and more complete recrudescence of immature ovaries in fish exposed to LD 15:9. Ovulated eggs were found in fish maintained at intensities as low as 0.1 lu/m² but not in those maintained at 0.01 lu/m². Photoperiod lengths in excess of 12 hours are necessary for maintenance of ovarian maturation. This finding is in contrast with previous observations of recrudescence on shorter photoperiods.

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EFFECT OF STEROIDS ON FUNDULUS HETEROCLITUS FOLLICLE MATURATION IN VITRO. M.S. Greeley, Jr., D.R. Calder*, M.H. Taylor and R.A. Wallace. Univ. of Florida, Whitney Lab., St. Augustine, and Univ. of Delaware, Newark.

The effects of several steroids on F. heteroclitus follicle maturation in vitro are examined. At relatively high concentrations (1.0ug/ml) a number of steroids are able to effectively induce germinal vesicle breakdown in prematuration oocytes, including pregnenolone, corticosterone, cortisol, 11-deoxycorticosterone, 11-deoxycortisol, testosterone, progesterone, 17 α -hydroxyprogesterone, 20 β -dihydroprogesterone and 17 α -hydroxy-20 β -dihydroprogesterone. Cholesterol and 17 β -estradiol are ineffective. 11-Oxygenated steroids tend to be less effective than their 11-deoxysteroid counterparts. Steroids with a 20 β hydroxyl group (17 α -hydroxy-20 β -dihydroprogesterone and 20 β -dihydroprogesterone) are the most potent initiators of maturation, with partial activity at 1.0 ng/ml. These results suggest a possible physiological role for a 20 β -dihydroprogestin in the resumption of meiotic maturation in this teleost.

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THE RELATIONSHIP OF SOME STEROID HORMONES AND THEIR GLUCURONIDES TO THE TERMINAL STAGES OF OOCYTE MATURATION IN LANDLOCKED ATLANTIC SALMON. Y.P. SO* and D.R. Idler. Marine Sciences Research Laboratory, Memorial University of Newfoundland, Canada.

Peripheral serum levels of free and conjugated steroids were correlated with seven terminal stages of oocyte maturation in female salmon. 17 α ,20 β -dihydroxy-4-pregnen-3-one increased progressively from oocyte stage 1 to 6, with the glucuronide predominatively in stages 1 to 4 and the free steroid in stages 5 to 7. Pregnenolone levels were maximal at stage 1, followed by a surge in testosterone after initiation of germinal vesicle migration. Their glucuronides were always lower than the corresponding free forms. Progesterone, 17 α -hydroxy-pregnenolone, 5-pregnene-3 β ,17 α ,20 β -triol were not detected in the serum during final maturation. The present *in vivo* and *in vitro* study suggests that testosterone and its metabolites and pregnenolone stimulate germinal vesicle migration whereas 17 α ,20 β -P brings about germinal vesicle breakdown.

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OVARIAN CONTRACTIONS OF FUNDULUS HETEROCLITUS. S.M. Winner and M.H. Taylor. Univ. of Delaware, Newark.

Spontaneous contractions have been observed in ovaries of F. heteroclitus in vitro. These contractions have a frequency of 0.28 \pm 0.9/min (\bar{x} + SE, n=5) and amplitudes of 0.53 \pm .04 g (\bar{x} + SE, n=5). Acetylcholine (ACh), arginine vasotocin (AVT), oxytocin (OXY), and isotocin have been tested for ability to induce or modify ovarian contractions. Ovaries were suspended in a Ringer's-filled organ bath and connected to a strain gauge for tension measurements. ACh consistently resulted in dose-dependent (10⁻⁷ to 10⁻⁴ M) increases in tension. These contractions were not dependent on the reproductive state of the ovary. Contractions of lesser magnitude were seen with AVT and OXY but not with isotocin. AVT was effective in the range of 60.0 ng/ml to 1.2 ug/ml. OXY (0.01 IU/ml to 1.0 IU/ml) was less effective. None of the drugs tested modified spontaneous contractions. These contractions might facilitate egg release during spawning or function to move eggs within the ovary.

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AN INVESTIGATION OF ESTROGEN-BINDING ACTIVITY IN GOLDFISH LIVER AND PLASMA. J. Hannum and R. McPherson. Clarion University, Clarion, PA.

Estrogen-binding activity was investigated in nuclear salt extracts of liver from sexually mature female goldfish, Carassius auratus. Salt extracts of nuclei were found to contain high affinity ($K_d=3.42\text{ nM}$) and low capacity binding sites (.42 pM/g tissue). The binding sites were specific for estrogens, no significant competition by 5 α -DHT, progesterone, or cortisone was observed. A saturable binding component was also investigated in the plasma. This binder was found to have distinctive differences in regard to structural specificity compared to the estrogen-binding activity of the liver. It was found to have no affinity for DES while having affinity for both 5 α -DHT and progesterone. The goldfish liver estrogen-binding component was observed to have characteristics in common with estrogen receptors found in other vertebrates.

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EFFECTS OF PRL AND GH ON SECRETION OF PRL-SYNERGIZING ACTIVITY (SYNLACTIN) BY THE LIVER OF POSTMETAMORPHIC GRASS FROGS. B.C. Delidow and C.S. Nicoll. Univ. of California, Berkeley.

It has been shown that liver of bullfrog tadpoles releases prolactin-synergizing activity (synlactin), while that of adult frogs does not (Am. Zool. 24:117A). We investigated hepatic release of synlactin in young grass frogs (Rana pipiens) after treatment with PRL or GH. They were given daily injections of 10ug/g GH or 10ug/g PRL, or the solvent (0.1N NaHCO₃) for 10 days. Animals were killed 24hr after the last injection and the liver sliced, washed and incubated 3hr in 70% Medium 199. Liver incubation media (LIM) were dialysed and tested for PRL-synergizing activity in the pigeon crop-sac bioassay. Only GH increased shin length and body weight in frogs, but only LIM from PRL-treated frogs contained synlactin activity. We conclude that in young frogs PRL, but not GH, can stimulate the liver to secrete synlactin, though GH alone was able to promote growth. Similar experiments on R. pipiens tadpoles are in progress. Supported by NSF grant PCM 8203583 and NIH training grant T32-GM-7379.

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STRESS HORMONES AND TESTIS FUNCTION IN AN AMPHIBIAN. S.K. Boyd and F.L. Moore. Oregon State Univ., Corvallis.

To determine whether corticosterone (CS) directly modulates testis function, testes from Taricha granulosa were treated in vivo or in vitro with CS. In the first experiments, testes were incubated in vitro with various doses of CS and/or ovine LH. Measurements of androgen (T + DHT) in the medium indicated that LH-stimulated androgen synthesis was not affected by CS. In another experiment, males were injected ip with CS or saline or were untreated for 9 days. When testes from these males were incubated in vitro with ovine LH, it was found that testes from untreated males produced more androgen in response to LH than did testes from CS-injected males or saline-injected controls. Results of in vitro incubations, therefore, provide no evidence that CS directly inhibits testicular function. Some other unidentified stress hormone may act directly on the testis to suppress androgen production.

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INFLUENCE OF SOCIAL CUES ON THE TEMPORAL PATTERN OF TESTOSTERONE SECRETION IN MALE BROWN-HEADED COWBIRDS. A.M. Duffy, Jr. and J.C. Wingfield. Rockefeller Univ. Field Res Ctr., Millbrook, NY.

Brown-headed cowbirds (Molothrus ater) are brood parasites that exhibit no parental care and breed almost continuously for approximately 8 weeks in the summer. Males do not defend territories, but do guard females from the courtship activities of other males. Free-living males possess maximal levels of testosterone (T) when females arrive, and male-male competition is greatest. T levels are higher at that time in paired than in unpaired individuals. In the laboratory, dominant males have higher T levels than subordinates during hierarchy formation but not before or after. In addition, the onset of the seasonal rise in T is accelerated, and elevated T levels are maintained longer in photostimulated males paired with females than in similar males housed without females. Nonphotostimulated males show no such response to the presence of females. Thus, social interactions may play a major role in determining the pattern of plasma T in male cowbirds throughout the breeding season.

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EFFECT OF POULTS ON PLASMA PROLACTIN IN INCUBATING TURKEY HENS. H. Opel and J. A. Proudman*. USDA, Agricultural Research Service, Beltsville, MD

Turkey hens kept singly in 66 x 44 x 62 cm wire cages without eggs or nest materials exhibited incubation behavior accompanied by extremely high plasma prolactin (PRL) levels. The hens readily accepted artificially hatched poults. To provide adequate maternal care in a severely limited space, the hens typically spent 12-13 h of a 14 h light period sitting on the cage floor with wings slightly extended to cover the poults. Hen PRL levels fell sharply within 6 h of poult introduction, reached preincubation levels within 24 h and did not recover during 48 h after poults were removed. Incubating hens in adjacent cages, having visual and auditory contact, but no tactile contact with the poults showed no significant change in incubation behavior or in plasma PRL during the experimental period. Our results raise the possibility that tactile stimuli from hatchlings, rather than release of tactile stimuli from the eggs and/or the nest account for the sharp fall in PRL levels in incubating precocial birds at the time of hatch.

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PLASMA ANDROGEN DURING EMBRYONIC AND PERINATAL DEVELOPMENT IN MALE JAPANESE QUAIL M.A. Abdel Nabi and M.A. Ottinger, University of Maryland, College Park

Previous experiments in our laboratory have shown that endogenous steroid hormones change during development. The present experiment was designed to verify and extend these earlier results. Blood samples were collected from quail embryos and posthatch quail; plasma was pooled to allow measurement of androgen concentrations. Results were similar to those obtained previously. Androgen concentrations (ng/ml plasma \pm SE) were 2.7 ± 0.3 , 0.59 ± 0.1 , 0.58 ± 0.1 , and 1.10 ± 0.1 at 10, 12, 14 and 16 days of incubation respectively. Concentrations were still elevated at hatching (0.99 ± 0.4 ng/ml plasma) and at days 1 and 3, posthatch (2.58 ± 0.9 and 2.2 ± 0.9 ng/ml plasma, respectively). By 5 days, posthatch blood levels were declining. The timing of peaks in plasma androgen were similar to results from our earlier experiments. These results will also be related to neuroendocrine changes that occur during this period of development.

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NEONATAL ANDROGENIZATION IN GROUND SQUIRRELS. L. Smale, K. Pelz*, I. Zucker*, and P. Licht. Univ. California, Berkeley.

Male and female Spermophilus lateralis undergo circannual rhythms of body mass and reproduction but there are substantial sex differences in the seasonal pattern of weight gain and luteinizing hormone (LH) secretion. This study examined the effect of testosterone propionate (TP) injected on the day of birth on the development of these sex differences. Squirrels were gonadectomized at 47 days of age and then monitored for 1 year. Neonatally androgenized females attained peak body weights intermediate between those of oil-injected control females and control males. Trough body weights did not differ among the groups. Luteinizing hormone was detectable in all males and most TP-treated females but not in any control females during the first 4 months after gonadectomy. Other sexually dimorphic parameters of LH secretion were not affected by neonatal TP. These data support the hypothesis that testicular hormones secreted during the early postnatal period induce seasonally recurring sex differences in body mass and some aspects of LH secretion.

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ENDOCRINE AND ENVIRONMENTAL INFLUENCES ON COHO SALMON INTERRENAL ACTIVITY. Graham Young (assisted by G. Gottlieb), Univ. of California, Berkeley.

Increased in vitro sensitivity to ACTH and capacity for cortisol production by the interrenal of smoltifying coho salmon coincide with peak plasma thyroxine (T_4) levels and enhanced seawater (SW) adaptability. A role for cortisol in SW adaptation was suggested by short-term increases in plasma cortisol and interrenal sensitivity to ACTH after successful transfer of coho to SW; however, these increases may not be linked to osmoregulation but to non-specific stress (Young, Am. Zool. 24, 73A, 1984). In 1985, plasma cortisol levels and interrenal responsiveness to ACTH were assessed after transfer to SW of coho of optimal or of limited hypoosmoregulatory ability. The former group was characterized by relatively modest rises in plasma cortisol and enhanced interrenal responsiveness, whereas the latter displayed plasma cortisol increases and interrenal responses suggestive of "stress." Administration of T_4 in vivo or ovine growth hormone in vitro enhanced the sensitivity of the interrenal to ACTH in vitro; the action of T_4 appears to be indirect.

(Supported by UC Sea Grant R/F-101 and NSF grant PCM 84-05249 to H.A. Bern)

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ADRENAL STEROIDS REGULATE SERUM ELECTROLYTES IN BULLFROG TADPOLES. P.S. Brown, E.A. Horgan and P.A. Strempe. Siena College, Loudonville, NY.

Although adrenal steroids are known to be secreted by anuran larvae and have been shown to stimulate metamorphosis, there is little evidence for a direct osmoregulatory function for these hormones in anuran larvae. To investigate this possibility, Rana catesbeiana tadpoles (5.2±.7 g; TK stage 13.5) were treated with solvent, aminoglutethimide (AG), AG+corticosterone (B), AG+cortisol (F), or AG+aldosterone. AG decreased extracellular fluid (ECF) [Na] by 60% as well as plasma [Na] and [Cl]. Replacement with either B, F, or aldosterone maintained ECF and plasma electrolytes at control levels. Decreased [Na] in AG-treated tadpoles was not due to dilution since wet weight, body water and hematocrit were unchanged by AG treatment. Because no changes in metamorphic stage occurred during this 4 day experiment, these data suggest that adrenal hormones have a direct role in maintaining EC salts in prometamorphic bullfrog tadpoles that is not explained by their role in accelerating metamorphosis. Supported by NSF Grant PCM-83-02698 and a William and Flora Hewlett Foundation Grant of Research Corp.

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HORMONAL CONTROL OF TRANSDERMAL ION TRANSPORT IN NEWTS. S.C. Brown and L.M. Savage. SUNY @ Albany and Siena College, Loudonville, N.Y.

Voltage-clamped, *in vitro* ventral skin from Taricha granulosa and T. torosa was used to examine the electrophysiological consequences of: (1) *in vivo* salt depletion; (2) long-term *in vivo* treatment with prolactin (PRL) and human placental lactogen (HPL); and (3) short-term addition of AVT and aldosterone to the medium bathing the isolated skins. Plasma ions and osmolarity were significantly reduced in newts maintained in DW for 3 wks, whereas *in vitro* SCC was increased and R_e lowered. *In vivo* treatment with PRL or HPL significantly lowered *in vitro* TEP and SCC and significantly increased R_e . Addition of 10^{-9} AVT to the serosal bathing medium significantly increased SCC and TEP and lowered R_e with a mean maximum response time of 126±13 min. Addition of 3.5×10^{-6} M aldosterone to the serosa bathing medium caused a significantly increased SCC and TEP in experimental newt skin compared with a paired control from the same animal. The mean time to maximum response in aldosterone stimulated newt skin was 13.2±.8 hr. Supported in part by NSF Grant PCM-83-02698.

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IOPANOIC ACID AND THYROID HORMONES IN FISHES. Milwaukee Public Museum, Milwaukee, WI. R. Spieler, T. Noeske-Hallin, S. Yeo* and T. De Rosier*

In mammals, iopanoic acid (IOP) initially decreases circulating T3 and increases T4 (by blocking peripheral monodeiodination). In addition, IOP has a long half-life (2 wk in man) and low toxicity (LD₅₀ in mice = 9-14g/kg). Should these characteristics be similar in fishes, IOP could be a valuable tool for examining physiological effects of endogenous T3 in this class of animals. In 4 studies (2 with carp, 2 with rainbow trout) groups of fish were injected with one of several different doses of IOP (0, 0.25, 0.5, 1.0, 2.0 or 4.0 mg/fish; \bar{x} = 25g carp or 40g trout) or served as noninjected controls. Approximately 9 fish/group were sacrificed at different time intervals (days or weeks) after injection. Serum samples (N=1074) were assayed in duplicate for T3 and T4. Nonmortality was attributable to IOP dosage. IOP reduced T3 in all studies (as much as 40% in some cases). In general, maximum decrease occurred 7 days after injection. In some studies, however, there was a concomitant decrease in T4 (and a trend in T4 reduction in others). There were inconsistent differences in T3 and T4 levels both among and within treatments. The experimental design did not test if IOP is chronobiotic; phase shifts in diel rhythms of T3 and T4 might explain a large measure of the variance among and within treatments. This consideration notwithstanding, IOP does not appear at this time to have great potential as a tool for examining physiological differences in function of endogenous circulating T3 vs. T4 in fishes.

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TRIIODOTHYRONINE BINDING TO ISOLATED TILAPIA HEPATOCYTE AND BRAIN CELL NUCLEI. C.L. Brown. University of California, Berkeley, CA. RNA- and protein synthesis promoting actions of thyroid hormones in tilapia liver and muscle are reportedly maximal at or near 30°C, and this response is lost with age (Matty et al., 1982, Gen. Comp. Endocrinol., 47: 497-507). To elucidate mechanisms of temperature- and age-related changes in peripheral responses to thyroid hormones, we have studied the binding of T3 to nuclei isolated from possible target tissues in adult and juvenile tilapia. Maximal specific binding (ca. 16%) was observed at 30°C (ambient temperature of the fish) and at pH 7.4; binding decreased sharply in incubations which were conducted at lower temperatures or at other pHs. Adults and juveniles showed similar binding both in the liver and in the brain. These results suggest that temperature-dependent differences in the anabolic effects of thyroid hormones may be due, in part, to altered hormone-receptor interaction but that the loss of response of older tilapia to thyroid hormones is not due to a loss of hormone-binding competence. (Aided by NSF grant PCM 84-05249 and NIH grant CA-09041 to H.A. Bern).

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PERTUSSIN TOXIN BLOCKS MELATONIN ACTION UPON AMPHIBIAN DERMAL MELANOPHORES. B.H. White, M.D. Rollag, and R.D. Sekura*. Uniformed Services University of the Health Sciences and NICHD, Bethesda, MD.

In order to elucidate a mechanism of action for the pineal hormone melatonin, forskolin and pertussis toxin were used to explore whether melatonin acts on hormone-sensitive adenylate cyclase. Melatonin exerts a powerful aggregation of melanosomes in dermal melanophores in tadpoles of *Xenopus laevis*. Meningeal explants of stage 52-54 tadpoles were used in a bioassay system to test whether pertussis toxin, which inactivates the inhibitory nucleotide coupling protein, Ni, blocks melatonin's contracting ability. We found that forskolin causes dispersion of melanosomes, melatonin reverses this forskolin-induced melanosome dispersion, and pertussis toxin blocks the effects of melatonin. A protein corresponding to the Ni alpha subunit was found after SDS gel electrophoresis of melanophore-rich meningeal homogenates. We conclude that melatonin acts to inhibit adenylate cyclase via the inhibitory coupling protein, Ni. Supported by USUHS Protocol C07049 to MDR.

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ULTRASTRUCTURE OF THE PARATHYROID GLANDS IN SHELL-LESS AND *IN OVO* CHICK EMBRYOS. M. B. Clark, Univ. of Connecticut, Storrs.

Chick embryos were grown *in ovo* or in shell-less culture for 12, 15 or 18 days. Blood calcium values were measured and the parathyroid glands removed for ultrastructural examination. Serum calcium values were consistently lower in the shell-less embryos compared to the *in ovo* controls. The parathyroid glands of the 12 day shell-less embryos were conspicuously more active in protein synthesis than controls, as evidenced by presence of more rough endoplasmic reticulum (RER), lipid droplets and dense secretory granules. The latter were not seen in controls. At 15 days of incubation, the *in ovo* glands appeared to be more active than at 12 days. However, the glands of shell-less embryos still were more active, containing a profusion of RER membranes and many mature secretory granules. At 18 days of incubation, the glands of the two groups were ultrastructurally similar, both appearing equally active in protein synthesis. Clearly shell-less culture stimulated early synthesis of parathyroid hormone, presumably in response to hypocalcemia that results from absence of the shell.

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EFFECTS OF GASTRIN AND CCK PEPTIDES ON PANCREATIC EXOCRINE SECRETION IN THE PAINTED TURTLE, *Chrysemys picta*. P. Bond* and D.A. Gapp, Hamilton Coll., Clinton NY

Relative potencies of gastrin family hormones on pancreatic protein secretion in *Chrysemys picta* were determined using an *in vitro* perfusion system. Minced pancreatic tissue was perfused with oxygenated medium (37°C) for a 40-minute period. Increasing concentrations of sulfated and unsulfated CCK, CCK10-20, caerulein, gastrin I and gastrin II were perfused and fractions collected at 4-minute intervals. Protein content of the perfusate was determined using a modified Lowry protein assay. The sulfated CCK8 and caerulein stimulated secretion much more strongly than the other analogues, suggesting a preference for a sulfated tyrosine residue at the 7th position from the C-terminal. The comparatively low potencies of gastrin II and unsulfated CCK8 are probably due to the presence of the tyrosine at the 6th position and the absence of the sulfate group, respectively. It appears that the exocrine pancreas of the painted turtle is more responsive to CCK-like than gastrin-like hormones.

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MOSQUITO DIURESIS: *IN VIVO* EFFECTS OF HEAD EXTRACT. G.D. WHEELOCK*, D.H. PETZEL and H.H. HAGEDORN. Cornell Univ., Ithaca, N.Y.

A new *in vivo* assay was developed to examine the effects of mosquito head extract on diuresis in blood fed *Aedes aegypti*. Females fed blood containing tritiated water (20 μ Ci/ml) were held in a vial for 30 min., removed and the radioactivity in the vial counted by liquid scintillation. Decapitation immediately after feeding resulted in only 8% of the urine output of intact females. Blood fed, decapitated females injected immediately with boiled extract increased urine output 5 fold compared to blood fed, decapitated, saline injected controls. Unboiled extract did not increase urine flow over controls. Sodium content of urine collected between 5 and 10 min. after injection of extract or saline was assayed by WDS electron probe analysis. Sodium concentration was the same in both groups. However, sodium excretion increased 4 fold in extract injected females due to increased urine flow. The requirement for boiling the extract, and the magnitude of change in fluid and Na secretion are similar to previous findings regarding the effects of head extract on isolated Malpighian tubules. Supported by NSF PCM8403305.

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HUMORAL INHIBITION OF JUVENILE HORMONE SYNTHESIS IN LARVAE OF THE COCKROACH DIPLOPTERA PUNCTATA. C.R. Paulson and B. Stay. University of Iowa, Iowa City.

Decline in juvenile hormone synthesis by the corpora allata which occurs prior to metamorphosis was investigated in male larvae to determine whether humoral inhibition of the corpora allata occurs in addition to nervous inhibition. Changes in corpus allatum activity resulting from *in vivo* manipulations were measured using an *in vitro* radiochemical assay for juvenile hormone synthesis. Humoral inhibition was shown by the observations that activity of larval corpora allata declined during the final stadium whether the glands were innervated or denervated, and that activity of adult female corpora allata declined similarly following implantation into late final-instar larvae. However, inhibition did not occur in adult corpora allata implanted into larval hosts which had been decapitated. Extract of larval brains inhibited corpus allatum activity *in vitro*. Inhibitory effect of extract was lost following treatment with trypsin. These results suggest that a factor in the haemolymph inhibits juvenile hormone synthesis during the final larval stadium, and that this factor is a brain peptide.

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REGULATION OF JUVENILE HORMONE LEVEL BY JUVENILE HORMONE ESTERASE AFTER A BLOOD MEAL IN THE ADULT FEMALE YELLOW FEVER MOSQUITO, AEDES AEGYPTI. A.B. Shapiro* and H.H. Hagedorn. Cornell University, Ithaca, NY.

Juvenile hormone (JH) plays several roles in the reproductive physiology of the female Aedes aegypti, and there are dramatic changes in the amount of JH present in the animal during the course of the reproductive cycle. Juvenile hormone esterase (JHE) initiates the catabolism of JH. Therefore, the level of activity of JHE could be important for the control of the JH level. JHE activity in hemolymph of female mosquitoes at several times after a blood meal was determined. The levels of JH after a blood meal correlate well with the levels of activity of JHE in the hemolymph: JHE activity rises as JH levels fall after the blood meal, until 36 hours, when JH levels rise again and JHE activity falls. A JH analog, methoprene, and a JHE inhibitor, BEPAT, were topically applied to mosquitoes at a time after the blood meal when the JH level is lowest and the JHE activity is highest. These treatments significantly reduced the percentage of fertile eggs, suggesting that the JH level must be low at this time, and that JHE is responsible for regulating it.

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JUVENILE HORMONE LEVELS DURING A REPRODUCTIVE CYCLE IN THE ADULT MOSQUITO AEDES AEGYPTI. H.H. Hagedorn, F.C. Baker* and D.A. Schooley*. Cornell University, Ithaca, NY, and Zoecon Laboratories, Palo Alto, CA.

Juvenile hormone (JH) has several roles to play during previtellogenic and vitellogenic growth of the oocyte in the mosquito A. aegypti. It stimulates behavioral and physiological events after emergence that prepare the animal for the blood meal. However, its role after a blood meal is incompletely understood. JH III is the only JH found in the mosquito. We measured JH III levels by coupled GC-mass spectrometry. The amount of JH rose over the first two days after emergence from 0.7 ng/g to 7.5 ng/g and then slowly fell over the next five days in females not given a blood meal. In females fed blood on the third day after emergence, JH levels fell during the first three hours to 2.3 ng/g. The rate of decline then slowed so that levels had reached their lowest point (0.4 ng/g) by 24 hours after the blood meal. By 48 hours, levels of JH started to rise again so that by 96 hours they were equivalent to pre-blood-meal levels. The fluctuations of JH and 20-hydroxyecdysone after a blood meal will be compared, and their role in egg development will be discussed.

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ALTERNATIVES TO MAMMALIAN ANTISERA IN THE EVALUATION/IDENTIFICATION OF HUMAN PROTEINS. A.C. Smith. Veterans Administration Medical Center, Bay Pines, FL.

A project was initiated to investigate the possibility of making available an entirely new class of reagents for use in laboratory diagnosis. The study made use of natural products from marine invertebrates, protochordates (tunicates), and fishes. It was hypothesized that (1) natural fluids of marine animals react with human molecules and cells, and so are potential screening reagents in the clinical laboratory; and (2) natural products of marine animals could be modified by simple procedures to induce specific reactivity for selected human molecules. Natural Fluids. The body fluids from several marine animals were found to produce sex-differentiating reactions with human erythrocytes. This finding demonstrates the value of a natural reagent in detecting a previously unknown (sex-specific) surface structure on human cells. Modified Natural Products. Lens reagents, produced entirely *in vitro* from fish lenses, differentiated hemoglobins A and S; human and bovine serum albumins; erythrocytes of the ABO blood group; and erythrocytes from human females and males (confirming the results of the studies with marine animal body fluids).

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ANTIGEN UPTAKE BY GILL CELLS OF ATLANTIC SALMON GIVEN BATH IMMUNIZATIONS WITH YERSINIA RUCKERI BACTERINS. D. P. Anderson, A. C. Zapata, and M. Wisniewski* National Fish Health Research Laboratory, Kearneysville, WV; Univ. Leon, Faculty of Biology, Leon, Spain; and Appalachian Fruit Research Station, Kearneysville, WV.

Atlantic salmon (Salmo salar) were given 2-min bath immunizations with Yersinia ruckeri O-antigen or formalin-killed cells. Gill samples taken immediately after treatment were fixed and later examined by light and electron microscopy. Effectivity of immunization was confirmed by testing the immune response 21 days after bacterin bath by the passive hemolytic plaque assay to enumerate numbers of splenic antibody-producing cells and by passive hemagglutination to determine humoral antibody titers. Bacterial cells were observed entering the gill cells in a phagocytic-like manner at different stages. The immune response could be reduced by first treating fish with low doses (10 ppm) of phenol for 5 min. The point of blockage of the immune system is speculated to be when bacterin enters the gill cells.

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MITOGENIC RESPONSIVENESS OF NEWT SPLENOCYTES DURING REGENERATION AND FOLLOWING NON-AMPUTATIONAL WOUNDING. R.E.Sicard, M.F.Lombard², J.Foley^{2*}, & M.D.Albert^{2*}. R.I.Hospital, Providence, ¹Regis Coll., Weston, MA, ²Boston Coll., Chestnut Hill, MA.

Immunological influence on regeneration has been proposed, but not experimentally supported. Past studies showed effects on regeneration of administered immunological agents, but did not document immune status. This study reports differences in splenocyte response to T- and B-cell mitogens [concanavalin A (conA) & bacterial lipopolysaccharide (LPS), respectively] between newts undergoing regeneration and those healing wounds caused by surgical removal of the humerus. Both operations increased mitogenic responses at 2 days posttrauma. During regeneration, no increase (vs control) was seen at 5, 8, or 20 days post amputation. However, response to conA was reduced at 12 days, but elevated at 16 days after amputation; while response to LPS was unchanged. Following dehumeralizing, response to conA and LPS increased at 8 days, but was reduced at all other times posttrauma. This is the first evidence of altered immune status during regeneration. These results are consistent with a role for the immune system in amphibian forelimb regeneration. However, further studies are required to prove this role and to suggest the nature of its action.

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KINETICS OF CHICKEN MACROPHAGE ACTIVATION: COMPARISON OF FUNCTIONAL ACTIVITY AND REACTIVITY WITH MONOCLONAL ANTIBODIES. Y. Chu*, K.A. Trembicki* and R.R. Dietert, Cornell Univ., Ithaca, NY.

Harvestable peritoneal macrophages elicited by Sephadex stimulation of 3.5-5 week old female K strain chickens were found to undergo a major shift in activation status during the course of the response to the irritant. Six hours after injection, most adherent macrophages were nonphagocytic, failed to form EA-rosettes, and failed to react with either of two macrophage-specific monoclonal antibodies, CMTD 1 and CMTD 2. In contrast, the majority of peritoneal macrophages isolated 42 or 52 hours after stimulation were phagocytic for sheep erythrocytes, formed EA-rosettes, and reacted with the CMTD 1 antibody. A subpopulation of these macrophages also reacted with the CMTD 2 antibody. Cells from intermediate timepoints possessed intermediate phenotypes. These results suggest that major phenotypic changes occur in the chicken macrophage population during the recruitment and response of the cells to an irritant. Supported by CU Biotechnology Grant 157302 and USDA NY(C) 157424.

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CHARACTERIZATION AND COMPARISON OF ADHERENT CELLS FROM THE RAT THYMUS AT THREE DIFFERENT STAGES OF THYMIC DEVELOPMENT. D.C. Tsui and M. Cook*. University of Cincinnati, Ohio.

Adherent cells (AC) from the rat thymus at the developing, fully developed and acute involution stages were characterized and compared for five phagocyte related enzymes, Fc receptors and their stimulation of syngeneic thymocytes. There are significant shifts in the enzymatic profiles of leucine aminopeptidase and 5'-nucleosidase in AC from the developing thymus to acute thymic involution. The number of esterase positive AC peaks at full thymic development. Though all stages contain acid phosphatase positive AC, there is no significant difference in their relative abundance. Peroxidase activity is negative at all three stages. The number of Fc receptor positive, phagocytosing AC diminishes with acute thymic involution. AC from the fully developed thymus have the highest stimulatory effect on syngeneic thymocytes, while those from the acutely involuted thymus exhibit minimal effect. This study indicates that thymic AC, which have properties similar to phagocytes, differentiate during thymic development, and these cells, from developing and fully developed thymuses, enhance the proliferation of thymocytes.

THE EFFECTS OF OPIATES ON ANTIBODY PRODUCTION IN VIVO. A.A. Hagan¹, A. Pert* and R.J. Weber*. American University, Washington, D.C., and NIMH, Bethesda, MD.

Opiates have been shown to alter a variety of immune functions in vitro and in vivo (Weber, R.J. and Pert, C.B., 1984). For example, heroin addicts are immunosuppressed, and immune parameters such as natural killer cell activity, and in vitro antibody production, can be modulated by opiates or opiate peptides. We examined the antibody response to trinitrophenyl¹⁴⁰-ovalbumin (TNP-OVA) in Balb/c mice which were chronically infused with morphine from an implanted source. Serum antibody levels to TNP were determined using an ELISA assay. Doses of 30 µg per hour for a period of one week had no significant effect on the primary or secondary responses to TNP-OVA. However, implantation of a 75 mg morphine pellet caused a suppression of antibody production to TNP. Therefore, the primary antibody response in vivo to a T-dependent antigen was suppressed by chronic infusion of opiates. ¹(Supported by the American University Faculty Research Grant.)

REPRODUCTIVE BEHAVIOR IN MALE LIZARDS TREATED WITH THE ANTIANDROGENS CYPROTERONE ACETATE AND FLUTAMIDE. R. R. Tokarz. Univ. of Miami, FL.

Cyproterone acetate (CA) has both antiandrogenic and antigonadotropic properties, whereas flutamide (F) has only antiandrogenic activity. The purpose of this study was to investigate the effects of CA and F on male reproductive behavior in the lizard Anolis sagrei. Reproductively active males were implanted with subcutaneous pellets containing either CA, F, or placebo (P). Pellets delivered CA and F at a constant rate of 0.1 mg per day. Behavioral tests were staged between treated males and stimulus males and females after three weeks of treatment. Aggressive and courtship behavior in CA-treated males, but not in F-treated males, was significantly less than in P-treated males. Thus antiandrogens with both antiandrogenic and antigonadotropic activity may effectively inhibit male reproductive behavior in lizards.

ANALYSIS OF A SEX ATTRACTANT PHEROMONE IN GARTER SNAKES. R.T. Mason and D. Crews Institute of Reproductive Biology, Univ. of Texas, Austin, TX.

Male red-sided garter snakes, Thamnophis sirtalis parietalis, detect unmated females by means of a sex attractant pheromone released from the female's dorsal surface. Pheromone samples were obtained in the field by washing the skin of females, males, and female-mimics with hexanes. These washes were biologically active eliciting courtship behavior from sexually active males in field tests. Males discriminated hexane washes of females and female mimics from washes of males. Pheromone samples were analyzed with a gas chromatograph/mass spectrometer. The chromatograms showed clear and distinct peaks that were compared to known traces from a gc/ms computer library. Supported by NIMH NRSA to RTM and NICHD 16687 and NIMH NRSA MH00135 to DC.

STERNAL GLAND SCENT COMMUNICATION IN THE RUFOUS ELEPHANT-SHREW, ELEPHANTULUS RUFESCENS. F. W. KOONTZ NEW YORK ZOOLOGICAL PARK, BRONX.

Sternal gland scent communication in captive Elephantulus rufescens was studied to determine its intraspecific communicatory function. The sternal gland, composed of holocrine sebaceous and apocrine glands, became active about 30 days after birth, however, marking was inhibited until after dispersal from the natal site. Among adults, males had larger glands and marked more often than females. Marking was not affected by either cage size or the female's estrous phase but marking did increase during agonistic encounters. Marking sites were concentrated at trail junctions. Sebum aged 120 days still elicited behavioral responses. Animals discriminated sebum on the basis of sex, individuality, and female reproductive state. Introduction of "deodorized animals" reduced sex-specific aggression levels. It was concluded that sternal gland scent communication facilitates social categorization, which is necessary for the regulation of agonistic behavior.

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THE ONTOGENY OF CONSTRICTING BEHAVIOR IN RAT SNAKES AND BOA CONSTRICTORS.

Mark A. Milostan and James C. Gillingham, Central Michigan Univ., Mt. Pleasant, MI.

Literature is virtually nonexistent in regards to constricting behavior in neonate snakes. The objective of this study was to investigate the ontogeny of constriction in naive Elaphe obsoleta and Boa constrictor. Using mice as food, over 40 feedings were filmed per snake during a three year period. Discrete components of the constriction phase were identified and followed over time using cinematographic analysis. This made it possible to estimate and compare the ontogenetic stability of constricting patterns within and between species. Neonate boas did not show any significant differences in patterns from older, larger, and more experienced individuals. Conversely, Elaphe exhibited greater variation in patterns during early growth but became more stereotypic in older snakes. These results suggest that interspecific divergence in developmental patterns may have some ecological basis. Additional measurements also show that rat snakes significantly reduce handling time as they mature. Such an increase in efficiency was not observed in boas since they are proficient constrictors from the start.

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SOCIAL PLAY AND FACTORS PRECIPITATING ESCALATION INTO AGONISM IN JUVENILE PUNARÉS (THRICHOMYS APEREIOIDES). K.V. Thompson and J.A. Cranford, Virginia Polytechnic Inst. and State Univ., Blacksburg.

Differences in the content of social play with respect to genetic relatedness was investigated in juvenile punarés (Thrichomys apereoides). Family groups and unrelated dyads were observed, and the initiator, content, sequence and duration of social interactions were recorded. Play bouts between unrelated juveniles were shorter in duration and ended more frequently with one juvenile exhibiting avoidance behavior than those between littermates. Agonism, never observed among littermates, occurred in 12% of encounters between unrelated male juveniles when both had prior experience in the observation arena. All encounters which escalated incorporated play prior to the occurrence of agonism. Agonism was initiated by the subordinate juvenile immediately following performance of dominance reinforcement behaviors by the dominant juvenile. These results support hypotheses of the concurrent development of competitive social skills and dominant relationships through play.

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LIGHT SAMPLING BEHAVIOR IN PHOTOENTRAINMENT OF CIRCADIAN RHYTHMS. P. DeCoursey, Univ. South Carolina, Columbia.

These experiments examine the means by which a nocturnal hole-dwelling rodent, the flying squirrel, assesses the day-night regime in entraining its internal timer to a relevant time of day. Phase Response Curves as well as entrainment patterns of squirrels in wheel cages were first documented. Then, simulated den cages were constructed with a darkened nest box connected via a dark tunnel to a feeding-exercise area on a light-dark schedule, such that the interface of tunnel and outer area served as a port for inspection of the light schedule. Monitoring of movements of individual squirrels in den cages was carried out for periods up to 18 months by means of infrared photocells and a running wheel, in order to detect the time at which each squirrel tested the photoregime. A maximum of several minutes light per day was seen by squirrels on 12 hr L: 12 hr D schedules. When an animal's internal timer brought it to the light sampling port in advance of the light-dark transition, delay phase resetting of its clock took place; on succeeding days, the animal free-ran. These data form the basis for a model of circadian photoentrainment in nocturnal rodents.

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CIRCADIAN PHOTOENTRAINMENT: % OF LIGHT SCHEDULE VIEWED BY A NOCTURNAL RODENT. S.A. Menon, (intro. by S.E. Stancyk), Univ. of South Carolina, Columbia.

The hypothesis was tested that brief glimpses of light seen by a nocturnal, den-dwelling rodent at an appropriate time of day suffice to synchronize its daily activity-rest cycle with the environmental cycle. Simulated dens were designed and the activity of 4 flying squirrels (Glaucomys volans) and 1 deer mouse (Peromyscus leucopus) was individually recorded with infrared photocell monitors and a recording wheel, to determine time of checking light conditions and circadian phase of activity. Recordings of entrainment were made for at least 21 days. For the mouse, maximum amount of light seen was 2.1% (11 min of 9hr L: 15hr D) while minimum was 0.6% (3 min). For one squirrel, maximum light seen was 1.4% (8 min of 9hr L: 15hr D) while no light was seen on 12 of the 21 days. Light was usually seen near onset of activity time (CT 12) where it induced a delay phase shift of activity; subsequently, most animals free-ran for several days. The relevance of these data for transitional and proportional hypotheses of photoentrainment of circadian rhythms is discussed.

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THE NEXT EXPERIMENT: TEMPERATURE AS A ZEITGEBER FOR CIRCAANNUAL RHYTHMS. D.E. Davis. 777 Picacho Ln. Santa Barbara CA.

The Z for circannual rhythms of weight is not known. Squirrels (*Spermophilus beecheyi*) were caged individually. Fed ad lib, kept at either northern (NH) or southern hemisphere (SH) daylength and 20 C. or southern hemisphere (SH) temperature cycle. All sqs were 6 months old at the start. Expt I. Sqs on NH and 20 C had maximum weight in Sep. or Aug. for 7 years. Sqs on SH and 20 C ran freely, as did sqs on LD 12:12. Expt II. Sqs on NH and 20 C had maxima in Aug for 3 year but when switched to SH temp. advanced in 2 years to April. Sqs on SH and 20 C ran freely for 3 years but when switched to SH temp. kept their maxima at April for 2 years. Expt III. Sqs on NH day length and SH temp. advanced to July in 3 years while sqs on SH daylength and SH temp. advanced to June. Expt IV. Sqs on intens illumination (1000 lux) showed no difference in 5 years from those on weak (200). Expt V. Sqs started on SH daylength in Feb. showed no difference from those started in Sept. Next Exp*. Maintain sqs on constant daylength (LD 12:12), and SH temp. for 5-8 years. Entrinment for circannual rhythms may require 2 factors.

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CALLING SONG RECOGNITION AND PHONOTAXIS IN CRICKETS. L.A. Doherty. Cornell University, Ithaca, N.Y.

In the acoustic communication system of crickets, males produce calling songs that serve to attract conspecific females for mating. In some species of crickets, the recognition of male calling song and the elicitation of positive phonotaxis in receptive females involves the evaluation of several calling song temporal properties that appear to have different weightings in the recognition process. All of these properties, including pulse and chirp repetition rates and pulse and chirp durations, contribute to the total attractiveness of the acoustic signal. Some properties, such as pulse repetition rate, may have weightings that are much higher than those of other temporal properties, leading one to believe that these other properties are not essential for calling song recognition. However, when the attractiveness of the most potent properties are diminished, the effects of other less potent properties on triggering recognition and phonotaxis become more evident. In this paper I present results of ongoing phonotaxis studies that provide evidence for the existence of temporal property interactions and different weighting factors in the recognition of male calling song by females. The results of several phonotaxis assays are considered, including phonotaxis in arenas, in flight, and on a locomotion compensator. These results indicate that in addition to searching for necessity and sufficiency of temporal properties in communication systems, we should also consider how animals recognize and act upon particular combinations of signal properties. (Supported by the Max-Planck Society and an NIH postdoctoral fellowship).

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AVERSIVE STIMULI GENERALIZATION IN YOUNG AVIAN INSECTIVORES. D. L. Evans,† H. Badruddine, N. Castoriades. American Univ. of Beirut.

We presented sets of naive common quails with 6 different sequences of 3 similar aposematic insects. Our goal was to determine whether naive predators initially form a sharply defined aversive gestalt which would then stimulate an avoidance response only in the presence of that signal. These birds usually generalized the signals and did, indeed, reject later, similar but not identical, signals. Therefore, anti-predatory signs need not be identical to be mutually protective for prey organisms. Müllerian systems in nature can have variable components.

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ONTOGENY OF AVIAN ACTIVITY RHYTHMS. C.J. Fisher, D. Attai* and P.J. DeCoursey. Vassar College, Poughkeepsie, N.Y., and Univ. South Carolina, Columbia.

Shell-less culture of chick embryos facilitated direct observation of developing rhythmicity. Muscle activity was studied in White Leghorn chick embryos from the start of culture on day 3 of development to day 19, the limit of survival. Rates of amniotic (smooth) muscle and skeletal muscle contraction under constant lighting and temperature conditions were measured. Amniotic contraction commenced on day 4, increased through day 10, and then dropped off sharply. Skeletal muscle contractions, expressed as % time active, began about day 7, correlated with rapid limb growth, and continued as long as embryos survived. Neither individual data nor pooled means for data through day 12 of development suggested circadian rhythmicity. From days 13-17 small, short-term fluctuations in rate of skeletal muscle contraction were seen, which increased gradually in amplitude and period. On days 18-19, changes in activity rate from about 9% to 69% at approximately 12-hour intervals suggested incipient rhythms which may lengthen into circadian rhythms.

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HYPOPHYSES IN JUVENILE OSTEOGLOSSID TELEOSTS: UPDATE. S. Holtzman, NY College of Osteopathic Med, Old Westbury, and Brookhaven Nat'l Lab, Upton, NY

In 1968 Kerr described the characteristics of a hypothetical ancestral teleostean hypophysis. The glands in 2 juvenile silver arowanas, Osteoglossum bicirrhosum, were described by Holtzman et al at these meetings in 1981. The gross morphology of the glands appeared to fit Kerr's theory: the dorsal surface of the pars distalis is separated from the anterior surface of the infundibulum by a vascular membrane; the neurohypophysis interdigitates with the pars intermedia only. These observations have now been confirmed in 5 additional juvenile O. bicirrhosum and 2 juvenile black arowanas, O. ferrerei. Scott and Fuller (1976) described the hypophyses in the Malaysian osteoglossids, Scleropages formosus, in relation to reproductive development. The glands in juvenile scleropages appear to be similar to the glands in juvenile arowanas, supporting the concept that the developing hypophyses in osteoglossid teleosts represent extant examples of an early stage in the evolution of the teleostean hypophysis. (Supported in part by DOE contract No. DE-AC02-76CH00016).

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THE EFFECTS OF ESTRADIOL-17B AND THYROTROPIN-RELEASING HORMONE (TRH) ON PROLACTIN RELEASE FROM THE ROSTRAL PARS DISTALIS (RPD) OF THE TILAPIA, OREOCHROMIS MOSSAMBICUS IN VITRO I. E. Barry and E. G. Grau. Univ. of Hawaii, Honolulu.

Spontaneous prolactin (PRL) release increased in a dose-related manner following estradiol-17B (E_2) pretreatment. Thyrotropin-releasing hormone also stimulated a dose-related increase in PRL release from E_2 -preincubated RPDs, but had no effect on tissues not previously exposed to E_2 . The maximal PRL response, nearly 3X control release, occurred at 50 nM TRH. Higher doses of TRH were less effective in stimulating PRL release. These findings indicate that TRH may be an important hypothalamic prolactin-releasing factor in the tilapia. Furthermore, the potentiation of PRL cell responsiveness to TRH by E_2 suggests that the control of PRL secretion may shift with variations in the reproductive state of the tilapia. Supported by NSF Grant PCM-83-14294 and NOAA Sea Grant NA85AA-D-SG082-A/R-31 through the Hawaii Sea Grant College Program to E.G.G. and by a Sigma Xi Grant-In-Aid and East-West Center Fellowship to T.P.B.

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RAPID CHANGES IN PROLACTIN (PRL) RELEASE FROM THE PITUITARY OF THE TILAPIA, OREOCHROMIS MOSSAMBICUS. E. G. Grau, C. N. Ford, L. M. H. Helms, and S. K. Shimoda. University of Hawaii, Honolulu.

Rostral pars distalis tissue was placed in perfusion culture to investigate temporal patterns in the secretory responses of PRL cells. Release was quantified by measuring 3H -Leu-labeled PRL in the perfusate. Baseline release was established in hyperosmotic (HR) medium (355 mOsm) for 3 hrs. Upon exposure to hyposmotic (HO) medium (280 mOsm) PRL release increased rapidly within 10-30 min, and remained elevated for at least 3 hrs thereafter. Release remained at baseline during continued exposure to HR medium. Somatostatin (SRIF) both substantially blocked the stimulation of PRL release by HO medium and elicited a rapid reduction in release (within 10 min) from levels that were already elevated. The rapidity of these changes suggests that the actions of SRIF and reduced medium osmotic pressure on PRL secretion are at least partly independent of any potential effects on hormone synthesis. Supported by NSF Grant PCM-83-14294 and by NOAA Sea Grant NA85AA-D-SG082-A/R-31 through the Hawaii Sea Grant College Program.

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BIOCHEMICAL SEPARATION OF SALMON PITUITARY THYROTROPIN (TSH) AND GONADOTROPIN (GTH). P. Swanson, W.W. Dickhoff and A. Gorbman. Univ. of Washington, Seattle.

TSH and Gth were isolated from adult coho salmon pituitary glands. After final extraction in acidic alcohol, proteins were fractionated using gel filtration chromatography and chromatofocusing. TSH activity was measured *in vivo* in salmon parr. Gth (steroidogenic) activity was determined *in vitro* using cultures of adult salmon ovarian follicles. Biologically active proteins were examined for purity and subunit nature by gel electrophoresis. Antisera generated to the purified hormones was characterized immunostaining of Western blots. Using these procedures TSH activity eluted at pH 6.3 on chromatofocusing. Six protein peaks which eluted from pH 5.4 to 4.0 contained Gth activity. All hormones have an estimated molecular weight of 40 kilodaltons and consist of two subunits. Since microheterogeneity of pituitary glycoproteins is common, the multiple GTHs could represent isoforms of one Gth. (supported by NIH training grant 5T32-GM07270-10 and NSF grant DCB-8416224)

STRUCTURAL FEATURES OF HUMAN GROWTH HORMONE (hGH) AND PLACENTAL LACTOGEN (hPL) RELATED TO THEIR BIOLOGICAL PROPERTIES. C.S. Nicoll, G.L. Mayer* and S.M. Russell. Univ. of California, Berkeley.

Although the complete amino acid (a.a.) sequence of several GHs, PRLs and of hPL has been determined, little is known about the structural features responsible for their common or diverse bioactivities. hGH and hPL should be useful for providing clues to such features since they are structurally very similar (85% identical a.a. homology) but they are different biologically: they both have PRL activities but only hGH has GH activity. The a.a. sequences of hGH and hPL were compared with those of GHs from 8 other species and with PRLs from 7 species. hGH and hPL differ from other GHs in 50 and 60 residues, respectively. Among these residues, 12 in hGH and 13 in hPL are identical with corresponding residues in one or more of the PRLs. Using other information it is possible to reduce the number of critical residues associated with PRL activities of hGH and hPL to 8 and 9, respectively. hPL differs from hGH at 28 residues and 11 of these are in positions that are invariant in other GHs, but 6 of the 11 are conservative substitutions. Thus, hPL's lack of GH activity may be due to as few as 5 substituted residues. NSF grant 82-03583

Parrotfish Thyroid Ultrastructural Changes After *In Vitro* Bovine Thyrotropin (bTSH) Stimulation. C.J. Smith and E.G. Grau.

Six groups of thyroid glands of *Scarus dubius* were compared by electron microscopy after a 4 hour culture with bTSH. Three groups, 1) control, 2) tissues exposed to 1 mIU/ml bTSH, and 3) tissues exposed to 20 mIU/ml bTSH, did not differ from each other in relative surface density of rough endoplasmic reticulum (rER), or relative surface area of lysosomes and engulfed colloid droplets. Thyroids exposed to 5 mIU/ml bTSH showed an increase in microvilli, rER, engulfed colloid droplets, and lysosomes. Tissues exposed to 10 mIU/ml bTSH showed an even greater increase in these structures, with the apical portion bulging into the lumen. Most cells in tissue exposed to 20 mIU/ml were broken apart, but a few intact cells contained large engulfed colloid droplets extending from the apical to basal borders. This tissue's dose-response curve shows that thyroid hormone release peaks at exposure to 10 mIU/ml bTSH, and declines upon exposure to 20 mIU/ml bTSH. The decline may be due in part to the cell lysis seen in this group. The lysis may be the result of the engulfment of more colloid than the membranes could contain. Funding by: NSF Predoctoral Fellowship (Smith) NSF Grant PCM-83-14294 (Grau). U.H. Sea Grant NOAA NA 81AA-D-00070 (Fast and Grau).

CHANGES IN THYROIDAL RESPONSE TO BOVINE THYROTROPIN (bTSH) DURING THE PARR TO SMOLT TRANSFORMATION OF COHO SALMON (*ONCORHYNCHUS KISUTCH*). W.W. Dickhoff and P. Swanson. Nat. Mar. Fish. Serv. and Univ. of Washington, Seattle.

The parr to smolt transformation (smoltification) of anadromous salmonids is associated with a surge in blood levels of thyroid hormones. A study of the elevation of blood thyroxine (T₄) in response to administered bTSH (0.2 to 7 mIU/g) in intact fish was conducted to evaluate thyroid sensitivity during smoltification. The thyroid was relatively insensitive to exogenous TSH in January and February. An increase in thyroid sensitivity was observed to occur in parr in late March. During the endogenous T₄ surge in April, there was no significant additional elevation in T₄ in response to exogenous TSH. Thyroid sensitivity remained high from May through July. These results indicate that the coho salmon thyroid is insensitive to bTSH in late winter but increases before and remains high after smoltification. Thus, smoltification cannot be defined by the increased sensitivity of the thyroid. (Supported by NSF DCB 8416224 and Wash. Sea Grant R/A-42).

THYROID HORMONES, GILL (Na⁺-K⁺)ATPase, AND SEAWATER TOLERANCE IN SALMON EMBRYOS. C.V. Sullivan and W.W. Dickhoff. Univ. of Washington and Nat. Mar. Fish. Serv., Seattle.

Increases in plasma thyroxine (T₄) and triiodothyronine (T₃) levels, gill Na⁺, K⁺-ATPase activity (ATPase), and seawater (SW) tolerance occur in juvenile salmon during smoltification. Smoltification occurs in embryos of some species. Plasma levels of thyroid hormones (TH), gill ATPase activities, and SW tolerance were evaluated in developing embryos of five salmon species in order to examine the relationship between thyroid function, osmoregulation, and embryonic development. In general, plasma T₄ levels (5-15 ng/ml) increased during development. Maximal T₄ levels usually coincided with completion of yolk-sac absorption. Plasma T₃ levels were low (0-3 ng/ml) during this time. In chum salmon embryos a maximum gill ATPase activity of 18 umoles ATP hydrolyzed·mg protein⁻¹·h⁻¹ (units) coincided with completion of yolk-sac adsorption and development of SW tolerance. Coho, chinook, sockeye, and Atlantic salmon embryos had lower gill ATPase activities (2-8 units) which changed little during development. There were differences between species in the pattern of development of SW tolerance, but no correlation between plasma TH levels, gill ATPase activities, or SW tolerance were noted. (supported by NSF DCB-8416224 and Wash. Sea Grant R/A-42)

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THE NATURE OF TSH EFFECTS ON THE THYROID GLAND (TG) IN DEVELOPING AND MATURE JAPANESE QUAIL. M.J. McNichols and F.M. Anne McNabb, Dept. of Biology, Virginia Tech, Blacksburg, VA 24061.

This study examined the nature and time course of TSH stimulation of TG function with respect to iodine (I) uptake, thyroid hormone (TH) production and release. The TG is responsive to a single TSH injection in embryos, chicks and adults as shown by increased TG-³²P uptakes (2 through 8 hrs) and increased serum TH (30 min through 8 hrs). However, TG-¹²⁵I uptakes were not increased by TSH exposures up to 24 hrs. A dual-label experiment in chicks using ³²P and ¹²⁵I verified the lack of an I response while confirming TG stimulation.

Chronic (> 1 wk) TSH injections resulted in elevated serum T4 concentrations, decreased TG-T4 content and increased TG-¹²⁵I uptakes. Manipulation of I availability demonstrated that the elevated TG-¹²⁵I uptakes with chronic TSH did not result merely from a TG-I deficiency caused by sustained high hormone release. Thus stimulation of TG-¹²⁵I uptake requires prolonged TSH exposure in contrast with the short-term effects of TSH on hormone release and hormone production (as shown by increased serum TH, increased ³²P uptake and hormone labelling within 6 hrs.) Supported by NIH ROI 28216.

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ENZYMATIC CHARACTERIZATION OF AVIAN HEPATIC 5'-MONODEIODINASE PATHWAYS. F.M.A. McNabb, L.J. Lyons and T.E. Hughes. Dept. of Biology, Virginia Tech, Blacksburg, VA 24061.

Two types of 5'-D from quail liver were characterized biochemically to compare their properties with those of mammalian (mml) enzymes. Type I activity, the fraction inhibited by propylthiouracil (PTU) and characteristic of mml liver, also predominates in avian liver. However, Type II (not inhibited by PTU) accounts for up to 50% of the activity. Iopanoic acid (IOP) inhibited all activity, demonstrating the enzymatic nature of activity measured in our *in vitro* system (assay for T₃ production by liver homogenates with abundant substrate and cofactor available). T₃ production from T₄ by both pathways increased progressively with increased enzyme concentrations, substrate concentrations, and incubation times. Enzyme activity for both pathways was maximal at 37°C and pH 6-8. Km values were 1.58 μM T₄ for Total and 0.90 nM T₄ for Type II activity, as are characteristic of the mml pathways. The effects of goitrogens were as on mml 5'-D: methimazole and thiourea were without effect, 2-thiouracil inhibited Type I but not Type II activity. Supported by NIH ROI 28216 and a BRSG grant.

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CORTICOSTERONE, LIPID STORES AND FORAGING IN DARK-EYED JUNCOS, JUNCO HYEMALIS. D. Yarian*, M. Ramenofsky and J.M. Gray*, Vassar College, Poughkeepsie, New York.

Stress-induced elevations of corticosterone (B) are well known. Ramifications of hormonal fluctuations are associated with promotion of gluconeogenesis and foraging in birds and mammals. We hypothesized that stress-induced increases in (B) would result in depletion of energy stores which, in turn, would stimulate foraging, thus replenishing utilized fuels. To test this hypothesis male juncos were administered B, metyrapone or control implants. Foraging behavior and measures of lipid metabolism (body weight, fat deposition, lipoprotein lipase activity (LPL) in muscle and fat) were monitored. Results indicate that B depletes muscle mass of the pectoralis-supracoracoideus complex while conserving lipid stores. LPL in muscle was elevated while that in adipose tissue remained unchanged. Although this mechanism is, at present, unclear, these intriguing results highlight a specificity of the catabolic action of B, which preserves lipid, a major fuel utilized by birds. (Funded by NSF grant BNS 84-03798).

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PLASMA CORTICOSTERONE:CORTISOL RATIOS IN SYRIAN HAMSTERS DECREASE WITH AGE AND HEART DISEASE. J.E. Ottenweller, W.N. Tapp* and B.H. Natelson*. VA Med. Ctr., East Orange, NJ.

Both corticosterone (B) and cortisol (F) contribute to total plasma glucocorticoid concentrations in hamsters. We measured B and F in young (3-5 mo.) and old (12-19 mo.) male hamsters, which had heart disease (BIO 14.6) or were healthy controls (F1B). Hamsters were kept on a 12:12 L:D schedule with food and water available *ad libitum* and were sacrificed by decapitation. Plasma hormone levels were determined by specific RIA's. B and F concentrations were similar in young animals of the two strains with the B:F ratio being 4:1 (B=2.0±0.2 and F=0.5±0.1 μg/dl). While B was higher than F in all groups, the ratio dropped to 2:1 in old controls (19 mo.) and sick (12 mo.) hamsters (P < 0.01). In heart failure, B=1.5±0.1 and F=1.2±0.1 μg/dl. In old controls, B=1.45±0.1 and F=0.9±0.1 μg/dl. These data suggest that species which secrete both B and F, such as man, may regulate adrenal 17-hydroxylase activity and/or clearance of B and F to alter the ratio of corticosterone to cortisol in plasma. Supported by VA Research Funds.

A HIGH AFFINITY CORTISOL RECEPTOR IN THE GILLS OF THE BROOK TROUT, SALVELINUS FONTINALIS. P. K. Chakraborti*, A. Chakraborti* and M. Weisbart. St. Francis Xavier Univ., Antigonish, Nova Scotia, Canada.

In vitro binding of [³H]cortisol (F) to gill cytosol preparation demonstrated high affinity (K_a $0.31 \pm 0.02 \times 10^7/M$, N_{max} 223.9 ± 22.8 fmoles/mg protein) and specific steroid binding. The kinetics of the binding at 0°C showed association and dissociation rate constants of 0.002 nM/min and 0.007 nM/min respectively and a half life of the receptor-ligand complex of 29.2 min. Competition studies with [³H]-labeled cortisol and different inert steroids showed the binding hierarchy as: dexamethasone > triamcinolone acetonide > 11-deoxycortisol > F > corticosterone > cortisone > progesterone > 17 β -estradiol > 17 α ,20 β -dihydroxyprogesterone > testosterone > pregnenolone. Gel filtration chromatography indicated a molecular weight of 326,000 Daltons and Stokes radius of 5.96 nm. Low levels of high affinity binding were also detectable in salt extracts of gill nuclei. (Supported by NSERC grant A0781 and RDG1405 to M.W.)

PANCREATIC ISLET HORMONES OF SALMON: PURIFICATION AND PRIMARY STRUCTURE. E. Plisetkaya, H.G. Pollock*, J.R. Kimmel* and A. Gorbman. University of Washington, Seattle and Veterans Administration Hospital, Kansas City, MO.

Insulin (INS), somatostatin (SS), glucagon (GLU), glucagon-related peptide (GLU RP), and pancreatic peptide (PP) have been isolated from principal pancreatic islets of 3000 coho salmon (Oncorhynchus kisutch) by gel filtration and reverse phase HPLC, and their amino acid sequences have been determined by J.B. Rouse and J.W. Hamilton (Veterans Administration Hospital, Kansas City) as follows: INS A-chain GIVEQ CCHKPCNIFDLQNYCN, B-chain AAAQHLGSHLVDALY LVCGEKGFYYPK; GLU HSECTFSNDYSKYQEERMAQDFV QWLMNS; GLU RP HADGTYTNSVSTYLQDQAAKDFVSWLK SGRA; SS-25 SVDNLPPRRKAGCKNFYWKGFSTC; SS-14 AGCKNFFWKTFTSC. Salmon PP seems to be a 36-amino acid peptide. The differences and similarities in structure as compared to mammalian and other fish islet hormones, as well as some biological activities of salmon islet peptides will be demonstrated. (Supported by NSF DCB-8415957 and NIH AM 0907219)

CARDIAC STIMULATORY EFFECTS OF ARGININE VASOTOCIN IN BULLFROG, Rana catesbiana. J.S.K. Sham and P.K.T. Pang. The Johns Hopkins University, Baltimore, and Texas Tech University, Lubbock.

The antidiuretic and vasopressor effects of arginine vasotocin (AVT) in bullfrog have been well documented. However, the cardiac stimulating effects of AVT is unknown. We found that AVT possesses positive chronotropic and inotropic effects in bullfrog *in vivo*, after the neural reflex has been blocked by atropine and propranolol. In isolated spontaneously beating frog atria, AVT increased the beating rate by 20% and the contractile force by 100%. The inotropic effect of AVT was also demonstrated in electrically driven atria and ventricles. Propranolol was found ineffective in blocking the cardiac effects of AVT. In conclusion, AVT stimulates cardiac beating rate and force in bullfrog, and is not act via cardiac β -adrenoceptors.

CRUSTACEAN CHROMATOPHOROTROPIC FACTORS FROM THE CRICKET, ACHETA. C. J. Mohrher and K. Ranga Rao. Univ. of West FL, Pensacola, FL.

Although analogs of crustacean red pigment concentrating hormone (RPCH) have been isolated from insect sources, less is known about the distribution of peptides related to crustacean pigment-dispersing hormones (PDHs). We found that extracts of whole heads and various components of the cephalic neuroendocrine system of the cricket, Acheta, elicit melanophore pigment dispersion and leucophore pigment concentration in destalked Uca pugilator. These activities are due to thermostable peptides. Upon gel filtration chromatography, the chromatophorotropins from Acheta emerge in two peaks. The first peak is chromatographically similar to the 1928-dalton PDH of Uca, and elicits chromatophore pigment dispersion. The second peak, apparently of lower molecular size component(s), elicits melanophore pigment dispersion and leucophore pigment concentration. Work is in progress to further purify and characterize these peptides. (Supported by NSF grant DCB-8314737)

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REDUCED RESPONSIVENESS OF STARFISH OOCYTES TO THE MEIOSIS-INDUCING HORMONE FOLLOWING AN EXTENDED EXPOSURE TO 1-METHYLADENINE AT HIGH PRESSURE. J. G. CLOUD. Univ. of Idaho, Moscow.

For immature starfish oocytes, the meiosis-inducing activity of 1-methyladenine (1-MA) is reversibly blocked by increasing ambient pressure during the hormone dependent period. Extending the incubation time with 1-MA at high pressure to twenty hours did not result in an increase in oocyte maturation but did result in a reduction in the percentage of oocytes that matured in response to 1-MA when subsequently incubated at atmospheric pressure. This reduced responsiveness of oocytes incubated with 1-MA (1 µg/ml) at high pressure (4500 psi) for twenty hours is not detectable in oocytes incubated under identical conditions in filtered seawater alone, cannot be attributed to the presence of an inhibitor substance, cannot be explained by a delay in the onset of germinal vesicle breakdown and is not reversed by maintaining the treated oocytes at atmospheric pressure for up to twelve hours before the addition of 1-MA.

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TREHALASE IN BEAN-SHAPED ACCESSORY GLAND AND SPERMATOPHORE OF TENEBRIO MOLITOR. T. Yaginuma and C.M. Happ. Univ. of Vermont, Burlington.

Trehalase activity was first examined in a reproductive system of 10 day-old male adults. In testis and tubular accessory gland (TAG), the activity was very low (1.5 nmol of glucose released/min/pair testes and 0.1 nmol/min/pair TAG) but in bean-shaped accessory gland (BAG), it was found to be 400 nmol/min/pair BAG. Trehalase in BAG was a soluble type and had an optimum pH of 5.7 and a Km value of 5.5 mM for trehalose. In BAG just after adult ecdysis, the activity was 4 nmol/min/pair BAG. From 1 day to 6 days, it increased linearly by 100 times and then reached a plateau. In specific activity, it increased by 20 times. In the deposited spermatophore, trehalase activity was found to be 13 nmol/min/spermatophore. In BAG of 4 day-old isolated abdomens which had been prepared just after adult ecdysis, the activity was similar to that in the same aged controls. These results suggest that trehalase is involved in the terminal differentiation of BAG and transferred into spermatophore and that an occurrence of the high activity in BAG does not require factor(s) from the brain, CC and CA. Supported by NIH AI-15662.

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NEUROHORMONAL AND HORMONAL STIMULATION OF ECDYSTEROID PRODUCTION BY TESTES OF THE TOBACCO BUDWORM, HELIOTHIS VIRESCENS. M.J. Loeb, E.P. Brandt and C.W. Woods. USDA, Insect Reproduction Lab., Beltsville, MD 20705.

Testes from late last larval instar and mid-pupal Heliothis virescens secrete ecdysteroids spontaneously *in vitro*. Testes from younger larvae can be stimulated to do so by Testis Ecdyotropic (TE) from brains of late last instar and midpupal animals; early last instar testes are used to assay for TE activity. TE, a peptide of moderately low molecular weight, can be partially purified by HPLC. Although bioassay of ecdysteroid-free active fractions elicits response, 20-hydroxyecdysone in the incubation medium induces even more ecdysteroid. Testes producing ecdysteroid spontaneously release 2 to 200 times more detectable ecdysteroid in the presence of increasing titers of 20-hydroxyecdysone in the incubation medium. Thus 20-hydroxyecdysone provides positive feedback reinforcement for ecdysteroid synthetic activity by testes. Dual control of testis ecdysteroid production by TE and exogenous ecdysteroid is implied.

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ESTERASES AND PROTEASES IN MERCENARIA MERCENARIA HEMOCYTES. C.A. Moore and S.R. Gelder, Lasell College, MA, and Univ. of Maine, Presque Isle, ME.

Previous studies have identified numerous degradative enzymes within the hemocytes of M. mercenaria. Six acid hydrolases including indoxyl-acetate esterases -A, -B, and -C have been localized as primary and secondary lysosomes. Li et al. (1973) showed that esterases varied amongst types of human blood cells; they differentiated these esterases by comparing the results following the use of specific substrates. Three of these substrates (Naphthol AS-D choroacetate; Naphthol AS acetate; and δ-Naphthol acetate) were used to further characterize the esterases in Mercenaria hemocytes. As some esterases mimic the reactions of proteases, three representative peptidases were sought, DAP I, II, and IV. Since hemocytes incorporate proteinaceous materials of both external and internal origin, an array of protein degrading enzymes was predicted. Supported by NSF-PCM-8316396.

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IN VITRO RESPONSE OF NURSE SHARK LEUCOCYTES TO PORCINE C5a. S. Hyder Smith and S. Obenauf*. Florida International Univ. and Univ. of Miami, Florida.

The *in vitro* chemotactic response of nurse shark leucocytes to endotoxin-activated rat serum previously described was further examined to determine whether the cells were responding to C5a of activated serum (as in the case with mammalian cells). Purified porcine C5a was employed and a chemotactic response was observed. Optimal cell migration was obtained at C5a dilutions between 1:1000 and 1:2000. For comparative purposes activated guinea pig and human serum were assayed to determine whether these sera stimulate chemotactic migration. Although a migratory response was seen in response to guinea pig serum, human serum failed to stimulate a response. These results indicate that shark leucocytes may be capable of differential recognition of C5a from different species. Currently the response of shark leucocytes to sera from lower vertebrate species is being examined.

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GROWTH FACTOR IN CULTURES OF FISH EPITHELIAL CELLS. B. A. Hamby*, E. M. Huggins, Jr.* and M. M. Sigel. USC School of Medicine, Columbia.

The EPC line was initiated by Dr. N. Fijan and Dr. D. Sulimanovic in 1969 from carp epidermal herpes virus induced hyperplastic lesions. A subculture of these epithelial cells was kindly supplied to us by Dr. B. Lindgerding. The cells have been grown in Eagle's MEM containing 10% fetal bovine serum and 1% gentamicin at 23-24°C. Supernatants and extracts of these cells were tested for their effect on catfish peripheral blood lymphocytes and mouse thymocytes. Increased proliferation was observed with the fish lymphocytes in the presence of the supernatants and to a greater extent with the cell extracts. There was no stimulatory effect for mouse thymocytes and in fact the preparations caused an inhibition of proliferation especially in the presence of mitogens. The nature of the factor has not been determined and we are investigating the possibility that it may represent a cytokine in the family of interleukins. We have already demonstrated that catfish lymphocytes recognize and respond to human IL-1.

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LYMPHOID CELLS IN RANA PIPIENS: A TWO-COLOR IMMUNOFLOUORESCENCE STUDY OF SURFACE AND CYTOPLASMIC MARKERS. Leslie D. Zettergren and Barbara J. Fenn*. Carroll College, Waukesha, WI.

Fluorochrome-conjugated peanut agglutinin (PNA) and affinity-purified, fluorochrome-tagged F(ab')₂ antibody fragments specific for (i) IgM, (ii) nylon wool nonadherent splenocytes (NSS), and (iii) monoclonal antibodies were used in two-color staining combinations in order to define mononuclear cell populations (MNC) in larval liver, thymus and urogenital tissue (UGT). We found (i) 25-50% of MNC were surface (s)NSS⁺, (ii) 5-25% of MNC were sPNA⁺, and (iii) 5-15% of thymus MNC were sOKT-11⁺/sT-11⁺. Among sPNA⁺ UGT MNC, 5-20% contained cytoplasmic (c)IgM; while about one-third of sNSS⁺ MNC were cIgM⁺. These observations suggest that (i) heterogeneous MNC subpopulations may be simultaneously defined by fluorescence techniques in *Rana*, and (ii) the sites and patterns of MNC ontogeny and differentiation in frogs may be similar to those of birds and mammals. (Partially supported by a Hewlett Fdn. Grant of Research Corp. and the NIEHS Aquatic Biomedical Research Center of Med. College of Wisc. and Univ. of Wisc.-Milwaukee.)

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TRANSIENT DECLINE IN ADOPTIVE IMMUNITY IN NEONATAL CHICK HOSTS. F. Seto Univ. of Oklahoma, Norman.

The levels of acquired immunity in neonatal chick hosts were equal to or greater than those in embryo hosts when transferred cells were from B haplotype-matched donors. However, the adoptive immunity expressed by the grafted immune cells in B haplotype-mismatched neonatal chick hosts was greatly reduced and is believed to be the consequence of an incipient host allograft reaction that manifests itself at this age. In other experiments with 1 to 8-day old B haplotype-matched chick hosts, the immune level was consistently lower with 4 to 6 day hosts. This coincides approximately with the onset of immunocompetence to the test antigen. When the adoptive immune levels of 1 to 6 day chick hosts, pretreated earlier with cyclophosphamide (CY), were compared with those of untreated hosts of comparable ages, no consistent changes were observed, although slight reduction was detectable in older CY-treated hosts. The nature of the transient host decline in immunosupportive capacity is not clear but there is little direct evidence for an involvement of a suppressor cell system.

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DETECTION OF O-ACETYLATED (O-Ac+) SIALOCONJUGATES ON HUMAN MELANOMA BY CANCER ANTENNARIUS LECTIN (CaL). M.H. Ravindranath, J.C. Paulson,* E.L. Cooper, and R.F. Irie.* Division of Surgical Oncology, UCLA School of Medicine, Los Angeles, CA 90024

We tested iodinated Cancer antennarius Lectin (CaL) for its binding capacity to mammalian red blood cells (RBCs). Only O-Ac+ RBCs such as those of the equine and murine varieties showed strong cpm. I-125-CaL bound to RBCs was removed by EDTA and subjected to electrophoresis, and its homogeneity and molecular weight were confirmed. To establish sensitive methods for the detection of O-Ac+ sialoconjugates on human tumor cell membranes, two immunoassays were developed using melanoma cell lines rich in O-Ac+ gangliosides as targets. The first assay, the immunoadherence assay, involved adherence of human RBCs to CaL-anti-CaL-complement formed on O-Ac+ melanoma cells, and was sensitive when the anti-CaL was of IgM class. The other assay, which involved I-125-protein-A binding to CaL-anti-CaL complexed on cell membranes, was sensitive when the antibody was of IgG class. These assays will be useful in investigating O-Ac+ sialoconjugates on human tumor cells. (Supported by NCI Grants CA29605, CA12582, and CA30647, by NSF Grant DCB-85-10930, and by the Fulbright and the Ben and Joyce Eisenberg Foundations.)

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FRESHWATER SHRIMPS (DECAPODA: NATANTIA) FROM VENEZUELA, AND THEIR BIOGEOGRAPHICAL RELATIONSHIPS. G.A. Pereira Univ. of Maryland, College Park.

A survey of Venezuelan freshwater shrimps was made during the last 4 years. 32 species were found, pertaining to the families Sergestidae (1), Atyidae (5), and Palaemonidae (26). The genus *Macrobrachium* is the most diverse and widespread, with 20 species. Ecologically, the species found can be arranged in two groups: those found in coastal rivers which require estuarine zones for reproduction, and those which live in inland waters, totally independent of estuaries. All 3 families are represented in the former group while only the Palaemonidae (and probably Sergestidae) are represented in the second group. Shrimps from group one are widely dispersed, and show close relation with the freshwater shrimp fauna of the West Indies and tropical eastern Atlantic drainages. While species in group 2 are not widely dispersed, they are found in both Amazon and Orinoco basin, including distinct groups of morphologically related species. Research funds by CONICIT S1-1259 and Univ. of Maryland.

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THE DISTRIBUTION AND ECOLOGY OF THE CRUSTACEAN CLASS REMIPEDIA. J. Yager. Old Dominion Univ., Norfolk, VA.

In 1979 an unusual troglolithic crustacean was discovered in an anchialine cave in the Bahamas. Due to the characters of this animal, a new class, Remipedia, was proposed. Since the discovery of the first remipede, *Speleonectes lucayensis*, additional representatives of the class have been found in anchialine caves throughout the West Indies and in the Canary Islands. Investigation of the physical environment indicates a complex vertical stratification of the water column. Most remipedes are found in polyhaline waters of long residence time, with low dissolved oxygen and often below a layer of hydrogen sulfide. Due to the abundance of several of the new species, more details concerning the functional morphology and general characteristics of the class are now available.

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SYSTEMATICS, ECOLOGY AND ZOOGEOGRAPHY OF THE EASTERN PACIFIC SPECIES OF ALPHEUS (CRUSTACEA, DECAPODA). W. Kim and L. G. Abele. Florida State University, Tallahassee.

A revision of the genus *Alpheus* revealed 53 nominal species reported from the eastern Pacific. Of these 23 are considered valid and an additional 22 new species are described, resulting in 45 eastern Pacific species. Morphological and possible subgeneric relationships among the species were examined using 67 characters. Phenetic and phylogenetic results were compared. The species occur in a variety of habitats including coral (18 species), rocky intertidal (29 species), mangroves (3 species) and sand-mud (21 species). Most species occur in several habitats while a few (e.g. *Alpheus lottini*) are only found in a single habitat. Seventy eight percent of the species are endemic to the eastern Pacific while 11% also occur on both coasts of the Atlantic. Four percent are shared with the Indo-West Pacific and 2% each with the western Atlantic, eastern Atlantic and Indo-West Pacific and all other regions.

TWENTY-ONE SPECIES OF FIDDLER CRABS (GENUS UCA) FROM A SMALL TIDAL RIVER ON THE PACIFIC COAST OF COSTA RICA. F.H. Barnwell and W.A. Szelistowski. University of Minnesota, Minneapolis, and University of Southern California, Los Angeles.

The tropical eastern Pacific coastline of Central and northern South America has been identified as the center of species diversity for fiddler crabs but little information is available on details of regional and local distributions. We collected crabs along the Rio Lagarto from their farthest upstream occurrence to the mouth of the river near Punta Morales in the Gulf of Nicoya. Freshwater banks and brackish mangrove forest of the upper river yielded Uca ecuadoriensis, brevifrons, herradurensis, galapagensis, zaca, argillicola, festae and limicola while tidal mud and sand flats at the mouth provided U. heteropleura, stylifera, ornata, panamensis, batuenta, saltitanta, oerstedii, inaequalis, tomentosa, beebei, stenodactylus, deichmanni and terpsichores. This level of local diversity is unexceptional for the region but extraordinary when compared to 15 species reported for all of eastern North America between Massachusetts and Yucatan. Thus, the tropical Pacific coast offers a rich and accessible resource for comparative biological research on the genus Uca.

KOREAN BARNACLES (CRUSTACEA, CIRRI-PEDIA, THORACICA). I.H. Kim and H.S. Kim. Kangreung National Univ. and Seoul National Univ., Korea.

The specimens were collected at 72 localities in South Korean waters. The majority were obtained from inshore and shallow water. In total, 51 species and 1 subspecies were identified and classified into 2 suborders (Lepadomorpha and Balanomorpha), 12 families and 27 genera. Among them one species of the genus Paralepas within the Heteralepidae, one of the genus Chirona (true brackish water species) and two species of Acasta within the Archaeobalanidae are new to science. In South Korean waters, 16 species were found from the Yellow Sea, 30 from the South Sea, 35 from the Cheju Island region and 23 from the East Sea. When these 52 species or subspecies are grouped into four climatic components, 14 species (27%) are tropical, 24 (46%) are temperate, 4 (8%) are boreal and 10 (19%) are worldwide; 22 of 24 temperate zone species appear to be endemic to Far East Sea. Balanus amphitrite, B. eburneus and B. improvisus have recently immigrated into Korean waters.

PRELIMINARY SURVEY OF STOMATOPOD CRUSTACEA IN THE GULF OF NICOYA, COSTA RICA. A. Dittel. Universidad de Costa Rica, San Pedro

Stomatopod crustacea were sampled by trawl monthly at 8 stations and weekly at 4 stations in the Gulf of Nicoya, a tropical estuary in the Pacific coast of Costa Rica, Central America during 1981-1982. Four species of stomatopods were identified: Squilla parva, S. mantoidea, S. aculeata and S. panamensis. Differential patterns of distribution between the various species were observed. S. aculeata was found in most stations but was more abundant in the upper Gulf, while S. parva and S. mantoidea were found only in the lower Gulf. S. panamensis was uncommon. The association between the observed distributional patterns and the physicochemical characteristics of the Gulf are discussed.

DENSITY INFLUENCED DISPERSAL OF COPEPODS: IMPORTANCE OF SPECIES PATTERNS. S.K. Service, Univ. of South Florida, Tampa Fl.

The effects of increased meiofaunal abundance on harpacticoid copepod dispersal were experimentally investigated in a Florida intertidal sandflat habitat and in a laboratory experiment. In the field, ambient sediment was defaunated and then stocked with three levels of harpacticoid copepod densities. Dispersal of copepods, measured by decreasing sediment density, was monitored for all density treatments over a four hour period. Total copepods showed an increase in dispersal with increasing sediment density. Three species were selected for population-level examination of the density-dispersal relationship. Two of three species demonstrated the pattern of increased dispersal with increasing density. A laboratory experiment was conducted to further investigate this relationship. Total copepods again show the pattern of increased dispersal with increased density, however there is an overall reduction in numbers dispersing. Dispersal of harpacticoid copepods appears to be related to density and is species-specific.

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DISTRIBUTIONS OF CO-OCCURRING
CALLIANASSA CALIFORNIENSIS AND
C. GIGAS. D.P. Berschauer.

Univ. of California, Irvine.
 The deposit feeding mudshrimp, Callianassa californiensis and C. gigas are potential competitors and coexist in high densities in the mudflats in Bahia de San Quintin, Mexico. The hypothesis that they partition space vertically within the sediment, and/or by tidal height, was tested. No differences in the patterns of vertical distribution were found between the two species, however there was tidal height segregation in that C. californiensis inhabited the high intertidal zone and C. gigas inhabited the low intertidal zone. C. gigas is significantly larger at all tidal heights where it occurs alone than where it occurs with C. californiensis. C. californiensis is significantly smaller in lower tidal levels where it co-occurs with C. gigas. Size differences of species in allopatry vs. sympatry may be related to competitive interactions between the two species.

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INFAUNAL INTERACTIONS IN THE BAY OF FUNDY.
 W. Herbert Wilson, Jr. Dalhousie Univ.,
 Halifax, NS, and Northeastern Univ.,
 Boston, MA.

The infauna of the Minas Basin of the Bay of Fundy is dominated by the amphipod, Corophium volutator, with summer densities exceeding 50,000/m². To test for the importance of competition between Corophium and other infaunal species, sediment cores were taken from an upper intertidal area dominated by polychaetes and were maintained in running seawater in the laboratory. The mean field density of Corophium was added to half of the cores. A third treatment with Corophium maintained alone was also established. After five weeks, only the nephtyid polychaete, Aglaophamus neotenus, declined in abundance in the presence of Corophium. Polychaetes did not affect the abundance of adult Corophium but did significantly depress juvenile abundance. In late July, the intertidal site dominated by polychaetes was colonized by Corophium. Population changes are currently being monitored and will be reported.

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EFFECTS OF COMPETITION AND PREDATION ON
 THE DISTRIBUTION OF CREPIDULA SPECIES.
 M.A. Shenk. Univ. of Delaware, Newark.

The three Crepidula species are common epifaunal associates of hermit crabs along the Atlantic coast of North America. The species have limited microhabitat overlap within the hermit crab assemblage. Competition between Crepidula species, and predation are two alternative hypotheses to explain Crepidula distributions. Selective removal of presumed competitors from replicate sets of shells had no effect on Crepidula densities. Thus competition between Crepidula species does not explain the field distribution patterns. A manipulation of predator densities within enclosures had significant effects on Crepidula densities and distributions; each species occupies a refuge from predation on field shells. These findings indicate that predation, not competition, determines the microhabitat distributions of Crepidula species.

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CHEMICAL FEEDING DETERRENTS IN A MARINE
 ALGA: EFFECTS ON THREE SYMPATRIC
 HERBIVORES. J.E. Duffy and M.E. Hay*.
 Curriculum in Marine Science, Univ. of
 North Carolina, Chapel Hill.

The brown seaweed Dictyota dichotoma produces a diterpene alcohol, pachydictyol A, which we hypothesized might deter feeding by its common herbivores. Sea urchins (Arbacia punctulata), spot-tail pinfish (Diplodus holbrooki), and a mixture of amphipod species were offered portions of a palatable seaweed (Gracilaria foliifera) coated with either 1) crude organic extract of Dictyota dissolved in ether, 2) pachydictyol A in ether, or 3) pure ether as a control. Extracts were applied at concentrations naturally occurring in local Dictyota populations. Crude extract significantly reduced grazing by all three herbivores. Pachydictyol A was as effective as crude in deterring grazing by fish and amphipods but was ineffective against urchins. In preference experiments with several spp. of algae Dictyota ranks low for fish and urchins but high for amphipods, suggesting that amphipod feeding preferences are a complex function of plant chemistry and other characteristics such as plant morphology and predation risks associated with feeding on specific plants.

TROPHIC ROLES OF THE TROPICAL LIMPET-LIKE PREDATORY GASTROPOD, DRUPA. F.I.M. Thomas* and A.J. Kohn. University of Washington, Seattle.

Most limpet-like gastropods are herbivores or suspension-feeders, but *Drupa* (Neogastropoda: Thaididae) retains the predatory habit typical of its family. Gut contents of three *Drupa* species co-occurring on the windward, seaward reef platform of Enewetak Atoll were analyzed to identify prey species. The major food of *D. ricinus* was the vermetid gastropod *Dendropoma gregaria*. *D. arachnoides*, considered conspecific with *D. ricinus* by some workers, preyed almost exclusively on the nereid polychaete *Ceratonereis mirabilis*. The commonest prey of *D. morum*, the largest species, was the nereid *Perinereis singaporiensis*. Diets differed within species between exposed and protected portions of the reef. Prey size and predator size were positively correlated. The results are compared with data from studies of other predators of the same prey species at Enewetak, and with J.H. Taylor's data on the diets of *Drupa* species elsewhere in the Indo-West Pacific region. (Supported by NSF Grant DEB 81-17945.)

PREDATOR-PREY SIZE INTERACTION IN THE ENERGY BUDGET OF THE ESTUARINE GASTROPOD THAIS HAEMASTOMA. D.W. Garton. State University of New York at Stony Brook.

Energy budgets were determined for individual oyster drills fed diets restricted to either 1) hatchery-reared oyster spat 1-2 cm in length, or 2) wild-caught juvenile oysters 4-5 cm in length. Mean scope for growth was positive in both diet groups, however oyster drills fed small oysters had a mean scope for growth twice that of oyster drills fed large oysters (228.4 cal/day vs 107.0 cal/day, respectively). This was a consequence of the interaction of predator and prey size. Small oyster drills (<750 mg dry wt) fed large oysters had significantly lower weight standardized scope for growth than small oyster drills fed small oysters. Scope for growth of large oyster drills (>750 mg dry wt) was not affected by oyster size. Differences in metabolic energy losses did not contribute to differences in scope for growth. These results suggest that for a predatory gastropod there are considerable energetic benefits for selecting optimum size bivalve prey.

PREDATION BY STOMATOPOD CRUSTACEA ON MOBILE INVERTEBRATES IN TROPICAL THALASSIA-RUBBLE HABITATS. G.K. Roderick, S.M. Shuster, and R.L. Caldwell. University of California, Berkeley.

Stomatopod crustacea are abundant in many tropical and temperate marine communities, yet their importance as predators is not well understood. In a field study, we measured the intensity and effects of predation by the stomatopod, *Gonodactylus bredini*, on populations of mobile invertebrate prey in a *Thalassia*-rubble community on the Atlantic coast of Panama. We first document 65 acts of predation in the field by *G. bredini* in a range of sizes on several species of *Cerithium* gastropods (mainly *C. eburneum*) and on hermit crabs in *Cerithium* shells; stomatopod size and prey size were highly correlated. Secondly, in a multifactorial design with replication we used artificial cavities to manipulate local densities of stomatopods (35-45mm). Predation was intense only on smaller (less than 16mm) gastropods and hermit crabs, demonstrating size-specific vulnerability for prey. Also, predation varied seasonally, corresponding with gastropod recruitment. These results suggest that stomatopods may be important in structuring populations of their prey. (Supported by NSF BNS Grant 80-23414 to RLC.)

THE ORIGIN OF TROPHIC SPECIALIZATION IN WRASSES. S.L. Sanderson, Harvard Univ., Cambridge, MA

A number of morphologically specialized species in the marine teleost family Labridae have limited dietary breadths (e.g. *Cheilinus unifasciatus* and *Gomphosus varius*). Generalized species (e.g. *Thalassoma ballieui* and *T. duperrey*) have a typical percoid body shape, undifferentiated dentition, and a relatively broad diet. High-speed films of prey capture were digitized to provide plots of morphological parameters (e.g. gape and premaxillary protrusion) against time. To investigate the neuromuscular basis for these kinematics, electrodes were implanted in the major jaw abductors and adductors. The results suggest that radiation into various trophic niches has involved morphological and behavioral specialization rather than the acquisition of unique neuromuscular activity patterns. This is inconsistent with reports that specialized cichlids and centrarchids do possess unique patterns. An examination is needed of the constraints on the functioning of labrid oral jaws that could account for a different process of evolutionary diversification in the Labridae compared to the closely-related Cichlidae. Supported by an NSF Graduate Fellowship.

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AIR BREATHING AND RISK OF AQUATIC PREDATION IN THE DWARF GOURAMI, COLISA LALIA. N.G. Wolf. McGill Univ., Montreal, Que.

In a laboratory experiment examining aquatic predation as a potential factor selecting against the evolution and use of air breathing in fishes, dissolved O₂ concentration was used to manipulate the frequency of air breaths taken by dwarf gouramis. At low oxygen levels (0 and 1 ppm), the gouramis breathed air more frequently and spent more time out of cover (benthic vegetation) than they did at higher oxygen concentrations (3 and 8 ppm). When exposed to predation by snakeheads (Channa sp.), gouramis were caught more quickly at low oxygen levels. Most captures occurred when the gouramis were out of cover. These results indicate that the vulnerability of a bimodally breathing fish increases when it breathes air more frequently, leaving cover to go to the surface.

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MUCOUS SECRETIONS OF CONVOLUTA "PULCHRA": A FUNCTIONAL-ECOLOGICAL APPROACH. Klauser, M. D., Univ. of Maine, Orono.

The functional significance of the mucous secretions from the frontal organ and epidermal body glands of the acoel turbellarian Convoluta "pulchra" was determined in experiments that tested choice of the animals between sand previously exposed to C. "pulchra" (natural sand) and acid-cleaned sand, and experiments testing the effect of mucus on the growth rates of the acoel's food item, Nitzschia curvilineata. Since C. "pulchra" preferentially chose natural sand over acid-cleaned sand ($p < 0.05$; $z = 2.45$), it is proposed that mucus is involved in the gregarious spatial distribution of the animals by acting as an attractive signal to conspecifics. Secreted mucus also was found to enhance growth of the diatom, N. curvilineata. More than twice the initial diatom concentrations were found after the same time span in dishes containing mucus as compared to controls ($p < 0.05$; $U = 25$). In addition, it was found that these mucous secretions agglutinate sediment particles into an interstitial system of tunnels and trails, thus stabilizing the sediment. Supported by NSF grant BRS 81-16894.

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THE ROLE OF NEPHTYS BUCERA (POLYCHAETA) IN THE FOOD WEB OF THE SURF ZONE COMMUNITY. J.J. McDermott. Franklin and Marshall College, Lancaster, PA.

The population under study is located mainly below MLW of an exposed sandy beach at Avalon, New Jersey. N. bucera is the only large polychaete in the shallow surf, but it is subordinate in numbers and biomass to the smaller spionid Scoelelepis squamata. Over 100 worms, ranging in wet weight from 0.2 to 2.7 g, were collected periodically from 1978-85. Food items found along their entire digestive tracts were identified and counted. Donax variabilis (juveniles), the most common prey, was ingested whole and thus digested in the shell. Next in importance was Scoelelepis, but Nephtys can seldom take full advantage of this mid-intertidal species because their distributions overlap only slightly for most of the year. The amphipod Amphiporeia virginiana and the anomuran Emerita talpoida were eaten sporadically. Thus N. bucera is a predator of the most common benthic invertebrates of the surf zone community; these in turn play a major role in the nutrition of surf zone fishes. Nephtys, however, has never been identified in the gut contents of these fishes. (Supported in part by research grants from F and M College).

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ON THE BIOLOGY OF METIS HOLOTHURIAE IN SEAGRASS HABITATS, TAMPA BAY, FLORIDA. S.S. Bell and M.O. Hall* University of South Florida, Tampa.

Metis holothuriae is a conspicuous harpacticoid copepod, distinguished by its red color and humpback morphology. Even though this copepod is easily identified and reported from phytal habitats around the world, virtually no information on the biology of this copepod exists. In Tampa Bay we have recorded large numbers of individuals of Metis on both seagrass blades and in sediments, especially during summer months. Although a distinct range of size classes has been recorded from field samples, no gravid females have been noted. Because members of the Metidae are distinct in having degenerate mouthparts, the mode of nutrition for Metis is particularly perplexing. Our observations in the laboratory indicate that the copepod browses among detrital flocs and algal epiphytes using first and second antennae and first pereopods to manipulate structure. Metis co-occurs in seagrass habitats with a host of other large, highly pigmented harpacticoids with good swimming ability.

THE INFLUENCE OF HYDROIDS ON THE RECRUITMENT OF FOULING ORGANISMS. Walter J. Lambert (intro. by L.G. Harris). Univ. of New Hampshire, Durham, NH.

Colonization in a fouling community was investigated to evaluate the role of hydroids in recruitment. Plexiglas panels were placed in Portsmouth Harbor, Portsmouth, NH and treated with $MgCl_2$ to remove micropredators. The presence of predators (particularly nudibranchs) in a hydroid community seems advantageous for the establishment of *Botrylloides aureum*. It is suggested that nudibranchs interfere with a hydroid community's defense against larval invasion. A comparison between predator recruitment and the sessile community suggests an attraction by nudibranchs to their preferred prey resource, *Obelia* or *Tubularia*. The presence of hydroids appears to benefit the recruitment of pycnogonids and caprellid amphipods by providing cryptic protection and to facilitate the establishment of the blue mussel, *Mytilus edulis*.

DAMSELFISH - SEA URCHIN COMMUNITY STRUCTURE OF A BACK REEF ENVIRONMENT AT MAGUEYES, PUERTO RICO. A. H. Williams, M. R. Garstka, K. Wasmund,* and D. L. West. Auburn Univ., Auburn, AL, and Univ. of Alabama in Huntsville.

The community of damselfish (Pomacentridae) and sea urchins occupying patches of staghorn coral (*Acropora cervicornis*) and coral heads (e.g. *Montastrea annularis*) in the sloping back reef of MARIO reef offshore from Magueyes Island was examined in September 1984 for comparison with similar communities off Jamaica. Four 25 m transect lines were laid perpendicular to the depth gradient at 3, 5, 8 and 10 m depth contours. Fish and urchin densities and coral and algal lawn dimensions were recorded. Twenty threespot damselfish (*Eupomacentrus planifrons*) were collected from both coral types for sex determination and gonadal analyses. Mean (\pm SE) damselfish, *Diadema antillarum*, and *Echinometra viridis* densities (no. inds. m^{-2}) along 3 transects were 0.14 ± 0.06 , 0.01 ± 0.01 , and 1.99 ± 0.46 , respectively. Within staghorn coral patches threespot and *Echinometra* densities (no. inds. m^{-3}) were higher (0.87 ± 0.48 and 29.89 ± 14.76 , respectively). Staghorn coral volume and algal lawn area averaged 0.30 ± 0.06 and 0.16 ± 0.04 along the transects. Mean threespot density was significantly higher along the 8 m transect, as compared to the 3 and 5 m depths. In staghorn coral, 78% of the fish were males with a mean total length (TL) of $76.3 \text{ mm} \pm 3.3$ and a mean sperm cyst length (SCL) of $0.06 \text{ mm} \pm 0.008$. Females from these patches were $74.7 \text{ mm} \pm 1.9$ TL and had a mean ovarian follicle length (OFL) of $0.09 \text{ mm} \pm 0.018$. Fish collected from head corals were 80% female, $76.44 \text{ mm} \pm 2.57$ TL, and had a mean OFL of $0.3 \text{ mm} \pm 0.05$. Males on these heads were smaller than all other groups but did not exhibit a significant difference in mean SCL. Females on head corals had significantly more mature follicles. Patterns of social organization within damselfish colonies appear to be consistent with similar communities in Jamaica.

EFFECTS OF SUSPENDED SEDIMENT AND BURIAL UPON SURVIVAL AND GROWTH OF GULF OF MEXICO CORALS. S.A. Rice. Univ. of Tampa, FL.

Laboratory experiments were employed to quantify the effects of high suspended sediment loads and total burial upon hard coral species from the central west coast of Florida. Eight species of corals were tested with survival and growth rates measured in suspended sediment tests and survival rates measured in burial tests. Coral growth rates were determined using the buoyant weight technique. Natural, unpolluted sediment from the Gulf of Mexico was used in all experiments. No significant differences between control and experimental treatments were found in 10 day survival rates, however growth rates were significantly lower in the experimental treatment exposed to an average suspended sediment load of 165 mg/l. Burial experiments were undertaken with seven of the coral species and produced LT_{50} values ranging from 7 to 15 days. *Scolymia lacera* was most sensitive to burial while *Solenastrea hyades* and *Stephanocoenia michelinii* were most tolerant to burial.

ORIGIN AND EVOLUTION OF EASTERN PACIFIC CORAL REEFS. R.H. Richmond. Smithsonian Tropical Research Institute, Panama.

The origin of the present coral fauna of the eastern Pacific has been an area of controversy and debate. Two theories proposed to explain the observed distribution of corals in this region are vicariance and long-distance dispersal of planula larvae. Experiments performed on the larvae of both *Pocillopora damicornis* and *Tubastrea aurea* indicate that planulae of these species remain competent for periods long enough to enable immigration from the central Pacific into the eastern Pacific. Major differences in life history characteristics have been observed between the geographically separated populations of *P. damicornis* from the eastern Pacific and Central Pacific Ocean. These include differences in fecundity, reproductive allocation, growth rate, age specific mortality, and interspecific competitive ability, and are hypothesized to be the result of divergent evolution via adaptation to local biotic and abiotic factors.

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EVOLUTIONARY DIVERGENCE OF POPULATIONS OF A MARINE ISOPOD IN PANAMA: BETWEEN OCEAN COMPARISONS. J.R. Weinberg, Woods Hole Oceanogr. Inst., MA.

Approximately 4 m y ago the Isthmus of Panama rose and split marine species into isolated, Caribbean and Pacific, populations. This barrier remained effective until at least 80 y ago, when the Canal was constructed. Excitrolana braziliensis is an abundant sand beach isopod occurring on both coasts of Panama. It was used to test whether interpopulational divergence was greater between- than within- oceans. Data were collected on morphological and genetic differences and reproductive isolation. Two morphs were discovered, but there was not one in each ocean, as expected if they were split by a landmass 4 m y ago. One morph occurs only in the Pacific. The other occurs in both oceans. The morph which only occurs in the Pacific differs greatly in morphology and genetic structure from the morph which occurs in both oceans. Taxonomists should split the morphs into two species. We do not know if the morph which occurs on both coasts has been split into Caribbean and Pacific populations for 4 m y or if interoceanic migration and breeding have occurred as a result of man's activities.

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"EGG-SHELL GRANULES IN SOME PRIMITIVE TURBELLARIA: MORE EVIDENCE FOR POLYPHYLY? M.B. Thomas, J.P.S. Smith, R. Chandler* and A. Barker*. Univ. of North Carolina, Charlotte and Univ. of Maine, Orono.

Mature oocytes (or vitellocytes, when present) of many turbellarians contain granules that react positively to histochemical tests for polyphenols. These "egg-shell" granules are released when the egg is laid, and participate in a quinone-tanning process that reinforces the egg shell. Mature oocytes of members of the turbellarian Orders Macrostomida, Acoela, and Nemertodermatida, and mature oocytes and vitellocytes of a member of the Order Prolecithophora were examined with the Fast Red Salt B test for polyphenols. Positively-staining granules were found in the oocytes and in the vitellocytes of the prolecithophoran, and in the oocytes of the macrostomids. No reaction for polyphenols was observed in the oocytes of the nemertodermatid or in those of the acoels. These histochemical differences are reinforced by preliminary ultrastructural studies, and we therefore conclude that the mode of egg-shell formation is yet another anatomical feature separating the Acoela and Nemertodermatida from the rest of the Turbellaria.

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PROTIST PHYLOGENY BASED ON SMALL SUBUNIT rRNA SEQUENCES. J.H. Gunderson, H.J. Elwood* and M.L. Sogin*, National Jewish Hospital, Denver, CO.

Comparisons of small subunit rRNA ("18S") gene sequences were used to determine phylogenetic relationships among the protists. The diversity observed within the protists is greater than that of the other three eukaryotic kingdoms combined. The deepest branchings among the protists examined so far are those of the euglenoids and kinetoplastids. These early events were followed by the divergence of the cellular slime molds, and then by a relatively recent period of intense protist evolutionary radiation during which the fungal, plant and animal lineages also appeared. The groups most closely related to these three kingdoms have not yet been identified, but the data refute the idea that metazoa arose from ciliates. These two groups are separated by plants, fungi and several other protist groups. Finally, our data suggest that the eukaryotic lineage is a very ancient one; the eukaryotic sequences don't converge on recognizably archaeobacterial or eubacterial groups.

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A PHYLOGENY OF PRIMITIVE FROGS (ANURA: ARCHAEOBATRACHIA). D.C. Cannatella. University of Kansas, Lawrence.

The phylogenetic relationships of 40 taxa of primitive frogs (suborder Archaeobatrachia) were resolved using more than 200 derived character-states of morphology. Each of the three superfamilies of archaeobatrachians (Discoglossoidae, Pipoidea, and Pelobatoidea) has been thought previously to be monophyletic. However, this study shows the discoglossoids to be a primitive grade. Within the Pipoidea, the Pipidae are the sister-group to the fossil family Palaeobatrachidae. The third pipoid family, Rhinophrynidae, is problematic in that although derived larval features ally it to the other pipoids, characters of the adult suggest a relationship to the Pelobatoidea. Within the family Pelobatidae, the Pelobatinae and Mego-phryinae are each monophyletic. (Supported by NSF grant DEB 8207681 to Linda Trueb.)

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PHYLOGENY OF OLD WORLD FRUIT BATS (MAMMALIA: CHIROPTERA): CONGRUENCE AMONG MOLECULAR, CHROMOSOMAL, AND MORPHOLOGICAL DATA SETS. C.S. Hood, Texas Tech Univ., Lubbock.

Phylogenetic relationships of the Old World nectar-feeding bats (Pteropodidae; Macroglorossinae) were assessed using data derived from histomorphology of the female reproductive tract. A cladistic analysis of the derived character states does not support the monophyly of the Macroglorossinae, if the African taxon Megaloglossus is included. The phylogenetic relationship of Megaloglossus to other pteropodid genera is not strongly supported, however, the female reproductive data support chromosomal and immunoelectrophoretic data that associate this nectar-feeder with the epomophorines. Taxonomic congruence among independent data sets shows that the subfamily Pteropodinae is a paraphyletic assemblage and that the systematic arrangement of macroglorossine bats should be reconsidered.

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ALLOZYMES AND THE BIOGEOGRAPHY OF THE LIZARDS OF THE GALAPAGOS ARCHIPELAGO. J. W. Wright and M. A. Simovich, Natural History Museum, Los Angeles, California.

Tissue samples representing the diversity of the lizards of the iguanid genus Tropidurus from the Galapagos Archipelago and mainland South America were subjected to allozyme electrophoresis. The allele distributions for genes coded by 32 loci were determined. These were treated both as genetic distance and character data and subjected to a battery of phenetic and phylogenetic analyses. The results provide significant new insights into the number and relative timing of founder events for the Galapagos populations and into the evolutionary histories and biogeography of the species and species groups on the mainland.

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THE PHYLOGENETIC RELATIONSHIPS OF BOLYERIID SNAKES: IMPLICATIONS FOR HIGHER LEVEL SNAKE SYSTEMATICS. F.J. Irish, Harvard University, Cambridge, MA.

Bolyeria and Casarea, now found only on tiny Round Island off the coast of Mauritius, form a monophyletic group characterized by the possession of an intramaxillary joint, a feature unique among amniote vertebrates. Their relationships to other snake lineages remain in dispute. Detailed anatomical studies of both preserved and osteological material reveal a combination of distinctly autapomorphic and apparently primitive characters. Derived features shared with advanced snake lineages may have been acquired independently through pedomorphosis. Critical examination of the latter hypothesis requires comparison with the supposed ancestral ontogeny, but identifying the appropriate primitive sister group is difficult. Snake evolution has proceeded largely by reduction and loss, and many primitive snakes are morphologically specialized, resembling members of similar habits in derived lineages. Thus recognition of primitive and derived character states is problematical, and most major snake lineages have not been adequately defined.

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XANTHINE DEHYDROGENASE ACTIVITY AS A MODULATOR OF PIGMENT CELL DIFFERENTIATION. S.K. Frost, M.E. Borchert*, S. Thorsteinsdottir* and S.J. Robinson*, University of Kansas, Lawrence.

Xanthine dehydrogenase (XDH) activity plays an integral role in the synthesis of purine (iridophore) and pteridine (xanthophore) pigments. In the Mexican axolotl several genes alter the types of pigment cells that differentiate in the skin: Melanoid axolotls have no iridophores, show a gradual (developmental) reduction in the number of xanthophores and an increase in melanophore number; axanthic axolotls lack both xanthophores and iridophores but have normal numbers of melanophores. XDH activity was assayed in skin and liver from wild type, melanoid and axanthic axolotls. Assays involved incubation of tissue extracts with pterin (XDH substrate) followed by separation of substrate and product (isoxanthopterin) by TLC and quantitation by scanning the TLC plate in a fluorometer. This technique revealed that levels of XDH are the same in axanthic and wild type tissues. In melanoids, however, XDH levels are substantially reduced. This and other biochemical and structural data suggest that melanoids result from defective XDH activity; axanthics do not.

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MECHANISMS OF MORPHOGENETIC SPECIFICATION IN SKULL DEVELOPMENT. P. Thorogood, Department of Biology, Southampton University, Southampton SO1 3TU, Britain.

The formation of cartilage and bone in vertebrate skull development is elicited by interactions between epithelia and mesenchyme derived either from the cephalic neural crest or from mesoderm. Transfilter culture and ultrastructural investigation have previously demonstrated that, in the avian embryo, chondrogenesis-promoting interactions are matrix-mediated. Immunohistochemical analysis has revealed a correlated compositional change in the extracellular matrix at the interface between such interacting tissues. Collagen type II is expressed in spatial and temporal patterns which i) map topographically with the sites of, and ii) correlate temporally with the duration of, chondrogenesis-promoting interactions which generate the cartilaginous neurocranium. A model will be introduced, proposing that the location and timing of collagen type II expression has a morphogenetic role by specifying, to a responsive mesenchyme, where and when a chondrogenesis-promoting interaction will take place.

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MORPHOLOGY AND DEVELOPMENT OF HEAD MESODERM IN EARLY EMBRYOS OF *SQUALUS ACANTHIAS*. E. H. Gilland, Harvard University, Cambridge, MA.

Embryos at stages from the first appearance of an embryonic thickening to well after the completion of neurulation were dissected and examined with SEM. The pro-otic mesoderm is organized into three regions corresponding to the classical hyoid, mandibular and premandibular "segments". However, the hyoid and mandibular regions are not simple, unitary structures; each comprises two somitomeres. The premandibular region derives from the prechordal plate. In *Squalus*, the prechordal plate is especially well differentiated from the anterior borders of the first pair of mandibular somitomeres and, unlike the condition in urodeles and amniotes, it is clearly a structural continuation of the notochord. Further development of the pro-otic mesoderm shows that the "head somites" of the Balfour-Goodrich segmentation scheme are secondary transformations of a greater number of earlier existing somitomeres and are therefore not serially homologous with trunk somites. A ventralward displacement of the somitomeres appears to give rise to the mesoderm of the mandibular and hyoid arches ("visceral tubes or stalks"), thus indicating that at least these two sets of branchial muscles may be somitic in nature. Supported by NIH GM-07598-07.

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VERTEBRAL DEVELOPMENT IN GYMNOPTERON AMPHIBIANS: RESEGMENTATION AND HOMOLOGY. M. H. Wake and D. B. Wake. University of California, Berkeley.

A number of authors have argued recently that resegmentation, or the composition of vertebrae from anterior and posterior halves of adjacent segments, and thought to occur in all terrestrial vertebrates, does not in fact occur. Therefore the phylogeny of vertebrae and the homologies of vertebral elements cannot be traced in terms of resegmented blocks of tissue. We present evidence for resegmentation in gymnopteron amphibians, now a key taxon in this debate. Gymnopteron amphibians have abundant sclerotome tissue, in contrast to other amphibians. Individuals have large numbers of segments and a strong developmental gradient. We present evidence of a division of sclerotome into more dense posterior and less dense anterior sclerotomites, and of a sclerocoel continuous with myocoel and nephrocoel. Posterior sclerotomites give rise to the neural pedicel rudiment, and we observe these cells in an intersegmental position. However, observational techniques do not allow the tracing of cell movements. To us, resegmentation is a subtle phenomenon, largely dependent on cell size and number. Supported by NSF.

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MECHANISMS OF HETEROCHRONY IN FROGS. S. Emerson and J. Travis*. Field Museum of Natural History, Chicago, Ill. and Florida State Univ., Tallahassee.

Frog species are often characterized by minor differences in relative hindlimb length. Heterochrony, or changes in developmental timing, can produce morphological differences in relative hindlimb length similar to those found among closely related species. The particular relationship between morphology and timing of development depends on which heterochronic mechanism is involved. Frogs raised under different environmental conditions show a negative phenotypic correlation between time to metamorphosis and relative hindlimb length. Relative hindlimb length and time to metamorphosis have a positive genetic correlation and no phenotypic correlation when frogs are raised under a single environmental regime. Consequently, selection on time to metamorphosis can result in a correlated response in relative hindlimb length because of the positive genetic correlation between the two variables. Supported by NSF Grants BSR83-05998 (SBE) and DEB81-02782 (JT).

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ONTOGENETIC REPATTERNING, A PROCESS UNDERLYING MORPHOLOGICAL TRANSITIONS IN THE EVOLUTION OF TERRESTRIAL SALAMANDERS. D. B. Wake and G. Roth*. Univ. of California, Berkeley, and Univ. Bremen, Bremen FRG.

The highly integrated feeding system of lungless salamanders (family Plethodontidae) has undergone dramatic change during the transition to complete terrestriality. The completely terrestrial Plethodontini has only modest abilities to feed by tongue projectility, and uses mainly tongue pad flipping. The equally terrestrial Bolitoglossini display extreme morphological and behavioral specialization for feeding using high speed, directional versatility, and long distance tongue projection. They differ from other plethodontids which use tongue projection, the *Eurycea* group, in many details. The *Eurycea* group is constrained in the degree of specialization for feeding by the existence of an aquatic larval stage and its development. The plethodontines, while lacking a larval stage, retain many of the developmental constraints and have evolved conservatively. By contrast, the bolitoglossines have experienced ontogenetic repatterning during the long embryonic period. Major differences are seen in eye frontality, in the development of the retinotectal projections, in the organization of the brain stem and spinal cord, and in the structure and functional morphology of the tongue skeleton and musculature. Ontogenetic repatterning counters the generally conservative nature of developmental systems and offers important opportunities for escape from systems of developmental and functional constraints on evolutionary transformations in morphology.

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MORPHOGENESIS OF THE CHELONIAN CARAPACE. A.C. Burke. Harvard University, Cambridge, MA.

The ribs and thoracic vertebrae of turtles are enclosed in a dermal carapace and are situated dorsal to the limb girdles. This situation is unique to turtles. The first appearance of the carapace is a thickening of the dermis which forms a ridge, dorsally circumscribing the trunk vertebrae of the otherwise typically vertebrate embryo. The dermal ridge forms a disc which grows radially, incorporating the ribs and overgrowing the scapula and ilium. Observations with light microscopy and SEM of cross sections through the incipient dermal ridge in embryos of *Chelydra*, *Chrysemys* and *Trionyx* show a relationship between ectoderm and mesoderm characteristic of epithelial-mesenchymal interaction. A marked thickening of the ectoderm overlies a condensation in the otherwise loose mesenchyme of the dispersing dermomyotome. This morphology is similar to that seen in the apical ectodermal ridge in the limb, which suggests a common mechanism of directional outgrowth. Thus a relatively simple developmental mechanism may be responsible for the radically altered chelonian *Bauplan*. Supported by NIH GM-07598-07

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ONTOGENETIC MODEL OF TOOTH MORPHOLOGY IN CARNIVORA.

R. Z. German and H. F. Winter*
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Because no cell resorption occurs during tooth ontogeny, a tooth documents the history of its growth. This research used the ontogenetic trajectory of a canine tooth as the basis of a morphologic model. This model consists of a specification of the initial numbers of cells and a set of equations describing the proliferation rate of these cells. Predictions from this model were made concerning relative shape during growth and the relationships that hold among adult teeth independent of size. These predictions were tested with 66 adult dog canine teeth and 40 incompletely formed teeth from dogs of known post natal age. The results indicate that the tooth shape can be defined by a single set of functions operating on species specific boundary conditions. The hypothesis that a common growth model exists for all Carnivora was tested using 30 species ranging in size from weasels to bears. The model that holds for dogs appears to be true for Carnivora, and differences in morphology are due to differences in the spatial distributions of cells prior to the start of growth.

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MORPHOLOGY AND HISTOCHEMISTRY OF GLYCOL METHACRYLATE EMBEDDED GRAVID MURINE UTERI. C.M. Conway, Y.S. Bilodeau*, and A.F. Conway. VA. Commonwealth Univ., Richmond, and Randolph-Macon College, Ashland, VA.

Gravid uteri, obtained from pregnant CD-1 mice on approximately day 10 of gestation, were fixed in cold buffered paraformaldehyde containing 2.5 mM calcium chloride and 0.1 M sucrose. Adjacent implantation sites were separated, dehydrated in glycol methacrylate, and subsequently embedded. Serial cross sections (2 μ) were stained for general morphology or according to histochemical protocols including periodic acid-Schiff (PAS), alpha naphthyl acetate esterase (ANAE), peroxidase-labelled goat antimouse IgG (P-GAM-IgG). Intracellular PAS positive material was present in some trophoblastic giant (TbG) cells located at the periphery of the developing placenta and in numerous large cells located in the decidua basalis (DB). These PAS positive decidual cells were in highest density near the developing placenta and near the myometrium. ANAE positive material appeared to be present in many of the TbG and decidual cells which were PAS positive. Staining with P-GAM-IgG was observed in the maternal blood spaces of the DB and decidua capsularis and between or on cells located in the DB.

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ANATOMY OF THE UPPER REPRODUCTIVE TRACT OF A PLANORBID FRESH WATER SNAIL. Nancy D. Green and A. F. Conway. Randolph-Macon Col., Ashland, Va.

Intact snails (Gyraulus sp.) were narcotized, fixed, decalcified, and embedded in Paraplast. Serial sections stained with Lillie's Azure-Eosin were used to reconstruct the structure of the reproductive tract. The gonad was an ovotestis composed of a series of anastomosing flattened hollow saccules oriented perpendicularly to the axis of the gonad. Developing sperm were found throughout the wall of most gonadal units, but developing oocytes were usually near the outer surface of the gonad. The gonadal units were connected to anastomosing ducts which merged to form the hermaphrodite duct at the surface of the gonad. The hermaphrodite duct was highly coiled near the gonad, then followed a straight course along the right side of the first body coil to the carrefour area. A series of 5 groups of 4 alveolar seminal vesicles evaginated from the surface of the hermaphrodite duct near its midpoint. The structure of the upper reproductive tract of Gyraulus sp. therefore differs markedly from published descriptions of the equivalent structures in closely related genera.

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COMPARATIVE ULTRASTRUCTURE AND PROTEIN UPTAKE OF TROPHOTAENIAL CELLS OF TWO GOODEID FISHES. F. Hollenberg and J. P. Wourms. Clemson University, Clemson, S.C.

Trophotaeniae are placental structures in viviparous goodeid fishes. Morphologically they are small rosette- or long ribbon-like evaginations of the embryonic hindgut. The ultrastructure of trophotaenial absorptive cells was compared in the goodeids Allophorus robustus (ribbon) and Goodea atripinnis (rosette) by transmission electron microscopy. The absorptive cells of Allophorus are characterized by numerous endocytotic pits and a prominent apical canalicular system (ACS). The apical part of the cells contain large vesicles (presumably lysosomes) and relatively few mitochondria. In Goodea cells there are few endocytotic pits. The ACS is poorly developed. There are few or no lysosome-like structures. Mitochondria are abundant. Horseradish peroxidase (HRP) was used to examine protein uptake. HRP was demonstrable in the ACS, and in transport vesicles and lysosomes of Allophorus cells following a 30 minute incubation. Little uptake was demonstrable in Goodea and this appeared limited to the ACS. We suggest these results reflect the utilization of different nutrient substrates by embryos of these species *in vivo*.

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PROTOTYPIC TROPHOTAENIAE AND OTHER PLACENTAL STRUCTURES IN EMBRYOS OF THE PILE PERCH, RHACOCILLUS VACCA (EMBIOTOCIDAE). J. P. Wourms and J. Lombardi. Clemson Univ., S.C. and Univ. of North Carolina, Chapel Hill.

Mid-gestation embryos (45mm TL) possess a hypertrophied hindgut. Elongated intestinal villi extend through an enlarged anus and probably absorb nutrients. Externalized intestinal villi are a prototypic stage in the evolution of trophotaeniae, structures that occur in goodeids, ophidioids, and a parabrotulid. Trophotaeniae, belong to the enterotrophic class of embryonic placentae. Tips of the hypertrophied fins possess spatulate extensions, termed epaulettes whose epithelial cells have stubby microvilli. Fin epithelial cells only have micropliae. At 55mm, few vestiges of trophotaeniae remain. Epaulettes are larger. Their epithelial surfaces have both stubby microvilli and fragmentary micropliae. They possess a capillary plexus supplied by a large artery and vein that run along each fin ray. Epaulettes are dermotrophic placentae that probably function in respiration and nutrition. Late in gestation, association of ovigerous folds and embryonic gill filaments constitute a branchial placenta.

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INTERACTION OF STEROIDS WITH OVARIAN TISSUE *IN VIVO* AND *IN VITRO* DURING OOCYTE GROWTH AND MATURATION IN BROOK TROUT (SALVELINUS FONTINALIS). C. A. LESSMAN, H. R. HABIBI* and R. C. COCHRAN. St. Francis Xavier Univ., N.S., Canada; Johns Hopkins Univ., Chesapeake Bay Inst., Shady Side, Md.

The effects of 17 β -estradiol (E2) implants *in vivo* on trout ovarian development were assessed in a longitudinal study. Ovarian biopsies were removed from females at monthly intervals. The biopsies were measured for largest oocyte size class, and tested *in vitro* for progesterone-induced meiosis reinitiation. Plasma E2 levels were monitored by RIA throughout the study. The results indicate an increase in E2 levels with increasing oocyte size in controls while E2 implanted animals had smaller or delayed peaks of plasma E2 with varying levels of follicle atresia. Ovarian follicles and oocytes denuded of somatic cells were incubated with 3 different radiolabeled progesterones. At 0, 6, and 24 h the incubates were extracted; the resulting extracts run on HPLC. Radioactivity associated with either follicles or denuded oocytes was lower than that in media extracts, and between 49 and 97% of exogenous steroid was converted over time to compounds with different retention times. This research was funded by NSERC of Canada. We acknowledge a gift of tritiated DHP from Drs. Weisbart and Idler.

A BINDING SITE ON THE SPERM PLASMA MEMBRANE WHICH RECOGNIZES THE MURINE ZONA PELLUCIDA. R. Richardson*, R. Robinson*, K. Hinds* and G.R. Poirier*, University of Alabama at Birmingham, Birmingham, Alabama.

Capacitated murine sperm bind to cumulus-free, zona pellucida-intact eggs at the apical portion of the sperm head. Pretreatment of such eggs with a purified preparation of the seminal inhibitor binding component (acceptor) isolated from murine cauda epididymal sperm significantly reduces the number of sperm that bind. Treatment of cauda sperm, preincubated under conditions known to induce capacitation, with the seminal inhibitor also reduces the number of sperm able to bind. These data are interpreted to mean that the seminal inhibitor acceptor on the sperm surface functions in the binding of sperm to the zona pellucida. Furthermore it suggests that the seminal inhibitor, which binds to the sperm surface at ejaculation, may protect the binding site until capacitation when such inhibitors are usually removed.

PROPERTIES OF A SEMINAL INHIBITOR BINDING COMPONENT ON MURINE SPERMATOZOA. R. Robinson*, R. Richardson*, K. Hinds* and G.R. Poirier University of Alabama at Birmingham, Birmingham, Alabama.

Murine cauda epididymal sperm contain a binding site on the plasma membrane which recognizes both proteinase inhibitors and the zona pellucida. Few sperm from the upper regions of the epididymis are able to bind inhibitor while the majority of those from the lower regions readily do so. Cauda epididymal and ductus sperm do not lose their ability to bind inhibitor after a 4-hour incubation in a medium known to induce capacitation. The proportion of ejaculated sperm with the seminal inhibitor bound to their surface decreases to about 10 % after 4 hours post coitus. However, approximately 80 % of these sperm show positive immunofluorescence when given the opportunity to rebind the inhibitor. Ultrastructural observations of the 4-hour uterine sperm revealed that 75 to 90 % of these cells have an intact plasma membrane over the apical portion of the acrosome. These data suggest that the binding site for the seminal inhibitor becomes functional during the epididymal sojourn and that it is not lost during capacitation.

SPERM INCORPORATION INTO THE TELEOST EGG. J. Wolenski and N.H. Hart. Rutgers Univ., New Brunswick, N.J.

During teleost fertilization, a single sperm is incorporated into the egg cytoplasm at a predetermined site of sperm entry (SES). The SES of *Brachydanio*, located in the animal pole, was a circular tuft of 15-20 microvilli that extend into the micropyle of the chorion. Routine TEM of the unactivated egg showed an electron-dense band of "filamentous material" subjacent to the SES. However, the band was visualized as a meshwork of 60-70 A filaments in cells fixed with tannic acid and saponin, and postfixed with osmium containing $K_2Fe(CN)_6$. A fertilization cone was formed at the SES with sperm head and mid-piece being incorporated within 1-2 min of gamete binding. During sperm entry, the band of filaments insinuated itself between the sperm nucleus and the egg plasma membrane. Filaments were difficult to discern in the core of the fertilization cone. Vesiculation of the sperm nuclear membrane was initiated shortly after sperm entry into the cytoplasm. Eggs treated with cytochalasin B (10 ug/ml) bind sperm to the SES; however, sperm were not incorporated into the cytoplasm. This suggested indirectly that sperm incorporation was dependent upon polymerization of actin filaments. (NIH supported)

TEMPERATURE AND BICARBONATE REQUIREMENTS FOR POLAR BODY FORMATION DURING *IN VITRO* MATURATION OF PORCINE OOCYTES.

L.A. Eng and E.T. Kornegay*. Virginia Polytechnic Institute and State University, Blacksburg.

The effects of culture medium composition, incubation temperature, and buffering system on polar body formation during porcine oocyte maturation *in vitro* were examined. Oocytes cultured at 39°C had a higher percentage of polar body formation than those cultured at 37°C. A culture medium based on Medium 199 with Earle's salts and supplemented with 15% young barrow serum was found to be superior to a modified Krebs-Ringer Bicarbonate medium (Toyoda & Chang, J Reprod Fert, 36:9, 1974) and just as good as a more complex formulation which is commonly used (Tsafiriri & Channing, J Reprod Fert, 43:149, 1975). If the bicarbonate buffer system (Earle's salts) of Medium 199 was replaced with a phosphate buffer system (Hank's salts), the rate of polar body formation was decreased. When the Hank's based medium was supplemented with a bicarbonate buffer system, polar body formation was restored to the level in Earle's based medium. This suggests that CO_2 /bicarbonate may be important for the normal maturation of porcine oocytes.

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ULTRASTRUCTURAL STUDY OF PRIMARY SPERMATOGONIA AND OOGONIA OF THE PLATYFISH. J.A. Flores, J.R. Burns and K.D. Kallman. George Washington Univ., Washington, DC and New York Zoological Society, New York.

To evaluate their degree of differentiation, electron microscopic observations on type A spermatogonia and oogonia are described. Both cell types were round to oval. Nuclear chromatin was clear and homogeneous, while perichromatin granules were rare. One to two nucleoli were present with distinct granular and fibrillar components. The nuclear diameter was significantly larger in type A spermatogonia ($9.3 \pm 1.3 \mu\text{m}$) than in oogonia ($6.5 \pm 1.3 \mu\text{m}$). Mitochondria of both cell types were spherical or slightly elongated with a clear matrix and were usually located at one cellular pole, occasionally possessing electron-dense granules. Nuage was associated with nucleopores and groups of mitochondria. Annulate lamellae appeared as long sheets paralleling the plasma membrane or as shorter pieces among mitochondria. Ribosomes were abundant as rosettes or sometimes associated with annulate lamellae. The Golgi, although present, was not prominent. Endoplasmic reticulum was even less frequent. It is concluded that few ultrastructural differences exist between these two cell types.

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A NEW TYPE OF BARRIER TO PARACELLULAR MOVEMENT OF MACROMOLECULES IN INSECT TESTIS. K.M. Baldwin*, M.J. Loeb, and J.G. Riemann. Howard Univ., Washington, D.C., USDA, Beltsville, MD, and USDA, Fargo, ND.

In insect testis, the germ cells develop as clones with each clone surrounded by somatic cyst envelope cells. The cyst envelope cells form a barrier separating the developing germ cells from the fluid in the testicular lumen. Our studies have been directed at elucidating the nature of this barrier. In Heliothis virescens testis, movement of macromolecular tracers (horseradish peroxidase and ruthenium red) into the germ cell cysts is blocked by a structure at the outer edge of the septate junctions joining the cyst envelope cells. This structure appears as a P-face ridge or an E-face groove in freeze fracture replicas, similar to a single-stranded tight junction. Unlike tight junctions, however, there is no fusion of adjacent cell membranes in this location. We conclude that a new type of occluding junction acts as barrier to paracellular movement of macromolecules in Heliothis testis.

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A MONOCLONAL ANTIBODY TO A 9.6Kd DIFFERENTIATION-SPECIFIC PROTEIN IN BEETLE ACCESSORY GLANDS. K.A. Grimes, C.S. Bricker and G.M. Happ. Univ. of Vermont, Burlington.

Monoclonal antibodies were produced against secretory proteins (plugs) of the bean-shaped accessory gland of Tenebrio molitor. One antibody (PL6.3) recognized a 9.6 kd protein present only in BAGs, plugs and spermatophores. A second antigen (5.0 kd) was also recognized, and may be a breakdown product of the larger protein. Antigen PL6.3 first appeared in 8 day pupal glands and increased 40-fold by the 8 day adult stage. Analysis of glands cultured with/without 20-hydroxyecdysone showed that hormone is necessary for in vitro antigen production. Antigen was restricted to type 5 and 7 of the eight cell types present in BAG. Ultrastructural studies showed antigen was present within type 5 and 7 granules, but not found in surrounding cytoplasm. Within the spermatophore, antigen PL6.3 surrounded the lumen and was localized to the whorled membrane layer identifiable at the ultrastructural level. Antibody PL6.3 will facilitate structural biochemical, and developmental analysis of this model system.

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PRELIMINARY OBSERVATIONS ON CORTICAL GRANULE COMPOSITION IN EGGS OF BRACHYDANIO. K. DAS*, N.H. Hart and J. Wolenski, Rutgers Univ., New Brunswick, N.J.

Studies have been initiated on the composition of cortical granules (CGs) of Brachydanio (teleost) eggs to evaluate the potential role of cortical granule exocytosis in the development of the vertebrate egg. Histochemically, CG contents showed strong, positive reactions with toluidine blue, PAS and Alcian blue 8GS stains, indicating the presence of mucopolysaccharides. Weak responses were recorded with general protein stains. To further examine the proteins of CGs, a method was developed to collect cortical granule exudate from 10 min activated eggs. Exudate (with chorions) from 50-75 eggs was treated with 0.125 M Tris-HCl (pH 6.8), 4% SDS, 20% glycerol and 10% mercaptoethanol, centrifuged for 5 min at 5000 rpm, and the supernatant then analyzed by SDS-PAGE using a 4% stacking gel with a 10% running gel. Four major soluble proteins were detected with Coomassie blue R-250 stain and 12 proteins with silver stain (Biorad). Polypeptide molecular weights ranged from 29K to 120K. Since the chorion did not appear to be solubilized during buffer treatment, these proteins are probably sequestered inside the intact granules. (Supported by NIH).

SEM VISUALIZATION OF MORPHOGENESIS DURING GASTRULATION IN THE SEA URCHIN, LYTECHINUS VARIEGATUS. J. Morrill, L. Santos*, S. Doyle* and S. Doty*. New College-USF, Sarasota, FL.

The overt appearance of dorso-ventrality and bilaterality during gastrulation is accompanied by the differentiation of at least 11 cell compartments: ciliated, apical plate ectoderm; anterior-ventral ectoderm; posterior-dorsal ectoderm; ventral-vegetal plate ectoderm; endoderm; primary mesenchyme (PMC) ring cells; PMC lateral arm cells; PMC spicule forming cells; secondary mesenchyme cells (SMC) and migratory pigment cells. Ectoderm and endoderm cells are ciliated, secretory, epithelial cells; PMC and SMC are invasive cells that probably alter the extracellular matrix (ECM) of the blastocoelic jelly and basal lamina. Spatial and temporal patterns of the ECM of the blastocoel accompany changing cell patterns beginning with the Okazaki cell pattern of the mesenchyme blastula. Primary invagination involves infolding, increase in cell number and cell migration of the vegetal plate. Secondary invagination and elongation of the endoderm accompany a non-linear increase in blastocoelic volume.

COMPARATIVE DEVELOPMENT OF AMBYSTOMA LATERALE AND A. MACULATUM. K.A. Talentino and E.M. Landre*. Simmons College, Boston, and Massachusetts Audubon Society.

Larval development of these two mole salamander species was monitored during a three-year study in a breeding pond where they are sympatric. Number of eggs/mass, mortality, and developmental stage were recorded, in addition to certain physical parameters of the pond. Post-hatching development was followed by collecting larvae with a mesh dip net. Larvae were also maintained in the lab in order to follow specific individuals through metamorphosis. Preliminary analysis indicates that number of egg masses deposited varies significantly from year to year. Yearly mortality rate is rather consistent for a specific developmental stage, but may be affected considerably by unusual weather conditions. A. laterale reached specific developmental stages earlier and attained greater total length and snout/vent length than A. maculatum prior to metamorphosis. Population levels of the two species have fluctuated significantly during the past five years. Massachusetts Audubon Society provided access to the field site. The Simmons College Fund for Research provided financial assistance.

THE EFFECTS OF METHYLAZOXYMETHANOL ACETATE ON THE DEVELOPING CHICK EMBRYO. N.K. Farzaneh, A.A. Hagan and J. Hill*. The American University, Washington, D.C. and The National Institutes of Health, Bethesda, Maryland.

Methylazoxymethanol acetate (MAM) is an antimetabolic, teratogenic agent which arrests cerebral development in mammals. To ascertain if MAM affects avian development, graduated doses of MAM were introduced into White Leghorn chicken eggs. Ninety eggs were injected with 0.20 cc saline, 10 mg/kg MAM or 20 mg/kg MAM dosages during days three, four or five of incubation. Factors used in assessing the effects of MAM were survivability of the eggs, brain and body weights, external brain measurements and histology of the forebrain. The study revealed that MAM has an effect on chick development. There were marked decreases in the overall size and weight of the bodies and brains of the MAM-treated chicks compared to the control chicks on the various days of treatment. The effect of MAM is dose-response and time related. The greatest reduction in brain size appeared on day three of incubation in the highest dosage group of MAM administration (20 mg/kg). Body weight was proportionally more reduced than brain weight on day three in the highest dose group.

DEVELOPMENT OF AXONAL PROJECTIONS FROM APPENDAGES TRANSPLANTED AT DIFFERENT ECTOPIC SITES IN AN INSECT. P. Sivasubramanian and D.R. Nässel*. University of New Brunswick, Fredericton, N.B., Canada, and University of Lund, Lund, Sweden.

Specificity of axonal pathfinding by growing neurons within the central nervous system (CNS) was studied in the fleshfly, Sarcophaga bullata. The axons were forced to enter the CNS at inappropriate sites by transplanting various organ primordia (leg, wing or haltere imaginal discs) at ectopic sites into host prepupae. Upon completion of metamorphosis, the sensory projections from these supernumerary appendages were examined by horseradish peroxidase tracing techniques. Although the majority of the ectopic neurons entered the CNS via one of the host's abdominal nerves, the halteres and wings projected almost always into their appropriate dorsal neuropil by following their specific pathways. This was true even if they were transplanted at ventral locations. However, no such specificity was noticed with ectopic legs. While the supernumerary legs developing at ventral and lateral sites projected into the leg (ventral) neuropil, most of the dorsally transplanted legs projected into inappropriate sites namely, dorsal neuropil. Why ectopic legs from dorsal sites innervate inappropriate neuropil whereas the ectopic haltere and wing neurons from ventral sites manage to find their specific projection sites is highly speculative at this time. Perhaps, the difference lies in the different types of sensillae present in these appendages.

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ETHANOL INFLUENCE ON GROWTH IN CHICK NEURAL RETINA CELLS. G. W. Kalmus, D. L. Lee*, and S. N. Pennington*. East Carolina Univ., Greenville, N. C.

It is proposed that ethanol reduces growth of an organism via a cyclic 3', 5' adenosine monophosphate (cAMP) mechanism. Growth and cAMP concentrations were measured in response to varying ethanol dosage in cultured chick neural retina cells. Ethanol alone (50 mg/dl) did not significantly reduce the total protein and did not appear to affect the DNA content of the cells. However, when a phosphodiesterase inhibitor was added at low concentrations (11.5 ug/ml of 1-methyl, 3-isobutylxanthine, MIX) to the ethanol sample, protein and DNA content was significantly reduced. Total protein content in the ethanol samples supplemented with MIX were reduced 19% compared to the vehicle values. Cyclic-AMP values for the ethanol samples alone were 20% higher than the controls while the ethanol plus MIX group was 24% higher than the vehicle group. This data suggests that although ethanol increases cAMP values, a phosphodiesterase inhibitor is necessary to maintain the higher cAMP concentrations, thus eliciting a cAMP mediated response that affects growth.

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THE BINDING OF MANNOSE TO CHICK CORNEAL EPITHELIAL CELLS IS IMPLICATED IN CELL ADHESION AND DESMOSOME FORMATION. M. McKisic* and J. Overton. Univ. of Chicago, Chicago, IL.

Cell adhesion and desmosome formation were studied in 11 and 15-1/2 day chick corneal epithelial cells by investigating cell interactions involving surface sugars and carbohydrate binding molecules. Older cells, which have a higher frequency of desmosomes, aggregated at a faster rate and formed more rosettes. Adhesive cell interactions involving 15-1/2 day cells, but not 11 day cells, appeared to be altered by mannose and its derivatives. Also, the aggregation of older cells was partially inhibited by cleaving high mannose groups from surface glycoproteins with the glycosidase endo-B-N-acetylglucosaminidase (Endo H), but was not affected by neuraminidase (NANase). The binding of labeled mannose to 11 and 15-1/2 day cells indicated that a greater number of high affinity, $K_D 4.4 \times 10^{-9} M$, binding sites were present on older cells. Furthermore, 15-1/2 day cells aggregated in the presence of Endo H or NANase formed fewer desmosomes, compared to the controls. These results suggest that the interactions between endogenous sugar residues and specific carbohydrate binding sites mediates cell adhesion and desmosome formation. Supported by NSF PCM 8316412.

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IN-VITRO RESPONSE OF PALATAL EPITHELIUM FROM THE EMBRYONIC MOUSE TO DIFFERENT EXTRACELLULAR MATRICES. M.S. Tyler, S. Tyler, and R.M. Pratt. Univ. of Maine, Orono, and NIEHS, Res. Tri. Pk., NC.

Palatal epithelium isolated enzymatically from 13-day embryonic mice was grown in primary culture to determine specificity of response to two extracellular matrices (ECMs): one (HR9-ECM) produced by a mouse-derived endodermal cell line, PF-HR-9, and one (CE-ECM) produced by bovine corneal endothelial cells. Results were analyzed using autoradiography of [³H]thymidine-labelled cultures and electron microscopy. On HR9-ECM, attachment was poor. Addition of cholera toxin (1ug/ml) and epidermal growth factor (EGF, 20ng/ml) together, but not individually, enhanced attachment. On CE-ECM, the epithelium attached, and spreading was enhanced by addition of EGF. EGF caused the medial epithelium to be maintained and promoted proliferation of oral but not nasal epithelium. Keratinocytes developed in the oral region, and squamous as well as ciliated rounded cells appeared in the nasal region. Palatal epithelium, therefore, was specific in its response to different ECM's. Supported by NIH Grant DE-04859. ECMs courtesy of D. Gospodarowicz, UCSF.

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DEVELOPMENT OF THE URINARY BLADDER IN RANA CATESBIANA TADPOLES. T.L. Powell and J.J. Just. Univ. of Ky., Lexington.

Growth and differentiation of the urinary bladder were examined at various stages of metamorphosis (Taylor-Kollros). Bladder weight (mg) per animal weight (g) at stage XVI was 0.054 ± 0.03 mg/g and increased to 1.13 ± 0.04 mg/g at stage XXIV. Two week froglets were not significantly different from adults at 1.44 ± 0.21 mg/g. A saline column, 0.4 cm in diameter, was used to fill the bladder through a cannula secured in the cloaca. Volumes were determined at a minimum of three hydrostatic pressures. Maximum volumes were reached at filling pressures of 10 to 30 cm saline and ranged from 0.33 ± 0.16 ml at stage XX to 1.80 ± 0.78 ml at stage XXIV. Maximum volumes were 4, 13, 22, and 28 percent of total body weight at stage XX, stage XXIV, two week froglets, and adults, respectively. Light microscope examination, using H & E staining on 12 μ sections, revealed initial appearance of the bladder at stage XII. Cells comprising the bladder appear the same at all stages. Electron microscope studies and bladder development during thyroxine induced metamorphosis are currently being conducted. Two other species of anurans have been examined and similar patterns of urinary bladder development are indicated.

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PEROXISOMAL B-OXIDATION IN BROWN FAT OF PERINATAL RABBITS. LP MANGURIAN AND RP DONALDSON*. George Washington Univ. Wash. D.C. Peroxisomes were isolated from brown fat of perinatal rabbits, not cold acclimated. Overall B-oxidation as well as the individual enzymes, acyl-CoA oxidase, hydratase, hydroxyl acyl-CoA dehydrogenase and thiolase, were measured. Acyl CoA oxidase is the rate limiting enzyme. The specific activities of catalase and acyl CoA oxidase were highest in 25 day old fetuses and then decreased progressively in postnatal rabbits. Mitochondrial cytochrome c oxidase on the other hand was greatest in newborns. Electron micrographs corroborate these findings. Densely packed mitochondria were seen in the newborns in contrast to less densely packed mitochondria in 25 day fetus. Visually, peroxisomes were more dense in fetuses compared to older rabbits. We have also found in purified peroxisomal fractions palmitoyl-CoA dependent cytochrome c reductase activity insensitive to Antimycin A and KCN. This activity is not present in mitochondrial fractions. We suggest the possibility of an electron transport system in the peroxisome which might channel reducing equivalents produced during peroxisomal fatty acid oxidation.

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STUDIES ON THE EXTRACELLULAR MATRIX IN REGENERATING LIMBS OF LARVAL URODELES. C. Cox and A. Mescher. I.U. Bloomington.

Amphibian limb regeneration is nerve-dependent and involves complete remodeling of the extracellular matrix (ECM) in the stump tissues. These changes in the ECM include synthesis and accumulation of hyaluronate. Since a hyaluronate-rich matrix is characteristic of several embryonic tissues in which cell migration and proliferation are active, this change in the ECM of the limb stump may be of key importance for the cellular events leading to limb regeneration. To ascertain whether the neural influence affects production of hyaluronate, we examined by histochemistry and microspectrophotometry the ECM in denervated limb stumps of *Ambystoma* larvae as they became reinnervated and began to regenerate. Such limb stumps show dedifferentiation and increased cell density in distal areas. Upon reinnervation, cell density is reduced and active cell proliferation begins. The decrease in cell density is accompanied by accumulation of extracellular hyaluronate. Stimulation of hyaluronate synthesis by the dedifferentiated cells may therefore be part of the growth-promoting effect of nerves in limb regeneration.

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PIGMENTARY PATTERN FORMATION INDUCED BY AUTOGRAFTED ERYTHROPHORES IN THE NEWT. Robert A. Zaccaria. Lycoming College, Williamsport, Pa.

Chromatophores of the black-ringed red spots in the red-spotted newt (Forbes, Zaccaria, and Dent, 1973) and of the black-bordered stripes in the broken-striped newt (unpub. obs.) constitute a dermo-epidermal chromatophore unit. The spots or stripes consist of epidermal erythrophores underlaid with dermal iridophores and are bordered by dermal melanophores. The maintenance of the pigmentary pattern as well as its reformation following partial surgical disruption was shown to be dependent on the presence of the erythrophores (Zaccaria, 77). In the present study, following the removal of the skin between two spots or stripes, an erythrophore-bearing wound epithelium developed. The epithelium was then auto-grafted to a recipient site which had been denuded of whole skin. At this site, iridophores from the surrounding dermis migrated under the transplanted erythrophores, and eventually, scattered dermal melanophores aggregated at the periphery of this pigmentary unit. The erythrophores thus induce the ectopic and *de novo* development of a highly organized pigmentary pattern.

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THE MESOGLEA OF HYDRA IS SYNTHESIZED BY BOTH ECTODERM AND ENDODERM. L. Epp., I. Smid* and P. Tardent.* Mount Union College Alliance, Ohio and University of Zurich, Switzerland.

Synthesis of hydra mesoglea was investigated in "reassembled" hydra, i.e. hydra regenerating from previously isolated and then recombined ectoderm and endoderm. Mesoglea remains adherent to the endoderm after tissue separation. TEM indicates that after reassembly "old" mesoglea is digested within the endoderm and a "new" mesoglea is synthesized. New mesoglea is first visible with TEM about 12 hours after tissue reassembly. The mesoglea has a normal appearance after about 48 hours. Ultrastructurally, it appears that both ectoderm and endoderm contribute to mesoglea synthesis. This was confirmed by autoradiography after individually labelling either ectoderm or endoderm with tritiated amino acids prior to tissue reassembly. Other autoradiographic studies, using intact hydra, indicate very rapid initial incorporation (5-6 hours) and long residence time (more than 2 weeks) of amino acids within the mesoglea.

Supported by NSF-INT 8304376 and Swiss NSF 3.174-0.81.

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THE EFFECTS OF X-IRRADIATION ON THE METAMORPHOSIS AND BUDDING OF *AURELIA AURITA*. M.J. Prokopchak*, D.B. Spangenberg and J. Shaeffer*. Eastern Virginia Medical School, Norfolk, Va.

With the aid of the *Aurelia* Metamorphosis Test System, the acute and subtle morphological and behavioral effects of irradiation on the Norfolk *Aurelia aurita* was described and the sensitivity to X-irradiation of those organisms receiving thyroxine and those not receiving thyroxine was compared. Levels of radiation were 0 (control), 5,000, 10,000, 15,000, 20,000 and 40,000 rads. Morphology of the ephyrae, including statolith and rhopalia numbers, were recorded using the light microscope. Developmental abnormalities of the scyphistomae and ephyrae were recorded with the scanning electron microscope and light microscope. Major findings from this investigation were the absence of rhopalia and statoliths following exposure with 15,000 and 20,000 rads, the decrease in pulse rate of developed ephyrae, and the development of two-bodied scyphistomae.

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STRUCTURAL AND FUNCTIONAL ORGANIZATION OF THE NERVOUS SYSTEM IN HYDRA: I. FEEDING BEHAVIOR RECOVERY DURING REPOPULATION OF NERVE-FREE HYDRA. B.A. Marcum and D.A. Clark*. California State Univ., Chico.

Hydra possess a diffuse nervous system composed of different nerve cell types arranged in a loose network. This nervous system coordinates complex behavioral patterns including the feeding response. At least 3 processes, tentacle waving, tentacle ball formation and mouth opening, comprise the feeding response; and each can be elicited by distinct chemical stimuli (Koizumi, *et al*, 1983). Reduced glutathione (GSH) stimulates the entire feeding response and has been shown to be the normal feeding behavior activator (Lenhoff, 1961). Experimentally produced nerve-free hydra display no spontaneous behavior nor do they respond to GSH. This study used nerve-free hydra, grafting techniques, and a GSH assay to characterize the functional reorganization and restoration of the nervous system. Homografts and heterografts of *H. attenuata* and *H. oligactis* were monitored daily for GSH sensitivity. In all cases the 3 distinct behavioral components, tentacle waving, tentacle ball formation and mouth opening returned sequentially rather than simultaneously. This gradual recovery coincided with a gradual increase in nerve cell numbers.

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A MORPHOLOGICAL VARIANT OF THE CHRYSAORA POLYP (CNIDARIA, SCYPHOZOA). R. E. Black. College of William and Mary, Williamsburg.

A clone of polyps having reduced tentacle number and greatly exaggerated, stolon-like basal structures has been maintained asexually through 15 passages over five years. No spontaneous strobilation has been seen, but strobilation can be induced in a low percentage by cold conditioning. Ephyrae are abnormal in form and nearly nonmotile. Cross-sections of the polyp show that cells of the epiderm are much more densely packed and columnar than normal. Chimaeras made from reaggregates of normal and abnormal cells are intermediate in form at first but resemble only the aberrant form after several weeks. The unusual form of the polyp could be produced by rapid cell division in the gastric region, with too few tentacle-forming sites, forcing cell movement toward the basal end. The possible action of morphogens has not been investigated.

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NUCLEOCYTOPLASMIC INTERACTION IN THE DE NOVO BIOGENESIS OF PLANARIAN MITOCHONDRIA. M. Morita, FL. Hall, and JB. Best. Colo State Univ, Ft Collins, CO

The historic conception of the mitochondrion as an acquired endosymbiont is challenged by a variety of evidence, which tends to replace the notion of mitochondrial autonomy with the demonstration of profound nuclear control. Certain nuclear emissions, referred to as chromatoid bodies in oocytes and as nuclear satellite material (NSM) in planarian stem cells, appear to be intimately associated with mitochondria. This nucleocytoplasmic interaction was investigated with electron microscopy in the totipotent planarian neoblast, and in a chemically transformed planarian cancer cell which displayed an exaggerated production of both NSM and mitochondria, and revealed a sequence of mitochondriogenesis which had remained hitherto obscure. The emission of precursor material from nuclear pores during a brief "critical period" prior to cellular differentiation, followed by a series of intermediate morphogenic stages, characterize the assembly of new mitochondria. These results suggest de novo assembly from NSM as the ultimate origin of the mitochondrion, with subsequent replication as penultimate biogenesis.

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THE SOFT TISSUE-BONE INTERFACE: HOW DO ATTACHMENTS OF MUSCLES, TENDONS AND LIGAMENTS CHANGE WITH AGE? A LIGHT MICROSCOPY STUDY. J.R. Hurov. Univ. of Texas, Austin.

Attachments of the popliteus muscle, semitendinosus tendon, medial collateral knee ligament and extensor retinaculum were studied histologically in rabbits aged 2-60 days. Soft structures inserted principally into fibrous periosteum or perichondrium in the age range studied. An extensive collagen fiber framework in cellular periosteum, present by at least 2 days of age, linked fibrous periosteum to subjacent skeletal connective tissue matrices. Maturation of soft tissue-bone interfaces was viewed from 2 related perspectives; 1) temporal patterns of skeletal connective differentiation and 2) incorporation of attachments into skeletal connective tissue matrices during growth and remodeling. Skeletal connective tissue differentiation and remodeling varied between attachment regions of single muscles and ligaments. Insertion regions were characterized by coarse-fibered periosteal bone and chondroid bone, both morphologically intermediate between cartilage and lamellar bone. Supported by PHS AML9632 and DE07047.

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EFFECTS OF DOPAMINE AND NEUROPEPTIDES ON THE ISOLATED EYESTALK OF THE FIDDLER CRAB. T.A. Butler and M. Fingerman. Tulane Univ., New Orleans, LA.

The neuroendocrine system of the eyestalk of the fiddler crab, Uca pugnator, releases pigmentary hormones. Eyestalk ganglia were bathed in transmitter- or neuropeptide-containing solutions. The resulting superfusates were then assayed in isolated legs for chromatophoretropic activity. Eyestalks bathed in dopamine (DA) (10^{-5} to 10^{-4} M) released both black and red pigment concentrating hormones. Haloperidol (10^{-6} M), a DA antagonist, blocked this release. Met-enkephalin (Met-Enk) (10^{-10} to 10^{-4} M) also elicited the release of both hormones, and its action was blocked by naloxone (10^{-6} M). FMRFamide (10^{-11} to 10^{-5} M) released red, but not black, pigment concentrating hormone. Naloxone (10^{-6} M) had no effect on the action of FMRFamide. When injected directly into isolated legs, neither Met-Enk nor FMRFamide produced pigment concentration. Supported by NSF Grant PCM-8300064.

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VERIFICATION OF THE MAJOR FORM OF PIGMENT-DISPERSING HORMONE IN THE EYESTALKS OF UCA PUGILATOR. C. A. Zahn and K. Ranga Rao. Univ. of West FL, Pensacola, FL.

Crustacean pigment-dispersing/light-adapting hormones occur in multiple forms. The first characterized hormone (DRPH, α -PDH), NSGMINSILGIPRVMTAAamide, was identified as the major form in the eyestalks of the prawn Pandalus borealis (Fernlund, 1971, 1976). Recently a novel form of this hormone (β -PDH), NSELINSILGLPKVMMDAAamide has been characterized as the major form of PDH in the fiddler crab Uca pugnator (Rao et al., 1985). The extraction procedures employed in these two studies were different. In order to determine whether these procedures contributed to differential extraction of the multiple forms of PDH, the Uca PDH was re-extracted and chromatographed according to the procedure for Pandalus. β -PDH was found to elute at about 1 column volume on cation-exchange chromatography and account for 91% of the recovered activity. A peak corresponding to α -PDH was absent in Uca. This shows that regardless of the extraction procedure, β -PDH is the major form of this hormone in eyestalks of Uca. (Supported by NSF grant DCB-8314737)

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C-TERMINAL DELETION ANALOGS OF A CRUSTACEAN PIGMENT DISPERSING HORMONE. J. P. Riehm* and K. Ranga Rao. Univ. of West FL, Pensacola, FL.

This study deals with the effect of deamidation and C-terminal truncation on the potency of Pandalus DRPH (α -PDH): Asn-Ser-Gly-Met-Ile-Asn-Ser-Ile-Leu-Gly-Ile-Pro-Arg-Val-Met-Thr-Glu-Ala-NH₂. Bioassay of synthetic analogs for melanophore pigment dispersion in destalked fiddler crabs (Uca pugnator) showed that deamidation causes a 300-fold decrease in potency. The analogs 1-17-NH₂ and 1-16-NH₂ were about 3 times more potent than 1-18-OH. Further truncation led to decreases in potency, with the peptide 1-9-NH₂ being the smallest C-terminal deletion analog to display activity (0.001% potency). Smaller analogs (1-8-NH₂, 1-6-NH₂ and 1-4-NH₂) were inactive when tested in doses as high as 500 nmoles/crab. These results along with work on N-terminal deletion analogs are expected to help identify the core sequence important for PDH action. (Supported by NSF grant DCB-8314737)

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THE EFFECT OF VIBRATION, CENTRIFUGATION, AND LIMB AUTOTOMY ON CHROMATOPHORES IN UCA PUGILATOR. R. E. Weinstein*, J. M. Roberts*, and C. F. Herreid II. SUNY/Bufalo.

Exercise in fiddler crabs promotes a color change: melanophores show pigment concentration, erythrophores and leucophores show pigment dispersion. Blood removed from the exercised crabs and injected into isolated Uca pugilator leg segments causes similar changes, suggesting the presence of a blood-borne factor. In an effort to see if other stresses cause chromatophore changes we subjected Uca pugilator to high frequency mechanical vibration in a sonic cleaner and observed melanophore pigment concentration and erythrophore and leucophore pigment dispersion. Blood drawn from crabs subjected to vibration caused similar chromatophore changes in isolated leg segments. In experiments involving gravitational stress, where Uca pugilator were spun in a centrifuge at 1,500 RPM, again chromatophores altered as they did in both exercise and vibration. Similar results seen in the exercise, vibration, and centrifugation experiments suggest that stress in general causes the presence of a blood-borne factor which induces chromatophore responses. Autotomy did not induce any changes in chromatophores.

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HORMONAL MODULATION OF PHEROMONE-MEDIATED BEHAVIOR IN A CRUSTACEAN. R. A. Gleeson, M. A. Adams* and A. B. Smith III*. C. V. Whitney Laboratory, Univ. of Florida and Monell Chemical Senses Center, Phila.

Courtship display behavior in the male blue crab, Callinectes sapidus, is normally triggered by a pheromone which is present in the urine of pubertal females. Recently it was discovered that with bilateral ligation of the eyestalks of males, frequent bouts of spontaneous display behavior are induced within a few days. The objective of this study was to determine whether the induction of this behavior is due to a loss of neural input from the eyestalk ganglia, or from the absence of a hormonal factor(s) elaborated and/or released in the eyestalk. In experimental males the optic nerves were cut using a procedure which did not disrupt hemolymph flow to the eyestalks. Spontaneous display behavior was virtually absent in the experimental group relative to controls. These results indicate the presence of an eyestalk hormone which modulates the activity of CNS pathways organizing the behavior. A positive correlation with hypertrophic changes in the androgenic glands and display activity suggests a possible role of androgenic hormone(s) in the regulation of this behavior. [Supported by NSF grant #PCM-8308776].

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JUVENILE HORMONE-LIKE COMPOUNDS IN LIBINIA EMARGINATA. H. Laufer, D.W. Borst, F.C. Baker*, and D.A. Schooley*. Univ. of Connecticut, Storrs, Illinois State Univ., Normal, and Zoecon Corp., Palo Alto, CA.

JH-like compounds may have important roles in the regulation of crustacean reproduction and larval development. To determine the presence of such compounds in Libinia, we analyzed its hemolymph by GC/MS procedures. Both methyl farnesoate (MF) and JHIII were detected at concentrations of 10-50 ng/ml and 3-30 pg/ml, respectively. We also examined several tissues for the secretion of these compounds during incubation with methyl-radiolabeled methionine. Only mandibular organs (MOs) secreted material that co-eluted on HPLC with MF and JHIII, with rates of synthesis from 1-20 ng and 1-10 pg/gland/hr, respectively. The identity of both compounds was further confirmed by GC/MS. However, the low levels of JHIII detected in both hemolymph and culture medium appear to reflect the non-specific chemical oxidation of MF during analysis. Therefore, our data suggest that MF may be a crustacean JH or a prohormone that is converted by peripheral tissues to some other active compound (such as JHIII). (Supported in part by Sea Grant NA82AA-D-00018 and NSF grant PCM82-08665).

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METHYL FARNESOATE PRODUCTION BY THE CRUSTACEAN MANDIBULAR ORGAN. D.W. Borst, M. Sinkus*, and H. Laufer. Illinois State Univ., Normal, and Univ. of Connecticut, Storrs.

We have recently reported that methyl farnesoate (MF) is secreted by the mandibular organs (MOs) of Libinia emarginata. To determine the generality of this observation, we analyzed the secretory products of MOs from several other crustaceans, including Cancer borealis, Callinectes sapidus, Cambarus bartonii, and Homarus americanus. MF was secreted by MOs from males and females of these species. Rates of MF secretion varied considerably between individuals of each species, but were generally higher in Brachyurans (up to 33 ng/mg gland/hr) than in Macrurans (up to 0.1 ng/mg/hr). The secretory rate of MOs from females appeared to be correlated with vitellogenesis in some species. In Libinia, MOs from non-vitellogenic juvenile females secreted low levels of MF (<0.1 ng/gland/hr) while adult females secreted higher amounts (3-38 ng/gland/hr). Likewise, MF secretion by MOs from female Homarus was highest in vitellogenic individuals. Our data suggest that MF is a common product of the crustacean MOs and may be involved in the regulation of vitellogenesis in the female. (Supported in part by Sea Grant NA82AA-D-00018).

EXTRACTS OF EYESTALKS FROM FIDDLER CRABS CONTAIN HIGH LEVELS OF ECDYSTEROIDS. P.M. Hopkins. Univ. of Oklahoma, Norman.

Eyestalks were removed from recently collected fiddler crabs, *Uca pugilator*, at the Florida State Univ. Marine Lab during the summer. The eyestalks were frozen and lyophilized at the station and returned to Oklahoma for bioassay. Eyestalks were extracted in deionized, distilled water, sonicated for 60 secs, put in a boiling water bath for 10 mins and centrifuged at 15K X g for 3 mins. The precipitate was discarded and the supernatant was applied to an HPLC Bio-Sil TSK 250 column (BioRad). The effluent was monitored at 280 nm. A large peak at the tailing end of the effluent had very high ecdysteroid-like RIA activity. Other extraction protocols plus RIA, HPLC-TSK 125 separation, C-18 reversed phase HPLC separation, thin-layer chromatography and mass spectrometry substantiated that the compounds extracted from the eyestalks were, indeed, a mixture of ecdysone, 20-hydroxyecdysone and other metabolites of ecdysone. Levels of ecdysteroid extracted were as high as 2000 pg per single eyestalk. The ratio of ecdysone to 20-hydroxyecdysone was 8:1. The implications of these results in light of much earlier reports of high titers of juvenile hormone in the crustacean eyestalk and of ecdysones in other anterior segments of crustaceans will be discussed.

ECDYSTEROIDOGENESIS BY CRAB Y-ORGANS IN VITRO: CALCIUM ANTAGONIZES cAMP-MEDIATED INHIBITION BY MIH. M.P. Mattson and E. Spaziani. Dept. of Biology, University of Iowa, Iowa City, Iowa 52242.

The eyestalk putative neuropeptide, molt-inhibiting hormone (MIH), suppresses Y-organ ecdysteroid secretion by raising cAMP. Basal secretion was enhanced by external Ca; MIH suppression did not require ext. Ca but its action was blunted by high ext. Ca. Inhibitors of Ca transport mimicked, and enhanced, MIH action, whereas a Ca ionophore raised basal secretion 3-fold and completely blocked MIH action, even in 0 ext. Ca. Effects on secretion by forskolin or dbcAMP, which mimic MIH, were inhibited by ext. Ca but an MIH-mimicking inhibitor of phosphodiesterase activity (IBMX) was not affected. Ext. Ca or ionophore lowered cAMP; MIH or IBMX increased cAMP, effects which were blunted by raising ext. Ca. A calmodulin blocker (TFP) depressed ecdysteroid secretion, increased cAMP and dramatically enhanced the action of MIH or forskolin in raising cellular cAMP. Phosphodiesterase activity, measured directly, increased linearly with ext. Ca and was lowered by TFP. Apparently, Ca, released intracellularly, counters MIH action by decreasing cAMP through a calmodulin-linked rise in phosphodiesterase activity.

CELLULAR CONTRIBUTION TO THE REGENERATION BLASTEMA IN THE AXOLOTL. K. Muneoka, University of California, Irvine.

The cellular contribution to the blastema from three different tissues of the limb stump has been analyzed using the triploid/diploid cell marker in the axolotl. Grafts of full skin, cartilage and nerve sheath were made from triploid donors into diploid hosts. Quantitative data for the percent contribution to the medium bud blastema from these tissues was gathered from histological sections of experimental chimeric blastemas as compared to control triploid blastemas. The cellular contribution from dermal tissues was found to be strikingly high; ranging as high as 78% of the blastemal cells with a mean of 46%. The dermis itself was found to represent only about 19% of the stump cells thus indicating that the dermis overcontributes by greater than 2 fold to the blastema. Conversely, both the cartilage and the nerve sheath undercontribute relative to the percent of cells they represent in the stump. These data correlate with the influence these various tissues have on the formation of the limb pattern during regeneration. Supported by NIH Grant HD 06082.

PATTERN ONTOGENY OF CHROMATOPHORE ORGANS IN THE SKIN OF CEPHALOPOD MOLLUSCS. R.T. Hanlon. Marine Biomedical Inst., Univ. Texas Medical Branch, Galveston.

Squids and octopuses use complex body patterns to communicate. The basic elements of this system are pigmented, neurally controlled chromatophores in the dermis. To observe morphological pattern formation, 6 octopuses (*O. joubini*) and 14 squids (*Sepioloa robusta*, *S. affinis*) were reared from hatching through 3 months, and photomicrographs were made of the dorsal mantle skin every 2 weeks. These species have a simple pattern repertoire and only yellow and brown chromatophores. The standard morphological array is non-random, consisting of larger brown chromatophores interspersed with smaller yellow chromatophores; mean density of chromatophores is 6 per mm² in *Sepioloa*. During ontogeny, some yellow chromatophores develop into browns in as little as 6 days. There appears to be a zone of lateral inhibition around all chromatophores, resulting in new yellows developing in unoccupied spaces of the skin. The rate of recruitment of new chromatophores is about 0.8 chromatophores per mm² per week in *Sepioloa*. Since each chromatophore is large, highly visible and controlled neurally, cephalopods may be useful in studying positional information at the organ level.

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ENVIRONMENTAL INFLUENCES ON OVUM SIZE IN A LABORATORY POPULATION OF THE FROG, BOMBINA ORIENTALIS. R. H. Kaplan. Reed College, Portland, OR.

Thirteen individual oriental fire-bellied toads, Bombina orientalis, were each bred four times. Prior to breeding an individual was kept for a minimum of eight weeks at either 24°C or 16°C with food ad libitum or at a reduced level. Breeding was induced with human chorionic gonadotropin after which the female was transferred in a random fashion to one of the remaining four treatments. All of the ova of a clutch were measured to the nearest 0.01 mm. It was found that single females can produce viable ova of very different sizes at different times. The mean values for an individual ranged from 2.25 to 1.95 mm. The amount of food provided had the greatest effect with decreased food resulting in a significant decrease in ovum size. A significant food x temperature interaction indicated that this effect was greater at the warmer temperature. These data are the first to show that the natural variation in ovum size and the consequences of such variation in amphibian populations may be primarily due to the plasticity of the vitellogenic process within a given individual.

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VARIATION IN RELATIVE CLUTCH MASS IN SNAKES AMONG AND WITHIN SPECIES. R. A. Seigel*, N. B. Ford, and H. S. Fitch*. Savannah River Ecology Laboratory, Univ. of Texas-Tyler, and Univ. of Kansas.

We examined the relationship between relative clutch mass (RCM) and female body size (SVL) both within and among different species of snakes. In 10 of 12 within-species comparisons, RCM varied independently of SVL. We suggest that this independence of body size and RCM is explainable on ecological grounds alone. In among-species comparisons, RCM decreased with increasing body size in both viviparous colubrids and viviparous viperids, but only the colubrid sample was statistically significant. In 20 egg-laying colubrids, RCM increased slightly (but not significantly) with increasing female SVL. We suggest that the differences in the SVL/RCM relationship between reproductive modes is related to the increased costs of viviparity resulting from long gestation times.

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CLONAL REPRODUCTION IN HYBRIDS OF THE CYPRINID FISHES PHOXINUS EOS AND P. NEOGAEUS. K.A. Goddard, R.M. Dawley, and R.J. Schultz.* Univ. of Connecticut, Storrs, and Cornell Univ., Ithaca, N.Y.

Phoxinus eos x neogaeus hybrids are widespread and abundant throughout North America. They are generally female and can exist in the absence of one or both parent species. These features are indicators of clonal reproduction by some unusual meiotic mechanism such as parthenogenesis or gynogenesis. Diploid hybrids collected at one New Hampshire site accept tissue grafts from each other, indicating that these individuals are genetically identical, and thus reproduce clonally. Triploid hybrids, identified by chromosome counts and electrophoresis, are as abundant as the diploids at this site and others nearby. While some triploids accept grafts from the diploids, others do not. Preliminary fin graft analyses, chromosome counts and electrophoretic analyses indicate that similar hybrid communities exist in New York, Maine and eastern Canada. Diploid P. eos x neogaeus hybrids appear capable of reproducing partially or completely independently of the parent species by parthenogenesis or gynogenesis, while the triploids apparently are produced by a more complex mechanism.

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POPULATION DIFFERENCES IN ENERGY UTILIZATION IN GROWTH AND REPRODUCTION IN THE MARINE SHORE FISH, HYPSOBLENNIUS JENKINSI. T.M.C. Present. Scripps Inst. Ocean., La Jolla, CA.

Local populations of Hypsoblennius jenkinsi are found in a diversity of habitats and are subject to a wide range of survivorship conditions. Life history theory predicts that as adult survivorship decreases relative to juvenile survivorship, there is a selective advantage for organisms to increase reproductive effort or the proportion of available energy used in reproduction rather than growth. To determine if patterns of energy use in H. jenkinsi are consistent with a model of adaptation to local survivorship conditions, estimates were made of the relative amounts of energy used in growth and reproduction over a single annual cycle by one-year-old females in two populations that experience very different survivorship conditions. Results indicate that, contrary to the predictions of life history theory, individuals exposed to higher mortality risks do not devote a lesser proportion of available energy to growth. Population differences in energy use can be explained as representing responses to different food supplies rather than as adaptations to different survivorship conditions.

AGE AND GROWTH OF THE LEMON SHARK, NEGAPRION BREVIROSTRIS (POEY), AS DETERMINED BY MARK/RECAPTURE DATA AND THE EXAMINATION OF TETRACYCLINE LABELLED VERTEBRAL CENTRA. S.H. Gruber, C.A. Brown, and A.D. Henningsen. RSMAS, University of Miami, Miami, Florida.

A multiple mark tagging program involving two lemon shark populations was conducted from 1979 to the present. In the Florida Keys, 1935 sharks were marked with a variety of tags, injected with tetracycline HCl, and released, as were 280 sharks in Bimini, Bahamas. There were 123 Keys recaptures and 92 in Bimini. Time at large and lengths at release and recapture were utilized in a least squares method estimating von Bertalanffy growth curve parameters of $L_{\infty} = 303.8\text{cm}$, $K = 0.05$, and $t_0 = -3.17$, predicting maturity near age 14 and 95% L_{∞} after 55 years. Vertebral centra were removed from 56 recaptures and ground along a frontal plane. Annual bands and circulus formation occurring every 28 days were validated using the tetracycline marker. Estimated ages from circulus counts describe a growth curve with $L_{\infty} = 310.6\text{cm}$, $K = 0.06$, $t_0 = -2.28$, predicting maturity near age 12 and 95% L_{∞} after 50 years. Results agree that this shark is slow growing and long-lived.

CHARACTERIZATION OF LOGGERHEAD AND GREEN TURTLE POPULATIONS IN THE INDIAN RIVER LAGOON SYSTEM, FLORIDA, WITH COMMENTS ON USE OF THE TERMS, "JUVENILE" AND "SUB-ADULT." L.M. Ehrhart. Univ. of Central Florida, Orlando.

Mendonca and Ehrhart (1982) and Ehrhart (1983) have shown that loggerhead and green turtle populations of the northern region of the Indian River are composed of immature individuals and that size structures of the populations are very different. Purported differences in growth rates suggested that the age structures might, however, be similar. In the summers of 1982 through 1985 turtles of both species were live-captured in nets in the central region of the Indian River. As in the northern region, loggerheads (CLs Range: 43-80 cm) are about twice as large as green turtles (CLs Range: 28-64 cm). Recent evidence suggests that growth rates and maturation times are similar in green turtles and loggerheads (Frazer and Ehrhart, 1985). This implies that age structures of the two Indian River populations are quite different and that the ecologic geography of the species can be used to define life history stages ("juvenile" and "subadult") that are biologically more meaningful than those previously defined arbitrarily.

EFFERENT PROJECTIONS OF THE OLFACTORY BULBS IN THE PACIFIC HAGFISH. R. G. Northcutt. Univ. of Michigan, Ann Arbor.

The telencephalon in Pacific hagfish, Eptatretus stouti, is large and the pallium laminated, perhaps due to hypertrophy of olfactory and/or tactile inputs. To examine the first possibility, HRP (Sigma, Type VI) was injected unilaterally into the olfactory bulbs of six adult Pacific hagfish. Following survival times of 10-14 days at 12°C, brains were processed by a Hanker-Yates protocol. Lateral and medial olfactory tracts exit the bulb. The lateral tract runs dorsomedially within the hemisphere and gives rise to superficial and deep subdivisions. The superficial subdivision terminates throughout the extent of pallial lamina 1, whereas the deep subdivision terminates throughout laminae 4 and 5. Fibers also decussate in the anterior and habenular commissures to terminate in the contralateral pallium as well as bilaterally in the hypothalamus. A medial olfactory tract terminates in the rostral ventromedial hemisphere. Pallial lamination is related to olfactory hypertrophy, but not all laminae receive direct olfactory input. (Supported by NIH grants EY02485 and NS11006.)

SECONDARY MECHANOSENSORY LATERAL LINE PATHWAYS OF THE SPINY DOGFISH. R.L. Boord and R.G. Northcutt. Univ. of Delaware, Newark, and Univ. of Michigan, Ann Arbor.

The medial octavolateralis nucleus (MON) is a primary medullary center that receives information from peripheral lateral line and octaval mechanoreceptors as well as from central nervous system sources. Anterograde transport of horseradish peroxidase injected into MON of 5 juvenile spiny dogfish Squalus acanthias, reveals that most MON efferents project directly, as commissural fibers, to the contralateral MON, and to the midbrain via ipsilateral and contralateral lemnisci. The ipsilateral lemniscus is situated, at medullary levels, dorsal and lateral to the contralateral lemniscus but both ascend to mesencephalic levels parallel to the electrosensory pathways and terminate within the optic tectum and, lateral to the torus semicircularis, within the medial part of the lateral mesencephalic nucleus (LMN). Ipsilateral fibers appear to terminate in a paratrigenial nucleus as they ascend so that the larger number of fibers to LMN is contralateral. The mechanosensory part of LMN of primitive squalomorph sharks is the apparent homologue of the dorsomedial subdivision of the LMN complex of those elasmobranchs that possess a hypertrophied midbrain roof, e.g., skates. Supported by NIH grants.

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DEVELOPMENT OF THE THERMORECEPTIVE PIT ORGANS IN THE BOID SNAKE PYTHON REGIUS. A. H. Savitzky, Old Dominion Univ., Norfolk, VA.

A series of embryos of Python regius permits the first study of development of the thermoreceptive pit organs in a boid snake. Embryos were sequentially removed from eggs, fixed in phosphate buffered formalin, and the heads serially sectioned and stained. Difficulty was encountered in applying existing staging criteria for colubrid snakes to the embryos of P. regius. Pit organs are first evident externally at a stage approximately equivalent to Zehr Stage 30-33. The supralabial pits invaginate in series from anterior to posterior. Thus, the pits which are deepest in the adult are the earliest to form. As in pit vipers, the pit organs of boids arise much later in embryonic development than do the primary cephalic sense organs. Nevertheless, their development begins quite early relative to the total period of embryonic development, prior to the appearance of cephalic scales or pigment. (Supported by NSF Grant No. BSR-8415752).

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TERMINAL NERVE OF ODONTOCETE WHALES L.S. Demski, S.H. Ridgway,* J.H. Bullock and M. Schwanzel-Fukuda*. Univ. of Kentucky, Lexington; NOSC, San Diego; UCSD, La Jolla; and Rockefeller Univ., New York.

In dolphins (Pacific bottlenosed, common and Pacific whitesided), the TN is characterized by many osmium stained strands running parallel in the pia on the ventromedial surface of the frontal lobe. In larger whales (killer and beluga), the TN is primarily a single trunk (several mm) in the midline between the hemispheres. In both types, the fibers enter the cranium from paired medial foramina located dorsal to the frontal lobes. In Tursiops, TN bundles enter the brain in the anterior perforated substance or run along the optic chiasma or branches of the anterior cerebral arteries. In Delphinus, ganglia are distributed along the TN with the largest situated at the point of cranial entry. The latter contains many (>1000) round cells (30µm) and a lesser number of smaller LHRH-immunoreactive fusiform neurons. The TN of all forms examined is mostly, if not entirely myelinated (fibers up to 5µm). The functional significance of the well-developed TN in mammals which have lost the olfactory system will be considered. Supported by the NIH, NSF and NOSC.

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THE RECOGNITION OF HOMOLOGOUS NEURONS IN THE OPTIC TECTUM: A DISCUSSION OF METHOD. Thomas E. Hughes. Duke Univ., Durham, North Carolina

In comparative neuroanatomy, as in other comparative sciences, various criteria have been proposed to be the most useful for recognizing homologous relationships. A historical review of the comparative study of the optic tectum reveals that researchers using different criteria for homology - such as cell position, dendritic morphology, or axonal connections - have proposed very different hypotheses about which neurons are homologous in the optic tectum. This disparity can provide useful insight into comparative neuro-anatomical method. For example, if cell position is used as a criterion for homology, then cells in the same position are thought homologous while their dendritic arbors, axonal connections, or both, are inferred to have changed. Conversely, if dendritic morphology is thought to reveal homology, similar looking cells are sought regardless of other criteria such as position. The use of any one or two criteria limits the data collected, precludes certain hypotheses of homology from consideration, and is an assumption about what does, and does not, change during evolution.

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COMPARTMENTALIZATION OF RAT LATERAL GASTROCNEMIUS MUSCLE A.W. English, S. Donahue, and O.I. Weeks, Emory University, Atlanta, GA

The anatomy, innervation patterns, and histochemical composition of the lateral gastrocnemius (LG) muscle were examined in adult rats. Primary branches of the nerve to LG were stimulated to deplete muscle muscle glycogen. Sections of muscle stained for glycogen were used to visualize these innervation territories. Adjacent sections were reacted for demonstration of myosin ATPase and succinate dehydrogenase. Fibers were classified using these stains as types FG, FOG, or SO. Rat LG consists of three heads, organized about two tendons of origin and single tendon of insertion. The nerve to LG divides into four naturally occurring branches which each innervates a distinct muscular volume. These four compartments have a distinct relationship to the three heads. The medial head contains mostly type FG and very few type SO fibers. The distal part of the intermediate head contains a large number of type SO fibers and many fewer type FG fibers. Thus the organization of LG in rats is strikingly similar to that of cats and other mammals, suggesting that such an organizational pattern may be a widespread phenomenon.

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SYNAPSE ELIMINATION AND THE ESTABLISHMENT OF NEUROMUSCULAR COMPARTMENTS. S. Donahue and A. English (intro. by L. Wineski). In adult rats, the lateral gastrocnemius (LG) muscle is compartmentalized about its primary muscle nerve branches. At birth all LG fibers are innervated by more than one axon but later all but one of these synapses is eliminated. To determine the role of synapse elimination in the establishment of LG compartments, innervation patterns were examined using selective EMG techniques. In pups older than five days, stimulation of single LG nerve branches evoked EMG activity only in parts of the muscle corresponding to adult innervation territories. No EMG activity was observed in other parts of LG or in medial gastrocnemius (MG). In younger pups, nerve branch stimulation produced EMG activity which was more widespread, involving adjacent but denervated compartments but not MG. The amplitude and reliability of evoked cross-compartmental potentials was quite variable, suggesting that they result from activation of synapses already targeted for elimination. Thus immature innervation patterns do cross compartmental boundaries, but probably not to the extent that synapse elimination could be considered compartment-specific.

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COPULATORY EXHAUSTION: MODIFICATION OF ENDOGENOUS OPIOID FUNCTION RENEWS SEXUAL PERFORMANCE. S.J. Bauman*, R.B. Pitkin, and J.D. Cross*. Allegheny College, Meadville, PA.

The present investigation explored the role of endogenous opioids in the "Coolidge Effect" - renewal of copulatory behavior in sexually satiated male rats when presented with a novel female. Tail-flick latencies of male rats were measured prior to and following copulatory exhaustion (30 min. without mount attempt) to measure changes in endogenous opioids. The latencies increased significantly indicating an increase in opioids. Sated males were then exposed to one of five post-exhaustion treatments: novel estrus female; odor of novel estrus female; non-estrus female, naloxone injection (opioid antagonist); empty arena and tail-flick latencies measured again. Significant declines in tail-flick latencies were observed for the novel estrus female, odor of novel estrus female and naloxone treatment. These results confirm that endogenous opioids play a role in male satiation and suggests an interaction between pheromone perception and endogenous opioids and the possibility of an endogenous, fast-acting opioid antagonist.

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REPRODUCTIVE SUCCESS IS DEPENDENT ON FIRST ESTABLISHING HIGH RANK IN FEMALE WILD HOUSE MICE. P. Franks and S. Lenington*. Univ. of Wisconsin, Madison and Institute of Animal Behavior, Rutgers Univ., Newark, NJ.

F₁ and F₂ generation house mice were studied in a semi-natural environment to determine dominance and reproductive success correlated with T Locus genotype. Groups of 2 to 4 males and 4 to 6 females were placed into a 6 by 12 ft room for 20 days on a reversed day-night light cycle. The males were not related to any other mouse in the group, but females could have been related to each other. Social interactions such as approaches and attacks, and time spent together, were recorded during 1 h daily observation periods. 20 groups were observed. Dominance rank was established before behavioral estrus occurred. Those females who were top ranked had a greater probability of coming into behavioral estrus than did lower ranking females. Top ranked females also had a greater probability of producing young than did lower ranked females.

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VISUAL CUES FOR PREY SELECTION BY FORAGING TREEFROGS. A.N. Freed. Johns Hopkins Univ., Baltimore.

Do visual cues aid treefrogs (Rhyla cinerea) in the discrimination and selection of prey? I examined feeding response times of treefrogs in relation to the visual cues provided by natural prey. Simple linear regression indicates that prey size (length and dorsal surface area), perceived prey size (i.e., subtended visual angle), shape (length/width ratio), crawling speed, the rate at which prey are perceived to move (i.e., subtended angular velocity), and the distance of prey from the predator at the time of prey detection significantly influence the response time of foraging frogs. Multiple linear regression indicates that treefrogs respond more slowly to distant items and more quickly to prey that exhibit large visual angles (i.e., large and nearby items), large length/width ratios (i.e., elongate items), and high crawling speeds. All but one prey species elicits response times that are significantly different from the reference species (Musca domestica). Treefrogs consistently discriminate among prey that are morphologically and behaviorally similar regardless of their phylogenetic relationship (closely-related vs. unrelated).

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INCREASE IN VISUAL SENSITIVITY AND BIOLUMINESCENT FLASHING ACTIVITY IN FIREFLIES. A. B. Lall and S. Supattapone* The Johns Hopkins University, Baltimore, MD 21218

North American fireflies can be divided into two groups: a) those which restrict their luminescent activity to a short period at twilight (twilight active) and b) those which are active all night (dark active). Threshold sensitivity of the compound eyes was monitored over long periods by recording ERGs. In dark active fireflies of genus Photuris visual sensitivity increased dramatically (1000-10,000 X) between 1830-2100 hrs. This increase in sensitivity occurred only when the insects were maintained under strict natural ambient illumination diurnal rhythm. When fireflies were placed in total darkness, the increase in sensitivity was not synchronized with evening hours. Twilight active fireflies of genus Photinus showed only slight increase in visual sensitivity over the same period. Supported by BNS 8311127

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AN INVESTIGATION INTO INDIVIDUAL RECOGNITION IN THE BLACK-BILLED MAGPIE (PICA PICA). L. Reed. Idaho State Univ., Pocatello.

In a preliminary investigation using operant two-choice techniques, Black-billed magpies spent significantly more time near one of two conspecifics. This indication of preference (and recognition) was maintained through position reversals of the conspecifics. Little has been reported about visual cues controlling individual recognition. Magpies possess several physical features which may act as cues, with potentially the most salient being a white wing patch. This patch is more variable in juveniles than in adults and less variable among sibs than among non-sibs. In this ongoing investigation, magpies are trained to make simultaneous discriminations among photographs of wing patches (s^d) and the same photos with altered areas of white (s^A). It is hypothesized that magpies can discriminate between original and altered photos when the variability of the alteration is equal to or greater than the variation found among sibs.

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CORTICOSTERONE AND NALOXONE EFFECTS ON PREENING BEHAVIOR IN DOMESTIC CHICKENS. S. Williams and Lisa Tiberi*. Simmons College, Boston, MA.

Excessive grooming behavior has been documented in birds as a result of stress and intraventricular administration of ACTH and ACTH₁₋₂₄. Naloxone has been shown to decrease preening behavior in stressed birds. Increased ACTH leads to higher levels of corticosterone which influence energy production that may be used in stressful situations.

In the present study, two doses of corticosterone (0.002mg/kg and 0.02mg/kg) and one of naloxone (3.2mg/kg) plus oil and saline controls were injected s.c. into four-month-old, heavy-hybrid chickens in random order in double blind methods. Behavior was observed for 15 min. and recorded for 30-sec. intervals. Neither corticosterone nor naloxone significantly affected the preening behavior of chickens.

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WHETHER TO FEED OR FLEE: CHEMICAL CONTROL OF CRUSTACEAN BEHAVIOR. R.K. Zimmer-Faust. Univ. of Cal., Santa Barbara.

Feeding responses were initiated in 5 species of bathypelagic and littoral crustacea in laboratory experiments, using single amino acids occurring abundantly in natural prey. Escape responses were elicited in bathypelagic species by ammonia, a non-nutritive substance produced in copious amounts during bacterial degradation, and both feeding and fleeing were suppressed by an amino acid - ammonia mixture. Ammonia suppressed responses by littoral species to amino acids, but was otherwise ineffective. Chemical analytical procedures (HPLC and flow injection) coupled with computer simulations were used to estimate limits of behavioral detection. Concentrations deviating <5% above ambient seawater levels were detected, while concentrations of >0.5 log unit above ambient caused feeding or fleeing. Dose - response curves were typically hyperbolic, an observation agreeing with previous citations for insects and vertebrates. Results show that: (1) low molecular weight compounds induce or inhibit crustacean behavior at environmentally relevant concentrations, and (2) the decisions to feed or flee are mutually exclusive and under simple chemical control.

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STRUCTURE OF THE PEDAL APERTURE GLANDS IN *MYA ARENARIA*. Jon L. Norenburg. Mt. Desert Isl. Biol. Lab., Salsbury Cove, ME.

Vlès (1909, Mem. Soc. Zool. Fr. 22:90-141) observed in *Mya arenaria* a pair of "corps brun, organe glandulaire de l'orifice de sortie du pied." These pedal aperture glands are not described and are not mentioned in recent anatomical studies, including those on pedal function in *Mya*. Each gland lies along the internal edge of the aperture and is apposed to the foot during its protrusion. The gland is dominated by deep (up to 1.5mm), flask-shaped mucus cells with necks opening in the surface epithelium. The cell appears to contain two types of inclusion. One is relatively amorphous, consists of fine granular material in highly distended cisternae (RER?), and is positive for sulfated and non-sulfated mucosubstances (NSM). The other consists of strongly refringent granules (1x4um) which stain for NSM only and weakly for protein. The granule is a vesicle with a peripheral coiled array of electron-dense, paracrystalline fibers surrounding an electron-lucent core. This appears to be the dominant secretion at the gland's surface. Sediment does not adhere readily to the foot, hence, these granules may lubricate the foot, or they may aid in sealing the pedal aperture or in consolidating burrow sediments.

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A COMPARATIVE ANALYSIS OF SERTOLI-LIKE CELLS OF SOME MOLLUSCS AND ECHINODERMS. John Buckland-Nicks and Fu-Shiang Chia, Univ. of Alberta, Edmonton, Canada.

In prosobranch molluscs the Sertoli-like cells are modified columnar epithelial cells that maintain continuous contact with the basal lamina and extend from it to the lumen of the seminiferous tubule. Spermatogenesis takes place between adjacent Sertoli-like cells, but a continuous layer of cytoplasm separates the germ cells from the basal lamina. Thus there is no basal compartment and substances traversing from the interstitium must pass either through the Sertoli-like cells, or between them. However, between the cells, a junctional complex acts as a blood-testis barrier that blocks the passage of substances, such as the tracer lanthanum nitrate. Sertoli-like cells of prosobranchs readily phagocytize waste sperm and in most other aspects of their morphology they are analogous to the Sertoli cells of vertebrates.

In the echinoderms we have studied the Sertoli-like cells have a quite different morphology and might best be described as "pluripotent interstitial cells". Following ejaculation they can leave the basal lamina and behave like wandering amoebocytes, phagocytizing waste sperm in the lumen. There is no blood-testis barrier. Substances traversing from the genital haemal sinus can reach the spermatogonia directly or can pass unimpeded between adjacent Sertoli-like cells, as there is no junctional complex to prevent them. We suggest that the Sertoli-like cells in the testis of echinoderms are not true Sertoli cells and may have a completely different origin. Supported by an N.S.E.R.C. of Canada grant to F-S.C.

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FINE STRUCTURE OF THE LARVAL MIDGUT IN THE MOSQUITO, *Aedes aegypti*. Maira Cioffi. Temple Univ., Philadelphia, PA.

The midgut of larval *A. aegypti* was examined using light microscopy and transmission electron microscopy. The midgut is a simple uncoiled tube one cell layer thick, with a cluster of anterior caecae. The cecal and posterior midgut cells have a structure typical of digestive tissue, with a brush border of microvilli and cytoplasm packed with mitochondria, rough endoplasmic reticulum, Golgi complexes, lysosomes, and protein storage granules. However the cells forming the anterior one quarter of the midgut lack a brush border as well as ribosomes and other protein synthesizing machinery. Mitochondria are located at the apical and basal regions of the cell, and the bulk of the cytoplasm is filled with small vesicles. The basal plasma membrane is infolded to form a branching system of tubules closely associated with mitochondria, an organization typical of ion transporting cells. In addition, the cytoplasmic side of this membrane is studded with small particles characteristic of transporting membranes in insect epithelia. Therefore the ultrastructural evidence suggests that while the caecae and posterior midgut function in digestive processes, the anterior midgut is specialized for ion regulation.

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THE REPRODUCTIVE CYCLE OF *MYA ARENARIA* FROM LONG ISLAND SOUND AND RARITAN BAY. A. Cristini, E. Saiff, M. Schneider. * Ramapo College of New Jersey, Mahwah.

The state of the gonads of the bivalve *Mya arenaria* was monitored in natural populations from Raritan Bay and Long Island Sound and in clams from Long Island Sound caged in Raritan Bay for 11 months. The water temperature, Adenylate Energy Charge (AEC), lipid and glycogen content of tissues was measured and correlated to the condition of the gonad. All of the animals, natural populations as well as caged, were observed to spawn in March and in June. The spring spawning occurred when the water temperature was between 5-12°C, the early summer peak occurred when surface temperature ranged between 18-24°C. The AEC values were lower for animals from Long Island Sound caged in Raritan Bay, however, their reproductive cycle was not affected by the alteration of their adenylate pools. The concentration of lipids in the tissues of all the clams decreased prior to both spawning periods. The glycogen content in all the animals was high from October-December and exhibited a gradual decline from January-August during gamete development and release.

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SALINITY EFFECTS ON THE TOLERANCE AND DEVELOPMENTAL RATE OF THE SEA URCHIN, LYTECHINUS VARIEGATUS (ECHINODERMATA: ECHINOIDEA) R.A. Roller and W.B. Stickle. Louisiana State University, Baton Rouge.

Tolerance and developmental rates of the larvae of Lytechinus variegatus was examined as a function of salinity. Adults were induced to spawn and fertilization and subsequent development were followed in the laboratory (25°C) at the following salinities: 35, 30, 27.5, 25, 20, 15, and 10‰. The developmental rate varied directly with salinity for this species. There was an observed increase in the number of abnormal plutei and a decrease in survival at salinities below 35‰. Cell volume varied indirectly with salinity during early development (ANOVA). (Supported by a grant from the Petroleum Refiners Environmental Council of Louisiana).

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THE ENERGETIC CONTRIBUTION OF GLUCOSE AND GLYCINE TAKEN UP FROM NATURAL SEAWATER BY ADULT MARINE MUSSELS. W. T. Gorham. Univ. of Southern California, Los Angeles.

The removal of glycine and glucose by freshly collected adult Mytilus edulis was determined using radiolabeled substances added to ambient concentrations of dissolved organic materials in freshly collected natural sea water. Calculated uptake rates were estimated for substrate concentrations of 0.5 μM glycine and 1.0 μM glucose and were compared with the animals' energy and nitrogen demands as measured by oxygen consumption and ammonia excretion rates respectively. Respiration rates and ammonia excretion rates as well as either glycine or glucose removal were all determined for the same animals. The calculated uptake rates could have contributed roughly 13% to 14% of the mussels' energy requirements or 10% of the mussels' nitrogen requirements assuming a 0.5 μMolar concentration of free amino acids, a 1.0 μMolar concentration of simple sugars, uptake of total amino acids at a rate equal to that of glycine, and uptake of simple sugars at a rate equal to that of glucose.

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EFFECTS OF IONS ON NEMATOCYSTS ISOLATED FROM ACONTIA OF A SEA ANEMONE BY DIFFERENT METHODS. M. Hidaka and R.N. Mariscal. Florida State University, Tallahassee, FL.

We examined effects of Ca²⁺ and some other agents on nematocysts isolated from acontia of Calliactis tricolor by different methods. Undischarged nematocysts were isolated by immersing the acontia in (1) distilled water (DW) or (2) 1 M sucrose, or by squashing them in (3) 1 M Na citrate or (4) artificial sea water (ASW). Nematocysts isolated by different methods responded to various agents differently. Nematocysts isolated in ASW discharged in DW and 5 mM EGTA, but did not discharge in Ca-free ASW or 50 mM CaCl₂. Nematocysts isolated in citrate discharged when treated with any of the above solutions. Nematocysts isolated in DW and sucrose discharged only in EGTA after a latent period. Nematocysts isolated in ASW are considered to be closer to *in situ* nematocysts than others. Failure of Ca-free ASW to induce discharge in nematocysts isolated in ASW is not consistent with the recently proposed hypothesis that Ca-removal dissociates macromolecules to increase osmotically active particles and results in nematocyst discharge.

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EVIDENCE FOR TWO VISUAL PIGMENTS IN A DEEP-SEA MYSID. T.M. Frank. Univ. of California, Santa Barbara.

The spectral sensitivity of the bioluminescent mysid, Gnathophausia ingens, was determined by recording the electroretinogram from eyes of live, intact animals. The action spectrum (determined by utilizing a response criterion of 50 μV) exhibits a broad peak from 430nm to 550nm, suggesting the presence of more than one visual pigment. Chromatic adaptation experiments with both broadband and monochromatic light alter the shape of the spectral sensitivity curve, resulting in peaks at 450nm and 530nm. This selective bleaching, as well as waveform differences between responses to long wavelength and short wavelength light, also suggests the presence of two visual pigments. This is the first reported occurrence of possible multiple visual pigments in a deep-living crustacean. The presence of a 530nm pigment is completely unexpected in such an animal living below the photic zone at depths where the major known light source is blue bioluminescence (450-490nm).

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PRELIMINARY STUDIES ON KIDNEY ULTRASTRUCTURE IN THE BIVALVE *MYA ARENARIA* WITH OBSERVATIONS ON ORGANISMS FROM A POLLUTED SITE. G. Seiler and M.P. Morse. Bio.Dept., Marine Sci. Lab., Northeastern Univ., Nahant, Mass.

The pericardial gland-kidney complex forms the excretory system in *Mya arenaria*. Paired kidneys drain the pericardial cavity via ciliated renopericardial ducts. The kidney is differentiated by light microscopical observations into two distinct areas; the small proximal region and the enlarged distal region. The proximal region consists of columnar epithelial cells with an apical border of microvilli characteristic of reabsorptive surfaces. The majority of the organ consists of a distal secretory area made up of an extensively folded epithelium of cells with expanded apical tips. Beneath this layer are blood spaces filled numerous amoebocytes that are characterized by dense nuclei. In animals collected from polluted sediments (New Bedford, Mass.), the amoebocytes contain numerous inclusions. Similar granular materials are seen within the epithelial layer suggesting a possible sinus-to-lumen transport of waste materials.

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EMERGENCE OF LARVAL FLUKES FROM THE SNAIL, *Coniobasis semicarinata*: CONTRASTING RESPONSES OF CONGENERS TO L/D CYCLES. M.C. Lewis, I.G. Welsford, and G.L. Uglem. University of Kentucky, Lexington.

Proterometra macrostoma and *P. edneyi* (Digenea) require the same snail host, but different fish hosts in their life cycles. Larvae (cercariae) emerging from snails must be ingested by specific fish hosts to complete development. When infected snails were exposed to artificial L/D cycles at constant temperature (20C) *P. edneyi* emerged during photophase (85%:102/120), but *P. macrostoma* emerged during scotophase (72%:84/117). When the L/D regime was shifted relative to natural L/D cycle, peak emergence of both species was shifted with the new L/D regime. After 72 h in constant light or dark, emergence was no longer rhythmic in either species. Thus, L/D cycling appears to be important in timing the emergence of both species. These data suggest underlying circadian rhythms which would allow peak emergence of cercariae to coincide with the feeding periods of the fish hosts.

Supported by NSF grant PCM 8203378.

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EUSTRONGYLIDES TUBIFEX IN THE NORTHERN WATER SNAKE, *NERODIA SIPEDON*. C.R. BURSEY. Penn State Univ., Sharon.

Migratory and encysted nematodes, *Eustrongylides tubifex*, were found in northern water snakes, *Nerodia sipedon*. Encysted nematodes occurred in three forms: recently encapsulated, degenerating, and hyalinized; and were found in mesenteries, muscles, and subcutaneous tissue. Encystment was associated with hypotrophy, fibroplasia and eosinophilia. Migratory nematodes occurred within muscles, subcutaneous tissue and the coelom. Eggs were found within one nematode.

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THE JUMPING SPIDER (ARANEAE: SALTICIDAE) SUBFAMILY THIODININAE. R.J. Wolff. Trinity Christian College, Palos Heights, IL.

The jumping spiders in the subfamily Thiodininae sensu stricto are distinguished by two pairs of bulbous setae on the tibia of leg pair I. There are 17 species described in *Thiodina* and three new species. These occur throughout the neotropics with three species extending into the nearctic. There is also a *Thiodina* from Dominican amber which indicates a possible dispersal route through the Caribbean for the related North American *Thiodina puerpera*. *Parathiodina* from Haiti is considered a valid genus based on width of the third eye row, leg lengths, shape, and spination. The placement of *Cotinusa* and *Banksetosa* species with the bulbous setae is problematic. The posterior cheliceral teeth are useful for species identification (they could fit into all of the classical subfamilies based on cheliceral teeth).

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CONTRIBUTION OF EXCHANGE-DIFFUSION TO Na AND Cl FLUXES IN THE MANGROVE CRAB GONIOPSIS CRUENTATA. I.P. Zanders and M-J. Martelo. IVIC, Caracas, Venezuela.

The sodium and chloride fluxes between blood and medium were determined in crabs acclimated to 150, 100, 75, 50 or 25% seawater. The fluxes of ^{22}Na and ^{36}Cl were 3.8 and 2.1 mmol/hr x 100g, respectively, in crabs from 150% SW but both fluxes were considerably lower (about 0.6 mmol/hr) in those acclimated to 50% SW and below. The fluxes measured in the latter were completely accounted for by diffusive gains and losses between blood and medium, urinary losses and active uptake or excretion through the gills or other pathways. However, in 150% SW at least two-thirds of the measured fluxes remained unexplained. Replacing 500 mM sodium in 150% SW by isosmotic substitution with TRIS-chloride (=low Na-150% SW), brought about an immediate reduction of Na fluxes, from 3.7 to 0.6 mmol/hr. At the same time the Cl fluxes also decreased, but only from 1.9 to 1.5 mmol/hr. The results strongly suggest that the reduction of the Na (or Cl) fluxes observed in G. cruentata on acclimation to dilute media is caused by the disappearance of large components of exchange-diffusion and not by changes of the animals' permeability to these ions.

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ORGANISMAL RESPIRATORY RESPONSES OF FAIRY SHRIMP, STREPTOCEPHALUS SEALI, TO ENVIRONMENTAL HYPOXIA. G. Anderson. Univ. of Southern Mississippi, Hattiesburg.

Oxygen uptake rates and phyllopod beating frequencies were determined simultaneously for anostracans, Streptocephalus seali, subjected to normoxic and hypoxic conditions. Preliminary results demonstrate that unlike the oxygen regulator, Branchinecta mackini (Eriksen and Brown, 1980, Crustaceana 39:11-21), S. seali is an oxyconformer. At 26°C, oxygen consumption rate is near 0.8 mg O_2 /g/hr at $\text{PO}_2=154$ mm Hg and less than 0.1 mg O_2 /g/hr at $\text{PO}_2=10$ mm Hg. In contrast, ventilation frequency is nearly constant from $\text{PO}_2=154$ mm Hg to 11 mm Hg (3.4 ± 0.05 bps) but decreases sharply to less than 3 bps at $\text{PO}_2=10$ mm Hg. Shrimp exhibiting minimal ventilation (ca. 1.5 bps @ $\text{PO}_2 \leq 2$ mm Hg) recovered when returned to normoxic conditions. Spectrophotometric analysis of hemolymph revealed weak absorption peaks at 540 and 580 nm indicative of the respiratory pigment, hemoglobin. At present, work is underway to evaluate the effects of sex and life cycle stage on physiological responses to hypoxia.

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THE ROLE OF VISION IN CRAYFISH COMMUNICATION. C.A. Bruski and D.W. Dunham. Dept. Zoology, University of Toronto.

The effect of altered light level on the form and efficiency of agonistic communication was investigated in the crayfish Orconectes rusticus, a species normally active over a broad range of ambient light conditions. Isosexual pairs of males and females were observed interacting under moderate ambient light and in complete darkness (using infra-red video), in the laboratory. Type and frequency of behaviours, bout durations, and the sequential structure of interactions were analyzed. In the absence of light, bouts were fewer in number and longer in duration, and information transmission was lower than in the presence of light. Eventual losers of bouts had smaller behaviour repertoires than did winners under all lighting conditions, and the sequencing of behaviour in losers was more strongly influenced by altered light level than was that of eventual winners. The results suggest that visual input is an important permissive variable for efficient interaction in this species.

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LABORATORY STUDIES OF OLFACTION AND TASTE IN LAND HERMIT CRABS COENOBITA RUGOSIS. Dan Rittachof, Laura Barlow* and Alva R. Schmidt*. Duke Univ. Marine Laboratory, Beaufort, N.C.

Field and laboratory studies were performed to examine chemoreception in land hermit crabs C. rugosis. Crabs were collected on the Pacific Coast of Costa Rica as part of field studies and transported to the Duke University Marine Laboratory. Responses of crabs in the field were used to develop laboratory assays. Modifications of the assays used in the field tests were effective in assaying olfaction and taste. Field results showing attractive odors from horse feces, fruit, and fish were confirmed. Fasting and prior dietary history were important to assay responses. Pure volatile organic components of feces, rotting flesh, and fruits were tested with mixed success. Skatole (3-methylindole) was attractive to crabs but did not induce feeding responses. Feeding was stimulated by contact with nonvolatile compounds (such as sucrose). Land hermit crabs are basically ten-legged flies with respect to their responses to feces, fruit and carion. Supported by ONR contract #319-4002.

FACTORS INFLUENCING HABITAT SELECTION OF YOUNG JUVENILE SPINY LOBSTERS, *PANULIRUS ARGUS*. R.A. Tankersley, W.F. Herrnkind, and M. Butler. Florida State Univ., Tallahassee.

The effects of sediment and food abundance on selection of the red algae, *Laurencia* spp., as primary habitat by newly settled juvenile spiny lobsters, *Panulirus argus*, were studied using field and laboratory experiments. Juvenile lobster recruitment and settlement in areas containing sedimented and unsedimented *Laurencia* were estimated using artificial habitats and bottom censuses. Significantly greater numbers of juveniles inhabited unsedimented algae despite high levels of recruitment in the sedimented area. Lobsters introduced to aquaria containing sedimented and unsedimented *Laurencia* clumps consistently resided in the unsedimented algae. Algae sediment from both sites differed in amount and particle frequency distribution. Additionally, the abundance of potential epifaunal prey contained within *Laurencia* from both areas were determined and compared with food preference tests.

DIFFERENCES IN EFFECTS OF MERCURY ON PREDATOR AVOIDANCE IN TWO POPULATIONS OF THE GRASS SHRIMP, *Palaemonetes pugio*. D.B. Kraus and M.L. Kraus*. Dept. of Psychiatry, Univ. of Medicine and Dentistry, Newark, NJ and Dept. of Ecology, Rutgers Univ., Piscataway, NJ.

Adult *Palaemonetes pugio* were collected from two tidal creek systems, Piles Creek (PC), a mercury polluted estuary, and Big Sheepshead Creek (BSC), a relatively pristine creek. Adult killifish (*Fundulus heteroclitus*), a natural predator of *P. pugio*, were obtained from BSC. For each test, 10 dosed (0.01 mg/l mercuric chloride (HgCl) or 0.01 mg/l methylmercury (MeHg)), or control shrimp were introduced into a tank containing 3 fish. The time between capture of the first and second BSC dosed (HgCl) shrimp was significantly faster ($p < .05$) than that of controls. There were also significantly more ($p < .05$) BSC dosed (HgCl) shrimp captured after 2 hrs than controls. There were no significant differences for PC shrimp. Similar results were obtained using MeHg. These data suggest that PC shrimp may be physiologically adapted to mercury.

INTRINSIC MUSCULATURE OF THE DIGESTIVE SYSTEM OF THE BRINE SHRIMP: SCANNING ELECTRON MICROSCOPY OF THE INTESTINE. G. E. Tyson and D. S. Lyon*. Electron Microscope Center, Mississippi State Univ.

The alimentary canal of the adult brine shrimp (*Artemia* sp.) consists of (1) a short esophagus or foregut, (2) a long midgut comprised of a pair of globular ceca and a simple, straight intestine, and (3) a short rectum or hindgut (Reeve, 1963; Snyder and Wolfe, 1980). Scanning electron microscopy (SEM) was used to observe the external surface of the tubular intestine (exposed by dissecting away the body wall and adjacent organs) and revealed regularly arranged, discrete bands of circular muscle. Near the junction with the rectum, slender, widely spaced, longitudinal muscle strands were also present external to the circular muscle and were continuous with longitudinal muscle of the rectum. Also studied by SEM were features of the midgut ceca, intestinal epithelial cells, and peritrophic membrane. (Supported in part by Office of Graduate Studies and Research, Mississippi State University)

HORMONAL REGULATION OF REPRODUCTIVE BEHAVIOR DURING MATURATION. C.S. Rawlings and M.A. Ottinger. University of Maryland, College Park.

Experiments were designed to study effects of graded levels of testosterone on behavioral induction in castrates, efficacy of exogenous testosterone in castrates at different ages, time required for response, and effect of time between castration and implantation. In experiment 1, 30 birds, castrated at 3 weeks of age, were given implants of either 10, 20 or 30 mm in length. Behavior was observed for 2-16 days. Results showed no difference between the treatment groups. In experiment 2, 40 birds, castrated at 2 weeks of age, received 20 mm implants at either 3, 4, 5 or 6 weeks of age. Behavior was observed from 2-16 days, post-implantation. No response was observed in the 3 week group, most the 4 week group showed reproductive behavior, while a portion of the 5 and 6 week group showed reproductive behavior. Based on these data, it appears that the mechanism responsible for the elicitation of reproductive behavior may not be available prior to 4 weeks of age and a time lag of 3 weeks following castration may have negative effects on behavioral recovery.

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PLASMA STEROID HORMONES IN THE SEX ROLE REVERSED WILSON'S PHALAROPE. A.J. Fivizzani, M.A. Colwell and L.W. Oring. Univ. of North Dakota, Grand Forks.

The Wilson's phalarope, *Phalaropus tricolor*, is an excellent example of sex role reversal of avian reproductive behavior in that females compete intensely for males and males provide all parental care. Blood samples were obtained from Wilson's phalaropes during the reproductive season and analyzed for testosterone (T), dihydrotestosterone (DHT), estradiol-17 β (E) and progesterone (P) via RIA. During pairing and egg laying T levels in males were tenfold greater than in females. During incubation male T and DHT levels declined to levels similar to those of females prior to incubation. Levels of E were greater in pairing and laying females than in incubating males and similar to values reported for other avian species. Levels of P were significantly greater in females than in incubating males. These results indicate that the reversal of the typical avian reproductive behavior characteristic of this species is not based upon a reversal of androgen and estrogen levels in males and females but may be based upon differences in neural receptivity to typical hormone values. Supported by NSF Grant PCM 8315758.

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SUBCELLULAR DISTRIBUTION OF AROMATASE IN QUAIL BRAIN. Barney A. Schlinger and Gloria V. Callard. Boston University, Boston, MA.

It is recognized that several actions of testosterone on the central nervous system are mediated by conversion to estrogenic metabolites in target tissue. In the bird, estrogens participate in the organization and activation of singing, aggressive and copulatory behaviors. The purpose of this investigation was to ascertain the subcellular distribution of aromatase on the *Coturnix* quail hypothalamus-preoptic area. After homogenization in sucrose phosphate buffer (250-50 mM), aromatase was enriched 8-fold in the microsomal subfraction (100,000g pellet) and 2-fold in the 11,000g pellet comprised mainly of synaptosomes (pinched-off nerve terminals). 5 β -reductase was enriched in the cytosolic (100,000g supernatant) subfraction. Although aromatase is considered a microsomal enzyme in non-nervous tissue, the dual subcellular localization of aromatase in the avian brain suggests that elevated concentrations of estrogens may occur at the synapse and may independently influence synaptic function in parallel with classical estrogen action on the genome. (Supported by NSF DCB 82-08248).

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INFLUENCE OF NON-AROMATIZABLE ANDROGENS AND AROMATASE INHIBITION ON SEX DETERMINATION IN CHANNEL CATFISH. K.B. Davis, B.A. Simco, C.A. Coudie and R. Snellgrove*. Memphis State Univ., Memphis, TN and U.S. Fish and Wildlife Srv., SFCL, Marion, AL

Oral administration of 17-alpha ethynyltestosterone (17ET) or 17-beta-estradiol to sexually indifferent channel catfish produced all female progeny. The sex reversal is complete and functional since these fish spawned and produced a 3:1, male:female, sex ratio. This sex ratio is compatible with a normal homogametic female genotype (XX) with YY animals surviving and having a male phenotype. It was proposed that the androgen used was converted to a molecule with estrogenic properties by endogenous aromatase enzymes. We have tested two non-aromatizable androgens, dihydrotestosterone (DHT) and 11-ketotestosterone (11KT), and an aromatase inhibitor, norethindrone (NE), alone and in combination with aromatizable 17ET. The sex ratios as a percent female were: DHT=76; 11KT=61; 17ET, NE and NE plus 17ET all three gave 100% female progeny. It does not appear that endogenous aromatase conversion of exogenous androgens is responsible for feminization, and that NE has a feminizing effect.

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IDENTIFICATION AND CHARACTERIZATION OF AN ANDROGEN RECEPTOR IN THE BRAIN OF GOLDFISH (*CARASSIUS AURATUS*). M. Pasmanik and G. Callard. Boston University, Boston, MA.

Testosterone (T) is metabolized to estradiol (E) and 5 α -dihydrotestosterone (DHT) in the brain of numerous vertebrates including the goldfish. In order to understand the relationship between locally synthesized hormone and activation of a biological response, we have initiated studies of steroid receptors in goldfish brain. We report here the identification of an androgen receptor (AR) present in both cytosolic and nuclear extracts of brain homogenates. Using Sephadex LH-20 and DNA-cellulose affinity chromatography, this AR can be distinguished from a non-receptor androgen binding component also present in brain cytosol and from a sex hormone binding protein in the serum. It had a high affinity ($K_D=10^{-9}$ M) and limited capacity for androgen, bound T and DHT equally well but did not bind 11-ketotestosterone, estrogens or progesterone. The AR-ligand complex exhibited a very low rate of dissociation ($t_{1/2}=100$ min at 22 C; 6 h at 4 C). It was DNA adhering and eluted between 0.1-0.2 M NaCl. These characteristics resemble those of classical mammalian AR. This is the first report of an AR in fish, suggesting that AR, like ER, are ancient molecules. (NSF PCM 82-08248).

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HORMONAL MEDIATION OF MALE- AND FEMALE-LIKE BEHAVIORS IN AN ALL-FEMALE LIZARD SPECIES. M. Grassman and D. Crews. Univ. of Texas, Austin, TX.

Individuals of all-female lizard species exhibit copulatory-like behaviors that are correlated with the ovarian hormonal cycle. Here we report on the hormonal bases of these behaviors. Parthenogenetic Cnemidophorus uniparens were ovariectomized, and given silastic implants containing either progesterone (P) or estradiol (E); controls received blank implants (B). Ten pairs of the following combinations were observed: P females paired with E females, P females paired with B females, and B females paired with E females. Each pair was observed at regular intervals four hours a day for six days. P and E animals pseudocopulated more frequently than either P and B or B and E pairs ($P < 0.05$). Further, P animals consistently assumed the male-like role while E females were female-like in their behavior ($P < 0.05$). These data suggest that the postovulatory surge in P mediates male-typical behaviors and the preovulatory surge in E mediates female-like receptivity in C. uniparens. Supported in part by NIH NRSA 1F32HD06618-02 to MG, and NSF BNS 8202531 and NIMH NRSA to DC.

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Control of Sexual Behavior in Male Cnemidophorus inornatus. Jonathan Lindzey and David Crews; Institute of Reproductive Biology, University of Texas at Austin.

Individuals of the parthenogenic species Cnemidophorus uniparens exhibit male-like behavior during the post-ovulatory portion of the ovarian cycle. As part of ongoing studies into the evolution of hormone-brain-behavior relationships, experiments were conducted to determine the hormonal control of sexual behavior in male Cnemidophorus inornatus, one of the direct sexual ancestors of Cnemidophorus uniparens. Castrated males courted significantly less than did intact and control males. Castrates given silastic implants containing dihydrotestosterone (DHT) resumed courtship if the plasma androgen concentrations reach physiological levels. (Average physiological levels of DHT and T range from 9.8 to 17.4 and from 2.4 to 7.5 ng/ml, respectively.) These findings support the hypothesis that Cnemidophorus uniparens has modified the ancestral hormone-brain-behavior mechanism regulating male courtship and copulatory behavior. Supported in part by NSF BNS 8202531 and NIMH RSVA MH00135.

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PROSTAGLANDINS AND MATING BEHAVIOR IN FEMALE GARTER SNAKES. J.M. Whittier and D. Crews, Inst. Reproductive Biol., Univ. of Texas, Austin.

This study suggests that mating-induced declines of sexual attractivity and receptivity in female red-sided garter snakes (Thamnophis sirtalis parietalis) are mediated by prostaglandins. Females injected IP with 5 ug/g BW PGF₂^α became unreceptive (8/9) to males when compared with saline-injected, unmated control females (1/10). Further, these PGF₂^α-treated females were significantly less attractive to males 24 hr after treatment. Lower doses of PGF₂^α (1.0 and 0.5 ug/g BW) also inhibited receptive behavior; the latency to mating of females treated with these doses was threefold longer than controls. No significant changes in plasma levels of progesterone, testosterone, or estradiol were observed 24 hr after treatment with PGF₂^α. In addition, ovarian responses of the PGF₂^α- and saline-treated females were monitored for 6 wks. No alterations in frequency of post-treatment or post-mating ovarian growth were observed at any dose. These data suggest that while PGF₂^α can induce changes in sexual behavior that simulate the effect of mating, ovarian responses after mating are mediated by a separate mechanism.

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STRESS AND GONADAL STEROID SECRETION IN MALE ALLIGATORS. V. A. LANCE, Tulane University School of Medicine, New Orleans.

It is well known that environmental stress causes reproductive failure in domestic farm animals, and that stress-induced or pharmacologically induced increases in plasma corticoids in man and a number of mammalian species result in a rapid decline in plasma testosterone. The effect of the stress of captivity on gonadal steroid secretion in reptiles has however, generally been ignored. In order to test the effect of stress on gonadal hormone secretion in reptiles six mature male alligators were captured during April when plasma testosterone levels are maximum and a blood sample was taken within 5 min of captivity. Additional blood samples were taken at 4 hr intervals for up to 40 hr and plasma testosterone and corticosterone assayed by radioimmunoassay. Testosterone levels declined to 50% of the initial value by 4 hr and dropped to less than 10% of initial by 24 hr. Plasma corticosterone increased during the first 12 hr then declined at 24 hr and rose again at 40 hr. These results demonstrate that stress appears to have a rapid and dramatic effect on plasma testosterone in these reptiles, and that studies on reproductive cycles of non-mammalian vertebrates must take into account the effect of stress.

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HORMONAL REGULATION OF MYOMETRIAL ACTIVITY IN THE TURTLE, CHRYSEMYS PICTA. I.P. Callard and V. Abrams-Motz. Boston University, Boston.

Precise regulation of myometrial activity in vertebrates is important in the timing of egg retention, egg laying and parturition. Earlier studies from this laboratory established that estrogen and progesterone modify the inherent rhythmicity of the oviduct of Chrysemys picta *in vitro* and the current studies sought to examine the effect of progesterone (P), pretreatment on both *in vivo* and *in vitro* oviductal responses to the peptides arginine vasotocin (AVT), and relaxin (RLX). In post-ovulatory turtles, P treatment significantly decreased the number of eggs laid in response to a 10 ng injection of AVT. *In vitro*, myometrial strips from P-treated turtles were ten times less sensitive to AVT than control tissues, and the slowing effect of RLX on myometrial activity was inhibited. These results suggest that progesterone is an important modulator of myometrial responsiveness to AVT/RLX. In this way P determines the duration of egg retention and the timing of oviposition.

Supported by NSF PCM 81-04144

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FLUID MECHANICAL VALVING OF AIR FLOW IN BIRD LUNGS. D.O. Kuethe Duke University, Durham, NC.

Air flows in only one direction through the gas exchange passages in bird lungs, despite the fact that there are no mechanical valves in any of the bronchi.

In order to find out why the flow nevertheless is unidirectional, I took advantage of features of the gas exchanging bronchi which lend them to be calibrated as a flow meter. Using fixed duck lungs, I then experimentally manipulated the pressures of the air sacs. With these techniques, I demonstrated that certain features of the geometry of the large bronchi as well as certain air sac pressure differences are necessary for the natural flow pattern.

Further work with clear plastic models suggests that these necessary conditions are sufficient for the flow pattern under steady flow conditions. I have also found a physical explanation for how these conditions cause the fluid mechanical valving.

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RESPIRATORY AND CARDIAC RESPONSES OF RAINBOW TROUT AND BROWN BULLHEAD CATFISH TO WATERBORNE CYANIDE. P.L. Sawyer and A.G. Heath. Virginia Polytechnic Institute and State Univ., Blacksburg.

Changes in routine oxygen consumption (\dot{V}_{O_2}), heart rate (HR) and ventilatory frequency (V_f) and amplitude (V_{amp}) were recorded in rainbow trout (RT) and brown bullhead catfish (BBC) exposed to a gradually increasing cyanide concentration, selected to produce death in 8-9 hours in each species. Lethal cyanide concentration for BBC was an order of magnitude higher than for RT. RT showed gradually increasing bradycardia throughout the exposure period; BBC showed initial tachycardia followed by gradual bradycardia. Atropine injection suggests that bradycardia was in part due to vagal inhibition in both species. V_f and V_{amp} of RT was elevated throughout 95% of the exposure period and abruptly dropped; BBC showed a rapid increase in V_f with a dramatic increase in V_{amp} followed by a gradual decrease of both. \dot{V}_{O_2} changes paralleled ventilatory changes in both species. These results are similar to those seen during hypoxia in RT but not BBC, possibly due to a stress response produced by stimulation of gustatory and olfactory neurons of the BBC by cyanide.

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THE EFFECT OF FEEDING ON METABOLIC RATE AND SELECTED BLOOD PARAMETERS OF THE CHANNEL CATFISH, ICTALURUS PUNCTATUS. C.R. Brown and J.N. Cameron. Univ. of Texas Marine Science Institute, Port Aransas.

Specific dynamic action (SDA) refers to the increase in metabolic rate following the ingestion of a ration. The physiological changes associated with SDA were investigated using chronically catheterized catfish, fed various ration levels. The rate of oxygen consumption was elevated for approximately 24 hours after feeding, with a peak occurring at 4 hours. Plasma amino acid levels increased following feeding, reaching maximum levels at 4 hours. The essential amino acids showed the greatest degree of increase. Plasma ammonia and glucose levels also increased, while plasma protein levels showed no significant variation. The correlation between metabolic rate and amino acid levels suggests that increased metabolic rate may be due to the process of amino acid incorporation.

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POSTSYNAPTIC POTENTIALS IN CARDIAC MUSCLE OF THE DESERT SCORPION, *PARUROCTONIS MESAENSIS*. Roger D. Farley. University of California, Riverside.

The pacemaker ganglion in the dorsal midline of the scorpion heart elicits graded PSPs in the cardiac muscle. The muscle cells have resting potentials 30-45 mV, and the PSPs vary in amplitude from 10 to 40 mV, with duration as much as 0.2 sec. Simultaneous recordings from the posterior and anterior ends of the heart show that the PSPs at the posterior end usually precede those at the anterior end, causing a similar pattern of contraction with movement of blood anteriorly. The PSPs vary in amplitude and duration as the scorpion modulates heart activity in response to stimuli. The heart is stopped for brief periods or accelerated with the segmental nerves from the subesophageal and first three abdominal ganglia. Small pieces of heart with a length of cardiac ganglion contract rhythmically, suggesting that in the intact ganglion, the pacemaker cells are the neurons with the fastest frequency.

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CIRCULATORY FUNCTION DURING EXPANSION IN THE MOON SNAIL, *POLINICES LEWISII*.

G. B. Bourne, Univ. Calgary, Alberta and Bamfield Marine Station, British Columbia.

Following anesthesia in solutions of Althesin or xylazine (Veliger 26: 327), two sets of pressure catheters and impedance conversion electrodes were implanted into moon snails. The catheters were used to measure pressure simultaneously in the aorta and the aquiferous system while impedance conversion monitored all body movement within the shell and also gross movement of the shell (i.e., locomotion). Once sufficiently recovered, snails were caused to retract wholly or partially into the shell. Results indicate that during some phases of the expansion process, activity of the circulatory system is marked by periods of acardia when the heart stops and misses several beats. At these times, other body muscles are responsible for the pressure in the circulatory system which now functions hydraulically in the expansion process. There are indications that at these times no circulation of hemolymph occurs. Thus in the moon snail the hydraulic and transport functions of the circulation appear to be decoupled at certain phases of the expansion process.

(Supported by N.S.E.R.C., Canada)

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DEVELOPMENT IN LOW OXYGEN: MORPHOLOGICAL AND PHYSIOLOGICAL CONSEQUENCES IN THE BEETLE LARVA *TENEBRIO MOLITOR*. C. Loudon. Duke Univ., Durham, N.C.

Many insects developing in grain, rotting logs, stagnant water and soil may be exposed to gas mixtures significantly different from well-mixed air. In some insects, the ambient gas composition during development affects tracheal morphology. In order to investigate this phenomenon and to measure how tracheal geometry in turn influences relative gas exchange, *Tenebrio molitor* larvae (mealworms) were reared from eggs in constant oxygen concentrations of 21%, 15% or 10.5%. Larvae reared in lower oxygen concentrations had greater mortality, slower development and larger tracheae than larvae reared in higher oxygen concentrations. Oxygen uptake and tracheal water loss were measured for the different groups to evaluate the effect of tracheal diameter on gas movement.

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THE EFFECT OF TEMPERATURE ON HEMOLYMPH pH IN THE AMERICAN LOCUST. J.M. Harrison. Univ. of Colorado, Boulder.

Acid-base balance is poorly understood in insects. This study tested the effect of temperature on hemolymph pH in female *Schistocerca nitens*. Locusts reared with a photothermal gradient of 25-40°C were exposed to test temperatures for 24 h. Hemolymph was sampled quickly (11.6 ± .20 s) without CO₂ loss. Hemolymph pH varied with temperature:

	10°	25°	30°	35°
x	7.119	7.087	7.013	6.919
S.E.	.014	.018	.007	.008
n	10	8	9	10
dpH/dT	<.0021> <.0148> <.0188>			

The dissociation of protein imidazole groups and relative alkalinity were conserved at normally experienced body temperatures (25-35°C), but varied substantially at a colder temperature (10°C). Supported by a Sigma Xi grant and NIH AM31243 to T.T. Gleeson.

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UNUSUAL OXYGEN BINDING PROPERTIES IN THE BLOOD OF THE DEEP SEA HYDROTHERMAL VENT CRAB BYTHOGRAEA THERMYDRON. N.K. Sanders and J.J. Childress. Univ. of California, Santa Barbara.

Oxygen binding properties of hemocyanin were examined for fresh and frozen blood samples from the deep sea hydrothermal vent crab Bythograea thermydron. This brachyuran crab lives in an extremely variable environment and can experience drastic changes in physical and chemical parameters within distances of a few centimeters; previous work (Arp and Childress, 1981) indicated that O_2 binding in the whole blood of Bythograea was temperature independent. In the present study, the effects of temperature and pH on O_2 binding were examined for blood samples dialyzed against a physiological saline buffered with 0.05M Tris Maleate. Experimental temperatures ranged from 2°C-20°C at pH values of 7.4, 7.7, and 8.01. O_2 affinity was greatest at 10°C at all pH's, with higher numerical values of P_{50} (lower affinity) at temperatures above and below 10°C; pH effected O_2 binding at all experimental temperatures, shown by normal Bohr effects. It appears that Bythograea thermydron, an animal living in a thermally unique environment, has evolved a hemocyanin with unusual oxygen binding properties.

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CO_2 SENSITIVITY OF THE HEMOCYANINS (Hcs) AND HEMERYTHRINS (Hrs). C.P. Mangum and L.E. Burnett. Col. of William & Mary, Williamsburg, Va.

H^+ and Ca/Mg^{+2} bind to the same site and stabilize different conformations of many Hcs. It has been suggested that Cl^- and HCO_3^- act similarly. If so, sensitivity to the two should be invariably coupled. However we found all possible combinations. Some Hcs are sensitive only to Cl^- , some only to CO_2/HCO_3^- , some to both and some to neither. As suggested earlier, CO_2/HCO_3^- sensitivity of Hcs with reversed Ca/Mg^{+2} shifts can be explained in part or in full by the effect of HCO_3^-/CO_2 on ion activity. Since Ca/Mg^{+2} lower O_2 affinity, ion immobilization raises O_2 affinity and thus the CO_2/HCO_3^- effect is greatest at high pH. CO_2/HCO_3^- also raise the O_2 affinity of at least one Hc with a normal Ca/Mg^{+2} shift and the effect is pH independent; in this case the effect must be direct.

A variety of monovalent anions influence HrO_2 binding. Moreover sipunculid coelomic cells have the highest carbonic anhydrase activities of any blood cells outside of the vertebrates. Nonetheless coelomic HrO_2 binding is not sensitive to CO_2 .

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OXYGEN STORAGE BY HEMOGLOBIN. J.M. Colacino, J.R. Brannan* and M.A. Fields*. Clemson Univ., Clemson, SC.

An oxygen store can be characterized as a cell, tissue or compartment which contains oxyhemoglobin and which is surrounded by a diffusion barrier. A model is presented which predicts the rate and manner of oxygen release from such a store when the store is exposed to a zero oxygen environment. The environment is any region surrounding the store including external media and oxygen-consuming tissue. The model is defined by two non-linear, ordinary differential equations which take in to account hemoglobin concentration, store volume, store geometry, diffusion resistance and the rate constants for the reaction between hemoglobin and oxygen. A simple approximate solution to the model equations was obtained with singular perturbation techniques. The solution indicates that biologically realistic storage is predominately diffusion-limited, that storage times ranging from milliseconds to thousands of seconds are feasible, and that long duration oxygen storage can be achieved even at microscopic dimensions.

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ROUTES OF SLOW AND FAST FLEXOR MOTOR NEURONS THROUGH CRAYFISH GANGLIA ARE SEGREGATED. E.M. Leise and B. Mulloney. University of California, Davis.

The two sets of flexor muscles in the crayfish abdomen participate in different behaviors. The fast flexors generate the power-stroke for the tailflip escape response. The slow flexors help maintain bodily posture. To determine which ganglionic structures are important to the control of these activities, we studied a series of cobalt backfills of the flexor nerves and a set of horseradish peroxidase intracellular fills of flexor motor neurons. From serial thick sections we traced the routes of the filled cells through the axonal tracts, commissures and neuropils of the abdominal ganglia. Fast flexor motor neurons bypass the large, ventral horseshoe neuropil (HN) and the lateral neuropils (LN), but branch in the dorsal tracts and commissures. In contrast, the slow flexors branch in the HN and LN, and in more layers of dorsal tracts and commissures than the fast flexors. We conclude that both sets of motor neurons receive command input from axons in the most dorsal tracts, and that the more extensive branching of slow flexor motor neurons is a reflection of their participation in more behavioral activities.

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INDUCED CHANGE IN AXONAL SETS IN A NERVE OF *DROSOPHILA*, SHIBIRE. M.R. Hummon and W.J. Costello, COM, Ohio Univ., Athens.

A peripheral nerve, PDMN, innervates targets of the giant fiber pathway (GFP), including jump muscle (TTM) and an indirect flight muscle (DLM). We find that timing of onset of a 6h heat pulse (HP)(30C) during pupal development of the temperature-sensitive mutant *shibire* (*shi*) differentially affects PDMN components. In wild-type or non-HP *shi*, the adult PDMN includes identified ($d \sim 2-10 \mu\text{m}$) neurons of the GFP: motoneurons TTMn and 5 DLMn and interneuron PSI. There are also ~ 15 medium axons ($d \sim 1.0 \mu\text{m}$) and ~ 100 small axons ($d \sim 0.1-0.3 \mu\text{m}$), probably sensory. PDMN of adult *shi* flies is unaffected by HP (18-117h onset, 22C, $\sim 12-80\text{h}$, 25C) with respect to presence of TTMn, 5 DLMn and ~ 15 medium axons. Yet PSI is absent or severely altered with HP onset at 18-90h; such flies also show altered DLM electrophysiology. The number of small axons is ~ 200 in flies with 18h HP onset, but is the normal ~ 400 if HP onset is at 66-117h. Thus there is a critical period during development when the number of small axons in PDMN can be altered by exposure to HP. The *shi* defect may prevent normal cell death or induce extra divisions in formation of these axons. Supported by Musc. Dys. Assoc.

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CYTOCHEMICAL OBSERVATIONS ON THE STRIATED MUSCLE OF *LIMULUS*. M. Dewey*, F. Anapol and M. Srivatsan*. SUNY, Stony Brook, NY and Univ. of Illinois, Chicago.

The physiological properties of individual muscle fibers of *Limulus* have not been analyzed. The muscle fibers are unusual; they exhibit A-band and thick filament shortening upon sarcomere shortening below rest length and are triply regulated by Ca^{2+} (myosin heavy chain, light chain kinase and thin filament). Cytochemically the fibers fall into three general classes based on the Ca^{2+} ATPase activity in the absence of Mg^{2+} , i.e. dark, intermediate and light staining fibers. Analysis of fiber diameters, cross-sectional areas and fiber cross-sectional shapes by image processing (Tracor 5500 SIA) showed that the fibers were graded and did not fall into discrete morphological classes. However, the staining intensity ranged from large, dark to small, light staining fibers. Acid reversal was apparent. Myosin ATPase activity in the presence of Mg^{2+} was similar but acid reversal did not occur. SDH and NADH stained smallest fibers most intensely while intermediate and larger fibers stained predominately in the periphery. The staining patterns for SDH and DPNH were not completely coincident.

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MULTIPLE VARIANTS OF MYOFIBRILLAR PROTEINS IN CRUSTACEAN MUSCLES: EVIDENCE FOR TWO SLOW FIBER TYPES. D. L. Mykles. Biol. Div., Oak Ridge Natl. Lab., TN

Glycerinated muscle fibers from lobster, *Homarus americanus*, and land crab, *Gecarcinus lateralis*, have been analyzed by SDS-PAGE. In lobster, a total of two isoforms of paramyosin (P), three of troponin-T (TNT), five of TNI, three of TNC, three of myosin alpha light chain (αLC) and two of βLC were found in six muscles of the claws and abdomen. In both species only P showed a pattern completely consistent with fiber type: slow fibers contained a variant smaller (105 kD) than the major variant (110 kD) in fast fibers. More than one variant of a myofibrillar protein can be expressed in a single fiber, forming unique assemblages by which subgroups can be discriminated within the broader categories of fast and slow fibers. Two types of slow fibers, which differed in the variants of TNI and TNT, were found in the claw closer muscles of both crab and lobster. The minor (10-15% of muscle mass) type shared TN variants with lobster abdominal superficial fibers, suggesting they have similar contractile properties. (Operated by Martin Marietta Energy Systems, Inc. with the U.S. Department of Energy.)

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AVIAN SLOW SKELETAL MUSCLE DIMORPHISM: SLOW TWITCH AND SLOW TONIC TYPES. R. S. Hikida. Ohio University, Athens.

Experimental studies using avian fast and slow skeletal muscles often yield results that may or may not coincide with mammalian fast and slow muscles. Avian slow muscles have been thought to be slow tonic, as in lower vertebrates, while most mammalian slow muscles are slow twitch. By using a technique that allows ultrastructural analysis of histochemically-identified muscle fiber types, we show that slow fibers in the avian mixed muscles have twitch type characteristics, indicated by the Z-line structure and sarcotubular system. A comparison of these slow fibers with the classic slow tonic anterior latissimus dorsi and the fast twitch fibers indicated that these fibers are quantitatively intermediate in their sarcotubular content. The anterior latissimus dorsi consists of fibers with only a slow tonic morphology. Both slow fiber types contain multiple innervation. We conclude that avian muscles contain two slow muscle fiber types, one similar to the lower vertebrates, and the other similar to the mammals.

Supported by Grant AM 26922 from NIH.

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ELECTROMYOGRAPHIC AND HISTOCHEMICAL DIVERSITY WITHIN PIG MASSETER MUSCLE.

F.C. Anapol. Univ. of Illinois, Chicago.

Electromyographic (EMG) activity was recorded from deep and superficial levels of m. masseter during pig mastication. Following the shift from soft (pelleted pig chow) to hard (cracked corn) food, EMG activity in the superficial regions increased a significantly greater amount than in the deeper portions of the muscle. The effect was more consistent on the balancing than on the working side of the jaw. Pig masseter is homogeneously comprised of moderately high oxidative (NADH, SDH) muscle fibers. Approximately two-thirds of these exhibit alkaline-stable/acid-labile ("fast") myosin adenosine triphosphatase activity. However, the percentage of fast fibers decreases from superficial to deep as the percentage of acid-stable/alkaline-labile ("slow") fibers increases. These results suggest that for chewing harder foods, additional motor units are recruited progressively from deep to superficial and that the burden of force may be shifted from slower contracting units to faster units. This pattern of neural organization is well suited for rapid and sustained masticatory behavior required by the diverse omnivorous diet of pigs.

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MORPHOLOGIC CHANGES INDUCED BY EXERCISE IN ZUCKER RAT SKELETAL MUSCLES.

(intro. by J.W. Lynn) L. Gilloteaux, J. Bissler, W. Payne, and N. Paradise. Northeastern Ohio Univ. College of Medicine, Rootstown, OH.

Skeletal muscle fibers from genetically obese (fa/fa) and non-obese (Fa/-) soleus (S) and tibialis anterior (TA) present several of the characteristics of human mitochondrial myopathy of the hypothyroidism type. Following a morphometric analysis, we found that fast glycolytic (FG), fast oxidative glycolytic (FOG) as well as slow oxidative (SO) fibers present a marked hypertrophy in both S and TA of Fa/- rats compared to the same muscles of the fa/fa rats ($p \leq .05$). Heavier muscle mass previously reported for Fa/- can therefore be confirmed by our findings. As a result of a 5 week treadmill exercise program, the Fa/- rats decrease FG fiber diameter ($p < .05$) while the obese rats present fiber hypertrophy. This finding can be explained by denervation which usually precedes fiber atrophy. Following exercise, the original fa/fa weakly stained histochemical pattern for oxidative metabolism is replaced by a stronger checkerboard histochemical pattern. Supported by NEOUCOM Biomedical grant PHS-SO-7R058005-05 from NEOUCOM.

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CIRCADIAN AND SEASONAL VARIATIONS OF PLASMA INSULIN CONCENTRATION IN THE SYRIAN HAMSTER (*Mesocricetus auratus*).

C.J. de Souza* and A.H. Meier. Louisiana State Univ., Baton Rouge, LA.

Insulin concentrations varied considerably during the day and the phases of the rhythms varied with season, daylength and body weights. Cortisol concentrations also varied during the day but the phases remained unchanged. Glucose concentrations varied little during the day and were not synchronized with either hormone. Furthermore, the daily pattern of feeding (greatest during the scotophase) did not account for the insulin rhythms. The results suggest that the circadian rhythms of cortisol and insulin concentrations are regulated by different circadian pacemakers. Changes in the phase relations of these two circadian systems may have a role in the determination of seasonal metabolic conditions.

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HORMONAL CONTROL OF DROSOPHILA VITELLOGENESIS WITH HYBRIDOMA ANTIBODIES AS SPECIFIC PROBES. S-J.

Wu, J. Zhang* and M. Ma. Univ. of Maryland, College Park, MD.

Hybridoma antibodies to *Drosophila* soluble yolk protein (YP) were developed by both in vitro and in vivo immunizations followed by cell fusions for hybridoma production. The binding sites of these antibodies towards different YP components were identified with a combination of gel electrophoresis, electro-transfer blotting and immunohistochemical staining. A sensitive and specific enzyme-linked immunosorbent assay (ELISA) was developed utilizing characterized hybridoma antibodies as specific probes for monitoring *Drosophila* yolk polypeptides. The roles of juvenile hormone and 20-hydroxyecdysone in the control of yolk polypeptide synthesis and uptake will be elucidated by both in vitro organ culture and hormonal replacement therapy.

¹³C-NMR ANALYSIS OF SNAKE SKIN LIPIDS
P.J. Weldon and F.M. Schell*, Texas
A&M Univ., College Station, and Univ.
of Tennessee, Knoxville.

Snake skin lipids contribute to homeostasis by retarding transepidermal water loss, and they act as behavioral releasers in intra- and interspecific interactions. ¹³C-NMR was used to examine methylene chloride extracts of shed skins from snakes in the families Boidae, Colubridae, Elapidae, and Viperidae. Resonances consistent with cholesterol, sterol esters, triglycerides, and other lipids are observed. Interspecific variation exists in the degree of unsaturation of long chain hydrocarbon groups and in the presence of certain lipid classes.

A NEW LOOK AT ENZYME TEMPERATURE COMPENSATION. D.A. Powers. Johns Hopkins Univ., Baltimore, MD.

Thermal compensation of several enzymes were studied. Values were determined for the energy of activation to the transition state, the energy of bond-making and breaking, and the energy of substrate and cofactor binding. Values for their associated enthalpy and entropy parameters were also determined. Comparisons were made for: (1) homologous enzymes between species, (2) multilocus isozymes within an individual, and (3) allelic isozymes between individuals of the same species. These results reveal three general strategies of thermal compensation at the molecular level. Examples of each strategy have been studied. Experimental and calculation methods for determining these energy relationships, as well as the associated statistical problems have been explored. Our findings will be discussed in the context of the technical, conceptual, and paradoxical problems associated with the literature.

THERMAL ACCLIMATION OR DIFFERENTIAL REGULATION? D. L. Crawford*, A. Place*, R. Cashon*, D.A. Powers. Johns Hopkins Univ., Baltimore MD.

Specific activity of LDH & MDH from unacclimated fish, *Fundulus heteroclitus*, from Maine and Georgia were significantly different. Activities were approximately twice as great for Maine fish than those from Georgia. Purified enzymes from both populations indicate that the catalytic rate constants (k_{cat}) are identical. Since, specific activity is dependent on enzyme concentration and k_{cat} , it follows that Maine fish must have a higher enzyme concentration. To test whether this could be explained by thermal acclimation, *Fundulus* from a central location, Chesapeake Bay, were acclimated to 5, 10, 22, and 30C. After 30 days of acclimation, specific activities were not significantly different between thermal regimes. These results suggest that the intrinsic mechanism of regulation is different between the two populations.

SEXUAL AND TEMPORAL DIFFERENCES IN THE MIXED FUNCTION OXIDASE ENZYME SYSTEM IN *FUNDULUS HETEROCLITUS*. D.C. Sauer. Univ. of South Carolina, Columbia.

Experiments were designed to test for seasonal variability in the mixed function oxidase enzyme system and its relationship to changes in reproductive condition. Fish were sacrificed at the calendar full moon of each lunar cycle from March, 1984 through April, 1985. Hepatic microsomal tissue was assayed for aryl hydrocarbon hydroxylase and NADPH cytochrome-c reductase activities, and specific contents of cytochromes P-450 and b₅. Gonad somatic indices were also determined. Significant seasonal fluctuations were observed for all parameters measured. Low specific activities and contents were observed in the spring and summer followed by an increase coinciding with autumn gonad regression. High values were observed in the autumn and winter followed by a decrease coinciding with the onset of reproductive activity in the spring.

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ASPECTS OF THE ECOPHYSIOLOGY OF TERRESTRIALITY IN *ALICUS KIRKI*, THE ROCKSKIPPER BLENNY OF THE RED SEA. M.S. Gordon, H.G. Chin* and K.L. Martin. Univ. of California, Los Angeles.

A. kirki is a highly terrestrial amphibious fish. Common in the upper parts of many rocky intertidal areas around the Red Sea, it tolerates extremely hot, dry summer climate conditions. Field (Sinai, Egypt) and lab (Los Angeles) observations show that it is diurnal and spends over 80% of its time out of water. It grazes for long periods on tough algal mats exposed to full sun and wind. It uses behavioral microhabitat selection to moderate thermal and evaporative stresses. In the field most feeding occurs close to the water's edge, with fish frequently moistened by wavelets. Feeding areas shift tidally. Field body temperatures in winter are close to simultaneous water temperatures. During low tide intervals in hot weather they often hide in damp rock crevices and empty barnacle shells. Aerobic metabolic rates in and out of water are similar.

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FISH PREDATION ON GASTROPODS ON THE PACIFIC COAST OF COSTA RICA. S. Ortega. Univ. of South Carolina, Columbia.

The intensity of fish predation was measured by comparing loss of gastropod shells at four shores in the intertidal zone on the Pacific Coast of Costa Rica. Fish had little effect on shell disappearance of gastropods although some shell crushing occurred. Fish predation intensity in Costa Rica was variable in space and time and was lower than in Panama. Loss rate of gastropods in Costa Rica was as low as that documented for temperate regions, suggesting that variation among latitudes (temperate vs tropical) was no higher than variation at similar latitudes (Panama vs Costa Rica). Local variation within each region should be considered when temperate-tropical comparisons are made.

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VERTICAL DISTRIBUTION OF THE NEOGASTROPOD *ILYANASSA OBSOLETA* AFFECTED BY A LARVAL TREMATODE. L.A. Curtis. University of Delaware, Newark, DE 19716.

Larval trematodes in *Ilyanassa obsoleta* collected from different vertical positions along the shores of two Delaware estuaries were determined by dissection. Comparisons of samples show that beachface snails were often (70%+) infected with *Gynaecotyla adunca* whereas few (10%-) from below the beachface were so infected. Since uninfected snails did not distribute this way results indicate that the snail's behavior is altered by the parasite. This suggested a snail removal experiment to see how long it took to generate the observed pattern. The experiment was run on a Cape Henlopen sandbar inhabited mostly (80%+) by *G. adunca*-infected snails. Snails were removed from a 3X5m plot near the sandbar top on each of a series of low tides in July 1984. Among snails that repopulated the plot between tides 271 were examined and 86% had *G. adunca*. Thus the observed pattern is generated and maintained on a tidal basis. The next parasite host is the beach-hopper (*Talorchestia longicornis*), which occurs mainly high on beaches. An attractive hypothesis to explain results is that snail distribution is parasite-altered to facilitate cerariae finding the next host.

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EVIDENCE THAT FEMALE CONTACT PHEROMONES INFLUENCE THE MALES' REPRODUCTIVE BEHAVIORS IN THE AMPHIPOD CRUSTACEAN *GAMMARUS PALUSTRIS*. B. Borowsky and R. Borowsky, Osborn Laboratories of Marine Sciences, Boardwalk at West 8th Street, Brooklyn, New York 11224 & New York University, Washington Square, New York 10003

The reproductive behavior of males of this species may be divided into three sequential stages: 1) males travel to receptive females; 2) males pick up females and begin to carry them about (precopulation). Precopulation continues for a few days until the female molts, when 3) copulation occurs. The first stage is influenced by waterborne secretions from receptive females. In contrast, the second and third stages are apparently unaffected by this attractant. Instead, the evidence suggests that contact pheromones on the females' exoskeletons are the principal stimuli of precopulation and copulation. In addition, the males' performance of these behaviors is aided by the females' behaviors; receptive females orient their bodies in one way to facilitate the males' initiation of precopulation, and newly molted females orient their bodies in another way to facilitate copulation. The existence of several distinct stimuli for each of the males' behaviors may be an adaptation for the severe time constraints imposed by the females' reproductive physiology.

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ROLE OF PROTEIN AND FREE AMINO ACID POOLS IN THE SHORT-TERM SALINITY ACCLIMATION RESPONSE OF *CALLINECTES SAPIDUS*. S. Sanzone. Univ. of South Carolina, Columbia.

Levels of muscle fiber protein and hydration, and hemolymph protein, free amino acids (FAA) and ammonia were followed over a 72 hr exposure to reduced salinity. Adult male blue crabs acclimated to 30 ppt were transferred directly to 10 ppt. At 6, 12, 24 and 72 hr, comparisons were made between treatment and control groups for all parameters measured. Exposure to reduced salinity resulted in a rapid decrease in hemolymph osmolality by 6 hr. Cell protein content was significantly increased in the low salinity group by 12 hr. The treatment resulted in elevated levels of ammonia and major FAA in the hemolymph. Hemolymph protein was reduced in the low salinity group at 12 hr. In agreement with previous studies, these results suggest that FAA lost from the tissues during hypo-osmotic stress may be accounted for by catabolism and loss to the extracellular fluid. However, incorporation of FAA into cell protein is also implicated as a storage mechanism. Data do not suggest storage of cell FAA as hemolymph protein during the short-term salinity acclimation response.

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CALCIFICATION IN THE CRAB *CARCINUS* AS REDOX CELL ACTIVITY. F. S. B. Digby. McGill University, Montreal, Canada.

Earlier demonstration of electrical conduction in cuticle suggested that calcification in crustaceans might involve or arise from an electrode process, driven by small potentials generated across the cuticle. But normally *Carcinus* cuticle is 1.0 pH unit alkaline to its blood; if this difference is produced, Ca salts deposit. For this pH difference, potentials as measured through KCl bridges are clearly inadequate. Crab blood and cuticle are however reducing and platinum electrode potential differences between blood and seawater are equivalent to the difference in pH. Furthermore it can readily be shown that oxidation of reduced cuticle by air or oxygen produces base. It is suggested therefore that the calcifying regions correspond to the cathodic side of a redox cell, the electronic conducting part of the circuit being the quinonoid complexes with associated terminal oxidase activity. It is suggested that calcification arose following the development of quinone-tanned complexes for strength and protection; copper in the blood led to the formation of enzymes with terminal oxidase activity, producing alkalinity and calcification at the outer surface. (Canadian N.S.E.R.C. grants A4687, E1831)

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ADAPTATIONAL DIVERGENCE IN VOLUME REGULATION IN TRANS-ISTHMIAN *PACHYGRAPSUS TRANSVERSUS*. Joan D. Ferraris and Joanna E. Roth*. Mt. Desert Island Biological Laboratory, Salsbury Cove, ME. and Univ. of Alaska, Fairbanks.

Panamanian cognate species of marine decapod crabs have been geographically isolated from each other since the emergence of the Isthmus separated the Pacific and Atlantic Oceans. Due to upwelling, which occurs only on the Pacific coast, Pacific crabs normally experience lower and more variable temperatures than do Atlantic crabs. Correspondingly, during exposure to low temperature cycles [28 C (control) + 21 C (24 h) + 28 C (24 h) + repeat] at constant salinity, Pacific crabs maintained a stable total claw water Na, K, and Cl content (g H₂O or μM/g solute free ash free dry wt) while Atlantic crabs did not. Atlantic crabs increased (P < 0.05) in water, Na, and Cl content with each exposure to low temperature. In contrast, during exposure to high temperature cycles (control = 28 C; high = 35 C) Pacific crabs were unable to maintain stable water and ion content while Atlantic crabs did. These results may indicate that adaptation to low temperature cycles in Pacific crabs has reduced their ability to regulate volume in high temperatures. Supported by the Whitehall Foundation.

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COMPARATIVE MORPHOLOGY, CLASSIFICATION, AND PHYLOGENY OF THE DECAPODA. L. G. Abele and B. E. Felgenhauer. Florida State Univ., Tallahassee.

There is considerable disagreement over the internal classification of the Decapoda. Current suggestions include subdividing the group into two (Dendrobranchiata, Pleocyemata), three (Dendrobranchiata, Caridea, Reptantia), or four (Dendrobranchiata, Caridea, Stenopodidea, Reptantia) suborders. Each of the above classifications has been based on relatively few characters. These three hypotheses and some additional ones are examined through an analysis of approximately 60 characters, including some not previously considered. The analyses suggest several different classifications and phylogenies. The differences depend, in part, on the interpretation of branchial and foregut morphology.

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SIGNIFICANCE OF SPERM TRANSFER COMPLEXITY IN DECAPOD CRUSTACEANS. R.T. Bauer, Univ. of Puerto Rico, Rio Piedras

Anterior pleopods of many male decapods are modified for transferring a spermatophore onto the female's ventral surface or into a seminal receptacle. Little modification is observed in carideans, palinurids, stenopodids, and anomurans. Complex male gonopods and female spermathecae occur in dendrobranchiate shrimps, most astacidean crayfish and lobsters, and brachyurans. Relationships among female molting, mating, postmating interval, oviposition, and embryo incubation are quite variable and not easily related to sperm transfer complexity. There appears to be a phylogenetic pattern to sperm transfer and storage if the dendrobranchiate-pleocyemate view of decapod evolution is accepted. A gradient of increasing complexity of insemination method can be constructed with the Infraorders Caridea, Astacidea, and Brachyura. Within the Brachyura, the primitive Dromiacea and Archaeobrachyura have spermathecae separate from oviducts while the two structures are intimately linked in advanced Brachyura (definite internal fertilization, no loss of sperm at molting). All dendrobranchiates have specialized transfer but inefficient storage.

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THE NATURE OF THE CRETACEOUS DECAPOD RECORD OF NORTH AMERICA. G. A. Bishop*, Georgia Southern College, Statesboro.

The fossil record of the decapod crustaceans is sparse and fragmentary. Cretaceous North American fossil decapods comprise 90 taxa. One-third of the taxa are represented by one specimen, two-thirds by fewer than 8 specimens, and only 5 by more than 100 specimens. Differential fossilization selectively preserves some taxa and parts of some taxa (eg. carapaces and claws). Taphonomic analysis often allows differentiation of remains into detritus, exuviae, or corpses. Remains are commonly preserved in concretions composed of the minerals calcite, hematite, or apatite. Patterns of distribution, faunal similarity, and similarity of preservation suggest many of these fossil decapod assemblages are preserved community fractions. Although sparse and fragmentary this record is the primary data source for the interpretation of the evolution of the evolution of the decapod crustaceans.

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SYSTEMATICS AND ECOLOGY OF THE SNAPPING SHRIMP SYNALPHEUS SCAPHOCERIS COUETIERE, 1910 (DECAPODA: ALPHEIDAE). M. R. Dardeau. Dauphin Island Sea Lab, Alabama.

Many subspecies of Synalpheus described at the turn of the century have since proved to be based on specimens representing extremes of a wide range of variation in the nominate subspecies. Synalpheus scaphoceris, originally described as a subspecies of S. townsendi, is an exception. Synalpheus scaphoceris can be distinguished from the morphologically similar S. townsendi by a distinctive spotted color pattern, the strongly produced ventral rostral process, the blunt dorsodistal process of major pereopod 1, and the absence of appendices internae on the pleopods of the male. Male-female pairs of S. scaphoceris were associated only with large individuals of Madracis decactis (Lyman, 1857), a scleratinian coral, in samples from the Florida Middle Ground. Oviparous females were present in fall and summer but not winter samples. Juveniles were present in fall and winter but not summer samples. Synalpheus scaphoceris occurred less frequently, in fewer numbers and at much lower densities than did Synalpheus townsendi in samples of the host coral.

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TWO NEW COMMENSAL ALPHEID SHRIMPS FROM SOUTH FLORIDA. D.L. Felder and R.B. Manning. Univ. Southwestern Louisiana, Lafayette, and Smithsonian Institution, Washington.

A survey of infaunal decapods using a yabby pump to sample shallow water habitats in the Indian River near Fort Pierce, Florida, has yielded material of Leptalpheus forceps Williams and two undescribed alpheid shrimps that also carry their chelae flexed against their merus. These shrimps are commensals, living in burrows of stomatopods, decapods, and other macroinvertebrates.

A PRELIMINARY ANALYSIS OF THE INTER-GENERIC RELATIONSHIPS OF STENOPODIDEAN SHRIMPS. J. W. Goy. Texas A&M Univ., College Station.

Phylogenetic relationships are presented for the nine genera of stenopodidean shrimps based on examination of a variety of morphometric, meristic, and two-state characters. Some of these characters, such as branchial formulae, are of high reliability in the cladistic analysis. The genus Stenopus seems to be ancestral with two genera (Microprosthema and Odontozona) diverging in the same ecological zone, live tropical coral reefs above 50m. The remaining six genera are deep water forms, five of which are known commensals of Hexactinellid sponges living below 165m. Extreme variability of certain characters in all genera and possible convergence of characters for commensal genera makes interpretation of intergeneric relationships difficult. This analysis is offered as the first step in a better understanding of the phylogeny of the Stenopodea. Further examination of genera presently represented by only a few specimens and incorporation of more characters in the analysis, will lead to improvements on this preliminary analysis of the infraorder.

TWO NEW CARIDEAN SHRIMPS FROM MARINE CAVES OF WESTERN ATLANTIC ISLANDS. C.W. Hart, Jr. and Raymond B. Manning. National Museum of Natural History, Smithsonian Institution, Washington, D.C.

A shrimp belonging to a new family has been found in submerged caves in the Bahamas and the Turks and Caicos islands, and a third species of the genus Procaris (Procarididae) has been found in a cave on Bermuda. The new family may have affinities with shrimps recently found in the Galapagos Rift the new Procaris is closely related to those species previously described from Ascension and Hawaii.

A NEW GENUS AND SPECIES OF PROCARIDID SHRIMP FROM HAWAII. B. Kensley and D. Williams† Smithsonian Institution, Washington, D.C., and Freeport, Bahamas.

A new genus and species of procaridid shrimp is described from a pool on Hawaii Island. The new genus is characterized by the possession of appendices internae on the posterior three pairs of pleopods, by relatively elongate dactyls on all five pairs of pereopods, and by two arthrobranches on the third maxilliped and first three pairs of pereopods, and a single arthrobranch on the fourth pereopod. It is suggested that the new genus is more primitive than Procaris, the only other genus in the family. The diagnoses of the superfamily Procaridoidea and the family Procarididae are revised. The features of the new genus suggest that the procaridids may be more closely related to the Caridea than was originally thought. Some of the organisms co-occurring with the new shrimp including Procaris hawaiiensis and Halocarina sp. are discussed in relation to food webs.

A SHELF ASSEMBLAGE OF XANTHOID CRABS IN THE NORTHERN GULF OF MEXICO. D.L. Felder and N.N. Rabalais. Univ. of Southwestern Louisiana, Lafayette, and Louisiana Univ. Marine Consortium, Chauvin.

During the last ten years, studies of benthos on the broad continental shelf of the northern Gulf of Mexico have added appreciably to specimen holdings of decapod crustaceans. This wealth of material has permitted detailed systematic studies of several poorly known reptant groups, including a rich and relatively unknown assemblage of largely infaunal xanthoid crabs. Part of this assemblage was originally described on the basis of very limited specimen materials, and little was known of depth ranges and substrate preferences that are clarified by our studies. The known outer continental shelf xanthoid assemblage does not necessarily demonstrate a strong tendency for endemism, such as is evident in coastal brachyuran assemblages of the northern and western Gulf. However, the prevalence of previously unreported or undescribed species among shelf xanthoid materials suggests that this group is overall too poorly known in the western Atlantic to, at present, lend to zoogeographic syntheses. Descriptions and redescriptions based upon studies of present Gulf materials and re-examination of type specimens are essential to future zoogeographic comparisons.

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PHYLOGENETIC RELATIONSHIPS OF THE GENUS *AEGLA* (DECAPODA, ANOMURA, AEGLIDAE). J. W. Martin. Florida State Univ., Tallahassee.

Freshwater anomuran crabs of the genus *Aegla* are endemic to temperate South America. Traditional classifications of the Decapoda group aeglids with galatheids, porcellanids, and chirostylids in the superfamily Galatheoidea. However, several characters of the carapace and pereopods would seem to ally aeglids with the hermit crab families. These characters are described using light and electron microscopy. For 11 decapod families that are now or were previously placed in the Anomura I examined 43 characters. A preliminary phenetic analysis does not closely group aeglids and galatheids, but does indicate a closer relationship between *Aegla* and the superfamily Galatheoidea than between *Aegla* and the hermit crabs. Phenetic and phylogenetic analyses of the Anomura are compared.

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THE EFFECTS OF FEEDING AND STARVATION ON THE LEVEL AND CONTENT OF NUCLEIC ACIDS IN THE GUT TISSUES OF *LYTECHINUS VARIEGATUS* (LAMARCK) (ECHINODERMATA: ECHINODEA). T.S. Klinger, S.A. Watts, and D. Forcucci*. Bloomsburg Univ., Penn., and Univ. of South Florida, Tampa.

Maximum gut indices of individuals fed *ad libitum* over a four-week period were 2.7 fold higher than those of individuals starved over the same period. The concentration of DNA in the gut tissue was 1.3 fold lower and total DNA was 2.3 fold higher in fed individuals than in starved individuals. The concentration of RNA in the gut tissue was the same in fed and starved individuals. RNA:DNA ratios were 2.2 and 1.5 in fed and starved individuals, respectively. Changes in the size of the gut during feeding or starvation are the result of changes in both cell size and number. Maximum changes in the synthetic capacity of the gut tissue (RNA:DNA) occurred within 1 week. Maximum changes in the size of the gut occurred within 3 weeks.

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ALLOCATION OF NUTRIENT RESOURCES IN THE REGENERATING ASTEROID *LUIDIA CLATHRATA*.

J.M. Lawrence, T.S. Klinger, J.B. McClintock, S.A. Watts, C.-P. Chen, A. Marsh, L. Smith. Dept. of Biology, Univ. South Florida, Tampa 33620.

Intact individuals and individuals with two adjacent arms amputated were fed or starved for 3 months during the gametogenic period. The radius of the arms did not change in any of the groups. The radius and amount (g dry weight) of regenerating arms of fed individuals were twice as great as those of starved individuals. The amount of body wall, pyloric caeca, and gonad in an arm increased in fed individuals and decreased in starved ones independently of regeneration. The amount of pyloric caeca in an arm increased more in fed, regenerating individuals than in fed, intact individuals; the total amount of increase in the pyloric caeca was equivalent in the two groups. Absorbed nutrients are allocated primarily to growth of the intact arms and the pyloric caeca and gonads which they contain, and secondarily to regeneration. This increase in functional capacity in terms of nutrient storage (pyloric caeca) and reproduction (gonads) is greater than if the absorbed nutrients were allocated primarily to regeneration.

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EVIDENCE OF THE NUTRITIONAL ROLE OF DISSOLVED ORGANIC MATERIAL DURING REGENERATION BY AN AMPHIURID BRITTLESTAR. L.A.J. Clements, Univ. of South Carolina, Columbia, S.C.

Disc loss by amphiuroid brittlestars precludes feeding on particles. The only nutrients available for regeneration are dissolved organic material (DOM) or material already stored in tissues. To test the hypothesis that DOM (amino acids) has an effect on the rate of disc regeneration by the brittlestar *Micropholis gracillima*, ten animals were incubated for 14 days in seawater media with various levels of amino acids added. Animals in all treatments regenerated disc tissue. Those in artificial seawater with no DOM added showed the slowest rate of regeneration. Animals in low DOM media (2.5 $\mu\text{mol/liter}$) and those in natural seawater had similar rates of regeneration; those in high DOM media (25 $\mu\text{mol/liter}$) showed accelerated regeneration. Increasing the concentration of DOM in seawater increased the rate of regeneration. This is the first experimental demonstration that dissolved amino acids can be used as a food source during regeneration.

RELATIONSHIP BETWEEN EGG VOLUME AND ENERGY CONTENT WITHIN A SINGLE SPAWN OF THE STARFISH PTERASTER TESSELLATUS. Larry R. McEdward and Louise K. Coulter*, Department of Zoology, University of Alberta, Edmonton.

Pteraster tessellatus produces large (1.22 mm diameter), buoyant, orange eggs that develop into pelagic lecithotrophic larvae. A sample of 44 eggs from a natural spawning had a mean volume of 0.95 mm^3 (SE = 0.01; range = 0.83-1.08). The mean energy content of individual eggs was 351 joules (SE = 0.04; range = 2.52-3.98). Energetic density ranged from 2.52 to 4.50 joules mm^{-3} (mean = 3.70; SE = 0.05). Although there is considerable variation in egg volume and energy content (ranges vary from 27-53% of mean value), energy content is not significantly correlated with egg volume ($r = 0.25$; $p > 0.05$). Energetic density was inversely correlated with volume ($r = -0.39$; $p < 0.05$). It is not known whether the variations in egg size and energy content are evolved, adaptive responses to variation in the larval environment or are a necessary result of imprecision inherent in oogenesis. Variation in egg volume might result from differences in hydration. The lack of correlation means that egg dimensions are poor predictors of differences in energy content among eggs within a spawn. Therefore it will be difficult to examine the consequences of differences in parental investment of materials and energy among sibling offspring.

UPTAKE AND METABOLISM OF ^{14}C -GLYCINE BY LARVAE OF CREPIDULA FORNICATA (MOLLUSCA: GASTROPODA) A. Lord, Tufts Univ. Medford Mass.

Larvae of the marine gastropod Crepidula fornicata take up ^{14}C -glycine from concentrations of 0.17-10.2 μM . Uptake is linear from 2 to 100 minutes. The transport constant, K_t and maximum rate of uptake, J_{max} are 7.7 μM and 22 ng/larva/hr for larvae fed normally before experiments and 6.38 μM and 17 ng/larva/hr for larvae starved 48 before experiments. Both fed and starved larvae metabolize ^{14}C -glycine, catabolizing it to $^{14}\text{CO}_2$ or incorporating it into protein within 10 minutes after exposure begins. All experiments were done in .22 μm filtered, autoclaved seawater. Although fed and starved larvae take up ^{14}C -glycine at similar rates (2149 pg/larva/100 min vs. 2062 pg/larva/100 min) from 1.02 μM concentrations, starved larvae respire significantly more glycine as $^{14}\text{CO}_2$ and incorporate significantly less into protein (one way analysis of variance $p < 0.05$). These experiments indicate that fed and starved larvae may use dissolved glycine in different ways, with starved larvae catabolizing glycine for immediate energy needs, and fed larvae storing it in protein.

THE INFLUENCE OF ELEVATED KCl ON METAMORPHOSIS OF LARVAL CREPIDULA FORNICATA (MOLLUSCA: GASTROPODA). J.A. Pechenik and W. Heyman*. Tufts Univ., Medford, MA.

Measuring the length of time that metamorphosis can be delayed by marine invertebrate larvae deprived of suitable adult habitat requires that the time at which larvae become competent to metamorphose be determined. We have studied the potential use of KCl, NaCl, CaCl_2 , and GABA for testing competence in larvae of the marine gastropod Crepidula fornicata. GABA (10^{-7} - 10^{-6}M) and CaCl_2 (20 mM additions) did not elicit metamorphosis, but 100% metamorphosis was typically obtained within 8 h by increasing the KCl concentration of seawater by 20 mM. The effect was not due to increased osmotic concentration of the medium; a much lower response was obtained by elevating NaCl levels by 20 mM. Larvae first became responsive to the added KCl at shell lengths of about 800 μm , approximately the size at which larvae of this species can first be induced naturally. Juvenile growth following natural induction of metamorphosis is not significantly different ($P > 0.10$), for at least the first 5 days, from that following induction by elevated KCl. (NSF OCE-8500857)

THE EFFECTS OF CADMIUM EXPOSURES ON GROWTH OF LARVAE OF AN HAWAIIAN BIVALVE, ISOGNOMON CALIFORNICUM. Amy Huffman Ringwood. Univ. of Hawaii, Honolulu.

Three-day-old bivalve larvae were exposed to a series of Cd concentrations (from 2 to 50 ppb) for 14 days. The cultures were then subdivided and some larvae were exposed to Cd for an additional 14 days while others were ongrown in clean seawater. The effects of Cd on growth (shell dimensions, and shell and tissue weight) were determined. Although size is commonly used to evaluate the effects of toxic substances on growth, weight was found to be a more sensitive indicator. Both shell and tissue weight were affected. Growth was reduced during the first 7 days of exposure at all Cd concentrations, but partial recovery was observed during the second week, suggesting that larvae possess Cd-sequestering or detoxifying mechanisms with an activation lag phase of at least 7 days. With continued exposure, recovery was sustained in the low Cd concentrations, while at high concentrations inhibition of growth prevailed. At the highest concentration, morphological abnormalities of the velum occurred. During the ongrown period, recovery was observed in the lowest concentrations only.

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ONTOGENETIC LOSS OF ARENOPHILIC MANTLE GLANDS IN ENTODESMID BIVALVES. R.S. Prezant, Univ. of Southern Mississippi, Hattiesburg.

Juvenile members of the marine, crevice dwelling bivalves Entodesma saxicola and E. cuneata, possess numerous small multicellular glands along their mantle edge that secrete an adhesive mucin through and over their periostracum. This mucin serves to attach foreign particles to the outside of the thin juvenile shell. The outer extraneous cover helps protect and stabilize the juveniles in their then oversized crevice homes. With growth the bivalves gain stronger byssal attachments, become tightly wedged in crevices, and develop thicker, stronger shells. With the gradual attainment of the latter attributes the bivalves show a concomitant loss in the number of arenophilic mantle glands as the role of the adhesive mucin is replaced by adult features.

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EARLY REGENERATIVE EVENTS IN THE COELOMIC LINING OF THE STARFISH TUBEFoot. M. J. Cavey and R. L. M. Marsden*. Univ. of Calgary, Alberta, Canada.

The coelomic lining in the tubefoot of Pisaster ochraceus is a complex myoepithelium consisting of adluminal cells and retractor cells. The early regenerative responses of the myoepithelial cells have been studied by light and electron microscopy in the stumps of amputated tubefoots. Organizational differences quickly develop between adluminal cells in the terminal and subterminal sectors of the stump. Terminal cells lose anchorages to the myoepithelial basal lamina and form a flattened layer over the severed ends of the underlying retractor cells. Subterminal cells, retaining connections to the basal lamina, appear in a conspicuously folded layer that is indented by the adjacent retractor cells. The removal of damaged retractor cells is a principal activity during the first 24 hours of regeneration. Fragments of retractor cells are basally engulfed by the adluminal cells and transported in vacuoles to the apical cytoplasm, where they are released, either unaltered or as lysosomal residual bodies, into the water vascular canal. Transcellular clearance of the damaged retractor cells preserves the junctional complexes between the adluminal cells.

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SWIMMING OF CILIATED MARINE INVERTEBRATE LARVAE: RELATIONSHIP BETWEEN SPEED AND MORPHOLOGY. H. Lee. Wellesley College, MA.

For ciliated organisms, a consideration of the propulsive and drag forces involved in swimming gives rise to a model that relates speed with several morphological parameters. The present study investigates this relationship among 64 developmental stages of 30 species of marine invertebrate larvae. Results include: a) speed and body size were not correlated; b) speed increased significantly with the length of larval cilia; and c) larvae with transverse ciliary bands generally swam faster, while larvae with convoluted bands swam uniformly slowly.

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DOES MORPHOLOGY PREDICT ECOLOGY? HYPOTHESIS TESTING WITHIN A FRESH WATER FISH COMMUNITY. Michael E. Douglas and William J. Matthews. Oklahoma State University and University of Oklahoma.

Can morphometric data serve as an index of niche width or community structure? Only if phenotypic measurements are significantly related to habitat, for this is how species segregate in both terrestrial and aquatic communities. To test this ecomorphological hypothesis, we generated pair-wise taxonomic distances between 17 freshwater fish species (in 8 genera and 4 families) using the following data: (1) various transformations of 41 phenetic measures; (2) the % occurrence of 23 food items in gut analyses; and (3) 25 microhabitat measures. Matrix comparisons were performed using the Mantel Test. When comparisons were made within a family of fishes, morphology and microhabitat were found to be significantly related. However, the niche/phenotype relationship breaks down when analyses are performed over several different families (the usual situation for community assays).

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SYMMETRIC RESPIRATORY CURRENTS OF FLATFISHES. K.F. Liem, S. Kehl and E. Brainerd. Harvard Univ., Cambridge, MA and Friday Harbor Laboratories, WA.

Previous studies hypothesized that flatfishes (Pleuronectidae) breathe asymmetrically by exhaling from the eyed-side only. Our experiments show that various pleuronectid species generate symmetrical pressures in both opercular cavities, resulting in symmetrical exhalent currents as elucidated by cineradiography and the movements of dyes.

Symmetrical respiratory currents are made possible by the presence of an interconnecting channel between the two opercular cavities. The interconnecting channel, which is formed by a notch in the urohyal, plays a key role in equalizing the pressures of the two opercular cavities thereby ensuring the maintenance of symmetrical respiratory currents under varying environmental conditions. Experimental blockage of the channel results in unequal pressures and asymmetrical currents. Electromyographic data also show symmetrical activity in the major respiratory muscles. (Supported by NSF DCB 85-00585 to K.F. Liem).

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COLORIMETRIC ANALYSIS OF THE PHARYNGEAL MUSCLES OF THE PARROTFISH, GENUS SCARUS. K. W. Gobalet. Loyola University, New Orleans, Louisiana.

Muscle color has been used to interpret the function of the muscles of the pharyngeal mill of parrotfish. The six pairs of muscles (L.EXT. 4, L. POST., R. DORS., OBL.D., AD. 5, TR.V.) that adduct or produce shear between the pharyngeals are red indicating endurance related activity for grinding algae and abrasive material. This color contrasts with the muscles of fishes that don't triturate their food. Six muscles used in respiration (STH., A 3, A.A.P., A.O., G.H., L.A.P.) show remarkable constancy in their color patterns. In over 20 species examined, there are distinctive white and pink to red regions. The pink to red regions are interpreted to correspond to aerobically active regions used during normal respiration. The white regions are probably recruited during feeding, forced respiration and the "cough."

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EFFECTS OF FASTING ON THE FISH INTESTINE AND ITS DIVERTICULAE. A. Hossain and H. M. Dutta, Biological Sciences, Kent State University, Kent, OH

Light and electron microscopes were used to investigate the effect of fasting on the fish intestine and diverticulae. In a laboratory designed experiment, bluegills were forced-fasted for 100 days. A comparison was made with well nourished bluegills. Health reports were prepared. Gross and microscopic anatomy were evaluated both qualitatively and quantitatively by applying histological as well as histochemical techniques. Behaviour of goblet cells in both intestine and diverticulae were recorded by both light and electron microscopic study. The effect of fasting was more prominent in intestine than its diverticulae. Mucosal surface area was reduced upto 45% in intestine while the reduction did not exceed even 25% in caeca. Electron microscopic search revealed several changes among which the destruction of microvilli and macrophagic infiltration in the intestinal enterocytes were very common. Unlike mammals fish appear to be very tolerant to fasting.

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VARIATION IN SECONDARY SEXUAL CHARACTERS IN Leptodactylus pentadactylus (ANURA: LEPTODACTYLIDAE). A.P. Jaslow. Rhodes College, Memphis, TN.

Several physical characters relating to male breeding behavior and fighting are found in Leptodactylus pentadactylus. These include large keratinized chest spines, one or two keratin-covered bony wrist spines, and hypertrophied arms. Variation in these characters was correlated with animal size and season. The three keratinized structures showed a hierarchical pattern of occurrence. Snout-vent length explained some of this pattern as well as some of the variation within these characters. Structures lost through injury were regrown during the breeding season in some males. Although previously thought to be permanent in L. pentadactylus, these characters were lost after the distinct breeding season seen in Panama. The upper arm of L. pentadactylus had a greater girth than the lower arm, and was much larger than those of females. This sexual dimorphism is supported by a dramatic difference in humeral structure. Beyond this skeletal dimorphism, male L. pentadactylus gain additional upper arm muscle girth during the breeding season.

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GROWTH RATES AND PATTERNS OF SEXUAL DIMORPHISM IN ANEIDES FLAVIPUNCTATUS.
N.L. Staub, Univ. of California, Berkeley.

The plethodontid salamander Aneides flavipunctatus is sexually dimorphic: adult males have significantly broader heads than females. To determine how this dimorphism arises ontogenetically, a mark-recapture study was undertaken in Mendocino County, CA. 67 out of 348 marked salamanders were recaptured between November 1984 and April 1985. Head dimorphism is not explained by differences between males and females in body length or growth rates. Heads of males and females that reached sexual maturity during the 1984-85 season grew in width more rapidly than in juveniles and older adults, with males exhibiting this change more dramatically than females. This sexual difference in head growth rate accounts for the head dimorphism observed in adult A. flavipunctatus. A von Bertalanffy growth curve was fit to these recapture data to provide estimates of salamander age. Sexual maturity is reached during the third year, and large adults (>80mm) are approximately 7 years old. The evolution of sexual dimorphism in the genus Aneides will be examined using ontogenetic information.

704a

CUTANEOUS MUSCULATURE ASSOCIATED WITH THE PELVIC "SEAT PATCH" IN BUFONID ANURANS.
R. M. Winokur and S. D. Hillyard. Univ. of Nevada, Las Vegas.

Epidermal sculpturing of the pelvic skin or "seat patch" of Bufonids has been shown to facilitate the adsorption of soil particles to the skin and to enhance substrate moisture absorption (Hillyard, S.D., Copeia 1976:314-320). Dissections of B. woodhousei and B. marinus reveal that fibers from the gracilis minor muscle attach via numerous bundles to the dermal surface of the seat patch. These attachments have long been known but their potential relationship to the function of the seat patch has gone unnoticed. A small integumentary muscle takes its origin from paired triangular muscle masses ventral to the cloaca and has fibers extending longitudinally into the seat patch where they attach to the dermis. Fibers from these two muscles thus form a complex trabecular latticework and attach to each other as well as to the skin. Histological examination and direct electrical stimulation demonstrate that these muscles can significantly modify the pattern of epidermal sculpturing of the skin and may play a role in optimizing the uptake of substrate moisture. S.D.H. was supported in part by N.S.F. #Int 83 111 87.

704b

DIFFERENCES BETWEEN ONTOGENETIC AND REGENERATIVE CARPAL PATTERNING IN THE RED-BACKED SALAMANDER, Plethodon cinereus. C.E. Dinsmore and J. Hanken. Rush Medical College, Chicago and Univ. Colorado, Boulder.

We have examined two geographically isolated populations of Plethodon cinereus to determine the relationship between native and regenerate carpal patterning. Native limbs were amputated and whole mount stained for limb skeletal pattern analysis. The regenerates were subsequently removed and similarly analyzed. We have not found any correlation between native and regenerate carpal patterns on the same individuals. Furthermore, inter-element fusions are at much higher frequency in regenerates and differ qualitatively from native variant fusion patterns suggesting a differential responsiveness to epigenetic constraints during embryonic development versus adult limb regeneration. Supported by the Dahlgren Fund (CED) and NIH 1 R23 DE07190-01 (JH).

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NUTRITION AND PHOTIC HISTORY MODIFIES PHOTOPERIODIC RESPONSES OF THE FEMALE GOLDEN HAMSTER. L.B. Johnson, R.A. Hoffman. (Intro. by C. Beuchat). Colgate Univ. Hamilton, N.Y.

In a recent paper (Johnson & Hoffman, in review), we demonstrated that a commercial diet supplemented with seeds enhanced growth rates and inhibited (delayed?) reproductive atrophy in hamsters. In other work (Hoffman & Johnson, 1985), photic history was found to modify reproductive responses and growth. We now report results of a study on the combined effects of photic history and nutrition on golden hamsters exposed to short photoperiods. Eight weeks after exposure to a short photoperiod (LD 8:16 hrs) the standard commercial pellet diet was supplemented with seeds/nuts or 20% sucrose. At autopsy five weeks later, all but 3 hamsters in the pellet and sucrose-supplemented groups possessed nonfunctional ovaries and atrophied uteri, while only 1 of 13 in the seed-supplemented group was so affected. Animals born in the dark were heavier than those born in colony conditions, but photic history had no effect on the reproductive system.

Partially supported by the Lighting Research Institute.

TERMINATION OF GONADAL REFRACTORINESS IN TURKISH HAMSTERS. S.M. Hong and M.H. Stetson. University of Delaware, Newark.

Photorefractoriness to short days is terminated by about 11 wks of long day treatment in golden hamsters. To determine the duration of long day treatment necessary to terminate refractoriness in Turkish hamsters, refractory hamsters were subjected to LD16:8 for 5, 10, 15, or 20 wks and then returned to LD12:12. Ten wks of long day exposure was sufficient to restore sensitivity to short days. Photoperiods of longer than 17 hrs of light cause gonadal regression in Turkish hamsters. We tested whether these very long days (LD20:4) can terminate refractoriness also. Refractory females were exposed to LD16:8 or LD20:4 for 15 wks. Upon return to LD12:12, 70% of both groups became anestrus after 15 wks. These results indicate that a) as in golden hamsters, refractoriness to short photoperiods in Turkish hamsters can be terminated 10 or more wks of long day exposure, and b) very long days (LD20:4) terminate refractoriness, even though they induce gonadal regression in reproductively active animals.

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CIRCADIAN RHYTHM OF LIPOGENIC RESPONSIVENESS TO INSULIN AND PROLACTIN IN PRIMARY CULTURE OF HEPATOCYTES. A.H. Cincotta* and A.H. Meier. Louisiana State Univ., Baton Rouge, LA.

Hepatocytes from male golden hamsters held on LD 14:10 (lights on 0800) were cultured in monolayer. The culture medium (supplemented Waymouth's also containing 3.5×10^{-10} M bovine insulin) was changed every 4 h over the course of the experiment. Lipogenesis (14 C-acetate incorporation into total cell lipid) was assayed at 4-h intervals during a 48-h period (day 2 and 3 of culture). Dramatic circadian variations were observed with peak lipogenic activity at 2400 and 0800 on both days. Prolactin almost doubled lipogenesis, only if assayed at 2400 and 0800 and only when added to culture 20 h before these times. Lipogenesis is the net consequence of a circadian rhythm of sensitivity to insulin which in turn is augmented by prolactin at a specific temporal relation to the sensitive interval.

REGULATION OF THE ANNUAL BREEDING CYCLE OF MALE MUMMICHOGS, FUNDULUS HETEROCALITUS. R.C. Cochran. Ches. Bay Inst., Johns Hopkins Univ., Shadyside, Md.

Sperm production by a field population of *F. h.* was monitored with a sperm index during 1983-85. Significant changes in the index were seen denoting seasonal, monthly, and diurnal rhythms in sperm production. These rhythms were correlated with changes in the serum concentrations of 3 androgens, listed in order of predominance- 11 β -hydroxytestosterone, 11-ketotestosterone, and testosterone. Serum androgen levels were determined by RIA following ether extraction and HPLC resolution of the steroids from a uBondapak C18 column using methanol-water (56:44) for isocratic elution.

DIFFERENTIAL REGULATION OF GONADOTROPIN SECRETION IN THE RAT: DYNAMIC PERFUSION OF ANTERIOR PITUITARY GLAND FRAGMENTS. E.S. Hiatt, N. Guttman* and N.B. Schwartz* Northwestern University, Evanston, IL

In rats, ovariectomy (OVAX) leads to a doubling of serum FSH by 6h with no significant rise in LH until 4 days later. This dramatic difference in response to removal of gonadal feedback suggests differences in mechanisms regulating LH and FSH secretion. An automated dynamic perfusion system (AcusystTM) was used to examine basal and GnRH-stimulated LH and FSH secretion by individual ant. pit. glands removed on the AM of metestrus (Od), or on the 2nd or 6th day post-OVAX. The glands were quartered and placed into individual chambers for a 6h perfusion (10 ml/h) in MED 199. After 4h, all chambers received 2 15-min pulses of a long-acting GnRH agonist (15 nmol/ml) at 1 pulse/hour. By 2d post-OVAX, basal secretion of FSH was elevated significantly, while LH was only slightly increased over Od levels; both LH and FSH were highest at 6d. Response to agonist was greatest at Od, but much reduced by 2d and 6d post-OVAX. These data suggest that the rise in serum LH and FSH levels after OVAX may be due to temporally distinct elevations of basal secretion rates rather than increased pituitary responsiveness or increased hypothalamic "drive".

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GONADAL STEROID SECRETION FOLLOWING STIMULATION OF THE HYPOTHALAMIC-PITUITARY-TESTICULAR AXIS IN BROWN BULLHEADS, ICTALURUS NEBULOSUS. P.M. Rosenblum and I.P. Callard. Boston University, MA.

In order to investigate the regulation of the teleost hypothalamic-pituitary-testicular axis, I. nebulosus were treated with salmon gonadotropin (SG-G100), salmon gonadotropin-releasing hormone (sGnRH) or an opioid antagonist, naloxone (NAL). Plasma testosterone (T), 11-ketotestosterone (KT) and estradiol-17 β (E2) were measured following treatment. SG-G100 elicited parallel time-dependent increases in T and KT, however a higher dose was required to elicit KT secretion. No effect on E2 secretion was seen. After sGnRH, T and KT were increased, with a more prolonged secretion of KT. A slight increase in E2 was seen. No clear dose response to sGnRH was observed. NAL did not increase steroids in these animals. The effects of these treatments varied during the annual cycle, with maximal T and KT responses to SG-G100 and sGnRH in the spring. sGnRH also induced E2 secretion at this time. In animals near spawning, NAL induced E2 secretion. These data suggest the involvement of GnRH and endogenous opioids in the secretion of gonadotropin(s) in this species.

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GONADAL CHANGES FOLLOWING OLFACTORY-BRAIN AXIS INTERRUPTION IN PLATYFISH. M.P. Schreiber, H. Margolis-Nunno, L. Halpern-Sebold, F. Caracheo* and S.L. Weiner*. Brooklyn College, New York.

Structural and functional links exist between the olfactory system and the nucleus olfactoryretinalis (NOR), an LHRH containing brain area important in reproductive system physiology (Brain Res., 302 (1984): 180-183). In this study the NOR was bilaterally lesioned (NORX) or the olfactory epithelium (OE) surgically removed (OEX) in mature fish. 3-5 wks after surgery, the OE in NORX fish is convoluted, has fewer apical projections, decreased vascularity, and more pyknotic nuclei. In OEX fish, ir-LHRH is intensified in NOR cell bodies and processes. In NORX and OEX males Leydig and Sertoli cells are frequently enlarged and spermatogenesis is active; however most sperm packets are in the efferent ducts. Advanced stages of oogenesis also appear discharged into ducts; yolk eggs are generally fewer or absent.

Our observations suggest that following NORX or OEX, gametes are actively produced and released without storage. It appears, too, that information transfer between the NOR and OE is bidirectional. (Supported by NIA-AGO 1938 and PSC-CUNY.)

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INDUCTION OF OOCYTE MATURATION IN THE MARINE TELEOSTS, ATLANTIC CROAKER (MICROPOGONIAS UNDULATUS) AND SPOTTED SEATROUT (CYNOSCIION NEBULOSUS). J.M. TRANT and P. THOMAS. University of Texas Marine Lab, Port Aransas.

Final oocyte maturation (FOM) in Atlantic croaker and spotted seatrout is induced in vitro by an ovarian steroid of unknown identity. The potency of a variety of steroids in inducing FOM was examined in an in vitro bioassay. Hydroxyl groups at positions 17 α , 21, and 20 β increased FOM-inducing activity of the progesterone and pregnenolone steroid nuclei. However, hydroxylation at the 11 β position was strongly inhibitory. In addition, hydroxylations at 3 α , 18, 19 positions decreased activity. The 3 β HSD inhibitors, cyanoketone and epotane, did not block GtH-induced FOM, whereas the 17 α hydroxylase inhibitor, SU10603, blocked FOM. This indicates the natural maturation inducing steroid (MIS) is not a 3 keto, Δ 4 steroid, but it does contain a 17 α hydroxyl group. The steroid produced by maturing oocytes were fractionated by HPLC and assayed for FOM activity. A fraction which had considerable FOM activity did not co-chromatograph with any of the MIS's proposed in teleosts.

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BIOASSAY FOR FUNDULUS GONADOTROPIN(S): IN VITRO OOCYTE MATURATION & STEROID PRODUCTION BY ISOLATED OVARIAN FOLLICLES. Y-W.P. Lin, M.J. LaMarca* and R.A. Wallace. Univ. of Florida, Whitney Lab., St. Augustine.

Isolated ovarian follicles from several species were cultured in order to develop an in vitro bioassay system for Fundulus gonadotropin (GTH). An homogenate of frozen Fundulus pituitary (FP), when tested in the heterologous systems using follicles from Rana, Xenopus and Carassius was strikingly ineffective in provoking either germinal vesicle breakdown (GVBD) or steroid production. In the homologous system using Fundulus follicles, FP was capable of inducing both GVBD and steroid production in a dose-dependent fashion. Testosterone, progesterone and 17 α ,20 β diOH prog. were detected by RIA in the culture media after FP stimulation. There was however, a marked seasonal sensitivity of the Fundulus follicles to FP stimulation in vitro. Follicles obtained from fishes outside of the breeding season were unresponsive to stimulation by LH or FP. These same preparations of FP were capable of provoking GVBD in follicles obtained in May. In conclusion, Fundulus GTH shows a stringent species specificity and the Fundulus follicles exhibit a seasonal-dependent responsiveness to its own gonadotropin(s).

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INFLUENCE OF WATER POTENTIAL AND TEMPERATURE ON EGGS OF SNAPPING TURTLES (*CHELYDRA SERPENTINA*) INCUBATING ON DIFFERENT TYPES OF SUBSTRATES. G.C. Packard, M.J. Packard, K. Miller and T.J. Boardman*. Colorado State Univ., Fort Collins, and Franklin & Marshall Coll., Lancaster, PA.

Flexible-shelled eggs of snapping turtles were incubated on sand and on vermiculite to determine whether responses of eggs and embryos to environmental temperature and water potential are affected by characteristics of the substrate. Both temperature and water potential had major effects on duration of incubation, hatching success, and size of hatchlings. In general, incubation was longer, hatching success was higher, and hatchlings were larger at low temperatures (26.0 C) and at high water potentials (-150 kPa) than they were at high temperatures (28.5, 31.0 C) and at low water potentials (-550, -950 kPa). Despite major differences in physical characteristics of sand and vermiculite, however, only minor variation in the data was introduced by incubating eggs on the different substrates. Also, patterns of response were similar on sand and vermiculite, so no major conclusion would have been affected by selecting one medium over the other for use in this investigation.

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EFFECT OF VARIATION IN WATER BALANCE OF EGGS ON CALCIUM MOBILIZATION AND GROWTH BY EMBRYONIC PAINTED TURTLES (*CHRYSEMYS PICTA*). M. J. Packard and G. C. Packard. Colorado State University, Fort Collins.

Painted turtle eggs exposed to wet environments absorb more water, incubate longer, and produce larger hatchlings than do eggs exposed to drier conditions. Embryos in wet environments also grow faster and accumulate more calcium than do embryos in dry environments. Young from eggs incubated on wet substrates contain less residual yolk than do those from eggs on dry substrates, but calcium content is similar in the two groups. Yolk calcium is reduced to levels that preclude use of residual yolk for post-hatching growth. Hatchlings from eggs in wet settings obtain 56% of their calcium from the eggshell but those from eggs in dry settings obtain only 40% of their calcium from that source. Thus, the hydric environment to which eggs are exposed has subtle effects on both growth and calcium mobilization of embryonic painted turtles.

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EFFECT OF DIETARY SALT ON GROWTH AND DEVELOPMENT IN WHITE IBIS NESTLINGS. J.W. Johnston and K.L. Bildstein*. Winthrop College, Rock Hill, SC, and Baruch Inst., Univ. of South Carolina, Columbia.

21-24 day old white ibis (*Eudocimus albus*) nestlings were hand-reared on an ad lib diet of crayfish (*Procambarus* sp., 535 mOSM)(N=12) or on a saltwater diet of fiddler crabs (*Uca* spp., 1080 mOSM)(N=12). A third group (N=4) was fed crayfish "spiked" with a salt load equal to that of fiddler crabs. Brackish-water (480 mOSM), collected at the nesting colony, was provided to all three groups. Growth rate (tarsi length, toe pad, culmen, 2nd primary and middle rectrix), weight, and apparent metabolizable energy were followed for 3 weeks. Birds raised on crayfish grew and developed at rates equal to those of wild nestlings. Birds raised on fiddler crabs or "salty" crayfish lost >3% of their body weight/day, even though they produced a hyperosmotic nasal gland fluid (1325 mOSM). When switched from brackish-water to freshwater, the birds on a fiddler crab diet began gaining weight immediately. Supported by Winthrop College grants to JWJ and KLB and by an NSF-LTER grant to KLB.

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GnRH INDUCES FERTILE MATINGS IN *Iguana iguana* DURING THEIR REFRACTORY PHASE. J.A. Phillips, B.L. Lasley*, and F. Frye*. Zool. Society of San Diego, California.

An agonist of avian GnRH (d-Arg⁶ chicken II) was administered via intraperitoneal osmotic pumps to female green iguanas to evaluate its effect on behavior and gonadal function. Seven days post-implant the GnRH induced territorial and courtship behavior in untreated male cagemates. Within 10 days mating occurred. The pumps were depleted after 14 days and courtship behavior ceased soon after. Six weeks post-implant a second courtship/mating period was observed between the hormone-treated females and their mates. Mating was successful and females oviposited 2-2.5 months later. Control pairs did not exhibit courtship/mating behavior until approximately four months later, the normal date for these events. The results suggest that GnRH can elicit a proximal behavioral response as well as an ultimate gonadal effect in reptiles. This type of therapy may help increase reproductive rates in endangered species.

This research was supported by an Endangered Species Research grant from Kaiser Development Corporation.

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IN SITU ENERGETICS OF CORAL REEF BRITTLE STARS (OPHIUROIDEA) DURING ORAL DISC AND ARM REGENERATION. K.M. Sullivan. Univ. of Miami, Coral Gables, Fla.

Four species of coral reef brittle stars were collected off reefs in the Dry Tortugas and Key Largo, Fla. Intact individuals were held in closed and circulating respiration chambers moored in situ for monitoring oxygen consumption and ammonia/urea excretion. After 12 hours, arms were autonomized and energetics experiments again conducted. Respiration rates (using ash-free dry weights) ranged from 0.25-0.76 mg.O₂ g⁻¹ h⁻¹ in intact animals and 0.11-0.22 in autonomized individuals. Ammonia was the primary nitrogenous waste in intact animals, while urea was the primary nitrogenous waste in regenerating brittle stars for up to 24 hours after losing an arm. Possible energy sources for regeneration are free amino acids or soluble proteins. Glycogen and lipid content analysis of brittle stars indicated insufficient energy stores for arm regeneration.

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ULTRASTRUCTURAL AND BIOCHEMICAL CHARACTERIZATION OF MINERALIZING AVIAN LEG TENDON. L.S. Eyster and W.J. Landis*. Harvard Medical School and Children's Hospital, Boston, MA.

Calcifying leg tendons from two avian species have been studied by transmission electron microscopy and gel electrophoresis to characterize structural and chemical changes in this tissue during mineralization. Gastrocnemius tendons from domestic turkeys 7-15 wks old were x-rayed for localization of mineral. Uncalcified, newly calcifying, and calcified regions from the same tendons were examined with TEM; ultrastructural comparison of the three regions showed differences in cell size and shape, development of collagen fibrillogenesis, and presence of extracellular vesicles possibly involved in tendon mineralization. Polyacrylamide gel patterns of the non-collagenous proteins from mineralized and unmineralized leg tendons as well as neck tendons (which never mineralize) from turkeys and chickens (19-28 wks old) indicated distinct differences. These results reflect temporal and spatial elaboration of matrix in an avian model of vertebrate calcification. Supported by NIH grants AM07112 and AM34078.

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PATTERN OF FEED RESTRICTION DELAYS FIRST BREEDING IN MICROTUS OCHROGASTER. G. Linder, J. Bauer,* and C. Morrell.* Cornell University, Ithaca, N.Y.

Work relating nutrition and reproductive success in small mammals indicates the pattern of feed restriction elicits different responses in laboratory-housed M. ochrogaster. Daily feed consumption was measured (=baseline), then one feed-restriction regimen was allowed a 60% baseline feed ration over 10-d, while another was offered variably increasing feed quantities. After the 10-d feeding trial, animals were returned to an ad libitum diet and breeding pairs were established within feed-restriction groups. Reproductive effects were then evaluated on criteria of time to first litter, for example, and morphological and physiological measures, e.g., testicular sperm counts and functional enzymes. Mated-pairs fed a 60% ration had reproductive success not unlike ad libitum fed controls; mated-pairs offered variably increasing quantities of feed had delayed times to first litter. These results suggest future work regarding nutritional effects potentially altering small mammal population dynamics.

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A PROTEINASE THAT DEGRADES CRUSTACEAN EXOSKELETON. J.J. O'Brien and D. M. Skinner. Biol. Div., ORNL, Oak Ridge, TN

The separation of epidermis from the membranous layer (ML) of the crustacean exoskeleton (apolysis) occurs early in proecdysis. "Forced apolysis" (FA; induced by chilling for >30 minutes) was observed in anecdysis, very early in proecdysis, and in metecdysis in the land crab, Gecarcinus lateralis. It was also found in all brachyurans tested (7 families). Extracts of G. lateralis branchiostegite epidermis contained both cathepsin D and alkaline cysteine proteinase (ACP) activities whether or not they were obtained from crabs which had undergone FA. FA was not detected in an astacuran (H. americanus) nor was ACP activity, although cathepsin D activity was, arguing against enzyme inactivation. ACP ranged in size from 53-67 kD (gel filtration) and 61 kD (SDS-PAGE). Autoradiography showed ACP hydrolyzed specific ML proteins as well as casein, the commonly used substrate. Optimal conditions for ACP activity mimic those seen in apolysis; ACP may function in apolysis. (Supported by the Seed Money Program and Martin Marietta Energy Systems, Inc. with the U.S. Department of Energy.)

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METABOLISM OF ECDYSONE BY TESTES OF THE EUROPEAN CORN BORER, OSTRINIA NUBILALIS (HUBNER). D.B. Gelman, C.W. Woods* and A.B. Borkovec*. IRL, ARS, USDA, Beltsville, Md.

Testes from European corn borer last stage larvae, pupae and pharate adults cultured in vitro in the presence of (³H)-ecdysone were found to convert ecdysone primarily to 20-hydroxyecdysone. Conversion was localized in testis sheaths. Rates of conversion were maximum in testes of wandering larvae (just prior to testis fusion), a time when hemolymph titres of ecdysone and 20-hydroxyecdysone peak. Conversion dropped considerably in pupal testes and was maintained at a low level throughout pharate adult development. Therefore, the conversion of ecdysone to 20-hydroxyecdysone that occurs in the corn borer just prior to pharate adult formation was not mirrored by similar activity in the testes. Interestingly, previously determined ecdysteroid profiles of larval testes revealed an absence of ecdysone, while those from pupal testes showed that ecdysone peaked just prior to pharate adult formation. Relative rates of conversion, then, correlated well with previously determined concentrations of ecdysone and 20-hydroxyecdysone in testes, concentrations that do not necessarily mirror hemolymph ecdysteroid levels.

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DOES THERMAL ACCLIMATION AID AMPHIBIANS? ACCLIMATION OF LOCOMOTOR METABOLISM AND PERFORMANCE IN SALAMANDERS. M.E. Feder. The University of Chicago.

Phylogenetic and allometric variation in the minimum metabolic rate (SMR) has predictable consequences for activity metabolism and locomotor performance in vertebrates. To test whether similar consequences attend variation in SMR due to thermal acclimation, two species of salamanders were exercised at controlled speeds (0-47 cm/min) in an exercise wheel while their oxygen consumption was measured. The working hypothesis was that acclimatory variation in activity metabolism and locomotor performance should parallel acclimatory variation in the SMR. The first species, *Desmognathus ochrophaeus*, undergoes a decline in SMR upon warm acclimation. Warm acclimation likewise reduced oxygen consumption during locomotion at 13 C in *Desmognathus*, but did not affect the maximum sustainable speed. At 21 C, warm acclimation improved stamina but did not affect oxygen consumption during locomotion. In *Bolitoglossa subpalmata*, a second species that undergoes no acclimation of the SMR, acclimation affected neither oxygen consumption nor maximum sustainable speed during locomotion at 13 C. However, at 21 C, acclimation affected both oxygen consumption and stamina, despite no variation in the SMR. These contradictory results suggest a critical reassessment of the adaptive significance of metabolic acclimation for amphibians.

Supported by NSF Grant BSR83-07089.

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METABOLIC COMPENSATION TO TEMPERATURE IN SALAMANDER EMBRYOS. Allan W. Smits. Univ. of Massachusetts, Amherst.

Metabolic compensation is well-known for adult amphibians, however, it seems strangely unknown or untested in amphibian embryos which must develop within sedentary egg masses, without the benefit of body temperature regulation. Metabolic acclimation was tested in salamander (*Ambystoma maculatum*) embryos in seven developmental stages from neurulation through post-hatching. Rates of O₂ uptake in cold-reared (12 C) embryos measured at 12 and 22 C exceeded those of warm-reared (22 C) embryos by two-fold throughout pre-hatching development. Metabolic rates of both groups tripled at hatching (Stage 40 for warm-reared, Stage 46 for cold-reared), despite concomitant decreases in body mass. No differences in embryo stage, dry body mass or embryonic protein content (minus yolk) existed between acclimation groups to account for their metabolic dissimilarity. The biochemical capacities permitting thermal acclimation are apparently present even in the earliest stages of the amphibian life cycle. (Supported as a Parker B. Francis Fellow of the Puritan-Bennett Foundation)

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SEASONAL CHANGES IN STANDARD METABOLISM AND HABITAT TEMPERATURES OF SCOLOPORUS OCCIDENTALIS LIZARDS. J.S. Tsuji. Univ. of Washington, Seattle.

O₂ consumption rates (V_{O2}) of *Sceloporus occidentalis* from southern California were measured throughout the year at their activity temperature (35°C) and two inactivity temperatures (16 & 10°C). V_{O2} at all test temperatures were highest in spring when lizards are the most active, decreased during summer, and were lowest in late-summer when habitat temperatures were hottest. V_{O2} of lizards in fall and winter were intermediate between spring and summer rates. In fall and winter, lizards experience the coolest temperatures, and consequently, are active only on warmer days. These results suggest that: (1) these lizards may lower metabolic rates to compensate for higher body temperatures and water stress during warm seasons; and that (2) these lizards raise metabolic rates more in response to increased activity in spring, rather than in compensation for the depressing effect of cooler temperatures on V_{O2} in winter. Comparative results from a northern population in Washington will be discussed.

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THE INFLUENCE OF EMBRYONIC DEVELOPMENTAL TEMPERATURE ON THERMAL TOLERANCE OF TADPOLES OF THE EASTERN SPADEFOOT TOAD, *SCAPHIOPUS HOLBROOKI*. Paul V. Cupp, Jr. Eastern Kentucky University, Richmond.

Critical thermal maxima (CTM) were determined for tadpoles of *S. holbrooki* reared at different temperatures from early cleavage through hatching and then acclimated at 20°C. In an initial study, *S. holbrooki* larvae of developmental stage 28 (after Gosner) that had hatched at 30°C had a significantly higher CTM than those that had developed and hatched at 25, 20 and 15°C. When the study was repeated, *S. holbrooki* larvae that had hatched at 30°C had a significantly higher CTM than those that hatched at 15 and 10°C, and those larvae that had hatched at 20°C had a significantly higher CTM than those hatched at 10°C. These data indicate that early thermal experience, possibly during a critical developmental period, may bring about significant changes in the thermal tolerance of an organism. This may prepare the larvae for survival at temperatures that occur in their shallow breeding pools. Also, effects of early thermal experience may contribute to differences in thermal tolerance sometimes observed between local populations.

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THE EFFECT OF DEHYDRATION ON ENERGY METABOLISM OF A TERRESTRIAL SALAMANDER. M. Stefanski, R.E. Gatten and E.H. Pough. Cornell Univ., Ithaca, N.Y., and Univ. of North Carolina, Greensboro.

We determined the oxygen consumption (VO₂) and whole body lactate (WBL) content of *Plethodon jordani* during rest and activity at 15°C and 25°C when animals were fully hydrated and dehydrated to 85% body mass. For activity measurements, salamanders were manually stimulated to locomote continuously for 5 min on dry circular tracks (circumference = 20.5 cm) within air-tight chambers. Running speeds were .036 km/hr at 15°C and .054 km/hr at 25°C. These were determined to be the fastest speeds for which both hydrated and dehydrated animals consistently completed 5 min of exercise at the respective temperatures. VO₂ was measured by analysis of gas samples withdrawn from the chambers. VO₂ and WBL increased significantly with activity for both hydrated and dehydrated animals at both temperatures. Resting VO₂ tended to be greater for dehydrated vs. hydrated animals, but other metabolic differences between these two groups were not pronounced. Substantial dehydrational stress seems to have a minimal impact on the short-term activity metabolism of this species. (Supported by McIntire-Stennis Project #564).

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AEROBIC AND ANAEROBIC METABOLISM IN CALLING FROGS: THE EFFECT OF TEMPERATURE. T.L. Taigen and K.D. Wells. Univ. of Connecticut, Storrs.

Vocal advertisement by male spring peepers (*Hyla crucifer*) to attract females begins early in the spring and continues for 6-8 weeks. During this period, calling frogs experience body temperatures ranging from 5 to 25°C. We investigated the vocal behavior and energetics of sound production in these animals at 7, 10, 15, 19, and 23°C. With decreasing temperature, calling rate declines, while call duration increases. At each of the five experimental temperatures, metabolic rates during sustained calling were 15-20 times resting metabolism. Metabolic rates in calling frogs also exceeded those attained during exhaustive locomotor exercise at all temperatures. A multiple regression analysis of our pooled results identified calling rate, body mass, and temperature as significant determinants of oxygen consumption. These variables accounted for 82%, 7%, and 2%, respectively, of the total variance in calling metabolism. Lactate levels in calling and noncalling frogs, measured at 10 and 19°C, were not significantly different. It appears that the energetic cost of producing a single call is relatively constant, and independent of temperature.

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SEXUAL COMPETITION AND CALLING ENERGETICS IN TREEFROGS. K. D. Wells and T. L. Taigen. Univ. of Connecticut, Storrs.

The effect of sexual competition on the energetic cost of calling was investigated in *Hyla versicolor*. Oxygen consumption of males increased with calling rate and call duration, reaching a peak of about 1.7 cc O₂/(g·h) at 19°C, one of the highest levels measured in an ectothermic vertebrate. Both call duration and calling rate were influenced by chorus density. Males in a dense chorus gave longer but less frequent calls than isolated males; estimated oxygen consumption remained relatively constant. Playbacks of calls of different durations and rates caused males to increase call duration and decrease calling rate, but again rates of oxygen consumption remained about the same. Hence, males adjust their vocal signals according to social context, but this has little influence on the energetic cost of calling. The calling effort of most males appears to be near the maximum level they can sustain, regardless of the level of vocal competition in the chorus. We found no evidence of seasonal changes in calling effort, despite the fact that females appeared to be less common late in the season.

POWER INPUT AND OUTPUT DURING CALLING IN HYLID FROGS. K. N. Prestwich, K. E. Brugger* and M. Topping* College of the Holy Cross, Worcester, MA and Univ. Florida, Gainesville.

We measured rates of oxygen consumption ($\dot{V}O_2$) and sound fields of north Florida hylids with different sizes and calling behaviors. At 29°C, Hyla gratiosa's (12.5g) peak calling $\dot{V}O_2$ was 1.21 mL O_2 /(g*h) at 3600 calls/h, duration ca. 0.2 s at a mean sound pressure level (SPL) of 91 dB (at 50 cm). At 27°C, in H. squirella (2.2 g), calling $\dot{V}O_2$ reached 2.1 (much higher than previously reported) at calling rates of 6000 calls/h, mean call duration of 0.18 s. and 88 dB mean SPL. Mean $\dot{V}O_2$ for maximal locomotory activity was 1.25 (H. gratiosa, 27°C) and 1.79 (H. squirella, 28°C).

Sound fields were essentially omni-directional. Sound-production efficiencies (P_{out}/P_{in}) in hylids are all less than 1% and are similar to calling insects. Estimation of calling energetics from analysis of the call will be discussed.

CATALASE ACTIVITIES IN TISSUES OF THE SOUTHERN LEOPARD FROG, Rana utricularia. F.E. Friedl and M.A. Vitale. Univ. of South Florida, Tampa.

As part of a comparative study on hydroperoxide metabolism, catalase (EC 1.11.1.6) was estimated in liver, kidney, heart, and lung homogenates of R. utricularia. The decrease in H_2O_2 substrate absorbance at 230 nm was recorded using a stopped-flow method. Reactions at 24.5°C were buffered at pH 7.1 and contained 1 mM H_2O_2 . Activities are expressed as an overall rate constant referenced to homogenate protein concentration (sec⁻¹·microgram protein⁻¹·ml⁻¹). The rate constant is demonstrably proportional to catalase content. It was found that activities followed the order liver > kidney > lung ≈ heart with values of 0.00156, 0.00032, 0.00006 and 0.00006 respectively. Although comparison of absolute values is difficult, our data agree with the order liver > kidney > heart found for R. ridibunda by Barja de Quiroga et al. (Comp. Biochem. Physiol. 80B:853, 1985)

STIMULATION OF DIURESIS IN THE HOUSE CRICKET BY A FACTOR FROM THE CORPUS CARDIACUM. J.H. Spring and S.R. Hazelton. Univ. of Southwestern Louisiana, Lafayette.

The Malpighian tubule system of the cricket can be maintained in an active state *in vitro* for upwards of six hours. Initial secretion rate is nearly 4 μ l.h⁻¹, declining to 1.5 μ l.h⁻¹ by hour 5. As determined by X-ray microanalysis, the major anions in the urine are chloride (72 mM) and sulphate (34 mM) and the cations are potassium (28 mM), sodium (16 mM), magnesium (13 mM) and calcium (6 mM). One pair of corpora cardiaca (CC) added to the saline bath (2.0 ml volume) doubles the secretion rate of the tubules. Higher concentrations of CC cause no further increase, and doses as low as 0.01 CC measurably affect secretion rate. The increased rate of urine formation does not appear to be caused by an increase in potassium transport, as the concentrations of this cation in the urine remain unchanged or only slightly elevated during stimulation. Sodium (peak value 50 mM) and chloride (peak value 110 mM) both increase significantly during stimulation, while the concentrations of all the other ions decrease. Whether this decrease is due to decreased transport or increased reabsorption by the ampulla is not yet clear. Supported by NSF grant DCB84-16829.

Na,K-ATPase ACTIVITY AND HYPOSMOREGULATION IN THE BRINE SHRIMP, ARTEMIA SALINA. C.W. Holliday. Lafayette College, Easton, PA.

Brine shrimp are strong hypoosmoregulators over a wide range of salinities. Changes in Na,K-ATPase enzyme specific activity (ESA) in phyllopods, metepipodites, phyllopods minus metepipodites, guts, heads, bodies and maxillary glands were measured in brine shrimp acclimated 21-30d in 50‰, 100‰, 200‰ and 400‰ sea water (SW, 100‰ SW = 1000 mOsm). ESA in phyllopods, metepipodites, guts, heads, and maxillary glands increased significantly (X 1.6-2.3) with salinity over the range tested. ESA in bodies and phyllopods minus metepipodites did not change significantly. ESA in metepipodites was high and increased with increasing salinity from 8‰ to 25‰ of total body ESA, strongly implicating these organs in salt transport out of the animal in concentrated media. ESA in guts, heads and maxillary glands was lower, but showed similar increases, also implicating these organs in salt transport.

Supported by Research Corporation.

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CL/HCO₃ ANTIPORT BY BASOLATERAL MEMBRANE VESICLES OF LOBSTER HEPATOPANCREATIC EPITHELIAL CELLS. G. A. Ahearn, M.L. Grover*, and R. T. Tsuji*. University of Hawaii, Honolulu, Hawaii 96822.

Purified epithelial basolateral membrane vesicles were prepared from lobster hepatopancreas using sorbitol gradient centrifugation. ³⁶Cl influx (4 sec uptake) was a hyperbolic function of [HCO₃]_i, suggesting the occurrence of carrier-mediated anion antiport. ³⁶Cl influx was stimulated in decreasing order by the following intravesicular anions: Cl⁻ > NO₃⁻ > HCO₃⁻ > SO₄²⁻ > HPO₄²⁻. Vesicles preloaded with HCO₃⁻ illustrated greater ³⁶Cl uptake rates in the presence of a transmembrane pH gradient (pHi > pHo) than those vesicles having bilaterally equal pH values. Cl⁻/HCO₃⁻ exchange was shown to be electrogenic by a valinomycin-induced K⁺ diffusion potential (inside -) in the presence of a transmembrane proton gradient (pHi > pHo). ³⁶Cl influx was a biphasic function of [Cl]_o, exhibiting both carrier-mediated and diffusional transport components. ³⁶Cl influx was a sigmoidal function of pHo, suggesting that more than one H⁺ may be cotransported across the membrane with each Cl⁻. The data support a model of basolateral HCl/HCO₃⁻ antiport. Supported by NSF Grant No. PCM81-18366.

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DIVALENT CATION BINDING BY EXTRACELLULAR CONCRETIONS FROM THE GILLS OF UNIONIDS. J.W. McNeil and H. Silverman. Louisiana State Univ., Baton Rouge.

Binding of divalent cations by concretions from *Anodonta grandis* was studied both *in vivo* and *in vitro*. Animals exposed to Zn, Cd, and Mn for several weeks showed little binding of the metals to concretions. Eight hr after injection of ⁴⁵Ca or ⁶⁵Zn, concretions bound 1000X more Ca than Zn per mg of concretion. Further, the presence of ⁶⁵Zn in mussel tissues, gonad, kidney, mantle, and gill is two-fold greater/mg than found in the concretions, indicating no specific Zn incorporation. In contrast, ⁴⁵Ca in concretions was 3-4 fold higher than in any of the tissues. *In vitro* studies on isolated concretions indicate 80-85% binding of ⁴⁵Ca, while Zn is bound only 60% under similar conditions. These data suggest metal binding to concretions *in vivo* is specific for calcium and can occur extracellularly, but is carefully regulated. Further, it is unlikely that these concretions serve as part of a detoxification system. Supported by NSF-DCB 83-03789.

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PARTICIPATION OF CHLORIDE IONS IN FLUID RESPONSES OF THE BODY WALL OF THE LAND SLUG, *ARIOLIMAX COLUMBIANUS*. I. Deyrup-Olsen and A.W.Martin. Univ. of Washington Seattle.

The body wall of *Ariolimax* responds to mechanical stimulation by releasing mucus vesicles and fluid. The latter is formed as an ultrafiltrate of blood modified in composition as it traverses the specialized channel cells of the body wall. Na and Cl ions are conserved, whereas the levels of K and HCO₃⁻ ions are significantly higher in the fluid emerging through the body wall than in the blood (Martin and Deyrup-Olsen, 1985, Fed. Proc. 44: 998). The processes whereby these modifications take place are blocked by transport and permeability modifying agents including ouabain, amiloride, furosemide, SITS, and 9-anthracenecarboxylic acid. In the case of the body wall *in vitro* (sac preparation) furosemide, alone among these agents, failed to block if the sac was filled initially with Ringer solution in which Cl was replaced with NO₃⁻ or gluconate. The results suggest that Cl ions participate in body wall responses in 2 distinct ways: (1) excitation of the channel cells; (2) exchange of Cl for HCO₃⁻ (Cl reabsorbed from the ultrafiltrate).

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THE EFFECT OF HEAVY METALS AND METABOLIC INHIBITORS ON CALCIUM UPTAKE IN *FUNDULUS HETEROCLITUS*. G.R. Sauer. Univ. of South Carolina, Columbia.

Zinc and cadmium have been shown to reduce calcium uptake by regenerating fish scales. Since the gills are thought to be the major site of calcium uptake, the toxic action of metals on this tissue could explain these results. The uptake of calcium-45 from environmental water was determined after 2, 12, 24 and 48 hours in the gills, blood, and regenerating scales of control and metal-exposed fish. Cadmium reduced calcium uptake in all three tissues while zinc reduced uptake by the scales only, suggesting that the metals influence calcium uptake by different mechanisms. Calcium-45 uptake experiments were performed with isolated gill tissues in the presence of zinc and cadmium, a calcium-binding antagonist, lanthanum, a calmodulin blocker, trifluoperazine, and the ATPase inhibitors ouabain and quercetin. Lanthanum significantly reduced calcium uptake by the gills suggesting that calcium may be taken up by fish gills via a facilitated diffusion process.

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CALMODULIN MAY BE INVOLVED IN CELL VOLUME REGULATION IN RESPONSE TO LOW SALINITY. S.K. Pierce, D.L. Cronkite, and L.H. Smith. Univ. of Maryland, College Park, and Hope College, Holland, MI.

Previously we have shown that cell volume recovery in isolated blood cells of *Noetia ponderosa* exposed to a hypoosmotic stress is sensitive to external Ca^{2+} . In addition, Ca^{2+} influx into *Noetia* blood cells occurs immediately following hypoosmotic stress. The calmodulin inhibitors trifluoperazine and chlorpromazine, alter cell volume regulation in the clam blood cells. We have now tested *Noetia* blood cells for the presence of calmodulin. A cell lysate was chromatographed on DEAE-cellulose and phenyl-sepharose. A protein was purified which bound to phenyl-sepharose in the presence of Ca^{2+} and eluted with EGTA. The protein comigrates with bovine calmodulin on a C-18 reverse phase HPLC column and on SDS-polyacrylamide gels. These results indicate that calmodulin is present in *Noetia* blood cells and, in company with our previous work, suggests that calmodulin is involved in cell volume regulation. (Supported by NIH #GM23731 and TS&GCMB, INC.)

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A PEPTIDE WITH EFFECTS ON THE CHLORIDE SHUNT PERMEABILITY OF MALPIGHIAN TUBULES. D.H. PETZEL, C.J. PROSPER* and K.W. BEYENBACH. Cornell Univ., Ithaca, N.Y.

Of the three peptides which we have isolated by HPLC from a saline extract of *Aedes aegypti* mosquito heads, two peptides cause increases in secretion rates of fluid, Na and Cl by Malpighian tubules (MT), while the other, Peptide I (PI) does not affect the rate of fluid secretion nor the ionic composition of the secreted fluid. However perfusion of *Aedes* MT with symmetrical Ringers solutions followed by bath addition of PI results in a depolarization of the transepithelial voltage (V_t) from 52mV to 11mV (lumen positive) and a 4-fold decrease in transepithelial resistance (R_t). These results are similar to those previously observed with the saline extract which was shown to be dependent on bath Cl. Under perfusion conditions when the transepithelial Nernst potential for Cl is equal to V_t (bath=157mM, lumen=20mM) addition of PI results in no change in V_t but a 2-fold reduction in R_t . These results are consistent with the notion that one of the effects of PI is to increase the Cl permeability of the shunt pathway while not affecting fluid secretion. Supported by NSF PCM8403305.

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Ca^{2+} ENTERS HYPOOSMOTICALLY STRESSED GLYCERA DIBRANCHIATA RED COELOMOCYTES AND INFLUENCES CELL VOLUME RECOVERY. A. D. Politis and S. K. Pierce. U. of Maryland, College Park, MD.

Volume recovery of *Glycera* red coelomocytes exposed to hypoosmotic media requires the presence of external Ca^{2+} . The site of Ca^{2+} action is unknown. A net ^{45}Ca influx occurs in these cells following media dilution (930-480 mosm). The ^{45}Ca influx occurs within seconds after the hypoosmotic exposure and the increased ^{45}Ca levels remain constant for at least 10 minutes. ^{45}Ca influx does not occur in cells exposed to media ionically equivalent to 480 mosm but osmotically equivalent (with sucrose) to 930 mosm. Therefore, the ^{45}Ca influx is triggered by an osmotic stimulus. The Ca^{2+} ionophore A2318, potentiates both cell volume recovery and net ^{45}Ca influx during hypoosmotic stress. These results suggest that the site of Ca^{2+} action during cell volume recovery is intracellular. (Supported by NIH GM-23731, Sigma Xi, and TS&GCMB)

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MORPHOLOGICAL VARIATIONS IN THE PARAPAGURUS PILOSIMANUS COMPLEX (CRUSTACEA, PAGUROIDEA, PARAPAGURIDAE). R. Lemaître, Univ. of Miami, Florida.

A worldwide review of *Parapagurus* hermit crabs has shown that 12 of the taxa assigned to this genus represent a group of closely related forms defined as the *Parapagurus pilosimanus* complex. In the western Atlantic the complex is represented by five species: *P. pilosimanus*, *P. nudus*, *P. scaber*, *P. n. sp. A*, and *P. n. sp. B*. The morphological variations exhibited by these species have been studied in detail based on the examination of nearly 3500 specimens. Two factors have been found to be primarily responsible for the great intraspecific variation and interspecific overlap of character ranges displayed, i.e., relative growth, and sexual dimorphism. The range of variations observed in continuous or discontinuous characters of diagnostic importance are described, quantified, and fully illustrated. The variations described herein can be considered indicative of the variations that could be expected in the complex in general. The results of this study will be used to evaluate the remaining members of this characteristically variable group of deep-water paguroids.

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SQUAT LOBSTERS, *Munidopsis*, ASSOCIATED WITH MESH ENCLOSED WOOD PANELS SUBMERGED IN THE DEEP SEA. A. B. Williams and R. D. Turner, NMFS, Systematics Lab., USNM, Washington, D.C., and MCZ, Harvard Univ., Cambridge, MA.

Squat lobsters, *Munidopsis crassa* and *M. nitida* were retrieved with the aid of the deep submersible ALVIN from 5 X 10 mm mesh bags containing experimental wood panels after 11 to 46 months of submergence in the Western Atlantic Ocean at depths of 1830 to 4000 m. Changes in carapace dimensions from megalopa to adult were determined for each species from specimens in this series. Largest *M. crassa* had a mean carapace width of 20.8 mm in bags submerged a mean 18 months. If these animals entered the bags at a maximum of 10 mm carapace width, it is conservatively estimated that they increased in carapace width at a mean 0.59 mm/month during residence in the bags. *M. nitida*, rarely exceeding 11 mm in carapace width, would not be trapped by the mesh.

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FEEDING BIOLOGY AND MOUTHPART MORPHOLOGY OF THREE SPECIES OF CORAL GALL-CRABS (DECAPODA, CRYPTOCHIRIDAE). R.K. Kropp, Univ. of Maryland, College Park.

The results of this study challenge the long-standing hypothesis that coral gall-crabs are filter feeders. I studied three species of gall-crabs, *Hapalocarcinus marsupialis*, *Utinomia dimorpha*, and *Favicola rugosa*. Feeding behavior of each species was observed in the laboratory. All three species were seen to ingest coral mucus. *Hapalocarcinus* collected mucus by fanning the third maxillipeds or by scratching the coral surface with the legs. *Utinomia* used chelipeds to collect mucus and other debris, or to snip pieces of coral polyp tissue. *Favicola* used mouthparts to make a mucous ball which then was swept along the coral surface to pick up mucus and debris. SEM photographs of each species' mouthparts show setae ill-suited for filter feeding, but useful for collecting coral mucus. Metabolic studies of *Hapalocarcinus* and *Utinomia* suggested each had a relatively high carbohydrate diet. In conclusion, coral gall-crabs are not filter feeders, but feed on mucus produced by the coral host.

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CARRYING BEHAVIOR IN BRACHYURAN CRABS. M.K. Wicksten, Texas A&M Univ., College Station.

Carrying is a behavior in which the last pereopods of a crab are used to lift and hold an object dorsally over the crab. This behavior is found in the families Homolidae, Dromiidae, Tylolidae and Dorippidae. These crabs have subdorsal pereopods ending in hooks, subchelae, spines or curved dactyls. Similar modifications are found in the Latreillidae and Homolodromiidae. All of the families that carry except for the Dorippidae have been classified in the section Dromiacea. I suggest that carrying is a conservative feature that should be used in defining this section. It is noteworthy that the extinct Eocarcinidae, among the oldest known brachyurans, had subdorsal pereopods. Were the earliest crabs carriers?

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SUPERIOR OBLIQUE MUSCLE REGENERATION PATTERNS FOLLOWING MUSCLE SECTIONING IN THE XENOPUS TADPOLE. R.F. Fangboner, Trenton State College, N.J.

Completely severed superior oblique muscles (SOM) in tadpoles of stage 53 regenerated over a period of 18 days. The pattern of regeneration was influenced by the placement of the cut and the condition of the distal trochlear nerve (NIV) sheaths. NIV was cut in all animals and four surgical formats were followed. In some animals A) the SOM was cut so that the distal NIV sheaths retracted toward the origin of the SOM, B) the SOM was cut so that the distal sheaths retracted toward the insertion, C) the distal sheaths were destroyed and then the SOM was cut, and D) the SOM was cut so that the sheaths retracted toward the origin and then the distal sheaths were removed. A portion of the animals were observed at 6, 12 and 18 days using methylene blue *in vivo* and histological techniques. Series "A" was the most successful with 100% showing nearly normal SOM by 18 days. Series "B" and "C" were less successful, 23% and 20% respectively. Series "D" had a number of animals showing no regenerative activity. Series "B" and "C" frequently showed a misdirection of muscle fibers. SOM regeneration seems to be more effective when regenerating from the muscle's origin.

MACROPHAGE MOBILIZATION DURING LENS REGENERATION FROM THE IRIS IN NEWTS.
R.W. Reyer, West Virginia Univ., Morgantown.

Studies already published, using TEM, have demonstrated that depigmentation of the dorsal iris epithelium during initial stages of lens regeneration involves the invasion of this epithelium by macrophages. By means of scanning electron microscopy, the mobilization of these cells on the surface of the iris facing the vitreous has been observed. They appeared by 6 days after lentiectomy and subsequently increased in number so that, in some cases, the macrophages appeared to be closely packed together. Many of these cells exhibited large lamellipodia while others had only low ridges or small protruding blebs on their surface. The iris epithelium itself was smooth with low ridges or, in other cases, it was covered by small tubular, spherical or cup-shaped bodies. In cryo-fractured preparations, macrophage invasion of the posterior iris epithelium was occasionally observed. It is concluded that mobilization of many macrophages occurs during dedifferentiation of iris epithelium. (Supported by WVU Med. Corp. and NIH Grants 5 S07-RR05433-18, 2 S07-RR054433-22).

REGULATION OF SPERM MOTILITY IN THE NEWT

M.P. Hardy and J.N. Dent.

Dept. of Biology, Univ. of Virginia, Charlottesville

We examined sperm motility in the red-spotted newt *in vivo*. Sperm were motile within the spermatothore, but quiescent within spermatic fluid (the sperm-bearing fluid of the vasa deferentia), and the spermatheca. The effects of changes in osmolality, specific osmolyte concentrations, and pH on sperm motility were examined *in vitro*. The osmolality of the spermatic fluid was 110 mOsm per Kg. Less than 50% of sperm were motile in saline media isosmotic with spermatic fluid, whereas more than 90% of sperm became motile when immersed in hypotonic media with osmolalities near that of pond water (less than 10 mOsm per Kg). Motility in isosmotic solutions persisted beyond 12 hours, whereas in hypotonic solutions it declined sharply and ceased by 6 hours. Sperm stored *in vitro* for 5 days at 4 deg in iso- and hyperosmotic media retained fertilizing capacity but those in hypotonic media did not. Increases in levels of potassium, in comparison with calcium and sodium, stimulated sperm motility most noticeably at osmolalities between 110 and 215 mOsm per Kg. Extremes of pH reduced or prevented motility within 12 hours, but at physiological levels (pH 7 to 8) sperm motility persisted beyond 12 hours. We infer a major role of osmolality in the enforced quiescence of sperm during storage in the vas deferens and the spermatheca, and in the activation of sperm upon discharge from the vas deferens into pond water before entrance into the cloaca of the female.

TWO DISTINCT MOTILE FORMS UTILIZED BY THE AFLAGELLATE SPERMATOZOON OF MACROSTOMUM TUBUM IN ACHIEVING TRANSLATION.
L. A. Mink* and W. D. Newton. Arkansas State University, Jonesboro.

Phase contrast observation and video tape records of the motility exhibited by free swimming spermatozoa released by macerated live specimen of *M. tubum* show two distinct methods for achieving rapid translation: a three-dimensional helical "propeller-like" rotation of the functional posterior end and a different 3-D "brace-and-bit" auger-like rotation of the entire cell. The presence of cortical singlet micro-tubules in the form of two sheets (Newton, W. D. (1980) *J. Ultrastruct. Res.* 73:318-330) suggests that motility is achieved by the curling or twisting of these sheets.

REGULATION OF SPERM MOTILITY BY A PHOSPHORYLCREATINE SHUTTLE. Robert M. Tombes, Charles J. Brokaw and Bennett W. Shapiro.* Univ. of Washington, Seattle and Cal.Tech., Pasadena.

Sea urchin sperm contain two isozymes of creatine kinase (CrK) by immunological and enzymatic criteria, located, respectively, at the mitochondrion and along the flagellum as termini of a proposed phosphorylcreatine shuttle (Cell 41:325, 1985). When whole sperm CrK is specifically inhibited, coupled but not uncoupled respiration is depressed and motility patterns are affected. Flagellar waves are initiated at normal frequency and wavelength, but attenuate in amplitude along the flagellum; attenuation is proportional to the degree of CrK inhibition. Attenuation is not observed, however, in CrK-inhibited, ATP-reactivated permeable sperm. Phosphagen kinases are found in other primitive sperm which rely solely upon energy produced at the base of the head, but not in modified sperm, which have an extended midpiece and shorter tails. Thus, a phosphorylcreatine shuttle appears to be responsible for energy transport from mitochondrion to tail in sperm with spatially separated sites of ATP production and utilization. Supported by NIH grants GM23910, GM18711 and HD0 7183-06.

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MEIOFAUNA SEE THE LIGHT? PHOTOBHAVIOR OF HARPACTICOID COPEPODS. K. Walters.

Univ. of South Florida, Tampa.

Active movement of meiobenthic copepods from subtidal sediments into the water column occurs nightly in both sand and seagrass subtropical habitats. The relationship between harpacticoid vertical movement and light intensity was examined on nine dates in the field. Light levels were recorded at water and sediment surface and copepod movement determined with an emergence trap over two hour intervals bracketing sunset and sunrise. Maximum vertical movement occurs during the two hours just after sunset on 8 of 9 dates, however some species can be found to ascend throughout the night. This post-sunset period does not represent the time of maximum absolute or relative decrease in light intensity. Either an absolute quantal intensity, e.g. threshold, or a lag in the response of harpacticoids to changing intensities may be responsible for initiating upward movement. Relative increases in light intensity were not always responsible for a cessation in upward movement either. Species identification, ontogenetic stage, sex and even sediment densities modify the overall pattern and role of light intensity in harpacticoid vertical movement.

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EFFECTS OF LIGHT AND DARK ON EYES OF THE POLYCHAETE NEREIS LIMNICOLA. R. M. Eakin and J. L. Brandenburger.* Univ. of California, Berkeley.

Electron microscopy of eyes of Nereis limnicola revealed profound damage to the photoreceptor microvilli when the worms were illuminated by a weak light for 24 h. The microvilli regenerated when the worms were returned to darkness for three h. No observable effects on other parts of the sensory cells or any part of a supportive cell were seen as a result of exposure to light. The breakdown products from microvillar degradation were removed from the opticoels by phagocytosis and pinocytosis by both sensory and supportive cells. The phagosomes and pinosomes then fused with primary lysosomes of GERL origin. Digestion probably took place in the lysosomes. Lysosomes were identified by the presence of the digestive enzyme acid phosphatase, using a cytologic stain combined with EM. Regeneration of the microvilli involved a formation of new submicrovillar ER and its fusion with the cell membrane from which a basal regrowth of the microvilli occurred. Although a circadian turnover of photoreceptor membrane has been demonstrated in other invertebrates this is the first report of the cycle in an annelid. Supported by NIH grant GM 28778.

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FIRST DESCRIPTION OF A BRITTLESTAR PHOTORECEPTOR SYSTEM. G. Hendler and M. Byrne. Los Angeles County Museum, and Harbor Branch Foundation, Inc., Ft. Pierce, FL.

The internal radial nerve of a brittlestar generates impulses in response to light/dark stimuli, but pigmentation and the crystallographic properties of the brittlestar skeleton shield the nerve from external illumination. SEM results show that the skeletal plates of Ophiocoma wendti bear microscopic glassy calcite tubercles that can channel light through the skeletal stereom. TEM results show that large nerve fibers within the skeleton lie beneath the glassy tubercles. Furthermore, thick sections show that the chromatophores responsible for the diel color-change cycle of O. wendti migrate through the skeletal stereom to expose the glassy tubercles or shield them from light. We propose that the glassy tubercles, intraskeletal nerve fibers, and chromatophores are a functional unit that allows O. wendti to respond to light and shadow under varying levels of ambient illumination.

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IMMUNOHISTOCHEMICAL LOCALIZATION OF NEUROTRANSMITTERS IN THE NERVOUS SYSTEM OF THE PLUTEUS LARVA OF STRONGYLOCENTROTUS DROEBACHIENSIS. B.W. Bisgrove. Univ. of Victoria, Victoria, B.C., Canada.

Fixed, whole-mount preparations of S. droebachiensis larvae were stained by indirect immunofluorescence using polyclonal antibodies against serotonin, dopamine and gamma-aminobutyric acid (GABA). In eight-armed larvae serotonergic cell bodies and cell processes are concentrated in the apical region of the oral hood between the anterolateral arms. Serotonergic axons are also associated with the ciliary bands. The dopaminergic component of the nervous system includes an oral ganglion and neuropile associated with the lower lip of the larval mouth. As well, tracts of axons which arise from ganglia located at the base of the postoral arms run basally along the entire ciliary band. GABAergic neurons are associated with the upper lip and give rise to axons that encircle the mouth. The esophagus is also innervated by GABAergic neurons located on the dorsal surface of the upper esophagus. Serotonergic cells first appear in gastrulae and dopaminergic and GABAergic components are present in prism stage larvae. The development of the nervous system appears to continue throughout larval life. (Funded by an NSERC grant to R.D. Burke).

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EVAPORATIVE COOLING IN THE DESERT CICADA, *DICEROPROCTA APACHE*. E. C. Toolson. Univ. of New Mexico, Albuquerque, NM 87131.

Heath and Wilkin (1970) reported that thoracic temperatures of *D. apache* measured in the field were 2 - 5°C below an ambient temperature of 44.5°C. They attributed the temperature difference to the ability of the cicadas to locate cool microhabitats in the mesquite trees that they occupy. However, when exposed to moving dry air (rh less than 5%) at 45.5°C in the laboratory, *D. apache* can maintain its thoracic and abdominal temperatures from 2 to 5°C below ambient for at least an hour without access to drinking water. The temperature difference rapidly disappears when the cicadas are transferred to an rh of 100%. The reduced body temperatures result from very high rates of evaporative water loss; at 45.5°C, *D. apache* loses 12 - 18% of its body mass per hour. The ability to evaporatively cool may be crucial when cicadas are unable to locate or occupy cool microhabitats.

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THE ROLE OF CARBONIC ANHYDRASE IN CALCIFICATION IN THE GORGONIAN *LEPTOGORGIA VIRGULATA* (OCTOCORALLIA, GORGONACEA). R.J. Kingsley and N. Watabe. Duke Univ., Durham, N.C., and Univ. South Carolina, Columbia.

The enzyme carbonic anhydrase has been found to be involved in the calcification process in the gorgonian *Leptogorgia virgulata*. The mesoglea of this octocoral contains minute calcitic spicules. In addition, there are amorphous calcium carbonate granules found in the central axis of each of its branches. Carbonic anhydrase activity in the tissue is exceptionally high. The enzyme has been localized at both the light and electron microscope levels in the axis, axial epithelium and scleroblasts. Calcium uptake studies using the carbonic anhydrase inhibitor, Diamox, show significantly greater uptake of calcium in axes and spicules subjected to the inhibitor. These results contrast the findings of other calcifying organisms where Diamox reduced calcium uptake. The present results support and elaborate upon previous data which indicate that the axis as well as the scleroblasts of *L. virgulata* are actively involved in the calcification process.

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CRYSTALS IN THE PENIS OF LAND SNAILS OF THE GENUS *ANGUISPIRA*. J. W. ATKINSON AND K. E. H. ATKINSON. MICHIGAN STATE UNIVERSITY, EAST LANSING.

Crystals have been observed in the lumen of a series of diverticula in the inner wall of the penis of *Anguispira alternata* and *A. kochi*. These structures have been found in all examined specimens of both fixed and unfixed tissue. Light microscope study of sectioned material reveals crystals which range in size from 1 µm to 25 µm and are shaped as three-pointed "jacks" in *A. kochi* but as equilateral triangles in *A. alternata*. When viewed with scanning electron microscopy, *A. alternata* crystals appear as tetrahedral structures. Similarity of chemical composition and/or structure between penis crystals and the radula of *A. alternata* may exist since preliminary histochemical analysis with light microscopy indicates sulfhydryl groups and calcium in both. SEM X-ray microanalysis indicates that crystals of *A. alternata* contain high concentrations of sulfur and calcium. The function of the penis crystals is unknown. Supported in part by BRSG Grant #2-S07 RRO7049-15 awarded by the Biomedical Research Support Grant Program, Division of Research Resources, National Institutes of Health.

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ULTRASTRUCTURE OF THE TRANSRECTAL COELOMODOCTS OF A SEA CUCUMBER (ECHINODERMATA; HOLOTHUROIDEA). G.L. Shinn. Harbor Branch Institution, Ft. Pierce, FL.

The perivisceral coelom of *Stichopus californicus* is connected to the lumen of the hindgut by up to two hundred short transrectal ducts. The ducts have a pseudostratified epithelium composed of monociliated tonofilament-containing cells, myoepithelial cells, gland cells, and bundles of nerve cell-like processes. The duct lumina are bordered, in most places, by the tonofilament containing cells. The myoepithelial cells are predominately circular in orientation; they are arranged in a layer among the bases of the tonofilament containing cells. Some of the myoepithelial cells border the duct lumen; their contractile projections parallel the duct axes. Functions of the ducts will be discussed. The duct epithelium is composed of the same cell types as is the peritoneum and the ducts appear to develop by evagination of the peritoneum. The ducts are thus "coelomoducts" *sensu* Goodrich. It is hypothesized that myoepithelial coelomoducts are pleisomorphic among coelomate organisms, and that, primitively, coelomoducts provided a mechanism for controlling the volume of the coelomic fluid.

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MECHANICAL ASPECTS OF THE EVOLUTION OF THE MAMMALIAN SECONDARY PALATE. A.P. Russell and J.J. Thomason. University of Calgary, Canada and Ohio University, Athens.

Closure of the secondary palate occurred independently in several groups of mammal-like reptiles, and preceded a variety of changes in the head skeleton that have been associated with the emergence of the mammalian masticatory syndrome. Previous attempts to explain the origin of the secondary palate have concentrated on the emergent properties that accrue from its completion, and not upon the sequence of changes leading to its completion. We argue here, from a mechanical viewpoint, that the formation of the palate, in all of its incipient stages, provided structural buttressing for the rostrum as stress patterns altered with changes in mastication. We have employed a theoretical model on which our postulations are based. This model has been the subject of a series of static and dynamic tests, using the virginia opossum, to record stress patterns in vivo and in vitro.

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SEXUAL DIMORPHISM IN THE DENTITION OF FOSSIL HOMINIDS: A MULTIVARIATE APPROACH. S.S. Lieberman and C.E. Oxnard. University of Southern Calif., Los Angeles.

Univariate studies of dental dimensions in fossil hominids have shown that several patterns of sexual dimorphism exist. This study places the various fossil hominids in relation to extant species, by interpolating data for the fossils into multivariate (canonical variates) analyses that were generated for the extant species. Lengths and breadths of teeth for 307 specimens of Pan, Pongo, Gorilla and Homo form the reference population. The fossils used are Ramapithecus, Sivapithecus, Gigantopithecus, Australopithecus (robustus, boisei, afarensis, africanus), Homo habilis, Homo erectus, and Homo sapiens neanderthalensis. The data for the fossils are the modes for both putative females and putative males, of the lengths and breadths of the incisors, canine, premolars, and first two molars, for both the mandible and the maxilla. In extant and fossil hominids, sexual dimorphism is not a feature of size only, but is represented by several complex patterns. Of the 13 species studied, at least 8 different patterns of sexual dimorphism are elucidated. These patterns are graphically illustrated using Andrews high-dimensional plots of the canonical variates. These findings have direct implications on both the evolution of sexual dimorphism in hominids in general and on the evolution of structural sexual dimorphism in modern Homo.

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AN EVALUATION OF EPIPUBIC BONE FUNCTION: SCALING THEORY AND THE MARSUPIUM SUPPORT HYPOTHESIS. Thomas D. White. Univ. of California, Los Angeles.

Epipubic bone lengths and widths were scaled to body mass using data transformed to logarithms and the least-squares method of regression. Analysis of covariance was used to compare slopes between sexes and between groups possessing the marsupium and those without. Epipubic structure in taxa without a marsupium was found to scale as if it were related to litter mass. In taxa with a marsupium, epipubic structure is dimorphic, but the results indicated that the epipubic bones of females are more likely to fail mechanically than those of males given equal loading. Epipubic bone length (l) in taxa with a marsupium scaled significantly greater than geometric similarity ($l \propto Mb$, where $b = 0.440 \pm 0.028$, $N = 72$, $r^2 = 0.932$), implying that epipubic bone structure is suited to a function or functions other than support of a marsupium. This result is not inconsistent with the hypothesis that epipubic bones function in locomotion.

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GEOMETRIC FORMS OF MAMMALIAN CLAWS. S.O. Landry. State Univ. of New York, Binghamton.

Since claws, like rodent incisors, consist of a hard upper layer, the nail, plate, and a softer lower layer, the sole, (Boas, 1931) continuously extruded in circular form, claws might be expected to show the same structural relations to the forces impinging on them as incisors. Not so. The soft, sole material is almost completely enclosed by the plate material which comes down over the sides of the nail, to give a V-shaped or U-shaped cross section. It is this side wall that must absorb the tensile forces acting on the tip of the nail when it is providing traction as the animal moves over the ground. This is presumably the primitive function of nails. The shape of the nail is approximated by 90° arcs of two circles of different diameters, with different centers, the larger circle being the upper curvature. The meaning of this in functional terms, is obscure.

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FORM AND POSSIBLE FUNCTION OF THE COLLAGEN LAYER UNDERLYING CETACEAN BLUBBER. S.A. Wainwright, D.A. Pabst and P.F. Brodie.* Duke Univ., Durham, N.C. and Bedford Inst., Canada.

Beneath the cetacean blubber layer lies a wrapper of collagen fibers that are wound in right and left helices around the body. These fibers are tightly interwoven in the tail stock. We have seen this fiber sheath in animals from both suborders of Cetacea, including five species from three families of odontocetes, and one baleenopterid. A sheath of crossed helical fibers around cylindrical animals allows the body to bend in locomotion and not wrinkle. This morphology suggests the structure is functioning as a tension resisting member of a pressurized hydrostatic skeleton. It may be, as it is in other undulatory swimmers, a mechanism for storing elastic energy.

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ALLOMETRY OF SKULL PROPORTIONS IN THE CAPRINAE (BOVIDAE: MAMMALIA). C.B. Renzulli. Univ. of Chicago, IL.

The head-to-head collisions (clashes) of some male Caprinae load considerable forces on the skulls of these animals, and may generate torques which would tend to rotate their heads about the occipital condyles. These species would be expected to have specializations of the skull and the neck muscles to resist these forces compared to other Caprinae which do not clash. Features estimating functionally important characteristics of the cranium and the neck musculature were measured on the skulls of male Caprinae ranging from the small-horned Rupicaprini (chamois, serow, etc.) to the large-horned Caprini (sheep, ibex, etc.). Regressions were done to determine the interspecific allometric relationships of these cranial features with respect to basicranial axis length. Most of these measurements scaled isometrically, and rarely were any species outside the 95% confidence limits. These results suggest that some of the differences in skull shape among the Caprinae may be the result of scaling relationships and not associated with different methods of fighting.

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RELATIVE MUSCLE FORCE CONTRIBUTIONS TO TMJ LOAD IN PIGS AND HUMANS. G.S. Throckmorton. Univ. Texas Health Sci. Ctr., Dallas.

In mammals, three muscles (Temporalis, Masseter, Medial Pterygoid) generate most of the reaction forces at the teeth and at the temporomandibular (TMJ) joint. The effect of each muscle on the TMJ reaction force is influenced by the muscle force magnitude, direction, and moment arm length relative to those of the resultant muscle force. Differences among species produce different effects on TMJ load. Comparison between humans and pigs (pig data supplied by Dr. S.W. Herring) was made using a 2-dimensional computer model for calculations of the direction, θ , and magnitude, FJ, of the TMJ reaction force during isometric bites at various bite positions. Differences between pigs and humans include: 1) At equivalent bite positions (8.0 cm) FJ is lower in pigs. 2) In humans Temporalis and Medial Pterygoid magnitude had the least effects on FJ and θ respectively; in pigs Masseter magnitude had the least effect on FJ and θ . 3) Increasing Temporalis magnitude in pigs or Medial Pterygoid magnitude in humans increased FJ.