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Papers are listed in numerical order by Abstract Number.
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Abstracts of papers from the American Microscopical Society
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1

ECOLOGICAL FACTORS AND THE EVOLUTION OF SEXUAL DIMORPHISM IN CHERNETID PSEUDOSCORPIONS. D.W. Zeh. Univ. of Arizona, Tucson.

This study provides experimental and observational evidence that ecological constraints determine the extent to which sexual selection operates. Males of several pseudoscorpion species in the family Chernetidae possess significantly larger and more robust palpal chelae than do females. The degree of dimorphism is variable among species. Based on literature descriptions of habitat utilization, there is a significant positive association between the utilization of patchy habitats and the existence of sexual dimorphism. Also, experiments with the chernetid *Dinocheirus arizonensis* demonstrate that males interact aggressively and that fighting ability is positively correlated with chela size. A 2-way ANOVA shows significant effects of relative chela size and population density on mating success. The advantage of large size is increased at high density. Given that patchy habitats are associated with high densities in chernetids, these results explain the association between habitat utilization and sexual dimorphism in chernetid pseudoscorpions.

2

EFFECTS OF GENOTYPE, SOCIAL INTERACTION AND TESTOSTERONE ON ESTERASES IN MALE MOUSE URINE. J.B. Labov, D. Marra*, P. Allen*, and D. Zavotsky. Colby College, Waterville, Me.

The relationship of urine esterases to the pheromone responsible for pregnancy block in house mice was examined. In Experiment 1 urine was collected from individual males of 8 strains which had been both physically isolated and grouped 3/cage. Urine esterases were separated by electrophoresis, stained with esterase-specific substrate, and analyzed by scanning densitometry. In Experiment 2, urine obtained 2 weeks after castrating males was analyzed by electrophoresis and densitometry. Subjects were then injected with testosterone propionate daily for 2 weeks and their urine was reanalyzed. Significant strain differences in numbers and quantity of urine esterases were found during both isolation and grouping. These differences were also found for individuals of some strains due to caging. Castration reduced and testosterone restored urine esterase levels. We suggest that one or more low molecular weight urine esterases may function as the pregnancy block pheromone either directly or by cleaving a pheromone precursor in the urine.

3

BEE CONSTANCY AS A FUNCTION OF VARIATION IN FLOWER SHAPE AND COLOR. N. M. Waser (intro. by M. V. Price). Univ. of California, Riverside.

Several distinct flower-visiting behaviors have been described as "constancy", leading to some confusion. I argue that the term is best reserved for describing an animal that restricts its visits to flowers of one type in a mixture of types that offer essentially equal food rewards. Defined this way, constancy is distinct from preference based on unequal rewards, and is difficult to reconcile with optimal foraging theory (broadly construed) unless one hypothesizes that the animal is constrained in its ability to simultaneously remember how to forage from flowers of different morphology or color. A corollary is that the degree of constancy should depend on how strongly flower types in a mixture differ. To explore this, I constructed outdoor flower arrays in Costa Rica and Arizona, and observed foraging bumblebees and solitary bees. Constancy was enhanced when flowers in the arrays differed in morphology alone or color alone. This supports the idea that constancy is not a perfect adaptation as commonly proposed but rather a lack of adaptation best explained by memory constraints.

4

CAUSES OF VARIATION IN HOST DISCRIMINATION IN THE PIPEVINE SWALLOWTAIL BUTTERFLY, *BATTUS PHILENOR*. D.R. Papaj. Duke University, Durham, N.C.

A Texas population of the pipevine swallowtail butterfly (*Battus philenor*) regularly exhibits seasonal variation in the distribution of eggs on its two *Aristolochia* hosts. Ovipositing females employ both visually-based discrimination of leaf shapes and chemically-mediated contact selectivity in the location and selection of suitable hosts, but only variation in the former is correlated with variation in host preference. Field and enclosure experiments examined the importance of genetic differentiation and learning as sources of variation in host-selection behavior. Early- and late-season females are not inherently different in leaf-shape preference; rather, the leaf shape for which females search depends only on the leaf shape of the host species to which they are exposed. By contrast, genotypic differences between early- and late-season females are reflected in contact responses on each host type. These results support the theory that alterations in host use by herbivorous insects first arise through genetic changes in behavioral responses to plant secondary chemistry.

5

ENCOUNTERS OF NAIVE *Nephila clavipes* MALES WITH FEMALES IN TWO IMMATURE SIZE CLASSES. E.M. Hill. Tulane Univ., New Orleans, and Einstein Coll. Med., The Bronx, NY.

As *N. clavipes* females increase in size and approach sexual maturation (21 mm), males are recruited to their orbs where mating occurs. This field study was conducted to determine how male distribution is influenced by male behavior and by female aggressiveness to visitors. Naive males were placed in the orb barrier strands of females 12-14 or 16-20 mm in size. Behavior was observed for 20 m. More males tested with large females adopted a slow movement mode of probing, alternating with advances of a few mm. Males placed with larger females displayed more high-frequency abdominal vibrations associated with mating, approached closer to the female and were more likely to remain the following day. Thirty percent of the males tested with small females left the orb within ten minutes. Small and large females differed in their responses to male approach. Small females were more likely to orient toward the male, pluck the web strands, approach and/or fight with the male. It is concluded that male and female behavior both contribute to the observed size distribution of males on female webs.

6

BLUE WAVELENGTH SPECIFIC BEHAVIOR AND SPECTRAL MECHANISMS OF VISION IN FIREFLY *PHOTINUS SCINTILLANS* ♂♂. A. B. Lall, H. H. Seliger* and P. Chapados*. The Johns Hopkins Univ., Baltimore, MD.

The wavelength specificity for the initiation of flashing activity in a twilight active firefly *P. scintillans* was determined by obtaining an action spectrum of the flashing activity initiated in the presence of monochromatic wavelengths (400-620nm) at different intensities in a test chamber in the lab. The action spectrum possessed a maximum in the blue with a depression in the green. The response in the blue could be inhibited by concomitant green light. Since the behavioral action spectrum involves the blue spectral mechanism, it is hypothesized that the blue receptors control the initiation of flashing behavior in the twilight active male fireflies. Further studies on the effects of UV light are in progress.

7

THE ROLE OF EXPERIENCE IN BEHAVIORAL TIME-SHARING. Avery Nelson Gilbert. Monell Chemical Senses Center 3500 Market St., Phila., PA 19104

In behavioral time-sharing a dominant behavior both permits the onset and controls the termination of a subordinate. The subordinate does not alter the temporal pattern of the dominant, but merely fills the time available to it. I examined the maternal and copulatory behavior of female Norway rats mating at the postpartum estrus. I manipulated the costs and benefits of mating by disrupting pups once mating began. Multiparous females were able to switch between these two incompatible behavioral subsystems by means of a time-sharing arrangement in which sex was dominant to maternal behavior. Nest disruption increased maternal behavior which was largely confined to preprogrammed down-times in copulation (post-ejaculatory intervals). In contrast, primiparous females did not show time-sharing. Maternal behavior intruded into sex, and they did not retrieve pups efficiently. These results demonstrate that prior experience with the component behaviors may be necessary to the display of time-sharing.

8

CIRCADIAN TIMING: CULTURE OF ISOLATED HAMSTER SUPRACHIASMATIC NUCLEI (SCN). P. J. DeCoursey, Univ. South Carolina, Columbia, and C. J. Fisher, Vassar College, Poughkeepsie, N.Y.

The mammalian circadian pacemaker, the SCN, has previously been cultured *in vitro* for only 30 hours. Reported here are results of a culture technique which extended survival time up to 6½ days. Thin hypothalamus slices containing the SCN were cultured as explant grafts on the chorioallantoic membrane (CAM) of chick embryos. A small perforated chamber was positioned on the CAM; the donor slice was centered above the basal hole and incubated with various solutions at 37°C. Grafts were removed for histological examination after 2, 4 or 6½ days of culture. Light microscopy of grafts indicated a relatively intact structure of a portion of the SCN cell bodies and of the 3rd ventricle wall, but a breakdown of fiber tracts. Rapid penetration of CAM vessels appeared responsible for graft survival. The technique has potential for unequivocally demonstrating the self-sustained rhythmic output of SCN neurons, as well as for pharmacological studies of isolated SCN.

9

COLOR INTENSITY AS A PREDICTOR OF RESPONSIVENESS IN MALE THREESPINE STICKLEBACKS
W. J. Rowland. Indiana University, Bloomington.

The intensity and extent of nuptial coloration of male sticklebacks (Gasterosteus aculeatus trachurus) varies between individuals of a population and within individuals over time. Since coloration is influenced by the male's internal state, the degree to which such color develops in a male might serve as an indicator of his tendency to respond to territorial intruders. This hypothesis was tested by using nested males that differed in the degree to which their nuptial coloration had developed. The color state of each male was estimated and then its response to live conspecifics and dummies that were introduced into its tank was measured. The results reveal a positive correlation between a male's color state and his response to intruders: brighter males tend to attack and court more to male and female intruders, respectively, than do males whose colors are less developed. This suggests that the intimidating effect for males and sexual attractiveness for reproductive females that nuptial coloration exhibits is based on the greater responsiveness of brighter males to either of these two categories of intruders.

10

REPRODUCTIVE STRATEGIES IN A SIMULTANEOUSLY HERMAPHRODITIC REEF FISH, SERRANUS FASCIATUS. C. W. Petersen. Univ. of Arizona, Tucson

Serranus fasciatus is the first fish reported from nature in which smaller individuals are simultaneous hermaphrodites while larger individuals are males that have lost female function. The social system of this fish was studied in the Gulf of California during the summers of 1982 and 1983. All males maintained permanent territories which they defended from other males but not against hermaphroditic individuals. These territories contained from 1 to 8 hermaphroditic individuals which spawned as females almost exclusively with the male. Males had higher social encounter rates than hermaphrodites and spent large amounts of time patrolling their territories, especially during the evening spawning period. Hermaphrodites obtained male function by occasionally sneaking on pair spawns (10%) and rarely (less than 1%) by spawning in the male role of a pair spawn with another hermaphrodite. Size or age dependent shifts of gender allocation in simultaneously hermaphroditic animals are poorly understood and such studies should provide insight into this sexual strategy.

11

MODIFICATION OF THE ENDOGENOUS BEHAVIOR PATTERNS OF TWO SPECIES OF SARSIA (CELEENTERATA; HYDROMEDUSAE) BY TEMPERATURE, LIGHT AND PRESSURE.
L. M. Fassano. Friday Harbor Lab., Univ. of Washington, and Univ. of Wisconsin, Madison.

Observations of the behavior of free-swimming jellyfish under controlled conditions in an observation chamber, were made for correlation with electrical recordings of the margin pulse and swim pulse coordinating systems which control endogenous behavior. Light is of major influence in determining the behavioral pattern; temperature also influences it but does not reverse swimming direction. Modest pressure changes (cm of water) have no demonstrable effect. The behavior of the undescribed Sarsia "L" * will be compared to a homogenous population of Sarsia tubulosa from a laboratory pool. (R.L. Miller, '82)

12

INTERSPECIFIC AND INTRASPECIFIC AGGRESSION AMONG SYMPATRIC SIBLING SPECIES.
N. Knowlton. Yale Univ., New Haven, Ct.

The snapping shrimps Alpheus armatus and A. immaculatus are territorial, defending their host, the sea anemone Bartholomea annulata, against all alpheid symbionts except potential mates. Contests over anemones were staged in the field and laboratory between two individuals of the same size and sex, and injuries received were then noted. Contests between heterospecific individuals resulted in more severe and frequent injuries to both winners and losers than contests between conspecifics, because an animal injured during a contest was more likely to give up when its opponent was a conspecific. This result conflicts fundamentally with conventional expectations based on both competition theory (interspecific competition less intense than intraspecific competition) and models for the evolution of aggression (asymmetric contests less escalated than symmetric contests).

13

MALE SIZE, MATING SUCCESS, AND MATING STRATEGY IN THE MOSQUITOFISH, *GAMBUSIA AFFINIS* (POECILIIDAE). A.L. Hughes, Indiana Univ., Bloomington.

In mosquitofish populations in southern Indiana, males maturing in early summer do so at small body sizes. Those maturing in late summer delay maturation, attaining larger body sizes. Laboratory experiments showed that females tend to prefer the larger of two males and that larger males can outcompete smaller males for access to females. One hypothetical advantage for early summer males of small body size is that it enables the male to employ energetically costly mating strategies such as the pursuit and forcible insemination of nonreceptive females. Experiments confirmed the prediction that small males are more likely to employ the strategy of pursuit when confronted with a nonreceptive female, while large males are likely to continue courtship. An ethological assay of seasonal changes in female receptivity showed that females are least receptive in mid-summer, when smaller males are abundant.

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UNDERWATER OBSERVATIONS ON COLOR PATTERNS AND SPAWNING IN A SYNCHRONOUS HERMAPHRODITIC SEA BASS. L.S. Demski and J.G. DULKA*, Univ. of Kentucky, Lexington.

Clark (Science, 129:215; Lady and the Sharks) reported several color patterns for the sex phases of *Serranus subligarius*; however sufficient detail is not given to support further investigation. Thus, we videotaped these fish (52 spawnings in 29 pairs) at St. Andrews Bay, FL (July & Aug. 1983) in order to produce baseline data. Male phase animals are banded with darkest markings on the posterior half of the flanks, especially the dorsal fin spot and the most caudal band. Female phase fish are typically dark over the posterior half of the body and light anterior to the white abdominal marking; banding is sometimes evident in the dark area. Fading of the dorsal fin spot, area below it as well as formation of a dark V pattern (Clark's reverse banding) are all correlated with increased sexual arousal; the latter is observed only just before spawning climax. Although these changes appear to be signals to the "male", other factors can trigger male spawning as one pair spawned while both were in the male-phase color pattern. Intruders joined pairs at spawning climax in 4 instances. Their speed precluded analysis of coloration.

15

FORAGING BEHAVIOR OF THE SEA STAR (*Asterias forbesi*). D.B. Campbell. Univ. of R.I., Kingston.

The energy maximization premise of optimal foraging theory was tested using mussels (*Mytilus edulis*) as prey. Field observations and laboratory experiments showed that preferred prey size was positively correlated with predator size. Optimum prey size was estimated by subtracting the energetic costs of opening and feeding on mussels from energetic benefits, and dividing the net energy benefit by feeding time. Most sea stars select mussels which provide the maximum rate of energy intake, but very large sea stars select mussels smaller than the optimum size. Sea stars have a random search path in the field, and are capable of "switching" their prey-species preference. This study supports some of the predictions of optimal foraging models for an animal with a very limited learning capability.

16

THE ACCLIMATION OF ANEMONE FISHES TO SEA ANEMONES: PROTECTION BY CHANGES IN THE MUCCOUS COAT OF THE FISH. W. R. Brooks and R. N. Mariscal. Florida State University, Tallahassee, FL.

Following acclimation, the anemone fish *Amphiprion clarkii* is able to live unharmed among the tentacles of sea anemones. Two hypotheses have been presented to describe how anemone fishes become protected during acclimation. One suggests that the fish coats itself with anemone mucus to mask its chemical stimulus for cnida discharge. The second suggests that the fish is protected by altering its own mucous coat in some way. In order to test these alternate hypotheses, a surrogate anemone was constructed from inorganic materials. The fish were allowed to orient to the surrogate anemone prior to being placed with a real anemone (*Heteractis malu*). After being with the surrogate anemone, the acclimation times to the real anemone decreased seven-fold. This indicates that the fish is not becoming protected by coating itself with anemone mucus, but rather suggests that it is protected by altering its own mucous coat.

17

Preliminary Results of Inhibition of Phonotaxis by Highway Noise for Several Species of Anurans (Bufonidae and Hylidae). A.N. Barrass and L.F. Cohn.* Vanderbilt University, Nashville, TN.

Female anurans from two genera, Bufo and Hyla, were tested in lab experiments to determine if highway traffic noise masking would deter phonotaxis to species-specific male mating calls. Male long calls were recorded in the field for playback in the lab. Females were collected in amplexus and tested in a two choice experiment. Highway noise and call patterns were analyzed for frequency and intensity components. Females were tested for reaction rates to the control, long call/species, and call plus noise. Sound pressure levels for both mating calls and traffic noise were matched in lab experiments to those measured in the field. Observations in the field were compared to those in the lab to note deviation in female selective behavior. Five of the six species tested showed significant deviation from the control when the noise was introduced. Initial data on traffic noise masking appears to support the hypothesis that female selection based upon acoustic cues may be complicated due to abiotic noise intrusion.

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GONADOTROPIN-RELEASING HORMONE IN TWO CYCLOSTOMES, THE SEA LAMPREY (PETROMYZON MARINUS) AND HAGFISH (EPTATRETUS STOUTI). S. A. Sower, N. M. Sherwood* and E. Plisetskaya. University of New Hampshire, Durham, University of Victoria, Canada, and University of Washington, Seattle.

Immunoreactive gonadotropin-releasing hormone (GnRH) was extracted from brains of adult spawning sea lampreys with acetone/HCL and petroleum ether. High pressure liquid chromatography and cross reactivity studies show lamprey brains to contain a peptide chromatographically and immunologically identical to the mammalian form of GnRH. The salmon form of GnRH was not detected in the lamprey brains. Immunoreactive GnRH was not detected in the brains from hagfish using five different antisera which react against different portions of the GnRH molecule. These data suggest that the mammalian GnRH may be the ancestral molecule and thus conserved in evolution.

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A RELATIONSHIP BETWEEN THE NUMBER OF LUTEINIZING HORMONE RELEASING HORMONE (LHRH) CONTAINING NEURONS AND GONADOTROPS IN PLATYFISH. L.R. Halpern-Sebold, M.P. Schreiberman, H. Margolis-Kazan and H.J. Th. Goos*. Biology Dept., Brooklyn College and Univ. of Utrecht.

The number and location of gonadotrops containing ir-LHRH and ir-gonadotropin (GTH) and of neurons in the brain containing ir-LHRH were determined in early and late maturing genotypes of Xiphophorus maculatus from birth to adulthood. In all neonates, ir-GTH and ir-LHRH are found in cells of the lateral and ventral caudal pars distalis, and in PAS+ cells of the pars intermedia. In early maturers, ir-LHRH neurons appear at 4-5 wks and the number of ir-gonadotrops increases 3-5 fold between 5 and 18 wks (sexual maturity). Late maturing sibs follow a pattern of development that begins later (9 wks for ir-LHRH neurons), is more protracted (10 to 59 wks for gonadotrops), and ends with the presence of fewer ir-brain and pituitary cells than that of early maturers. Our results demonstrate a direct quantitative relationship between the number of LHRH containing neurons and the number of gonadotrops in both early and late maturers. (Supported by NIH-NIA, #AGO 1938, and PSC-CUNY)

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THE EFFECTS OF ANDROGENS ON THE STRUCTURE AND FUNCTION OF THE BRAIN-PITUITARY-GONAD AXIS OF PLATYFISH. M.P. Schreiberman, L.R. Halpern-Sebold, H. Margolis-Kazan and P.W. Perlman*. Brooklyn College, 11210.

Eight week old immature male Xiphophorus maculatus of early and late maturing genotypes received 10ug of testosterone (T), 11-keto-T (11-KT), or sesame oil 3X weekly for 4 wks and were then processed for histological and immunocytochemical examination. The pituitaries and testes of both genotypes injected with either androgen were better developed than controls, however, fish receiving 11-KT had more gonadotrops containing ir-LHRH and gonadotropin and more advanced stages of spermatogenesis than those given T. In the brain, ir-LHRH perikarya were found in the nucleus olfactoretinalis in all groups, while only injected fish had ir-perikarya in either the nucleus preopticus periventricularis (T) or the nucleus lateralis tuberis (NLT;11-KT). No ir-LHRH perikarya have ever been observed in the NLT of uninjected late maturing (NSr) fish. Our results suggest that the different maturation-rate-regulating effects of androgens may be due in part to their differential actions on brain centers known to control reproductive system development. (Supported by NIH-NIA, #AGO1938 and PSC-CUNY)

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SEASONAL CHANGES IN RADIOIMMUNOASSAYABLE LHRH IN MICRODISSECTED BRAIN AREAS OF THE ROUGH-SKINNED NEWT (*Taricha granulosa*). R. T. Zoeller and F.L. Moore. Oregon State University, Corvallis, OR.

To investigate the role of LHRH in the neuroendocrine control of seasonal reproduction in rough-skinned newts, males were collected monthly from March 1982 to June 1983. All animals were sacrificed within 2.5 h of capture. LHRH was measured in specific brain regions: infundibulum (I), rostral hypothalamus (RH), ventral preoptic area (POA) and dorsal habenulum (control). Corticosterone (B) and androgen (A) were measured in plasma by RIA. There was a significant negative correlation ($r = -0.62$; $p < 0.05$) between plasma B and A concentrations with A being higher in the breeding season when B was lower. LHRH content of the I, RH and POA changed seasonally; the highest levels occurring in Feb and June and the lowest in March. Although LHRH content in the I, RH and POA tended to covary throughout the year, there were discernible differences, e.g., LHRH in the POA failed to drop in the spring but stayed elevated throughout the summer, unlike the LHRH content of the I and RH.

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IMMUNOCYTOCHEMICAL LOCALIZATION OF THYROTROPIN RELEASING HORMONE IN TADPOLE AND FROG BRAIN. K. M. Mimmagh*, J. L. Bolaffi[†], and J. C. Kaltbach. Mt. Holyoke College, S. Hadley, MA and [†]Tufts Univ. School of Medicine, Boston.

Indirect immunoperoxidase anti-peroxidase staining was used to localize TRH in the brain of *Rana catesbeiana* tadpoles and frog. Brains were excised, fixed in 5% acrolein/0.1M PO_4 buffered saline, washed, embedded in gelatin, and cut sagittally on a vibratome at 60-100 μ m. Sections were incubated in a well characterized antibody and processed by a peroxidase anti-peroxidase method. For controls antibody was preadsorbed with synthetic TRH. Immunoreactive cell bodies, fibers, and nerve endings are widely distributed in the brain of the frog and of the tadpole throughout larval development. TRH-positive perikarya are present in the infundibulum and nucleus accumbens septi but are most abundant in the preoptic region. Immunopositive nerve fibers and endings are particularly dense in the median eminence and pars nervosa and less so in the pars intermedia. No reaction product is found in the pars distalis. These results may prove significant with respect to hormonal control of metamorphosis and neuroregulation in Amphibia.

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SOMATOSTATIN-LIKE IMMUNOFLOUORESCENCE IN THE HYPOTHALAMUS AND PITUITARY OF SEVERAL TELEOST FISH. E.G. Grau[†], R.S. Nishioka, G. Young^{*} and H.A. Bern, University of California, Berkeley. [†]University of Hawaii, Honolulu.

Prolactin secretion is affected by numerous factors. For a prolactin regulator to attain putative physiological significance, its delivery to prolactin cells must be demonstrated. Aminergic innervation of the rostral pars distalis (RPD) exists in several teleost fish but it is absent in tilapia *Sarotherodon mossambicus* and in the goby *Gillichthys mirabilis*. Somatostatin (SRIF) is an effective inhibitor of tilapia prolactin release *in vitro* (Grau et al., 1982, Endocrinol. 110: 910). Using an antiserum to SRIF, we have observed SRIF-like immunofluorescence in preoptic hypothalamic neurons which send their processes to the pituitary. In tilapia (but not in *Gillichthys* or *Fundulus heteroclitus*) immunofluorescent fibers penetrate deeply into the adenohypophysis including the RPD, suggesting that SRIF may be an important regulator of PRL secretion in this species. In addition, small neurons and a large plexus of fine fibers with SRIF-like immunofluorescence have been seen in the tuberal region and olfactory lobe of tilapia. (Aided by NSF grant PCM81-10111).

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IMMUNOREACTIVE SEROTONIN AND SOMATOSTATIN IN THE BRAIN AND PITUITARY OF THE PLATYFISH. H. Margolis-Kazan, M.P. Schreiber and L. Halpern-Sebold. Department of Biology, Brooklyn College, Brooklyn, N.Y. 11210.

The neuropeptides serotonin (5HT) and somatostatin (SRIH) have been localized in adult platyfish, *Xiphophorus maculatus*, using peroxidase anti-peroxidase (PAP) immunocytochemical procedures. In the brain, immunoreactive (ir-) 5HT is found in the nucleus recessus lateralis and nucleus recessus posterioris of the paraventricular organ. Pars intermedia cells of the pituitary react strongly with anti-5HT, while prolactin cells occasionally show much weaker immunoreactivity.

Ir-SRIH is frequently observed in the nucleus lateralis tuberis and in rhombencephalic areas of the brain, but its presence is most conspicuous and consistently noted in perikarya and fibers of the ventral tegmentum in the mesencephalon. In the pituitary, anti-SRIH is highly specific for somatotrops which appear to be surrounded by granules of ir-SRIH. (Supported by the NIH-NIA, grant #AGO 1938 and by a PSC-CUNY award)

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THE INFLUENCE OF BLINDING AND REMOVAL OF THE FRONTAL ORGAN ON THE ACTIVITY RHYTHM OF *XENOPUS LAEVIS*. Keith Anderson and Fred Turek. Northwestern Univ., Evanston.

We have shown that adult female *Xenopus laevis* display an entrained circadian activity rhythm when placed into an artificial light-dark (LD) cycle composed of 10 hrs light and 14 hrs dark (10L:14D). Removal of the eyes does not alter the pattern of entrainment to 10L:14D or prevent the display of a free-running activity rhythm during exposure to constant dark (DD), demonstrating that the eyes are not required for the generation of the circadian activity rhythm or for its entrainment to an LD cycle. To extend our search for the structures involved in regulation of the circadian activity rhythm, activity was recorded from 2 groups of frogs--sighted frogs with frontal organ removed, and blind frogs with frontal organ removed. All frogs entrained to a 10L:14D cycle. During exposure to DD, frogs from both groups displayed free-running rhythms with circadian periods. These results reveal that the frontal organ, like the eyes, is not required for the generation of the circadian activity rhythm or for its entrainment to an LD cycle. (Supported by Sigma Xi Grant in Aid of Research and the Whitehall Foundation)

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ENDOCRINE-LIKE CELLS IN THE MIDGUT OF *AEDES AEGYPTI*. M. R. Brown. Univ. of Georgia, Athens.

The ultrastructure of a cell type randomly distributed in the mosquito midgut resembles that of peptide hormonogenic cells in the vertebrate gut. The endocrine-like cells are flask-shaped and positioned basally in the midgut epithelium. Many of the cells extend into the midgut lumen with a cap of microvilli; some cells have basal side extensions that contact several digestive cells. The most notable characteristic of the endocrine-like cells is the secretory granules concentrated in the basal area of the cell. These granules are formed by the cell in a manner typical of cells that export peptides or proteins and are released by exocytosis. With light microscopy, we have observed cells in the posterior midgut that are immunoreactive to antisera against bovine pancreatic polypeptide and are similar in shape, distribution, and position to the endocrine-like cells. We are testing antisera to other vertebrate peptides and are combining immunocytochemistry with electron microscopy to determine the specific location of the peptides within the immunoreactive cells.

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Utilization of Monoclonal Antibodies for Mosquito Vitellogenesis Research by Ma M., Newton P.E. Gong He, Kelly T.J. and Masler E.P., University of Maryland, College Park, and Insect Reproduction Laboratory, USDA-Beltsville.

Monoclonal antibodies to the soluble yolk proteins of *Aedes atropalpus* and *A. aegypti* were produced by hybridomas between the fusion of P3X63.653 myeloma cells and the splenocytes of BALB/c mice immunized with a mixture of the *Aedes* yolk extracts. Ascites fluid collected from mice inoculated with the cloned hybridoma cells contained high specificity and affinity to the yolk extracts of both species. Monoclonal antibodies specific to vitellin and vitellogenin were characterized by a combination of high resolution gel electrophoresis, electroblotting and histochemical staining methods. An ELISA procedure was developed using these well characterized monoclonal antibodies for monitoring vitellogenesis in individual mosquitoes. Using this procedure, the peak period of vitellogenin synthesis in *A. atropalpus* was found to be 18-24 hrs post adult eclosion.

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IN VIVO AND IN VITRO EXPRESSION OF VITELLOGENIN mRNA AND TOTAL RNA IN THE MOSQUITO, *AEDES AEGYPTI*. J.V. Racioppi, R.M. Gemmill,* H.H. Hagedorn, and J.M. CALVO.* Cornell Univ., Ithaca, NY.

Previous experiments showed that decapitation of mosquitoes following a blood meal prevents the release and subsequent increase in ecdysterone levels. The effect of ecdysterone on vitellogenin (Vg) mRNA and total RNA was investigated. Ecdysterone stimulates significant (50-75% of maximal) accumulation of Vg mRNA in blood-fed, decapitated animals but only low accumulation ($\leq 6\%$ of maximal) in non-blood-fed, decapitated animals. These results indicate that ecdysterone is necessary but not sufficient for maximal levels of Vg mRNA expression. Ecdysterone injections had no effect on total RNA accumulation in fat bodies in these same experiments. *In vitro* experiments confirmed that ecdysterone is not sufficient for maximal Vg mRNA expression. It elicited only 2-3% of a maximal response when incubated with fat bodies *in vitro*. In addition to stimulating the release of ecdysterone, the blood meal must provide some other factor(s) necessary for Vg gene expression and the accumulation of total RNA in fat bodies.

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INVOLVEMENT OF PROSTAGLANDINS IN *HELISOMA* REPRODUCTION. S.C. Kunigelis and A.S.H. Saleuddin. York Univ., Downsview.

In the freshwater pulmonate gastropod, *Helisoma duryi* copulation is prerequisite to egg production. Virgin snails produce egg masses irregularly, containing an average of 2 non-viable eggs. Following the first mating of virgin snails, the rate of egg mass and oocyte production is greatly elevated. If subsequent mating does not occur egg production declines to a basal level characteristic of virgin animals. Artificial "insemination" of mated animals with PGE₂ produced a dose dependent response. The number of egg masses and oocytes/mass were found to increase. PG synthetase activity was highest in virgin ovotestis and least in single mated animals. High levels may reflect the readiness but inactive state of the virgin ovotestis. Low enzyme activity following a first mating reflects the onset of vitellogenesis and ovulation. Intermediate levels found in regularly mating animals correlate well with regular egg production suggesting that PG synthetase activity is co-regulated with the rate of egg production. These observations suggest that PG's may be involved in the induction of mated behaviour and the stimulation of egg production.

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PURIFICATION OF THE EGG DEVELOPMENT NEUROSECRETORY HORMONE (EDNH) FROM HEADS OF THE MOSQUITO *Aedes Aegypti* AND ITS EFFECTS *IN VIVO*. G. Wheelock* and H. H. Hagedorn. Cornell Univ., Ithaca, N.Y.

A neurosecretory hormone, EDNH, from the brain is necessary for egg development after a blood meal. We have purified EDNH from head extracts using high pressure liquid chromatography and here report the effects of purified EDNH when injected into the live animal. EDNH has no effects when injected into the non-blood-fed female. If females are blood-fed, decapitated, and then injected they do respond as shown by increased ecdysteroid and vitellogenin titers. Purified fractions that stimulate ecdysterone production by ovaries *in vitro* are also active *in vivo*. In comparing the activity of HPLC-separated fractions we found that a single fraction eluting near 34% CH₃CN is active *in vivo* and *in vitro*. Another fraction eluting at 30% has activity only *in vivo*. We also occasionally see an active fraction at 37%. We believe that the fraction eluting at 34% is the active hormone while the other two could be precursors or metabolites.

31

DOES JH-ACID HAVE A HORMONAL FUNCTION IN THE LARVAL-PUPAL TRANSFORMATION OF *MANDUCA SEXTA*? S.P. Sparagana and G. Bhaskaran. Texas A&M University, College Station.

Injection of juvenile hormone (JH) or JH-acid into post-wandering (5-7 day fifth instar) allatectomised *M. sexta* larvae prevents the precocious adult differentiation of susceptible imaginal tissues (eyes, wings, mouth parts) which is observed in uninjected, allatectomised controls.

Larvae allatectomised as day 0 fifth instars were injected with JH-I, JH-I-acid, JH-III, JH-III-acid, JH-III-diol, or farnesoic acid in dosages ranging from .001 µg to 1.0 µg. JH-I and JH-I-acid were equally effective in preventing precocious adult development at all doses. The tissues only responded to the highest doses of JH-III, JH-III-acid, and JH-III-diol. Farnesoic acid proved ineffective in eliciting normal development. Possible interpretations are that the injected JH-I-acid acts as the hormone responsible for preventing premature metamorphosis of imaginal tissues, or that the JH-I-acid is a prohormone which is methylated to JH by target tissues. In view of the high JH esterase activity present in mature fifth instar larvae, it is suggested that endogenous JH-acid plays a role in the larval-pupal transformation.

32

ECDYSONE SECRETION BY THE PROTHORACIC GLANDS OF *MANDUCA SEXTA*: INVOLVEMENT OF CYCLIC AMP. W. A. Smith, L. I. Gilbert and W. E. Bollenbacher. Univ. of North Carolina, Chapel Hill.

Steroidogenesis by the insect prothoracic glands (PG) is stimulated by a cerebral neuropeptide, the prothoracicotrophic hormone (PTTH). The involvement of cAMP in the action of PTTH was investigated in *Manduca sexta* using an *in vitro* assay based on measurement of secreted ecdysone. The steroidogenic effects of PTTH are mimicked in both larval and pupal PG by treatments designed to increase intracellular levels of cAMP (isobutylmethylxanthine, cAMP analogs). In addition, stimulation of PG with either crude or partially purified PTTH leads to an increase in intracellular cAMP within minutes of exposure. However, the degree of stimulation of the PG (fold and magnitude) appears to vary depending upon the developmental state of the gland. The results suggest that cAMP is involved as a second messenger in PTTH action, but that the developmental status of the PG modulates intracellular responses to the neurohormone. (Supported by research grants from NIH and NSF, and NIH training grant NS07166).

33

COLD ACCLIMATION INDUCES HYPERTROPHY IN CATFISH LIVER. J.D. Kent, M. Koban, and C.L. Prosser. Univ. of Illinois, Urbana.

Changes in enzyme activities were correlated with liver hypertrophy during thermal acclimation. The hepatosomatic index and protein content of catfish liver was doubled upon acclimation from 25° to 15°C; there appear to be no major alterations in DNA, neutral lipid, phospholipid, H₂O, or glycogen content between the two acclimation groups. Hypertrophy occurred with acclimation temperature irrespective of whether the fish had been fasted or fed. Morphological studies indicate increased cell volume in 15°C-acclimated liver. Six enzymes were assayed from catfish acclimated to 25° and 15°C: cytochrome oxidase, citrate synthase, G-6-PDH, 6-PGDH, 3-OH acylCoA DH, and LDH. Only G-6-PDH exhibited a significant thermal compensation when based on protein; CS, 6-PGDH, 3-OH acylCoA DH, and LDH showed partial compensation when expressed on DNA. If assessed as total liver activity, all enzymes showed marked thermal compensation in activity. It is suggested that during thermal acclimation many enzymes which had previously been thought to show either no or inverse compensation, e.g. LDH, may indeed compensate in terms of the total tissue capacity for activity. (Supported by NSF Grant PCM 79-14186).

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FISH HEPATOCYTES IN PRIMARY CULTURE: A MODEL SYSTEM FOR TEMPERATURE ACCLIMATION STUDIES. M. Koban and C.L. Prosser. Univ. of Illinois, Urbana.

To ascertain whether temperature acclimation is a systemic or cellular response, hepatocytes from 15°C-acclimated catfish were isolated by collagenase perfusion and cultured without serum in minimum essential medium on plates coated with 'biomatrix' (Rojkind et al. J. Cell Biol. 87:255, 1980) prepared from catfish liver; 'biomatrix' includes most extracellular matrix components. Hepatocytes were incubated at 7°, 15°, and 25°C for 20 or more days; plates were harvested every 4 days. Short-term incorporation of ³H-leucine into protein at each incubation temperature was constant for up to 30 days, indicating continued cell viability. Maximal activity measurements at 15°C of cytochrome oxidase, citrate synthase, glucose-6-phosphate dehydrogenase, and lactate dehydrogenase after 20 days in culture had the pattern 7°>15°>25°, which is similar to the pattern of temperature compensation during *in vivo* acclimation. It is suggested that temperature acclimation may be a cellular response in catfish liver, and systemic input such as hormones may not be as important as previously thought. (Supported by NSF Grant PCM 79-14186)

35

CHANGES IN AEROBIC METABOLISM AND MUSCLE BIOCHEMISTRY OF OVERWINTERING FRESHWATER FISHES. K.M. Sullivan. Center for Limnology, University of Wisconsin, Madison.

Largemouth bass (Micropterus salmoides) and yellow perch (Perca flavescens) were collected in late summer and fall, and held throughout the winter under conditions of low temperature, oxygen and food. Throughout the winter, respiration and ammonia excretion rates were measured twice monthly on whole fish. Liver and muscle tissue were excised and aerobic respiration rates were determined with a Warburg apparatus. Muscle enzyme activities, protein and lipid content of the fish were also determined. Yellow perch, a predominantly cool-water fish, showed lower but extremely variable rates of oxygen consumption during the winter months, and lower aerobic metabolism in liver tissues, and a high tolerance to hypoxic conditions. Largemouth bass, a predominantly warm-water species, showed a relatively constant oxygen consumption rate throughout the winter, with a sharp drop as visceral lipid stores were depleted. Aerobic metabolism was high in liver tissues, and tolerance to hypoxic conditions was low in bass.

36

CONSEQUENCES OF ELEVATED BLOOD KETONE CONCENTRATION WHICH ACCOMPANIES HIBERNATION IN SPERMOPHILUS BELDINGI. B. L. KRILOWICZ. (intro. by J. A. Moore). Univ. of Ca., Riverside.

Total blood ketone concentration is elevated in hibernating Spermophilus beldingi relative to fed non-hibernators ($P < 0.001$). Muscle tissues removed from hibernating animals and incubated in media containing physiological concentrations of glucose and ketone, show reduced glucose uptake in the presence of ketone. There is an approximately linear relationship between glucose uptake by the tissues and ketone concentration in the incubation medium. In heart this relationship is described by the equation $y = 37 - 15x$ ($r^2 = 0.17$; $P < 0.05$) and in pectoralis by the equation $y = 31 - 24x$ ($r^2 = 0.17$; $P < 0.01$), where $y =$ glucose uptake in $\mu\text{moles g}^{-1} \text{hr}^{-1}$ and $x =$ ketone concentration in mM. There is no change in lactate efflux from the tissues in the presence of ketone ($P > 0.05$). Elevated blood ketone concentration during hibernation in S. beldingi leads to decreased glucose utilization by muscle tissues and ultimately to a sparing of body protein.

37

THE EFFECTS OF TEMPERATURE ACCLIMATION UPON FIBER TYPE RECRUITMENT IN FISH MYOTOMAL MUSCLE. P.T. Loughna, L.C. Rome and G. Goldspink (intro. by S.L. Sanderson). Univ. of Hull, U.K.

Electromyography in carp has shown that mechanical power output of oxidative muscle is reduced at low temperatures and thus glycolytic fibers must be employed at low swim speeds resulting in fatigue. We examined the effects of temperature acclimation upon the swimming speed at which white muscle was recruited using electromyography. Fish were acclimated for 2 months at 8°C, 15°C and 26°C and then swam at 10°C and 20°C. At 10°C, the swimming speed at which white muscle was initially recruited was significantly higher in fish acclimated to low temperatures. Recruitment at 10°C occurred at 30 cm/s, 26 cm/s and 21 cm/s in fish acclimated at 8°C, 15°C and 26°C respectively. At 20°C white muscle was recruited at 44 cm/s in all groups. Thus, temperature acclimation of muscle allows fish to maintain higher sustainable swimming speeds at low temperatures.

Supported by Nato and NERC grants to G. Goldspink. LCR was a Leverhulme Fellow.

38

REGULATION OF TISSUE ICE FORMATION IN A FREEZE TOLERANT INSECT. R. E. Lee, Jr. and E. A. Lewis. Miami University, Hamilton, Ohio.

The effects of temperature and duration of exposure on tissue ice formation in third instar larvae of the goldenrod gall fly, *Eurosta solidaginis*, are examined. Exposure at -23 C requires 48 hr for the attainment of maximal ice formation, 64% of total body water. Initially freezing is rapid with 20% of body water forming ice during the first hour, followed by a rate decrease to 0.94%/hr until equilibrium ice formation is reached. For both New York and Ohio populations ice content was inversely related to temperature. Ohio larvae contained 4-7% more ice than comparable specimens from New York at test temperatures between -15 to -30 C. Although the lower lethal temperature limit of -27.5 C for New York larvae was 5 C lower than that for Ohio specimens, in each population mortality occurred when 66-67% of total body water froze. These results support the critical minimum cell volume hypothesis of Meryman which states that freeze injury occurs when a critical proportion of body water is frozen.

39

SEASONAL VARIATIONS IN FREEZING TOLERANCE OF THE PULMONATE GASTROPOD, *MELAMPUS BIDENTATUS*. S.H. Loomis. Connecticut College, New London.

Seasonal variations in the freezing tolerance of *M. bidentatus* were examined. The temperature at which 50% of the snails died (LT₅₀) varied from -5°C in July to -13°C in December. There was no significant change in the mean freezing temperature or mean supercooling temperature of snails collected in the summer or winter. Water content in the snails varied from 2.6 mg/mg dry wt to 3.6 mg/mg. The higher water contents were probably due to exposure of the snails to periods of rain just prior to collection. About 67% of the snails total water was frozen at the LT₅₀. Whole animal glycerol concentrations varied from 1.14 to 2.96 μmoles/g fresh wt. Proline concentrations varied from 1.0 to 2.19 μmoles/g fresh wt. Sorbitol and trehalose were not detected. There appears to be a correlation between the glycerol+ proline concentration and the freezing tolerance of the snails. This work was supported by a grant from Research Corporation.

40

OFF-FLAVOR IN CHANNEL CATFISH (*ICTALURUS PUNCTATUS*): IMPLICATIONS ON BLUE-GREEN ALGAE. H. G. Leggett, E. J. Watkins, G. F. Pessoney, and R. T. van Aller. University of Southern Mississippi, Hattiesburg, Mississippi.

Off-flavor is a term given to any offensive taste or odor found occurring in channel catfish (*Ictalurus punctatus*). Off-flavor occurs in 50-80% of channel catfish, thus disrupting orderly harvesting and marketing. We believe the source of off-flavor to be secondary metabolites produced by blue-green algae (Cyanochloronta). Tentative evidence, from field and laboratory observations, implicate several genera of blue-green algae as the major source of off-flavor in pond raised Mississippi delta catfish.

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PROBLEMS IN INTENSIVE CULTURE OF CHANNEL CATFISH (ICTALURUS PUNCTATUS). E. J. Watkins, H. G. Leggett, G. F. Pessoney, and R. T. van Aller. University of Southern Mississippi, Hattiesburg, Mississippi.

Stocking rates in commercial channel catfish (Ictalurus punctatus) ponds have steadily increased in recent years in an effort to maximize yields. These high stocking rates often exceed the environmental carrying capacity of the fish ponds. As a result emergency mechanical aeration and chemical treatments must be frequently employed to prevent mortality resulting from the low dissolved oxygen and high toxic ion levels.

42

BIOLOGICAL AND LEGAL ASPECTS OF WETLAND CREATION: PANACEA OR PANDORA'S BOX? T. DiMatteo. Florida State Univ., School of Law, Tallahassee, Florida.

The concept of wetland creation as a mitigation device is explored. Present knowledge available indicates that a conservative approach, emphasizing preservation of ecosystems is necessary. At present, the only workable plan is to preserve and not attempt to create that which we do not fully understand. All disciplines of the scientific community must cooperate, with ecologists playing a dominant role. There must be interaction between scientists and lawyers/politicians as well, so constructive policy decisions can be made. Ecological problems, while generally presented in scientific terms, will only be solved by the regulation of human behavior. It is also suggested that while economic values are often placed on wetlands to justify their existence; a more non-economic/non-utilitarian approach is needed as a basis for habitat preservation in general.

43

MOLTING AS A SELECTION BOTTLENECK IN CRAYFISH EXPOSED TO ACID MINE POLLUTION. M.S. Galloway and W.D. Hummon, Ohio Univ., Athens

While conducting static bioassay experiments using acid mine waters from southeastern Ohio, data were obtained on number of successful and unsuccessful ecdyses. Cambarus bartoni cavatus molted frequently and with 82-90% success in solutions of 150 (upstream), 600 (downstream), and 1200 $\mu\text{mhos}/\text{cm}^2$ (25°C) of conductivity. They molted less frequently and with only 50% success in a solution of 2000 μmhos , and none successfully molted in solutions of 3300, 3400 or 5000 (pollution source) μmhos . Cumulative frequency distributions of success vs failure over the range of conductivity differed significantly (Kolmogorov-Smirnov test, $p < 0.01$). That molting acts as a selection bottleneck in elevated conductivity has now been corroborated by field observations under comparable circumstances. Crayfish in mid-molt were found dead in seepage pools of upstream sites having conductivities of 800 and 1700 μmhos during the drought of summer 1983. Other crayfish from the same pools completed ecdysis, but with reduced fitness related to morphological aberrancies (loss of appendages, extrusion of gills).

44

METABOLIC RESPONSES OF THE CRAYFISH PROCAMBARUS CLARKII TO REDUCED pH AND ELEVATED ALUMINUM CONCENTRATION. A.J. Becker, Jr. and E.C. Keller, Jr. West Virginia University, Morgantown.

The oxygen consumption rates were measured for newly-hatched Procambarus clarkii. The crayfish were placed in 2.5 ml syringes, filled with filtered aquarium water, in a temperature bath at 10°C. At 30 minute intervals, 0.1 ml samples were injected into a Radiometer type E-5046 oxygen electrode with a PHM 71 acid-base analyzer. From the change in partial pressure of oxygen (PO_2), oxygen consumption rates (VO_2) were calculated. VO_2 s were measured for organisms exposed to decreased pH's (7 to 3), increased Al concentrations (0.01 to 100 mg l^{-1}), and the same range of pH's at 100 mg l^{-1} Al. There was a significant increase in VO_2 at pH's below 6, from 182 ± 9 to $253 \pm 14 \text{ ul h}^{-1} \text{ g}^{-1}$ at pH of 3. No significant changes occurred associated with Al exposure; however, although the same trend, to increased VO_2 at decreased pH, was seen with the Al addition, the increases were significantly lower than in the pH experiments.

45

ADAPTATIONS OF ECHINODERMS TO SALINITY. W. B. Stickle. Louisiana State Univ., Baton Rouge.

I compared the 28-d salinity tolerance (LC50) and activity coefficients (AC = 1000/righting time in sec.) of *Eupentacta quinquesemita* (tolerance only), *Leptasterias hexactis*, and *Strongylocentrotus droebachiensis* from Friday Harbor, WA, high salinity environment, with responses of populations from near Juneau, AK, a low salinity environment. The LC50 of *E. quinquesemita* and *L. hexactis* from Friday Harbor was higher (26.3‰ and 15.7‰ S, respectively) than that of sea cucumbers and starfish from Juneau (12-13 and 12.9‰ S, respectively). The LC50 of *S. droebachiensis* from Friday Harbor was similar to that of sea urchins from Juneau (13.0 and 12-13‰ S, respectively). AC of *L. hexactis* from both populations varied directly with salinity but at 15‰ S starfish from Juneau had a higher AC (3.5) than starfish from Friday Harbor (0.86). Urchins from Juneau had a higher AC than those from Friday Harbor partially because they are smaller. Physiological races of sea cucumbers and starfish from near Juneau are adapted to lower salinity than those from Friday Harbor, but no difference exists in the tolerance of sea urchins from the two areas. Funded by LSU Council on Research.

46

EVOLUTIONARY INTERACTION OF THERMAL PHYSIOLOGY AND FIELD BODY TEMPERATURES OF ANOLIS LIZARDS. F. H. van Berkum. Univ. of Washington, Seattle.

Central American *Anolis* lizards that experience different field body temperatures differ in their thermal sensitivity of sprint speed. Lizards from cool areas sprint faster at lower temperatures than do lizards from warm areas. Nevertheless, these lizards are not active in the field at body temperatures that maximize their sprint speeds. I examine whether this sub-maximal performance might be attributed to some evolutionary constraint that prevents thermal physiology from fully adjusting to the species' field body temperatures. I assume that the range of possible thermal physiologies that has been available to these anoles over evolutionary time is the range of thermal physiologies exhibited by this closely related group today. Using this assumption, I show that some of these *Anolis* species could sprint faster in the field if they had evolved the thermal physiology of another *Anolis* species. Therefore, submaximal performance probably does not reflect evolutionary constraints, but might reflect ecological factors.

47

ACCUMULATION OF PERLS' POSITIVE IRON (PPI) IN HYALIN CARTILAGE OF F344 RATS. A. S. Rivenson, B. Mu*, J. Silverman*, R.E. Madden*. American Health Foundation and New York Medical College, Valhalla, NY.

Iron accumulates in large quantities in the cartilage of diseased joints (i.e. rheumatoid arthritis). This phenomenon is probably the pathologic homologous of a physiologic process of iron deposition in some hyalin cartilages. Tracheal cartilages of 50 F344 rats (25 male +25 female), one year or older, have been studied for PPI content. All contained variable quantities of PPI. Iron appears to overlap or coat deposits of calcium stored earlier in the same cartilage. The relationship between Ca⁺⁺ and Fe⁺⁺⁺ seems strictly determined: Ca appears in younger rats. Fe is added later. Both are stored in the cartilage matrix and increase in quantity with the advancement in age. PPI coating Ca deposits is also found in other organs in normal or pathologic conditions (teeth, large blood vessels, prostatic corpora amylacea, etc.). The degree of the cartilage hemosiderosis may be used to estimate the biologic age of F344 rats.

48

VERTEBRAL BENDING IN LOCOMOTING MAMMALS. P. A. Pridmore. (intro. by C. Gans). Univ. of Michigan, Ann Arbor.

Movements of the vertebral column are commonly characterized as sagittal in mammals and lateral in most reptiles and amphibians. Observations on various mammals raised doubts as to the accuracy of this view. Cinematographic records of the marsupials *Caluromys* and *Monodelphis* reveal respectively slight and substantial lateral bending at slow to moderate locomotor speeds. Sagittal bending is negligible at slow to moderate locomotor speeds but becomes substantial during high speed locomotion. Negligible lateral bending is observed during high speed locomotion. These observations confirm that lateral bending is a significant locomotor feature of some small to medium sized mammals. Overall the type and extent of vertebral bending that is observed in quadrupedal vertebrates appears to reflect the sequence of limb movement ("gait"), limb posture and size of the animals concerned. (Supported in part by Dr. Scholl Fellowship and DHEW-PHS-G-1R01DE05112-03.)

49

SCRATCH-DIGGING ADAPTATIONS IN KANGAROO RATS. Kevin M. Heinz (intro. by J.A. Moore). Univ. of California, Riverside. Forelimb skeletal characters were analyzed as adaptations to scratch-digging in seven species of *Dipodomys*. Structural modifications which should increase the out-force against the substrate are: a reduction of the out-lever, an increase in the in-lever, or an increase in the in-force. Although the species examined illustrate differences in their strategies for scratch-digging, the major modifications within *Dipodomys*' forelimbs are: (1) A lengthening of the olecranon with respect to the ulna, thereby increasing the in-lever to out-lever ratio, (2) an increase in humerus width/length ratio, providing a larger surface area for the origin of the manus flexors, (3) an increase in the length of the teres major from which the major humeral flexor, *M. teres major*, originates, and (4) an increase in the scapula area and spine dimensions, permitting greater surface area for the attachment of the muscles which stabilize the shoulder. Significant differences were found between species for the skeletal characters related to these modifications. These skeletal differences are correlated with the type of substrate the species inhabits.

50

ARCHITECTURE OF MAMMALIAN FOREARM AND LEG MUSCLES. D. McClearn. Harvard Univ., Cambridge, Ma. Muscle fiber length, angle of pinnation, and belly length can be predicted from two measures of connective tissue: length of aponeuroses of origin and insertion and distance between the most proximal points on the aponeuroses. Architecture can be modelled by varying these measures as well as the perpendicular distance between aponeuroses, width of aponeuroses, and pattern of splitting of insertion tendons. Unipinnate and some bipinnate muscles are topologically equivalent. Multipinnation reflects the need for a large surface area for muscle fiber attachment in heavy, short-fibered muscles. The patterns of architecture in multi-tendon muscles are a function of insertion tendon splitting. The model developed is consistent with empirical data (e.g., belly length and fiber length vary independently) and with data on the role of connective tissue in muscle development. Supported by NSF DEB 79-09797 & NIH 5T32 GM07117-05.

51

EFFECTS OF OVERLOAD ON PLANTARIS MUSCLE GRAFTS IN RATS. S.A. Mufti and T.B. McNemar*, Ohio University, Athens.

The main purpose of the present work was to investigate whether overloading of a muscle graft could induce hypertrophy and/or hyperplasia of the regenerating muscle fibers. Plantaris muscles were orthotopically grafted in rats. Two weeks later, right Plantaris was overloaded by removal of Gastrocnemius. Both control (CP) and experimental (OP) grafts were removed at weekly intervals. It was discovered that after 4 weeks of overload, the number of muscle fibers within OP more than doubled as compared to CP (6,574 vs. 2,830). Furthermore, average cross sectional area of fibers within OP was significantly smaller than in CP (273 μm^2 vs. 432 μm^2). These results indicate that overload applied at 2 weeks post-grafting in Plantaris muscle, results in extensive hyperplasia. Although the mechanisms involved in such hyperplasia are not clear, it is obvious that an increased number of regenerating muscle fibers within overloaded graft, if maintained and allowed to grow, could be of significant value in getting functionally better grafts.

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SCALING OF SPRINT LOCOMOTORY PERFORMANCE DURING GROWTH IN THE LIZARD DIPSOSAURUS DORSALIS. R.L. Marsh. Northeastern University, Boston, MA.

Burst speed and limb cycling frequency were measured at 40°C using cinematographic techniques. *Dipsosaurus* weighing from 7 to 70 g were in the laboratory on a 4 meter track. Limb cycling frequency is essentially mass independent during growth in these animals. Stride length in the smaller animals is longer than that predicted by geometric similarity. Due to the relatively longer stride of the smaller animals and the constant limb cycling frequency, burst velocity scales approximately as mass to the 0.15 power. The development of locomotory performance is related to morphological factors as well as the development of muscle contractile properties.

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THE SCALING OF LOCOMOTOR STRESS IN THE HINDLIMB OF THE GROWING CHICKEN. B. L. Manion. Univ. of Illinois at Chicago, Health Sciences Center, Chicago.

Chickens between the ages of 15 and 145 days were found to run with similar duty factors at physically equivalent velocities. This implies that their hindlimbs were experiencing proportionally similar forces. However, the actual stress and bending moments occurring in homologous parts of the limbs of running animals are also functions of the orientation of the limbs with respect to the ground force vector. Comparison of limb kinematics in these same birds has shown that limb orientation can vary considerably both within and between individuals even when other parameters of comparison are equal. Thus estimation of the relative increase in stress and bending moments experienced by different sized chickens during locomotion using only body mass and bone dimensions is likely to be very misleading. This consideration would apply even more so to interspecific studies with their potential for larger differences in limb posture during locomotion.

54

ELECTROMYOGRAPHY AND EPIPUBIC BONE FUNCTION IN THE BRUSH-TAIL POSSUM, TRICHOSURUS VULPECULA. THOMAS D. WHITE. UNIV. OF CALIFORNIA, LOS ANGELES.

EMGs and high speed cinematography were used to investigate activity in selected pelvic and abdominal muscles during postural maintenance and locomotion on a treadmill. Muscle activity was found not to differ significantly between females bearing pouch young and individuals without young. The *Mm. external oblique* and *pyramidalis* whose muscle fiber orientation make them most suited for adducting the epipubic bones exhibited activity consistent with the hypothesis that the epipubic bones are functional in locomotion rather than in support of the marsupium. (This work was supported by a grant under the Fulbright-Hays Act.)

63

pH-SENSITIVE CONTROL POINTS OF CARBOHYDRATE CATABOLISM IN ENCYSTED EMBRYOS OF ARTEMIA. J. F. Carpenter* and S. C. Hand. Univ. of Southwestern Louisiana, Lafayette

Intracellular alkalinization from pH_i 6.4-7.8 is a fundamental regulator of the reversible transition between anaerobic dormancy and aerobic development in hydrated cysts [Busa and Crowe (1983) *Science* 221: 366]. A reduction in trehalose levels (465 to 355 ± 16 µg/mg protein) and an increase in glycogen levels (29.9 to 76.9 ± 4.4 µg/mg protein) during aerobic incubation have been reconfirmed and are in contrast to the constancy of these metabolites during anoxia. There is a 3-fold reduction in CO₂ fixation during anaerobic incubation. A potential pH-sensitive site for glycolytic control is phosphofructokinase (PFK), which we have isolated from cysts to a purity of over 95%. *In vitro* studies demonstrate an acute, reversible loss of PFK activity as pH is reduced across the range cited above; there is no measurable activity at pH 6.6 and below. Physical studies are underway to elucidate any structural correlates of the inactivation. Finally, the ubiquitous enzyme trehalase is measurable at high levels in cysts, and we propose pH-dependent effects on the proportion and/or kinetics of the soluble and particulate molecular forms.

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EXPERIMENTAL MANIPULATION OF THE INTRACELLULAR pH IN MOLLUSCAN TISSUES. W. Ross Ellington. Florida State University, Tallahassee.

Phosphorus nuclear magnetic resonance spectroscopy was used to non-invasively monitor the intracellular pH (pH_i) in the tissues of a number of molluscs. The pH_i of tissues superfused with normoxic sea water ranged from 6.9 to 7.3. Anoxia resulted in a gradual acidification in all tissues investigated (hearts, catch muscles, mantle). Perfusion of gastropod hearts with hypercapnic sea water resulted in a rapid decrease in pH_i. Prolonged perfusion with hypercapnic sea water resulted in a gradual increase in pH_i indicating that a compensatory process was operating. The hypercapnic decrease in pH_i was fully reversed by switching the gassing atmosphere back to compressed air. The pH_i of bivalve mantle tissue was lowered by superfusion with sea water containing 100 mM L-lactate, which is metabolically inert in molluscs. The lactate effect was freely reversible. The pH_i of molluscan tissues can be easily and reversibly altered providing a useful system for testing hypotheses about the role of pH_i in the regulation of energy metabolism. (Supported by the Regulatory Biology Program of the National Science Foundation)

65

MODE OF ENERGY PRODUCTION DURING ENVIRONMENTAL AND FUNCTIONAL ANOXIA IN THE NEMERTEAN *CEREBRATULUS LACTEUS*. G. Gäde. Universität Bonn.

Swimming in well-aerated sea water is essential achieved by aerobic means. There was no significant change (compared to controls) in the levels of the adenylates, arginine, octopine, lactate, aspartate or succinate. However, exercise in anaerobic sea water lead to a drop in the phosphagen level and to some octopine production. Octopine dehydrogenase is the dominant dehydrogenase at the pyruvate branchpoint with 50 U/g w.wt., whereas the activities of lactate and alanine dehydrogenase were found to 0.5 and 3 U/g w.wt., respectively. During incubation of nemerteans in oxygen-free sea water for up to 66 h the phosphagen was almost completely diminished, arginine, but not octopine, formed. In addition, the levels of alanine, succinate and propionate were increased.

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66

THE QUATERNARY STRUCTURE OF THE TWO-HEXAMER HEMOCYANIN OF *CANCER MAGISTER*. Robert A. Graham. Inst. of Marine Biology, Univ. of Oregon, Charleston.

C. magister 25S two-hexamer hemocyanin contains six different subunits which differ in both charge and molecular weight, Larson et al., BBA (1981). The presence of heterogeneity of charge and/or molecular weight at the level of the native 25S two-hexamer was tested. By gel filtration, isoelectric focusing and electrophoresis, there appears to be only one kind of native 25S two-hexamer hemocyanin in the blood of *C. magister*. This is in contrast to some other crustacean hemocyanins which appear to be heterogeneous at the two-hexamer level. Preliminary evidence suggests that the six subunits of *C. magister* hemocyanin are in a ratio of 2:1:2:4:2:1. The fact that *C. magister* hemocyanin appears homogeneous has important implications for understanding the structural and functional role of subunit heterogeneity in the arthropod hemocyanins. Supported by NSF Grant PCM 82-07548 to Robert C. Terwilliger.

67

PERICARDIAL CAVITY PRESSURES IN SWIMMING FISHES. M.A. Freadman. Woods Hole Oceanographic Institution, Massachusetts.

A hydrodynamic pressure gradient is detectable along the body surface of swimming fishes. Research by DuBois et al. (1974, J.E.B. 60: 581-591) on swimming bluefish, has demonstrated positive pressures at the snout tip, negative pressures over the shoulder region and more positive pressures near the tail. These negative pressures, if transmitted to the heart region, could enhance venous return. Pericardial cavity pressures were measured via a needle-tipped catheter and Statham Pressure Transducer in bluefish (*Pomatomus saltatrix*) and tautogs (*Tautoga onitis*) swimming in a Brett-type water treadmill. Negative pericardial cavity pressures were detected in both species over swimming velocities of 12-50 cm s⁻¹ (-2 to -4 mm Hg in bluefish, -0.5 to -2 mm Hg in tautogs). The results suggest negative body surface pressures associated with swimming, are transmitted to the pericardial cavity. Such "exterior-interior" pressure relationships may represent an important circulatory adjustment during swimming activity.

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ECOLOGICAL PHYSIOLOGY OF DIVING BRADYCARDIA ASSOCIATED WITH FORCED HYPOXIA AND APNEA IN THREE TURTLE SPECIES. J.A. Meacham (intro. by M.G. Connell). College of New Rochelle, New Rochelle, N.Y.

One purpose of this investigation was to study bradycardia; as a result of apnea during a forced dive; in the snapping turtle, *Chelydra serpentina*, which is aquatic; the red-eared turtle, *Chrysemys scripta*, which is semi-aquatic; and the box turtle, *Terrapene carolina*, which is terrestrial. A second purpose was to determine the comparative effects of emerging the 3 species into a nitrogen atmosphere, resulting in forced hypoxia without apnea; and, a third purpose was to relate the specific gravity of the various species to their respective habitats. The average time required to reach a 75% reduction in heart rate upon forced submergence was less for the aquatic than for the semi-aquatic or terrestrial turtles (29 ± 3.2 min., 60 ± 9.4 min., and 90 ± 7.1 min. respectively). Nitrogen emersion resulted in increased heart rates for the aquatic and semi-aquatic but not for the terrestrial turtles. The average specific gravity of *T. carolina*, *C. scripta* and *C. serpentina* was 0.873, 1.065, and 1.033 respectively. Efficiency of conservation appears to be habitat dependent between species.

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Effects of lactic acid on blood acid-base balance and oxygen transport in rainbow trout. R. Packer and J. Brown* The George Washington University, Washington, D.C.

Trout (269-450g) were fitted with cannulae in the dorsal aorta and buccal chamber and placed in a respirometer at 16°C. After a 24 to 48 hr recovery period, doses of lactic acid (LA), ranging from 2.0 to 12.7 mg/100g body wt, were infused over a 10 min period via the dorsal aortic cannula. Ten min after LA infusion blood pH was depressed and LA was elevated. After 60 min blood pH had returned to control levels while LA was still slightly elevated. Ventilation rate and buccal ventilation pressure increased transiently but there were no consistent changes in O₂ consumption. The most striking effect of LA-induced acidosis was an anomalous increase in blood O₂ carrying capacity when blood pH declined from 7.90 (control) to 7.75, 10 min after LA injection. Preliminary investigation of this "reverse Root effect" in vitro also revealed a slight increase in O₂ carrying capacity of blood acidified from 8.1 to 7.85.

70

CONTROL OF AIR BREATHING AND GILL VENTILATION IN LONGNOSE GAR. N.J. Smatresk. Univ. of Texas at Arlington.

Longnose gar (Lepisosteus osseus) depend on pulmonary O₂ uptake as water PO₂ falls, while reducing gill ventilation. Air breathing frequency rose exponentially as PO₂ fell. Gill ventilation frequency changed little, but opercular pressure was greatest between 75-120 torr PO₂, and fell to < 50% of its maximal value in severe hypoxia. Blood PO₂ levels in the dorsal aorta fell and in the ventral aorta rose slightly during hypoxia. NaCN given arterially stimulated gill ventilation and had only a transient effect on air breathing. NaCN in the water flow stimulated air breathing but following a transient depression, gill ventilation returned to control levels despite continued high rates of air breathing. Anesthetized spontaneously breathing gar were used to measure the ventilatory responses to changes in lung volume and gas composition, and simultaneous changes in the PO₂ of the V.A. measured with an implantable electrode. These data suggest that air breathing is controlled by external chemoreceptors, while gill ventilation is controlled by internal chemoreceptors and may be secondarily controlled by lung stretch receptors.

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THERMAL RELATIONS OF THE MEXICAN BEAN BEETLE, EPILACHNA VARIVESTIS. D. L. Claussen. Miami Univ., Oxford, OH.

The Mexican bean beetle (MBB) is an important agricultural pest, which has, within the last century, expanded its range to include much of the eastern United States and parts of Canada. Adult MBBs are long-lived, and, in many locales, they are exposed to a very wide range of microclimatic conditions. This study assesses the thermal tolerance of the MBB in relation to field temperatures. Microclimate measurements, including operative environmental temperatures, were recorded over 12 hr periods during the summer and fall. Lethal temperature (TL50) and critical thermal maxima (CTM) methods were among those used to evaluate heat tolerances of both field acclimatized and laboratory acclimated MBBs. Adult MBBs have a high heat resistance, with one hr TL50s and CTMs of approximately 40 and 45 C respectively. At the other extreme, they cannot withstand freezing, but adult MBBs can supercool to below -15 C. This insect can thus survive at least brief exposure to temperatures spanning a range of about 60 C. Nevertheless, they are strongly affected by temperature, and ambient temperatures approaching their tolerance limits are not uncommon at many locations within their geographic range.

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THE INFLUENCE OF TEMPERATURE ON THE JUMPING BEHAVIOR OF THE MEXICAN JUMPING BEAN, C. Heckrotte, East Carolina University, Greenville.

The jumping behavior of the Mexican jumping bean (Laspeyresia solitans) is stereotyped and predictable. Temperatures above and below 25°C decrease the length of time that jumping occurs. The jumping stops relatively abruptly. The duration of movements is apparently controlled by an internal timer whose duration of operation is influenced by temperature. The frequency of movements show instantaneous temperature compensation from about 21°C to 45°C, whereas between 15°C and 21°C there is a large temperature dependence.

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EXPLORATION OF NEURAL PATHWAYS CONTROLLING LOCOMOTION IN THE SNAIL MELAMPUS BIDENTATUS. S. B. Moffett and K. A. Snyder.*
Washington State University, Pullman.

Pathways involved in locomotion were studied by severing central connections in anaesthetized snails. Locomotion was subsequently observed and recorded on vidiotape. The pedal wave is normally a bilaterally symmetrical direct wave with a propodial stepping component. Coordinating information travels between right and left sides of the nervous system through the cerebral and pedal commissures. Either pathway can effect coordination but if both are cut, pedal waves on right and left sides are asynchronous. Signals travel between cerebral and pedal ganglia via paired cerebro-pleural and cerebro-pedal connectives. Either pathway is sufficient for generation of locomotion. Isolation or excision of one pedal ganglion eliminates locomotory waves on the affected side. We conclude that generation of normal locomotion requires information transfer between cerebral and pedal levels and right and left sides of the nervous system but that the pathways subserving this behavior are redundant. Some snails in all experimental groups exhibit complete recovery of locomotory behavior in weeks to months.

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MORPHOMETRIC ANALYSIS OF THE AVIAN RESPIRATORY SYSTEM. H. R. Duncker and M. Guentert, Dept. of Anat. Univ. Giessen, Fed. R. Germany.

16 avian species, from hummingbird to mute swan, were investigated. Body and organs were weighed and the volumes of lung and air sacs determined from silicon casts. The volume of the pulmonary compartments was estimated stereologically step-wise in lung slices, microscopic sections and electron micrographs. The total volumes of vessels, conducting airways and gas exchange tissues were calculated, as were estimates of the gas exchange surface and tissue barrier thickness based on stereological analysis of electron micrographs.

These data allow the calculation of an Anatomical Diffusion Factor (ADF), characterizing the functional capacity of the investigated species for comparison with reptiles and mammals.

Birds show a five to eight fold greater ADF than do mammals.

All measured and calculated parameters of the respiratory system show a striking difference between galliforms and other birds.

The regression lines of all lung parameters of the non-galliform birds parallel those of reptiles and mammals, but their y-intercept is greater. In contrast, the slope of regression lines for galliform differs significantly.

75

NONADAPTIVE EVOLUTION OF AVIAN DRINKING METHODS. D.G. Homberger. Louisiana State Univ., Baton Rouge.

The existence of different drinking methods in birds has often been explained as having evolved in adaptation to specific selective pressure, e.g., suction drinking as an adaptation to arid environments to allow the uptake of dew or to reduce exposure to predators during drinking. In parrots, however, four different drinking methods evolved as byproducts of evolutionary changes due to feeding specializations involving the tongue, bill, and palate; e.g., the drinking method of the Psittacinae is a consequence of the evolution of their tongue as a tool cooperating with the bill in the husking of seeds, the drinking method of the Cacatuiinae is a consequence of the specialization of their bill and palate in adaptation to a diet of seeds and nuts, the drinking method of the Lorinae is a consequence of the specialization of their tongue in adaptation to palynovory; etc. Since also most non-psittacine drinking methods are based on interactions between the tongue and palate, a nonadaptive model may in general provide a better explanation for the polymorphism of avian drinking methods than conventional adaptive models.

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LIPID ABSORPTION IN THE ANTERIOR INTESTINE AND TRANSITION ZONE REGIONS OF THE INTESTINE OF THE ADULT LAMPREY, PETROMYZON MARINUS (L). R. M. Langille and J. H. Youson*. Univ. of Toronto, Ont.

TEM has revealed that lampreys fed highly unsaturated lipids display largely VLDL, rather than chylomicra production as is the case for teleosts. However, unlike other vertebrates and because lymphatics are absent, the VLDL of lampreys are transported directly to the vascular system. Within 5 min lipid is present in absorptive cells in the form of small, cytoplasmic lipid droplets and VLDL within SER and smooth tubules. By 45 min and lasting over the 5 hr time period examined, the cells are saturated with lipid droplets and lipoprotein particles (mostly VLDL) which filled RER, SER, smooth tubules and Golgi apparatus. VLDL are also observed extending deep into the connective tissue and within the lumina of the sinusoid-like capillaries. Gaps and overlapping cell borders probably permit the VLDL to pass into these blood vessels. Supported by NSERC of Canada.

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ACOUSTIC PROPERTIES OF COILED TRACHEA IN GRUIDAE. A. S. Gaunt, S. L. L. Gaunt and H. D. Prange*. Ohio State Univ., Columbus, and Indiana Univ., Bloomington.

The trachea in some species of cranes is elaborately coiled and imbedded in the sternum. Such bizarre structures are widely supposed to promote loud calls. Direct evidence regarding this supposition is scarce and equivocal.

We have investigated physiologic and acoustic properties of the trachea in nine species of cranes. Recordings of a bird's calls were made before and after surgical modification of its trachea or subjecting it to an He-O₂ atmosphere. Airsac pressure, airflow, and loudness of calls were also measured. Results suggest that: 1) all cranes, regardless of size or tracheal length, utter equally loud calls; 2) if the trachea is coiled, loudness is markedly reduced by bypassing the coil; 3) either He-O₂ or tracheal shortening raises the pitch of calls; 4) those species in which the trachea is coiled use less pressure and airflow when calling loudly. We tentatively conclude that the coiled trachea-cum-sternum forms a resonating, amplification system. Supported by NSF PCM-8302203 and National Geographic Society 2636-83.

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MOTONEURON PROPERTIES FOLLOWING MOTOR REINNERVATION IN CAT MEDIAL GASTROCNEMIUS. R.C. Foehring, * G.W. Sypert and J.B. Munson. Dept. of Neuroscience, Univ. of Fla. Coll. of Med., Gainesville, FL, 32610.

Electrical properties of motoneurons (MNs) innervating the cat medial gastrocnemius are closely related with the type of muscle unit innervated (Fleshman et al., *J. Neurophys.* 46). We used intracellular recording techniques to determine if the normal correspondence between MN and muscle unit properties is re-established 8-10 months following self-reinnervation. MN properties were generally appropriate for each unit type. To determine whether there were individual mismatches between MNs and muscle units, MNs were categorized on the basis of passive membrane properties.

Conclusions: Following 8-10 months reinnervation, MNs exhibit normal electrical properties and usually innervate appropriate muscle units. We are uncertain of the extent to which this is due to the MN converting muscle fibers, the converse, or competition among MNs for individual muscle fiber connections. Supported by NIH grant NS 15913, the MRS and RERDS of the VA, and the W.L. Gore Co.

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CENTRAL PROJECTIONS OF INNER EAR ENDORGANS IN THE BOWFIN, AMIA CALVA. C.A. McCormick. Georgetown University, Washington, D.C.

Projections of each of the inner ear endorgans were determined in Amia calva by HRP tracing techniques. Individual branches of the eighth nerve were impaled with an HRP-coated 000 insect pin. After survival at 27°C for 3-10 days, brains were processed after Mesulam ('78). The terminations of these nerves are largely confined to the four nuclei making up the octavus column, with very few fibers providing input to the overlying lateral line column. Each of the four octavus nuclei receives input from all of the inner ear endorgans. While these inputs terminate diffusely in the magnocellular and posterior nuclei, some segregation is present in the anterior and descending nuclei: Saccular and lagenar fibers terminate dorsally in these nuclei, whereas fibers from the semicircular canals and macula neglecta terminate ventrally. Utricular fibers terminate throughout these two nuclei. Thus, there are no first order octavus nuclei in Amia solely devoted to auditory processing.

Supported by NSF 18843.

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Effects of mating on sexual behavior of male and female red-sided garter snakes, Thamnophis sirtalis parietalis. J.M. Whittier, R.T. Mason, and D. Crews. Univ. of Texas at Austin.

Conclusions from previous studies on the effect of mating and the copulatory plug on sexual behavior of male and female garter snakes were tested in the field. Recently mated females were much less attractive to males than unmated females, confirming earlier research. However, some males did not discriminate between mated and unmated females and repeatedly courted mated females, even though these females would not mate a second time. Removal of the copulatory plug from the cloacae of mated females did not make them more attractive to males. In contrast to previous studies, courtship behavior of males was not inhibited after exposure to a female that had mated. Courtship of males that had recently mated was indistinguishable from that of unmated males. These results indicate that mating has a differential effect on male and female sexual behavior and that males in the field are capable of resuming courtship with another female immediately after mating or exposure to a mating pair. Supported by NICHD#16687.

108

THE USE OF AGGRESSIVE CALLS BY A NEOTROPICAL TREEFROG. Kentwood D. Wells. Univ. of Connecticut, Storrs.

The treefrog Hyla ebraccata has aggressive calls with buzz-like primary notes and secondary click notes. Calls with short primary notes are used in long range interactions between males; those with long notes are used at close range. Males shift gradually from short-note to long-note calls as they approach each other, producing a graded signal system, the first to be documented in anurans. Playbacks of synthetic calls indicated that high pulse rate alone is sufficient to elicit aggressive responses from males, but calls with both high pulse rates and slow rise times elicit the most aggressive responses. Two other species in the same area have very similar aggressive calls which are used in interspecific encounters. [Playbacks of aggressive calls of these species to H. ebraccata males elicit more aggressive responses than playbacks of the advertisement calls of these species.]

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TEMPORAL PATTERNS IN CALLING OF THE NEOTROPICAL TREEFROG, HYLA MICROCEPHALA. J. J. Schwartz. Univ. of Connecticut, Storrs.

The vocal behavior of H. microcephala was studied for three summers in Panama. Males call in dense choruses and employ both advertisement and aggressive calls. These consist of a primary note often followed by a number of secondary click notes. Advertisement calls show little variation in temporal parameters while aggressive calls are quite variable. Playback of conspecific calls and recordings of natural pairwise interactions between males revealed an array of phonoresponses. Males synchronize and often add notes to advertisement call responses. When interrupted, calls are often abruptly terminated or followed by an above average number of clicks. Notes in temporally overlapping multi-note calls are spaced more widely apart than notes in non-overlapping calls, reducing the probability of note overlap. Much of the vocal behavior of H. microcephala is similar to that reported in chorusing insects, and possibly evolved to reduce acoustic interference.

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FEMALE MIMICRY AS AN ALTERNATIVE REPRODUCTIVE TACTIC IN GARTER SNAKES. R.T. Mason and D. Crews. Univ. of Texas, Austin.

Male garter snakes discern females by a pheromone released from the female's dorsal skin. Laboratory and field studies indicate males do not court other males even if production of the attractiveness pheromone is artificially induced by estrogen administration. However, a recent field study in Manitoba, Canada, revealed that a small proportion (at least 33 of an estimated 1400) of male red-sided garter snakes Thamnophis sirtalis parietalis, elicited courtship from other males. Mating aggregations consisting of at least 5, and up to 17 males were observed formed around individual attractive males. The attractiveness of these males persisted for at least three weeks. Behavior tests demonstrated that although males do court these attractive males, they prefer females in simultaneous and sequential choice tests. The attractive males themselves courted and mated with the same frequency as did normal males. The physiological correlates of this behavior are being examined. Hypotheses to explain this alternative reproductive tactic will be presented. (Supported by NICHD 16687).

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A POTENTIAL PREMATING ISOLATING MECHANISM IN SYMPATRIC PLETHODON SALAMANDERS. Ellen M. Dawley. Univ. of Connecticut, Storrs.

Pairs of sympatrically occurring species within the Plethodon glutinosus - P. jordani complex were examined for behavioral species isolating mechanisms. Olfactometer experiments indicate that males of some of these pairs can determine species through air borne odors. Female responses vary with their reproductive condition. Both males and females can identify sex through air borne odors. These results are compared to olfactometer choice tests using allopatric species combinations in which premating isolating mechanisms are not necessarily expected to have evolved. At least one species can discriminate against an allopatric species based on odors. Skin secretions of the head and trunk regions probably provide sex and species information. The extreme similarity of courtship sequences among these Plethodon species suggest that olfactory cues are an important species choice mechanism.

(Supported by the Univ. of Connecticut Research Foundation and the Gaige Fund of the ASIH)

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FIELD STUDIES OF HUNTING BEHAVIOR BY BUSHMASTERS. H. W. Greene and M. A. Santana. Univ. California, Berkeley, and Univ. Costa Rica, San Jose.

Lachesis muta (Viperidae) is rare, poorly known, and endemic to tropical rain forest. We observed 7 in Costa Rica; 3 were radiotagged and followed for 10-45+ days. A 90cm female used 3 sites for 3, 6, and 25 days and moved a total of 50m. Ca. 40% of the time over 35 days was spent alert; ca. 1% of alert time was spent moving. Days were spent under small plants, nights in an alert posture exposed on the forest floor. The 24th night she ate a rodent weighing at least 40% of her mass, remained inactive for 9 days, then moved to a new site. Observations of other *L. muta* (lengths 1.6-2.2m) were consistent with these and indicate that they are very sedentary. Hunting sites were associated with *Welfia* palms, the seeds of which are dispersed by rodents that bushmasters eat. These snakes are extraordinarily cryptic, and move very slowly and infrequently. The hunting strategy of *L. muta* seems to be, find a "good" place to ambush prey, feed infrequently on large items, and minimize detection by enemies.

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PATCH SAMPLING BEHAVIOR OF STARLINGS FORAGING IN SIMPLE PATCHY ENVIRONMENTS. S. L. Lima. University of Rochester, NY.

Individual starlings were allowed to forage in patchy laboratory "environments" where all the patches were identical in appearance, yet some contained a fixed number of prey (randomly distributed within a patch) and others were empty. The state of a patch (empty or not) could be determined only from information gained while foraging, and the task for a starling was to determine the extent to which apparently empty patches should be sampled such that its rate of energy intake was maximized. Optimal behavior required that an apparently empty patch be sampled to a fixed extent before being given up as such, and each environment used differed in the optimal extent of sampling. In general, the sampling behavior of the starlings was in close agreement with the predicted sampling optima. The birds did, however, exhibit a distribution of sampling rather than a fixed value and they did not have a precise "idea" of the fixed number of prey available in some patches. Nevertheless, the starlings demonstrated an ability to arrive at a sampling strategy very similar to that predicted.

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EFFECTS OF HABITAT AND INTRASEXUAL COMPETITION ON THE POPULATION STRUCTURE OF A POLYGYNOUS BLACKBIRD. S. K. Robinson. Princeton Univ., N. J.

In southeastern Peru, female Yellow-rumped Caciques (*Cacicus cela*) fight to gain access to island colonies, which are the only sites that are safe from mammalian predators. Lakes with island colonies have large, stable populations, which may be at carrying capacity. Lakes without islands have small, fluctuating populations consisting of many young and undersized females that were aggressively excluded from island colonies. Male population size is directly proportional to the number of nests built by females. The age structure and weights of males do not differ between populations. Aggressive interactions among males determine which individuals in a population gain direct access to females and which are forced to adopt subordinate behavioral tactics. Thus, intrasexual competition determines the distribution of both sexes within and between habitats of different quality. These data fit models of habitat selection based on dominance interactions among individuals in a population.

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BEHAVIORAL DOMINANCE IN WHITE-CROWNED SPARROWS, *Zonotrichia leucophrys leucophrys*. Anna E. Ross, Department of Zoology, Clemson Univ., Clemson, S.C.

The objectives of the study are to test some of the current hypotheses about the nature of asymmetric contests and the influence of dominance relationships on winter social organization. Based on behavioral data from captive groups, adults (white crown) are dominant (% wins and rank) to brown crowns (young); within age classes, males are generally dominant to females. Groups of brown crowns are less stable, and form less linear hierarchies than groups of other age compositions. The "badge" of crown color does not reduce the number of interactions between the age classes. The frequency of intense interactions is not different from the prediction of the null hypothesis that the frequency of interactions is independent of crown color. Birds usually retained their relative status in a group after a period of separation. Males may increase in status over females in the early spring. Brown crowns which have lost to adults are more likely to lose contests with unfamiliar brown crowns in a new group. When the top ranked bird in a group is replaced, the new group is less stable and the hierarchy is less linear.

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PATCH EXPLOITATION AND RESOURCE DEFENSE IN MIGRATING RUDDY TURNSTONES (ARENARIA INTREPES).

K. Sullivan, Rutgers Univ., Newark

During spring migration Ruddy Turnstones forage extensively on Limulus polythemus eggs buried on sandy beaches. Turnstones were observed at naturally occurring patches and patches where I manipulated the number of eggs in a patch and the distribution of patches on the beach. Quantitative relationships exist between patch quality and the bird's foraging behavior. Ruddy Turnstones foraging at patches with large amounts of eggs had higher feeding rates, spent more time in a patch and were more likely to defend the patch against conspecifics than birds feeding at patches with few eggs. As the overall patch quality decreased the birds depleted each patch to a greater extent. When the distribution of patches was changed from a random to a regular distribution, the travel times between patches decreased and the birds stopped defending patches against conspecifics.

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OVERWINTERING OF NORTHERN MOCKINGBIRDS (MIMUS POLYGLOTOS) AND SUBSEQUENT BREEDING SUCCESS. James M. Utter, Linda L. Pearson,* Gorton C. Carruth* and Bradford J. Hurley,* State University of New York, Purchase, NY.

Populations in which some individuals migrate and others overwinter offer opportunities to study the selective advantages of these alternative behavioral strategies. We tested the hypothesis that overwintering provides individuals with early access to breeding sites, thereby enhancing reproductive output. Color banded mockingbirds were monitored on the SUNY Purchase campus through the year and reproductive output determined. Only 21% of the 14 individuals on winter territory remained to breed the next spring, but these individuals did establish territories prior to immigrants. No difference in reproductive output was found.

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IMPRINTING IN JAPANESE QUAIL: CONTEXT AND AROUSAL. S.C. Williamson*, A. Beulig. New College of U.S.F., Sarasota, Fl.

The role of contextual cues and arousal in the acquisition and maintenance of the imprinting response in Japanese Quail was investigated. Subjects were randomly assigned to four experimental groups, I. shock inside apparatus, II. no-shock inside apparatus, III. shock outside apparatus, and IV. no-shock outside apparatus, and a control group (V). Subjects in groups I-IV were confined on shock grids prior to a single training session at 12-15 hours posthatch, and received either a single .9 volt shock or no shock. A testing session occurred at 25 hours posthatch. The control group (V), which received no experimental manipulation prior to training, was trained and tested in the same manner. Sessions were conducted in a circular runway apparatus with a white light as the imprinting object. Groups I and IV showed significantly greater following times and activity scores. This suggests that for Japanese Quail: a) contextual cues do not play an essential role in acquisition of the imprinting response; and b) a general arousal mechanism may be involved in imprinting, with the arousal level influenced by external factors such as shock and changes in contextual environment.

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HYDROMINERAL BALANCE DURING AVIAN EMBRYONIC DEVELOPMENT: EFFECTS OF PROLACTIN AND GROWTH HORMONE. M.J. Murphy, P.S. Brown and S.C. Brown. SUNY @ Albany and Siena College, Loudonville, New York.

White Leghorn chick embryos were treated for 8 days with bovine prolactin (PRL) growth hormone (GH) or avian Ringer (Con). Hormone doses were 4-10 µg/g embryo wt/day on days 6-14. Allantoic fluid was collected on days 10 and 12 and analyzed for [Na] and [Cl]. Day 14 allantoic fluid, amniotic fluid and serum were analyzed for [Na] [Cl] and osmolality. Day 14 embryo wet weight, hematocrit and allantoic fluid volume were also determined. Both PRL and GH treated animals had significantly lower allantoic [Na] compared to Con; allantoic [Cl] was also reduced in both hormone groups. PRL and GH also decreased allantoic osmolality, whereas PRL but not GH increased serum osmolality. These data suggest that PRL and GH may act at the kidney (reducing the movement of Na and Cl into the allantois via the urine) and/or at the chorioallantoic membrane (by increasing the uptake of salts from the allantoic fluid).

(Supported in part by NSF grant PCM-79-22793.)

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A SYNERGIST OF PROLACTIN'S MITOGENIC ACTIVITY (SYNLACTIN) IS SECRETED BY THE LIVER. C.S. Nicoll, N. Hebert*, S. Steiny and B. Delidow*. Univ. of California, Berkeley.

We have previously reported that the mitogenic action of prolactin (PRL) on the pigeon crop-sac (PCS) mucosal epithelium involves synergism with an insulin-like growth factor (IGF), which we called synlactin (*Am. Zool.* 22:949, 1983). Because the liver is the major source of IGF's in mammals, we investigated this organ from pigeons and rats as a possible source of synlactin activity. Slices of liver were incubated in medium 199 for up to 4 hr. The liver medium itself had no stimulatory activity. However, when combined with a low dose of oPRL, the liver medium from pigeons strongly potentiated the effects of PRL. Injecting pigeons with either GH or PRL did not increase the secretion of synlactin activity. Liver slices from male rats or from virgin females that were injected with either saline or GH did not secrete significant synlactin activity *in vitro*. However, liver from PRL-treated virgin females and from pregnant and lactating rats did secrete significant amounts of synlactin. The possibility that the liver of amphibian and teleostean species can also secrete synlactin is being investigated.

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INTERACTION OF PROLACTIN AND THYROXINE IN EXPLANTS OF TADPOLE TAIL FIN IN VITRO. L.B. Ray and J.N. Dent. University of Virginia, Charlottesville, VA 22901

Explants of tail fin from *Rana catesbeiana* tadpoles cultured six days at 20° in 70% Hanks solution plus 150 nM thyroxine (T_4) lost 4% of surface area with a 47% increase in hexosaminidase (Hex) activity. Prolactin (0.1 - 10 $\mu\text{g/ml}$) inhibited the change in surface area in a dose-related fashion. Explants treated with T_4 + prolactin (10 $\mu\text{g/ml}$) decreased in surface area by only 10% but there was no difference in the specific activity of Hex or of acid phosphatase between grafts exposed to T_4 alone and ones treated with T_4 + prolactin.

Previous studies on whole (fin + muscle) tails *in vivo* indicated the antimetamorphic action of PRL to result from inhibition of hydrolytic enzymes. Our results suggest prolactin inhibits resorption in the fin by other means. In the whole tail, the mode of interaction between T_4 and prolactin may vary among the different tissues present such that changes in the enzyme activity of muscle may predominate over changes in fin.

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PRENATAL ALPHA-MELANOCYTE STIMULATING HORMONE (MSH): INFLUENCES ON SOMATIC AND BEHAVIORAL DEVELOPMENT IN THE CHICK AND RAT. J.T. Martin. Stockton State College Pomona, New Jersey

Alpha-MSH was infused at 1 $\mu\text{g/hr}$ onto the chorioallantoic membrane of developing dwarf chick embryos or into pregnant rats during the last third of gestation. Pituitary MSH activity was measured in dwarf and normal strain chick embryos from day 16-21 of development, and in offspring of MSH-treated rat mothers. Infusion of MSH resulted in reduced body, liver, and brain weights in female dwarf chick embryos and reduced body weights in male and female rat neonates. Offspring of MSH-treated rats had higher pain thresholds and more rapid habituation of locomotor activity in a novel environment than controls, but pituitary MSH activity was normal at birth and in adulthood. MSH probably does not act as a somatotrophic agent in the chick, and its absence is not the cause of dwarfing in autosomal or sex-linked dwarf chickens. MSH activity increased in normal and dwarf strains from day 18 to 21 and was negatively correlated with brain weight at day 19 in the autosomal dwarf strain.

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Thyroidal Responses to Thyrotropin during Development in Japanese Quail. Thomas E. Hughes and F. M. Anne McNabb. Dept. of Biology, Virginia Tech, Blacksburg, VA 24061.

Maturation of the thyroid-pituitary negative feedback response occurs between days 9 and 10 of the 16.5 d incubation period in quail. In 14 d embryos single injections of thyrotropin (TSH) are followed by parallel, statistically significant, increases in serum triiodothyronine (T_3) and thyroxine (T_4). The serum T_3/T_4 ratio does not change after TSH injection. Analysis of thyroid homogenates digested with Pronase indicates the serum T_3/T_4 ratio of 0.03 is equal to the ratio of hormones stored in the thyroid. These experiments and a preliminary study of embryonic liver monodeiodinase activity suggest that the increase in T_3/T_4 ratio, to >0.4 , during the perinatal hormone peak reflects increased peripheral T_4 to T_3 deiodination at that time. In contrast to the embryonic response, the postnatal response to TSH in 1 d chicks and adults involves only increases in serum T_4 and results in decreased T_3/T_4 ratios. Thus the nature of the thyroidal response to TSH changes with development. Supported by grant #ROI AM 28216 from NIH.

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INFLUENCE OF SECRETAGOGUES ON GROWTH HORMONE RELEASE FROM CHICKEN ANTERIOR PITUITARY CELLS IN PRIMARY CULTURE

Frank M. Perez, Jr.¹ Sasha Malamed¹ and Colin G. Scanes². Dept. of Anatomy, UNDNJ, Piscataway, N.J.² Dept. of Animal Sciences, Rutgers University, New Brunswick, N.J.

A primary culture system for anterior pituitary cells from the domestic fowl has been developed. Adenohypophyseal cells were dispersed by collagenase treatment and cultured for 48 hrs, followed by a two hour exposure to new media containing secretagogues. The media was assayed for GH by RIA. At the end of the culture, the somatotrophs had a normal appearance as revealed by electron microscopy. The presence of human pancreatic growth hormone releasing factor (hpGRF), thyrotrophin releasing hormone (TRH) and dbcAMP significantly increased the release of GH into the media. For instance the addition of hpGRF consistently increased GH secretion by $3.0 \pm .33$ (n=3) fold. Cultured anterior pituitary cells are a novel system for the study of GH secretion in the domestic fowl.

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CELLULAR REORGANIZATION DURING ALLOGRAFT REJECTION IN THE HAWAIIAN SPONGE CALLYSPONGIA DIFFUSA. L.C. Smith, I.S. Johnston, C.H. Bigger and W.H. Hildemann. Univ. of California School of Medicine, Los Angeles, Calif.

Transplantation immunity in Callyspongia diffusa has been investigated in great detail to reveal polymorphic histoincompatibilities and a highly discriminating immune system. In order to dissect the mechanisms of Callyspongia allograft rejection, including recognition of non-self, cytotoxicity, and memory, the cells of the animal must be morphologically and functionally characterized. Investigations using histology and ultrastructure show the overall changes that occur in the cellular organization during graft rejection. Monoclonal antibodies have been produced that identify some Callyspongia cell types. These reagents indicate the changes in distributions of certain cells in normal and rejecting tissue.

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EVIDENCE FOR HISTOINCOMPATIBILITY, AGING AND NEOPLASIA IN RIBBON WORMS AND EARTH-WORMS. C. Langlet and E.L. Cooper, Univ. de Reims, France; Univ. of California, Los Angeles.

Comparative immunology has advanced by studies of invertebrates from diverse phylogenetic groups. Comparisons between cell-mediated immune responses in ribbon worms (acoelomates) and earthworms (coelomates) show similarities between these two relatively distant phyla. Ribbon worms and earthworms share several immunologic traits as far as xenograft rejection is concerned. Differences occur in the immune response against allografts, accepted in ribbon worms but more or less rapidly rejected in earthworms. Recognition is probably the most basic event in the immune response. Regardless of the test system, ribbon worms and earthworms recognize foreign tissues, thus their immunocompetent cells must possess specific receptors. The first stage in the evolution of an immunodefense system was the development of a recognition system then acquisition of the capacity to reproduce by lymphocytes after antigenic challenge so that memory develops. Both groups undergo aging but neoplasia in invertebrates is not clearly understood. These suggest three interrelated phenomena. (Supported in part by NIH grant HD 09333-7 and NSF PCM 52-04879).

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IMMUNE RESPONSE AND CAPSULE FORMATION IN A GORGONIAN CORAL.

W.M. Goldberg, Florida International University, Miami, Florida

Xenic algal filaments and bacteria elicit a chronic inflammatory response in gorgonian corals of the genus Pseudoplexaura. The primary reaction is characterized by a proliferation of otherwise uncommon, granular amoebocytes in the mesoglea. Electronmicroscopic observations and cytochemistry suggest that these cells are directly involved in the recognition of non-self. Foreign material is first coated with a mesoglea-like material and subsequently enveloped by one or several amoebocytes. There is no evidence that these cells possess either acid phosphatases or peroxidases. Instead the amoebocytes transport xenic organisms to the center of the coral colony where they are coated with scleroprotein and incorporated into the host skeletal system. This study demonstrates that coelenterates can employ polyfunctional amoebocytes in their immune response, and that gorgonian corals can transform amoebocytes into specialized corticocytes for use in encapsulation of foreign material.

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N-ACYLAMINOSUGAR-SPECIFIC LECTINS IN THE SERUM AND A HEMOCYTE MICROSOMAL FRACTION FROM THE BLUE CRAB *CALLINECTES SAPIDUS*. G.R. Vasta and F.J. Cassels*. Medical University of South Carolina, Charleston, South Carolina 29425.

Callinectes serum and a hemocyte microsomal fraction agglutinated a panel of untreated and enzyme-treated vertebrate erythrocytes and lymphoid cultured cell lines. Cross absorption experiments suggested the presence of multiple specific lectins in the serum. The microsomal fraction showed a 21-fold increase in specific activity when compared to the hemocyte lysate suggesting that hemocyte lectins are membrane-associated. No significant differences on serum agglutination titers from male and female specimens were observed. Agglutination by serum and hemocyte lectins was inhibited by low concentrations of N-acylamino compounds including sialic, N-acetylmuramic and N-acetylglutamic acids, GalNAc, GlcNAc, ManNAc, and glycoproteins and polysaccharides which contain them: bovine submaxillary mucin, human orosomucoid, porcine stomach mucin and colominic acid. Purification of *Callinectes* serum and hemocyte lectins is now in progress.

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ISOLATION OF LEUCOTOXIC LECTIN FRACTION FROM HUMAN TISSUES. H.J. Allen and C. Karakousis*. Roswell Park Memorial Inst., Buffalo, NY.

Studies were carried out to compare the levels of lactose-inhibitable lectin(s) in normal and malignant tissues and to determine if the lectin(s) modulates leucocyte metabolism *in vitro*. Twenty-nine pair of tissues were examined by hemagglutination assay. The malignant tissue had higher hemagglutinating activity in 20 cases. A lectin fraction with potent hemagglutinating activity against trypsinized rabbit erythrocytes was isolated from several tissues using columns of melibiose, lactose- or asialofetuin-sepharose. The isolated lectin activity was completely adsorbed by paraformaldehyde-fixed human buffy coat cells. Cytoagglutination occurred at a lectin concentration of about 100 $\mu\text{g/ml}$ and this was reversed in the presence of lactose. Isolated mononuclear cells and PMN cells showed similar reactivity with the lectin(s). The lectin(s) inhibited DNA synthesis and protein synthesis by buffy coat cells *in vitro*. A dose-response curve showed saturation kinetics and a 50% reduction in amino acid incorporation was achieved at a lectin concentration of 70 nM . Inhibitors of hemagglutination only slightly reduced the toxic effect.

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PHYLOGENETIC DISTRIBUTION OF A THY.1-LIKE DETERMINANT. E.L. Cooper, E.A. Stein, R.K. Wright, A.E. Klempau. Univ. of California, Los Angeles, USA.

Thy.1 was first identified as a brain-thymus alloantigen in mice with two allotypic forms, Thy.1.1 (θ -AKR) and Thy.1.2 (θ -C3H). Thy.1.1 is found on brain, thymus, fibroblasts and myoblasts in mammals. In invertebrates there is evidence for a Thy.1 homolog in squid brain and on hemocytes of snails. Thy.1 from frogs has been recently purified (H. Mansour and E.L. Cooper). We have used earthworm coelomocytes, tunicate leukocytes and frog bone marrow cells and a monoclonal antibody 390 which has defined a Thy.1 determinant on human neuroblastoma, glioma, sarcoma, and teratoma, a generous gift of Dr. R.C. Seeger, (J. Immunol. 128:983-989). Coelomocytes, tunicate leukocytes and frog marrow were assayed by combined ab 390 and immunoperoxidase. Coelomocytes showed the highest degree of cross reactivity producing intense surface labeling. Although our results only show cross-reactivity, we are encouraged by mounting evidence suggesting the actual presence of molecules such as Thy.1 and β -2 microglobulin in many animal groups perhaps as components of the Ig superfamily. (Supported by NIH grant HD 0-9333 and NSF PCM 52-04879).

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EXPRESSION OF IMMUNOGLOBULIN IDIOTYPIC DETERMINANTS BY NON-IMMUNOGLOBULIN MOLECULES. CONVERGENCE OR HOMOLOGY? G.R. Vasta and J.J. Marchalonis. Medical University of South Carolina, Charleston, South Carolina 29425.

Monoclonal antibodies (mAb) specific for the phosphorylcholine (Pc)-binding myeloma protein TEPC 15 idiotype showed strong crossreactivities with the Pc-binding acute phase protein CRP and the sialic acid-specific agglutinin from *Limulus polyphemus* (LPA) (also reported to bind Pc) when tested in enzyme linked immunosorbant assays (ELISA). The specificity of those crossreactivities was confirmed by testing the binding of anti-TEPC 15 mAbs to CRP and LPA in the presence of Pc, p-nitrophenyl-Pc (pNPPc), N-acetylneuraminic acid (NANA) and bovine submaxillary mucin (BSM): binding of mAb to CRP and LPA was strongly decreased by pNPPc (100 mM) partially by Pc (100 mM) and unmodified by NANA (100 mM) and BSM (0.5%). Neither CRP or LPA showed significant overall amino acid sequence homology to vertebrate immunoglobulins; however, CRP, LPA and TEPC 15 shared short stretches of homology. It is possible that by selective pressure certain critical combining sites on putative recognition molecules resulted from convergence or that they were conserved through their evolution.

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MODULATION OF PACEMAKER ACTIVITY OF THE CARDIAC GANGLION OF THE DESERT SCORPION, PARUROCTONUS MESAENSIS. Roger D. Farley, University of California, Riverside.

The cardiac ganglion is a slender strand 50 micrometers in diameter and 15 mm. long on the dorsal surface of the heart. It contains about 30 neurons 15 to 45 micrometers in diameter. Modulation of heart frequency in intact animals is readily observed in electrocardiograms or by watching the heart through the transparent mesosomal tergites. Sudden bright light causes cardio-inhibition while noise, air currents or tactile stimulation causes acceleration. Cardio-accelerator and inhibitory fibers may be present in all the dorsal nerves from the subesophageal and first three abdominal ganglia, but inhibition is the dominant effect of electrical stimulation of these nerves from the subesophageal and first two abdominal ganglia while acceleration occurs with stimulation of nerves from the third abdominal ganglion. In perfusion experiments on the isolated heart, octopamine was found to be the most effective cardio-accelerator (10^{-8} M.), while gamma-aminobutyric acid reduces heart frequency at 10^{-6} M.

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CORRELATION OF MOTONEURON ACTIVITY, MUSCLE PROTEINS, AND CLAW DIMORPHISM IN THE LOBSTER HOMARUS AMERICANUS. W.J. Costello and C.K. Govind. Ohio University, Athens and Scarborough College, Toronto.

The adult lobster possesses dimorphic claws: a phasic cutter and a tonic crusher. The cutter closer muscle contains mostly fast fibers and some slow fibers; the crusher has only slow fibers. In the juvenile, both claws are symmetrical; closer muscles contain fast and slow fibers. After stage 5, differentiation occurs to produce dimorphic claws. We have found such differentiation is associated with changes in motoneuron activity and in muscle protein populations. The closer muscle is innervated by a fast closer excitor (FCE) and a slow closer excitor (SCE). The crusher FCE in intact claws fires at high frequencies (ave 37Hz) in long bursts; the cutter FCE fires at low frequencies (ave 2Hz) in very short bursts. In undifferentiated juvenile claws, the FCE in both claws fires at high frequencies in long bursts. After stage 5, FCE spike frequency in the putative cutter claw decreases in successive stages. Coordinated with activity changes is the appearance of proteins unique to adult muscle types. Thus, there appears to be a correlation in neural activity, synthesis of unique muscle proteins and claw dimorphism.

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SEROTONIN INTEGRATES LEECH FEEDING BEHAVIOR. C.M. Lent & M.H. Dickinson*. Brown University, Providence, RI.

We investigated the functional roles of 5-HT in feeding by Hirudo medicinalis. A brief bath in 5-HT ($30\mu\text{M}$, 20min) significantly enhances three components of behavior: swim initiation latency, bite frequency and blood meal size. In dissected preparations, 5-HT directly activates salivary secretion and pharyngeal pumping. Vibrational and thermal stimuli, which evoke feeding behavior, synaptically excite serotonergic Retzius cells. Intracellular stimulation of identified 5-HT containing neurons evokes both salivation and pharyngeal pumping.

Ablation of the 5-HT neurons with the neurotoxic analogue 5,7-DHT abolishes the feeding behavior of intact, hungry leeches. Brief exposure to exogenous 5-HT restores biting behavior to serotonin-depleted leeches and to well-fed leeches which will not otherwise bite a warm surface.

Thus, serotonin, which is found within a limited population of identifiable neurons, has a major role in leech feeding behavior.

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REGENERATIVE ELECTRICAL ACTIVITY IN THE SALIVARY GLAND CELLS OF LEECHES
Cameron G. Marshall

Brown University, Providence, R.I.

Salivary gland cells are present in the head region of both jawed (Hirudo medicinalis, Macrobdella sp) and proboscis-bearing (Hementeria) sanguivorous leeches. Intracellular recording shows that the cells are not electrically coupled, and confirms that these are unicellular glands, each extending a cellular process anteriorly. The cells fire action potentials of long duration (100-200 ms) in response to a depolarizing pulse, or after a hyperpolarizing pulse. The amplitude is 70-100 mV. The action potential is blocked by 5mM cobalt or manganese, and by micromolar D-600. The A.P. is supported when calcium is replaced by strontium or barium, persists in sodium-free Ringer, and is insensitive to high concentrations of tetrodotoxin. This evidence points to a purely calcium dependent spike. These findings extend knowledge of electrically excitable secretory cells to a hitherto unexamined phylum.

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ACTION OF OCTOPAMINE IN THE SALIVARY GLAND ISOLATED FROM THE TICK AMBLYOMMA AMERICANUM. T. L. Pannabecker and G. R. Needham. Ohio State University, Columbus.

Isolated salivary glands secrete fluid in a dose-related manner when exposed to octopamine. The half-maximal response occurred at about 60 μ M. The α -blocker phenolamine (10 μ M) failed to inhibit octopamine-stimulated (100 μ M) secretion. The dopamine-blocker thioridazine (50 μ M) irreversibly inhibited 0.1 μ M dopamine-stimulated and 1000 μ M octopamine-stimulated secretion. A maximally effective dopamine concentration (1 μ M) showed no further increase in the rate of secretion after adding octopamine (1000 μ M, 0.1 μ M). When preceded by amphetamine treatment (1000 μ M), glands responded to octopamine (100 μ M) with rates significantly lower than controls. The data suggest that octopamine receptors do not mediate fluid secretion and support the hypothesis that dopamine is the natural transmitter. The evidence suggests that octopamine may stimulate secretion by releasing catecholamines from presynaptic neurons.

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VISUAL SYSTEM OF THE GIANT CLAM TRIDACNA: BEHAVIOR AND RECEPTOR PHYSIOLOGY. L.A. Wilkens. Univ. of Missouri-St. Louis.

The giant clam has adapted to the coral reef environment by hypertrophy of the mantle siphon. Large fleshy lobes containing zooxanthellae extend past the shell margin for maximum light exposure. Numerous eyes line the mantle edge and initiate a variety of photic behaviors. The well-known shadow response is a coordinated retraction of the entire siphon, and when accompanied by valve adduction, water is forcibly ejected from the siphon apertures. A response not previously reported appears to aid the animal in orienting to incident light. This phototropic behavior can be evoked experimentally with a secondary light source. Lobes having eyes which face this light rapidly orient their upper surface in its direction. The eyes also mediate local retractions of the mantle, in both intact animals and in excised pieces. Intracellular recordings from the retina indicate that the photoreceptor response to light is exclusively hyperpolarizing. Two classes of receptor cell exist, however: a) non-spiking cells which give large (to 100 mV) receptor potentials and rapidly adapt to light; b) spiking cells which produce 3-5 mV spikes on the depolarizing phase (light off) of a non-adapting receptor potential. Supported by a Whitehall Foundation grant.

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DARK REGENERATION OF RHODOPSIN IN THE CRAYFISH RETINA. T.W. Cronin and T.H. Goldsmith. Univ. of Maryland Baltimore Co. and Yale Univ.

We followed the course of restoration of rhodopsin in crayfish photoreceptor organelles (rhabdoms) using an assay technique based on fluorescence from the stable metarhodopsin. Eyes of crayfish were exposed to light of known spectral content and allowed to recover in the dark. Each day, eyes were removed for measurement of metarhodopsin content in a number of rhabdoms. Recovery required about 36 h after blue-light (450 nm) exposure and up to 1 week after orange-light exposure (above 550 nm). Recovery was always gradual and continuous, and the total pigment concentration (rhodopsin + metarhodopsin) in the rhabdomic membrane remained constant. Light-adapted rhabdoms appeared different from dark-adapted ones: they became coated with pigment granules and their bands of microvilli became less distinct. These changes reversed as regeneration of rhodopsin proceeded. Therefore, the restoration of visual pigment in the crayfish eye apparently results from the addition of new rhodopsin molecules associated with membrane turnover. (NIH Grant EY-00222 and Training Grant EY-07000-08).

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AUTOTOMY IN THE LAND SLUG, PROPHYSAON FOLIOLATUM (Gould) (Arionidae). A.W. Martin, I. Deyrup-Olsen, and R.T. Paine. Univ. of Washington, Seattle.

Autotomy exists as a defense against predation in a number of animal groups, including Mollusca. Among these are the terrestrial slugs of the genus Prophysaon which can autotomize the posterior section of the foot. This process (Ingram and Hand, 1950; and others) has not been analyzed as to mechanism and control. In our studies with Prophysaon foliolatum we have found that autotomy results only from effective stimulation of that section of the foot which can be autotomized; connections with the head ganglia are not needed, although stimulation to the anterior body wall accelerates autotomy. The process is deeply depressed by injection of serotonin. The autotomized section has a high content of glycogen; and differs in mucus production from the rest of the body in that only the latter secretes a thick, bright yellow mucus when the animal is subjected to noxious stimulation. When carabid beetles (Schaphinotus angusticollis) attacked the slugs, the relatively long time (several hours) taken by the beetle to consume the autotomized tissue favored escape by the slug.

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PARTIAL ISOLATION AND CHARACTERIZATION OF NEUROFILAMENT PROTEINS FROM THE PILOT WHALE, GLOBICEPHALA MELAENA. L.K. Duffy, C. Abraham*, D.J. Selkoe* and K.S. Kosik*. Harvard Medical School, Boston, MA 02115

Mammalian neurofilaments (NF) consist of a triplet of proteins which in the human are of molecular weights 200 kd, 160 kd, 70 kd. NF's were partially purified from pilot whale subcortical white matter. The crude neurofilaments were solubilized in 6 M urea and further purified by DEAE cellulose and HPLC size exclusion chromatography. SDS-PAGE electrophoresis and immunoblotting were used for the initial characterization. The pilot whale NF triplet comigrated on one dimensional SDS-PAGE with human NF's and thus have similar molecular weights. Immunoblots of whale NF's cross react with both polyclonal (Ihara *et al.*, 1981, Proc. Jap. Acad., 57:153) and monoclonal (Anderton *et al.*, 1982, Nature 298:84) antisera specific for mammalian NF's. (Supported in part by NIH Grant numbers AG 01307 and NS 00289.)

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CELLULAR ORGANIZATION OF THE COELOMIC LINING IN THE "ACOELOMATE" POLYCHAETE MICROPHTHALMUS CF. LISTENSIS (HESIONIDAE). P.R. Smith, J. Lombardi and R.M. Rieger. Clemson Univ., S.C., and Univ. of North Carolina, Chapel Hill.

The interstitial polychaete Microphthalamus listensis is acoelomate in its body cavity organization based on classical light microscopical studies. Mesodermal organization was reinvestigated using TEM serial sections to reveal its cytology within the hatchling and the adult. In the hatchling, mesodermal cells are organized into 2 epithelia: somatic and splanchnic. Cell apices of the 2 epithelia are in apposition. Although there is complete absence of a coelom, mesodermal organization is of the coelomate type. In the adult, there is an anterior to posterior gradation in mesodermal organization from coelomate to "acoelomate". In the pharyngeal region, an extremely thin coelom filled with an electron-dense fluid lies between somatic and splanchnic cells. Proceeding posteriorly, there is a progressive reduction of splanchnic cells and as a result somatic cells lie in apposition to basal laminae of the gut, occluding the coelom. Results are discussed in relation to the evolution of the "acoelomate" Bilateria. (Supported by NSF grant DEB 8119652 to R.M. Rieger)

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TONGUES, TENTACLES AND TRUNKS: THE BIOMECHANICS OF MOVEMENT IN MUSCULAR-HYDROSTATS. W. M. Kier and K. K. Smith. Woods Hole Ocean. Inst., MA, and Duke Univ. Med. Center, Durham, NC.

A number of animal structures including the arms and tentacles of cephalopod molluscs, the tongues of many mammals and lizards and the proboscis of the elephant are composed almost entirely of muscle and as such lack any obvious system of skeletal support. We have investigated the means by which such structures create the diverse, complex and highly controlled movements which are characteristic of these organs. The most important feature of a muscular-hydrostat is that it is a structure of constant volume. In such a structure any decrease in one dimension will cause a compensatory increase in at least one other dimension. This principle allows us to explain how the muscle arrangements we have identified in these structures create the four types of movement observed: elongation, shortening, bending and torsion. We show that mechanical amplification of muscle displacement or force analogous to that provided by lever systems of a hardened skeleton is possible for muscular-hydrostats and other hydrostatic skeletons.

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FINE STRUCTURE OF THE BRANCHIAL TENTACLES OF THE VESTIMENTIFERAN TUBE WORM RIFTIA PACHYPTILA JONES (POGONOPHORA).

S.L. Gardner and M.L. Jones. Univ. of North Carolina, Chapel Hill and Smithsonian Institution, Washington, DC.

The obturacular (anterior) region of Riftia pachyptila is provided with many branchial tentacles that are exposed to the surrounding seawater. Tentacular organization was studied with light and transmission electron microscopy.

The epidermis consists of mucous cells, unspecialized epithelial cells and multiciliated cells. A specialized type of glial cell is situated within the epidermis on the anterior and posterior faces of each tentacle. Two intraepidermal nerve tracts are present ventrally in each tentacle. The tentacular coelomic cavity is lined with longitudinal muscle cells and contains two wall-developed blood vessels. These blood vessels are connected by numerous intraepidermal capillary loops, some of which loop into the multicellular pinnules. The branchial tentacles appear to be well-adapted for respiratory exchange in R. pachyptila and for uptake of materials necessary for its endosymbiotic prokaryotes. Supported by the Office of Fellowships and Grants, Smithsonian Institution.

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CONNECTIVE TISSUE OF THE DIGESTIVE GLAND OF THE LOBSTER, HOMARUS AMERICANUS. Jan Robert Factor and Michele Naar*. State University of New York, Purchase.

Ultrastructural and histological studies of the digestive gland of the lobster demonstrate two layers of connective tissue. The first surrounds the epithelial cells of tubules and consists of a basement membrane, contractile cells, and outer layer. The basement membrane is complex and has two layers that differ in structure and electron density. Circular and longitudinal processes extend from the contractile cells and contain contractile filaments. Bundles of circular contractile filaments are thicker and more numerous than those of longitudinal filaments. Longitudinal and circular filaments lie within the same cell, with a single cell body and nucleus. Microtubules are abundant at the periphery of the cell. The outer collagenous layer covers cells and processes but lies adjacent to the basement membrane where there are none. The second layer of connective tissue forms the outer limit of the organ. It has collagenous and cellular components and is similar to the connective tissue surrounding other regions of the midgut.

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INVESTIGATIONS OF THE DIGESTIVE GLAND OF THE BIVALVE CORBICULA. K. Chalermwat. Univ. of Southern Mississippi, Hattiesburg.

Two experimental populations of the bivalve Corbicula from Tallahala Creek were maintained in the laboratory for a period of six weeks. One was kept in a mixed culture of algae, protozoa, and bacteria; the other in distilled water. Bivalve pumping activity was most intense at night. Both populations produced large amounts of pseudofeces. Animals were sampled weekly from each experimental regime. Digestive gland and style systems are typically eulamellibranch. "Fed" animals all showed particulate matter in some portions of the gut. Digestive glands in the "fed" animals were regularly dominated by style dissolution and extra-cellular digestion phases of the digestive tubules; the nonfed specimens showed more random stages of digestion. Changes in digestive gland structure and potential digestive rhythms during 24 hour periods are presently being studied.

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MORPHOLOGY OF TAREBIA GRANIFERA (GASTROPODA:THIARIDAE) DIGESTIVE GLAND INFECTED WITH PHILOPHTHALMUS GRALLI (TREMATODA:PHILOPHTHALMIDAE) REDIAE. M.B.Kotrla. Florida State Univ., Tallahassee.

The morphology of Tarebia granifera digestive gland is described and the effects of infection with Philophthalmus gralli rediae are characterized histologically and ultrastructurally. Normal digestive gland is a branched tubular organ enveloped by the mantle. Digestive cells are located along the lateral aspects of the tubules and exhibit distinct activity phases. There are 2 types of synthesis cell, secretory and excretory, which occur in groups of 6-10 at the distal ends of the tubules. The inter-tubular spaces contain collagen fibers and 6 types of connective tissue cell. P. gralli infection induces pathological alterations in the digestive gland. Host tissue mass is reduced due to ingestion by rediae. Autolysis of digestive cells and hydropic degeneration of synthesis cells are hypothesized to result from the release of metabolites and extracorporeal digestive enzymes by rediae. A cellular defense reaction to infection occurs. Certain connective tissue elements proliferate, and in some hosts, encapsulate the parasites.

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ENERGY OF OSCILLATION OF THE LEGS, MODELLED ON THE FAST-MOVING ELEPHANT, CHEETAH, PRONGHORN, AND JACKRABBIT. M. Hildebrand and J.P. Hurley.* Univ. of California, Davis.

Masses and centers of mass were determined for the legs treated as 3-segment systems. Dimensions were measured on skeletons. Tracings from cine film provided locations and angles of joints at 19 positions equally spaced in time over the locomotor cycle. Potential and (using a Lagrangian formulation) kinetic energy were calculated for the transitions between positions, disregarding the muscular system and the roles of support and propulsion. The changing energy of the leg over its oscillation closely reflects the trajectories of joints and relative motions of segments. The magnitudes and somewhat reciprocal fluctuations in K.E. and P.E. are shown. The energy cycle of a digitigrade leg is contrasted with that of an ungulate by comparing pronghorn with cheetah and with "cheetahs" having pronghorn weight of leg, or length of leg, or joint angles. Contrasts are made among the weights and energies of a rabbit, an elephant, a rabbit-sized elephant, and an elephant-sized rabbit.

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SWIMMING DYNAMICS OF THE HARP SEAL AND RINGED SEAL. F.E. Fish, S. Innes and K. Ronald. West Chester Univ., West Chester, PA and Univ. of Guelph, Ontario, Canada.

The kinematics and energetics of submerged swimming were examined for the harp seal (*Phoca groenlandica*) and ringed seal (*P. hispida*). The seals were filmed with a cine camera while swimming in a water flume at velocities ranging from 0.6 to 1.44 m/s. Both species swam in a lateral undulatory mode in which one-half wave-length was observed in the caudal half of the body. The traveling wave moved posteriorly at a velocity higher than the swimming velocity. The amplitude increased to a maximum at the tip of the tail. The main propulsive effectors were the hindflippers, which moved through a lateral arc in conjunction with the undulations of the body. During the stroke cycle, only the digits of the trailing flipper were maximally abducted, while the digits of the lead flipper were adducted. The stroke frequency was found to increase with increasing swimming velocity for both species. In comparison to swimming modes exhibited by more terrestrial mammals, the mechanical swimming efficiency for the lateral undulatory mode displayed by these phocid seals was shown to be high.

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THE ENERGETIC PARADOX OF HUMAN RUNNING. D. Carrier. Univ. of Michigan, Ann Arbor.

Compared to other mammals the energetic cost of running is relatively high in man. In spite of this, man can run down a variety of cursorial prey (e.g. zebra, kangaroo), indicating that humans are adept endurance runners. Distance running by man is made possible, in part, by an exceptional ability to dissipate exercise heat loads. Most mammals lose heat by panting, which is coupled to both the breathing and locomotor cycles during running. This inter-dependence should limit the effectiveness of panting as a means of heat dissipation. Because sweating in man is not dependent on respiration it may be more compatible with running as a thermoregulatory mechanism. Furthermore, man's lack of body hair improves thermal conductance while running, as it facilitates convection at the skin surface. The energetic cost for a man to run a given distance does not change with speed. In contrast, horses have been shown to possess energetically optimal speeds in each gait. It is hypothesized that this difference is due to man's bipedal gait, which allows breathing frequency to vary relative to stride frequency. Their constant cost of transport may enable human hunters to pursue prey at the speed that is least economical for the prey.

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REGULATION OF RESPIRATORY AIRFLOW DURING PANTING AND FEEDING IN DOGS. A.A. Biewener, C.W. Soghikian*, and A.W. Crompton. Univ. of Chicago and Harvard University.

Movements of oropharyngeal and laryngeal structures during breathing and panting in dogs were studied using high-speed cine-radiography, correlated with recordings of expired and inspired airflow patterns (via thermocouples) at the nose and mouth. Our findings indicate that the soft palate is the principal structural component regulating the path of respiratory airflow in dogs. The cyclic movements of the soft palate during panting are accompanied by complementary movements of the posterior dorsum of the tongue (and epiglottis) and posterior pharyngeal wall to open and close alternately the oropharynx and nasopharynx. The epiglottis appears to play a passive role during changes in airflow; its movements at this time being closely coupled to movements of the posterior tongue and hyoid. The dogs did not breathe during lapping or mastication. Respiration commenced only after the food bolus had been swallowed. We suggest that specializations of the soft palate and epiglottis in dogs for thermal panting may restrict the formation of an adequate oropharyngeal seal during feeding.

(Supported by NIH Grant T32GM07117)

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MICROSCOPIC ANALYSIS OF THE DIGESTIVE TRACT OF BLUEGILL FISH, LEPOMIS MACROCHIRUS. H. M. Dutta and A. Hossain* Kent State University, Kent, Ohio.

The microscopic structures and functions of the digestive tract of bluegill fish have been regionally analyzed. Tissue samples consisted of twenty different spots of digestive tract of six fishes. The regional differences and similarities were recorded in relation to their microscopic structures in the same and between the specimens. These differences and similarities have been correlated with functions performed by nine regions of the digestive tract. The qualitative microscopic findings have been transferred into graphs and tables. Out of four basic layers, two (one full and another partly) are missing in buccal cavity and pharynx. The remaining parts have all the four basic layers. Taste buds and mucus cells are not uniformly distributed all over the tract. The importance of the intestinal caecae in relation to the function of stomach and intestine has been pointed out. The role of the caecae on the feeding habit of this fish has been analyzed.

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THE GAS BLADDER AS A CENTRAL COMPONENT OF THE LEIOGNATHID-BACTERIAL LIGHT ORGAN SYMBIOSIS. M. J. McFall-Ngai. University of California, Los Angeles.

Leiognathid fishes maintain a symbiotic luminous bacterium, Photobacterium leiognathi, in a circumesophageal light organ adnate to the gas bladder. They use the bacterially produced light in several behavioral displays. Morphological analyses revealed two novel and highly integrated functions for the leiognathid gas bladder of direct importance to the symbiosis: 1) a differential reflector-transmitter of bacterial light; 2) a source of O_2 for the luminescent system of the light organ bacteria. Purine deposition patterns for a wide variety of leiognathid species correlated well with the proposed species-specific bioluminescent behavioral modes. The separation of the light organ bacteria from the O_2 -rich gas bladder space by a thin, guanine-poor membrane, the close association of this membrane to the gas gland, and the apparent lack of an oval for gas reabsorption from the bladder, all implicate the gas bladder as a source of O_2 for the bacterial symbionts. Preliminary evidence indicates that O_2 diffusion from the bladder to the light organ directly influences bacterial luminescence.

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TRANSCENDENTAL ANATOMY AT HARVARD: AGASSIZ, GRAY AND WYMAN. T.A. Appel (intro. by R. Stevenson). American Physiological Society, Bethesda, Md.

This paper focuses on the morphological concepts imported from abroad by three pioneers of morphology in America, Louis Agassiz, Asa Gray and Jeffries Wyman. From the 1840s, when these three men all arrived in Cambridge, Harvard became the American center of the emerging specialty of morphology. Previously, botany and zoology in America had been largely limited to empirical description and classification of species and genera. There was little expertise in comparative anatomy or embryology. Agassiz, Gray and Wyman led in bringing European theoretical concepts to America. Among these was the search for structural homologies, understood (at least initially) not in an evolutionary context, but as evidence of God's plan of Creation. The morphological approach, which required an extensive knowledge of comparative anatomy and embryology, derived especially from France. Both Agassiz and Wyman studied in France where they were exposed to the classic confrontation between the claims of teleology and morphology, namely, the Cuvier-Geoffroy debate. Gray derived his concern with morphology from the French botanist, Candolle and the school of "philosophical botany."

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SOME ANATOMY AND ZOOLOGY LECTURES BY JEFFRIES WYMAN, M.D. (1856-1861). R. W. Dexter. Kent State Univ., Ohio.

Dr. Jeffries Wyman (1814-1874) taught anatomy and physiology at Harvard University, Lowell Institute, and Hampden-Sydney College in Virginia, after which he returned to Harvard in 1847 to continue teaching and to found a Museum of Anatomy and Physiology. He also served as Curator for Comparative Anatomy at the Boston Society of Natural History and laid the foundations for comparative anatomy in the U.S. Excerpts will be read from lectures he gave at Harvard between 1856-61 on anatomy and zoology, especially parasitology and embryology, as recorded by his students. Of special interest was his instruction in his belief (after Oken) of the cranium being derived from vertebrae, and of jaw bones as possible modified ribs; the controversy on spontaneous generation; parthenogenesis; and mammalian reproduction.

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AN ANALYSIS OF THE 1858 PAPERS OF WALLACE AND DARWIN. Walter J. Bock Columbia University.

The story of the 1858 papers of Wallace and Darwin is well known to all biologists. These papers deal with mechanisms of evolution. Darwin considered Wallace's paper to be a precise abstract of his 1842 manuscript. Yet these papers had an almost complete lack of response, including the famous remark by the President of the Linnean Society that nothing special had been published that year. Careful analysis of these papers supports this conclusion and suggests that Darwin overreacted to Wallace's manuscript. Wallace does not present a complete and sufficient set of mechanisms for evolutionary change. Darwin does this, but his statements are so brief and obscure that they can be understood only in the light of his 1859 book. Clearly to Darwin alone must go the credit for formulating the theory of evolution by natural selection.

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THE 1982 DARWIN CENTENNIAL: A RETROSPECTIVE. R.J. Wassersug. Dalhousie University, Halifax, Nova Scotia.

An effort has been made to survey all major symposia, lecture series and publications produced in commemoration of the 1982 centennial of Charles Darwin's death. Approximately 30 publications and 50 public gatherings have been identified so far. Italy, followed by the United States and Spain, did the most to commemorate the centennial. Relatively little Darwiniana of a specifically commemorative nature was issued in 1982 from communist bloc and Asian countries. In the United States commemorative celebrations were largely university based, less so elsewhere in the world. There appears to be no correlation between the countries and institutions doing the most active contemporary evolutionary biology and those most actively paying homage to Charles Darwin. This lack of association testifies to the autonomy (and maturity) of the study of Darwin and his influences, outside of biology. The growth and diversification of both the public interest in Darwin, (as perceived by the publishing industry) and the academic study of Darwin since the last major centennial is documented.

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PLASMA LUTEINIZING HORMONE CONCENTRATION IN WHITE-FOOTED MICE EXPOSED TO THE ANTICHOLINESTERASE ACEPHATE. B.A. Rattner and S.D. Michael*. Patuxent Wildlife Res. Ctr., Laurel, MD and SUNY, Binghamton, NY

Some organophosphorus insecticides have been reported to interfere with reproduction and even cause the decline of small mammal populations. The effects of such anticholinesterases on plasma LH concentrations were examined in male mice (*Peromyscus leucopus noveboracensis*) intubated with water (DW) or acephate (50 and 100 mg/kg) and sacrificed after 4 h. Brain acetylcholinesterase (AChE) activity was inhibited by 45 and 56%, and basal LH levels were reduced by 29 and 25% in mice receiving the 2 doses of acephate. Responsiveness to LHRH did not appear to be affected 4 h after intubation with 100 mg/kg acephate, as 5 ug/kg LHRH ip evoked a comparable rise in plasma LH after 30 min (2.4 and 3.6 fold) in DW-control and treated mice. Subchronic dietary exposure to 0, 25, 100, and 400 ppm acephate for 5 days resulted in a dose-dependent decline in brain AChE activity (23, 42, and 57%), but did not affect LH concentration or the weights of testes and seminal vesicles. These findings suggest that acute exposure to organophosphorus insecticides may impair reproductive function by altering LH secretion.

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IMMUNOREACTIVE LUTEINIZING HORMONE-RELEASING HORMONE (LH-RH) IN THE BRAIN OF A HOLOSTEAN FISH, *AMIA CALVA*. J.W. Crim. Univ. of Georgia, Athens,

An unlabeled antibody peroxidase anti-peroxidase immunocytochemical technique was used to localize mammalian-like immunoreactive (ir-) LH-RH in brains of bowfin (*A. calva*). Ir-LH-RH was distributed widely in a well-defined median eminence (ME), with marked specific immunostaining present in the outer vascularized layer. Immunostained neurosecretory fibers also were localized medially in the floor of the brain beneath the preoptic recess (POR); some stained processes penetrated the ependymal border of the POR. Initial comparisons of reproductively inactive (summer) and active (fall) fish suggest that immunostaining at the level of the POR varies with reproductive season, with diminished staining accompanying reproductive activity; immunostaining of the ME, however, was less variable. These observations indicate that bowfin have a mammalian-like ir-LH-RH; the distribution of immunostaining suggests that possible hypophysiotropic activity of LH-RH-like material has been conserved evolutionarily within the Holosteans, a "mainline" group of fishes. (Supported by NSF grant PCM 82-03970.)

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GONADOTROPIN RELEASE FROM DISPERSED QUAIL PITUITARY CELLS P.B. Connolly and I.P. Callard, Boston University, Mass.

Control mechanisms of avian luteinizing hormone release were studied using an enzymatically dispersed pituitary preparation from male Japanese quails (*Coturnix coturnix japonica*). After an 18 hour incubation, the cells were challenged for 90 minutes at 37C. Amounts of luteinizing hormone (LH) released increased linearly to a maximum of 300% of baseline with median eminence (ME) extracts in the range of 0.02 to 0.1 ME equivalents. No further increase was found with higher doses of ME extracts. Equivalent weights of cerebral cortex extracts had no LH releasing activity. Mammalian LHRH and putative avian LHRH (Gln-8 LHRH) had approximate equal potency increasing LH release to 250% of baseline. Overnight incubation (18 hrs.) with testosterone suppressed the response to avian LHRH in agreement with mammalian reports. The equipotency of avian and mammalian LHRH in this avian system is in contrast to reports that avian LHRH has only 3.4% of mammalian LHRH activity to release LH from a rat pituitary system. These comparative data suggest increased specificity of LHRH receptors in mammals compared to birds. (Supported by NSF Grant PCM 81-04144 to IPC)

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EFFECTS OF GONADOTROPIN-RELEASING HORMONE ANTAGONISTS ON OVARIAN RECRUDESCENCE IN THE LIZARD, *ANOLIS CAROLINENSIS*. R. R. Tokarz. Univ. of Miami, Coral Gables, FL.

Gonadotropin-releasing hormone (GnRH) antagonists were administered to female *Anolis carolinensis* to test the hypothesis that GnRH plays a role in the regulation of reptilian reproductive cycles. Females were obtained in early March prior to the period of ovarian recrudescence, assigned to one of 5 treatment groups, and placed under environmental conditions that initiate ovarian growth. Depending upon the group, animals were either treated daily for 12 days with sc injections of 10 µg of GnRH antagonist (either LRF: Ac-D(2)NAL¹, pFDPhe², DTrp³, DArg⁶; LRH-77: Acetyl-Ala-CDF-DTrp-Ser-Tyr-DTrp-Leu-Arg-Pro-Gly-amide; or LRH-147: Acetyl-DTrp-CDF-DTrp-Ser-Tyr-DArg-Leu-Arg-Pro-Dala-amide), with 0.02 ml peanut oil (control), or were untreated. Animals were sacrificed at day 29. The percentage of females with yolked follicles was much lower in the LRF (0%) and LRH-77 (12.5%) treatment groups than in the LRH-147 (63.6%), peanut oil (63.6%), and untreated (50%) treatment groups. Mortality prior to day 29 was also higher in the LRF and LRH-77 groups. These results suggest that ovarian recrudescence in *Anolis carolinensis* can be adversely affected by some GnRH antagonists.

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TEMPORAL SYNERGISM OF CORTICOSTERONE AND PROLACTIN AFFECTS GONADAL GROWTH IN NEWTS. L. J. Miller. Gannon Univ., Erie, PA

Significant variations in testis growth were obtained in red-spotted newts, *Notophthalmus viridescens*, after 14 daily injections of corticosterone followed either immediately (0), 8, or 16h by prolactin injections. Largest testes relative to body weight (GSI) occurred in the 0-h group and smallest testes occurred in the 16-h group. Testes weights in the 16-h group were approximately equal to those in a group (LD 16:8) examined prior to injections. Testes in the 0-h group approximated those in an unhandled group exposed only to the continuous light conditions used during the experiment. Thus the apparent photoperiodic increase in testis growth was inhibited by a specific temporal administration of corticosterone and prolactin.

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COMPARATIVE EFFECTS OF PROLACTIN ON INCUBATION BEHAVIOR AND TARGET ORGAN GROWTH IN RING DOVES. D.S. Janik and J.D. Buntin. Univ. of Wisconsin-Milwaukee.

Pairs of doves were separated from their nests and mates on the fourth day of their incubation period. Ovine Prolactin (PRL; 2.5, 5, 10, or 20 IU/100g.b.w./day, sc.) was administered twice daily for ten days. Birds were then tested in isolation for their response to a nest and eggs. Overall, the number of PRL treated birds displaying incubation behavior was greater than controls and more higher dose birds incubated than lower dose birds ($p < .05$). The quality of incubation behavior did not vary markedly across dose groups; however, females showed more quiet sitting behavior than males at lower doses ($p < .05$). Crop, liver, and body weight increased with PRL dose and body weight changes were sex specific. While oviduct weight was maximally suppressed by the lowest dose of PRL, testes weight did not change markedly with PRL treatment. Incubators had larger crops than nonincubators and the quality of incubation behavior was positively correlated with crop weight. We conclude that PRL affects target organ growth and promotes maintenance of incubation behavior; however, important sex and tissue differences exist in response to PRL.

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PROGESTERONE RECEPTORS IN THE OVIDUCT OF OVOVIVIPAROUS WATERSNAKES (*NERODIA*). S. Kleis and I.P. Callard. Boston Univ., Mass.

Steroid receptor mechanisms underlie reproductive tract adaptations associated with the processing of eggs in oviparous vertebrates, and their retention in viviparous species. Of particular interest in viviparity is the hormone progesterone. Previous studies from this laboratory (Ho and Callard, *Endocrinology*, in press) have identified a progesterone receptor in the chelonian species *Chrysemys picta*, and the present report concerns identification of a progesterone receptor in the ovoviviparous watersnake, *Nerodia*. Using DNA-cellulose and LH-20 column chromatography this receptor exhibits high affinity (K_A in $10^{10} M^{-1}$ range), low capacity binding, steroid and tissue specificity, and fluctuations correlated with the reproductive cycle and plasma steroid levels. It is anticipated that comparative studies of this kind will elucidate the importance of steroid receptors in the evolution of viviparity. (Supported by NSF Grant # PCM 81-04144 to IPC)

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THE ENDOCRINE PANCREAS OF THE TURTLE, *CHRYSEMYS PICTA*. D.A. Gapp and J.M. Polak*, Hamilton College, Clinton, NY, and Hammer-smith Hospital, London, England.

Endocrine cells of the painted turtle were identified immunocytochemically in sections of Bouin's-fixed pancreas. A, B, D and PP cells were found scattered individually or in small clusters throughout the pancreas with the exception of an endocrine cell-rich lobe near the spleen where islets were observed. In this lobe, islets were composed of a central mass of B cells surrounded by a loose mantle of A cells. D cells were not associated consistently with other cell types and occasionally were incorporated into the islets. PP cells were not found within islets or associated with other cells and were absent from the endocrine cell-rich lobe. The loose organization of the *Chrysemys* endocrine pancreas confirms previous observations as to the primitive nature of the chelonian islet. Moreover, the paracrine regulatory mechanisms postulated for other vertebrate islets may not be operable in the turtle islet where the scattered distribution of the D cells would not permit the close cell-to-cell apposition deemed essential for the central role of somatostatin in the intra-islet regulation of endocrine cell secretion.

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INTERACTIONS BETWEEN GROWTH HORMONES AND THEIR BINDING SITES IN SEVERAL VERTEBRATE SPECIES. John F. Tarpey and Charles S. Nicoll. Univ. of California, Berkeley.

Growth hormone (GH) binds to liver membranes of several mammalian species. To obtain information on comparative and evolutionary aspects of GH binding, membranes from several non-mammalian vertebrates were examined by radioreceptor assay (RRA). Specific binding of ¹²⁵I-bovine GH was not detectable in membranes from liver or kidney of pigeon, slider turtle, bullfrog, Coho salmon, or from liver of leopard shark. GH specifically bound to membranes from liver, but not kidney, of sturgeon (*Acipenser transmontanus*). The sturgeon hepatic receptor was compared with liver receptors from pregnant rats and mice, and male rabbits using GH and prolactin preparations of different species. The sturgeon RRA for GH was more sensitive than any of the mammalian RRA's, but the potencies were relatively similar in the mammalian and sturgeon RRA's. However, chicken, pigeon, shark and sturgeon GH's were quite active in the sturgeon RRA but they had little or no activity in the mammalian assays. Overall, the mammalian hepatic GH receptors are more closely related to each other than to those of the sturgeon. NSF grant PCM 82-03583.

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TIME-OF-DAY OF FEEDING AFFECTS GROWTH, FATTENING, AND SERUM HORMONE LEVELS IN CHANNEL CATFISH. T.A. Noeske, R.E. Spieler, and H.C. Parker. Milwaukee Public Museum, WI, and U.S. Fish and Wildlife Service, SE Fish Cultural Laboratory, Marion, AL.

Channel catfish *Ictalurus punctatus* were maintained on a 12L:12D photoperiod, 20⁰ + 1⁰C, and received one of two commercial diets either early (0730 h), late (1600 h), or at both times of day (feeding rate 2.5 g% body weight/day). After 6 weeks of feeding, body weight, body length, abdominal fat weight and mean serum cortisol and thyroxine levels (determined by radioimmunoassay) differed among feeding regime groups depending on the diet, time-of-day of feeding and/or feeding frequency. There were also diel variations in serum cortisol and thyroxine titers; the patterns of serum cortisol and thyroxine differed with diet and time-of-day of feeding, respectively.

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THE NADP-DEPENDENT ISOCITRATE DEHYDROGENASE ISOZYMES OF *FUNDULUS HETEROCLITUS* (L.). I. Gonzalez and D. A. Powers, intro. by L. DiMichele, Johns Hopkins Univ., Baltimore, MD.

Three IDH isozymes were purified and characterized. The isozymes exhibit differences in subcellular localization and tissue distribution. They are dimers with subunits of 45,000 D. Isoelectric pHS are 5.19 and 7.0 for the liver isozymes and 5.29 for the muscle form. Heat denaturation studies showed differences in thermal stability among the isozymes. The kinetics of thermal denaturation were not first order. Kinetic studies at pH 7.4 and 25⁰C showed no differences in the Km's for isocitrate in both liver isozymes (IDH-A₂ & IDH-B₂). The muscle form (IDH-C₂) has a higher substrate Km. Vmax and Km for isocitrate are pH independent but the Km for NADP is pH dependent. The IDH-B₂ and IDH-C₂ isozymes showed a ΔG⁰ of 15 Kcal/mol. These studies suggest that IDH-B₂ has a higher rate of catalysis than IDH-C₂.

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6 PHOSPHOGLUCONATE DEHYDROGENASE (6PGDH) OF FUNDULUS HETEROCLITUS: CLINAL VARIATION AND PURIFICATION. J. M. Stelling, I. J. Ropson and D. A. Powers, intro. by L. DiMichele, Johns Hopkins Univ., Baltimore, MD.

6PGDH, an important enzyme in the pentose shunt, displays clinal allelic variation. The locus has 2 major alleles. One allele predominates along the entire east coast. The other allele predominates in the less saline waters of the northern Chesapeake Bay and the Potomac River. Thus, 6PGDH shows little or no clinal variation along the east coast, but it has a dramatic allelic cline in the Chesapeake Bay and its tributaries. Of the other 20 loci examined, 6PGDH is the only locus that has such a difference between east coast and Chesapeake populations. This unique class of clinal variation must be accounted for when describing possible adaptive evolutionary strategies. 6PGDH has been purified by ion exchange, affinity and gel permeation chromatography. It is dimeric, with a subunit molecular weight of 42,000 D and a native molecular weight of 84,000 D.

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CLINAL VARIATION, INHERITANCE, AND CHARACTERIZATION OF HEXOSE 6 PHOSPHATE DEHYDROGENASE (H6PDH) FROM FUNDULUS HETEROCLITUS. I. J. Ropson and D. A. Powers, intro. by L. DiMichele, Johns Hopkins Univ. Baltimore, MD.

H6PDH, a microsomal enzyme similar to glucose-6-phosphate dehydrogenase (G6PDH) displays allelic variation with latitude. Populations are fixed for one allele at this locus in Maine and further north, while southern populations have two other alleles. The allelic isozymes are inherited in Mendelian fashion. Our data suggest this locus is loosely linked with another, phosphoglucosyltransferase-B. The enzyme was purified by ion exchange, affinity, and gel chromatography. The molecular weight of the enzymes was estimated to be 220,000 D by gel chromatography. It is apparently dimeric, with a subunit molecular weight of 104,000 D. However, the enzyme appears to be partially degraded *in vivo* to yield 50,000 D fragments that are active. Our data, together with data from the literature, suggest that H6PDH has evolved from G6PDH by covalent linkage of two G6PDH-like subunits.

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GENETIC VARIATION AND CHARACTERIZATION OF ASPARTATE AMINOTRANSFERASE (AAT) ISOZYMES OF FUNDULUS HETEROCLITUS. D. C. Brown, N. Ramakrishna, and D. A. Powers, intro. by L. DiMichele, Johns Hopkins Univ., Baltimore, MD.

Fundulus heteroclitus were collected from marshes along the East Coast of the US, and typed for mitochondrial and cytosolic AAT. The mitochondrial AAT locus is fixed for one allele south of Cape Cod, with a variant appearing in Maine at a gene frequency of 0.38. The cytoplasmic AAT locus is fixed for one allele in Maine; variants up to 0.1 gene frequency appear from Mass. to Ga. Alleles at both loci segregate as independent characters, yielding the expected F_1 ratios. Both isozymes have been purified and characterized as to molecular weight, isoelectric point, and K_m at 25°C, pH 7.5, and optimal substrate concentration.

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MAGNITUDE OF SEASONAL EFFECTS ON HEAT TOLERANCE IN FUNDULUS HETEROCLITUS. A.J. Bulger and S.C. Tremaine. Univ. of Virginia, Charlottesville.

This report summarizes the heat tolerance (CT_{max}) of F. heteroclitus collected over a two-year period and acclimated to seasonal temperatures in the laboratory. CT_{max} increased by more than 10°C to values over 44° through the acclimation range of 7-38°. At certain times of the year this species can tolerate short-term temperature increases of 24°. Tests indicate that seasonal adjustments in tolerance to heat stress persist at least 30 days after laboratory shifts to novel conditions of temperature and photoperiod. Seasonal adjustments in thermal tolerance are superimposed on a daily rhythm in CT_{max} which is strongly influenced by photoperiod and which occurs even after long exposure to constant temperature. It appears that adaptations to a highly fluctuating thermal environment include those which ignore current water temperature.

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Ca-ATPases in GILL EPITHELIUM OF SEA WATER AND FRESH WATER-ADAPTED FUNDULUS HETEROCLITUS. M. J. Paul and C. J. Burdick. CUNY, Brooklyn College.

Two Ca-ATPases have been characterized in gill epithelium of sea water (SW) and fresh water (FW) - adapted male killifish (Fundulus heteroclitus) - a $\text{Ca}^{2+} + \text{Mg}^{2+}$ - ATPase and a $\text{Ca}^{2+} + \text{Na}^+$ - ATPase. The optimum Ca^{2+} concentration for the Ca + Mg - ATPase is 0.01 mM, while the optimum Ca^{2+} concentration for the Ca + Na - ATPase is 20 mM. The Ca + Mg - ATPase activity is significantly higher in FW fish as compared to SW fish. The Ca + Na - ATPase on the other hand is significantly higher in SW fish. The results suggest that these enzymes may be involved in Ca-regulation in killifish.

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HORMONAL CONTROL OF ERYTHROCYTE FUNCTION IN FUNDULUS HETEROCLITUS. E. Lee* and L. DiMichele. Johns Hopkins Univ., Baltimore, MD.

It is well known that fish respond to hypoxia by increasing hemoglobin oxygen affinity. We have investigated the possible hormonal control of this phenomena by incubating erythrocytes in an artificial media containing various amounts of epinephrine or cortisol. Substantial increases in blood oxygen affinity were observed in treated cells. The mechanisms involved in increasing blood oxygen affinity appear to be cell enlargement, intracellular pH shifts, and an alteration of glycolysis. Moreover, we have found that epinephrine effects metabolism at non-stress levels. This finding indicates the epinephrine plays a role in maintaining normal erythrocyte function.

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CELL SURFACE SPECIALIZATIONS IN FUNDULUS HETEROCLITUS. C. E. Bailey. University of Arkansas, Fayetteville.

The changing developmental pattern of cell surface specialization and cell junctions during neurulation in Fundulus heteroclitus was examined by freeze-fracture replication, SEM and TEM. In the early stages of neural keel development the tightly packed undifferentiated cells exhibit numerous gap junctions. Intramembranous particles (IMPs) on the P-face range in size from 8-15nm and are distributed randomly over the non-junctional membrane. E-faces show the characteristic pitting in the gap junctions but display fewer total numbers of particles over non-junctional surfaces. Tight junctions are observed primarily along the lateral margins of cells, as well as near the edges of the keel, and feature well-dispersed particles along junctional ridges. As cavitation occurs and expansion of the neural tube proceeds, features indicative of exocytotic sites become evident along the forming neurocoel. Tight junctions forming at the new apical margins of the developing neuroblasts display on the P-face a network of strands commonly enclosing groups of individual IMPs. Gap junctions are still prominent and desmosomes begin to appear.

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PATERNAL CARE IN CANIDS
J.R. Malcolm. Univ. of Redlands CA

Paternal care is an integral part of the monogamous mating system seen in most canids. Male care has been reported in all species studied with food provisioning (usually by regurgitation), and babysitting as the commonest forms of care.

Large canids such as the wolf and the African wild dog tend to show more elaborate male care than small canids (e.g. red fox). Some species (e.g. coyotes) may show different levels of male care in different populations.

The critical evolutionary factors explaining the presence of male care are i) the effects of the male's care on the survival of his offspring, and ii) the ability of a male to mate with other females. These factors in turn depend on both ecological variables such as prey base, and seasonality, and social factors namely the extent to which other members of the species will help if the male does not, and the mating behavior of other males in the population.

Limited field data suggest that population density, and seasonality are the most important factors leading to paternal care in species with intra-specific variation in the trait.

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VARIATION IN PATERNAL INVESTMENT WITH MARSH PRODUCTIVITY IN POLYGYNOUS YELLOW-HEADED BLACKBIRDS. D. F. Gori (intro. by J. H. Brown). Univ. of Arizona, Tucson.

Models for the evolution of paternal care predict increasing parental investment by males as their ability to contribute to offspring survivorship increases and as the ability to attract unmated females decreases. Field observations on male Yellowheads indicate variation in the amount and timing of paternal care that is consistent with this prediction. The number of unmated females and their ability to raise young unattended are positively correlated with marsh productivity. Consistent with this, the proportion of males feeding young, the number of nests fed by investing males and feeding rates are lower in productive marshes. Males attracting more than the mean number of females in productive marshes have a lower probability of providing care and lower feeding rates than less successful males. Males that are not feeding young spend greater amounts of time in sexual advertisement. In unproductive marshes, paternal care commences as soon as the young are old enough to require aid; in productive marshes where the arrival rate of females remains higher for longer, care by successful males is delayed.

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A MISUNDERSTANDING OF THE CONCORDE FALLACY. R.C. Sargent* and M.R. Gross. Simon Fraser University, Burnaby, B.C., Canada.

Trivers predicted that mate desertion in animals with biparental care would depend on the relative difference between female and male cumulative parental investment. Dawkins & Carlisle, and Maynard Smith pointed out that investment theory states that future investments should depend on expected future payoffs, and not on whether or not past investments will be wasted. This principle, known as the Concorde fallacy, does not state, however, that expected future payoffs are independent of past investments. This potential misconception seems to have led behavioral ecologists to suggest that animals who base their current investments on their past investments are behaving suboptimally. In fact, in both optimal foraging and parental investment models, expected future payoffs depend on past investments. Thus, experimental manipulation of past investment in these models changes expected future payoffs. The converse, however, is false; past investment cannot depend on changes in expected future payoffs. Thus, to test whether animals commit the Concorde fallacy, investigators should manipulate expected future payoffs, and not past investment.

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POSSIBLE FEMALE CONTROL OF MALE CONTRIBUTION TO INCUBATION UNDER VARYING AMBIENT TEMPERATURES. M.A. Sydlik. Syracuse Univ., Syracuse, N.Y.

Male and female Zebra Finches alternate turns incubating, with the result that the eggs are covered 100% of the time regardless of ambient temperatures. The results of experimental manipulations indicate that while female attentive bout lengths do not appear to be influenced by ambient temperatures, male bout lengths are significantly shorter at low (14°C) than at high (30°C) ambient temperatures. Males perform a significantly lower proportion of the total incubation at low temperatures, while at high temperatures both parents perform about equal amounts of the incubation. Details of the nest exchange behaviors suggest that females limit male time on the nest at low ambient temperatures. A test of a model of random and non-random attentive bout lengths supports this conclusion.

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WHY SHOULD MALE FROGS CARE? D.S. Townsend. State University of New York at Albany.

In the Puerto Rican frog, Eleutherodactylus coqui, parental care is performed exclusively by males, and consists of high fidelity attendance of eggs at terrestrial oviposition sites. Males are present in their nests 97% of the time during the day and 77% of the time at night. Parental behavior involves brooding eggs and defending them against cannibalistic intruders. The benefits of the care provided are substantial. Clutches receiving care had 3.35 times the hatching success of those from which parental males had been experimentally removed (.775 versus .231). Because of the time invested in care, parental males incur costs as a result of reduced calling activity and reduced foraging. Field data and a simple model suggest that, while a male that abandoned eggs could obtain twice as many mates as a caring male, the substantially higher hatching success of a care strategy yields many more hatchlings over a breeding season. Parental males do have a low food intake. But, because the food intake of calling males is low also (L.L. Woolbright, personal communication), the relative decrement for parental males is small.

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PARENTAL INVESTMENT BY THE VICUNA. Paul C. Bosch and Gerald E. Svendsen*. University of Ohio, Athens.

The behavior of the vicuna (Vicugna vicugna) was studied at the Pampa Galeras Vicuna Reserve, Peru, to test two hypotheses based on parental investment theory: (1) Increased grazing time by females with young over females lacking young is a maternal investment, since extra energy must be garnered to support a suckling young. (2) Increased territorial defense by males with young on their territory compared to males without young on their territory is a paternal investment, since males have a high certainty of parentage of the young on their stable territories and by vigorously defending a territory, may provide their young with a protected, resource-rich environment. Observations were made on individual vicunas for a total of 147 one-hour periods, and included members of 17 family groups. In regard to the first hypothesis, ANOVA results indicate that lactating females spent significantly more time grazing than non-lactating females ($p < .001$). The data collected on males, however, did not indicate that males with more young on their territories spent more time in territorial defense than males with fewer or no young on their territories.

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ULTRASTRUCTURE OF ODONTOBLASTS IN THE SEA URCHIN TOOTH. C.P. Chen. Univ. of South Florida, Tampa.

The tooth of Lytechinus variegatus is composed of the chewing part, the shaft and the plumula. Odontoblasts are most abundant in the plumula, and occur in decreasing abundance along the shaft down to the chewing part. Free odontoblasts occur on the inner side of the plumula. Odontoblasts form pseudopodial cables and join syncytially into rows. Calcium carbonate is deposited within the skeletal sheath which occurs inside the syncytium. Nuclei of the odontoblasts are round in the free stage and ellipsoid in the early syncytial stage, and become elongated later as calcium carbonate is deposited. Numerous vesicles and dense bodies are present in the odontoblasts of the plumula, indicating the high level of secretory activity there.

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ENVIRONMENTALLY INDUCED CHANGES IN SHELL MICROSTRUCTURE OF THE ASIATIC BIVALVE CORBICULA. R. S. Prezant and K. Chalermwat. Univ. of Southern Mississippi, Hattiesburg.

Trophic and temperature conditions may act synergistically to alter "normal" internal shell microstructure of Corbicula fluminea. Environmental circumstances that negatively influence the overall well-being of the bivalve, produce shells with white internal pigmentation and crossed acicular microstructures. Healthy, growing clams maintained under satisfactory thermal and trophic conditions, produce shells with purple internal highlights and typical crossed lamellar microstructures. It is possible that during less than ideal conditions, the bivalve deposits the less ordered crossed acicular microstructural units at an energetically less "expensive" price. Shells found along shorelines are typically white internally. This may not be the sole result of solar bleaching, as previously thought, but may be reflecting the change in shell production induced within unhealthy or dying animals.

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THE DEPOSITION OF ORGANIC AND INORGANIC MATERIALS IN THE GASTROLITHS OF HOMARUS AMERICANUS. R.L. Radtke, Belle W. Baruch Inst., Univ. of S.C., Columbia, and Hawaii Inst. of Marine Biology, Univ. of Hawaii, Kaneohe.

The gastroliths of the American lobster, Homarus americanus, form prior to ecdysis and function as calcium storage structures. The structural and chemical composition of gastroliths was analyzed by Scanning Electron Microscopy and a multiplicity of chemical methods. X-ray diffraction analyses show that the mineralogy of lobster gastroliths is CaCO_3 in the calcite form with traces of vad-erite crystals. The gastrolith is a composite of triangular particles composed of calcite crystals in a protein matrix. Rhythmic patterns are present and suggest daily deposition. The protein matrix is approximately 20% of the gastrolith particles by weight with alanine (20.2%), glutamic acid (17.4%), glycine (9.5%) and aspartic acid (9.3%) as the predominant amino acids. Stable isotope analyses reveal that the oxygen and carbon isotopes are deposited in equilibrium with the environment. These data provide insights into the calcium storage mechanisms of the lobster.

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X-RAY DIFFRACTION ANALYSIS OF CALCAREOUS DEPOSITS IN PHYSARACEOUS MYXOMYCETES. S. K. Parker and R. W. Scheetz. Univ. of Southern Miss., Hattiesburg.

Powder x-ray diffraction using a wide-angle Gandolfi camera was utilized to investigate calcareous deposits in Myxomycetes of the order Physarales. Investigations of 35 species from diverse collections have shown several members of the family Physaraceae to contain a crystalline structure. Species of *Physarum*, *Fuligo*, *Craterium*, *Badhamia*, and *Diachea* showed indications of calcite in four species, possibly calcium formate in five species and vaterite in three species as a secondary compound. Five species produced insufficient diffraction lines for compound identification but the presence of two additional crystalline compounds was indicated. Species of the family Didymiaceae with the exception of *Diderma* sp. consistently showed calcite as the sole crystalline compound. These results are inconsistent with the general hypothesis that members of the family Physaraceae contain amorphous calcium deposits. The CaCO_3 is not exclusively in the form of calcite and additional crystalline calcium compounds may be present. Further studies are underway to determine how environmental conditions affect calcium deposition.

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A COMPARISON BETWEEN SELACHIAN AND REPTILIAN PROTEIN BIOSYNTHESIS DURING AMELOGENESIS. E.E. Graham, C.C. Bessem* and H.C. Slavkin. Texas College of Osteopathic Medicine, Ft. Worth and Univ. of Southern Calif., Los Angeles.

During vertebrate enamel formation, specific proteins, enamelin and amelogenin, are associated with its development. A comparison of protein biosynthesis between *Squalus acanthias*, Spiny Dogfish, and *Alligator mississippiensis*, American Alligator, using ^{35}S -methionine for culturing tooth organs in pulse/chase experiments was made. Previous experiments using a sequential dissociative extraction scheme and SDS/urea-PAGE stained with Coomassie brilliant blue and stains all visualized the proteins present in the developing enamel. The molecular weights of these proteins and selected isolated proteins amino acid composition were determined. These experiments suggest that during tooth development that the selachian ameloblasts secrete enamelin and the alligator ameloblasts secrete both amelogenin and enamelin. Lastly, these experiments suggest enamelin is a calcium binding protein.

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A LONG TERM STUDY OF THE TOOTH REPLACEMENT PHENOMENON IN THE GREEN IGUANA, *IGUANA IGUANA*. L. W. Kline. Univ. of Alberta, Edmonton Alberta.

A study using 11 green iguanas, *Iguana iguana* examined the growth of the animals, changes in the wave replacement of teeth, the increasing size of the teeth, and the posterior migration of tooth positions over a period of 2.7 years.

The results supported the view that tooth replacement is closely related to growth. The teeth were measured regularly and demonstrated a smooth increase in width (eg. dentary increased from 0.85 ± 0.09 mm to 1.31 ± 0.2 mm) as the lizards grew. The tooth positions were found to migrate posteriorly thereby providing adequate space for the ever larger teeth replacing their smaller predecessors. These observations suggested that the wave replacement of teeth allows for adequate growth of the dentition in length and height to maintain teeth of a size in proportion to the overall size of the individual.

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BODY TEMPERATURES AND THERMAL ECOLOGY OF GYPSY MOTH AND TENT CATERPILLARS. R. Knapp* and T. M. Casey. Cook College, Rutgers Univ., New Brunswick, NJ.

Ectotherms usually function optimally over a specific range of temperatures which may or may not be at the normal ambient temperatures (T_a) that they encounter. *Malacosoma americanum* and *Lymantria dispar* caterpillars were observed at four field sites on and around the Cook College campus from early May to late June. Behavior, body temperature (T_b), and T_a were recorded at 30 min. intervals during the day. *M. americanum* behaviorally thermoregulates T_b at $26-33^\circ\text{C}$ (slope of T_b vs. $T_a = .40, N=153$) over a range of T_a 's from 10 to 24°C by communal basking on the tent &/ or forming clumps in the tent. Behavior varied with time of day, T_a , and developmental stage. *L. dispar* is a thermal conformer (slope of T_b vs. $T_a = 1.03, N=324$), merely retreating to shaded tree trunks during the day. T_b 's were always 5°C or less above T_a 's from 18 to 34°C . Growth rates of *M. americanum* are temperature dependent, with the highest being at its preferred T_b of 30°C . Growth rates of *L. dispar* are less temperature dependent. Differences in behavior and thermal ecology are related to the different T_a 's encountered. Supported by NSF Grant PCM 80-11158 and NJ Agric. Expt. Sta. Project # 18511.

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TEMPERATURE SELECTION AND CENTRAL TEMPERATURE SENSITIVITY IN THE COCKROACH, *PERIPLANETA AMERICANA*. B. F. Murphy Jr. and J. E. Heath. Univ. of Illinois, Urbana-Champaign.

American cockroaches have been used to gain insights into the physiological basis of thermoregulation in insects. Temperature receptors have been described on the tarsi and antennae of *Periplaneta americana*. The loss of peripheral receptors does not significantly affect the temperature selection of cockroaches in a temperature gradient shuttlebox. Certain cells in the cockroach central nervous system are exquisitely sensitive to local temperature. It has been suggested that these cells may be central temperature receptors. Some temperature sensitive cells in the central nervous system also receive input from antennal temperature receptors but not in any as yet discernable pattern. Cockroach temperature regulation may then rely heavily on central temperature reception and peripheral receptors may serve primarily as nociceptors.

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ONTOGENY OF THERMOREGULATION IN BLUE-TONGUE SKINKS, *TILIQUA SCINCOIDES*. J.A. Phillips. Zoological Society of San Diego, CA.

The relationship between growth, and degree and pattern of thermoregulation was examined in captive-born blue-tongue skinks (*Tiliqua scincoides*) maintained on a diet of known composition and caloric content. Mean selected temperature during photophase decreased from 37.5°C to 30.8°C and caloric input required to increase body mass by 1.0 g increased from 2.8 to 7.5 kcal as the animals increased in body mass from 10 to 500 g. Although a diurnal pattern of body temperature was consistently noted in the skinks as they grew, at body weights between 10-200 g the animals sought significantly more heat than animals with body weights > 200 g. Additionally, young skinks (< 200 g) exhibited a distinct crepuscular use of ambient heat, whereas juvenile and adult skinks sought heat during the afternoon only. Because digestive efficiency voluntarily decreased ($p < 0.05$) as the skinks matured, the observed body temperature patterns appeared to be a developmental response. This research was supported by the Zoological Society of San Diego and a grant from Kaiser Foundation.

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INVERSE ACCLIMATION IN TEMPERATE AND TROPICAL SCHELOPORUS LIZARDS. J. S. Tsuji. Univ. of Washington, Seattle.

Inverse acclimation is a type of physiological response in which chronic exposure to low body temperature (T_b) decreases rather than increases (positive or compensatory acclimation) standard metabolism ($\dot{V}O_2$) at low T_b . Inverse acclimation is thought to be adaptive in seasonal environments by conserving energy in cool seasons when food is unavailable. If this reasoning is valid, then inverse acclimation should be more marked in temperate-zone than in tropical lizards. Experiments with *Sceloporus occidentalis* (Washington) and *S. variabilis* (Costa Rica) contradicted this hypothesis. Both species showed inverse acclimation of $\dot{V}O_2$ of similar magnitude. Moreover, both species decreased their critical thermal minimum, the T_b at which righting ability is lost, to the same degree after cold acclimation. Thus, either these acclimation patterns have some basis other than a response to temperate-zone conditions, or there has been insufficient time for *Sceloporus* to lose its temperate-zone adaptations after radiating into the tropics.

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THERMAL ACCLIMATION OF LOCOMOTOR PERFORMANCE IN ANURAN AMPHIBIANS. K. Miller and G. M. Zoghby*. Franklin and Marshall College, Lancaster, PA.

Acclimation is the principal strategy employed by amphibians in coping with environmental temperature changes. We examined the influence of acclimation on the effect of temperature on locomotion in three anuran species. Giant toads, *Bufo marinus*, moved most quickly at 22°C, and acclimation to that temperature further improved performance (inverse acclimation). Leopard frogs, *Rana pipiens*, also moved most quickly at 22°C, but acclimation to 12°C improved locomotor performance at that temperature (positive acclimation). Clawed frogs, *Xenopus laevis*, moved most quickly at 12°C and acclimation did not affect locomotion in this species. Thus, while acclimation clearly affects locomotor performance in some anuran species, the direction of change differs among them. In giant toads and leopard frogs the effects of temperature on locomotion are not parallel to the effects of temperature on the activity of lactate dehydrogenase enzyme from muscle. Clawed frogs appear to swim more efficiently at lower temperatures and this may explain the effect of temperature on locomotion in that species.

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BASKING BEHAVIOR OF THE TURTLE, Pseudemys scripta, IS AFFECTED BY DIGESTIVE STATE. K.A.Hammond, J.R. Spotila and E.A.Standora. State Univ. College at Buffalo, New York.

Fed and non-fed turtles were acclimated to and tested at four different temperatures (10, 20, 30, and 35°C) twice, once in the spring/summer seasons and once in the fall/winter seasons.

In the spring/summer seasons fed turtles basked significantly more than non-fed turtles ($P < .05$), and females basked significantly more than males ($P < .05$).

In the fall/winter seasons there were no statistically significant differences in the basking times of fed and non-fed turtles or between the basking times of males and females.

The number of days since feeding was also an important factor in determining the duration of basking bouts in the spring.

We suggest that basking in P. scripta is a complex behavior which is affected by digestive state, acclimation temperature, sex and time of year.

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THERMAL TOLERANCE AND ACCLIMATION IN THE ANURANS, BUFO TERRESTRIS, HYLA SQUIRELLA AND HYLA FEMORALIS. Paul V. Cupp, Jr. Eastern Kentucky University, Richmond, KY

Critical thermal maxima (CTM) were determined at acclimation temperatures (AT) of 10, 20, and 30°C for the anurans, Bufo terrestris, Hyla squirella, and Hyla femoralis from Bulloch Co., Georgia. Bufo terrestris had a significantly higher CTM at each AT than either H. squirella or H. femoralis. The CTM of H. squirella and H. femoralis were not significantly different at any AT. No relationship was observed between thermal tolerance and the geographic ranges of these species. In B. terrestris, the CTM was significantly higher at 30°C AT than at 20°C, and significantly higher at 20°C than at 10°C AT. While in H. squirella and H. femoralis, the CTM at 30°C is significantly higher than at 20°C AT, the 20°C group was not significantly different than those at 10°C AT. Since the CTM of B. terrestris decreases at 10°C AT this may reflect physiological adjustments that allow the species to begin breeding earlier than the hylid frogs.

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THE WATER BALANCE OF THE CALIFORNIA LEGLESS LIZARD, ANNIELLA. M. H. Fusari UCSC, Santa Cruz, California.

Evaporative water loss rates (EWL) measured at varying ambient temperatures and vapour density deficits (VDD) compared closely with those measured for other lizard species from mesic environments and/or fossorial habitats. At VDD 22.6mg H₂O l⁻¹dry air and 22°C EWL=1.11mg g⁻¹h⁻¹. Cutaneous EWL was 77% of total EWL. At lower VDDs and in sand the EWLs were markedly reduced. Relative humidity of even slightly moist sand was above 98%. Anniella could drink from sand over 7% soil moisture content and, under most conditions, preferred moist sand over dry. Water fluxes for force-fed lizards were 6.55 mg g⁻¹d⁻¹. Estimated field budgets indicated that, if lizards spent most of the day at their preferred temperatures in slightly damp sand they would be able to spend 1-4 h moving in dry sand at higher temperatures and remain in positive water balance without drinking. Seen in the context of the fossorial habitat these water budgets suggest that, by selecting temperature, VDD, and soil moisture content, the California legless lizard could practice behavioral osmoregulation.

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CARDIOVASCULAR FUNCTION IN A SEMI-INTACT PREPARATION OF APLYSIA CALIFORNICA IS AFFECTED BY SPONTANEOUS GILL MOVEMENTS. P.L. deFur and K. Lukowiak. George Mason Univ., Fairfax, and Univ. of Calgary, Alta.

Cardiac output was measured in a semi-intact preparation of Aplysia californica using a thermodilution technique used previously with other invertebrates. Heart rate was measured via an impedance technique and from hydrostatic pressures determined in the pericardium, anterior and abdominal aortae. At 15°C, mean cardiac output of 13 preparations ranged from 35 to 122 ml/kg-min at heart rates of 9-20 beats/min. Ventricular pulse pressure was 3-4 cm/H₂O and aortic pressure 3.5-5.5 cm H₂O. Cardiac output was reduced both preceding and following spontaneous gill movements (SGM), but cardiac output and blood pressure both were greatly elevated during SGM's. Cardiac output is little affected by changes in pH, HCO₃⁻ or buffering of the perfusate, so long as the changes are within the physiological range. It is concluded that changes in cardiac output result from adjustments of heart rate and cardiac stroke volume, independently, and from muscular contractions of the respiratory structures.

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THE EFFECTS OF THE MOLLUSCAN TETRAPEPTIDE FMRF-amide ON THE CIRCULATORY SYSTEM OF THE PINTO ABALONE, *Haliotis kamtschatkana*. K.G. Krajniak & G.B. Bourne Bamfield Marine Station, British Columbia & Univ. of Calgary, Alberta

Aortic and left efferent ctenidial blood pressures were recorded from unrestrained pinto abalones via Statham P23 Db transducers connected to the circulatory system by fine bore catheters. The pressure measurements were monitored on a Gould 2400 recorder. All doses of FMRF-amide were prepared in filtered sea water and administered via the ctenidial catheter. Heart rates rose in a dose-dependent manner with threshold at between 0.01 to 0.10 $\mu\text{g}/\text{kg}$ wet body weight. At higher doses (10-100 $\mu\text{g}/\text{kg}$) the tachycardia was followed by a decrease in heart rate, while aortic mean and pulse pressures rose. Further experiments using isolated hearts superfused with abalone saline and various concentrations of FMRF-amide were performed. Again heart rates rose in a concentration-dependent manner with threshold at 10^{-10} M. Contractility increased slightly at higher concentrations with tonic contracture occurring at 10^{-5} M. Thus this study indicates FMRF-amide may have an excitatory role in controlling circulation in *Haliotis kamtschatkana*.

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CHRONIC EXAMINATION OF THE HEARTBEAT IN THREE SPECIES OF GASTROPODS.

G.B. Bourne. Bamfield Marine Station, British Columbia & Univ. Calgary, Alberta.

At 11-12 °C, long-term recordings of the heartbeat were made in *Haliotis kamtschatkana*, *Polinices lewisii* and *Archidoris odhneri* by strain-gauge manometry and/or impedance conversion. Also, impedance conversion permitted simultaneous monitoring of locomotion. The more invasive strain-gauge manometry was used to establish the validity of impedance conversion for measuring cardiac activity in such organisms. Impedance conversion produced accurate heart rate information over long durations but usefully monitored cardiac inotropic activity only over the short term. There were individual and interspecific variations in heart activity. In all three species, this activity was marked by periods of acardia in which the heart missed 2 or more beats. While short acardiac bouts appeared to be a function of the normal heart, longer periods were trauma induced by surgery and handling. Generally *Archidoris* had more acardiac episodes than the other species. In *Polinices*, acardia was often associated with foot and mantle expansion and filling of the aquiferous system. Further study is needed to elucidate the significance of acardia in such organisms.

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HEMODYNAMICS AND GAS EXCHANGE IN ISOLATED PERFUSED CRAB GILLS. L. E. Burnett, D. D. Jorgensen, R. L. Infantino, Jr.* Univ. of San Diego and Univ. of Puget Sound, Tacoma, WA.

Pre- and postgill hydrostatic pressures, P_{O_2} , pH and total CO_2 were measured while varying the flow rate of "blood" through perfused gills of *Cancer productus*. The flow rate and direction of "branchial water" passing over the gills was also varied. The pressures driving "blood" through the gills was similar (3 cm H_2O) to that found *in vivo*. The resistance to "blood" flow through the gills was minimal (PRU=0.11-0.14) when the "branchial chamber" pressures were negative (-2 cm H_2O) and maximal (PRU=0.15-0.23) when "b.c." pressures were positive (+2 cm H_2O). O_2 exchange was most effective when "blood" and seawater flowed countercurrent to each other ($\text{P}_{\text{V}\text{O}_2}=15$; $\text{P}_{\text{a}\text{O}_2}=55$) and less effective when flow was cocurrent ($\text{P}_{\text{V}\text{O}_2}=17$; $\text{P}_{\text{a}\text{O}_2}=46$). Postgill total CO_2 was generally lower than pre by about 0.5 mM. The differences showed little detectable variation with flow. Postgill pH was consistently lower than pre, a surprising result attributed to the excretion of acid into or uptake of base from the "blood" as evidenced by pre/postgill differences in titrable alkalinity.

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RESPIRATORY DYNAMICS IN FISHES: PRESSURE-VELOCITY RELATIONSHIPS DURING NORMOXIC VENTILATION. G. V. Lauder. Univ. of Chicago

Water velocities in the respiratory tract of bass, *Micropterus salmoides*, were measured using a hot-film anemometer with a frequency response greater than 2000 Hz. The flow velocity waveform showed spatial variation within the buccal cavity with posterior measurement sites showing lower amplitude fluctuations than anterior sites. Velocity in both the buccal and opercular cavities showed temporal variation over the respiratory cycle, and 80% of signal power in the velocity waveform is between 1 and 10 Hz. Flow within the buccal cavity reached a maximum velocity of 50 cm/sec and did not decline to zero even when differential pressure across the gills was negative. Simultaneous measurement of dimensional changes in the branchial apparatus and pressure and velocity fluctuations showed that gill bar adduction coincides with both the pressure reversal across the gills and with maximum opercular flow velocity. Differential pressure across the gills is a poor predictor of flow velocity within the mouth cavity and may be an unreliable indicator of respiratory function. Supported by NSF PCM 81-21649.

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EFFECT OF LITHIUM UPON BLOOD PRESSURE AND ADRENAL CATECHOLAMINES IN THE DOCA/NaCl RAT. E.F. O'Connor and S. Oparil* Univ. of Alabama in Birmingham, Birmingham, AL

Lithium (Li⁺) has been reported to prevent the development of high blood pressure (BP) in the deoxycorticosterone (DOCA)/NaCl and in the spontaneously hypertensive rat. Our study was undertaken to examine the effects of Li⁺ (3mEq/100g BW) on adrenal catecholamine (CA) content specifically, adrenaline (A), noradrenaline (NA) and dopamine (DA) in DOCA/NaCl and control animals. The changes found are summarized below:

Treatment	BP	A	NA	DA
DOCA/NaCl	↑↑	-	-	-
DOCA/NaCl Li ⁺	↑↑	↑	↑	↑
DOCA	↑	-	-	-
DOCA/Li ⁺	-	↑	↑	↑
NaCl	-	-	-	-
Li ⁺ /NaCl	↑	↑	↑	↑
Li ⁺	-	↑	↑	↑
Control	-	-	-	-

Rats receiving Li⁺ showed increased adrenal medullary content of CA, independent of the blood pressure changes. We also found that Li⁺ did not prevent DOCA/NaCl hypertension; indeed Li⁺/NaCl treatment without DOCA/NaCl resulted in an increase in BP.

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THE EFFECTS OF ISOPROTERENOL ON pH OF RAT TRACHEAL MUCUS IN VIVO
Louis A. Gatto and David W. Barth*
SUNY College at Cortland, New York, 13045.

Adult male and female rats were anesthetized (50 mg·kg⁻¹ Nembutal®) and the pH of tracheal mucus was measured in situ, by means of a combination miniprobe that was inserted through a surgical window on the ventral wall of the trachea. pH readings were obtained for 90 minutes and recorded every 2.5 minute intervals. Control rats received an intraperitoneal injection of saline at 20 minutes. pH readings among the controls averaged 7.68 ± 0.04 (SD) units and did not vary significantly over time. The treated rats received intraperitoneally 50 mg·kg⁻¹ isoproterenol at 20 minutes and a statistically significant decrease in pH occurred within 2.5 to 12.5 minutes after the injection. pH decreased steadily over a period of 27 ± 4 minutes to 7.54 ± 0.08 units. The decrease was followed in all rats by steadily increasing pH readings for a period of 50 ± 52 minutes. pH returned to pre-injection levels in all rats within one hour of the injection. These observations show that systemic adrenergic stimulation has a temporary effect on the properties of luminal mucus in the rat trachea. (Supported by SUNY / Cortland F.R.P. Grant)

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TEM VISUALIZATION OF THE GLOMERULAR FILTRATION OF PVP IN THE MOUSE. J.M. COOK* and R. RODEWALD* (intro. by J.N. Dent). Univ. of Virginia, Charlottesville.

Three PVP fractions- low MW, high MW, and near serum albumin in size were prepared as TEM tracers as 10% solutions in saline. Tracers were given by tail vein injection (0.8 ml./100 g. body weight), allowed to circulate from 10 minutes to 4 hours. Cortical renal areas were drip fixed in situ under good blood flow, stopped flow, or stopped flow followed by reflow conditions. Tannic acid was added to the fixative to bind to PVP and later osmium. During good flow low MW PVP passes freely through the glomerular capillary wall (GCW). Medium and high MW PVP are usually retained at the endothelial fenestrae. During stopped flow the GCW becomes more permeable to medium PVP and this fraction can pass into the urinary space. If normal flow is re-established, barrier function at the level of the endothelium returns. High MW PVP does not enter the urinary space under either condition. PVP that enters the urinary space can accumulate at the vascular pole of the glomerulus. Fluid in the urinary space may not be well mixed in this region. PVP retention occurs mainly at the endothelial fenestrae and is flow dependent.

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URINE/BLOOD RATIOS OF FILTRATION MARKERS IN CRUSTACEANS AND OTHER ANIMALS WITH LARGE BLADDERS. John C. Cornell. Univ. of South Florida, Tampa FL 33620.

U/B ratios of inulin which differ from 1.0 are usually interpreted to mean that a change has occurred in the urine. Often, the U/B ratio is calculated from a blood concentration which is decreasing with time. Under these conditions, the apparent ratio may exceed the "true" ratio by an extent which is dependent on the blood volume and the bladder volume: $U/B_{\text{apparent}} \leq (U/B) \cdot [V/(V-W)]$, where V is blood volume, W is bladder volume, and U/B is the "true" ratio. This problem arises in animals which have a large bladder volume, e.g. many decapod crustaceans and amphibians. A series of equations have been derived which are useful in evaluating the value of U/B. At most time points it is difficult to calculate the value of U/B; however, it appears that U/B may be exactly determined when the tracer concentration in the bladder is at a peak, i.e., the first derivative is zero and the second derivative is negative. The equations suggest that some previous result have been misinterpreted and that inulin is not an ideal filtration marker in several decapods.

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THE ZOOGEOGRAPHY AND EVOLUTION OF STENOPODIDEAN SHRIMPS. J.W. Goy. Univ. of Southwestern Louisiana, Lafayette.

The zoogeographic distribution of the nine genera of stenopodidean shrimps (approximately 60 species) is reviewed. Three genera have depth distributions that correlates with tropical reef corals living above 50m. The remaining genera have depth distributions correlating with Hexactinellid sponges living below 165m; of which five genera are known commensals of these sponges. Color patterns are of great diagnostic value in the field and are the easiest means of separating closely related shallow water species. Deeper water species are most easily separated by host sponge specificity. The tropical Indo-West Pacific is taken as the center of evolution and dispersal for both shallow and deep water species. The Stenopodidea, having a soft exoskeleton and being small in size, do not fossilize well, so the fossil record does not reflect accurately the abundance and diversity of these shrimps before the recent. Present day distribution of the infraorder reflects the extent of the ancient Tethys Sea with subsequent speciation during closing off of this expanse of tropical waters. Formation of the Panamanian land barrier led to geminate species formation in at least one genus.

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GEOGRAPHY OF FRESHWATER CRABS IN THE NEOTROPICS: SIGNIFICANCE OF SETAL DISTRIBUTION AND CLASSIFICATION. A. Smalley and D. Dugas. Tulane University, New Orleans.

A patch of terminal pore setae occurs on the inner surface of the merus of the third maxilliped in three of the six tribes of Pseudothelphusinae. When the genera of Central American crabs are allotted to the tribes on the basis of this character, it appears that their present distribution cannot be explained by dispersal from centers of origin. Multiple freshwater invasions are suggested as the simplest explanation of their present distribution.

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THE EVOLUTION OF SHELL LOSS IN HERMIT CRABS. N. W. Blackstone. Yale Univ., New Haven, Ct.

Quantitative comparisons of geographic populations, species, and families of pagurid hermit crabs show reduced shell-living and increased size and symmetry at northern latitudes. Examples include the shell-living species Pagurus longicarpus and P. hirsutiusculus, the transitional species Labidochirus splendesens, and the free-living species of the Lithodidae. Interestingly, comparisons of coenobite hermit crabs show parallel trends of shell loss and morphological change in tropical terrestrial genera such as Coenobita and Birgus. This repeated carcinization of hermit crabs provides a hierarchical paradigm for the study of morphological evolution and suggests that different ecological causes may have produced similar evolutionary results.

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AMPHIPODS OF AN ISOLATED OCEANIC ISLAND: ASCENSION ISLAND, SOUTH ATLANTIC. C. K. Biernbaum. College of Charleston, Charleston, S.C.

Terrestrial, intertidal, and some subtidal amphipods were examined from the author's, Smithsonian, and British Museum collections. Thirty species were represented among the 8790 specimens, three species of which could not be identified below the genus level due to damage or lack of a male. Of the remaining 27 species, 15 (56%) are undescribed endemics, 8 (30%) are amphi-Atlantic in distribution, 2 (7%) are only found in the Eastern Atlantic/Indian/Pacific Oceans, and 2 (7%) are only found in the Western Atlantic. The degree of endemism is significantly higher than other taxa examined from the island and is probably due to both the lack of a planktonic larval stage and the deficiency of Southern Hemisphere amphipod collections.

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STUDY OF THE MARINE FAUNA OF THE GULF OF CALIFORNIA. THE GENUS *Sicyonia* H. MILNE EDWARDS. M.E. Hendrickx. Estación Mazatlán, ICML, Univ. Nacl. Autón. México.

From 1979 to 1982, a survey of the marine fauna of the Gulf of California, México, was undertaken, including a two year study of the Bay of Mazatlán, Sinaloa (BBMAZ Project), and a three-leg sampling project on the continental platform of southern Sinaloa (SIPCO) and a major cruise in the Gulf of California (CORTES) aboard the B/O "El Puma" of the Instituto de Ciencias del Mar y Limnología, UNAM. Excluding the genus *Penaeus*, 5 genera and 15 species of shrimps were found in trawls and 9 species of *Sicyonia* are reported for the Gulf of California. The zoogeography of the genus along the Pacific coast of America is discussed noting that *Sicyonia* is found to have a very broad distribution, extending from the southern Oregonian Province as far south as Callao, Perú, in the Perú-Chilean Southern Hemisphere Province. The Gulf of California fauna is made up of several components including a warm-temperate species, three endemic or almost endemic species and a series of five tropical species, three of which are widely distributed throughout the eastern Pacific Region. Information related to habitat, bathymetric range and importance for fishery is also provided for each species.

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GEOGRAPHIC VARIATION IN GROWTH AND SIZE AT MATURITY IN CRABS. A. H. Hines, J. W. Born* and K. L. Comtois*. Smithsonian Environmental Research Center, Edgewater, Maryland, and Dept. of Biological Sciences, Univ. of California, Santa Barbara.

Analysis of life history strategies of brachyuran crabs showed that female size is the major determinant of reproductive output. Interspecific comparisons of growth patterns indicate that the number of molts to maturity is relatively constant at about 14-15 molts among species with widely different adult sizes. However, the minimum, maximum and median size at female maturation showed marked variation among populations of grapsid and xanthid species sampled along latitudinal transects spanning 800 miles of California coast and 1100 miles of the east coast of North America. Moreover, laboratory rearing of crabs show that populations of disparate maturation size had equal molt increments, indicating that different populations undergo variable numbers of molts to maturity.

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DISPERSAL AND SPECIATION IN DEEP-SEA JANIROIDEAN ISOPODS (ASELLOTA: CRUSTACEA). G.D.F. Wilson. Scripps Institution of Oceanography, La Jolla, Ca.

Comparisons of the distributions of deep-sea janiroidean isopods have revealed patterns that shed light on dispersal and speciation in these taxa. The higher level taxa, families and genera, are very widespread, usually occurring in most ocean basins. In contrast, species have restricted distributions. Recent work on species flocks in the family Eurycopidae has found species ranges limited to small geographic areas, to depth zones, or both. At an intermediate taxonomic level, geographic ranges of clades of species are also intermediate in size between species and generic ranges, and may be interrelated in a hierarchical fashion. It is postulated that the lack of absolute barriers in the deep sea allow taxa to disperse widely, while environmental gradients over great distances or on the continental slopes and rises provide ample opportunity for speciation.

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CHEMICAL DEFENSE AND TOXICITY OF THE ASCOGLOSSAN OPISTHOBRANCH MOURGONA GERMAINEAE MARCUS (MOLLUSCA; GASTROPODA). K.R. Jensen. Florida Inst. Technology, Melbourne.

The ascoglossan opisthobranch *Mourgona germaineae* Marcus secretes a viscid mucus and autotomizes cerata when mechanically disturbed. Other small invertebrates, i.e. sea anemones, amphipods, and other ascoglossans, will die when placed with these autotomized cerata or in the water in which they have been autotomized. The toxin is methanol-soluble and water-soluble, thus is probably a small molecule. Simultaneous TLC of chloroform and methanol-water extracts of *M. germaineae* and of its food alga, *Cymopolia barbata* indicates that the toxin is most likely of dietary origin.

This research was partially supported by the Lerner-Gray Fund for Marine Research and by Sigma Xi, the Scientific Research Society.

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ANTIPREDATORY MUCOUS SECRETIONS OF THE MARINE POLYCHAETE PHYLLODOCE FRAGILIS. M. B. Glatzer. Univ. of Southern Miss., Hattiesburg.

Phyllodoce fragilis produces copious amounts of mucus when irritated. This secretion is distasteful to several species of fish and decapods that frequent the rock jetty where the worms are found. Predator-prey interactions have shown P. fragilis to be unpalatable to test predators 90% of the time. In cases where the worm was eaten, adverse reactions accompanied ingestion. The mucous cells are concentrated in the large dorsal cirri of the uniramous parapodia and, in lesser concentrations, in the ventral cirri and along the epithelial surface of the body segments. These secretory cells are pseudostratified with submerged cells having ducts leading to the surface. Histochemical tests have thus far shown the secretion to contain both weakly and strongly acidic mucopolysaccharides and sulfhydryl groups. Additional tests are presently being run to further discern constituents of the secretion. Large dense granules are concentrated along the epithelial surface of the secretory cells. It is possible that some heavy metal is being concentrated in the mucoid matrix and is responsible for the antipredatory nature of the secretion.

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AN ASSESSMENT OF TOXIC COMPONENTS FROM ISOLATED HYDRA NEMATOCYSTS. P.E. Suchy, S.L. DiBlasi*, and G.E. Lesh-Laurie. Cleveland State Univ., Cleveland, Ohio.

Marine cnidarians have been the focus of considerable research regarding the toxic substances contained within their nematocysts. Unfortunately, limited availability of such organisms has, on occasion, restricted the chemical characterization of the nematocyst toxins. The fresh-water cnidarian, *Hydra*, possesses the same prey-capture techniques, however, and can be cultured in unlimited quantities under laboratory conditions. Using a deoxycholate-trypsin dissociation, intact, undischarged nematocysts may be recovered. Following this isolation, individual nematocyst types are separated by isopycnic centrifugation using Nycodenz[®] gradients. Nematocysts layer with the following band hierarchy, from least to most dense: desmonemes, isorhizas, and stenoteles. Nematocyst contents are then systematically purified by gel filtration using Sephadex[®] (G-25, G-50). A₂₈₀-absorbing substances displaying hemolytic activity have been screened for potential cardiotoxic activity using a modified Langendorff heart preparation. Data reveal two components (MW < 10,000) eliciting positive inotropic effects. (Am. Heart Assn., NE Ohio Grant #4335.)

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IMMATURE NEMATOCYST DEVELOPMENT AND NEMATOCYST SYMBIOSIS IN AN AEOLID NUDIBRANCH. Paul G. Greenwood and Richard N. Mariscal. Florida State University, Tallahassee, FL.

The aeolid nudibranch *Spurilla neapolitana* feeds on cnidarians and incorporates their nematocysts into specialized structures known as cnidosacs. Our previous ultrastructural observations revealed for the first time, the presence of immature nematocysts within the cnidosacs. Recent histochemical and quantitative analyses have indicated that the immature nematocysts are maturing within the cnidosacs. It is suggested that the incorporation of unfired immature nematocysts is the basic mechanism that permits nematocyst uptake, storage and utilization by nudibranchs. Nematocysts may remain in the cnidosacs for weeks or months, and it appears that they avoid cellular digestion by "floating" free in the cytoplasm of the cnidosac cells. In addition, we have found a number of similarities between the aeolid nudibranch-nematocyst association and the well-known symbiotic association of sacoglossan opisthobranchs and chloroplasts. These observations suggest that the nudibranch-nematocyst relationship might be best considered as a case of commensalistic symbiosis.

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THE ROLE OF THE ZOOXANTHELLA, Symbiodinium microadriaticum, IN THE METABOLISM AND BEHAVIOR OF THE ANEMONE, Aiptasia pallida. E. Balser and R. S. Fox. Clemson Univ., Clemson, S.C. and Lander College, Greenwood, S.C.

The association between the endosymbiotic dinoflagellate, Symbiodinium microadriaticum, and the anemone Aiptasia pallida, was examined to determine the value of the relationship to the anemone. It was found that anemones with full use of their photosynthetic symbionts could survive with little or no weight loss for at least 50 days. Animals deprived of the use of the symbionts (by absence of light) lost 75% of their weight in 50 days. Aiptasia made slow migrations over several weeks to decrease the distance to a light source and were also found to extend tentacles and rotate the oral disc toward a nearby light source.

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PHOTOSYNTHESIS AND TRANSLOCATION OF NEWLY FIXED CARBON BY ZOOXANTHELLAE IN THE AEOLID NUDIBRANCH, *PTERAEOLIDIA IANTHINA*. I. O. Hoegh-Guldberg. The University of Sydney, N.S.W. Australia.

Zooxanthellae have been proposed to contribute to the nutrition of the sea slug, *P. ianthina*; however, no one has demonstrated that the zooxanthellae photosynthesize *in situ* and that the products of fixation move from the alga into the animal tissues. In carbon-14 labelling experiments, zooxanthellae photosynthesized *in situ* and 20-50% of the total fixation was associated with the host's tissues, mainly as glycerol, glucose, lipid and a range of amino and organic acids. The proportion of the total fixation released varied during the period of one year. Investigation of the life history of *P. ianthina* revealed that zooxanthellae are acquired *de novo* each generation and are probably derived by young aposymbiotic animals feeding on a symbiotic hydroid. The results of this study will be discussed particularly in reference to the limitations of the carbon-14 method for estimating the contribution of zooxanthellae to the animal host.

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PARTICLE SELECTION BY THE BRITTLESTAR *MICROPHOLIS GRACILLIMA* (STIMPSON) (ECHINODERMATA: OPHIUROIDEA). L.A.J. Clements. Baruch Institute and Marine Science Program, Univ. South Carolina, Columbia.

Particle selection based on size and organic coating by the deposit-feeding brittlestar *Micropholis gracillima* was investigated. Experiments were performed using glass beads (30-60 μ m, 75-150 μ m, 150-200 μ m, 250-300 μ m and 450-500 μ m) mixed together in equal proportions by volume. Three treatments were prepared from the bead mixture: uncoated, Bovine Serum Albumin (BSA)-coated and bacteria-coated. *M. gracillima* individuals were offered one of the treatments and comparisons of the beads available and ingested were made. Ophiuroids selectively ingested BSA-coated and bacteria-coated particles in the 30-60 μ m and 75-150 μ m size ranges. Remaining bead sizes were ingested in smaller proportions than available. Uncoated beads were also ingested in smaller proportions than available. These results show that *M. gracillima* can distinguish between particles of different sizes and organic coatings. Selection of small organically coated particles supports optimal foraging theory for deposit-feeders and may provide a means for investigating partitioning of food resources among sympatric ophiuroid populations.

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A MATHEMATICAL MODEL OF PASSIVE SUSPENSION FEEDING. Mark R. Patterson. Harvard University, Cambridge, MA.

A simple input-output model is proposed for passive suspension feeding in anthozoans. The *dynamic* response of passive suspension feeders to plankton patchiness is apt to be an important determinant of growth response, competition for food, and ultimately competition for space. Formulation of the resistive-capacitive model is motivated by the observation that filtration and handling of prey are discrete processes. In terms of the electrical analog of the model's equations, handling and filtration are modeled as "resistances" through which the "current" of plankton must pass in order to fill the organism's (or colony's) "capacitance". The model predicts characteristics of the "filling" curve (#plankton caught vs. time) for a passive suspension feeder; given the nature of the input (prey availability), it is possible to test predictions about the output (filling curve). These predictions are contrasted with those of a null hypothesis of linear feeding to saturation. In nature, prey availability approximates a step function due to plankton patchiness; in the lab it is possible to generate prey availability functions not generally encountered in nature. The model was tested for a boreal octocoral, *Alcyonium siderium*, and a sea anemone, *Metridium senile*. Agreement between predicted and experimentally measured values of the parameters in the model is good; passive suspension feeding functions in these anthozoans are not linear to saturation, but curvilinear and predictable using the two-step model.

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LACK OF HOST SPECIFICITY IN FEEDING BIOLOGY OF *CARCINONEMERTES* SPP. P. Roe. California State College, Stanislaus, Turlock.

U.S. West Coast brachyuran crabs in several families harbor nemerteans of the genus *Carcinonemertes*. Only two species of *Carcinonemertes* have been named from these crabs. Studies were conducted on host specificity of feeding biology as part of a larger study on worm biology. In the laboratory, juveniles of *Carcinonemertes epialti* from *Hemigrapsus oregonensis* ate 0.5-0.6 *H. oregonensis* egg/day, males ate 0.4 egg/day and reproducing female worms ate about 2 eggs/day. After reproduction, feeding decreased or stopped. Worms did not grow as large as ones on hosts. Similar results were obtained from worms feeding on eggs from unnatural brachyuran hosts. Worms feeding on eggs of *H. oregonensis* that grew into females typically laid 5-6 viable egg strings in 23-41 days from onset of feeding, even when isolated from other worms as juveniles. Results show that individuals of *Carcinonemertes* spp. under laboratory conditions show little host specificity and can certainly grow and reproduce with abnormal host eggs as food.

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EGG PREDATION EFFECTS OF NEMERTEAN CARCINONEMERTES ON DISTRIBUTION OF EGG MORTALITY IN THE BROODS OF TWO CANCRID CRABS. R.K. Okazaki. Univ. of California, Santa Barbara and Bodega Marine Lab, Bodega Bay.

This study attempted to determine if egg mortality is distributed evenly in the broods of yellow rock crab, Cancer anthonyi, and Dungeness crab, Cancer magister. Both species are important in California crab fisheries and are hosts to the egg predator Carcinonemertes. Second left pleopod, a large and more protected pleopod, was analyzed for egg mortality in C. anthonyi. Live and dead eggs were counted from egg setae snipped from the following nine pleopodal sites: lateral, medial, posterior bases, middles, and tips. Low mortalities (0-2%) were observed in eggs of early stages with the highest mortalities noted at the tip sites. However, as egg developmental time increased, higher mortalities (9-17%) were observed at medial bases than at the tip sites (2-12%). Egg setae from a medial base of one pleopod were taken until 25 samples without worms were obtained. Egg mortality averaged about 2% in these samples compared to 7% in the 11 samples with worms (n=12). Eggs of the worm-infested C. magister were analyzed to compare with those of C. anthonyi. The medial base showed highest mortalities (60%); whereas the tip sites averaged about 26%. Higher mortalities (32%) were observed at the other two base and three middle sites. These results indicate that background mortalities of crab eggs in early stages are about 0-2% and primarily occur at the tip. As eggs develop and/or nemertean feeding intensifies, higher mortalities appear at the medial base which may be a preferred feeding site. (Supported by California Sea Grant R/F-75 to A.M. Kuris.)

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TRANSFER ON HOST CRABS AT MOLTING AND MATING BY THE CRAB-EGG PREDATOR CARCINONEMERTES ERRANS, D.E. Wickham and P. Roe, Bodega Marine Lab, Bodega Bay and Stanislaus State Univ., Turlock, CA.

Worms of the genus Carcinonemertes dwell on the exoskeletons of both male and female host crabs but feed and reproduce only on the eggs of ovigerous female crabs. We sought to determine the proportion of the worms which settle on crabs that eventually reach an ovigerous host and complete the life cycle. Dungeness crabs (Cancer magister) which were approaching molt were held and the number of Carcinonemertes errans on these crabs was counted. Worms could be seen migrating across the exoskeleton to the decalcifying epimeral suture where they gained access to the new exoskeleton. Approximately 88% of the worms transferred to the new exoskeleton. Female crabs nearing molt were placed with males to allow mating between crabs which occurs at the female molt. Over 80% of the worms on the male crabs transferred to the female during mating. Carcinonemertes errans has effective behavioral adaptations which allow it to remain with hosts and to eventually reach its crab-egg food resource. (Supported by California Sea Grant R/F-75B)

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AN EPIDEMIC OF CARCINONEMERTES EPIALTI IN AN UNFISHED POPULATION OF HEMIGRAPUS OREGONENSIS. J. D. Shields and A. M. Kuris. Univ. of Calif., Santa Barbara.

In October 1982, an epidemic of C. epialti was documented on an unfished population of H. oregonensis at Campbell Cove, Bodega Bay, California. The overall infestation rate on these crabs was 95.2% (n=42). The intensity of the C. epialti infestation ranged from 0-1680 worms/crab with a mean density of 297 worms/crab. C. epialti is a crab egg predator. Crab egg mortality, presumably due to C. epialti, ranged from 3-95%. Crabs with more than 300 worms had the greatest egg mortality with approximately 95% of their eggs being dead. In March and August 1983, infestation rates of C. epialti were 6.0 and 57.9% respectively, with mean densities of 0.06 and 7.84 worms/crab. In March, egg mortality was high (range=3-90%) and apparently the result of a pathogenic fungal infection. Fungal infections were observed on all of the egg clutches examined.

Fishing pressure has been cited as a cause of epidemics of C. errans in heavily fished populations of Cancer magister. Our findings show that natural epidemics of C. epialti may occur in unfished crab stocks as well.

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GLYCOLYTIC ENZYMES AND A PEPTIDE CLOSELY RELATED TO FMRFamide ARE PRESENT IN NEUROSECRETORY CELLS IN NEMERTEAN CEREBRAL GANGLIA. I.M. Varndell and J.M. Polak. Royal Postgrad. Med. Sch., London, U.K.

Over the last two decades several authorities have described the morphology and tinctorial affinity of several putative neurosecretory cell types from nemertean cerebral ganglia. Using histochemical and immunocytochemical techniques we have been able to localise several groups of enzymes and one peptide to neurosecretory cells in Lineus ruber, L. viridis and Amphiporus lactifloreus. Acid phosphatase, naphthylamidase and nine dehydrogenases were localised to these cells. The application of the PAP technique at the light microscope level and the immunogold staining procedure at E.M. has revealed a peptide (hormone?) closely related to the molluscan cardioexcitatory peptide FMRFamide, to be localised to secretory granules within the neurosecretory cells. The cellular localisation of glycolytic and tricarboxylic acid cycle enzymes is often considered to be indicative of tissue with a high energy requirement. It seems likely that the putative neurosecretory cells in nemertean cerebral ganglia may satisfy this criterion by exhibiting rapid turnover of cytoplasmic components, possibly peptidic secretory material.

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RESPONSES OF CEREBRATULUS PROBOSCIS MUSCLE TO PUTATIVE NEUROTRANSMITTERS. W. R. Kem. Univ. of Florida, Gainesville.

Analysis of synapses in lower invertebrate phyla may provide insights regarding the evolution of synaptic neurotransmission processes. I have investigated the pharmacological actions of several putative neurotransmitters upon proboscis segments isolated from the heteronemertine *Cerebratulus lacteus* (Leidy). When incubated in artificial sea water at 15°C longitudinal muscle responsiveness to elevated K⁺-isotonic saline was maintained for at least 24 hr. In the absence of cholinesterase inhibitors, the proboscis was quite unresponsive to acetylcholine (ACh); 10⁻⁴M ACh elicited contractures that were about 10% the amplitude observed with elevated K⁺. Pretreatment with 10⁻⁴M DFP greatly enhanced ACh sensitivity; 50% maximal tension developed at 10⁻⁵M ACh. Eserine at 10⁻⁵M also sensitized the proboscis muscle to ACh. At 10⁻⁶M, Benzoquinonium was an effective ACh antagonist, while α-bungarotoxin and d-tubocurarine were ineffective. Epinephrine (5x10⁻⁵M) elicited several rapid contraction-relaxation cycles, probably by stimulating the nerve plexus. Several other putative neurotransmitters (dopamine, glutamate, 5HT) sometimes elicited small proboscis contractions. The above results are consistent with the notion that ACh functions as a neuromuscular transmitter in nemertines.

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MULTIVARIATE ANALYSIS OF INTRASPECIFIC VARIATION IN THREE FORMS OF THE HOPLONEMERTEAN *OERSTEDIA DORSALIS*.

Per Sundberg (intro. by C. Erseus). Dept. of Zoology, Univ. of Göteborg, Sweden.

The taxonomic status of three externally different forms of *O. dorsalis* was assessed by multivariate analyses (canonical variate and principal component analysis) based on 13 internal characters. It was hypothesized that if these forms are conspecific, the external distinctiveness should not be accompanied by a discontinuum in the variation in internal characters. The results discern a grouping of the morphs in the multivariate space, with two forms separated and the third positioned between them, with a variation overlapping the morphological range of the other two. It is concluded that the varieties are conspecific, but that gene flow is restricted. The forms are confined to separate habitats probably differing in selective regimes. This, in combination with the reduced gene flow, makes it a possible case of incipient sympatric speciation. Supported by NFR grant # B3954-104.

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HOPLONEMERTEAN ANCESTRY OF VERTEBRATES: AN OLD HEAD AND NEW BRAIN FOR CRANIATES. Donald D. Jensen, University of Nebraska, Lincoln, Nebraska.

Three different views of the evolutionary relationship of nemertean and vertebrates are found in the current literature. Many authors see no close relation between these groups. Several authors see the nemerteans as probable ancestors of the acraniate vertebrates. A third view is that one suborder (the monostyliferous hoplonemerteans) is the proximal invertebrate ancestor of the primitive craniate vertebrates and that the vertebrate head is not a new evolutionary development but a further development of the head organization typical of hoplonemerteans. This third view identifies hoplonemertean organs as homologous to vertebrate special sense organs, neural plate, neural crest, preoral gut, anterior somites, glandular and neural hypophysis, and notochord. This view interprets the vertebrate tubular brain as a compound structure derived by fusion of two nemertean organs (the tubular frontal organ and the solid cord nervous system). The possibility of testing the hoplonemertean theory by ultrastructural, histological, and physiological study of hoplonemertean sense organs is discussed.

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THE BIOACCUMULATION OF HEAVY METALS IN TWO SPECIES OF BRITISH MARINE NEMERTEANS. Eric G. McEvoy* and Ray Gibson. Liverpool Polytechnic, Liverpool, England.

Comparative studies on the total body burden of lead, cadmium and zinc have been carried out with two species of eulittoral nemerteans, *Lineus ruber* (Heteronemertea) and *Amphiporus lactiflorens* (Hoplonemertea). Individuals of both species collected from sample sites with differing pollutional loads have been analyzed with atomic absorption spectrophotometry subsequent to nitric acid digestion. Results indicate that heavy environmental loads of these metals are reflected in the levels detectable in both species, zinc especially showing evidence of major bioaccumulation. Current studies, involving a sepharose polymer technique, should resolve the problem of whether these metals are adsorbed by the epidermal mucus or absorbed into the body tissues, possibly by epidermal uptake. Preliminary results indicate that nemerteans may prove to be useful indicators of heavy metal pollution in the marine environment.

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EVOLUTION OF THE AMPHIBIAN TYMPANIC EAR AND THE ORIGIN OF FROGS John R. Bolt* and R. Eric Lombard. Field Museum of Nat. Hist. and Univ. of Chicago, Chicago, IL.

Recent anurans plus all but the most primitive temnospondyl labyrinthodont amphibians are proposed as a monophyletic taxon, based on shared derived characters of the stapes. These characters are: a straight ventral margin on the stapedia footplate; absence of processes from the stapes to the skull; a posterior notch in the footplate and an antero-posteriorly compressed shaft. Within the temnospondyls, the lower Permian dissorophoids are proposed as most closely related to Recent anurans, based on an interpretation of the dissorophoid quadrate dorsal process and the anuran tympanic annulus as sequential steps in a character transformation. In anurans the tympanic annulus develops as an outgrowth of the quadrate just posterior to the jaw articulation-- a position equivalent to that of the unique process of the quadrate to which the tympanum attached in dissorophoids. The common otic features of anurans and temnospondyls reinforce the concept of an "amphibian" type of tympanic ear as a unique structural complex with an origin separate from that (or those) of amniotes. Supported by NSF 80-02619.

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ACOUSTICAL IMPEDANCE IN FROGS WITH AND WITHOUT TYMPANIC EARS. Alan P. Jaslow, Thomas E. Hetherington, and R. Eric Lombard. Univ. of Chicago, IL.

Acoustical impedance was determined for Hyla cinerea and Atelopus chiriquiensis with an acoustical bridge. Measurements were made on the tympanum and shoulder in H. cinerea, which has a well developed tympanum, middle ear cavity, and stapes. These were compared to measurements on the lateral head and shoulder of A. chiriquiensis, which lacks a tympanum, middle ear cavity, and stapes. The acoustical bridge allows comparison in magnitude and phase angle between the sound wave (100-2000 Hz) projected to and reflected from a surface. Impedance magnitude (IM) of H. cinerea tympana, A. chiriquiensis lateral heads, and shoulders in both species, were generally similar throughout the frequency range. IM is highest at low frequencies peaking at 400 Hz. It decreases between 400 and 1500 Hz and remains constant to 2000 Hz. H. cinerea tympana did show a decrease (~25%) between 800-1300 Hz. Supported by NIH Fellowship NS06833, NS06531 and NSF Grant DEB-8002619.

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A SCANNING ELECTRON MICROSCOPE STUDY OF THE OLFACTORY EPITHELIUM IN MATURE AND AGING PLATYFISH (XIPHOPHORUS MACULATUS). Rachel Silverman, Martin P. Schreiber and Charlene L. Forest*. Biology, Brooklyn College, Brooklyn, N.Y. 11210

The olfactory epithelium of mature platyfish is contained within a thin plate, approximately 0.3 mm² in area. Radiating finger-like projections of ciliated sensory (neuro)epithelium are surrounded by a larger area of nonsensory tissue. The neuroepithelium consists mainly of two types of densely packed surface structures-- long, thin ciliary projections and ones which are thicker. The nonsensory epithelium displays an elaborate pattern of microridges. Mucus-producing goblet cells are located throughout this area. Light spherical patches, randomly distributed throughout the nonsensory epithelium, increase in concentration towards the periphery. With increasing age, degenerative changes are reflected by a decrease in the density of neuroepithelial projections and by a breakdown in the structural uniformity and arrangement of both sensory and nonsensory areas. (Supported by NIH-NIA, Grant #AGO 1938, and by a PSC-CUNY award to M.P.S.)

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MOTOR INNERVATION OF THE PROJECTILE TONGUE OF PLETHODONTID SALAMANDERS. D. B. Wake and G. Roth. Univ. of California, Berkeley, and Univ. of Bremen.

Motor innervation of the muscles related to mouth opening and tongue protraction and retraction in several species of plethodontid salamanders was studied by dissection and Palmgren serial sections, and by techniques using horseradish peroxidase. Nerves VII, IX, X, and the first two spinal nerves were investigated. Peripheral pathways were determined, and motor nuclei were localized. A well defined nerve XI was discovered which has the essential features of the nerve of amniotes. Its motor nucleus is far posterior, near the ventral roots of spinal 2, but it leaves the cranium with IX and X. Ramus hyoglossus is formed by spinal 1; fibers of spinal 2 do not reach the tongue. Ramus communicans VII-IX,X contains motor fibers which exit the brain through the second root of the IX,X complex. The motor neurons responsible for the very rapid mouth opening and tongue protraction (which involves VII, IX, and X and takes ca. 10 msec.) are in very close proximity in the same motor nucleus, and they are relatively few in number.

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DIENCEPHALIC AND MESENCEPHALIC ELECTROSENSORY CENTERS OF THE CLEARNOSE SKATE. R. L. Boord and R. G. Northcutt. Univ. of Delaware, Newark, and Univ. of Michigan, Ann Arbor.

Axonal degeneration, emanating from small electrolytic lesion sites confined to the lateral mesencephalic nucleus, reveals diencephalic and other midbrain connections of the ascending electrosensory pathways of *Raja eglanteria*. Efferents from the lateral nucleus include a dorsal projection consisting of commissural fibers and fibers that terminate about the cells of the anterior mesencephalic nucleus of either side, and a ventral projection to the posterior diencephalon. The diencephalic pathway terminates bilaterally within lateral posterior thalamic nuclei, and lateral tubercular nuclei that are situated dorsal to the main cell masses of the inferior hypothalamic lobes. The lateral mesencephalic and lateral posterior thalamic nuclei appear to be relay centers of the main ascending electrosensory pathway to the telencephalon; within anterior mesencephalic and diencephalic lateral tubercular nuclei there is likely overlap of electrosensory fibers with fibers carrying information from other sensory sources. Supported by NIH grants.

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WHAT GOOD ARE NON-TOPOLOGICAL MAPS? P. S. Ulinski. University of Chicago, Chicago, Ill.

There are many examples of topological or point-to-point projections between nervous system structures. More recently, examples of non-topological projections have been documented using the orthograde transport of horseradish peroxidase to visualize axons. These include the projections of the optic tectum to the reticular formation and to nucleus rotundus in the thalamus in reptiles and birds. This talk discusses some hypotheses about the functional significance of non-topological maps. One possibility is an involvement in the construction of complex receptive fields. A second is a role in transformations between codes in the spatial and frequency domains. A third is the formation of a distributed representation of the receptor surface.

Supported by PHS Grant NS 12518.

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WHO OWNS THE PRE-COLLEGE BIOLOGY CURRICULUM? W. A. Moyer. Former Executive Director, National Association of Biology Teachers, Reston, VA.

Diverse interests, including religious groups, publishers, politicians, administrators, and even biologists, have attempted at various times to control the pre-college biology curriculum. They have used tests, textbook censorship, national curriculum development projects, legislation, and teacher certification to achieve their ends. These methods have fallen short of their goals because they do not affect the equilibrium existing within the classroom. Education is the resultant of tensions generated between teacher, students, and subject matter, and of these the teacher is most important. From this it is argued that funding of teacher education, with the goal of producing teachers who are close to the mainstream of both biology and learning theory, is the most effective use of new government money. Only then will biology teachers assert their birthright, take control of the pre-college curriculum, and either resist or profit from external groups. ASZ can aid this process through involvement in college biology curricula.

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THE BRONX ZOO - A HISTORY OF CONSERVATION. C. Sheppard. New York Zoological Society, Bronx, N.Y.

The New York Zoological Society had a conservation mandate at its inception in 1895. Its role in preserving the American bison is well known. Less known is Society involvement in saving remnants of the California redwoods, halting the plume trade and in enactment of basic legislation including the Lacey Act. This involvement continues to the present with captive breeding of endangered species at the Bronx Zoo and an international program of conservation-oriented field studies and national park development.

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HISTORY OF BETA BETA BETA, SOCIETY FOR UNDERGRADUATE BIOLOGISTS. E. G. Stanley Baker. Drew Univ., Madison, N.J.

Founded informally in 1920 by three small-college biologists, Beta Beta Beta became a national organization in 1922. Started with three local groups, there are now 300 chapters. Activities include regional and national meetings and publication of Bios, a journal for undergraduate research, now in its 53rd year. This report will summarize the 60-year history and briefly assess the society's significance.

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THE SEARCH FOR HAGFISH EMBRYOS--A LESSON IN ZOOLOGICAL HISTORY. A. Gorbman, Univ. of Washington, Seattle.

The first and only successful effort toward collection of hagfish embryos was by Bashford Dean in 1898 at Monterey. By chance Franz Doflein was traveling in California at this time and he bore Dean's gift of a small number of embryos to Carl von Kupffer. Unfortunately Dean never made really good use of the specimens he collected, but Kupffer published a preliminary description of head development in 1899. Apparently he did no more with this material and the crude sketches that illustrated this paper have been reproduced many times in later citations and reviews of vertebrate phylogeny. They have been and remain the only source of information concerning early organogenesis in this most primitive vertebrate. About 1925 Dean presented about 50 preserved embryos remaining in his collection to Leroy Conel of Boston University, stipulating that they be sectioned by a skilful microtechnician in the Harvard Anatomy Department and then be kept for the use of later biologists in the Anatomical Museum at Harvard. It is remarkable that many more recent efforts to duplicate Dean's success in collecting hagfish embryos have failed despite the importance and promise of evolutionary information from this key vertebrate.

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ORGANISM, ORGANIC UNITY AND ORGANISMALISM. LOUISE RUSSELT KRAEMER and Eric Russert Kraemer, Univ. of Arkansas, Fayetteville, and Univ. of Nebraska, Lincoln.

In this paper we examine the view known as 'organismalism', the view that the organism itself and (not just its parts) is essential to adequate biological explanation. This view was held by many biologists at the beginning of the present century. In particular we investigate the comprehensive defense of this view by W. E. Ritter with his The Unity of the Organism (1919). We consider how Ritter's 'anti-elementalist' arguments have been weakened by subsequent developments in biology. We also discuss how a present-day version of organismalism might be defended.

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THE SCIENTIFIC TRAINING OF THOMAS JEFFERSON. Brother C. Edward FSC, Manhattan College, Bronx, N.Y.

The scientific training of Thomas Jefferson, informal by our standards, was about as good as could be obtained in 18th Century America. His earliest tutor in scientific matters was William Small at William and Mary College. Continued input came from a vast correspondence that included Rev. James Madison, Buffon, Joseph Priestley, and Caspar Wistar. Jefferson was also an insatiable reader, profoundly influenced by authors like, Linnaeus, Buffon, Malthus, and Cuvier. Furthermore, like any scientist, Jefferson learned from his own observations and studies, especially of fossils from western Virginia and from Big Bone Lick, Kentucky.

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BEHAVIORAL RESPONSE TO REWARD VARIABILITY IN THE FORMATION FLIGHT OF CANADA GEESE, *BRANTA CANADENSIS*. J. P. Badgerow. Syracuse Univ., NY.

Formation flight confers a reduction in energy expenditure from that necessary for solo flight. Applied aerodynamic theory provides a spatial distribution of the energetic reward corresponding to wing tip spacing positions within formations. This distribution is such that prediction of optimal patterns of positioning is conditional on the level of environmentally imposed stochastic variability in positioning. Observed frequency distributions of wing tip spacing are compared with probability distribution models incorporating predicted positional strategies. Observed distributions at low and high levels of environmental variability are also compared with each other. The comparisons indicate positions may be taken not simply according to their associated reward but in combination with the certainty with which the reward can be obtained. These results suggest the geese are making a risk-sensitive behavioral response to variability in the energetic reward offered by formation flight.

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MALE-MALE INTERACTIONS AND FEMALE RESPONSES IN THE FIREFLY *PHOTINUS MACDERMOTTI*. A.D. Carlson and J. Cope land. SUNY Stony Brook and University of Wisconsin-Milwaukee.

On Long Island in *Photinus macdermotti* mating behavior, roving males produce trains of single rhythmic flashes (patrolling flashes) and, subsequent to a female response, paired courtship flashes. When a non-courting (rival) male is introduced to a real or simulated courtship, it attempts to synchronize its flash to the courting male's second flash or to flash at a fixed latency after the female's response. Both flash types are aimed toward the female. Following such male flashes, the female will sometimes re-orient her response away from the courting male toward the rival male. Rival males rarely inject flashes between the first and second flashes produced by a courting male. The behavior of *Photinus macdermotti* on Long Island suggests a simpler explanation to *Photinus* and *Photuris* flash communications systems than the "co-evolutionary arms race" proposed by Lloyd (*Nature* 29:498).

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CALL DEVELOPMENT IN THE EUROPEAN STARLING (*STURNUS VULGARIS*): THE STRUCTURAL AND FUNCTIONAL MERGING OF TWO EARLY CALL TYPES. M. Chaiken. Institute of Animal Behavior, Newark, N.J.

Calls of individually marked nestlings were recorded daily in the field for three weeks after hatching. The calls were sonagraphed, and an oscilloscope was used to display the temporal patterning of vocal exchanges. When a chick is a few days old, its early peeps differentiate into two call types—a loud begging call and a soft call that is used antiphonally among brood mates. Shortly before fledging, the two call types merge back into one. This new call, which later helps fledglings maintain contact with their parents, combines the begging function with the antiphonal pattern of delivery. These results support the position that early developmental stages can often be viewed as adaptations in their own right, not simply as incomplete or undifferentiated precursors of adult behavior patterns.

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ANTI-PATHENOGENIC EFFECTS OF FRESH VEGETATION USED BY STARLINGS IN NEST CONSTRUCTION. L. Clark* and J.R. Mason, Monell Chemical Senses Center, Philadelphia, PA.

Within established colonies of *S. vulgaris*, utilization of nest boxes decreases with time, presumably as pathogen and parasite loads increase. Those starlings that continue to use boxes increase their use of fresh green vegetation in nest construction. Here, we report that such birds exhibit biased sampling of available green vegetation for inclusion in their nests ($p < 0.05$). For example, *Agrimona* sp. are included even though they are less abundant than other available species. We also present data consistent with one explanation for biased sampling. When cultured bacterial colonies from active nest boxes were used in disc diffusion experiments, no specimen of a random subsample of plants available to starlings but not found in nests inhibited bacterial growth. Conversely, 35% of a subsample of plants used in nests had inhibitory effects ($p < 0.05$). We propose that starlings respond to deteriorating conditions in nest boxes by using plants that have anti-pathenogenic effects.

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PARENTAL BEHAVIOR OF WILD HOUSE MICE. K. Egid and S. Lenington. Rutgers Univ., Newark, N.J.

A group of eight F1 generation wild house mice (Mus musculus) was released into a seminatural environment for 120 days during which time we recorded all interactions for a period of 1-3 hrs each day. Pregnancies and births were noted and young were individually marked at 15 days and their interactions with other juveniles and adults recorded. After 120 days the mice were removed and a new group of mice was released. In this study we were able to examine the role of the male in caring for litters. Additionally we observed that females which raised offspring in a communal nest nursed young other than their own. Although pregnancies occurred early in the trials, no litters born during the first 50 days survived for more than a few hours. Subordinate males as well as females often disturbed new litters and nests. Female aggression towards adult males and females increased during pregnancy.

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PARENTAL CHORES DISTRIBUTION IN THE MONOGAMOUS BLUE JAY. H. Laine. City Univ. of New York.

The findings of this 3 year study show the Blue Jay to be a continuously monogamous species with a clear division of labor between the sexes. Overall patterns reveal the female to be the primary nest builder, incubator and brooder of young. The male is responsible for providing almost all food for both the young and the female. Within each sex the distribution of chores changes significantly over the breeding season. Males increase their participation in behaviors associated with nest protection. Females, more active than males in all categories of behavior early in the season, shift their attentions to behaviors associated with nest care. Male behavior rates show considerable yearly variation, with little, if any, associated patterns. Female behavior rates are more consistent from year to year. The division of labor is one which suggests that, in the long run, males maximize their fitness by adjusting their behavior to females, which, in turn, adjust their behavior to environmental factors.

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AN EXPERIMENTAL STUDY OF BIPARENTAL CARE IN THE DARK-EYED JUNCO. L. Wolf (intro. by Ellen D. Ketterson). Indiana University, Bloomington.

It is commonly assumed that males of monogamous birds care for their young because without that care success in reproduction would be impossible or reduced. This study examines the significance of male care in the monogamous, double-brooded Dark-eyed Junco (Junco hyemalis) by quantitative comparison of reproductive success of females with and without the help of a male. Males of nine breeding pairs were captured at the time their eggs hatched and were held for the remainder of the breeding season; the nests of their mates (experimentals) were subsequently monitored, as were the nests of unmanipulated pairs (controls, N = 23). Earlier studies that have addressed this problem report no significant differences in growth rate of experimental and control nestlings. My preliminary results support these findings, and further, indicate no differences in several other variables that were considered important factors affecting the reproductive success of females: weight of young at fledging, weight loss of nesting females, survivorship of young to independence, and interclutch interval; however the sample size at this stage permits no firm conclusions.

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AIR EXPOSURE PATTERNS IN THE SHORE CRAB PACHYGRAPSUS CRASSIPES AS A FUNCTION OF SALINITY AND HUMIDITY. S.W. Shoemaker* and L.E. Burnett, Univ. of San Diego.

Periods of air exposure in Pachygrapsus were monitored continuously within a 65 gal aquarium using radiotelemetry. The signal of a transmitter attached to the carapace was significantly dampened when the crab was in water, permitting us to record the crab's movement in and out of water. In all cases crabs spent less time in air during the day than at night. Crabs spent more total time in air as the relative humidity increased from 74-76 to 90-97% at constant salinity. Decreasing salinity from 36 to 18 ppt also increased total air exposure time. At low salinity, however, total air exposure time was significantly decreased when r.h. decreased to 75%, indicating the importance of humidity in determining emersion behavior in this crab. The duration of most visits to air at any humidity were less than 10 min. However, at high r.h. (>90%) crabs visited the air at least once during the day and once at night for a period >1 hr and up to 6.5 hr.

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REMINERALIZATION OF INVERTEBRATE SKELETAL ORGANIC MATRIX IN VITRO. D.M. Manyak*, A.M. Bernhardt*, J.M. Shea*, and K.M. Wilbur. Duke Univ., Durham, N.C.

The organic matrix of molluscan shell has long been thought to initiate crystal formation and influence crystal orientation in vivo. We have attempted to examine this capacity by decalcifying fixed and unfixed skeletal material of molluscs and serpulid worms, immersing the matrix for various periods of time in physiological and other solutions containing Ca^{2+} and HCO_3^- , and examining it for remineralization with SEM, polarized light, and EDAX. The completeness of decalcification was also determined by these three methods.

Extensive remineralization occurred with the shell matrix of the scallop Argopecten irradians, burrow linings and pallets of the borer Bankia gouldi, and the tube of the marine annelid Hydroides dianthus. The ultrastructure of recalcified Argopecten shell was similar to normal shell. This was apparent to a greater degree in recalcified unfixed shell matrix. Crystal structure in the other species was varied, usually differing from normal. The lining of Hydroides tubes failed to recalcify, suggesting a difference in organic matrix, particularly with respect to its capacity to promote crystal formation.

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COELOMIC LINING IN ECHINODERM TUBE FEET AND IN ANNELIDA. R.M. Rieger, S.L. Gardiner, M.E. Fransen and J. Lombardi. Univ. of North Carolina, Chapel Hill and SUNY, Upstate Medical Center, Syracuse.

Fifteen species from all five classes of living echinoderms have been studied. While others have stressed recently the myoepithelial nature of the tube foot musculature, we presented the first evidence of the full incorporation of the podial muscle cells into the ciliated peritoneal layer. We have confirmed our findings in the tube feet of the ophiuroids Ophioderma brevispinum, Ophiothrix angulata and Ophiophragmus wurdemani and the crinoid Nemaster rubiginosa. The new material on the coelomic lining of the tube feet, together with our data on the coelomic lining of the body cavity in Annelida, identify now a morphological sequence between a single-layered epithelium of alternating muscles and peritoneal cells and a double-layered structure with a squamous peritoneal lining and a subperitoneal musculature. Supported by NSF grant GB 42211 to RMR.

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ENZYMATIC ACTIVITIES OF LYSATES OF ISO-LATED HEPATOPANCREATIC B CELLS IN THE CRAYFISH. D.J. Fyler* and E.J. DeVillez. Miami University, Oxford, Ohio

Nonenzymatic mechanical disaggregates of hepatopancreatic E,R,F and B cells of intermolt specimens of O. rusticus were prepared in Van Harreveld solution (435 mOsm., pH 7.6, 22 C) and separated on preformed density gradients (1.017-1.143 g/ml) of 50% Percoll-isosmotic saline. B cells and their residual vacuoles were recovered from 1 ml fractions of gradients at an approximate density of 1.076 g/ml. Lysates of the B cells and vacuoles consistently showed tryptic (TargME and Bz-Val-Gly-Arg-PNA) activities. The profile of amylolytic (soluble starch) activity also paralleled B cell distribution providing direct evidence for the storage function of B cells for these digestive enzymes, and supporting previous indirect histochemical evidence. In preliminary tests, the digestive fluid solubilizes native [^{14}C] collagen (assay by Gregory A. Grant, Washington Univ., St. Louis) which suggests a digestive function for the tryptic-collagenolytic component(s), but attempts to confirm such activity in B cell lysates have been equivocal. Supported by FRC-MU.

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A MOLLUSCAN INTERSTITIAL ASSEMBLAGE AT FORT PIERCE FLORIDA. M.P. Morse and J.L. Norenburg. Mar.Sci.Lab., Northeastern U. Nahant, Mass., and Marine Lab., Smithsonian Institution, Fort Pierce, Florida.

Interstitial solenogasters are characteristic of coarse shifting sand environments and are part of a molluscan assemblage which includes acochlidiaceans and members of the genus Pseudovermis. This assemblage has been found six miles off the coast of Fort Pierce Inlet at 16 m depth.

One of the solenogasters is described here. The living specimens are 1.7 mm in length, have a radular formula of 12(1:0:1), often are seen with developing eggs and have a characteristic set of spicules and plates associated with the epidermis. These worm-like forms have a flattened posterior end with a mid dorsal spicule-surrounded opening and the anterior one third of the body has curved lateral spines which point forward as the organism crawls.

As in other assemblages of this kind, there is no evidence of sulfides in the sediments. Similar assemblages have been found in both tropical (Fiji Islands, Belise) and temperate (Roscoff, France, Crow Neck, Maine and Friday Harbor, Washington) environments.

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ANTIBIOTIC SUBSTANCES FROM SEVERAL SPECIES OF BRYOZOANS. V.H. Ocasio* and R. Colon-Urban. SUNY College at Old Westbury, Old Westbury, New York.

Crude extracts of *Bugula turrita* and *Bugula stolonifera* have been previously reported by our laboratory to inhibit the growth of several gram positive organisms. This communication represents a continuation for the search of substances with potential antibiotic effects from other marine bryozoans including *Bugula neritina*, *Scrupocellaria diegensis*, and *Alcyonidium gelatinosum*. Extracts were prepared by homogenizing whole animals in 20% methanol followed by chloroform extractions. Aqueous and lipid soluble layers were obtained and bioassays were performed (disc diffusion method) on *Staphylococcus aureus* and *Escherichia coli*. The lipid soluble fraction of *S. diegensis* (1 mg/ml) and *B. neritina* (4 mg/ml) inhibited the growth of *S. aureus* after 24 hours exposure while *A. gelatinosum* (6 mg/ml) had no effects. No inhibition was shown against *E. coli*. A possible mechanism of action is presented. Supported by NIH Grant RR 01180-02.

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DEN LOCATION BY AND REPRODUCTIVE SUCCESS OF PIKAS: A RESOURCE DEFENSE MATING SYSTEM. C.A. Brandt. Duke Univ., Durham, N.C.

The denning habits and reproductive success of pikas was studied in a population in northeastern Oregon. Female pikas were found to den either in open talus or in places with limited access, such as natural holes in the ground or bedrock. These holes were limited in supply, but females denned in them more consistently from year to year than elsewhere. Den location held the single greatest influence on female reproductive output: more young were weaned from dens in holes than from dens elsewhere. During the mating period, male pikas gave territorial advertisement calls and vigorously defended nesting areas from other males whether or not any females were present. It is suggested that male pikas in this population obtain mates by defending attractive resources, i.e. valuable den sites, rather than by defending females directly.

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COVERABLE BADGES IN INTRAMALE TERRITORIAL DISPUTES. A. J. Hansen and S. Rohwer. Univ. of Tennessee, Knoxville, and Univ. of Washington, Seattle.

Kinglets (*Regulus*), many Kingbirds (*Tyrannus*), and some Agelaius blackbirds are all examples of birds having coverable patches of conspicuous coloration. We propose that coverable color patches evolved as two-stage cues of social status which act to minimize escalated fighting in intramale territorial disputes. We tested mechanistic predictions of both this and an alternative hypothesis involving species recognition in Redwinged Blackbirds (*A. phoeniceus*). Only predictions of the coverable badge hypothesis were found to obtain. Coverable badges are believed to be reliable assessment cues because of strong asymmetries which favor territory owners over intruders. This work provides the first comprehensive explanation of the function of epaulets in redwings and clears the way for the intraspecific comparisons which are required to determine the general credibility of the coverable badge hypothesis.

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ALTERNATIVE MATING STRATEGIES OF MALE WOODCHUCKS (*MARMOTA MONAX*). Paul T. Meier and Gerald Svendsen*. Ohio University, Athens.

Movements of radio-tagged, adult male woodchucks in a SE Ohio population were recorded 1979-1983. Adult male woodchucks can be separated into two groups based upon differences in movement behavior. The first is characterized by males (n = 6) whose home ranges remain the same throughout the year and between years. Their home ranges do not overlap with each other but do overlap the home ranges of 1-3 females. The second is characterized by males (n = 5) who have no definite home ranges but move from one area to another. Differences in movement behavior between the two groups can be interpreted as reflecting two alternative mating tactics. In the first group, males defend resources critical to female reproductive success and thereby limit access of other males to females. In the second group, males expend energy not in resource defense but in locating females during the breeding season. We conclude that the evolution of the two strategies is the result of the potential for a male to defend a resource (hibernacula) important to female fitness but where these resources are sufficiently spaced apart that defense of several is difficult by a single male.

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SOCIAL DIVERGENCE DESPITE ECOLOGICAL SIMILARITY IN TWO NEOTROPICAL MONKEY SPECIES. C. H. Janson. Univ. of Washington, Seattle.

In SE Peru, two capuchin species, Cebus albifrons and C. apella, eat nearly identical plant species. Yet their social systems are far more distinctive than socio-ecological theory might predict. In C. albifrons, group size is 10-20 animals, intra-group aggression is rare, and dominant and subordinate males have many friendly interactions. In C. apella, group size is only 6-14, and aggression is common, mostly from the dominant to subordinate males. Other marked contrasts exist in spatial structure, mating behavior, and grooming relations. The social differences between the two Cebus species may have arisen from social amplification of small ecological differences. A slight difference in the patch size of food trees used by the two Cebus could result in a cascade of self-reinforcing behavioral changes that lead to significant social evolution. I offer a specific model of this process that includes optimal resource defense, parental investment, and female mate choice to account for the contrasts in social structure between the two Cebus species.

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FOLIVORY AND FEMALE TRANSFER IN PRIMATES. Jim Moore, Harvard Univ., Cambridge, MA

Female-female relationships are often considered the basis of mammalian social systems, and nepotistic female bonding may have favored gregarious sociality in mammals via kin selection. In his 1980 discussion of female bonding in primate social groups, Wrangham suggested a relationship between female bonding and diet: briefly, because leaves are both less patchy and less valuable per unit than are most other resources, folivores have less to gain from membership in cooperative groups that displace other such groups from food. Consequently, non female-bonded species (i.e., species in which females routinely transfer out of their natal troops) should tend to be folivores. Wrangham considered only 4 of 30 primates to be non female-bonded, but in a recent review of a larger sample I found evidence of substantial female transfer in an additional 14 species. Here I focus on the relationship between female transfer and diet. Using both behavioral and morphological dietary indices, there is a positive association between female transfer and folivory. Though female transfer is far more common than generally believed, the distribution of the phenomenon supports Wrangham's model.

(Wrangham 1980 - Behaviour 75:262)

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THE OPTIMAL RELATIONSHIP BETWEEN AGGRESSION AND FEEDING RATE FOR AN ALPHA MEMBER OF A DOMINANCE HIERARCHY.

C.F. Rakocinski, M.S. Peterson* and T.A. Doherty*. Univ. of Southern Mississippi, Hattiesburg.

We examine the relationship between aggression and feeding rate for an alpha member of a dominance hierarchy under a premise of immediate energy maximization. We assume changing tradeoffs between time spent searching for, or being involved with, food and being aggressive over a wide range of food availability. Aggression is considered as an instrument for increasing the rate of energy intake. We expect the following: 1) there should be a turnover point of peak aggression which should occur at the level of food availability where search time approaches zero; 2) the peak should also coincide with the maximum feeding rate for that level of time spent feeding (i.e., not aggressing); 3) a maximum feeding rate should be maintained as time is released from aggression for food involvement; 4) the peak of aggression should shift to a higher level of food availability with increased contention. We are currently investigating these expectations using the bluegill sunfish.

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COMPETITION FOR MATES THROUGH AGGRESSION IN MALE AND FEMALE NEREIS ACUMINATA, A MARINE POLYCHAETE. V. R. Starczak. Univ. of Conn., Groton.

In Nereis acuminata female investment in reproduction is greater than that of males. Females reproduce once and die. Males remain with the young and can mate again after the young leave. Both sexes show intrasexual aggression. I tested hypothesis that competition for mates is more intense among males and that this is manifested through levels of aggression. Laboratory studies indicate that larger males displace smaller males from females, and males which win fights are more likely to obtain mates. This trend is not observed in females. Males are more aggressive than females in intrasexual fights. Female worms passed over one another and remained in the same tube without fighting (at least once during fight encounters) in 10 out of 20 trials. Males exhibited this behavior in only 3 out of 22 fights. Males and females do not differ in the duration of fights or number of escalations in a fight.

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SEASONAL VARIATION IN SEX-RATIO OF HUMAN BEINGS. Sureshwar Sharma
Univ. of Jabalpur, India.

Human sex-ratio, 108 males on 100 females is attributed to relative lighter weight, therefore faster movement of Y-sperms, which provides them better chances of fertilization. But the natural balancing forces do not allow this constantly in the same lines. This study is an attempt to find those natural forces among seasonal factors which control and direct this genetic event of sex-expression. 600 child births were recorded from maternity hospitals of Jabalpur in two years. Sex-ratio calculated male births divided by female births. Data of temperature and humidity at the time of conception (270 days back to birth) were taken from Govt. weather records. Graphs plotted on average fortnight data basis. Higher correlation value (0.31) between sex-ratio and atmospheric humidity at the time of conception indicates higher male births than female. Concluded that ecological factors have significant role in sex-expression viz. maintaining sex-ratio of human population.

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THE ADAPTIVE CONTROL OF OFFSPRING SEX RATIO BY FEMALE COYPUS (MYOCASTOR COYPUS). L. M. Gosling. Coypu Research Laboratory, Jupiter Rd., Norwich, U.K. NR6 6SP.

There are strong theoretical reasons for expecting parental control of offspring production in relation to their quality and sex, but little empirical evidence that it exists. Data from a 12 year study of Coypu reproductive biology suggests that adaptive control may exist in this species, and that one mechanism is selective abortion of entire litters. Females with large fat reserves abort small litters when these are predominantly female and reconceive larger litters; they retain small predominantly male litters. This pattern of abortion is predictable from the expected RS of male and female offspring in a polygynous mating system.

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ECOLOGICAL DETERMINANTS OF SOCIAL ORGANIZATION IN PIKAS. E.W. West

The daily and seasonal behavior patterns of pikas (Ochotona princeps) living on talus slopes in sagebrush, subalpine, and alpine habitats were studied to assess the importance of local ecological factors in determining social cohesion within the species. All populations were found to be asocial. Males and females maintained separate territories with overlap occurring only during the breeding season. Juveniles dispersed shortly after weaning. Social interactions were mainly agonistic except for cooperative predator warning calls. Predator pressure, interspecific competition with sympatric ground squirrels, and high ambient temperatures appear to restrict pikas to their talus habitat. Intraspecific competition for limited food and space on the talus apparently precludes the evolutionary development of higher forms of social organization.

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HISTOLOGICAL STRUCTURE OF THE SKIN GLANDS OF THE SPRINGBUCK, ANTIDORCAS MARSUPIALIS. G. W. Hearn. Beaver College, Glenside, PA.

The distribution, size, and structure of both apocrine and sebaceous glandular elements in the skin and specialized skin glands of the springbuck, Antidorcas marsupialis, were examined using standard histological techniques. Both the preorbital and interdigital glands resembled those described for other antelope. The large dorsal gland, which is unique to the springbuck, was predominantly apocrine, despite earlier reports of its sebaceous character. The results support the observation that skin glands associated with alarm reactions usually have an apocrine component.

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SOCIAL ENCOUNTERS BETWEEN UNFAMILIAR ADULT THRICHOMYS APEREIOIDES. K.V. Thompson and J.A. Cranford* Virginia Polytechnic Institute and State Univ., Blacksburg.

Social behavior was studied in Thrichomys apereoides to examine the presumed field observation of a polygynous social system. Unfamiliar adults were observed in single and mixed sex encounters in a neutral arena. The frequency of occurrence of 15 social behaviors and the sequences with which they occurred were recorded, in addition to morphological characteristics and age. No relationship was found between dominance status and age, weight or length. Dominant males differed from subordinates in the frequency of performance of both agonistic and nonagonistic social behaviors, while dominant and subordinate females differed only in the amount of approach and retreat behavior. Males performed more agonistic behaviors than females in single sexed trials. Aggression was lowest in mixed sex encounters, where males dominated females and performed more nonagonistic social behaviors. Male behavior did not vary as a function of female reproductive status. These results support field observations suggesting a polygynous social system, with the home ranges of several females being overlapped by the home range of one male.

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THE IMPACT OF AGGRESSION ON FEEDING EFFICIENCY DURING GRAZING. A. T. Rutberg. Univ. of Washington, Seattle.

Grass is a widely dispersed and supposedly undefendable resource. However, aggression among grazers is frequent, and probably influences feeding efficiency. Aggression frequency and feeding efficiency, estimated as the proportion of feeding time spent cropping, were measured in American bison between late winter and late spring at Yellowstone National Park, Wyoming, and the National Bison Range, Montana. Aggression was most frequent in habitats where grass was sparse. Animals incurring aggression suffered reduced feeding efficiency, but the strength of this effect varied between habitats. Aggression should be frequent and create important differences in feeding efficiency among grazing animals when both cropping times at a patch and travel times between patches are long. Long cropping times increase the opportunity for displacement at a food source, and long travel times imply a significant time-saving advantage to aggressive displacement. Thus, aggression in groups of animals feeding on dispersed resources may be viewed as defense of cropping time, rather than defense of space.

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SOCIAL STIMULATION OF FALL BREEDING IN THE MONTANE VOLE, MICROTUS MONTANUS. F.J. Jannett, Jr. Science Museum of Minnesota, St. Paul.

The effects of social stimulation on growth and reproduction of the montane vole (Microtus montanus) were investigated under natural fall decreasing photoperiod and temperature. In the first experiment, litters born to field-trapped females in August were "split." Control half-litters composed of both sexes were held in stable groups. Experimental half-litters composed of both sexes were periodically mixed in composition and an adult male was added. Females in control groups remained nulliparous and most stimulated females bred. Second, the adult males used to stimulate young voles had heavier testes and vesicular glands than isolated control adult males, and they gained weight. Thirdly, subadult males were held in small pools to which adult females were added; these males showed no increase in testes or vesicular gland weights when compared with control males. Increasing social stimulation within increasing populations of voles and lemmings may be the proximate cause of extended fall and winter reproduction.

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EFFECTS OF PRE- AND POSTNATAL UNDER-NUTRITION ON MANIPULATION OF OFFSPRING SEX RATIO IN GOLDEN HAMSTERS. U.W. Huck¹, J.B. Labov², P. Vaswani^{*1}, and R.D. Lisk¹. ¹Princeton Univ., New Jersey and ²Colby College, Waterville, Me.

This study examined the influence of maternal undernutrition on sex ratio and differential survivorship of male and female offspring in golden hamsters (Mesocricetus auratus). Newly mated adult females were undernourished during pregnancy and lactation (-- group), during lactation alone (+- group), or fed ad libitum during both periods (++ group). Offspring sex ratio (males:females) at birth was significantly greater for ++ and +- females compared to -- animals. Females did not manipulate postnatal sex ratios of their litters, but relative mean body weights of male and female pups were correlated with postnatal levels of maternal nutrition. Females undernourished during lactation (-- and +-) provided proportionately less postnatal investment to sons than to daughters.

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SCENT-MARKING IN THE GRAY SHORT-TAILED OPOSSUM (*MONDELPHIS DOMESTICA*). B.H. Fadem and E.A. Cole*. New Jersey Medical School, Newark.

Characteristics of scent-marking behavior were studied in *M. domestica*, a small pouchless, Brazilian marsupial of the family Didelphidae. Twenty laboratory-bred males and females were tested both in a clean test box and in a test box which had been previously marked by a male. It was found that mature males used head, chest and flanks to mark and that the level of marking was directly related to age. Sexually immature males did not mark. Two of eight females marked at low levels and used only head and flank. Eighty-seven percent of the marks made in the previously marked box were made in areas marked by the preceding male. Although little is known about the natural behavior of this species, functionally, marking behavior may, as in other mammals, serve to define the home range or to advertise the presence of reproductive males. This study was carried out as part of an effort to examine the effects of gonadal hormones during early development (prenatally in eutherian mammals and postnatally in marsupials) on species specific sexual and sexually dimorphic behavior patterns in *M. domestica*. This study was supported in part by a grant from the Foundation of the University of Medicine and Dentistry of New Jersey and NIH Grant HD16018 NICHHHD.

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SOCIAL DOMINANCE IN FEMALE BIGHORN SHEEP. Beth Bennett. Univ. of Colo., Boulder.

Social interactions in a group of six adult female bighorn sheep (*Ovis canadensis canadensis*) in the Denver Zoological Gardens were studied to determine the existence of a dominance hierarchy. A strongly linear, age-based hierarchy was found. Advantages of high rank included predictability of response from subordinate animals, reliability of information encoded in display behavior, priority of access to food, and possibly to mates. Preferential space use or territorial behavior was not associated with high rank. Time budget analyses were used to investigate two groups of free-ranging ewes to corroborate the conclusions generated by the captive animal study. Both groups of sheep allocated time similarly in five behavioral categories, suggesting that captive and free-ranging animals behave in similar fashion, and that a dominance hierarchy is not an artifact of captivity.

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BRAIN HEATERS IN THE BILLFISH. B.A. Block. Duke University, Durham, N.C. 27706.

Marlins, swordfish and sailfish have warm brains and eyes but their muscle and viscera are at water temperature. The billfish have a specialized organ for heat production which is positioned beneath the brain and adjacent to the eyes. This tissue is derived from part of the superior rectus eye muscle and is supplied with blood via a large vascular heat exchanger originating from the carotid arteries. The different species of billfish exhibit a range of development of the brain heater tissue. In all of these fish the heater tissue has a high capillary density and the cells are packed with mitochondria indicating a high oxidative capacity. Atrophied muscle fibers are present throughout the tissue. Lipid and glycogen are rare, suggesting that fuel is extracted directly from the blood. This heater may be thermogenically active at all times.

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SEASONAL SHIFT IN THERMOREGULATORY ABILITY OF THE DEER MOUSE, *PEROMYSCUS MANICULATUS*. K.E. Conley and W.P. Porter*. Univ. of Wisconsin, Madison.

Mechanistic heat transfer models evaluated for summer and winter fur properties, thermogenic capacity and microclimate conditions were used to determine the range of T_a below 30 °C over which thermoregulation is possible. Calculations reveal that the seasonal change in thermogenic capacity plays the major, and in fur properties the minor, role in the reduction of the minimum T_a for thermoregulation under burrow conditions from -5 °C during the summer to -30 °C during the winter. However, above ground a 1 m s^{-1} wind, common in deer mouse microclimates, permits thermoregulation to only 8 °C and -10 °C during summer and winter, respectively. Nocturnal T_a in southern Wisconsin frequently remains below -10 °C during the winter, thereby restricting foraging activity above ground to short periods. Laboratory measurements from published reports are presented that confirm many of these results.

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METABOLISM OF MALE RACCOONS, *PROCYON LOTOR*, IN SUMMER. J.N. MUGAAS, E. BROUDY* AND J. SEIDENSTICKER*. W.V. School of Osteopathic Med., Lewisburg, and National Zoological Park, Washington, D.C.

Basal and thermoregulatory metabolism was determined for 8 adult male raccoons. Oxygen consumption was measured at 5°C intervals from 10° to 35°C. Measurements were conducted on fasted animals (10 h) between 06:00 and 20:00 h during July and August, 1983. Two animals were from the National Zoo and each had a surgically implanted body-temperature transmitter. The other 6 were captured on the Conservation and Research Center at Front Royal, Virginia during the investigation. Mean body wt. was 4.5 kg ± 0.69. The thermoneutral zone extended from 20°C to at least 35°C. The mean metabolic rate within thermoneutrality was 0.44 mL O₂/gh ± 0.081 (955 kJ/day; R.Q. = 0.8; 20.097 kJ/L O₂), 5% higher than the predicted value (0.42 mL O₂/gh; 904 kJ/day). Wet and dry thermal conductance reached a minimum at 20°C (0.0232 mL O₂/gh°C and 0.0206 mL O₂/gh°C, respectively). During metabolic trials body temperatures of the "zoo" animals varied from 37.4° to 39.5°C being lowest between chamber temps. of 10°C and 25°C. When caged outdoors these individuals showed highest body temperatures at night (38°C to 39°C) and lowest during daylight (37°C to 38°C).

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DAILY TORPOR PATTERNS IN SOUTHERN PEROMYSCUS UNDER SEMI-NATURAL CONDITIONS. M.G. Tannenbaum and E.B. Pivorun, Clemson University, SC.

To assess the importance of daily torpor under field conditions, radiotelemetry was used to monitor body temperatures of *P. maniculatus* (Pm) and *P. leucopus* (Pl) held outdoors. At bimonthly intervals over a 2 yr. period, mice were trapped, implanted IP with transmitters, & immediately placed into outdoor enclosures in their natural habitats. With ad lib food and water, 25% of the monitored individuals of each species displayed spontaneous torpor. Torpor was only observed from late Oct to early Apr, and only at $T < 1^{\circ}\text{C}$ for Pm and $T < 6^{\circ}\text{C}$ for Pl. The montane Pm underwent^a torpor 3 times as frequently as Pl, a Piedmont species, and the mean depth & duration of torpor was slightly (non-significantly) deeper & longer, respectively, for Pm vs. Pl. Food restriction raised the proportion of mice entering torpor and the total frequency of torpor. Rationing also significantly ($p < .001$) lengthened mean duration and lowered mean depth of torpor compared to ad lib values. Mean duration of induced torpor was significantly ($p < .05$) longer for Pm than for Pl (4.5 vs. 2.9 hr), and the latter suffered greater mortality when faced with limited food.

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A FIELD STUDY OF THERMOREGULATION IN *XYLOCOPA VIRGINICA*. Joel M. Baird. Rutgers University, New Brunswick, NJ.

Thoracic, abdominal and head temperatures were measured in individual field collected *Xylocopa virginica* engaged in a variety of behaviors over a wide ambient range of temperature, insolation, wind and relative humidity. Linear regressions of body temperature (T_b) on T_a indicate a well developed thermoregulatory ability. Physical factors, especially T_a and insolation, significantly affected T_b in both sexes. Behavior also significantly affected T_b , heat production being a function of the energy demands of each behavior. Environmental effects on T_b are modified by activity and vary with different behavioral regimes. The sexes differ significantly in the regulation of tagma temperature, most notably in the ability of males to regulate head and thoracic temperature to a greater extent than females, especially during high energy behaviors. This may be related to the necessity for males to respond more rapidly and precisely than females.

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THERMOREGULATION OF BUDGERIGARS EXPOSED TO MICROWAVES (2.45 GHz CW) DURING FLIGHT. D. Byman, F. E. Wasserman*, T. H. Kunz, B. A. Schlinger* and S. P. Battista*. Pennsylvania State Univ., Dunmore, Boston Univ., Boston, MA, and Arthur D. Little, Inc., Cambridge, MA.

Budgerigars (*Melopsittacus undulatus*) flying at 37 km/h in a wind tunnel were exposed to 2.45 GHz continuous wave microwave radiation at power densities of 50 and zero (control) mW/cm² for 600 s. Body temperatures were measured before and after flights and thermoregulatory behavior was observed during and after flights. A power density of 50 mW/cm² induced thermoregulatory behaviors at ambient temperatures (T_a) above 26°C. At T_a 's above 27°C, a significant linear relationship ($T_b = 31.56 + 0.41T_a$) existed between T_b and the post-flight body temperatures (T_b) of irradiated birds whereas there was no significant relationship between T_a and T_b after control flights. Irradiated Budgerigars became hyperthermic ($T_b > 43.5^{\circ}\text{C}$) and were forced to land before the end of the 600 s exposure period when T_a was greater than 32°C whereas non-irradiated birds could fly indefinitely at T_a 's as high as 36°C. Budgerigars that were forced to land usually required more than 600 s to recover from thermal stress.

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RESPIRATORY AND CARDIOVASCULAR FUNCTION IN CRAYFISH EXPOSED TO LOW pH. N. E. Patterson. George Mason Univ., Fairfax, Va.

Respiratory and cardiac performance as a function of water acidity were assessed in Procambarus clarki. Scaphognathite rate (f_{SC}) was measured from branchial pressure, and heart rate (f_H) was measured by an impedance technique. Rates were measured on crayfish in deionized, decarbonated water (pH 7.0, 16°C); after 24, 48, 72, and 96 hours in water acidified to pH 3.8 with H_2SO_4 ; and after 24 and 48 hours of recovery in deionized water (pH 7.0). Under acid conditions, f_{SC} increased rapidly over the first 48 hours of exposure, from between 1.6-8.1 times resting rates. f_{SC} remained significantly elevated, and the frequency of ventilatory pauses decreased significantly throughout acid exposure. Pausing occurred only after short (i.e., 10 secs.) bursts of hyperventilation, in contrast to pausing under normal conditions. No pausing was noted after 48 hours in acid. f_H was significantly elevated for at least 72 hours. During recovery, f_H and f_{SC} decreased gradually over 48 hours. Pausing frequency was slightly elevated. These data show a ventilatory response to metabolic acidosis, perhaps due to influx of H^+ ions.

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ENERGY METABOLISM DURING HYPOXIA AND SUBSEQUENT RECOVERY IN THE STONE CRAB. J.L. Albert and W.R. Ellington. Florida State

Specimens of the stone crab Menippe mercenaria survived severe hypoxia ($PO_2 < 8$ mm Hg) for at least 12 h at 28-30°C. Hemolymph L-lactate concentrations rose to ~ 50 mM. In contrast, tissue lactate levels in the cheliped closer, leg socket, and heart muscles ranged from 16-20 μ moles per g wet wt following hypoxia. This represents a significant concentration gradient between the tissues and the hemolymph. This gradient may reflect the formation of calcium lactate in the hemolymph. L-Alanine concentrations in the hemolymph also increased during the time course of hypoxia. In the cheliped closer and the leg socket muscles, there was a significant utilization of the phosphagen, arginine phosphate, during hypoxia. In addition, ATP levels fell and there were corresponding increases in ADP and AMP levels in these two tissues. During recovery, there was typically no change in hemolymph lactate levels during the first h. However, within 12 h, 90% of the accumulated lactate had been cleared from the hemolymph. We conclude that the stone crab has a relatively high capacity for sustained lactate formation and subsequent metabolism during post-hypoxic recovery.

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COMPARATIVE EFFECTS OF HYPOXIA ON BLOOD pH AND LACTATE LEVELS IN MACROBRACHIUM ROSENBERGII AND PROCAMBARIVS CLARKI. N. A. Mauro, C. Thompson* and S. A. Melacha* Hartwick College, Oneonta, New York.

In the prawn Macrobrachium blood pH increases from 7.40 to 7.81 between 80-40 torr due to a hyperventilatory response. This change in pH contrast with the crayfish where blood pH remains constant at 7.77 over the same O_2 tension range. At 15 torr, in both species blood pH drops to about 7.5. Prawn hemocyanin (HCN) has a P_{50} of 28 at pH 7.4 and a Bohr effect of -1.3 ; while, crayfish HCN has a P_{50} of 5 and is independent of pH modulation (Mangum, 1982). At 40 torr, the relatively high HCN O_2 affinity for both species sustains O_2 transport at a substantial level and results in a small lactate accumulation. At 15 torr, the rate of lactate accumulation by prawn and its rate of removal when returned to normoxia are more rapid than for the crayfish.

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DESICCATION RESISTANCE AND USE OF THE MANTLE CAVITY FOR AERIAL RESPIRATION IN THE MANGROVE BIVALVE MOLLUSC, GELOINA EROSA. Robert F. McMahon. Univ. Texas at Arlington, Arlington.

Specimens of Geloina erosa were collected from a high littoral, mangrove covered beach in Shuen Wan, New Territories, Hong Kong. Valve movements of emerged clams were monitored at 20°C for 24-48h by displacement gauge. In air G. erosa alternates between closing the valves tightly and gaping while exposing mucus-sealed mantle edges for shorter periods. During mantle edge exposure the inhalent siphon may be held open allowing gas exchange between the mantle cavity and external atmosphere. Within periods when the inhalent siphon was open individuals were observed to initiate a series of alternating valve adductions and deductions lasting up to 1h, ventilating the enlarged mantle cavity (approximately 75% of internal shell volume) and renewing its oxygen stores. Subsequently, the siphon and/or valves were closed. Measurements of water loss rates indicated that this aerial respiratory behavior is more conservative of evaporative water loss than that of continual gaping but less than that of continual valve closure.

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BLOOD ACID-BASE BALANCE IN THE SEA MUSSEL, *Mytilus edulis*. C.E. Booth, D.G. McDonald, and P.J. Walsh. McMaster Univ., Hamilton, Ontario and Univ. of Ottawa, Ont.

In vitro analysis of *Mytilus* blood indicates a low buffering capacity, nearly identical to seawater. Consequently, blood pH is very sensitive to PCO₂ fluctuations caused by valve closure and altered seawater PCO₂ levels. When CO₂ excretion is impaired (air-exposure and hypercapnic anoxia) blood pH falls sharply, but when CO₂ excretion is enhanced (hypocapnic anoxia) blood pH rises above control values. 'pH-HCO₃' diagram analysis showed no evidence of metabolic acidosis in any of the above treatments; any acidic anaerobic end-products in the blood were either neutralized immediately by mobilization of volatile buffers (eg. CaCO₃) or excreted into the ambient seawater. Measurements of low or negative acid excretion rates suggest the former. Blood pH regulation in *Mytilus* is imprecise and appears to be due strictly to the physico-chemical properties of the blood.

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THE EFFECT OF ANOXIA ON INTRACELLULAR pH IN THE SEA MUSSEL *MYTILUS EDULIS* L. P.J. Walsh, C.E. Booth, and D.G. McDonald*. Univ. of Ottawa, Ontario and McMaster Univ., Hamilton, Ontario.

To assess the role of pH in the regulation of the transition to anaerobic metabolism in bivalve molluscs, intracellular pH was measured by the distribution of 5,5-dimethylxazolidine-2,4-dione in the tissues of *Mytilus edulis* under anoxic conditions. Air-exposure for 8h resulted in significant decreases in pHi of adductor muscle, foot, and mantle, and the extent of pHi decrease was inversely correlated with tissue buffering capacity. The extent of pHi decrease in adductor muscle was not sufficient enough to inhibit pyruvate kinase or activate phosphoenolpyruvate carboxykinase to any significant extent. The changes in pHi would have minimal effect on the direction of carbon flow at the "PEP-Branchpoint". The larger changes in pHi observed in mantle tissue may potentially effect metabolism in this tissue. Lastly, different patterns of pHi variation were noted under different anoxic conditions (nitrogen equilibration). These results have important implications for experimental design in studies of anoxic metabolism.

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N-ACETYLTRANSFERASE RHYTHMS IN THE CHICK PINEAL GLAND DEPEND ON PRIOR LIGHTING S. Binkley, K. Mosher*, B. White*, Temple U., Philadelphia, PA.

N-acetyltransferase activity (NAT) exhibits a circadian rhythm in the chick pineal gland which is responsible for daily melatonin cycles. The NAT profile (NAT versus time) was photoperiodic. Shortening the dark period to 4h 'focussed' the NAT peak to as little as 4h; lengthening the dark period to 16h lengthened the NAT peak to 12h. The focussed peaks had higher amplitudes than those that lengthened. The NAT peak in the second night of DD following LD8:16: was 2h longer and slightly lower in amplitude than the NAT peak following LD16:8. Peak NAT *in vitro* occurred 5h earlier following LD16:8 than following LD8:16. One day of LL increased the amplitude of the NAT profile, but after 12 days of LL the NAT profile was damped and the amplitude of the NAT cycle *in vitro* doubled. The data support hypothesis of a timed 'program' for NAT that is 'written' by the prior environmental lighting.

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EFFECT OF PINEALECTOMY ON THE CIRCAANNUAL BODY WEIGHT RHYTHM OF *SPERMOPHILUS TRIDECIMLINEATUS*. W.B. Sinnamon and E.B. Pivorun. Central Wesleyan Col., Central S.C. and Clemson Univ., Clemson, S.C.

Young, female *S. tridecemlineatus*, born in our laboratory in May, 1980, were individually caged, maintained at 21 C in a natural photoperiod, and provided with food and water *ad lib*. In July, 1980 the squirrels were randomly separated into two groups; seven were pinealectomized and six were sham-pinealectomized. Body weights, to the nearest gram, were measured weekly for each animal through two hibernation seasons commencing in August, 1980 and continuing through August, 1982. Both the pinealectomized and sham-pinealectomized squirrels displayed the circannual body weight cycles typical of seasonal hibernators. Although the initial mean body weights were equal for the two groups, the pinealectomized group displayed significantly ($p < .05$) higher mean body weights compared to the sham-operated group during the period of maximum weight gain for both hibernation seasons. The mean body weights during the second hibernation season tended to be higher for both groups than during the first hibernation season.

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MATERNAL INFLUENCE ON THE INTERPRETATION OF PHOTOPERIOD INFORMATION BY JUVENILE MONTANE VOLES (*MICROTUS MONTANUS*). T. H. Horton. University of Utah, Salt Lake City.

Growth rates of microtine rodents are variable. Laboratory studies have shown that short photoperiods (8L:16D) inhibit growth and sexual maturation of several microtine species. Field studies have shown that voles born in spring under short or intermediate photoperiods grow rapidly while those born in summer exhibit inhibited growth and delayed sexual maturation. Previous work with *M. montanus* has shown that the photoperiod present prior to weaning influences how voles will respond to photoperiods seen following weaning. The results to be presented show that, when voles are exposed from the day of birth to a photoperiod of 14L:10D, the post-weaning development is dependent on the photoperiod seen by the mother during gestation. Those voles whose mothers were exposed to 8L:16D during gestation attain a larger body size and heavier reproductive tract weights than voles whose mothers were exposed to 16L:8D during gestation. These results suggest that the response of juvenile voles to photoperiods following weaning are conditioned in utero or during lactation by the mother.

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COLD TEMPERATURES DURING THE SPRING SYNCHRONIZE CIRCAANNUAL CYCLES IN GROUND SQUIRRELS: Janet E. Joy. Univ. Texas at Austin.

Endogenous circannual cycles free-run in constant conditions with periods generally shorter than a year. It is not known how these cycles are phase-shifted and brought into synchrony with the natural year. The possibility that temperature can synchronize these cycles was tested with thirteen-lined ground squirrels that were kept in the cold (4°C) for different amounts of time. When the animals were in the cold, many of them became stuck in the spring phase of their cycles. After they were moved from cold to warm conditions, their cycles were phase-delayed relative to control animals. Thus it appears that temperature may be a primary cue responsible for the yearly synchronization of circannual cycles in ground squirrels.

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MELATONIN RHYTHMS IN THE EYES, PINEAL, AND BLOOD OF JAPANESE QUAIL. H. Underwood, S. Binkley, T. Siopes* and K. Mosher*.

Melatonin levels in the eyes, pineal and blood of Japanese quail exposed to LD 12:12 show robust daily rhythms with high levels occurring in the night and low levels occurring during the day. Since melatonin is synthesized in both the eyes and pineal of birds, the relative contribution of these structures to the blood melatonin levels was examined. A rhythm of blood melatonin persisted in birds blinded by complete orbital enucleation and in pinealectomized birds but the night-time levels were reduced by 33% and 54%, respectively, as compared to melatonin levels in control quail. Only a small melatonin rhythm (13% of control levels) was detected in pinealectomized-blinded quail. This "residual" rhythm could indicate either the contribution of extra-pineal, extra-ocular, sources of melatonin or melatonin secretion from remnants (if any) of pineal tissue remaining after pinealectomy. The pineal rhythm of melatonin content in both sighted and blinded quail was virtually identical showing the participation of extraretinal photoreceptors in the entrainment of the pineal melatonin rhythm.

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PRIMING OF BIOLUMINESCENT COUNTERSHADING IN A MIDWATER SHRIMP. M. I. Latz and J. F. Case*. Univ. of California, Santa Barbara.

The luminescent response to dim light stimulation by previously untested specimens of the midwater shrimp, *Sergestes similis*, differs from the typical counterillumination response. Animals are initially unresponsive; bioluminescence is induced several minutes after the onset of stimulation and reaches maximum intensity after approximately 25 min. Once luminescence is induced, responses exhibit the typical fast kinetics of the counterillumination response.

Visual input is necessary to maintain this primed state. Upon return to the dark, there is a transition from the fast responses of the primed condition to the characteristic slow responses of untested animals. Serotonin treatment stimulates luminescence with similar slow response kinetics. Isolated light organs do not respond to serotonin, but in intact animals are capable of essentially instantaneous light emission upon eyestalk squeezing. This suggests that the priming process and serotonin action involve the luminescent control system, perhaps via a hormonal linkage.

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ECOLOGY AND FEEDING BEHAVIOR OF THE ANCHIALINE SHRIMP *PROCARIS ASCENSIONIS*. B.E. Felgenhauer and L.G. Abele. Florida State University, Tallahassee.

The shrimp *Procaris ascensionis* occurs in land-locked pools that are under tidal influence. Previously considered to be rare our field observations during March 1983 revealed densities of 18.0 ± 5 individuals m^{-3} in lava caves leading off surface pools. Size segregation is evident; small individuals occur among benthic algae while large individuals often swim upside down in the water column using pereopodal exopods and pleopods. *Procaris* is a voracious predator on benthic gammarid amphipods and atyid shrimp although gut contents include plant material. Once prey is captured it is held within a cage formed by the spinous pereopods while *Procaris* swims upside down. Prey detection is probably by mechanoreceptors as sectioning of the eye revealed no ommatidia.

Sectioning demonstrated that *Procaris* is dioecious but external sexual characters remain unknown.

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DIGESTIVE PHYSIOLOGY OF PENAEID SHRIMP: RELATIONSHIP OF SIZE, SPECIES AND DIET TO DIGESTIVE ENZYME ACTIVITY. P.G. LEE and A.L. LAWRENCE. Texas A&M Univ., College Station.

The effects of diet and size on the digestive enzymes of penaeid shrimp were evaluated. Several species, *Penaeus vannamei*, *P. setiferus* and *P. aztecus*, and sizes (6-25g) of shrimp were utilized in a series of thirty day growth trials. The shrimp were grown in 2650 liter indoor tanks and fed ad libitum with six pelleted diets having three protein levels (22, 30 & 38%) and two animal protein to plant protein ratios (2:1 & 1:1). Upon termination of the growth trials an extract of the digestive tract was assayed for total (per g tissue) and specific (per mg protein) activities of nine digestive enzymes. The following activities were detected; trypsin, carboxypeptidase A and B, amylase, chitinase, non-specific esterase and lipase. The extracts lacked chymotrypsin and pepsin activities. The influences of size, species, protein level and protein source did have significant effects on total digestive enzyme activities. Protein in the diet exerted a greater influence on total activities than the other components of the diet. (Supported in part by a Texas A&M Sea Grant Program Marine Fellowship).

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CHANGES IN SHELL CONDITION AFFECTING HERMIT CRAB SHELL PREFERENCE. T. McClintock. Florida State Univ., Tallahassee.

Hermit crab shell preference is usually measured in terms of shell size parameters of "perfect" shells unaltered by the bionts, damage, or decay affecting a majority of hermit crab shells. To estimate the effects of such alterations I measured shell exchange frequency. Of *Pagurus pollicaris* collected in *Polinices duplicatus* shells, 34% of those collected by chance encounter during skin diving and 64% of those collected at artificial predation events inhabited shells either fouled, broken, or pitted. Unaltered empty *P. duplicatus* shells were entered by 51% of predation event crabs and 34% of chance encounter crabs, a significant difference probably related to differing shell conditions among the two groups because shell exchanges increased with decreasing shell condition. Manipulations of shell condition were performed on the crabs' shells to assess the crabs' "perceptions" of changes in condition of their shells. Damage, which reduces shell fit, increased shell exchange more than kleptoparasitic bionts (also potential egg predators) and fouling. This result suggests that predation is a greater local selective influence on *P. pollicaris* than factors reducing reproductive output.

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FACTORS DETERMINING THE HORIZONTAL DISTRIBUTION OF *PANOPEUS HERBSTII* FORMS *OBESA* AND *SIMPSONI*. Roger Menendez and L.G. Abele, Florida State University, Tallahassee, Florida 32306.

Panopeus herbstii forma *obesa* and *simpsoni* are sympatric on oyster reefs in the northern Gulf of Mexico. The *simpsoni* form occurs only on oyster reefs in the low intertidal and subtidal zones among oyster clumps. The *obesa* form burrows high on the oyster reef as well as in salt marsh tidal creeks. Transplant and caging experiments were conducted to determine the limits of distribution for the *simpsoni* form. *Simpsoni* individuals transplanted to tidal creeks had the highest survival in cages with oyster clumps and lowest survival without cages or oyster clumps. Oyster reefs apparently provide protection from predators and physical stress for *simpsoni* individuals. Apparent inability to burrow and lack of cover in tidal creeks exclude the *simpsoni* from this habitat.

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SHORELINE AVOIDANCE IN DIAPTOMUS LEPTOPUS. D. L. Lovett. Univ. of Michigan, Ann Arbor.

Migration patterns of Diaptomus leptopus were examined in a bog lake which lacks a littoral zone. The unique morphology of the lake permitted the examination of diel horizontal migration in the absence of interference from either shallow water or macrophytes. The daytime densities of D. leptopus at horizontal distances between 1-6 m from the edge of the lake were found to be significantly lower than densities at distances beyond 7 m. At night densities became uniform across the lake. Shoreline avoidance is suggested as the mechanism responsible for the development of the daytime distribution pattern. The random nighttime distribution appears to be brought about by a lack of orientation.

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OBSERVATIONS ON POSTINFECTION MORTALITY AND GROWTH OF PALAEEMONETES PUGIO FOLLOWING EXPOSURE TO THE BOPYRID ISOPOD PROBOPYRUS PANDALICOLA. G. Anderson. Univ. of Southern Mississippi, Hattiesburg.

Of 123 isolated P. pugio larvae exposed to 1 or 2 cryptoniscus larvae of P. pandalicola, 119 (97%) became infected within 24 hrs. Initial host mortality was high (26% at 48 hrs); delayed host mortality prevented most parasites from reaching sexual maturity. Preliminary observations indicate that growth of infected shrimp is slower than in controls and molting frequency of infected P. pugio decreases when parasite reproduction commences at about 8 weeks post-infection. P. pugio postlarvae are not infected as readily as larvae (only 12 of 32 exposed postlarvae became infected). P. pandalicola exhibits some degree of host specificity for the normal host, P. pugio. Of 70 Palaemonetes vulgaris larvae and 20 postlarvae exposed to parasites, 38 larvae but no postlarvae became infected. However, mortality of infected larvae was 92% at 48 hrs post-infection. No permanent infections were established in P. vulgaris.

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PERAEPOD MORPHOLOGY AND LOCOMOTION IN THE AMPHIPOD GENERA CERAPUS AND SIPHONOECETES.

J.D. Thomas. Newfound Harbor Marine Inst., Big Pine Key, FL.

Amphipods in the genera Cerapus and Siphonocetes were examined to determine morphological adaptations to similiar habitats (tubes). Specimens were observed and those appendages used in locomotion were submitted to SEM analysis. Cerapus builds parchment tubes on silty substrates while Siphonocetes constructs sand tubes inside a secondary domicile. Amphipods in both genera use modified peraeopod(s) and uropods to grasp the inside of the tube during locomotion. Siphonocetes uses peraeopods 5 and 6 to grasp its relatively heavy domicile, while Cerapus uses only peraeopod 5 to hold its lightweight parchment tube. Cerapus uses uropod 1 to sever its tube and swim using its setose second antennae. Siphonocetes moves by pulling itself forward with stout second antennae. SEM analysis shows structural similarities with other small shell-inhabiting crustaceans.

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JEFFRIES, W.B., H.K. VORIS and C.M. YANG. Dickinson College, Carlisle, Pa., Field Museum of Natural History, Chicago, Ill., and National University of Singapore. A NEW PEDUNCULATE BARNACLE FROM THE SEAS ADJACENT TO SINGAPORE; HOSTS AND INFESTATION SITES.

The major diagnostic features of a new species of Octolasmis (Gray, 1825) from the seas adjacent to Singapore are presented. A formal description of this new form has been submitted for publication elsewhere. Of 53 species of decapods examined, two were found to host the new species of barnacle. One of two Matuta lunaris (Forsk., 1775) (Family Calappidae) and fourteen of fifteen Galene bispinosa (Herbst, 1794) (Family Xanthidae) were hosts. In G. bispinosa sixty percent of a total of 378 barnacles were located on the anterior floor of the branchial chambers beneath the gills and along the anterior, inner margins of the carapace. When on the gills, the barnacles were found primarily on the ventral side and proximal third of gills numbered 3, 4 and 5.

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EXTERNAL STRUCTURE OF THE CORNEA OF STOMATOPOD CRUSTACEA. H. Schiff, B. C. Abbott, and R. B. Manning. Univ. of Torino, Italy, Univ. of Southern California, Los Angeles, and Smithsonian Institution, Washington.

In three superfamilies of Stomatopoda, the cornea is divided by a band of specialized ommatidia, the middle band. This band is six facets wide, with the facets shaped differently, in the Gonodactyloidea and Lysiosquilloidea, two facets wide in the Squilloidea. The band is absent in the Bathysquilloidea. Differences in the middle band may be related to distance evaluation, color and motion vision, and available light in the habitat, and must have developed early in the phylogenetic history of the group.

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HYBRIDIZATION IN HYLA GRATIOSA AND H. CINEREA AND ITS INFLUENCE ON PHYSIOLOGICAL TOLERANCES. J. R. Layne, Jr. and M. A. Romano*. Miami Univ., Oxford, Ohio.

Viable hybrid populations of H. cinerea and H. gratiosa have existed near Auburn, Alabama for at least 25 years. Outside of the breeding season, the latter species inhabits upland forests; whereas, the former species remains in moist lowland areas. We assessed the genetic composition, desiccation tolerance and critical thermal minima (CT_{min}) of hybrid and non-hybrid adult male frogs. Starch gel electrophoresis was used to examine five diagnostic loci to assess the status of each animal. At one locus (MDH) a pronounced allele frequency shift was noted between the pure H. cinerea and the H. cinerea genetic component of the F₁ hybrids. Desiccation tolerance was determined by drying frogs individually in a stream of moving air (R.H. = 38%, temp = 25°C). CT_{min} was determined by cooling the animals in a water bath. H. gratiosa has a higher desiccation tolerance and CT_{min} than does H. cinerea. Preliminary evidence suggests intermediate values for these parameters in the hybrids. These data are discussed relative to environmentally imposed selection which may be acting on hybrid frogs.

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PARALLEL SELECTION OF ELECTROMORPH FREQUENCIES IN THE GRAY TREEFROG, HYLA CHRYSOSCELIS AND HYLA VERSICOLOR. M. A. Romano, D. B. Ralin, S. I. Guttman, and J. H. Skillings. (intro. by R. G. Sherman). Miami Univ., Oxford, Ohio.

The tetraploid treefrog, Hyla versicolor, and its diploid progenitor, H. chrysoscelis are extremely similar morphologically and ecologically, and, more importantly, they share virtually all of the same protein polymorphisms. If selection operates to determine some electromorph frequencies then the diploid and tetraploid would be expected to exhibit similar electromorph frequencies where they occur sympatrically. Sympatric populations of H. versicolor and H. chrysoscelis were sampled from widely separated localities in Texas, Oklahoma, Missouri, Illinois, and Indiana-Ohio. The data were analyzed by means of a statistic that measured the degree to which the two species parallel one another in terms of electromorph frequency. Seven of 11 polymorphic loci were significantly correlated ($P < .05$). These results demonstrate unequivocally that natural selection is an important force in maintaining and shaping allele frequencies in natural populations of the gray treefrog.

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AMYLASE IN THE AMPHIPOD GAMMARUS PALUSTRIS: A CHEMOSENSORY HYPOTHESIS TO ACCOUNT FOR HETEROZYGOTE DEFICIENCY AND DIFFERENTIAL FOOD CHOICE. R. Borowsky †, B. Borowsky ††, and Haleh Milani* † †Dept. Biol., N. Y. Univ., ††Osborn Labs., N. Y. Zool. Soc., New York City.

G. palustris is polymorphic for salivary amylase, and populations in the NYC area have two common alleles. Repeated collections demonstrate a consistent pattern of heterozygote deficiency characteristic of population subdivision rather than selection against the heterozygote. Computer simulations show that the observed distribution can be generated by non-random mating if homozygotes choose different subniches. Experiments suggest that genotypes with the slow allele tend to choose Enteromorpha over Ulva for cover and food, more often than do fast homozygotes. Christensen (1977, *Hereditas* 87:21) demonstrated both food choice based on amylase genotype and heterozygote deficiency in the isopod Asellus aquaticus. Our results suggest that this may be a general phenomenon, at least in the peracarida. We hypothesize that salivary amylase may play a chemosensory role and condition behavior by controlling the nature of the oligosaccharide pool produced by the hydrolysis of substrate.

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THE FREQUENCY OF ATROPINESTERASE ACTIVITY IN TWO NATURAL POPULATIONS OF LAGOMORPHS: A CASE OF COEVOLUTION. V. A. Teubner* and C. P. Black, University of Toledo, Toledo, Ohio.

Recent coevolutionary theory has focused on the interaction between plants and their predators, the herbivores. The present study was designed to examine the effect of plant alkaloids on frequency serum atropinesterase activity in two natural, geographically isolated populations of cottontail rabbits (*Sylvilagus* sp.). Animals were collected from the Arizona (desert cottontail) and the Ohio (eastern cottontail) areas and frequency of serum atropinesterase activity was compared. The desert cottontails (*S. audubonii arizonae*) had an enzyme frequency of 0.81. In contrast, the eastern cottontail's (*S. floridanus*) enzyme frequency was 0.17. Stomach contents were analyzed for the presence of alkaloids for each species. Three basic conditions for the occurrence of coevolution were also proposed in this study. This system agrees with the predictions made from the coevolutionary theory and suggests that the three proposed conditions are necessary for coevolution to occur.

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REPRODUCTION AND POLYPLIIDY IN PUMPKIN-SEED X GREEN SUNFISH HYBRIDS. R.M. Dawley. Univ. of Connecticut, Storrs, CT.

In a number of fishes, amphibians, and reptiles hybridization can trigger unusual meiotic mechanisms that lead to polyploidy. Here I report the existence of such a mechanism in a population of Pumpkinseed x Green Sunfish hybrids in Hall's Pond, Eastford, CT. The hybrids are abundant, outnumbering both parent species. Female hybrids are fertile and, when backcrossed to either parent species, produce triploid offspring. Differences in electrophoretic staining intensity indicate that female hybrids produce diploid eggs that are subsequently fertilized to yield triploid offspring. However, only a few adult triploids have been found in Hall's Pond. Male hybrids are probably sterile, even though they are seen guarding nests with fry. Males produce only a small amount of abnormal sperm and lab spawnings involving male hybrids resulted in eggs that failed to develop. The electrophoretic phenotypes of fry from the nests of fourteen male hybrids suggest that these fry are not the hybrid's offspring. (Supported by grants from the T. Roosevelt Mem. Fund of the AMNH and the Raney Fund of the ASIH).

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INTRASPECIFIC VARIATION IN DIET, HABITAT SELECTION, AND METABOLIC CHARACTERISTICS OF A DART-POISON FROG, *DENDROBATES PUMILIO*. C. E. Busher and T. L. Taigen. University of Connecticut, Storrs.

Populations of *Dendrobates pumilio* in the Bocas del Toro region of Panama vary dramatically in color, degree of toxicity, and habitat. Frogs from Isla Bastimentos are predominantly reddish-orange in color, highly toxic, and live in the litter on the forest floor. In contrast, those from Isla Colon are pale green, relatively non-toxic, and usually found calling and foraging in vegetation 2-6 m above the ground. An analysis of stomach contents of frogs from these two populations reveals significant differences in the type of prey taken and in the relative importance of each type in the diet of the animals. Interpopulation variation in metabolic characteristics parallel these ecological and behavioral differences. The frogs on Isla Bastimentos have higher resting metabolic rates and greater aerobic capacities than their counterparts on Isla Colon. An intrapopulation analysis of V_{O_2} rest and V_{O_2} max shows no correlation between these metabolic features. This suggests that the differences between populations in V_{O_2} rest and V_{O_2} max have arisen independently and apparently stem from different sources.

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ALGAL SYMBIOSIS IN FRESHWATER SPONGES: INTER-HABITAT AND INTER-SPECIES VARIATION IN CHLOROPHYLL CONTENT. T.M. Frost (intr. by D. Lodge). Univ. of Wisconsin, Madison.

Most freshwater sponges are green due to the presence of zoochlorellae which play an important role in sponge energetics. I found that 50 to 80% of the growth of *Spongilla lacustris* was attributable to algal activity. Here I compare the chlorophyll content of a number of sponge species in a variety of habitats. Chlorophyll in *S. lacustris* varies significantly across 9 lakes with a greater than 3 fold difference among habitats. Similarly, three species which occupy the same microhabitat in one lake exhibit significant differences in chlorophyll. These differences in chlorophyll suggest that the contribution from autotrophy and, potentially, heterotrophy may vary significantly. Considering the potential return from algae this variation suggests that the presence of symbionts has costs as well as benefits. I am currently testing the hypothesis that adaptations to use algal symbionts have concomitant costs for the heterotrophic systems of sponges.

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GROWTH AND SEXUAL STRATEGIES IN THALASSOMA DUPERREY, A HERMAPHRODITIC FISH. R. M. Ross. Thiel College, Greenville, Pa.

Adults of T. duperrey, a protogynous hermaphrodite, were collected and growth observed in captivity to study the relationship between growth and reproduction among primary males, females, and secondary males. Sexual maturity is reached at 60 mm SL, less than 1 yr after fertilization. Gonosomatic index peaks in both sexes at 120 mm, nearly 2 yr later. Shortly thereafter females change sex and males undergo color change. Simultaneously gonosomatic index falls abruptly and remains low in large fish. These changes appear to reflect differences in reproductive effort over a lifetime and may be the optimum strategy given the social and mating system of this fish. Small individuals apparently allocate a greater proportion of energy for growth than reproduction, perhaps to minimize the period of low fitness. Intermediate-sized fish generally invest heavily in gametes. Large fish (both primary and secondary males) greatly reduce their investment in gametes, probably trading the energy required to maintain reproductive territories for it. This kind of gonad ontogeny involving gonad regression, as seen in this and other labrid fishes, is unique among vertebrates.

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COMPARISON OF TESTIS STRUCTURE BETWEEN THE PROTOGYNOUS SEA BASS, CENTROPRISTIS STRIATUS, AND TWO OTHER PERCIFORM FISHES, THE RED DRUM, SCIAENOPS OCELLATUS, AND SNOOK, CENTROPOMIS UNDECIMALIS. D. E. Roberts, Jr.* and H. J. Grier. Florida Department of Natural Resources, Bureau of Marine Research, St. Petersburg, Florida.

C. striatus undergoes spontaneous sex reversal during which time ovarian tissue is replaced by testicular tissue. Comparison of testis structure in this species with that of S. ocellatus and C. undecimalis, which do not undergo sex reversal, reveals a system of branching tubules in all three species wherein developing sperm are confined to cysts along the tubule periphery. Mature sperm are observed in the tubule lumen. While the appearance of spermatogenic tissue was similar in all three species, unique structural characteristics were inherent to the testis of C. striatus due to the persistence of the former ovarian cavity and lamellae projecting into it. Unlike S. ocellatus and C. undecimalis, where sperm are transported dorsomedially to a main duct system, C. striatus sperm are conducted peripherally to an anastomosing system of ducts beneath the tunica albuginea.

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ALTERNATIVE INTERPRETATIONS OF MAMMALIAN REPRODUCTIVE EVOLUTION. D. G. Blackburn. NYSCVM, Cornell Univ., Ithaca, NY.

The reproductive patterns of living prototherians and metatherians are widely assumed to represent intermediate stages in an evolutionary transition from therapsid reptiles to eutherian mammals. Analysis of developmental and reproductive data suggests alternative scenarios to be equally plausible, i.e., viviparity evolved independently in marsupials and placentals, altriciality evolved convergently in monotremes and marsupials. Many of the apparent synapomorphies of eutherians and metatherians are linked to ovum size, and thus may be a consequence of parallel trends towards microlecithality. Differences between the fetal nutritional modes of the two groups suggests separate origins of matrotrophy. Evidence is presented indicating that endothermy and parental care preceded lactation which in turn led to the development of altriciality. The hypothesis that the marsupial reproductive pattern is derived rather than primitive for therians is congruent with growing evidence (Parker, 1977; Hayssen et al., 1983) that marsupials exhibit a specialized strategy which facilitates reproduction in highly unpredictable environments.

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A COMPARISON OF THE NORMAL AND DIABETIC CHINESE HAMSTER HARDERIAN GLAND BASED ON FINE STRUCTURE AND ENDOCRINE EVIDENCE. G. W. Kalmus and T. L. Sobol*. East Carolina Univ., Greenville, N. C.

Alterations have been observed in the fine structure of the Harderian gland of diabetic Chinese hamsters. Compared to controls these glands were found to have a decrease in weight, alveolar size, number of cells per alveolus, cell radius, number of type II cells per alveolus, and increased relative concentric lamellae area to total cytoplasm. Cells with cleft structures were observed in Harderian glands of diabetic animals to a far greater extent than in controls and appear to be related to the formation of vacuoles within the cytoplasm of type II cells. Thyroid gland weight was lower in diabetics versus controls. Weights of pineal gland, adrenals and gonads were higher in diabetics versus controls. The total pituitary weights were higher in diabetics versus controls while the posterior pituitary weight was higher in diabetics. The Harderian gland may be related to the retinal-pineal-gonadal chain.

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GILL MORPHOLOGY OF ANCESTRAL VERTEBRATES. J. Mallatt. Washington State University, Pullman.

Gill morphology is widely said to uphold the division of vertebrates into Gnathostomata and Agnatha. The branchial arches of jawed and jawless fish are assumed homologous; the arches lie on opposite sides of the gills (internal vs. external), so common view concludes the gills were independently evolved in the two groups. A gill-less common ancestor must have been very simple and ancient (early Cambrian). I challenge this scheme by arguing that gills of lampreys and jawed fish are too similar to have been independently derived. Rather, branchial arches of the groups are non-homologous, for they differ in location, not only in the gills but also with respect to other organs (aorta, thyroid, visceral muscles). Common ancestors of gnathostomes and lampreys were fish with fully developed gills that could have lived as late as the Silurian. Constructing a gnathostome pharyngeal pattern requires only the addition of internal branchial arches to an agnathan pharynx (larval lamprey). I speculate that internal arches evolved to protectively reinforce the inner margins of the pregnathostome gill as this lineage switched from an ancestral microphagous feeding mode to macrophagy.

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AN EXPLANATION FOR COMPLEX CHARACTER EVOLUTION. P. Maderson, Brooklyn College NY11210. The problem of mammalian middle ear evolution is exacerbated by the assumption that all its features changed simultaneously to ensure functional continuity. Fossils can never reveal a/ the exact location of the tympanum nor b/ when reception of aerial vibrations became its primary biological role. The embryogenesis of the external meatus suggests that it is not an ingrowth but a double fold of skin compressed by adjacent developing muscles. The "vestigial" pars flaccida (PF) plays a major role in pressure equilibration during pharyngeal tissue movements, a functional problem that began with the origin of the palate and mastication. As the pars tensor (PT) is merely an adjacent integumentary specialization, insertion of the incus and malleus between the distal stapes and the tympanic tissues could have occurred gradually as the PT evolved, so that the major reorganization need not have affected aerial hearing. If selection was primarily concerned with pressure equilibration, the original biological role of the incus and malleus might have been the induction of the neomorphic PT. Selection on the ossicles as components of an auditory system could have occurred much later. Analyses of this type might be applicable to many "complex characters". (NIH NS 13924; CUNY 6-63175).

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INTRASPECIFIC MACROEVOLUTION: FUNCTIONAL MORPHOLOGY OF A HIGHLY POLYMORPHIC CICHLID FISH. K.F. Liem and L.S. Kaufman. Harvard Univ., Cambridge, Ma.

Polymorphism in the cichlid *Cichlasoma minckleyi* is interpreted as an incipient intraspecific macroevolutionary transition. The two morphs possess radically different morphology. It is postulated that this stable polymorphism without assortative mating show some degree of differential trophic habitat selection by morphs during ecological crunches. Tachytelic quantum morphological specialization has arisen intraspecifically by quantitative changes in some basic parameters of development resulting in an interrelated series of alterations in functionally correlated elements. A causal link between the abundance of various food resources and phenotypic tracking of the environment has been experimentally established. The extremely specialized morphology of one morph does not increase its efficiency in feeding upon preferred food, but rather enhances the exploitation of a secondary less preferred food during "ecological bottlenecks". Supported by NSF Grant BSR-82-06888 to KFL.

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"ESCAPE" FROM A CANALIZED PHENOTYPE: LIMB SKELETAL VARIATION IN THE RED-BACKED SALAMANDER. J. Hanken. University of Colorado, Boulder.

The salamander genus *Plethodon* (Amphibia: Plethodontidae) generally is considered an archetype of morphological stasis among vertebrate taxa. This is especially true of the limb skeleton, which in fundamental features (mesopodial patterns, digital formulae) is identical in nearly all species. Two peripheral populations of the red-backed salamander, *P. cinereus*, in Nova Scotia exhibit a high incidence of limb skeletal variants which is exceptional for this morphologically conservative species and genus. Included are 11 combinations of fused adjacent carpal or tarsal cartilages, which result in 13 different overall carpal and tarsal patterns, and variant phalangeal formulae. Several variants are unique to these populations and represent morphological rearrangements as great as those cited as "key innovations" in other plethodontid genera. Many predominant variants are identical to those which most frequently characterize limb evolution elsewhere in the genus and family; this may provide evidence of developmental or functional constraints on limb evolution in the Plethodontidae. The genetic basis and geographic extent of this variation are unknown.

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MODIFICATIONS OF INTRACELLULAR ION CONCENTRATIONS IN THE GILLS OF FIDDLER CRABS ACCLIMATED TO DIVERSE SALINITIES. Wright, D. A., I. P. Zanders and M. J. Martelo. Chesapeake Biological Lab., Solomons, MD and I.V.I.C., Caracas, Venezuela.

The intracellular contents and concentrations of potassium, sodium and chloride were determined in the gills of Uca minax acclimated to various media, ranging from 150‰ SW to freshwater. The gill intracellular K content remained roughly constant at 278 $\mu\text{mol/g}$ dry weight over the range of salinities tested, while the intracellular concentration decreased slightly, from 293 $\mu\text{mol K/ml}$ (in crabs from 150‰ SW) to 259 $\mu\text{mol/ml}$ (in those from FW). The intracellular Na and Cl contents also remained constant, at about 128 and 193 $\mu\text{mol/gdw}$, respectively, whereas the intracellular concentrations of these ions, kept at 90 and 129 $\mu\text{mol/ml}$ respectively, in the gills of crabs from 150, 100 or 50‰ SW, fell to 61 and 203 $\mu\text{mol/ml}$ respectively, in those from FW. The capability to maintain the gill intracellular ion levels relatively constant, in the face of large variations of external concentration, may be an important factor to ensure effective hypo- or hyper-regulation of the blood, as is characteristic of euryhaline decapod species such as Uca spp.

UMCEES Ref. No. 83-97 CBL

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PHYSIOLOGICAL EVIDENCE FOR A BLOOD-BORNE FACTOR AFFECTING AGGRESSIVE BEHAVIOR IN LOBSTERS. M.L. Schwanke, J.S. Cobb and G. Kass-Simon. Univ. of R.I., Kingston.

Aggression in the lobster Homarus americanus varies over the molt cycle. Responses of the claw opener muscle were used to represent one component of this behavioral change. An isolated claw preparation was perfused with hemolymph from lobsters in various molt stages while physiological properties of the dactyl opener were monitored. Plasma samples used for perfusion were obtained from lobsters in mid-proecdysis (stages D₁/D₂) and postecdysis (stages A/B) since these represent, respectively, the most and least aggressive phases of the molt cycle. The results indicate that premolt blood was more effective than postmolt blood in altering claw opener activity. In 8 of 23 preparations premolt plasma caused membrane depolarizations in the muscle fibers and induced contractions in 5 of 10 preparations, while postmolt plasma produced these effects in only one case. We suggest that a blood-borne factor, differentially present at certain stages of the molt cycle, may modulate at least some peripheral neuromuscular events involved in the changes in postural behavior observed in aggressive lobsters.

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ENDEMISM AND FAUNAL TRANSITION AREAS FOR FIDDLER CRABS (UCA SPP.) IN THE GULF OF MEXICO. F.H. Barnwell and C.L. Thurman. Univ. of Minnesota, Minneapolis, and Univ. of Missouri, St. Louis.

Thirteen species of Uca are confirmed for the Gulf of Mexico; the United States and Mexico have ten apiece and share seven. Five species are endemic to the Gulf and a sixth is restricted mainly to the peninsulas of Florida and Yucatan. Members of subgenus Minuca have northern and southern range limits near the Carolinean boundaries at Tampa Bay and the Rio Grande (Hedgpeth, 1953), while species of subgenus Celuca tend to separate to east and west at the sedimentary transitions between carbonate and terrigenous substrates near Apalachee Bay in the north and Laguna de Terminos in the south (Price, 1954). The high level of endemism in the Gulf fiddler crabs would appear to reflect their adaptation as semi-terrestrial deposit feeders to regional climatic and edaphic differences in their marginally marine upper-shore habitat. (A full account will appear in the Zoological Journal of the Linnean Society.)

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SYSTEMATICS AND BIOLOGY OF THE GENUS PARAMOERA (AMPHIPODA: EUSIROIDEA) IN THE NORTHEAST PACIFIC. Craig P. Staude. Friday Harbor Laboratories, University of Washington, Seattle.

Amphipods of the genus Paramoera (and allied genera) have been investigated along the west coast of the United States and Canada through direct field observations and examination of museum collections. Seven distinct species have been recognized, four new to science. Species are distinguished by several characters including ornamentation of the gland cone and setosity of the third uropod. Species show preferences for grain size, beach exposure, and salinity. Paramoera is known from around the Pacific from a wide variety of habitats (e.g., kelp, icebergs, lava tubes, and ground water), yet along the west coast of North America it is primarily associated with gravel/cobble beaches. This distribution has several biogeographical implications. P. mohri attains abundances of over 40,000 per m², and provides a significant prey resource for sculpins and juvenile salmon. (Assistance from the Nat. Mus. Canada, U.S.N.M., Lerner Fund, Egtvegt Trust, U. Wash. Grad. School, and Friday Harbor Labs. is gratefully acknowledged).

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LOCAL DISTRIBUTIONS OF SOME MARINE ISOPODS (CRUSTACEA) IN FLORIDA. Sara-Ann F. Treat. Mangrove Systems, Inc., Tampa, Fla.

Several species of marine isopods have been collected from both the east and west coasts of Florida in the course of extensive benthic sampling programs. Abundance of common species appears to be closely related to habitat type but varies widely over both space and time. The quantity and kind of vegetation present is correlated with the occurrence of some isopod species. Some data indicate that the distribution of morphological types of epibenthic isopods is closely tied to the presence and relative abundance of narrow vs. wide-bladed seagrasses. These preliminary observations lead to the conclusion that biotic factors are critical in determining the local distributions of some isopod species.

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OCCURRENCE OF CERATASPIS, A RARE LARVAL GENUS OF OCEANIC PENAEIDS, FROM STOMACHS OF PELAGIC FISHES. S.G. Morgan, C.S. Manooch, III*, D.L. Mason*, and J.W. Goy. Univ. of Maryland, College Park; NMFS, Southeast Fisheries Center, Beaufort, N.C.; and Univ. of Southwestern Louisiana, Lafayette.

Analysis of the stomach contents of tunas and dolphin-fishes from the North Atlantic Ocean resulted in the collection of 240 specimens of the larval crustacean genus Cerataspis. Eighty-seven percent of the specimens collected were C. monstrosa and 13% were C. petiti. Surface-feeding Katsuwonus pelamis, Thunnus albacares, T. atlanticus and Coryphaena hippurus preyed upon the last three mysis stages of Cerataspis. Thunnus albacares and K. pelamis accounted for 95% of the Cerataspis collected. Other pelagic fishes feeding in deeper waters did not consume a single specimen, although mysis stages I and II have only been collected from deep water plankton tows. Fishes feeding around Sargassum are more likely to feed on Cerataspis. Ninety-three percent of Cerataspis were collected from coastal waters off North Carolina. Cerataspis monstrosa and C. petiti have a circumglobal distribution between 40°N and 40°S.

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GROWTH AND BREEDING SEASONALITY IN A NORTHERN POPULATION OF THE MARSH CRAB, SESARMA RETICULATUM (SAY)
R. E. Mulstay, Delaware Valley College, Doylestown, Pa.

Growth and breeding seasonality of Sesarma reticulatum on Long Island, New York was investigated over the course of several years. While mature females are on the average slightly smaller than males, the difference is not statistically significant and both sexes reach a maximum size (carapace width) of 33 mm. These animals become mature at about 14 mm after which the chelipeds of the male grow at a faster rate than in females, leading to the striking sexual dimorphism that is characteristic of this species. Ovigerous females occur in the population from mid-June through August. This species ranges from Woods Hole, Mass. to the Texas Gulf coast. Compared to conspecifics in North Carolina (Seiple, 1979: Marine Biology, 52:77), S. reticulatum on Long Island attains a larger size and has an abbreviated breeding season.

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EFFECT OF HERBIVORE GRAZING INTENSITY ON CORAL REEF ALGAL COMMUNITIES: BIOMASS AND PRIMARY PRODUCTIVITY. R.C. Carpenter. Univ. of Georgia, Athens and West Indies Lab, St. Croix, USVI.

Shallow coral reef algal communities are very productive and withstand intense grazing pressure by several types of herbivores. The standing crop and metabolism of experimental backreef algal communities were determined concurrently with measures of grazing intensity by fishes and urchins. A negative relationship exists between grazing intensity and algal biomass. Primary production ($\mu\text{gO}_2\text{-ug chl.a}^{-1}\text{-hr.}^{-1}$) is positively correlated with grazing intensity. This increase in efficiency (production per unit biomass) more than compensates for the reduction in standing crop so that production per unit area is also positively correlated with grazing intensity. Intense herbivory on coral reefs apparently leads to algal communities dominated by species with high P/B ratios. Assemblages of these algal species provide a sustainable resource for coral reef herbivores.

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PAPILIO MACHAON SYRIACUS VERITY: AN APOSEMATIC LARVA'S DEFENSIVE MECHANISMS.

Dale Evans, American Univ. of Beirut.

I determined the frequencies and the characteristics of the responses to various predator-mimicking stimuli. The caterpillars reacted by everting their osmeteria and/or by raising the anterior portion of their bodies. The larvae rarely (20%) responded to substrate vibration but frequently did so with the various tactile stimuli: dorsal anterior touch, 52%; anterior squeeze, 64%; dorsal posterior touch, 96%. The same response was most likely to be repeated after the same stimulus was repeated. Habituation usually occurred after many ($\bar{X}=20.0 \pm 16.87$) consecutive stimulations. Birds can learn to avoid this species. Ants can exhaust the larva's chemical defenses. The high frequency of defensive reaction may indicate that non-learning predators are a significant mortality factor.

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A COMPUTER METHOD OF CREATING TOOTH WEAR CLASSES FOR THE STUDY OF AGE STRUCTURE IN A RODENT POPULATION.

James J. Goodyear, B.G.S.U., Bowling Green, OH 43403

Multivariate statistical techniques were used to create tooth wear classes in an African murid (Arvicanthis abyssinicus) which can be analogized to age classes and used to follow population fluctuations. Each molar cusp of every specimen was considered a character and was assigned a character state number corresponding to the degree of its wear. The resultant data matrix was subjected to the factor, cluster and discriminant analysis procedures of the SAS packaged computer programs. The groups produced are similar to those created by the traditional method of visual inspection. The computer system chooses characters objectively and can handle large numbers of specimens and variables, always classify a specimen definitively, add new specimens to the scheme, easily change the number of groups, and (potentially) interface with other computer programs and data bases for further analysis of the population.

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HAIR OF THE AMERICAN MASTODON INDICATES AN ADAPTATION TO A SEMIAQUATIC HABITAT.

K.F. Hallin, Milwaukee Public Museum, Dept. of Geology, WI 53233.

The first occurrence of soft tissue preservation of the extinct Late Pleistocene/Holocene (9000-10000 ya) American mastodon (Mammuth americanum) provides new information on the paleoecology of mastodons. Histologic and SEM examination of subdermal carbonized material containing matted hair revealed the presence of collagen fibers, fine guard hairs with a continuous (hollow) medulla, and a furry undercoat morphologically similar to that commonly found in semiaquatic and aquatic mammals. Prior to this discovery, mastodon ecology was inferred from associated pollen and faunal and depositional analyses which indicated open pine and spruce woodlands and spruce forests. Although mastodons appear to have been tolerant of several environments, the presence of a furry undercoat suggests an adaptation to a semiaquatic habitat.

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ON THE HETERONEMERTEAN Lineus atrocaeruleus (Schmarda, 1859). M. Sánchez and H.J.A. Moretto (intro. by Jon L. Norenburg). Pontificia Universidad Católica de Chile and Universidad de Buenos Aires, República Argentina.

The present study completes the description of L. atrocaeruleus presented by Friedrich (1970), who used material collected from the Chilean coast during Lund University Chile Expedition (1948-49). In his original description, he stated that it would be necessary to redescribe the species using better material. Studies of 50 specimens were done in vivo. For a microanatomy description 15 worms were cut serially in 6 micrometer sections. The specimens studied by Friedrich (1970) and the material collected by Dr. Plate in Chile, and described by Burger (1896), were also used. The present work completes the diagnosis of L. atrocaeruleus and discusses some morphological characteristics of the internal anatomy which are of taxonomical importance. Supported by Grant N970/81 from DIUC Pontificia Universidad Católica de Chile and Grant 9193/80 from Conicet, República Argentina.

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HISTORICAL INTERRELATIONS BETWEEN THE AMERICAN ASSOCIATION OF ANATOMISTS AND THE AMERICAN SOCIETY OF ZOOLOGISTS.

G.E. Erikson. Brown University, Providence. Accounts of the early history of the Am. Soc. of Zoologists trace its origins back through the Am. Morphological Soc. to the Am. Soc. of Naturalists, but, strangely, make few references to the Am. Assoc. of Anatomists and its parallel development, though their interrelations were close and long sustained. They shared members, officers, meetings, goals, subjects, techniques, institutions, and journals. Many papers of the zoologists, as well as the proceedings of the ASZ (until the American Zoologist was started in 1951), were published in the two journals of the AAA. Research in progress on the history of the AAA reveals that nearly half of its early members were also members of the ASZ. This means, for the growing movement to research and write the history of the ASZ, that the rich and extensive archives of the AAA at Brown University--manuscripts, publications, photographs, oral history, and a large computerized data bank--can offer, for a large element of shared history, a ready resource and a computer system to access and analyze it. The exhibit will illustrate present uses of these resources and suggest potential developments for researching the history and present status of the ASZ.

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CLAM GANGLIA CONTAIN PEPTIDES HAVING CRUSTACEAN RED PIGMENT CONCENTRATING ACTIVITY. M. J. Greenberg, K. R. Rao, H. K. Lehman, D. A. Price* and K. E. Doble* Whitney Lab, Univ. of Florida, St. Augustine, and Univ. of West Florida, Pensacola.

Both red pigment concentrating hormone (RPCH) and adipokinetic hormone (AKH) are potent stimulators of clam hearts. But about 40% of hearts are unresponsive, an incapacity specific to the action of these hormones. Fractions of clam ganglion extracts were tested for RPC activity in Uca pugnator. A peak of activity, strongly retained by Sephadex G15, was detected. The active fractions also concentrated the erythrocytes of shrimp (Penaeus) and of isolated Uca legs. Thus, the effective agents in clam extracts must be directly chromatophoretropic. They must also be peptides since incubation with chymotrypsin abolishes activity. The pooled fractions from the peak of RPC activity had a concentration equivalent to about 5×10^{-8} M AKH or RPCH; and no cardio-stimulation could be detected. Clam ganglia could contain one or more close analogs of RPCH or AKH, or they could contain larger amounts of relatively unrelated peptides that cross-react with the highly sensitive Uca assay.

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A MECHANISM OF ACTION FOR THE INHIBITION OF CIRCADIAN BLACK PIGMENT DISPERSION BY NAPHTHALENE IN THE FIDDLER CRAB, UCA PUGILATOR. G.C. Staub and M. Fingerman. Tulane Univ., New Orleans, La.

Naphthalene inhibits circadian black pigment dispersion in fiddler crabs exposed to 8 ppm naphthalene for 96 hrs. The present study shows that this inhibition is reversible. Exposure to naphthalene did not alter the frequency of the circadian rhythm, but decreased the amplitude. Naphthalene exposed crabs had four times more black pigment dispersing hormone (BPDH) stored in their eyestalks than did control crabs at noon after a 96 hr. exposure. This hormone was releasable with an injection of exogenous norepinephrine (NE). Black pigment dispersion in response to a black background was not inhibited by naphthalene nor was circadian black pigment dispersion when the crabs were kept on a black background throughout the experiments. The background experiments eliminate NE synthesis and metabolism and the postsynaptic adrenoceptor as possible sites of action for naphthalene. It is concluded that naphthalene acts to inhibit the release of BPDH by interfering with some aspect of the presynaptic control of BPDH release by NE. Supported by grants from the Tulane G.S.S.F. to G.S.

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ENZYME LINKED IMMUNOASSAY OF BLACK PIGMENT DISPERSING HORMONE FROM UCA PUGILATOR. L. Scott Quackenbush and Milton Fingerman. Tulane Univ., New Orleans, LA.

New Zealand white female rabbits were immunized with Freund's complete adjuvant, methylated bovine serum albumin and 30 μ g of black pigment dispersing hormone (BPDH). Serum from immunized rabbits was incubated with a crude extract of crab eyestalks, and then assayed for biological activity. This serum blocked black pigment dispersion, but did not affect red pigment dispersion. Pre-immune serum and naive serum had no effect in these assays. The antibody titer to BPDH was estimated to be 1.5 mg/ml using a precipitin test. A peroxidase-labelled goat antibody to rabbit IgG was used with the rabbit antibody to BPDH in an enzyme linked immunoassay (ELISA). The hemolymph of intact crabs that were adapting to a black background for 45 minutes had 8.8 ± 0.9 ng immunoreactive BPDH/50 μ l hemolymph. Hemolymph from eyestalk ablated crabs had no detectable immunoreactive BPDH. Isolated eyestalks bathed in saline containing 10X normal K⁺ released 4.5 ± 0.4 ng immunoreactive BPDH/50 μ l into the perfusion fluid. The level of immunoreactive BPDH in the medium returned to an undetectable one after washing with normal saline.

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IN VITRO SECRETORY ACTIVITY OF Y-ORGANS FROM THE FIDDLER CRAB, *UCA PUGILATOR*. P.M. Hopkins and B.S. Watson* Univ. of Oklahoma, Norman.

Radioimmunoassay (RIA), high-pressure liquid chromatography (HPLC) and morphological criteria were used to identify ecdysteroid-secreting tissues ("Y-organs") of the crab, *Uca pugilator*. In *Uca*, the Y-organs are located at the junction of the branchial and prebranchial chambers and are morphologically similar to the Y-organs of macrurans. Y-organs (and mandibular organs, muscle tissues, testes and blood) were removed from intact and eyestalkless male crabs and cultured for 15-24 hours. Culture media and blood were assayed for RIA-active material.

Following eyestalk removal in *Uca*, there is a lag period during which there is no growth of regenerating limbs, blood ecdysteroids remain at intermolt levels and Y-organs have very low secretory activity. The lag period is not the result of a protracted influence of some eyestalk factor, for Y-organs from eyestalkless crabs show a brief lag period in secretory activity following the first induced molt. The end of the lag period is noted by an increase in blood levels of ecdysteroids and in secretory activity of cultured Y-organs. Y-organ activity peaks several days before the peak in blood ecdysteroids. Y-organs from donors in late premolt have lower secretory activity than Y-organs from early premolt.

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EXERCISE AND COLOR CHANGE: DURATION AND INTENSITY EFFECTS ON CHROMATOPHORES OF RUNNING CRABS. S.M. Mooney and C.F. Herreid, II, SUNY/Bufalo.

Color change occurs in several crab species during exercise. The chromatophore response is mediated by a blood-borne factor. Male *Uca pugilator* were exercised on a treadmill, with the chromatophores observed at 5 min intervals. Fifteen animals were run at each of three velocities: 0.15, 0.25 and 0.35 km/hr. Color change over time was analyzed using linear regression techniques. At all three velocities black chromatophore pigment concentrated while red and white dispersed. Unexercised controls showed no change. Color change depends directly upon the duration of the run, while the intensity of exercise does not have a significant effect. Each of the three types of pigment cells were found to have a unique response to the blood-borne factor released during exercise. Supported by NSF Grant PCM 79-02890 and BRSG S07 RR 07066-18 of NIH.

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ENDOCRINE REGULATION OF MALE GENITAL DEVELOPMENT IN MALACOSTRACA. G. G. Payen. Univ. P. & M. Curie - CNRS, Paris, France.

Male genital development is regulated by a number of substances. In genetic ♂, descriptive studies together with androgenic gland (AG) ablations and testes or AG implants into ♀ indicate that: 1) influence of an androgenic inductor is necessary for ♂ morphogenesis of the genital tract (GT) and spermatogonial differentiation, 2) a certain titre of circulating androgenic hormone (AH) may be required to maintain the differentiation of gonidia into spermatogonia and also for the initiation of spermatogenic activity. The course of spermatogenesis and its intensity are generally regulated by the gonadotropic action of AH. In certain amphipods and decapods, *in vitro* culture of testes and cauterization of the median region of the protocerebrum show that a ♂ cerebral hormone ensures the maintenance of the integrity of both the testicular germinative zone and the entire GT, including AG. Masculinization of the brain appears due to AH. Existence of a ♂ genitalotropic neurohormone released by decapod eyestalks (ES) was recently elicited following destalking and injection of an aqueous ES extract into ♂ prawns. This moderating hormone seems to act directly on the GT and by way of the AG. Its properties and characteristics are discussed.

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EFFECTS OF SYNTHETIC DRPH ON THE OMMATIDIAL PIGMENTARY EFFECTORS OF *PALAEEMONETES PUGIO*. K.R. Rao, D.G. Doughtie,* P.A. Robinson,* and J.P. Riehm.* Univ. of West Florida, Pensacola.

The ommatidial pigmentary effector system of *Palaemonetes pugio* is composed of distal pigment cells, reflecting pigment cells, and reticular cells. The distal pigment cells contain two types of granules, one with varying morphology (from platelet shape to amorphous state) and the other with features characteristic of ommochrome-containing granules. The latter are morphologically similar to the screening pigment granules (the so-called proximal pigment) in the reticular cells. The reflecting pigment cells contain granules characteristic of pteridine inclusions. Parts of the reflecting cell cytoplasm are found as caps on the distal dark pigment cells. During the course of normal adaptation to light and dark conditions, all three cell types display pigment movements. When injected into dark-adapted *Palaemonetes*, synthetic *Pandalus* DRPH triggers light-adaptational pigment movement in distal and reflecting pigment cells but not in the reticular cells. The peptide-induced effect is relatively more rapid and extensive in distal pigment cells than in reflecting pigment cells.

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INHIBITION OF Y-ORGAN CHOLESTEROL UPTAKE AND ECDYSONE SECRETION *IN VITRO* BY A FACTOR FROM CRAB EYESTALKS. R.D. Watson and E. Spaziani. Univ. of Iowa, Iowa City.

Crab Y-organs are thought to be under the negative control of molt inhibiting hormone (MIH), a neuropeptide from the eyestalks. Y-organs from 48hr deeyestalked Cancer antennarius donors were cultured for 24 hr in crustacean saline + 10% crab serum + ¹⁴C-cholesterol. One gland of a pair received eyestalk extract, the other saline vehicle. Tissues were assayed for radioactivity; media were assayed for ecdysteroids by HPLC. Under these conditions, glands receiving eyestalk extract took up less cholesterol and secreted less ecdysone than contralateral controls. The inhibition was dose-dependent and tissue-specific. Glands were fractionated by differential centrifugation: 17% of the total counts were in nuclei and cell fragments, 1% in mitochondria, 19% in membranes and 59% in the cytosol. Buoyant density centrifugation revealed that the ¹⁴C-cholesterol in media was bound to the lipoproteins of the serum supplement. The results indicate MIH regulates molting by controlling Y-organs directly, and suggest the inhibition may be at the level of cholesterol uptake or ecdysone secretion or both. (Supported by Sigma Xi, NAS Bache Fund, and NIMH 5T32MH15172-05.)

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O₂ UPTAKE AND TRANSPORT DURING A MOLT IN CALLINECTES SAPIDUS. C.P. Mangum, B.R. McMahon, P.L. deFur and M.G. Wheatly. Col. William & Mary, Williamsburg, Va., Univ. Calgary, Canada and George Mason Univ., Fairfax, Va.

The concentration of hemocyanin (Hc) which transports 90 % of the O₂ consumed by a stage C crab, falls fourfold during a molt. The decrease coincides with water uptake, but it cannot be fully explained by dilution. Net catabolism and re-synthesis does not involve selection of any of the 5-7 units. No intrinsic changes in O₂ binding occur, although extrinsic factors such as H⁺, Ca²⁺ and lactate raise O₂ affinity in stage A and lower it in stage B. During exuviation (E), blood PO₂ decreases and lactate increases, suggesting an inadequate O₂ supply to tissue. Immediately following exuviation (A1) the general body surface is highly O₂ permeable and blood PO₂ rises to the point where little HcO₂ is released to tissue. Despite the virtual absence of Hc, which is now responsible for less than 10% of the O₂ consumed, total O₂ uptake rises. We suggest that this increase is possible because of supplementary O₂ uptake across the general body surface into superficial tissue, where the new exoskeleton is being formed, and possibly into the general circulation as well.

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COMPENSATION FOR CHANGES IN ACID-BASE STATUS OCCURRING DURING THE MOLTING CYCLE IN THE BLUE CRAB CALLINECTES SAPIDUS. B.R. McMahon, P.L. deFur¹, C.P. Mangum², M.G. Wheatly. Depts. of Biology, University of Calgary, George Mason University¹, and College of William and Mary².

Samples of hemolymph removed from SW acclimated Callinectes sapidus (RATHBUN) during intermolt (C₄) and at intervals throughout the molting cycle allowed measurement of circulating gas tensions; pH and carbon dioxide content. The acid-base status thus determined at stage C₄ was equivalent to literature values. During the premolt (stages D₁-D₄) carbon dioxide tensions increased progressively reaching very high values for an aquatic species (PaCO₂>13 torr). A potentially severe respiratory acidosis however was completely compensated by mechanisms involving a concomitant increase in hemolymph [HCO₃⁻+CO₂]. Following molting elevation of hemolymph lactate is associated with significant metabolic acidosis partially compensated for by increased loss of CO₂ across the reduced diffusion paths provided by the rejuvenated gills and initially thin and expanded body surface. Although hemolymph CO₂ levels tend to remain elevated and pH depressed through stages A₂-B₂ no significant acid-base disturbance persisted beyond stage A₁.

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CARBONIC ANHYDRASE ACTIVITY AND CALCIUM DEPOSITION DURING THE MOLT CYCLE OF CALLINECTES SAPIDUS. R.P. Henry and G.A. Kormanik. Univ. of Penn., Phila., Pa. and Univ. of North Carolina at Asheville.

Carbonic anhydrase (CA) activity was measured in the epidermis and gills of the blue crab throughout the molt cycle. Epidermal CA activity remains constant from intermolt through the premolt stages, but increases sharply (5 fold) in the immediate postmolt stage and remains elevated thereafter. The anterior gills show a similar pattern of CA activity, but in the posterior gills enzyme activity increases 3 fold in mid-premolt and remains high through the molt and postmolt stages. Calcium deposition into the carapace was measured via ⁴⁵Ca incorporation into isolated pieces of cuticle and epidermis. The rate of Ca deposition from blood to the shell begins to rise just prior to molting and increases further after ecdysis. However, the rate of Ca incorporation from seawater is much higher during late premolt, suggesting that a large portion of the mineral is taken up directly from the ambient medium. The CA inhibitor acetazolamide failed to affect blood Ca levels and also failed to retard Ca incorporation, whereas the Na/K ATPase inhibitor ouabain did reduce Ca deposition.

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PHYSIOLOGICAL RESPONSES TO SUSTAINED EXERCISE IN THE LAND HERMIT CRAB *COENOBITA COMPRESSUS*. M.G. Wheatly¹, B.R. McMahon¹ and W.W. Burggren². ¹Univ. of Calgary and ²Massachusetts.

Land hermit crabs were trained to walk along the inside inclined surface of a rotating respirometer. During such a bout of spontaneous activity the crab covered on average 54 m in 148 min which equated to a running speed of 0.6 cm (or 0.2 BL) sec⁻¹, a speed rarely maintained for so long in decapods. Gas exchange rates were monitored in quiescent and active crabs and hemolymph was correspondingly sampled for blood gases and acid-base status. R was characteristically 0.6-0.8 at rest (30°C) dropping as low as 0.2 during activity when CO₂ flux did not parallel the 5-8X rise in M_O2. Respiratory CO₂ retention (P_rCO₂ increased 3 to 25 torr) contributed significantly to a hemolymph acidosis (pH decreased 7.73 to 7.35) which was partially compensated by elevation of [HCO₃]⁻ despite appreciable accumulation of lactate (10 mM). If activity culminated in accessibility to water the H⁺ deficit was totally accountable by measured excretion rates of H⁺ (4856 μEq h⁻¹kg⁻¹). The physiological responses described would appear to differ from short sprinting bursts documented in other species.

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LOCALIZATION OF Na⁺+K⁺-ATPASE IN BASOLATERAL MEMBRANES OF CRAB GILL ION-TRANSPORTING CELLS. D.W. Towle, W.T. Kays and M. Cioffi. Univ. of Richmond, Va., and Temple Univ., Philadelphia.

Sodium uptake and NH₄⁺ excretion by outwardly-facing epithelia of euryhaline animals may have both apical and basolateral components. We have shown that Na⁺+K⁺-ATPase is restricted to basolateral membranes of blue crab gill epithelial cells, using an ultracytochemical technique. Homogenization of gill regions rich in ion-transporting cells, in a buffered sucrose solution containing EDTA and deoxycholate, followed by density gradient and differential centrifugation, produced a vesicular membrane fraction enriched in Na⁺+K⁺-ATPase activity, and deficient in cytochrome oxidase and acid phosphatase, markers for mitochondria and lysosomes. Cytochemical localization of Na⁺+K⁺-ATPase indicated that the membrane fraction is a homogeneous preparation of basolateral vesicles. Apical membranes appear to be separated from the basolateral fraction by the purification procedure.

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ATP-DEPENDENT Na⁺ TRANSPORT BY BASOLATERAL MEMBRANE VESICLES FROM CRAB GILL. L.A. Fuhrman, E.R. Stansbury* and D.W. Towle. Univ. of Richmond, Va.

Basolateral vesicles from ion-transporting cells of blue crab (*Callinectes sapidus*) gill, highly enriched in Na⁺+K⁺-ATPase activity, were prepared by density gradient and differential centrifugation. Using a rapid filtration technique, we have demonstrated Na⁺ uptake by these inside-out vesicles. Uptake is dependent on external ATP and an internal counterion, either K⁺ or NH₄⁺. Sodium transport by the vesicles is inhibited by nigericin and vanadate, but not by amiloride. In the presence of 100 mM K⁺, ouabain (1 mM) has little effect either internally or externally, probably reflecting the low sensitivity of decapod crustaceans to this Na⁺+K⁺-ATPase inhibitor. The ability of NH₄⁺ to serve as a counterion in Na⁺ transport by basolateral vesicles supports a model of gill Na⁺ uptake in which Na⁺/NH₄⁺ exchange occurs at the basolateral membrane.

Supported by Jeffress Memorial Trust, National Science Foundation (PRM-8213306), and Univ. of Richmond Faculty Research Program.

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SALINITY-INDUCED CHANGES IN GILL Na⁺,K⁺-ATPase IN THE FIDDLER CRAB, *UCA PUGNAX*. C.W. Holliday, Lafayette College, Easton, PA.

The enzyme, Na⁺,K⁺-ATPase, has been implicated in adaptive increases in gill ion transport in osmoregulating crustaceans. Ionic requirements of gill Na⁺,K⁺-ATPase specific activity (ESA) were characterized and ESA was measured in crude homogenates of individual gill pairs of crabs acclimated 21d to 10,50,100,150 and 200% sea water (SW) under two conditions: continuous immersion or a "natural" environment with dry sand and SW. In immersed crabs gills 5 and 6 contained 75% of total gill ESA and all gills significantly increased ESA in 10% SW relative to 100% SW controls; crabs in 50% SW had significantly higher ESA in gills 3-6. Acclimation to 150 or 200% SW did not significantly change gill ESA. Crabs in the "natural" environment had essentially the same ESA response but were able to hyper- and hyporegulate much better than immersed crabs. Thus, gill Na⁺,K⁺-ATPase appears to be important in adaptation to dilute media only. The time-course of changes in gill ESA after acute transfer from 100 to 10% SW showed two phases: a rapid (1d-7d) increase in crude homogenate ESA and a long-term (7d-14d) increase in microsomal ESA. Supported by Lafayette College.

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CONCENTRATIONS OF NEUROTRANSMITTERS IN THE CENTRAL NERVOUS SYSTEMS OF UCA PANACEA AND CALLINECTES SAPIDUS. T.A. Butler and M. Fingerman. Tulane Univ., New Orleans, La.

Precise determination of biogenic amine concentrations is now possible with high pressure liquid chromatography (HPLC) and electrochemical detection. We devised a simple method for the analysis of three neurotransmitters from the tissues of crabs. A Beckman HPLC with a C18 μ -bond-pack column was used in conjunction with a BioAnalytical System LC 4A electrochemical detector. Standards (50 ng) of norepinephrine (NE), dopamine (DA) and octopamine (OCT) were separated and detected. Nervous tissue from crabs was extracted in 70% perchloric acid, and then sonicated and centrifuged. Aliquots (20 μ g) were injected onto the column in a 10% methanol, 0.05% octylsodium sulfate buffer. DA (0.3 μ g/gr) was found in both the cerebral and thoracic ganglia of both crabs at the same level. The thoracic ganglia of both crabs had higher levels of OCT (0.02 μ g/gr) than the cerebral ganglia (0.006 μ g/gr). NE did not vary within tissues assayed, but was found in higher levels of Uca (0.07 μ g/gr) than in Callinectes (0.01 μ g/gr).

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TRANSPORT AND METABOLISM OF PROLINE BY ISOLATED LOCUST RECTA. J.H. Spring. Univ. of Southwestern Louisiana, Lafayette.

Locust recta depend primarily on proline obtained from the lumen to provide the energy to support ion transport. 14 C-proline was used to follow the unidirectional fluxes across isolated recta under short-circuited conditions. Steady-state proline uptake averaged 410 nMoles/h/rectum, with a flux ratio greater than 75. When active Cl^- transport was stimulated with cAMP, proline uptake declined to a steady-state value of 240 nMoles/h/rectum. To determine whether the decline in transepithelial proline transport was simply due to an increased rate of intracellular metabolism, the rate of proline consumption was measured by collecting the $^{14}\text{CO}_2$ evolved. Stimulation of the epithelium by cAMP did cause a 30% increase in $^{14}\text{CO}_2$ production; however, this was insufficient to account for more than 20% of the observed decrease in proline transport. This decrease must therefore represent a real decline in the rate of transport, possibly due to competition with the chloride transport system.

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EPIDERMAL TAURINE TRANSPORT IN MARINE MUSSELS. S.H. Wright. University of Arizona College of Medicine, Tucson.

Taurine (Tau), a β -amino acid, is the major constituent of the free amino acid pool in the gills of Mytilus edulis and M. californianus. To study possible links between regulation of the amino acid pool and epidermal amino acid transport, the uptake of Tau into gill tissue was examined. In both species transport was inhibited by β - and γ -amino acid analogues. Tau itself was most effective in inhibiting uptake of 0.1 μM Tau (K_i in M. calif. of 3 μM), followed by β -alanine ($K_i=7 \mu\text{M}$). In order of decreasing effectiveness as inhibitors: Tau > β -ala > γ -aminobutyric acid (γ -ABA) = β -ABA >> α -ABA. Naturally occurring neutral, acidic, and basic amino acids had little effect on Tau transport. The apparent half-saturation constant for Tau uptake into intact, actively pumping mussels was on the order of 3-5 μM , with maximal rates of uptake on the order of 1 $\mu\text{mol}/(\text{g wet soft tissue} \cdot \text{hr})$. It is concluded that Mytilus gill has an epidermal transport process specific for β -amino acids, and that the probable role of this transport is the re-accumulation of Tau lost from the gills into the inhalent water stream. (Supported by NSF grant PCM-8216745)

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UPTAKE AND INCORPORATION OF AMINO ACIDS BY A FRESHWATER SNAIL. S.E. FORD. Duke University, Durham, N.C.

Although a wide variety of marine invertebrates demonstrate the capacity to absorb dissolved organic matter (DOM) from ambient water, a similar ability has been denied for freshwater organisms. Contrary to this belief, however, the freshwater snail Helisoma duryi demonstrates a powerful capacity to absorb large quantities of isotopically labeled amino acids from surrounding water. These substances are absorbed rapidly and from low concentrations (10^{-8} to 10^{-7}M). Furthermore, the amino acids are transported throughout the body and incorporated into macromolecules in all tissues examined. These results suggest that organisms inhabiting freshwater, where DOM concentrations range up to 40 mg/L, much in small MW fractions, have the capacity to obtain as much, if not more, nutritional benefit from dissolved organics as do marine forms.

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GLUCOSE ABSORPTION ACROSS THE MIDGUT OF THE BLUE CRAB, *CALLINECTES SAPIDUS*. K. H. Chu. Woods Hole Oceanographic Institution, Woods Hole, MA.

I have studied the mechanism of D-glucose transport across the midgut of *Callinectes sapidus*, using an *in vitro* perfusion technique. The transmural flux and mucosal uptake of glucose were determined using ^3H - and ^{14}C -labelled glucose. I demonstrate that (a) there is a net mucosal to serosal flux of $40 \text{ nmoles cm}^{-2} \text{ hr}^{-1}$ (5 mM glucose); (b) unidirectional mucosal to serosal flux is inhibited by cyanide, azide, mucosal phlorizin, and serosal ouabain; (c) absence of luminal Na^+ or presence of galactose reduces the flux whereas fructose or L-glucose has no effects; and (d) the Na^+ -dependent mucosal glucose uptake displays Michaelis-Menten kinetics ($J_{\text{max}} = 0.67 \text{ nmoles cm}^{-2} \text{ min}^{-1}$; $K_{\text{T}} = 0.12 \text{ mM}$). These results are consistent with the hypothesis that glucose transport across the midgut of *C. sapidus* is mediated by a luminal Na^+ -coupled, phlorizin-sensitive stereospecific saturable transport system, the operation of which is dependent upon a Na^+ -gradient generated by the basolateral Na^+ - K^+ ATPase.

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ADAPTATION OF INTESTINAL NUTRIENT TRANSPORT IN ENDOTHERMS. W.H. Karasov, D.H. Solberg*, and J.M. Diamond* Physiology Dept., UCLA.

We measured intestinal glucose and proline absorption *in vitro* in similar-sized mammals (3 rodents) and reptiles (2 lizards, 1 turtle) eating the same plant diet. Several features of intestinal transport were similar among the animals: (1) proximal small intestine positions had higher uptake rates than distal positions, while uptake in the large intestine was negligible; (2) in the proximal small intestine, passive influx of glucose and proline comprised less than 10% and 33%, respectively, of total uptake at high solute concentration (50 mM); (3) maximal active transport rates, V_{max} (nmoles/min, cm^2 nominal surface area), and apparent Michaelis constants, K_{m}^* (mM), were of similar magnitude at 37°C. For example ($(V_{\text{max}}, K_{\text{m}}^*)$):

	glucose	proline
desert iguana	(164,1)	(137,2)
desert woodrat	(239,1)	(480,3)

While nutrient uptake per cm length intestine can be similar in similar-sized mammals and reptiles, the former have longer intestines. We conclude that a primary mechanism by which the higher nutrient requirements of endotherms are met is by an increase in absorptive surface area through increased gut length. Supported by NIH grants GM 14772 and MH 31272.

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THE SYNTHESIS AND UPTAKE OF 5-HYDROXYTRYPTAMINE BY THE CESTODE *Hymenolepis diminuta* P. Fibeiro and R.A. Webb (intro. by A.S.M. Saleuddin). York University, Downsview, Ontario.

Serotonin (5-hydroxytryptamine: 5-HT) is ubiquitous among invertebrates where it is synthesized from tryptophan via 5-hydroxytryptophan (5-HTP). However, some parasitic platyhelminths do not appear to synthesize 5-HT by this pathway and thus may obtain this amine from the host. Incubation of *Hymenolepis diminuta* in ^3H -tryptophan resulted in substantial ^3H -5-HTP and ^3H -5-HT formation. Furthermore, the tissue levels of 5-HTP and 5-HT, as determined by HPLC-ECD, were significantly depressed when the animals were deprived of tryptophan. On the other hand, the tissue levels of 5-HTP were significantly increased following incubation with a 5-HTP decarboxylase inhibitor. The present results suggest that, unlike other platyhelminths, *H. diminuta* has the enzymatic capacity for the synthesis of 5-HT from tryptophan. However, the 5-HT stores in this animal may not be entirely endogenous in origin. Using a radioligand binding assay and HPLC methods, this study has identified putative tegumental 5-HT transport sites. Thus while *H. diminuta* can synthesize 5-HT some may be of exogenous origin.

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CHEMOAUTOTROPHIC SYMBIANTS IN THE BIVALVE *LUCINA FLORIDANA* FROM SEAGRASS BEDS.

M. R. Fisher and S. C. Hand. Univ. of Southwestern Louisiana, Lafayette.

Enzymatic and histological evidence suggests that the eulamellibranch *Lucina floridana* possesses bacterial symbionts capable of a chemoautotrophic metabolism fueled by sulfide oxidation. Activities of ribulose-1,5-bisphosphate carboxylase (RuBPCase), phosphoribulokinase, APS reductase, ATP sulfurylase and nitrite reductase were measured and partially characterized in homogenates of fresh gill tissue. SEM (freeze-fractured gill) and TEM reveal numerous rod-shaped, procaryotic inclusions in vacuoles of large, eucaryotic cells located deeply within demibranch cross sections; no such inclusions are seen in the ciliated gill epithelium. Energy dispersive X-ray analysis of gills reveals sulfur as a dominant element. *Lucina* is found in population densities of $83 \pm 11/\text{M}^2$, closely associated with the O_2 -releasing root systems of seagrasses in sulfide-rich sediments ($1.7 \pm 0.3 \text{ mM}$, *Thalassia* beds; $2.5 \pm 0.6 \text{ mM}$, *Ruppia* beds). Based on above abundance data and the *in vitro* RuBPCase levels of $3.0 \pm 0.5 \text{ units/g gill}$, *Lucina* could contribute $340 \pm 95 \text{ g C/M}^2/\text{year}$ (based on half-maximal velocity) to the gross carbon fixation of seagrass beds.

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PREY CAPTURE, ABSORPTION EFFICIENCIES AND GROWTH IN HIGH- AND LOW-SHORE SEA ANEMONES (*ANTHOPEURA ELEGANTISSIMA*). W.E. ZAMER and J.M. SHICK. Univ. of Maine, Orono.

Prey capture surface areas have been quantified in high (13 h emersion) and low (4 h emersion) shore anemones. The surface area is greater for low anemones (51.1 cm²) compared to high anemones (48.9 cm²) of the same basal disk diameter (3.0 cm). However, dry weights of prey from coelenterons of high and low anemones collected after a single tidal immersion are the same (1% of dry body wt.), indicating that high shore anemones capture as much prey as low shore anemones but with a smaller prey capture surface area and in a shorter immersion time. Absorption efficiency varies inversely with ration size and is greater in high (86%, 1% ration) compared to low (82%, 1% ration) anemones regardless of ration size or immersion regime. Net growth efficiency (K₂) is also irreversibly higher for the high animals (45-53%) compared to low animals (37-44%). Because reproductive capability is directly related to body size in these animals, increased K₂ in high anemones may reflect the overall importance of reproductive effort relative to other components of the energy budget under conditions of low food availability.

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POWER REQUIREMENTS FOR FISH SWIMMING: AN EXPERIMENTAL TEST OF THEORY. M.S. Gordon, H. Chin and L. Attardo. Univ. of California, Los Angeles.

Current theory predicts that the power required for swimming by fishes increases in proportion to absolute swimming speed raised to the 2.5 power. This theory was developed on the basis of studies of teleost fishes swimming in the subcarangiform mode, obtaining thrust from lateral oscillations of their bodies. We have estimated power requirements for swimming in seven species of teleost fishes which keep their bodies rigid during steady prolonged cruising speed swimming: three species of labriform swimmers, four of ostraciiform/tetradontiform swimmers. Estimates of rates of power generation were based on rates of oxygen consumption during steady swimming in water tunnels. Values for the exponent in curves relating mass-specific metabolic rates to absolute swimming speeds were estimated in two ways. Twenty-two of twenty-four estimates were significantly lower than the theoretically predicted 2.5. Sixteen were for values below 10% of the predicted value. New theory seems needed to account for these results. (Supported by NSF grants PCM 77-23805, 80-20980, and UCLA Biology-Fisheries program)

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ENERGETICS OF PENGUIN SWIMMING. C.A. Hui. Naval Ocean Systems Center, San Diego, and U.C.L.A.

The energetic efficiency and cost of transport were determined for two Humboldt penguins (*Spheniscus humboldti*) over the range of swimming speeds 0.25-1.25 m/s. The power input ($\dot{V}O_2$) of each bird was measured as it swam in an open-flow metabolic chamber suspended in front of a moving boat. The power output was determined from results of tow tests on a carcass and wind tunnel tests on wings. Efficiency (e), power output divided by power input, increased with speed ($e=0.045V^{2.74}$; $r^2=.92$) and had a maximum of 10.1%, higher than that reported for other swimming homeotherms. Increasing efficiency by changing from surface to submerged swimming uncoupled the cost of transport from speed over the range 0.50-1.25 m/s. The mean of 0.69 ml O₂/kg-m (SD=.17) is lower than the cost of transport reported for other swimming homeotherms. Penguins use swimming to transit to and from foraging sites so the low, speed-independent cost of transport facilitates efficient foraging effort, a factor of direct ecological importance when raising chicks.

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BURST SWIMMING IN ALLIGATORS AND THE EFFECT OF TEMPERATURE. J.S. Turner, T. Baynes*, C.R. Tracy* and B. Weigler*. Dept. of Zoology, Duke Univ., Durham, N.C. and Dept. of Zoology and Entomology, Colorado State Univ., Ft. Collins.

When startled, juvenile alligators swim away in a sudden burst. The velocity attained during burst swimming increases as body temperature is increased from 15 to 25°C, and then is relatively independent of temperature from 25 to 35°C. The alligators also swim differently as body temperature is varied. The legs often are used as paddles at low temperatures, and the animals usually swim with the head breaching the water. As body temperature is increased, the alligators are more likely to swim completely submerged and the legs tend to be tucked at the side of the body, so that locomotion is powered by oscillation of the tail. At body temperatures of 30-35°C, swimming is still powered by the tail, but the animal again tends to swim with the head breaching the water. These patterns occur only in burst swimming; behavior at slow swimming speeds does not depend on temperature. Differences in swimming behavior significantly affect the speed at which an alligator swims.

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A REEXAMINATION OF MAMMALIAN METABOLIC RATES. V. Havssan and R.C. Lacy*, Cornell Univ., Ithaca, NY, and Franklin and Marshall College, Lancaster, PA.

Basal metabolic rate (EMR) and body mass data for 293 species representing 15 orders and all three extant mammalian infraclasses were obtained from a literature search. The allometric relationships between EMR and mass were determined by fitting least squares regression lines to log-transformed data. Covariance analyses on those orders with more than three species represented indicate significant heterogeneity among taxa. Insectivora differ from all other orders with respect to slope, while the remaining orders differ with respect to elevation. Newman-Keuls tests for a posteriori comparisons suggests three groupings: Edentata have the lowest EMRs; Marsupialia and Primates fall together in the middle; and the remaining orders, on average, have greater metabolic rates at any given body mass. Further examination of the large order Rodentia indicates significant heterogeneity in EMR allometry among families and even among genera within the Cricetidae. These results suggest that there is no single allometric relation between mass and EMR for mammals as is commonly assumed.

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TRAINING THE SIDEWAYS RUNNER. J.M. Harwitz*, R.J. Full, and C.F. Herreid, II, SUNY/Buffalo.

Forty-eight fiddler crabs, Uca pugilator, were trained on a treadmill 5 days a week for a 5 week period. Trained crabs were compared to an untrained control group. Three criteria were used to evaluate the effects of training: 1) Performance on endurance tests at treadmill velocities ranging from 0.1 to 0.4 km/hr. 2) Net whole body lactate production and 3) Oxygen consumption (\dot{V}_{O_2}) were determined during a 15 min treadmill run at 0.16 km/hr.

The trained crabs showed an increased endurance when compared to untrained animals at velocities of 0.1 to 0.2 km/hr. No difference in time to fatigue was observed at velocities greater than 0.2 km/hr. The rate of whole body lactate production during exercise was significantly decreased in the trained animals. Peak \dot{V}_{O_2} was increased in the trained crabs and the time required to attain one-half peak \dot{V}_{O_2} was much shorter than in the untrained group. These data suggest that the metabolic system of the fiddler crab is modified in response to long term exercise training. Supported by NSF Grant No. 79-02890.

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COCKROACHES PULLING PAPERCLIPS: AN ENERGETIC EVALUATION OF LOADING. J.A. Assad, R.J. Full and C.F. Herreid, II. SUNY/Buffalo.

The aerobic response to pulling weights was determined for the cockroach Blaberus discoidalis. The animals were run on a miniature treadmill respirometer, with a small hole in the rear allowing for a harness system to extend from the animal out of the respirometer. The harness (thread secured with dental wax above the animal's approximate center of mass) was draped over an air pulley and a series of weights (paperclips) were attached during the exercise periods. The animals were run at 0.07 km/hr following a 15 minute rest period. After an initial 10 minute run without a weight the load attached to the harness was increased by 0.5 times the animal's mass at 10 minute intervals during the run. The rate of oxygen consumption was monitored continuously and rose with each addition of weight to a new steady-state value. Steady-state values attained increased linearly with the weight pulled. The increase in the energetic requirement observed is approximately proportional to the weight pulled. This is comparable to data obtained for mammals (rats, dogs, horses and humans) carrying loads. Supported by NSF Grant PCM 79-02890.

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RUNNING GHOSTS (OCYPODE QUADRATA): AN ENERGETIC COMPARISON OF SMALL AND LARGE CRABS. R.J. Full, SUNY/Buffalo.

Five small (2.1g) and five large (26.6g) ghost crabs were exercised on an enclosed treadmill for 20 min after a 30 min rest period. The range of exercise velocities for the small group was 0.13 to 0.28 km/hr while the larger animals ran at 0.20 to 0.60 km/hr. The mass specific resting oxygen consumption (\dot{V}_{O_2}) of the large crabs was 1/3 that of the smaller animal's rate. Both sizes showed a similar aerobic response to exercise; a rapid increase in O_2 uptake resulted in a steady-state consumption ($\dot{V}_{O_{2SS}}$). $\dot{V}_{O_{2SS}}$ increased linearly with velocity. A Y-intercept significantly elevated over the resting \dot{V}_{O_2} was found in both groups. Minimum cost of transport values (Mrun), the amount oxygen required to move a gram of animal one kilometer, were comparable to values determined for vertebrates of a similar mass. The allometric relationship developed from an interspecific comparison of birds and mammals shows a decrease in Mrun with an increase in body mass. Intraspecific comparison of Mrun in the ghost crab follows this trend over an order of magnitude in mass. As the crab grows, the mass specific cost of transport declines. Supported by NSF Grant PCM 79-02890.

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METABOLISM OF CRAWLING CATERPILLARS-SOFT BODIED INSECTS. T. M. Casey, Cook College, Rutgers Univ., New Brunswick, NJ.

Oxygen consumption ($\dot{V}O_2$), speed, and stride characteristics of tent caterpillars (*Malacosoma americanum*) were examined during continuous performance on a perspex enclosed speed controlled treadmill. Experiments were videotaped for later analysis of frequency of body wave contraction and distance per contraction. Tread speed was adjusted to the preferred speed of each individual. Performance was continuous for periods of up to 25 min. Net $\dot{V}O_2$ (active - rest) during steady state performance was 3.5 ml O_2 /g/hr \pm 1.9 S.D., 2.5 times greater than aerobic scope measurements obtained by forcing the animals to continually right themselves. Preferred speed varied from .03 to .087 km/hr for caterpillars on the treadmill and was similar for animals on a solid floor (N=50). Frequency of body waves and distance per wave were positively correlated with speed. Net cost of transport (1182 J/g/km) was inversely related to mass and averaged about five times greater than predictions based on mammals and insects, but was well below the cost of crawling in soft bodied snails. Unlike snails, crawling of caterpillars appears to be primarily aerobic. (Supported by NSF Grant PCM 80-11158 and by NJ Agric. Exp. Sta. Project # 18511.)

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CARBOHYDRATE METABOLISM DURING PRE-FLIGHT WARM-UP IN THE TOBACCO HORNWORM MOTH, *MANDUCA SEXTA*. B. Joos, The University of Michigan, Ann Arbor.

Although the primary flight fuel in Lepidoptera is lipid, *M. sexta* flight muscle contains modest amounts of the storage carbohydrate, glycogen. Muscle glycogen levels of quiescent moths are highest immediately after eclosion, drop significantly during the first 24 hours post-eclosion and then rise to an intermediate level which is maintained until the onset of debilitation and death. This glycogen store is insufficient to support sustained flight, but is mobilized during pre-flight warm-up behavior. Extrathoracic carbohydrate stores are not significantly depleted during warm-up. The *in vitro* activity of muscle phosphofructokinase, an important indicator of glycolytic flux, is low; however Q_{10} is \leq 1.5 for the range 15C°-37C° suggesting that glycolytic flux is temperature independent. Mobilization of endogenous glycogen is probably critical to the rapid increase in metabolic rate during the early portion of warm-up when body temperature is still low.

(Supported by a Sigma Xi Grant-In-Aid and the Rackham School of Graduate Studies.)

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Ca^{++} -DEPENDENT EMBRYONAL CARCINOMA CELL AGGREGATION: A FUNCTION OF DENSITY TO WHICH CELLS WERE GROWN. M.E. Snook* and M.J. Rosenstraus, Rutgers University, New Brunswick, NJ.

Embryonal carcinoma (EC) cells provide a model system for studying embryonic cell adhesion. Aggregation of an F9 EC cell line is modulated by cell density. Cells non-enzymatically harvested from cultures containing $< 2.5 \times 10^5$ cells/cm² formed aggregates containing > 15 cells with 20% of the cells remaining as single cells. Cells harvested from cultures containing 5×10^5 cells/cm² formed 2-10 cell aggregates and 40% of the cells remained unaggregated. The Ca^{++} -dependent aggregation system was responsible for this difference; high and low density cultures both exhibited equally low aggregation in the absence of Ca^{++} and Mg^{++} . Cells harvested from high density cultures using trypsin + Ca^{++} to protect the Ca^{++} -dependent aggregation system aggregated like non-enzymatically harvested cells from low density cultures. Thus, a trypsin-sensitive cell surface molecule is responsible for reducing the aggregation of cells grown to high density. A cell surface glycoconjugate(s) may regulate the Ca^{++} -dependent aggregation system since a wheat germ agglutinin-resistant mutant cell line aggregated well when grown to the high density.

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METHODS FOR PRESERVATION AND REMOVAL OF EXTRACELLULAR LAYERS ON THE EGG OF THE PULMONATE GASTROPOD *Lymnaea palustris*. A.J. Ransick and J.B. Morrill, California St. Univ. Northridge and New College, Sarasota, FL.

Our SEM/TEM analysis of fertilized eggs prior to 1st cleavage revealed a 3-component vitelline layer (VL): an inner, cell surface layer (IVL); an outer layer (OVL), thickest in the animal hemisphere (AH); and uniformly distributed 0.05 μ m-wide electron opaque spheroids (SPH) embedded in the OVL. Treatment of encapsulated eggs for 15 minutes with 8.75mM dithiothreitol (DTT) in pond water (PW) buffered to pH 9.0 dissolved both OVL and SPH, exposing underlying oolemma, microvilli (MV) and remnants of the more DTT-resistant IVL radiating from AH-MV as webbed fibers. One percent tannic acid added to the primary fixative (1% glutaraldehyde in PW plus 0.1M cacodylate, pH 7.2) increased preservation of IVL fibers in both normal and DTT-treated eggs, while 0.05% cetylpyridinium chloride increased preservation of OVL in normal eggs. The highest density of MV occurs in the AH where the VL components are most substantive. They may function with microtubule arrays in the cortical cytoplasm to anchor the egg cortex and blastomeres and, thus reinforce the proper pattern formation in this highly mosaic embryo.

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STEREO SEM ANALYSIS OF DEVELOPMENTAL PATTERNS IN THE BLASTULAR WALL AND BLASTOCOELIC EXTRACELLULAR MATRIX DURING EMBRYOGENESIS IN THE SEA URCHIN, LYTECHINUS VARIEGATUS. D. S. GALILEO* and J. B. MORRILL. New College, Sarasota, Fla.

Embryogenesis from hatched blastula to late gastrula of *L. variegatus* was analyzed by SEM stereo pairs of dry-fractured embryos. Particularly noted were changes in the shapes of the ectodermal cells of the blastular wall and changing patterns in the extracellular matrix (ECM) with respect to location and activities of mesenchyme cells. Okazaki's classical optical patterns in the blastular wall are caused by ectodermal cells that bend and have oriented, overlapping lamellopodia. The blastocoelic ends of the ectodermal cells become covered with a mat-like basement membrane (BM). During primary mesenchyme cell (PMC) ingression, a fibrous ECM fills the blastocoel and is concentrated around the PMCs. This matrix becomes sparse during PMC migration and is absent during the early and midgastrula stages. An ECM reappears with the onset of the filopodial activity of the secondary mesenchyme cells (SMC) during late gastrulation. Both the early and late appearing ECMs may reflect the condensation occurring during fixation of macromolecules of the degraded BM; they are probably not present in live embryos.

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ENHANCED CHONDROGENESIS WITH CYTOCHALASIN B. J. Shambaugh and M. Lems*. Goucher College, Towson, MD.

Embryonic chick limb mesenchyme cells in micromass culture form cartilage-producing nodules by the third day of incubation. The number of nodules formed is proportional to the cell number at termination. Addition of cytochalasin B significantly increases the number of nodules by 30% or more, while the cell number is not different from untreated cultures. The enhancing effect is seen with exposures of 72-24 hrs before termination and with doses from 0.25 to 25 ug/ml. Colchicine at 10 ug/ml completely inhibits nodule formation and affects cell number. These results are relevant to the findings of Hewitt and Elmer (Diff. 10:31, Cell Diff. 7:295) on mouse limb cells that cytochalasin B but not colchicine inhibits clustering of Con A binding sites, and that decreased Con A site clustering is also observed with increasing stage of development. In the present study, cyto B has a greater effect on cells from earlier stages. Thus, cyto B may cause precocious recruitment of cells into the chondrogenic pathway.

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SURFACE PROPERTIES OF PORPOISE AND KILLER WHALE SKIN IN VIVO. H. Gucinski* and R.E. Baier. State Univ. NY and Calspan Adv. Technology Center, Buffalo, NY.

Surface chemical/physical data collected from living marine mammals proves their "modified skin" to share remarkable similarities with other biological cell layers --such as intraoral tissues and blood vessel endothelial linings-- that exhibit nonadhesive interactions with flowing aqueous suspensions. These surfaces are smooth, dominated by glycoproteinaceous components, and of critical surface tension between 20 and 30 mN/m, as documented by surface texture replicas, internal reflection infrared spectra, and contact angle measurements, respectively. This suite of common characteristics describes a "steady state" surface condition correlating with low-drag, biofouling-resistant behavior of materials in contact with natural fluids. Synthetic materials with closely matched surface properties have shown excellent biocompatibility in prosthetic devices such as artificial hearts and arterial replacement grafts. Current work focuses on prospects for further biomaterials improvement with surface-tethered polymer chains that mimic the histologically demonstrated superficial layer on porpoise skin.

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COEXISTENCE OF A NONSYMBIOTIC CORAL IN OPEN REEF ENVIRONMENTS: A PARADOX TO THE CORAL REEF PARADIGM. G.M. Wellington and R.K. Trench*. Univ. of Houston, Tx. and Univ. of California, Santa Barbara.

Success of reef-building corals at tropical latitudes is largely attributed to the presence of endosymbiotic algae which facilitate calcification, growth and acquisition of energy. At Palau (Micronesia) we investigated several potential mechanisms to explain coexistence of the nonsymbiotic coral, Dendrophyllia micrantha in open reef environments dominated by high cover of symbiotic corals. Calcification estimates with labelled $^{45}\text{Ca}^{++}$ indicate a rate 5-6 times slower than rapid growing symbiotic Acropora. By contrast, vital staining and direct time course measurements show unexpectedly rapid linear extension of apical polyps; equal to or greater than many symbiotic species. Colony sizes averaged 48.5 cm (n=241, max. 235) in height. In addition, a major coral predator, Acanthaster, did not feed on Dendrophyllia in either 'choice' or 'non-choice' experiments yet readily attacked rapidly growing symbiotic species. We suggest that a combination of rapid linear growth and differential resistance to coral predators may explain how a nonsymbiotic coral can coexist in space-limited open reef environments.

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THE DEVELOPMENT OF SWEEPER TENTACLES IN DIRECT COMPETITIVE ENCOUNTERS AMONG REEF CORALS. E.A. Chornesky. The Univ. of Texas, Austin.

Colonies of the Caribbean reef coral Agaricia agaricites often develop elongate "sweeper tentacles" on colony margins close to other sessile animals. These tentacles may damage opponents in competition for substrate space and can affect the long term consequences of such interactions. The formation of sweeper tentacles was experimentally induced by placing colonies of A. agaricites in contact with potential competitors including various corals, a gorgonian, and a zooanthid. Development of sweeper tentacles was localized on tissues about 5 mm. from the region of contact. Depending on both the competitor used and the distance separating it from A. agaricites, sweepers developed around wounds from extracoelenteric digestion by opponents or after non-damaging contact with opponent tissues. Control experiments showed that sweeper tentacles do not develop in response to inanimate tactile contact or damage simulating extracoelenteric digestion. Thus, recognition of competitor tissues appears to be a necessary stimulus for formation of sweeper tentacles.

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THE ROLE OF ENVIRONMENTAL STRESS IN THE DEVELOPMENT OF CORAL DISEASES AND MICRO-PARASITE INFESTATIONS. E. C. Peters. Univ. of Rhode Island, Narragansett.

Thirteen species of stony corals from St. Croix and Puerto Rico were examined histologically for the presence of disease or tissue abnormalities, in relation to various environmental conditions. Apparent epidermal cell hyperplasia and other lesions were associated with edge-zone sediment-algae accumulations, damselfish algal lawns, and sedimentation. Several types of intracellular protozoans were observed, as well as necrosis due to "white band disease" and "black line disease" and/or associated microorganisms. The results of this survey demonstrate that corals are susceptible to invasion by possibly pathogenic microorganisms and microparasites. Their distribution may be mediated more by acute changes in micro-habitat conditions or injuries to individual colonies than to chronic adverse environmental conditions over a particular reef.

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CYCLICAL FORMATION OF MUCUS SHEETS BY THREE CORAL SPECIES. M.A. Coffroth (intro. by C.A. Loretz). Univ. of Miami, Miami.

The Caribbean corals Briareum asbestinum, Porites astreoides and P. furcata produce mucus which periodically forms a sheet which covers the colony and then is sloughed off into the water column. The relationship of mucus sheet formation to environmental conditions was studied by monitoring mucus sheet formation concurrent with measurement of water temperature, salinity, and temperature. Field experiments were also conducted to determine whether reduced salinity, reduced current, increased turbidity or increased sedimentation would induce mucus sheet formation. Mucus sheet formation was independent of the environmental parameters, but was cyclical. P. astreoides colonies produce mucus sheets synchronously one week prior to the full moon while P. furcata colonies produce mucus sheets on the full moon.

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PATCHWORK PATCHREEFS: THE CLONAL DIVERSITY OF PORITES COMPRESSA IN KANEHOE BAY, HAWAII. C.L. Hunter and C.C. Kehoe, Univ. of Hawaii, Manoa.

Intraspecific competition, genetic diversity, and the relative contributions of sexual vs. asexual reproduction in the coral Porites compressa were assessed by allografts, isografts, and field observations. Branches from colonies from 0.5 to 40 m apart were grafted in four linear transects (from seaward to leeward across the reef) and four "scatter" transects. Each colony in a 2X10 m area was mapped and determined as one of 12 morphotypes based on phenotypic characteristics and grafting results. Three morphs dominated in percent cover and frequency on the reef, comprising approximately 45% of the total P. compressa cover. These three morphs were not found on nearby patchreefs, where other morphs were predominant; the genetic structure of each patch reef is unique. P. compressa is a broadcast spawner and the success of larval recruitment on "mature" patch reefs is low; survival of fragments is high, resulting in a patchwork of a small number of clones or "individuals" making up a single population.

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CORAL FECUNDITY AS A BIOLOGICAL INDICATOR OF REEF STRESS. B.L. Kojis* and N.J. Quinn. PNG Univ. of Technology, Lae, Papua New Guinea.

The effects of depth and sedimentation on fecundity and abundance of Acropora palifera was quantitatively compared at two reefs over one year. Reef 1 had >10 times the sedimentation of reef 2. Other abiotic factors were similar.

Transects were done at each reef to assess % A. palifera cover. Samples of colonies at each reef at selected depths were collected, decalcified and the number of larvae/cm² of tissue counted.

We found A. palifera was more restricted in depth, less abundant and less fecund on reef 1 than reef 2. On reef 2, abundance and fecundity decreased with depth with colonies at depths >12m having <1/2 the fecundity of surface colonies.

Sedimentation with its concomitant turbidity is an important determinant of abundance, depth distribution and fecundity in A. palifera. It is suggested that coral fecundity can be used as a biological indicator of sublethal stress on reefs threatened with increased sedimentation.

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SEXUAL REPRODUCTION IN CARIBBEAN REEF CORALS. A.Szmant-Froelich, L.Riggs* and M. Reutter*. RSMAS, Univ. of Miami; Univ. of Puerto Rico, Mayaguez; Florida State Univ.

The patterns and mode of sexual reproduction of ten species of scleractinian coral were studied by sampling biweekly the 9 species with an annual cycle and at 2-3 day intervals the species with a lunar cycle. Montastrea annularis, M.cavernosa, Acropora palmata and A. cervicornis are simultaneous hermaphrodites but oogenesis precedes spermatogenesis; their gametogenic cycles are short and end with broadcast spawning in late summer. Dendrogyra cylindricus and Siderastrea siderea were the only dioecious species, and also spawned during late and early summer respectively. Mycetophyllia aliciae and Diploria strigosa are hermaphroditic with oogenesis preceding spermatogenesis but they are brooders and planulate during Feb.-April and late summer respectively. Porites astreoides and Favia fragum are simultaneous hermaphrodites that brood their larvae; the former planulates during fall and spring and the latter exhibits lunar cycles in gametogenesis, embryogenesis and planulation throughout the year. These preliminary results indicate that reproductive patterns of reef corals are diverse and complex and that previously proposed life history strategies need reexamination.

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THE ROLES OF AGE, SIZE AND INJURY IN SEXUAL REPRODUCTION AMONG JAMAICAN GORGONIANS. C.M. Wahle. Univ. of Texas, Austin.

Plexaura homomalla was found to undergo a delay in onset of sexual maturity during three surveys between 1978 and 1982. Eggs were present only in colonies taller than 20cm (n=173). Jamaican gorgonians are commonly injured in ways that physiologically isolate distal regions from the main body of the colony. In a survey of fecundity among naturally isolated regions on gravid females, gonads were found only on isolates larger than about 20x10cm. Based on this pattern, replicate female colonies were experimentally divided into permanently isolated regions of three sizes. At the following reproductive peak in August 1982, gonads were present only in large and medium-sized isolates, and never in small isolates on the same colonies. This loss of fecundity among isolated regions of otherwise reproductive gorgonians suggests that: 1) colony size and not age controls both onset and continuation of gametogenesis; 2) injury can subtly reduce colony fecundity without noticeably affecting its size; and 3) such injuries can create mosaics of different life history stages coexisting within the same colony.

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ROLE OF HALIMEDA IN REEF SYSTEMS. L. Hillis-Colinvaux. Ohio State Univ., Columbus.

The calcareous green alga Halimeda achieves high densities in a variety of reef habitats. It is successful on both consolidated and unconsolidated substrates unlike most algae. At Enewetak Atoll, Marshall Islands, 90-100% cover is achieved on shallow platforms in a high physical energy regime by H. opuntia. High densities (>50%) are attained by a mixture of growth strategies at deeper lagoonal sites such as the Halimeda meadows of -21 m. On the outside of the atoll rock growers and sprawlers extend to >-140 m. At -90 m, cover by this hermatypic greatly exceeds that of hermatypic corals, at some sites being ca 40%; it also grows considerably deeper than the corals. These sizeable populations of Halimeda in reef systems such as Enewetak provide a baffle to wave energy, a nursery environment and benthic substrate for invertebrates, vertebrates and algae, and a carbonate contribution which may exceed easily the 0.8 g plant⁻¹ yr⁻¹ baseline calculation obtained for the sand-growing H. incrassata. The genus is considered relatively unimportant as a dietary item; its major contribution to the carbon cycle being to the detritus portion.

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RESOURCE ALLOCATION IN MIGRATORY INSECTS: TRADEOFFS BETWEEN WING SIZE AND BODY WEIGHT. M. J. Angelo and F. Slansky Jr., Univ. of Florida, Gainesville.

When starved from all but the first day of the last instar, larvae of a presumed migratory moth, the velvetbean caterpillar (*Anticarsia gemmatalis*), were able to pupate and produce adults. These exhibited a wide range of body weights (BW) and wing areas (WA). The BW to WA relationship indicated that as BW decreased due to starvation, moths are produced with significantly lower wing loading ratios ($WLR=BW/WA$) than would be expected based on the predicted allometric relationship for BW and WA (i.e. $BW=length^3$ and $WA=length^2$). Similar results were found for three other presumed migratory noctuid moths.

We propose that this differential allocation of food to BW and WA in seasonally migratory insects in response to crowding, starvation or other environmental factors is an adaptive response producing individuals with a lower WLR that is presumably more efficient for long distance flight. This hypothesis is consistent with the principles of insect flight energetics.

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MODELS FOR OPTIMAL TIMING OF AMPHIBIAN METAMORPHOSIS. D. C. Heckel. Clemson Univ., SC

Dynamic optimal control models have been used to predict optimal allocation between vegetative and reproductive growth in annual plants, and optimal caste allocation in colonies of social insects. Here I apply them to solve for the optimal timing of the onset of metamorphosis in amphibian larvae, when the goal is to maximize body size at the end of metamorphosis. The main result is that under many conditions, in populations of individuals obeying the optimal strategy, body size and growth rate are positively correlated at the initiation of the metamorphic process. This correlation was hypothesized in a widely-cited 1973 paper of Wilbur and Collins (Science 182: 1305) on intuitive grounds. Hence their intuition can be justified in terms of optimality theory. I also discuss certain restrictions in applying these models, describe a proposed experimental test of Wilbur and Collins' hypothesis, and propose methods of verifying whether the optimality model itself is valid for amphibians.

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FIELD STUDIES OF ENVIRONMENTAL EFFECTS ON GROWTH RATES WITH SIBLING GROUPS OF THE SAILFIN MOLLY. J. C. Trexler. Florida State University, Tallahassee.

I studied the effects of environment on early growth of sailfin mollies, *Poecilia latipinna*, by raising groups of half-siblings under two environmental conditions, one warmer and more saline than the other. Brood-mates can only be considered half-siblings because multiple mating leaves paternity uncertain. The mothers of these fry were collected from two different environments, one with low salinity and the other high. I collected gravid females from the field and later separated their broods into groups of five half-sibs. These groups were reared in cages divided between two ponds. Therefore, the fry's environment was crossed with effects due to parentage and population of origin. ANOVA indicated that the juveniles reared in the more salty, warmer pond grew faster than their half-sibs in the fresher, cooler pond. This was true for offspring of females from both fresh and saltwater populations. There were significant differences in growth rates among the offspring of different females from the same population suggesting a genetic influence on growth.

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THE LIFE CYCLE OF *GAMMARUS LACUSTRIS* IN SHEEP LAKE, ROCKY MOUNTAIN NATIONAL PARK, COLORADO. L. T. Spencer. Plymouth State College, Plymouth, N.H.

The life history of *Gammarus lacustris* was determined by periodic collections made in 1966 from Sheep Lake, Rocky Mountain National Park. Sheep Lake is a small, shallow, semi-drainage lake at 2,617 m. The physical parameters of the lake were examined along with the amphipods. Two of the physical factors, temperature and oxygen content, directly affected the life cycle of the amphipod, whereas the effects of other physical factors were indirect. The amphipod had an annual cycle in Sheep Lake. Breeding occurred from March to the end of June. The size of the breeding females decreased as the lake temperature rose. This was also true of the young produced. At least three brood per season were produced by many of the females. The amphipod acted as the intermediate host in the life cycle of *Polymorphus minutus*, an acanthocephalan parasite. The effects of this parasite on the life history of the amphipod are described. During the summer of 1966 approximately 50% of the amphipods were infected by the cysticanth stage of *P. minutus*. Although the presence of the parasite affected the maturation of some infected amphipods, others appeared to be unharmed.

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LOGGERHEAD (*CARETTA CARETTA*) AND GREEN TURTLE (*CHELONIA MYDAS*) NESTING DENSITIES ON A MAJOR EAST-CENTRAL FLORIDA NESTING BEACH. L. M. Ehrhart and P. W. Raymond*. Univ. of Central Florida, Orlando.

Bjorndal et al (1983) suggested that beaches in south Brevard Co., Florida support the greatest densities of loggerhead turtle nesting in the southeastern U.S., but no systematic, season-long nesting survey has previously been done there. Our objective was to quantify the extent of both loggerhead and green turtle nesting in south Brevard Co., and to define annual variation. In summer, 1981, a total census of 9.3 km of beach at Indian-Melbourne Beach revealed that 1304 loggerhead clutches had been deposited. In 1982 the study area was expanded by 19.7 km (south to Sebastian Inlet) and a sample census (56% of time-distance) of 5416 loggerhead nests provided a ratio estimate of 9674 ± 225 nests ($\bar{x}=334/\text{km}$) for the entire 29 km. Mean density in the more southerly 20 km was 450/km, and exceeded 600/km in some areas. In 1982, 47 green turtle nests were observed. Destruction of nests by predators and other factors is virtually nil. These results suggest that loggerhead nesting densities in south Brevard Co. exceed those seen anywhere else in the western Atlantic.

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EFFECT OF SUBSTRATE WATER CONTENT ON THE DEVELOPMENT OF YELLOW-BELLIED SLIDER TURTLE EMBRYOS. A. L. Caudle, Savannah River Ecology Lab., Aiken, S. C.

Pseudemys scripta eggs were incubated in substrates of known water content. Except in the most anhydrous substrate, the incubation period and hatchling size were relatively insensitive to differences in the hydric environment. Egg mortality was the greatest in the driest substrate. For the dehydrated eggs the incubation period was abbreviated, the carapace was softer, and the hatchling size was reduced. Total time spent in the incubation cavity was directly correlated with substrate water content, and may reflect the time required to absorb and close the residual yolk into the abdominal cavity. The amount of lipid mobilized from the yolk increased as a function of time, and was relatively independent of the hydric environment. These results suggest that the development of P. scripta in natural nests may be unaffected by the hydric environment unless the eggs are severely dehydrated.

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PARENTAL INVESTMENT IN THE SNAPPING TURTLE (*CHELYDRA SERPENTINA*). D. C. Wilhoft. Rutgers University, Newark, N. J.

Females and eggs were collected from a New Jersey population of snapping turtles between 1977 and 1980. Clutch size averaged 31.4 eggs (2 SE=5.04; n=70) and was highly correlated ($r^2=0.41$; $p<0.001$) with body size (plastron length) of the females. Wet mass of the clutches averaged 281.5 g (2 SE=23.8; n=70) and was highly correlated ($r^2=0.47$; $p<0.001$) with body size. Egg mass was weakly correlated with female size ($r^2=0.01$; $p<0.05$, n=712). The coefficient of variation of intra clutch egg mass averaged 4.3% (2 SE=0.56; n=26) and was not significantly related to female size ($r^2=0.03$; n=26). The ratio of wet clutch mass to wet mass of female body averaged 0.07 (SE=0.008; n=24) and no correlation was noted between female mass and percent weight of clutch ($r^2=0.02$; n=24). No significant relationship ($r^2=0.005$; n=712) between egg mass and clutch size was noted. Hatchling size was significantly related to egg mass ($r^2=0.61$; n=13) and body size of the females ($r^2=0.31$; n=13). This data would suggest that Chelydra serpentina has optimized investment per offspring and conforms to models that maintain responses to short term environmental changes in resources among adults will be in offspring number.

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AGE-SPECIFIC REPRODUCTIVE TRAITS OF A FACULTATIVELY NEOTENIC SALAMANDER, AMBYSTOMA TALPOIDEUM. Raymond D. Semlitsch (intro. by Laurie J. Vitt) Savannah River Ecology Lab., Aiken, S.C.

The reproductive strategy of a species in varying environments often involves compromises among reproductive traits such as the timing of reproduction, frequency, clutch size (mass and number), and egg size. Ambystoma talpoideum is capable of becoming neotenic in relatively permanent ponds but can metamorphose if that pond dries. Reproductive traits (clutch size, clutch mass, egg size) were measured for known-age individuals in five populations (two neotenic) of A. talpoideum for two years. All three reproductive traits were positively related to age. However, when the effect of body size was removed by analysis of covariance only clutch mass and egg size increased with age. Neotenic adults were younger and smaller in body size than terrestrial adults. When the effect of body size was again removed by analysis of covariance neotenic adults produced smaller eggs but a larger clutch size and clutch mass. These data suggest that the advantages associated with increased egg size are greater than the fitness gained by producing more eggs of the same size for terrestrial morphs but is not for neotenic morphs.

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THE SIGNIFICANCE OF CLUTCH SIZE VARIABILITY IN THE BLUE TIT: AN EXPERIMENTAL TEST OF THE "GOOD PARENT" HYPOTHESIS. N. Nur. Livingston College, New Brunswick, NJ.

Large intra-population variation in clutch size (e.g. 5 to 15 in the blue tit Parus caeruleus) has often been attributed to differences in the quality of the breeding individual and/or its territory. A 3-yr study in Wytham Wood, England, in which the brood size of pairs was manipulated ($n=215$) or not ($n=128$), indicates the actual number of young in the nest is of significance to parent and brood, but neither the original clutch size nor the difference between original ("intended") and actual (manipulated) brood size predicts subsequent reproductive success or costs. While, among manipulated broods, brood size and offspring survival were negatively correlated, among control broods the correlation was positive. This finding can be attributed to larger clutches being laid early in the breeding season, when post-fledging survival is high. There is thus no support for the hypothesis that pairs attempting to rear large broods are "better parents" (e.g. likely to be more successful) than those setting out to rear small broods. Differences in clutch size may be attributed to differences in female condition at the time of egg-laying.

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SIZE INCREASE IN EUNICEAN POLYCHAETES. K. Fauchald, Smithsonian Inst., Washington D.C.

Increase in size in eunicean polychaetes is separable into three components: Increase in segments, in length, and in girth. Based on measurements of 500+ specimens of several onuphid and eunicid species, it was demonstrated graphically that these components are in part independent and that the pattern of increase in size is species-specific. The maximum numbers of segments and length are limited in most species in both families, but in a few species in each family size appears limited only by life-span.

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THE EFFECTS OF FOOD QUANTITY AND QUALITY UPON SOMATIC AND GONADAL GROWTH OF LYTECHINUS VARIEGATUS LAMARCK (ECHINODERMATA: ECHINOIDEA). I. S. Klinger, B. M. McCarthy, and J. M. Lawrence. Dept. of Biology, Univ. of South Florida, Tampa.

Feeding rates of Lytechinus variegatus were higher upon artificial agarose foods containing Sargassum sp. than Thalassia testudinum. Test growth was greater for individuals fed Sargassum sp. and increased with food quantity. Gut indices reflected the quantity of artificial food but were not affected by quality. Neither the quality nor the quantity of artificial food affected gonadal indices. In the field, gonadal indices were higher for individuals inhabiting an area of little macrophytic food than for individuals in an area of abundant macrophytes. Gut indices were similar for individuals inhabiting both areas. These data suggest that foods and feeding cannot be directly related to somatic growth or reproductive effort as internal allocations of resources in echinoids are plastic.

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DRIBBLERS AND SWAMPERS: REPRODUCTIVE PERIOD AND RECRUITMENT IN CARIBBEAN SEA URCHINS. R. Andrew Cameron, University of Puerto Rico, Mayaguez.

The timing of reproduction in benthic marine invertebrates is thought to be shaped by larval and juvenile survival. Few ecological correlates have been determined for recruitment, the particularly crucial transition from larval to adult life. Larval abundance, substrate selection and post-settlement mortality together dictate patterns of recruitment. I have measured reproductive state, larval abundance and size distributions for Lytechinus variegatus, Echinometra viridis and Tripneustes ventricosus. Larvae of L. variegatus, the species with the least synchronous spawning pattern, were present at all sampling times. Larvae of the species with the most synchronous pattern, E. viridis, were only found on one date. The third species, T. ventricosus, was seldom represented in the larval collections. Seasonal recruitment patterns as interpreted from size-frequency distributions do not correlate with the spawning and larval abundance data. Possible causes for the lack of correlation, including differences in length of larval period or early juvenile growth and mortality are discussed.

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ANNUAL RECRUITMENT IN TWO POPULATIONS OF A BRACKISH-WATER OPHIUROID. R.L. Turner. Harbor Branch Inst., Ft. Pierce, FL, and Fla. Inst. Technol., Melbourne.

Ophiopragmus filigraneus is endemic to brackish waters of Florida. Recruitment of juveniles was studied in two sea-grass beds in the Indian River lagoon system: a tidal site with estuarine conditions imposed by two nearby inlets; an atidal site where seasonal changes in rainfall and evaporation produce wide, long-term changes in salinity. Ophiuroids were sampled monthly by two core/sieve methods --one for adults and one for juveniles. The tidal population had large gonads in the fall, low percent autotomy, low density, and poor recruitment. The atidal population had small gonads, high percent autotomy, high density, and good recruitment. Juveniles with oral-frame diameters of .83-.98 mm appeared in "adult" cores in November, before spawn out. Growth of the cohort was followed until July, when juvenile and adult modes merged. Work on "juvenile" cores is in progress. Late fall recruitment might be related to reduced stingray predation and disturbance, which are probably also responsible for contrasting demographic and reproductive conditions at the two sites. Supported by a postdoctoral fellowship from HBI and sabbatical leave from FIT.

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TISSUE-SPECIFIC AVOIDANCE RESPONSES AND ESCAPE RESPONSES OF THE SUB-ANTARCTIC LIMPET *NACELLA EDGARI* TO THE STARFISH *ANASTERIAS PERRIERI*. J.B. McClintock and J.M. Lawrence. Univ. of South Florida, Tampa. *Nacella edgari* and *Anasterias perrieri* co-occur in the subtidal zone of the Bay of Morbihan, Kerguelen. *Nacella edgari* shows avoidance and escape responses to *A. perrieri* in a kelp forest and the laboratory. Field observations indicated that *N. edgari* were preyed upon by *A. perrieri*. However, frequency of capture was low, reflecting the effectiveness of avoidance and escape behaviors. Responses by the limpet consisted of extension of the pallial tentacles, mushrooming and rotation of the shell, and flight. *Nacella edgari* showed tissue-specific avoidance responses to homogenates of tube-feet and body-wall tissues of *A. perrieri*. The intensity of the response was positively related to the concentration of homogenates and significantly greater for tube-feet than body-wall tissues. Tissue-specific responses may reflect qualitative or quantitative differences in the "active substance" of tube-feet and body-wall tissues. Supported by NSF grant DPP-8108992 to the junior author and by the Territoires Australes et Antarctique Français.

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THE WORLD'S LARGEST BEE REDISCOVERED LIVING IN ASSOCIATION WITH TERMITES. A. C. Messer, intro. by J. Laerm, Univ. of Georgia, Athens.

Chalicodoma pluto (Smith) (Hymenoptera: Megachilidae), the world's largest bee, was known from only two 19th-century specimens, and presumed extinct. The bizarre, stag beetle-like mandibles and expanded labrum of the 39mm long females puzzled entomologists since the species was described in 1861. Rediscovered on three remote islands in the North Moluccas of Indonesia, *C. pluto* was found to nest communally in association with tree-dwelling termites. Using their extraordinary mouthparts, females gather resin and wood and fashion these materials into galleries resistant to termite invasion. Resins used in nest construction were shown to contain volatile antibiotics. The first males of the species were taken, and male territorial behavior observed.

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A COMPARISON OF NEMATODE COMMUNITIES FROM SUBLITTORAL SAND AND MUD. R.A. Eskin, P.A. Montagna and B.C. Coull. Univ. S. Carolina, Columbia, S.C.

Nematodes, diatoms, bacteria, salinity, temperature, and depth of the RPD layer were sampled fortnightly for 1 year at sublittoral mud and sand sites in S. Carolina. Bacteria, diatoms and nematodes were enumerated; nematodes were identified to species. A few species were highly abundant at both sites. Except for these few generalists there was little species overlap. The sand site was more diverse. Correlations between fluctuations in abundance and the factors sampled were evaluated. Temperature and depth of the RPD layer were coupled and frequently had a significant correlation with the mud populations but not with the sand populations. The potential food sources, bacteria and diatoms, were not regularly correlated with nematode abundance at the mud site, but were more often correlated at the sand site. Some species had highly seasonal population cycles; others were always present but varied greatly in abundance.

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NEW HYDROTHERMAL VENT DISCOVERY IN THE NORTHEAST PACIFIC: TUBE-WORM BIOHERMS AND BACTERIAL GLUE. V. Tunnicliffe, Univ. of Victoria, B.C. and S.K. Juniper*, Inst. of Ocean Sciences, Sidney, B.C.

In August 1983, the Canadian submersible PISCES IV located vents on the Juan de Fuca spreading zone at 46°N, 300mi off the U.S.-Can. border. Clear, slow-flowing water was measured up to 35°C. Vents varied from diffuse flows through bacterial mats to large (over 2m high) structures built of tube worms. These masses were comprised largely of mucilaginous material which included bacterial filaments, mineral fragments and broken tubes. This binding mucus was most dense at the centre of the mass. The close tube worm mass may help contain and recycle local bacterial production. Collections include six new (tentatively) species: a large pogonophoran, two ampharetid polychaetes, a polynoid polychaete, a gastropod - all with red pigments - and a limpet. Populations were highly localized and appeared to vary with respect to flow rates. Stratification within the community was marked while the surrounding deep water assemblage showed only minor influences from these nutrient sources. All Canadian-American SeaMount Expedition members gratefully acknowledged.

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ELECTROPHORETIC COMPARISON OF DISJUNCT GULF OF CALIFORNIA AND PACIFIC OUTER COAST POPULATIONS OF A MARINE SHORE FISH, HYPSOBLENNIUS JENKINSI. T.M.C. Present. Scripps Inst. of Oceanog., La Jolla, CA.

Hypsoblennius jenkinsi is one of about 30 fish species in the northern Gulf of California that also occur on the Pacific coast of Southern California and northern Baja California but which are absent or exceedingly rare in the warmer waters of southern Baja California. It is not clear what levels of gene flow are maintained between the disjunct populations nor when and how this distinctive distribution pattern originated. An electrophoretic survey of 38 presumptive loci in H. jenkinsi from the disjunct Gulf and Pacific outer coast populations was conducted. Resulting genetic similarity (I) and standard genetic distance (D) values are .9621 and .0386 respectively. Although no fixed allelic differences were found, the highly significant frequency differences observed at 6 loci suggest that there is little or no gene flow. Divergence time as calculated from standard genetic distance is approximately 730,000 years but further electrophoretic comparison of local demes within the Pacific population suggest that this may be an overestimate.

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ENDANGERED ICHTHYOFAUNA OF THE SOUTHWEST UNITED STATES: AN EXAMPLE USING THE GILA TOPMINNOW. POECILIOPSIS OCCIDENTALIS. M.E. Douglas and R.C. Vrijenhoek, Okla. State Univ., Stillwater, OK, and Rutgers University, New Brunswick, NJ.

The fossil history of the southwestern ichthyofauna speaks of isolated lineages that are relictual and extinction-prone. The steady decline of this fauna has been documented. For example, Poeciliopsis occidentalis was once widespread in the Gila River drainages of the southwest, but is now restricted to a series of isolated pools in southwest Arizona where it is rapidly declining in abundance. Although currently on the U.S. Endangered Species List, this form is abundant in 4 riverine systems of northwest Mexico. We evaluated the distribution of genetic variability in 7 Arizonan and 16 Mexican populations of this fish using starch-gel electrophoresis. Our results indicate 3 distinct subspecies. Those fish in Arizona are not unique, but instead represent the northern most (ecologically marginal) populations of two widespread Mexican subspecies. The Gila topminnow is endangered in the United States only if we recognize this status solely on the basis of national boundaries.

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DEVELOPMENTAL STABILITY AND GENOMIC CO-ADAPTATION IN HYBRID SUNFISH. J. H. Graham and J. Felley (intro. by N. Hart). Rutgers Univ., Piscataway, N.J., and McNeese State Univ., Lake Charles, La.

Using fluctuating bilateral asymmetry as a measure of developmental stability, we tested the hypothesis that genomic coadaptation mediates developmental stability in natural populations. If true, bilateral asymmetry will be highest in hybrid populations. We examined developmental stability in 11 populations of Enneacanthus obesus, E. gloriosus, and naturally occurring hybrids. Hybrid populations were identified on the basis of 4 electrophoretic marker loci. Hybrid populations were more asymmetrical than populations of the parental species. In addition, asymmetry was linearly related to the level of introgression. These results support the hypothesis that, at least in some outbred populations, coadaptation mediates developmental stability. Inconclusive results obtained by previous researchers may have been due to coadaptation evolving independently within static hybrid zones.

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SYMPATRIC, MULTIPLY-CONVERGENT EVOLUTION OF THE LAND SNAIL GENERA MESODON AND TRIODOPSIS (GASTROPODA: PULMONATA: POLYGYRIDAE). K.C. Emberton. Univ. of Chicago, Chicago, IL.

These two genera are similar in number of species (ca 35 each), total range (eastern U.S.), and geographic patterns of species diversity and endemism (peaks in the southern Appalachians and the Ozarks). Both have radiated into the same ecological niches, resulting in a wide variety of shell shapes with multiple convergences between the two genera. Several pairs of species with closely convergent shells occur in micro-sympatry. Before examining sympatric, convergent species in detail, I am attempting to stabilize the systematics of the two genera, using secondary sexual characters as well as electromorphs (16 loci, ca 135 alleles).

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COMPARISON OF COURTSHIP BEHAVIORS AND INTERSPECIFIC CROSSES IN THE SCHIZOCOSA OCREATA SPECIES COMPLEX (ARANEAE; LYCOSIDAE). G.E. Stratton. Bradley Univ., Peoria, IL

There are 5 species in the S. ocreata species complex as defined by the morphology of the genitalia. Each species has distinct courtship behaviors with recognizable courtship songs. Mature males of crassipes and ocreata have tufts of black bristles on the tibiae of the forelegs. The courtship of these species involves tapping, waving and arching the forelegs. Mature males of the other species lack the bristles and do not move the forelegs during courtship. Several pairs of these species overlap in geography, habitat, and season of reproduction. It was hypothesized that behavioral reproductive isolating mechanisms would be of greater importance between those species that overlap than in those that do not overlap. This was found to not be true. In 115 attempted interspecific crosses, it was found that each species is effectively isolated by courtship behavior. Males of each species will court females of any species; females are highly discriminating and are receptive only to males of their species.

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HYDRA TENTACLES: ULTRASTRUCTURAL ANALYSIS OF SERIAL SECTIONS. M.K. Lyon*, L.A. Hufnagel*, & G. Kass-Simon. Univ. of Rhode Island, Kingston.

Ultrastructural reconstruction of serial sections of distal tentacles of H. attenuata reveals 2 levels of ectodermal organization: The battery cell complex (BCC): an epitheliomuscular cell enclosing nematocytes & neurons. The BCC Ring: a contiguous arrangement of BCC's around the circumference. IN THE TENTACLE NO CELLS EXIST OUTSIDE THESE COMPLEXES. The battery cell has 3 distinct regions: cell body, attenuated extensions & myonemes. Extensions & myonemes project distally & proximally along the tentacle. There are mature or degenerating upright nematocytes, and immature, prone ones. All battery cells contain a completely enclosed neuron with an internalized sensory complex. Some cells also enclose a 2nd neuron, whose sensory complex extends into the outside medium. We propose: BCC's act as the functional unit during bending; BCC rings become the functional unit during shortening. Attenuated extensions provide flexible cushions, forming an insulating barrier between myonemes & external medium. Prone nematocytes are migrating to sites of insertion; some degenerate *in situ*. Enclosed neurons are mechanoreceptors. Supported in part by the Am. Heart Assoc.

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DEVELOPMENTAL PATTERNING OF THE NEMATOCYTE BATTERY COMPLEX IN THE TENTACLES OF HYDRA OLIGACTIS. P.E. Suchy and G.E. Lesh-Laurie. Cleveland State Univ., Cleveland, Ohio.

Cnidarian nematocysts serve purposes ranging from locomotion and attachment to prey-capture and defense. Quantitative analysis of the tentacle nematocyst population from Hydra oligactis reveals a patterning of individual nematocyte-battery complexes expressed uniformly throughout the tentacle's length. Data indicate the formation of the "typical battery" occurs at the base of each tentacle. This project addresses the patterning, formation, and cellular integrity of battery complexes during steady-state conditions, and during periods of starvation, asexual reproduction, and regeneration. Data were obtained from glutaraldehyde-fixed hypostomes which were photographically enlarged and the tentacles reconstructed as composites. From these records, no preferential pattern nor number of nematocysts was observed as the "typical" battery, regardless of its location. Nematocyst counts reveal a constant proportion of each nematocyst type (~ 69% desmonemes, 17% stenoteles, and 14% isorhizas) throughout the tentacles of steady-state and asexually reproducing hydra. (Am. Heart Assn., NE Ohio Grant #4335).

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COMPARATIVE MICROSCOPY OF HYDRA NEURONS. L. Epp and J. A. Westfall. Mount Union College, Alliance, Ohio and Kansas State University, Manhattan, Kansas.

This is the first report of scanning electron microscopy of isolated neurons of *Hydra* and their correlation with neuronal features visible by phase microscopy and transmission electron microscopy. Multipolar and bipolar epidermal and sensory gastrodermal neurons from body column and pedal disk were compared. Pedal disk neurons were smaller, had thicker neurites and more cytoplasm in their perikarya than their counterparts in the body column. A correlation could be made between relatively large and heterochromatic nuclei from TEM and LM; others which appeared small and granular from TEM appeared small and refractile using LM. Perikarya generally had the shape of the nucleus, spherical for heterochromatic nuclei and elliptical for granular/refractile nuclei. A perikaryal cilium was frequently visible on pedal disk epidermal neurons and an apical cilium on gastrodermal sensory cells using the three types of microscopy. This study is part of a long range program to describe, in detail, the primitive nerve net of *Hydra*. (Supported in part by NIH Grant NS-10264).

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EYE DEVELOPMENT IN THE MARINE GASTROPOD, *ILYANASSA OBSOLETA*. B.L. Gibson. Univ. of Rhode Island, Kingston and Eye Research Institute of Retina Foundation, Boston.

The adult *Ilyanassa* eye is composed of a retinal layer, an extracellular lens, cornea, neuropile, optic nerve and connective tissue capsule. The retinal layer is a mixture of photoreceptor, pigmented and occasional ciliated cells. The photoreceptor cells contain small electron-lucent vesicles (ELVs), multivesicular bodies (MVBs), melanosomes and highly elaborated photosensitive microvilli. The neuropile contains photoreceptor axons, accessory neurons and their neurites. The embryonic eye forms from 3 velar ectodermal cells which invaginate and differentiate into the photoreceptor, pigmented and corneal cells. All 3 contribute material to the forming lens. Before hatching, the embryonic eye is without a capsule, optic nerve, or accessory neurons. The photoreceptor cell lacks ELVs, MVBs, and melanosomes but its microvilli are highly elaborated. Prior to metamorphosis, the larval eye has assumed its adult organization: there are many more retinal cells, the optic nerve and capsule are visible and the photoreceptor cells contain ELVs, MVBs and melanosomes. Larvae were generously provided by Dr. Jan Pechenik.

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5S RNA AND tRNA SYNTHESIS IN ANIMALIZED SEA URCHIN EMBRYOS. A.F. O'Melia, George Mason Univ., Fairfax, Va. and Marine Biological Laboratory, Woods Hole, Ma.

Animalization (ectodermalization) was induced by continuous treatment from the 2-cell stage with Evans Blue. Cleavage, mesenchyme blastula and pluteus stage embryos of *Arbacia punctulata* and corresponding stages of animalization each were labeled for 3h with (^3H)-guanosine. Purified sRNA (NaCl-soluble) preparations were fractionated by electrophoresis on 10% polyacrylamide gels. Quantitative measurements of rates of accumulation of newly made 5S RNA and tRNA were calculated and compared in control and in experimental embryos at each developmental stage. The results showed that the rate of synthesis of 5S RNA and of tRNA per embryo and per cell are similar in control and in Evans Blue-animalized embryos at each stage. In contrast to the inhibition of nucleolar rRNA synthesis observed in Evans Blue-animalized embryos (O'Melia, A.F. 1983, *Develop., Growth and Differ.* 25: 171-180), the alterations in normal cell associations and interactions induced by Evans Blue in sea urchin embryos did not affect the synthesis of 5S RNA and tRNA. (Support: ORAS, GMU).

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THE PATTERN OF GASTRULATION IN MACROCEPHALIC ANURAN EMBRYOS. K.R. Kao and R.E. Elingson, Univ. of Toronto, Canada.

Macrocephalic tadpoles produced by hybridization or by injection of germinal vesicles (GV) into the blastocoel have a blastocoel roof which is thicker than that of controls during gastrulation. Archenteron formation and blastopore closure are accomplished however, indicating that normal thinning and spreading of the blastocoel roof are not requirements for these events. The inhibition of cell rearrangements leads to an accumulation of ectodermal cells in the anterior of the embryos. Vital dye marks placed on regions of *Xenopus laevis* early gastrulae normally fated for the mid-trunk map to the head when the embryos are injected with GVs. In addition, macrocephalic embryos have a neural tube that is enlarged anteriorly, but is smaller posteriorly when compared to control embryos. These results suggest that macrocephaly results from a localized inhibition of ectodermal cell rearrangements as opposed to the action of an axial structure determinant (Malacinski, *Cell Diff.*, 3(1):31, 1974). Our study also supports a model of epiboly (Keller, *J.E.E.M.*, 60:201, 1980) in which passive stretching of the ectoderm occurs due to tension at the blastoporal rim.

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A RECESSIVE MUTANT OF *XENOPUS LAEVIS* AFFECTING MAINTENANCE OF NEURAL STRUCTURE. C. Kaye, D. M. Krotoski-Gwozdzowski*, M. Dimenstein*, D. Reinschmidt*, and R. Tompkins.

A recessive lethal mutant, light lethal (ll), was recovered from a wild-caught female by gynogenesis. Mutant animals can be recognized by their reduced melanin pigmentation beginning at stage 42. Iridophores develop, but are white rather than reflective. This partial albino causes a severe shortening of the body axis, although they remain capable of swimming up until death. Mutant animals begin to feed at stage 47 but die at stage 50 or 51. Histology revealed that neural degeneration begins at stage 47 and affects the older portions of the eye and other neural structures. Grafts of mutant eyes into normal hosts at stage 32 survive until metamorphosis. The older proximal portions of these mutant eyes show extensive degeneration; often the eyes are partially collapsed. The distal ciliary margins of these eyes remain relatively normal and continue to grow. Death of the grafted eyes may be secondary to the collapse seen at metamorphosis and consequent loss of blood supply. The major defect caused by this mutant is probably degeneration of differentiated neural structures.

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THE EFFECT OF METAMORPHIC CLIMAX ON ANURAN LIMB REGENERATION J.M. VanStone. Trinity College, Hartford, Connecticut.

The influence of metamorphic climax upon *R. sylvatica* hind limb regeneration was studied by amputating primary regenerates located on animals just entering the period of climax. These primary regenerates with foot stages X to XIII developed from thigh level amputations of normal stage VIII limbs, and were located on animals in stages XVII to XIX. Following amputation of these primary regenerates at the ankle level, the animals reached stage XX (forelimb emergence) in 2 to 7 days. At 16 to 17 days post amputation the responses consisted of 1 negative, 11 abortive growths and 4 abnormal feet. The abortives consisted largely of cartilaginous growths although in some cases slips of muscle were also formed. The abnormal feet were recognizable feet with 3 to 4 digits consisting of well formed phalanges. These observations strongly suggest that the systemic changes characteristic of anuran metamorphosis have an antagonistic effect upon the process of limb regeneration the intensity of which correlates with the length of regeneration time prior to onset of climax.

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COMPARISON OF REPTILIAN VITELLOGENINS R.E. Bast, J. Zimnochow and A.R. Gibson (intro. by F.P. Doerder). Cleveland State Univ., Cleveland.

SDS-polyacrylamide gel electrophoresis was used to determine the molecular weights (MW) of vitellogenin (Vg) polypeptides from representatives of several reptilian orders. The synthesis of Vg by males and nonyolking females was induced by subcutaneous injection of 17β -estradiol. Posttreatment plasma concentrations of protein-bound, alkaline-labile phosphorus were 100 to 500 times pretreatment levels. Electrophoresis of pre and post-treatment plasma samples revealed the *de novo* appearance of at least 2 polypeptides of high molecular weight in all animals. Under denaturing and reducing conditions of electrophoresis an animal's Vg polypeptides were either of similar MW, about 250,000, or of dissimilar MW whose sum approximated 250,000. Experiments with denatured but not reduced plasma proteins indicated that the sets of smaller polypeptides are linked by disulfide bonds. Since the MW of native Vg in all examined reptiles was about 450,000, we concluded that native Vg is a dimer consisting of either 2 large polypeptides, or 2 each of both smaller polypeptides forming heterodimers held together by disulfide bonds.

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EFFECT OF GROWTH HORMONE (GH) AND PROLACTIN (PRL) ON VITELLOGENIN (VG) SYNTHESIS IN CULTURED COCKEREL HEPATOCYTES. K.D. Boehm, I.R. Johnson*, and J. Ilan*. Case Western Reserve Univ., Cleveland, Ohio.

In vivo induction of VG, the female-specific, liver-derived, yolk-precursor protein, by estradiol (E2) in cockerels has been well-documented. *In vitro* induction of VG by E2, however, has not been satisfactorily demonstrated in cockerel hepatocyte monolayers. Our recent work has shown that cockerel hepatocyte monolayers are capable of synthesizing and secreting VG when plated in the presence of serum from E2-treated roosters. In contrast, addition of E2 to cultures plated in the presence of serum from roosters not treated with E2 resulted in no detectable synthesis and secretion of VG. These data suggest that, unlike amphibians, avian hepatocytes require other factor(s) for *in vitro* expression of the VG genes. Evidence from reptile studies suggests that GH or some related peptide is required for hepatic synthesis and secretion of VG. In an attempt to elucidate the hormonal regulation of VG gene expression in birds, GH and PRL were administered to cockerel hepatocyte monolayers. Results obtained by PAGE suggest that these cells synthesize and secrete a protein which comigrates with authentic VG. NIH AM21312.

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CONCAVALIN A - INDUCED CHANGES IN CYCLIC - AMP DISTRIBUTION INHIBIT NEURAL TUBE CLOSURE IN THE EARLY CHICK EMBRYO. D. R. Bjorkman* and G. W. Kalmus, East Carolina Univ., Greenville, N. C. 27834

Concanavalin A (Con A) has been shown to inhibit neural tube closure in the early chick embryo (stage 10) without interfering with cellular migration, when applied to stage 5 embryos in culture. Application of 2-100 µg/ml Con A to embryos in culture resulted in 60 to 90% failure of posterior neural tube closure. Normal cAMP distribution within the developing neural tissue has been determined immunohistochemically in our laboratory with a fluorescein labeled antibody to cAMP. Frozen sections of both Con A treated and untreated embryos were stained immunohistochemically for cAMP. Con A was found to alter the normal distribution and concentration of cAMP in the developing neural tissue, and particularly to decrease the cAMP concentration in that part of the neural tissue which forms the luminal surface of the future neural tube. Since the mechanism of neural tube closure is known to involve active microfilament constriction along the luminal surface, Con A may inhibit neural tube closure through a mechanism involving cAMP-dependent microfilament constriction.

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HISTOCHEMICAL STUDY OF GLYCOSAMINOGLYCAN DISTRIBUTION IN THE CHICK EMBRYO DURING EARLY LIMB DEVELOPMENT. S.M. Thiem*, C.M. Conway, and A.F. Conway. VA Commonwealth Univ., Richmond, and Randolph-Macon College, Ashland, VA.

The distribution of glycosaminoglycans (GAGs) in stage 11-26 embryos was studied by selective GAG degradation followed by Alcian blue staining. Staining intensity in embryo sections receiving no degradative treatments increased temporally indicating increased GAG deposits. Localized deposition was observed in the perinotochord region at all stages, in limb cores at stages 22-26, and in the subectodermal mesoderm of both limbs and flanks at stages 22-26. Reduction in staining intensity following treatment with chondroitinase ABC, testicular or Streptomyces hyaluronidase, or nitrous acid reagent indicated regional differences in GAGs. Heparin/heparan sulfate appeared to be components of the mesoderm and ectoderm, but not of the basement membranes or limb cores. GAGs of the limb cores appeared to include hyaluronic acid and one or more of the following: chondroitin, chondroitin-6-sulfate, chondroitin-4-sulfate, or dermatan sulfate. The GAGs found in the limb region may play a role in limb growth or may be an indication of chondrogenesis.

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EFFECT OF db-cAMP ON SKELETAL DEVELOPMENT IN EMBRYONIC CHICK MANDIBLE. M.S. Tyler, Univ. of Maine, Orono.

Previous work has shown that in vitro treatment with db-cAMP stimulates bone resorption (Herrmann-Erlee, '70, *Calcif. Tissue Res.* (Suppl.) 4:70). This study shows that db-cAMP can also prevent bone from forming. Embryonic chick mandibles (HH 24-29) were cultured in the presence and absence of db-cAMP (1 mM) and theophylline (1mM) for up to five days. Light microscopic examination showed that db-cAMP treatment inhibited membrane bone formation in early stages tested and inhibited or reduced osteogenesis in later stages tested. The treatment did not inhibit chondrogenesis and in certain instances appeared to enhance it. Dibutyl-yl-cAMP treatment also caused precocious differentiation of mucus-secreting regions of the oral epithelium, but did not alter the stratified squamous aboral epithelium. Results indicate that db-cAMP has different effects on different skeletal elements and on different types of epithelia. (Supported by NIH grant DE-04859-04A1.)

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EFFECTS OF EXCESS VITAMIN-A ON DEVELOPMENT OF EMBRYONIC CHICK MANDIBLE. R.A. DeWitt* and M.S. Tyler, Univ. of Maine, Orono.

Excess vitamin-A caused epithelial ciliogenesis and interfered with skeletogenesis in the embryonic chick mandible. Ultrastructural and light-microscopic studies of cultured mandibles (HH 25) treated with varying concentrations of vitamin-A (trans-retinoic acid) and harvested at 24-hour intervals for up to six days showed the sequence of events elicited by the vitamin-A. The first indication of epithelial changes was a cellular thickening and a rearrangement of organelles into a pattern typical of cilia-forming cells. Ciliogenesis followed a pattern typical of primary ciliogenesis, and a single cilium/cell was found by the sixth day. Within the mesenchyme, low concentrations of vitamin-A inhibited membrane bone- but not cartilage-formation. Higher concentrations inhibited membrane bone-formation and caused resorption of extant cartilage. Results indicate that vitamin-A induced ciliogenesis follows a normal developmental pathway and that at the stages tested membrane bone is more sensitive to the inhibitory effects of vitamin-A than is cartilage. (Supported by NIH grant DE-04859-04A1.)

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BETA KERATIN: A BIOCHEMICAL MARKER FOR FEATHER DIFFERENTIATION.

FISHER, C.J. and R.H. Sawyer. Vassar College, Poughkeepsie, N.Y. and U. of S. Carolina, Columbia.

The feather, a class-specific structure found only in birds, is characterized by the presence of feather barbs, histologically, and beta keratin, biochemically. This insoluble protein is normally found only in feathers and certain scales of birds and reptiles. It can first be identified in the mid-dorsal feather tract of normal chick embryos on day 13, using indirect immunofluorescence of beta keratin. Chick reticulate scales, which normally produce only alpha keratin, can be transformed into feathers by intra-amnionic injection of Vitamin A on days 10-12 of development. In these induced feathers, barbs containing beta keratin are present. Thus, beta keratin is a useful biochemical marker for both normal and abnormal feather differentiation. Vitamin A-induced ptilopody may also serve as a model for studying gene regulation of keratin synthesis.

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INDUCTION OF ECTOPIC ANTLERS BY SUBCUTANEOUS GRAFTS OF FALLOW DEER PERIOSTEUM.

R. J. Goss and R. Powel*. Brown Univ., Providence, R. I.

The histogenesis of deer antlers has been studied by grafting frontal periosteum from presumptive antler regions beneath the skin elsewhere on the body. In 6-month old fawns, when antler pedicles first become palpable, discs of periosteum 1.5 cm in diameter were transplanted subcutaneously to the lower forelegs. During the following spring and summer ossification occurred at the graft site, followed by the induction of velvet in the overlying skin. Short antlers up to 1 cm long formed apically. They shed their velvet by early autumn, and were replaced by outgrowths up to 10 cm long in succeeding years. Periosteal discs 0.75 or 0.40 cm in diameter gave rise to subcutaneous ossicles, but failed to induce antler growth in the integument. The frontal bones produced pedicles and antlers in only about 20% of the cases in which 1.5 cm discs of periosteum were excised, but in approximately 80% of those from which the lesser amounts had been removed. It is concluded that antlers originate in the frontal periosteum, if it is present in critical amounts, and that the induction of velvet skin is not specific to the scalp.

554a

STIMULATION OF HEXOSAMINE PRODUCTION IN STOMACH CELL CULTURES BY TAPEWORM LARVAL CULTURE PRODUCTS. Rikihisa, Y. and N. Pratt and Y. C. Lin (intro. by L. A. Eng). Virginia-Maryland Regional College of Veterinary Medicine, Virginia Tech, Blacksburg.

Development of larvae of the cestode parasite *Taenia taeniaeformis* in the liver of rats induces not only gross hyperplasia of the gastric mucosa but also excessive mucus production in the stomach without any direct contact with the stomach. Because the taeniid larvae are known to release an acidic proteoglycan *in vivo* and *in vitro*, we investigated the effects of larval secretory products on cultured rat and dog stomach cells. *In vitro* secretory products stimulated the growth of both rat and dog stomach cells at concentrations of 3-9 µg protein/ml. At concentrations greater than 30 µg protein/ml, those products inhibited the growth of stomach cells, but stimulated hexosamine production up to 20 times. By transmission and scanning electron microscopy the stimulated cells had multiple granules in the cytoplasm. These results suggests that larval secretory products are involved in the induction of hypermucus secretion as well as gastric hyperplasia. Supported by USDA Hatch Grant 2125060.

554b

Amplification of Mitochondrial DNA in Bovine Oocytes G.S. Michaels* and P.J. Laipis*

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The demonstration of a 100 fold difference of the amount of mitochondrial DNA (mtDNA) between Bovine follicular oocytes and somatic cells suggest that their DNA is amplified during oogenesis. We report here experiments which measure the amount of mtDNA in oocytes at different stages of follicular development. In an attempt to measure the timing of this amplification, we isolated total DNA from follicular oocytes which had been sorted by size. MtDNA was separated by agarose gel electrophoresis, and immobilized on nitrocellulose filters. Hybridization with the complete mtDNA genome or cloned mtDNA restriction fragments revealed a 22% increase in amount of mtDNA while the oocyte increased in volume 22 fold. The amount of mtDNA increased from 3.2 to 4.2 pg per oocyte when the range of oocyte diameters increased from 50-80 to 120-140 µm. Oocytes isolated from a 265 day fetus contained 2.35 pg of mtDNA/oocyte. These data suggest that the majority of the mtDNA amplification occurs prior to the addition of the zona pelucida, probably during fetal development.

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EFFECT OF TEMPERATURE ON ESTROGEN RECEPTOR
TRANSLLOCATION IN TURTLE LIVER EXPLANTS.S-m. Ho. Tufts University, Boston.

In homeotherms (birds and mammals), the interaction of estrogen (E) with hormone receptor (R) is composed of two steps: first, formation of a cytoplasmic ER complex; second, translocation of the ER complex to the nucleus. The second step is highly temperature dependent, occurring at 37°C but not at 4°C. The goal of the present study is to reveal whether the ER translocation process in poikilotherms is equally sensitive to temperature. Turtle liver explants were maintained in hormone and serum-free medium for three days and showed to contain ER in cytosol. Cultures were exposed to three different temperatures (4, 15, 25°C) following treatment with 10⁻⁸M estradiol. Translocation of ER into nuclear compartment was demonstrated at all three temperatures. An additional phenomenon was observed in cultures maintained at 15 and 25°C. Rapid increase in cytosolic ER occurred before the translocation of ER into nuclei. This early increase in cytosolic ER could be attributed to unmasking of inactive ER or synthesis of new ER. Our data indicate possible differences in steroid hormone action between poikilothermic and homeothermic species.

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LIVER CYTOSOLIC ESTROGEN RECEPTOR AFTER
HYPOPHYSECTOMY AND GROWTH HORMONE
TREATMENT IN THE FEMALE TURTLE. D. Riley,
R. McPherson and I.P. Callard. Boston
Univ., Ma. and Clarion State College, Pa.

In the present study we have further elucidated the mechanism by which growth hormone acts on the liver to modulate its sensitivity to estrogen in reptiles. Using DNA-Cellulose affinity chromatography estrogen receptor levels were measured in liver cytosol prepared from the following animal groups (a) sham operated (b) hypophysectomized (c) hypophysectomized plus growth hormone replacement. A dramatic effect on cytosolic estrogen receptor levels was observed. Levels of estrogen receptor in control animals were in the range 68±6.35 fmol/g tissue, whereas no binding activity was present post-hypophysectomy. This receptor was partially restored in hypophysectomized animals by growth hormone replacement therapy to a level approximately 36% of that of control (24.5±2.5 fmol/g tissue). These data, suggesting a degree of dependence of cytosolic estrogen receptor upon growth hormone provides at least a partial explanation for the previously observed effects of hypophysectomy and growth hormone treatment on estrogen induced vitellogenesis in reptiles.

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THE EFFECTS OF 17 α -ESTRADIOL ON RABBIT
TRACHEAL EPITHELIUM IN VIVO AND IN VITRO
B. Chojnowski* and E. Aiello. Fordham
University, Bronx, N.Y.

Treatment of ovariectomized rabbits with 125 μ g/kg of 17 α -estradiol (E) s.c. daily for 9 days increased the total number of secretory cells significantly from 4.3 to 24.1% of the cell population as visualized by AB/PAS staining.

Tracheal explants were cultured for 2 weeks and examined as above. The total number of stained cells/500 μ m of epithelium was increased from 4.3±0.9 to 12.8±12.6 at 10⁻⁵M E and to 10.5±7.2 at 10⁻⁶M.

Outgrowths from 50 control and 64 treated explants were examined as whole mounts after staining. Differentiated cells were counted within 2 high power fields (0.126 mm²) of the explant. E at 10⁻⁵M caused a significant increase in the number of ciliated cells, 12.6 vs 8.7. Microvillous cells did not increase. The total number of secretory cells increased from 0.1 to 0.2/field. The finding that in every one of the comparisons, the mean number of differentiated cells in the treatment group exceeded that in the control group strongly suggests that E encourages differentiation. (Supported in part by a Shering-Plough Foundation Fellowship to B.C.)

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NEUROANATOMIC DISTRIBUTION OF AROMATASE
AND 5 α -REDUCTASE IN GOLDFISH (CARASSIUS)
AND TOADFISH (OPSANUS). M. Pasmanik and
G.V. Callard, Boston Univ., Boston.

Aromatase (AR) and 5 α -reductase (RE), enzymes which regulate conversion of circulating androgen to biologically active metabolites (estradiol and dihydrotestosterone), were assayed in neuroendocrine tissues (NET) by measuring product formation from ³H-androstenedione. As reported in other teleosts, the brain and pituitary had extremely high AR (>5000 fmol/mg protein/h). In both fish, AR was concentrated in forebrain although discrete regional differences were more pronounced in goldfish (preoptic/ant. hypothalamus [hpoa]>telencephalon post. hypothalamus=inferior lobes). In general, mid- and hindbrain had low AR. An exception was the medulla of toadfish in which levels were similar to those in hpoa. In this species, the posterior brain stem is reported to have androgen-binding cells and a sex dimorphic nucleus controlling vocalizations. RE in pituitary exceeded levels in brain. Also, the neuroanatomic distribution was different from AR. Distinctive patterns of androgen metabolic enzymes within NET may determine the quality, quantity, and spatial distribution of active metabolites.

(NSF PCM 82-08248)

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THE IN VITRO EFFECTS OF PHOSPHODIESTERASE INHIBITORS ON STEROID INDUCED FINAL MATURATION IN YELLOW PERCH (PERCA FLAVESCENS) AND BROOK TROUT (SALVELINUS FONTINALIS) OOCYTES. D.A. DeManno, Univ. of Notre Dame, Notre Dame, IN. 46556.

Yellow perch and brook trout intrafollicular oocytes were incubated in vitro with stimulatory levels of $17\alpha, 20\beta$ -dihydroxy-4-pregnen-3-one ($17\alpha, 20\beta$ -PG) alone or with the phosphodiesterase inhibitors 3-isobutyl-1-methylxanthine (IM-xanthine) and SQ 20,006. Incubations were run at 12°C and oocytes were assayed for germinal vesicle breakdown (GVBD) at 48 hrs. In both species IM-xanthine and SQ 20,006 at 1.0mM completely inhibited $17\alpha, 20\beta$ -PG induced GVBD. In perch, SQ 20,006 was more effective than IM-xanthine at levels below 1.0mM. In trout, the reverse was true. $17\alpha, 20\beta$ -PG alone induced 100% GVBD while controls without steroid did not mature. The results indicate phosphodiesterase inhibitors can successfully block GVBD in intrafollicular oocytes of yellow perch and brook trout. However, further studies are necessary to determine whether the block is due to an increase in cyclic nucleotides or some other mechanism.

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ESTRADIOL- 17β REGULATION OF OVARIAN PROGESTERONE PRODUCTION AND OOCYTE MATURATION IN RANA PIPIENS. Y.-W. P. Lin and A.W. Schuetz Johns Hopkins Univ., School of Hygiene, Baltimore, MD.

The role of estrogen (E) in modulating progesterone (P) production and oocyte maturation was examined in cultured amphibian ovarian follicles. P levels in ovarian follicles were measured by RIA. Frog pituitary homogenate (FPH) induced a rapid and dramatic increase in follicular P conc. which preceded germinal vesicle breakdown (GVBD). Addition of E to cultured follicles markedly decreased FPH-induced P production and GVBD in a dose dependent fashion. Increased doses of FPH did not overcome E inhibition of P production and GVBD. Rather, high doses of FPH, in the absence of E, enhanced P production and decreased the incidence of GVBD. Our results suggest that E can modulate the oocyte meiotic maturation at two different sites, by acting: 1) directly on the oocyte to block P effects, 2) indirectly by blocking follicle wall P production. Hence E may play an important role as an intrafollicular regulator of oocyte maturation.

(Supported by NSF and NIH).

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A STUDY OF THE PRODUCTION OF SPERMATOPHORES IN THE RED-SPOTTED NEWT M.P. Hardy and J.N. Dent, University of Virginia, Charlottesville, Virginia

The spermatophore of the red-spotted newt is composed of a mucilaginous conical base bearing a spherical cap that contains a mantle of sperm on a mucoid core. Males that were depositing spermatophores were frozen in Freon 12. Cloacas were fixed in Zenker's. Paraffin sections stained sequentially with Azure A (AzA), Alcian Blue (AB), and PAS, showed that 3 sets of glands collectively produce the spermatophore. The anterior-ventral glands secrete the bottom layer of the base (AB+), the posterior-ventral glands its stalk (AzA+), and the pelvic glands the core of the sperm cap (PAS+). Males in breeding conformation received local intramuscular injections of: arginine-vasotocin, 35 μ g/gm body wt.; norepinephrine (NE), 30 μ g/gm; prostaglandin F 2α , 3 μ g/gm; acetylcholine (ACh), 6 μ g/gm; or saline, 0.1 ml. NE caused an eversion of cloacal gland villousities and the emission of typical, but unattached, sperm caps. An extrusion of AB+ material from the vent was observed in response to both ACh and NE. Production of complete spermatophores may require stimuli from the central nervous system.

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REGULATION OF STEROIDOGENESIS IN THE SPINY DOGFISH, SQUALUS ACANTHIAS. P.C. Tsang and I.P. Callard, Boston Univ., Mass. and Mount Desert Island Biological Laboratory, Salsbury Cove, Maine

Although pathways of gonadal steroid biosynthesis in elasmobranchs have been partially elucidated, the role of gonadotropins and specific sites of synthesis are not well understood. In this study, we have demonstrated that mid-pregnant (stage C) female Squalus acanthias but not early pregnant (stage A) respond to pituitary ventral lobe (VL) extract by dramatic increases in circulating testosterone (T) and estradiol- 17β (E) within ten hours. In vitro studies using collagenase dispersed ovarian cells indicate that the granulosa layer is the primary source of T and E, and that T production is maximal in late pregnancy and E in mid-pregnancy. In vitro steroid production is markedly dependant on steroid substrate level. These studies suggest that ovarian steroid synthetic capacity and responsivity vary with follicular development in this species, and that the granulosa layer is the primary site of steroid synthesis. Supported by NSF grant PCH 81-04144 to IPC.

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ESTROGEN BINDING IN THE TESTIS OF THE DOGFISH (*SQUALUS ACANTHIAS*). Paul Mak and Gloria V. Callard, Boston Univ., Boston.

The mechanism of intratesticular estrogen action was investigated in *Squalus*, a species in which the activities of key enzymes in androgen (A) and estrogen (E) biosynthesis have been correlated with the seminiferous cycle. A moiety which bound E with high affinity ($K_D=1.5 \times 10^{-9}M$) but not androgen (T and DHT) or progesterone was demonstrated in nuclear extracts. This E binding macromolecule also interacted with 3β -androstenediol and moxestrol and had a sedimentation coefficient of 5S on a high salt sucrose gradient. Nuclear binding activity was highest in the zone comprised of spermatogonial stages. Neither LH-20 nor DNA-cellulose affinity columns revealed specific E binding activity in testicular cytosol, suggesting that receptors may be located exclusively in the nucleus. Since the body fluids of *Squalus* are characterized by high osmolarity (low free water), we tested the effects of ionic strength, dilution, and urea on the redistribution of receptors in cytosol vs nuclei. Results indicate the shark may be a natural animal model for reevaluating the classic concept of steroid action (HD-16715).

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CYTOCHROME C DERIVED FROM *HYMENOLEPIS DIMINUTA* (CESTODA). D.D. Culler* and C.F. Fioravanti. Bowling Green State Univ., Bowling Green, OH.

Energetically, adult *H. diminuta* is essentially anaerobic. However, Kim and Fioravanti (1983) demonstrated that *H. diminuta* mitochondrial membranes catalyze both cytochrome c reductase and oxidase activities as made evident employing horse-heart cytochrome c. These findings led to an investigation of the possible presence of cytochrome c in the cestode. It was found that *H. diminuta* tissue contains a protein simulating mammalian cytochrome c. When reduced, the cestode cytochrome displayed absorption peaks at 550, 500 and 412nm corresponding to the α , β and γ bands of reduced horse-heart cytochrome c. In addition, the molecular weight of the helminth cytochrome was approximately 12,000 daltons. Quantification of helminth cytochrome c gave a mean value of 4.8 μ g/g tissue. Whether the cestode's cytochrome c is associated primarily with the mitochondrial fraction and has the same degree of reactivity as horse-heart cytochrome c, in terms of mitochondrial oxidation/reduction, remains to be determined. Supported by NIH AI-15597, AI-00389 and a Sigma Xi Research Grant-in-Aid.

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CYTOCHROME C REDUCTION AND OXIDATION BY *HYMENOLEPIS DIMINUTA* (CESTODA) MITOCHONDRIA. Y. Kim* and C.F. Fioravanti. Bowling Green State Univ., Bowling Green, OH.

Adult *H. diminuta*, an intestinal parasite, is predominantly anaerobic with respect to mitochondrial energetics. Via an NADH-dependent, electron transport-coupled fumarate reductase system, ATP is generated anaerobically with concomitant succinate accumulation. A lesser, rotenone-sensitive NADH oxidase is noted which is relatively insensitive to antimycin A, azide or cyanide and results in peroxide formation. Recent findings demonstrated that *H. diminuta* mitochondrial membranes also catalyze antimycin A-sensitive NAD(P)H and succinate-cytochrome c reductase activities. NAD(P)H-cytochrome c reductase displays rotenone-sensitivity and NADH is the preferred reductant. Moreover, the cestode's mitochondrial membranes exhibited cyanide-sensitive cytochrome c oxidase and cytochrome c peroxidase activities. Although the physiological roles of the above reactions remain to be determined, the data suggest that the reduction and oxidation of cytochrome c represent a branching of the helminth's electron-transport mechanism. Supported by NIH AI-15597, AI-00389 and RR-07192.

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INTRAMITOCHONDRIAL RELATIONSHIP OF NADPH: NAD TRANSHYDROGENASE AND "MALIC" ENZYME IN *HYMENOLEPIS DIMINUTA* (CESTODA). J.R. McKelvey* and C.F. Fioravanti. Bowling Green State Univ., Bowling Green, OH.

In *H. diminuta*, malate is the substrate for a mitochondrial dismutation reaction and anaerobic phosphorylation. One arm of the reaction is catalyzed by NADP-specific "malic" enzyme. However, the electron transport-coupled fumarate reductase, acting in the generation of ATP, requires NADH. An NADPH:NAD transhydrogenase links the "malic" enzyme with the fumarate reductase. Experiments with *H. diminuta* fractionated mitochondria demonstrated that the NADPH:NAD transhydrogenase is a component of the mitochondrial inner membrane (IM) while "malic" enzyme is primarily in the matrix compartment. Assessment of these activities in intact and sonically disrupted mitochondria indicated that the transhydrogenase is oriented towards the matrix-side of the IM. Thus, malate oxidation in the matrix couples to hydride transfer resulting in NADH accumulation on the matrix side of the IM. Supported by NIH AI-15597 and AI-00389.

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TISSUE SPECIFIC ISOZYMES OF ALANOPINE DEHYDROGENASE IN PROTOHACA STAMINEA.
J. H. A. Fields. Univ. of San Diego.

Alanopine dehydrogenase was found in all tissues of Protothaca. The adductor muscle and gills had electrophoretically distinct forms of the enzyme. These isozymes had comparable affinities for NADH and pyruvate, but showed distinctive affinities for the amino acids 2-aminobutyrate, alanine, and glycine. The gill isozyme had a higher affinity for 2-aminobutyrate and alanine ($K_m = 23$ and 31 mM respectively) than for glycine (K_m approx. 3 M). The adductor muscle isozyme had a slightly higher affinity for glycine ($K_m = 99$ mM) than for alanine or 2-aminobutyrate ($K_m = 151$ and 207 mM respectively). Affinities for the products alanopine (gill isozyme, $K_m = 12$ mM) and strombine (adductor isozyme, $K_m = 7.2$ mM) were comparable. The adductor isozyme was inhibited by succinate, whereas the gill isozyme was unaffected by succinate at concentrations less than 50 mM. Both isozymes are presumed to assist in balancing redox during anoxia. The data suggest that the adductor muscle would be the main site of strombine metabolism in the recovery period, as the gills and other tissues lack a dehydrogenase that can metabolize strombine.

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CATALASE AND PEROXIDASE ACTIVITIES IN TISSUES OF ELLIPTIO BUCKLEYI AND GEUKENSIA DEMISSA (MOLLUSCA: BIVALVIA).
M.A. Vitale, F.E. Friedl and J.D. Borrelli*. Univ. of South Florida, Tampa.

Mantle, gill and body tissues of the freshwater clam Elliptio and the intertidal marine mussel Geukensia were tested for enzymatic activities using the decrease in H_2O_2 absorption at 230 nm for catalase and guaiacol as a donor for peroxidase. Apparent K values ($K \times 10^{-3}$ sec $^{-1}$ mg protein $^{-1}$) for catalase H_2O_2 decomposition in mantle, gill and body were respectively 4.4 , 6.9 and 22.4 for Elliptio and 31.4 , 20.9 and 23.7 for Geukensia. Apparent specific activities for peroxidase were 3.5 , 4.6 and 0.85 for Elliptio, and 0.03 and 0.02 for the mantle and gill of Geukensia. No peroxidase activity was detected in the body tissue of Geukensia. While catalase activities of the same body regions appear relatively similar in these bivalves, peroxidase activities of the freshwater Elliptio are much higher than those of the saltwater Geukensia.

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A BIOCHEMICAL AND HISTOCHEMICAL STUDY OF HEPATOPANCREAS PEROXIDASE OF THE CRAYFISH, CAMBARUS ROBUSTUS.
D.P. Merrill, T.R. Tiersch*, R.S. Austin* and R.A. Reife*. Rochester Institute of Technology, Rochester, N.Y.

Crayfish are among the few invertebrates reported to possess peroxidase activity. The enzyme is found within the hepatopancreas. Consisting of two lateral pairs of lobes, each with a central lumen leading to the midgut, the organ is the primary site of digestion and nutrient absorption. Its surface is a simple columnar epithelium organized into numerous hollow, blind-ending tubules. Homogenates of 18 hepatopancreases were assayed for peroxidase activity using guaiacol as substrate. Although present in all organs, peroxidase activity displayed a greater than 50-fold difference between the two extremes (0.05 vs. 2.72 units/mg protein). Histochemical examination using diaminobenzidine revealed peroxidase within a line of cells extending along the distal two-thirds of the lengths of the tubules. Beginning with the apical embryonic (E) cells, where the enzyme is contained within small ($2-5$ μ m) vesicles, the differentiation and proximal migration of this cell line culminates in a large cell (B-cell) with a peroxidase-positive supranuclear vacuole. The contents of this vacuole are discharged into the tubule lumen.

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IDENTIFICATION OF NON-MITOCHONDRIAL CREATINE KINASE ENZYME ACTIVITY IN ISOLATED SEA URCHIN MITOTIC APPARATUS. M.S. Saft. Univ. of Health Sci./Chicago Medical School, N. Chicago.

The cell requires ATP to progress through mitosis. Metaphase mitotic apparatus (MA), isolated from first cleavage sea urchin embryos with intact membrane vesicles, exhibit a creatine kinase (CK) activity when creatine phosphate and ADP are added. Extraction of the MA with 0.5% Triton X-100 solubilizes 68% of the CK activity. This soluble fraction includes ATP dependent Ca^{2+} transport enzyme. Remaining CK activity is found associated with astral and spindle fibers of the insoluble mitotic skeleton. The CK activity was not affected by Triton X-100 at concentrations up to 2% . This CK activity is not mitochondrial in origin, as isolates have no cytochrome c oxidase activity (an inner mitochondrial membrane enzyme). Measurements of specific activity indicate that CK activity of the MA (0.95 U/L) is 20% that of rabbit skeletal muscle (4.7 U/L). Present pursuits include purification of the CK activity for comparison to other invertebrate and vertebrate CK. The CK activity described is a non-mitochondrial, integral constituent of the sea urchin MA.

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PHYSICO-CHEMICAL PROPERTIES AND KINETICS OF LACTATE DEHYDROGENASE (LDH) FROM HEART AND FLIGHT MUSCLE OF THE HOUSE SPARROW, *Passer domesticus*. W.W. FARRAR, and Y.J.K. FARRAR.* Eastern Kentucky University, Richmond.

The LDH isoenzymes of sparrow heart and muscle migrate electrophoretically reversed compared to other vertebrates. Purification and examination of heart and muscle LDH reveal the following: 1) Similarity in amino acid composition between sparrow heart and muscle LDH isoenzymes with other avian species whose LDH isoenzymes migrate normally electrophoretically. The amino acid compositions therefore fail to reveal the basis for reversed electrophoretic migrations; 2) A molecular weight of 141,750 for heart LDH (LDH-4) and 141,100 for muscle LDH (LDH-2 and LDH-3). SDS-gel electrophoresis reveals a subunit molecular weight of 35,000 for both heart and muscle LDH showing that sparrow LDH exists as a tetramer; 3) Both heart and muscle LDH operate through an ordered sequential BiBi mechanism with NADH as the first adding substrate and NAD⁺ as the last released product. Sparrow heart LDH has a lower Km for pyruvate (15 μM) and NADH (2 μM) than do the isoenzymes from muscle (62 μM for pyruvate and 13 μM for NADH).

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LIMULUS AMEBOCYTE LYSATE: DIAGNOSTIC ASSAY OF ENDOTOXIN INHIBITION BY SERUM. A. Bucklin. University of San Diego.

The use of *Limulus* ameboocyte lysate (LAL), an *in vitro* bioassay of endotoxin concentration, has been questioned for assays of endotoxin in serum because of marked serum inhibition of the biological activity of endotoxin. This study uses the optical density properties of the LAL reaction with endotoxin to directly assay the capability of human serum to inhibit endotoxin activity. The actual endotoxin content of serum (after removal of inhibition by dilution) is similarly assayed. The potency of lipopolysaccharide (LPS), measured as Endotoxin units per ng, prepared from several bacteria is determined by standardization against the U.S. reference standard endotoxin. The endotoxin inhibitory capability of serum, measured as LPS concentration at one-half maximum OD, was highly correlated with LPS potency in saline controls ($r = 0.96, \alpha < .01$). Potency differences most probably reflect lot-to-lot variation in concentration and preparation of the LPS.

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OXYGEN BINDING PROPERTIES OF THE BLOOD OF A VARIETY OF MARINE CRUSTACEANS. A.J. Arp, N.K. Sanders and J.J. Childress. University of California, Santa Barbara.

We examined the oxygen binding properties of hemocyanin in the blood of a variety of crustaceans collected from midwater, deep-sea, and shallow benthic habitats. Oxygen equilibrium curves were generated for the whole blood of these animals using a series of temperature and pH values. The effect of pH on the oxygen affinity of the blood was large in the majority of the animals examined. The effect of temperature on the oxygen affinity of the blood was minimal in deep living, nonmigrating species. In comparison, animals that make daily vertical migrations showed a greater effect of temperature on the oxygen affinity of the blood. The temperature sensitive oxygen affinity of the blood of migratory crustaceans may allow for greater regulation of oxygen transport in these animals.

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THE PRESENCE OF HEMOGLOBIN IN *SOLEMYA VELUM* (BIVALVIA, PROTOBRANCHIA). J.E. Doeller, D.W. Kraus* and J.M. Colacino. Clemson Univ., S.C.

Solemya velum is a small burrowing clam that inhabits fine sandy subtidal sediments with a characteristic sulfide odor. It contains a very reduced digestive system. Cavanaugh (1983) found that the gill tissue of *S. velum* contains intracellular sulfur-oxidizing chemoautotrophic bacteria. This fact was suggested by its particular anatomy and habitat in light of recent studies of the vent tubeworm and clam. We have determined that its gill tissue also contains intracellular hemoglobin. Using individual gill filaments in microspectrophotometry, we found that the hemoglobin has a high affinity for oxygen, with a P50 of 1-3 mmHg (20 C, pH 7.0). Our preliminary data also show that the oxygen consumption rate of *S. velum* is not increased by sulfide. Under *in situ* conditions, sulfide may increase the oxygen consumption rate, as was found in the vent clam (Childress and Mickel, 1982). Because hemoglobin is present in the gill, which comprises about one half the body of *S. velum*, it may be involved in sulfide metabolism. This work was supported in part by grants from the Lerner-Grey Fund for Marine Research and the Slocum-Ianz Foundation.

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MAXIMUM OXYGEN CONSUMPTION IN DEER MICE AS A FUNCTION OF ALTITUDE AND HEMOGLOBIN GENOTYPE. M. A. Chappell and L. R. G. Snyder. Univ. of California, Riverside.

Deer mice (*Peromyscus maniculatus*) show the most diverse array of hemoglobin polymorphisms of any mammal. The species occurs at altitudes ranging from below sea level to above 4300 m. Frequencies of alpha-globin haplotypes in natural populations are correlated with native altitude. We measured maximum rates of oxygen consumption ($\dot{V}O_{2max}$) during treadmill exercise and cold exposure in laboratory lines of mice carrying common alpha-globin haplotypes in identical-by-descent (IBD) condition. When measurements were made at low altitude (365 m), mice carrying the alpha-globin haplotype predominant in low altitude populations had the highest $\dot{V}O_{2max}$. When the same IBD lines were tested at high altitude (3800 m), individuals carrying the haplotype predominant in high altitude populations were the best performers. These data indicate that deer mouse hemoglobin polymorphisms may have evolved as a response to selection for maximal aerobic capacity at different native altitudes.

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ERYTHROCYTE PHOSPHATES AND OSMOTIC FRAGILITY IN THE AUSTRALIAN LUNGFISH AND OSTEOGLOSSID, *SCLEROPAGES SCHNEICHARDTI*. R.E. Isaacks and H.D. Kim. V.A. Medical Center, Miami, FL and Univ. Mo., Columbia.

The packed cell volume (PCV), hemoglobin concentration (g/dl), and mean corpuscular volume (μM^3) in the Australian lungfish, *Neoceratodus fosteri*, and in the osteoglossid, *Scleropages schneichardti* were 32.3 and 29.9, 10.5 and 10.0, and 407 and 176, respectively. Total acid-soluble phosphates (TPI) from the red blood cells (RBC) of the lungfish and osteoglossid were 35.3 and 18.1 $\mu\text{moles per cm}^3$ RBC, respectively. Inorganic phosphate (Pi), adenosine triphosphate (ATP) and guanosine triphosphate (GTP) represented 16.4, 39.7, and 17.8% of the cell phosphates in the lungfish, respectively. Inositol bisphosphate was not present in red cells of *N. fosteri*. In the osteoglossid, Pi and ATP represented 37.6 and 46.4% of the erythrocyte phosphate, respectively, with only traces of GTP present. The osmotic fragility of erythrocytes of *N. fosteri* are quite resistant to hemolysis with minimum hemolysis beginning at 35-30 mM and complete hemolysis occurring at 20 mM NaCl. The red cells of *S. schneichardti* showed minimum resistance to hemolysis at 95-90 mM with hemolysis continuing to completion at 60 mM NaCl.

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GEOMETRIC CONSIDERATIONS IN FACILITATED AND NON-FACILITATED OXYGEN TRANSPORT.

J. M. Colacino, Clemson Univ., SC.

The maximum $\dot{V}O_2$ of a body which obtains O_2 by diffusion alone is affected by the distribution of the O_2 consuming regions (sinks) in that body. To quantify this effect, the computed $\dot{V}O_2$ of planar, cylindrical and spherical bodies with homogeneous sink distribution was compared to the maximum $\dot{V}O_2$ of bodies of the same size and shape, but with non-homogeneous sink distribution. The non-homogeneities were produced by a simple symmetric restriction of the sink region toward the center of each type of body. In all cases the maximum $\dot{V}O_2$ for bodies with non-homogeneous distribution was less than $\dot{V}O_2$ for the corresponding homogeneous cases. Maximum $\dot{V}O_2$ of the sphere was markedly reduced by restriction of the sink. The planar body showed only a small reduction and the cylinder was intermediate. The effect of non-homogeneous distribution of Hb on facilitated transport was also studied. Simple computations indicated that if, in a planar transport region of thickness t , Hb (and hence facilitation) was restricted to a layer of thickness $t/2$, the maximum O_2 transport rate could not be more than 2^2 times the unaided transport rate for equal O_2 gradients.

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EFFECT OF NAPHTHALENE AND ENDOGENOUS FACTORS ON OXYGEN CONSUMPTION IN *NEOMYSIS AMERICANA*. R.L. Smith and B.R. Hargreaves. Lehigh University, Bethlehem, PA.

Oxygen uptake ($\dot{V}O_2$) of individual mysids was measured in a novel continuous flow respirometer for 24 h periods, and in a sealed chamber respirometer for several hours. Mysids were acclimated 30-100 d under conditions which allow complete life-cycle cultivation. $\dot{V}O_2$ was normalized for animal size using an unconventional linear regression: $\log(\dot{V}O_2)$ vs $\log(\text{body water})$. Compared to the conventional regression, $\log(\dot{V}O_2)$ vs $\log(\text{body mass})$, the new approach showed two advantages: significantly greater coefficient of determination, r^2 , and removal of differences in $\dot{V}O_2$ between sexes. In contrast to the sealed chamber method, continuous flow respirometry yielded hourly minimum and maximum $\dot{V}O_2$'s; minima were lower than mean values from sealed chamber experiments, providing better estimates of standard metabolic rate. Hourly data also showed a daily cycle when adjusted to represent a standard size animal. Exposure to ca. 1 mg/l naphthalene increased $\dot{V}O_2$ and apparent metabolic scope for activity (maxima-minima); exposure to ca. 0.1 mg/l naphthalene depressed metabolic scope. Both exposures caused aberrations in the daily cycle.

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PROTECTION AGAINST PHOTOSYNTHETIC OXYGEN BY ANIMALS CONTAINING ENDOSYMBIOTIC ALGAE. J.A. Dykens and J.M. Shick. Dept. of Zoology, Univ. of Maine, Orono.

The net production of O_2 in the west coast sea anemone *Anthopleura elegantissima* declines just at noon due to anemone contraction. This behavior is modulated by both photosynthetically produced O_2 as well as ultra-violet light. Filtering out U.V. light or inhibiting photosynthesis with DCMU inhibits anemone contraction. Elevating PO_2 causes immediate contraction when anemones are in sunlight but not when in shade. This anemone attaches sand and shell debris to the body column which not only decreases desiccation during air exposure, but also acts as a sun screen. Anemones attach more sand when exposed to either sunlight or elevated PO_2 in darkness than animals protected from U.V. or with photosynthesis blocked by DCMU. Levels of the protective enzymes superoxide dismutase (SOD) and catalase show regional differences with the aposymbiotic pedal disk containing less than the body column or tentacles. These differences are also seen in the bivalve *Tridacna squamosa* where tissues further removed in the circulatory path from the site of O_2 production contain diminishing amounts of SOD and catalase.

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POST-METAMORPHIC PHYSIOLOGICAL CHANGE IN RELATION TO ANURAN LIFE HISTORIES. F. Harvey Pough and Suzanne Kamel.

Cornell Univ., Ithaca, N.Y., and The Univ. of Chicago, Ill.

We tested the hypothesis that the magnitude of post-metamorphic change in anuran metabolism is related inversely to the duration of the tadpole stage and directly to the amount of post-metamorphic growth. American toads (*Bufo americanus*) spend approximately 8 weeks as tadpoles and increase in mass 2000-fold between metamorphosis and adulthood. Wood frogs (*Rana sylvatica*) spend 10 weeks as tadpoles and adults are 300 times the mass of newly-transformed individuals. Green frogs (*Rana clamitans*) may require a year to complete larval development, and adults are only 20 times the size of just-metamorphosed frogs. As predicted, toads and wood frogs show steep increases in mass-specific rates of exercise oxygen consumption in developmental stages 24 and 25, whereas green frogs do not. Allometric changes in resting metabolism during the day and night, endurance, hematocrit, hemoglobin concentration, and heart mass also differ among species, but not all show a clear relationship to organismal performance. (Supported by Federal Hatch Funds from the New York State Agricultural Experiment Station.)

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ENERGETIC IMPLICATIONS OF WIDELY FORAGING PREDATION IN CNEMIDOPHORUS. R.A. Anderson and W.H. Karasov. Dept. of Biology and Dept. of Physiology, U.C.L.A.

Doubly labeled water measurements of field metabolic rate (FMR) and water influx were made in two species of *Cnemidophorus* (*tigris* and *hyperythrus*) in three habitats in the Southwest. The FMR's of these widely foraging lizards (360-570 $J g^{-0.8} d^{-1}$) are 60-150% greater than the FMR's of wait-and-ambush iguanid lizards. This increased FMR is not due to differences in resting metabolism, field body temperature, or daily activity period length but relates to the higher activity costs of *Cnemidophorus*. While these lizards have high rates of energy expenditure, they also have high rates of energy intake. This is reflected by the water influx rates of *Cnemidophorus* (64-134 $\mu l g^{-0.8} d^{-1}$) which are 120-350% greater than those of iguanid lizards. Higher net rates of energy intake (intake minus expenditure) might also result in higher instantaneous rates of growth and reproduction in *Cnemidophorus*.

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ENERGETICS AND ADAPTIVE STRATEGIES OF TAIL REGENERATION AND REPRODUCTION IN TWO SYMPATRIC GECKOS. H. Y. Cheng. Tulane Univ., New Orleans, La.

Occurrence of tail loss is very high (>90%) in both species of *Sphaerodactylus* geckos, *S. clenchi* and an undescribed species, in Hispaniola. Both species are continuous breeders, lay a single egg per clutch and two to four clutches per year. (4- α)-leucine is used as a tracer and the relatively incorporation into protein is used to indicate the relative amount of output. The results show that in case of tail loss, *S. clenchi* will shunt its main effort to tail regeneration but the undescribed species will still keep its main effort to reproduction. The undescribed species appears to be more adaptive than *S. clenchi* as long as the food availability is sufficient for both species. However, natural selection will favor *S. clenchi* as the food availability is low.

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CONTRACTILE AND ULTRASTRUCTURAL PROPERTIES OF RED AND WHITE LIZARD MUSCLE. T. T. Gleeson and I. A. Johnston. Univ. of Colorado, Boulder, and Univ. of St. Andrews, Scotland.

The iliofibularis (IF) muscle is composed of both oxidative (red) and glycolytic (white) fiber type regions. Single fibers were isolated from each region, chemically skinned, and maximum Ca^{++} -activated force development (P_0) and unloaded contraction velocity (V_{max}) measured at 40°C. The IF was also fixed *in situ* and prepared for electron microscopy for determination of capillary and mitochondrial densities. V_{max} of white fibers were twice that of red fibers (16 vs 7 $\text{lo}\cdot\text{s}^{-1}$) while P_0 of all fibers were similar ($\approx 32 \text{ N}\cdot\text{cm}^{-2}$). Mitochondrial volume densities were similar to those of mammals (lizard red, 7.6%; white, 3.8%) although capillary densities were lower (lizard red, 621 mm^{-2} ; white, 71 mm^{-2}). Theoretical diffusion distances for oxygen in red muscle were 1/3 that in white muscle. White fibers appear to be adapted for anaerobically supported burst activity, while red fibers are adapted for aerobic, slow movements. Supported by NSF, NIH and NERC grants.

617

INFLUENCE OF MUSCLE TEMPERATURE ON LOCOMOTORY PERFORMANCE. L.C. Rome. Harvard Med. Schl., Boston.

A theory has been developed to explain how the large temperature dependence of the mechanics and energetics found in isolated muscle ($Q_{10} = 2-3$)¹ affect locomotion with varying muscle temps. In submaximal performance, such as walking in lizards, both the energetic cost and stride frequency are independent of muscle temp. Electromyography on swimming carp have suggested that motor units are recruited in the same order at low and high temps, but that the order is "compressed" into a more narrow speed range at low temps.³ Hence, at low temps, animals use more muscle fibers which include faster fiber types, thus enabling them to maintain their energetics and mechanics independent of muscle temp. During maximal performance, however, such as a frog jumping, all the muscle fibers are used, thus precluding differential fiber recruitment. Power output during jumps, therefore has a similar temperature dependence ($Q_{10} = 2.7$) as isolated muscle.⁴

- 1) Rome & Kushmerick 1983 AJP244C 100-9.
- 2) Rome 1982 J Exp Biol 97:411-426.
- 3) Rome & Loughna 1983 Fed Proc 42(3):469.
- 4) Hirano & Rome J Exp Biol (in Press).

618

CONSEQUENCES OF AERIAL RESPIRATION FOR ANURAN LARVAE. M.E. Feder, The University of Chicago, Chicago.

Although air breathing is assumed to be advantageous for amphibious vertebrates, seldom are these advantages examined explicitly. Work on anuran larvae in my laboratory has shown that air breathing may seldom be advantageous in general and is sometimes disadvantageous: Air breathing increases stamina in some species, but decreases stamina in others due to its interaction with buoyancy. Encounters between tadpoles and their predators may seldom be sufficiently prolonged to improve survivorship. Air breathing may attract predators and is energetically expensive; growth rates of tadpoles are inversely related to the cost of breathing air. Air breathing may promote tolerance of hypoxic water, but some lungless species tolerate hypoxia well. These observations suggest that a general explanation for the widespread occurrence of air breathing in anuran larvae is yet forthcoming, and that examinations of adaptive significance necessitate measurements of organismal performance and natural environments.

Supported by NSF 78-23896.

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FUNCTIONAL CONFLICTS BETWEEN FEEDING AND GAS EXCHANGE IN SUSPENSION-FEEDING TADPOLES OF *XENOPUS LAEVIS*. M.E. Feder, D.B. Seale, M.E. Boraas*, R.J. Wassersug, and A.G. Gibbs*. The Univ. of Chicago, Center for Great Lakes Studies, Univ. of Wisconsin-Milwaukee, and Dalhousie Univ., Halifax, Nova Scotia.

Air-breathing larvae of *Xenopus laevis* (Amphibia: Anura) use buccopharyngeal surfaces for both gas exchange and capture of food particles suspended in the water. These functions may conflict: tadpoles may clog these surfaces with food and mucus when feeding, and decrease buccopharyngeal ventilation in dense food suspensions. Pulmonary respiration may permit the buccopharyngeal surfaces to be used primarily for food entrapment. In dense yeast suspensions, tadpoles increase rates of air breathing. This increase is not due to any increased metabolic requirement. Conversely, if air breathing is prevented, tadpoles evidently use the buccopharyngeal surfaces for gas exchange at the expense of ingestion. Exclusively water-breathing larvae in hypoxic water ingest significantly less algae than air-breathing tadpoles, even though the former increase buccopharyngeal ventilation.

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ENERGETICS OF VOCALIZATION BY AN ANURAN AMPHIBIAN (Hyla versicolor). T. L. Taigen and K. D. Wells. Univ. of Conn. Storrs.

The metabolic requirements of vocalization by Hyla versicolor were determined by measuring oxygen consumption and whole body lactate content of calling animals. Call rate (calls/h) and call duration (msec/call) are both significant determinants of aerobic metabolism during calling, accounting for 84% of the total variation in oxygen consumption of calling frogs. Aerobic metabolism increased linearly with call rate and call duration, reaching a peak value of $1.7 \text{ cm}^3 \text{ O}_2/(\text{g}\cdot\text{h})$ at 20°C . Whole body lactate levels of unrestrained frogs in a large chorus decreased significantly during 1.5 h of continuous calling. Hence, there appears to be no anaerobic contribution to vocalization at steady-state, although lactate levels may be slightly elevated at the onset of an evening of calling. Calling rates of frogs in a chorus increased gradually from an initial mean value of 500 calls/h (at 2030 h) to nearly 1400 calls/h (at 2100 h). These data indicate that acoustic advertisement by Hyla versicolor is one of the most energetically expensive activities regularly undertaken by an anuran, and indeed, is one of the most demanding ever measured in an ectothermic vertebrate.

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THE EFFECT OF DEPRIVATIONS ON FEEDING PATTERNS IN BLACK-CAPPED CHICKADEES (Parus atricapillus). C.P.L. Barkan. SUNY Albany.

As part of a study investigating the relationship between meal patterning and optimal foraging theory, research is being conducted on feeding patterns of Black capped Chickadees. Chickadees deprived of food for periods up to an hour were able to compensate completely for this loss by an immediate post deprivation increase in feeding rate. Deprivations longer than one hour resulted in a high initial post deprivation feeding rate which was insufficient to make up for missed food. Following this initial high rate, they assumed an intake rate similar to that observed under nondeprived conditions. Although these birds were unable to immediately make up for missed food, they were able to compensate almost entirely by increasing intake on the day following the deprivation. These results implicate two different regulatory processes governing feeding rate. One process, responding to small, short term fluctuations in food intake rate, results in an immediate compensation in the form of larger meal size immediately following the deprivation. The other process responds to larger fluctuations and results in a delayed response in the form of an increased feeding rate throughout the following day.

622

FIELD METABOLIC RATES AND WATER TURNOVER IN TWO HAWAIIAN SEABIRDS. H.I. Ellis, T.N. Pettit and G.C. Whittow. Univ. of San Diego, CA and Univ. of Hawaii Medical School, Honolulu.

Nine Brown Noddies (Anous stolidus) and ten Wedge-tailed Shearwaters (Puffinus pacificus) were studied using a doubly-labeled water technique on Tern Island in the Northwestern Hawaiian chain. Total body water of both species averaged 65% using oxygen dilution space. Wedge-tailed Shearwaters lost an average of 0.33% of their initial body weight (384g) per day, whereas the smaller (194g) Brown Noddies lost 1.82% da. Average field metabolic rate (FMR) of Wedge-tailed Shearwaters was $2.62 \text{ ml CO}_2/\text{g}\cdot\text{hr}$ (=613.7 kJ/da); for Brown Noddies, average field metabolic rate was $3.03 \text{ ml CO}_2/\text{g}\cdot\text{hr}$ (=352.2 kJ/da). Comparisons are made of FMR between these species and other seabirds. (Supported by Sea Grant NI/R-15.)

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REGULATION OF REPRODUCTIVE RESTLESSNESS IN THE SPINY LOBSTER PANULIRUS ARGUS.

R. N. Lipcius.

Florida State Univ. and Florida A & M Univ., Tallahassee.

The adaptive significance and control of the timing of mating behavior have been inferred repeatedly by noting the accurate correspondence between precise organismal rhythms and cyclic environmental factors; temporal variability has seldom been examined as a potential adaptation. Thus, I quantified diel laboratory patterns of the spiny lobster frontal approach, a naturally occurring courtship act that follows mate searching and has been observed in nature only once. The data indicate that (1) photoperiod is at least corequisite to temperature in timing the onset and increasing the frequency of mating behavior, and (2) the reproductive process incorporates potentially adaptive plasticity in the daily timing of mating behaviors, as reflected in a protracted state of reproductive restlessness that is adjusted to patterns of female residency and movement, physiological limitations, and the distribution of critical resources.

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AN ANALYSIS OF DISPLAYS OF FECUNDITY AS A FUNCTION OF CRUSTACEAN SIZE.

A. M. Wenner, D. Hubbard*, J. Shoffner*, and K. JeIlison*. University of California, Santa Barbara.

Fecundity has been plotted as a function of size in any one of four manners: linear, semi-log, full log, or as a function of cube of length or width. When analyzing sand crab (*Emerita analoga*) data, we gained additional insight as to the relationship between size and fecundity by separating size frequency distributions into modal size classes before calculating regressions. Each of the sub-plots had approximately as high a correlation coefficient as that found for the entire set of values, despite the shorter span involved, and the fit of the line for each of the sub-plots was generally better than for the data as a whole. It also became apparent during the data analysis that each of the four manners of data display facilitated our understanding of the relationship in one way or another; which manner was best varied somewhat with location and date. The modal separation technique also permitted a better recognition of seasonal variation in fecundity.

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ULTRASTRUCTURE OF THE SPERM OF THE SPANISH LOBSTER, *SCYLLARUS CHACEI*. C.E. McKnight and G.W. Hirsch, Univ. So. Florida, Tampa, Florida.

The stellate sperm of *Scyllarus chacei* are characteristic of many reptantian decapods. It consists of a central cell body 4-5 μ m in diameter with multiple arms measuring 10-12 μ m in length. The acrosome and nucleus are at opposite ends of the cell body with a cytoplasmic area containing a lamellar complex derived from the endoplasmic reticulum and mitochondria. A few intact mitochondria and microtubules are also present. The nuclear envelope is folded and irregular. The chromatin is extremely diffuse. The radial arms are extensions of the cytoplasm. Microtubules extend the length of the arms. The acrosome is PAS positive and possesses a complex substructure consisting of 40 fin-like projections which arise from a central core. The sperm in the tests are immature. Spermiogenesis is completed in the anterior vas deferens. During the maturation process, the sperm become encapsulated in spermatophores of approximately 100 sperm each. Various stages during the development of the sperm will be discussed.

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THE EXISTENCE OF A WATER-BORNE MALE ATTRACTANT SECRETED BY RECEPTIVE FEMALES OF THE AMPHIPOD CRUSTACEAN *MICROEUTOPIUS GRYLLOTALPA* (COSTA). B. Borowsky, Osborn Laboratories of Marine Sciences, Brooklyn, New York 11224

Males of the tube-building amphipod *M. gryllotalpa* cruise from tube to tube, testing the nature of each occupant until they find a receptive female. They also share the receptive female's tube until copulation occurs. It was hypothesized that a water-borne chemical attractant secreted by receptive females might serve to guide males specifically to their tubes. A choice-test apparatus, designed to mimic field conditions, was employed to test this hypothesis. The results demonstrated that receptive females do secrete a male attractant, but males and non-receptive females do not. Other experiments demonstrated that the attractant remains potent for at least 1.9 hours, but does not, by itself, stimulate the males' courtship behavior.

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COURTSHIP AND SEXUAL SELECTION IN *CATALEPTODIUS FLORIDANUS*, A SHALLOW WATER CARIBBEAN XANTHID CRAB. N.A. Engstrom. Northern Illinois Univ., DeKalb, Illinois.

Cataleptodius floridanus is an abundant, herbivorous, territorial crab species in coral rubble habitats throughout the Caribbean. The dense population studied on Long Cay, Glover's Reef atoll, Belize, Central America, is concentrated in the extreme low intertidal zone. Competition for territories is determined mainly by size with large individuals dominating smaller ones. Sexual dimorphism prevails and males grow larger than females. Large males tolerate the presence of smaller females but exclude smaller males. Thus, every summer from 1979-83 females outnumbered males 3:1 in the favored habitat. Courtship consists of a male stalking, capturing and subduing a female. Females resist capture and break away from males except those substantially larger than themselves. Therefore, only large males reproduce.

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MORPHOLOGICAL VARIABILITY IN THE ZOEAL STAGES OF THE SARGASSUM CRAB, PORTUNUS SAYI. Isabelle P. Williams. Woods Hole Oceanographic Institution, Wood Hole, Ma.

Larvae from three female Portunus sayi (Gibbes) were reared in the laboratory at 35% and 25°C. Survival of 1st stage zoeae to megalops was 15-25%; 10-15% survived to the 1st crab stage.

Setal counts on all appendages vary widely among individuals of the same stage often overlapping with adjacent stages and vary even by left-right asymmetries within single individuals. The usefulness of setal counts to distinguish stages or species is thus limited.

The number of zoeal intermolts in Portunus sayi, usually 8, varies from 6 to possibly 9 or 10 due to the omission or duplication of morphological stages. The morphology of the intermolts also varies due to the occurrence of "combined forms" possessing the characteristics of adjacent stages. Zoeal variations in number and morphology occur between the 4th and 7th stages. The data show an increase in survival in the 4th to 7th stages that is directly proportional to morphological variation.

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EFFECTS OF DIURNAL VERTICAL DISTRIBUTION AND PATCHINESS OF DECAPOD LARVAE ON DISPERSAL ALONG THE INNER CONTINENTAL SHELF OF VIRGINIA. R. C. Maris and J. R. McConaughy. Old Dominion Univ., Norfolk.

Vertical distribution and effects of patchiness of decapod larvae were studied from samples collected at a single station located 18km off the Virginia coast, by the Chesapeake Light Tower (35°54.3'N, 75°42.8'W). Neuston, 1m, 3m, 8m and epibenthic (11m) plankton samples were collected at two hour intervals for 30 hrs on 5-6 Sept. 1980. Callinectes sapidus dominated the collections, and all stages were distributed mainly in the upper 3m, but large temporal variations were noted. Horizontal drifting of larval patches likely occurred, because no vertical movements were evident. Mechanisms causing aggregations of larvae must play vital roles in dispersal patterns. Larvae of Cancer irroratus and Portunus spp. were also found mainly at the surface, which aids in long range dispersal. Abundances of larvae near the bottom were found for Pagurus spp., and other anomurans, Uca spp., Libinia spp., and various xanthid crabs. Congregations near the bottom may help in larval retention near estuarine or shelf areas. This work was supported by the Office of Sea Grant, NOAA.

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THE FIRST ZOEAL STAGE OF A HYDROTHERMAL VENT CRAB (CRUSTACEA: DECAPODA: BYTHOGRAEIDAE). Cindy Lee Van Dover* Austin B. Williams and Jan Robert Factor. Univ. of California, Los Angeles; National Marine Fisheries Service, Systematics Laboratory, National Museum of Natural History, Washington, D.C.; and State Univ. of New York, Purchase.

The first zoeal stage of a bythograeid crab is described. The zoea has numerous distinctive features which set it apart from all other known brachyuran larvae. These include the ornamentation of the carapace, abdomen, and telson, as well as details of the appendages. The zoeal morphology supports Williams' (1980) establishment of the Superfamily Bythograeioidea.

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CORRELATION OF METABOLIC VARIATIONS WITH MOLT CYCLE IN JUVENILE ALASKAN KING CRAB T. C. Shirley. Univ. of Alaska, Juneau.

Respiration rate, ammonia and primary amine excretion rates and wet weight were measured for 80 juvenile (\bar{X} =22.4 g wet wt.) Paralithodes camtschatica at weekly intervals for 11 weeks and analyzed with respect to day of molt cycle. The same measurements were made on another group of 75 crabs for 5 weeks. Metabolic measurements were made in a flow-through system maintained at 10 C and 30 ppt salinity under a natural photoperiod. Ammonia and primary amine excretion rates had a significant 25 fold decrease immediately postecdysis and gradually returned to intermolt rates in 10 days. Weight-adjusted oxygen consumption rates also decreased immediately postecdysis but could be partially explained by 15% increases in percent body water that accompanied ecdysis. O:N ratios increased significantly, up to 8 fold, for the five day postecdysial period. Caution is advised in the use of O:N ratios in assessing stress in frequently molting crustaceans. Funded by Outer Continental Shelf Environmental Assessment Program.

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ACTIN LOCALIZATION IN THE AMOEBO-FLAG-ELLATE STAGE OF MYXOMYCETES. S.E. DuBois and R.W. Scheetz. Univ. of Southern Mississippi, Hattiesburg.

Actin was localized in the flagellate stage of Myxomycetes using the fluorescent probe nitrobenzo-oxadiazole-phalloidin (NBD-Ph). The posterior region of all cells examined fluoresced when treated with the probe. The anterior region encompassing the basal bodies and nucleus showed little or no fluorescence. Presence of actin was confirmed using a KI extractant control. Disrupted negatively stained preparations viewed in the TEM revealed an organized filamentous network that bound heavy meromyosin yielding typical arrowhead-decorated filaments. Spores possessed intense fluorescent foci when stained with NBD-Ph. Fluorescence was lacking in unstained controls or controls extracted with KI. Germinating spores lost the discrete foci and showed no fluorescence once protoplast emerged. Actin aggregates in the dormant spore disperse during germination. The actin enriched posterior region of swarm cells may function in pinocytosis and phagocytosis.

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AGE-RELATED, NON-LINEAR INCREASE OF SUBCUTICULAR AUTOFLUORESCENT GRANULES IN A FRESHWATER GASTROTRICH (LEPIDODERMELLA SQUAMMATA). M.R. Hummon, Ohio Univ., Athens

Living animals were examined with epifluorescence microscopy at 5 life stages (n=3 to 9; parthenogenic reproduction completed by 3d; \bar{x} lifespan, 14-22 days). Negatives from timed exposures of blue autofluorescence (AF) (exciter filters 355-425 nm, barrier filter 460 nm) were evaluated on an ordinal scale. Post-hatch juveniles exhibited AF only in gut contents and edges of the cuticular scales. By 1d, distinct AF granules occurred near the center of scales of the dorsal head and neck. By 2 and 3d, accumulations of granules under single scales were larger, and some AF granules appeared under scales of the abdomen. Older animals (≥ 17 d) showed only slight further increase in AF granules. Thus, most increase occurred during the period of parthenogenic egg formation rather than in the latter part of the life cycle. TEM images show osmiophilic granules in accumulations up to 2x3 μ m, located between the cuticle and the epidermis. Rarely, granules were seen within the epidermis, but their etiology was not evident. The autofluorescence and fine structure of the granules suggest that they may be aging pigment, or lipofuscin.

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SECRETORY CELL ACTIVITY IN HYDRA AFTER FEEDING. I. Kessler. College of Saint Elizabeth, Convent Station, New Jersey.

Daily feeding of Hydra sets up a regular pattern of secretory cell depletion and replacement. At various time intervals after feeding Hydra were fixed for histological study. The relative position, population size and number of dividing cells were determined for each stage after staining in Alcian Blue. The mature cell population discharged rapidly during the first hour after feeding and was replaced between 5 and 7 hours. All stages of secretory cell development were observed undergoing mitosis. The peak of mitotic activity was between 18 and 20 hours, too late to make a significant contribution to replacement. Very few secretory cells were observed "lost" into the gastrovascular cavity. The population dynamics, as studied here, indicate re-synthesis over cell loss and replacement as the main developmental pathway during secretory cell activity after feeding. Cell replacement through mitosis provides for growth and maintenance of a steady state balancing a small cell loss.

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THE POLYMORPHIC SPERMATOOZOA OF A MARINE SNAIL, FUSITRITON OREGONENSIS, PROVIDE USEFUL MODELS FOR STUDYING CELLULAR MORPHOGENESIS. John Buckland-Nicks and Fu-Shiang Chia. Univ. of Alberta, Edmonton, Canada.

Sperm polymorphism has been studied in the Oregon whelk, Fusitriton oregonensis with light and electron microscopy. The males consistently produce three types of sperm: Viable eupyrene sperm that fertilize the eggs; apyrene carrier sperm that transport fifty or more eupyrene sperm; and apyrene lancet sperm that induce sperm segregation in the female bursa.

Both apyrene sperm develop from spermatogonia that have irregular, swollen nuclei and small mitochondria, but even at this stage it is possible to detect differences between them. Their subsequent development involves a number of important cellular events, which make them useful as models for studying cellular morphogenesis in general: 1. Flagellogenesis - multiple centrioles are generated from fibrogranular precursors in the cytoplasm, either by "de novo" synthesis, or in conjunction with a parent centriole; 2. Depolymerization of DNA - the nucleus forms a number of discrete vesicles, which are broken down by secretions from Golgi bodies and/or endoplasmic reticulum; 3. Yolk bodies, granular vesicles and dense bodies form in the cytoplasm as the nuclear vesicles degenerate; 4. Granular vesicles and dense bodies pass out of the sperm by exocytosis.

Since individual sperm can be obtained from the testis (immature) or seminal vesicles (mature), it should be possible to study these cellular events in great detail, using techniques such as video-enhanced contrast microscopy, monoclonal antibodies, autoradiography and cytochemistry. Supported by an NSERC of Canada grant to F.-S.C.

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JH-DEPENDENT FORMATION OF ENDOCYTOTIC ORGANELLES AND LIGAND-DEPENDENT STIMULATION OF THE VITELLOGENIN-ACCUMULATIVE PATHWAY IN MOSQUITO OOCYTES. A.S. Raikhel* and A.O. Lea. Univ. of Georgia, Athens.

We found that at eclosion the oocytes of Aedes aegypti lacked coated vesicles and were not competent to internalize proteins. Horseradish peroxidase (HRP), injected at eclosion, reached the oocyte surface but was not internalized. During normal previtellogenic development, the oocytes produced many coated vesicles and within 3 days were competent to sequester proteins. The production of coated vesicles was blocked by allatectomy at eclosion and stimulated, in allatectomized females, by implantation of CA. *In vivo* studies demonstrated that in competent, non-vitellogenic oocytes, both vitellogenin (VG) and a non-specific protein, HRP were internalized but followed either a specific VG-accumulative route or a common degradative route. The factor that directed both VG and HRP to the VG-accumulative route was VG itself; in the absence of VG, HRP entered the degradative route. We characterized the VG-accumulative route by EM immunocytochemistry with anti-VG-antibody and the degradative route by tracer visualization. (Supported by NIH grant AI-17297).

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SENSITIVITY OF THE CORTICAL REACTION TO CYTOCHALASIN B IN EGGS OF BRACHYDANIO. M.J. Donovan* AND N.H. Hart

Rutgers University, New Brunswick, N.J.

Previous studies have shown that the cortical reaction in B. rerio includes the exocytosis of cortical granules and the retrieval of membrane from the egg surface. Experiments were undertaken to determine the response of these membrane-related events to cytochalasin B (CB). Eggs exposed to selected concentrations of CB with and without preincubation showed cortical granule exocytosis in the normal time frame. SEM study of CB-treated egg surfaces during the cortical reaction revealed the abnormal persistence of cortical crypts and extensive membranous patches at sites of exocytosis, suggesting that the drug impedes membrane recovery. TEM of the cortices of such cells showed apparent reduction in coated vesicles and fewer multivesicular bodies. To further support the CB-sensitivity of membrane retrieval, eggs were preincubated in CB and ³H-sucrose (0.5 uCi) for 15 mins. and then activated. A significant reduction in label uptake was obtained. These observations suggest that a contractile mechanism is involved in reorganizational movements of the "later phase" of the cortical reaction. (Busch Fund Supported).

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THE EFFECTS OF A23187 UPON CORTICAL GRANULE EXOCYTOSIS IN BRACHYDANIO EGGS. M.E. Schalkoff and N.H. Hart

Rutgers University, New Brunswick, N.J.

The divalent ionophore A23187 has been used to examine the effects and mode of action of calcium in unactivated eggs of Brachydanio rerio. Eggs treated with either a 1 uM or a 10 uM bath of A23187 in a calcium-containing Fish Ringer's Solution were induced to undergo an exocytosis of cortical granules. Eggs bathed in a calcium-free ionophore solution also exhibited exocytosis, suggesting that this secretory event occurs independently of extracellular calcium. Disturbances in the surface morphology of ionophore-activated cells were frequently observed, including the disappearance of micropliae and the formation of membrane-limited blebs. TEM sections through the cortices of ionophore-activated eggs revealed an electron-dense layer subjacent to the blebs. To determine whether cortical granule exocytosis was self-propagating once initiated, A23187 was delivered to a restricted portion of the egg surface using either an ionophore-coated Sephadex bead or a glass capillary tube. Virtually all cells placed in contact with the ionophore-coated glass tube exhibited exocytosis restricted to the area of stimulation. (Busch Fund Supported)

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INITIAL CONTACT AND FUSION OF NEURAL FOLDS IN THE CEPHALIC REGION OF THE CHICK. M.C. KOSCIUK*, M.F. KERESZTURY*, R.G. NAGELE*, and H. LEE. Rutgers Univ., and UMDNJ-N.J. School of Osteopathic Med., Camden, N.J.

In the midbrain region where fusion of the neural folds is about to occur, cells forming the prospective fusion area differ from the remainder of neuroepithelial cells in that they are cuboidal, have relatively smooth apical surfaces, and contain irregularly shaped nuclei. Once contact of the neural folds is made, cells in the fusion area become organized into a wedge-shaped mass consisting of presumptive neural crest cells. Shortly thereafter, the surface ectoderm forms a continuous layer. As neurulation proceeds, the size of the wedge-shaped mass gradually diminishes, and neuroepithelial cells from the two leading edges eventually establish an interdigitation of cytoplasmic extensions and develop junctions on apposed cell surfaces in the midbrain and more caudal regions. Microfilaments are organized into prominent bundles and associated with the developing junctions prior to fusion. After completion of neural tube closure, microfilament bundles along with actin- and myosin-specific fluorescence become inconspicuous.

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YOU CAN'T TELL A BRITTLESTAR BY ITS COLOR. G. Hendler. Smithsonian Institution, Washington, D.C.

The ability of brittlestars to change color and color pattern on a diel schedule is reported for the first time. Individuals of the Ophiocoma species examined each possess a unique pigmentation pattern. During the day, O. wendti, O. paucigranulata, and O. echinata are dark reddish-brown, and largely pale-gray and black at night. Nocturnal colors accentuate patterns of banding and variegation that are masked during the day. Ophiocoma pumila does not change color. Ophiocoma wendti alters color gradually between 0500-0630 and 1600-1800 hrs. The transformation proceeds from the distal to proximal ends of the arms, and at different rates for different arms. Portions of arms and isolated arm plates undergo the same diel changes as whole O. wendti. Experiments in progress are designed to ascertain the significance of color change for the survival of brittlestars, and to determine whether color change is an endogenous rhythm or a function of ambient light levels.

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GRAZING ON GORGONIANS BY THE BUTTERFLY FISH CHAETODON CAPISTRATUS: MONTHLY VARIATION IN FEEDING PREFERENCES. H.R. Lasker. State University of New York, Buffalo.

C. capistratus regularly feed on polyps of gorgonian corals. In areas with dense and diverse gorgonian faunas C. capistratus display distinct species preferences. Examination of feeding in a 100m² study site in the San Blas Is., Panama indicated that Plexaura homomalla was the preferred prey, although P. homomalla was only the second most abundant species. Plexaura sp., the most common species, was disproportionately absent from C. capistratus' diet. However, the week following the full moon was characterized by a dramatic increase in feeding on Plexaura sp. Heavy feeding was restricted to several large colonies from which hundreds of polyps were removed. Switching prey preference to Plexaura sp. may correlate with a lunar reproductive cycle in Plexaura sp.

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PARTIAL PREDATION ON TROPICAL GORGONIANS: FORAGING BEHAVIOR OF CYPHOMA GIBBOSUM. C.D. Harvell* and T.H. Suchanek.

(Intro. by R.R. Strathmann). Univ. of Washington, Seattle and West Indies Lab, St. Croix, U.S.V.I.

Between colony movements and within colony distributions of marked Cyphoma gibbosum were studied on gorgonian dominated reefs at St. Croix, U.S.V.I. A striking aspect of Cyphoma foraging is the brief residence time of adult individuals on prey colonies. Mean residence time/colony averaged over all prey species was 3.4 days and varied as a function of predator age and prey type. The amount of damage sustained by a colony was dependent on prey identity, but was rarely extensive. Damage by Cyphoma mostly occurred in the upper half of colonies, although Cyphoma must always traverse basal colony regions prior to and following a feeding bout. These patterns of partial predation may be a consequence of intracolony variations in prey quality.

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FORAGING ECOLOGY OF HERBIVOROUS REEF FISHES IN MIXED-SPECIES GROUPS. Nancy G. Wolf. Woods Hole Oceanographic Institution, Woods Hole, MA.

Tagged parrotfish and surgeonfish spent more time feeding when in groups than when alone. Scarus iserti and Acanthurus bahianus ate more Ceramium nitens, a selected food, and less blue-green algae with sand, an avoided food, as group size increased. Some species changed diet in response to group composition. A. bahianus consumed less Ceramium as the proportion of parrotfishes increased. Sparisoma ate less Halimeda, a food that it selects but the other herbivores avoid, when the proportion of non-congeneric group members increased. Thus, fishes such as Sparisoma and Acanthurus experience some costs when in mixed groups, but can participate in larger groups with a concomitant increase in time devoted to foraging.

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SPATIAL ORGANIZATION AND REPRODUCTION OF A SEX-CHANGING FISH-AND-CRAB PREDATOR, THE RED HIND. D.Y. Shapiro & Y. Sadovy*. Univ. of Puerto Rico, Mayaguez, P.R.

Within a 100x100 m grid on a 10-m deep coral reef, 20 tagged individuals occupy home ranges of 86-4708 m². Home ranges are centered primarily around either of two concentration points, with home range of 8 or more individuals overlapping heavily at each point. Concentration points are being characterized to examine how the spatial distribution of home ranges influences the distribution of prey. Gonad sampling indicates that red hinds spawn primarily during one week of January each year, in mobile aggregations several miles offshore of the study grid. Existing ideas on sex change suggest (a) that ultimate reasons for changing sex relate to enhanced opportunity to reproduce on the spawning ground, and (b) that proximal causes of sex change concern alterations of behavioral interactions within the social system, not necessarily occurring at the time or place of spawning. The extent to which red hind spatial structure within the study grid maps onto the 6-day spawning aggregation is being investigated.

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CHANGES IN REEF FISH POPULATIONS AT LOOE KEY NATIONAL MARINE SANCTUARY. J. A. Bohnsack. Univ. of Miami.

This study examines the changes in reef fish populations at Looe Key National Marine Sanctuary, Florida Keys, following the prohibition of spearfishing in 1980. Visual fish surveys conducted prior to sanctuary establishment showed significantly smaller piscivorous predator populations, significant differences in prey species composition, and significant differences in predator composition compared to control reefs (Molasses and French Reefs) in the Key Largo Coral Reef Sanctuary which had been protected from spearfishing since 1960. Most predator populations significantly increased after the spearfishing ban although some population levels remain well below those on control reefs. Results show the resiliency of certain reef fish species to reduced harvesting pressures.

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FISH GRAZING AND DIVERSITY OF ALGAE: INTERMEDIATE DISTURBANCE ON HAWAIIAN REEFS. M.A. Hixon and W.N. Brostoff. Univ. of California, Irvine, and Univ. of Hawaii.

On tropical reefs, intense grazing by schooling fishes is known to result in most exposed coral-rock surfaces being covered by crustose coralline algae. Identical substrates within damselfish territories, however, are dominated by mats of filamentous algae. To test the effects of various levels of fish grazing intensity upon local algal diversity, 63 coral-rock and PVC-plastic settling plates were sampled after a one-year exposure to three separate field treatments: exposed outside damselfish territories (high), exposed inside territories (intermediate), and within fish-exclusion cages (low intensity), including appropriate cage controls. Although algal biomass varied inversely with grazing intensity, the substrates exposed inside territories showed the greatest diversity of algal species. These results suggest that territorial damselfishes can act as "keystone species" by their ability to enhance local reef diversity through "intermediate-disturbance" effects. Unlike previously described keystone species, however, damselfishes enhance prey diversity by decreasing rather than increasing overall predation intensity relative to areas where they are absent.

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HERBIVORE DIETARY SELECTIVITY AND ALGAL PALATABILITY ON A JAMAICAN CORAL REEF. D.E. Morrison and G.P. Schmalz*. University of Georgia, Athens.

Field dietary selectivity of the dominant shallow and deeper water herbivorous fishes, the parrotfishes *Scarus croicensis-taeniopterus* complex and *Sparisoma atomarium*, respectively, on a coral reef at Discovery Bay Jamaica was investigated by *in situ* observations of foraging activity. Preliminary results indicate that both fishes feed selectively. The most abundant item in the diet of *S. croicensis-taeniopterus* is filamentous algae, while *Halimeda*, an articulated calcareous alga, is the most common item in *S. atomarium*'s diet. Both species avoid *Lobophora*, the most abundant macroalga on the reef. The palatability of the dominant reef macroalgae to other herbivorous fishes and the sea urchin *Diadema antillarum* was also assessed *in situ*. Shallow water fishes consumed *Dictyota*, but not *Lobophora* or *Halimeda*. *Laurencia* was the only alga tested that was avoided by *Diadema*. Algal palatability to different herbivores will be discussed in relation to potential anti-herbivore defense mechanisms.

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THE EFFECTS OF HERBIVOROUS FISHES IN CARIBBEAN CORAL REEF COMMUNITIES.

S.M. Lewis, Duke University, Durham, N.C.

Several distinct herbivore groups contribute to the high grazing intensity characteristic of tropical reefs. The role of herbivorous fishes in the families Acanthuridae and Scaridae in determining the composition and relative abundances of algal and coral species within benthic communities was examined using experimental reduction of grazing pressure. In shallow back reef areas in Belize the benthic community was found to be dominated by a high diversity, low biomass algal turf. Relative abundances of macroalgal, algal turf and coral species were observed to remain relatively stable over several seasons. Reduced grazing intensity in herbivore exclusions rapidly and dramatically altered existing patterns of species abundances. Within exclusion treatments several macroalgal species exhibited significantly increased abundance through both vegetative growth and spore recruitment. Algal transplant studies suggest that these represent species which are highly preferred by herbivorous fishes. In addition, these studies demonstrate that grazing by herbivorous fishes is an important mediator of the competitive interactions between algae and scleractinian corals.

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THE LARVAL DEVELOPMENT OF KINBERGONUPHIS SIMONI (SANTOS, DAY AND RICE 1981) (POLYCHAETA: ONUPHIDAE) H.L. Hsieh and J.L. Simon. Univ. of South Florida, Tampa.

Development of *Kinbergonuphis simoni* was studied using SEM. Larvae are lecithotrophic and develop within the maternal tube. The egg coat is retained as the cuticle of the larva. Larval ciliation patterns differ markedly from those of typical planktonic trochophores. Setae first appear at the 3 setiger stage. The type and composition of setae change as segments are added. Larval setal types differ from those of adults. The external morphology of larvae resembles the adult form after 7 setigers. Larval jaws are shed at the 14-15 setiger stage, and are replaced by adult jaws. Both larval and adult jaws possess asymmetric maxillae. When larvae reach 16-20 setigers, they leave the maternal tubes and build their own tubes. The first pair of branchiae develop on the 9th setiger at 36-37 setiger stage. The features of development of this species are: (1) no planktonic larva, (2) larval jaws differ from those of the adult and are shed, (3) some setal types are present in larvae only.

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MORPHOMETRIC ANALYSIS OF THE GROWTH AND FORM OF AN ECHINOPLEUTEUS. L.R. McEdward. Univ. Washington, Seattle and Friday Harbor Laboratories.

Since the feeding mechanism of echinoid larvae results in a linear relationship between organismal clearance rates and ciliated band length, the geometry of larval growth determines the allometric scaling of feeding capability. Changes in size, shape, ciliated band length, arms, surface area and volume were measured during growth of the pluteus larva of *Dendraster excentricus*. Larval shape changes as new arm pairs grow. Larval size (length), increases hyperbolically during this period with an asymptote at the initiation of posterodorsal arm growth. Total arm length, band length, surface area and volume increase linearly throughout development. These shape changes result in increases in the band length per unit surface area and in the (size-independent) ratio of surface area to volume suggesting that growth of larval arms is an effective means of scaling feeding structures relative to body size.

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FUNCTIONAL DIFFERENCES IN FEEDING AND SWIMMING ACTIVITIES CORRELATED WITH CILIATION PATTERNS OF PLUTEUS LARVAE. H. Lee. Woods Hole Oceanogr. Inst., MA.

Pluteus larvae of *Strongylocentrotus drobachiensis* possess two patterns of ciliary arrangement: a) a convoluted band and b) epaulettes, transversely parallel rings. The convoluted band increases in length to the 8-armed (8-PL) stage, then decreases during resorption of larval tissue. Epaulettes are formed at the full 8-PL stage, and remain prominent during the onset of larval tissue resorption.

Filtration and swimming rates were determined over development at three food concentrations. Till the 8-PL stage, filtration rates increased with development and with decreasing food concentrations. Swimming rates were similar over different food concentrations and remained low till formation of epaulettes, then increased significantly. During larval tissue resorption, filtration rates decreased, while swimming rates remained high. Thus filtration rates are correlated with prominence of the convoluted band, and swimming rates with the epaulettes. Pattern in life history suggests early development of convoluted ciliary pattern for feeding and growth, and later development of epaulettes for increased swimming speeds prior to settlement.

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MECHANISMS OF RAPID MORPHOGENESIS DURING THE METAMORPHOSIS OF A MARINE BRYOZOAN.

C.G. Reed, Dartmouth College, Hanover, NH.

During the metamorphosis of marine bryozoans, a series of rapid morphogenetic movements internalize the ciliated larval epithelium and cover the metamorphosing larva with the presumptive adult epidermis. These movements have been examined by light and electron microscopy and analyzed by experimentation with cytochalasin B (CB) and $MgCl_2$ in the cellularioid *Bugula neritina*. Unlike most bryozoans, the adult epidermis is derived almost entirely from the internal sac in cellularioids. As the ciliated epithelium involutes, the pallial epithelium is gradually drawn out to cover the aboral hemisphere. After involution, the oral margin of the pallial epithelium constricts and the aboral hemisphere is pulled down against the everted sac. Ultrastructural and experimental evidence indicates that the constriction is due to the temporal alignment of CB-sensitive microfilaments 5.5 nm in diameter. The pallial epithelium adheres to the everted sac and contracts, pulling the sac epithelium up over the metamorphosing larva. The position and time of appearance of the microfilaments in a different region of the pallial epithelium supports the hypothesis that they generate the force for elevation of the sac epithelium.

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FURTHER STUDIES ON THE RELATIONSHIP BETWEEN GROWTH, DIFFERENTIATION AND DURATION OF LARVAL LIFE IN PROSOBRANCH GASTROPODS. J.A. Pechenik, G. Lima and R. Dobbertein. Tufts University, Medford, MA.

Larval dispersal potential is in part a function of the amount of time that metamorphosis can be delayed. Duration of planktonic life differs markedly both among and within species, and seems related to differences in rates of development. Individual larvae of *Crepidula fornicata* show a positive relationship between rates of growth (size, weight, protein content) and rates of morphological differentiation. They show an inverse relationship between rate of development (growth or differentiation) and duration of planktonic life. This relationship is apparent for larvae reared under a single temperature, different temperatures, and different food concentrations. In contrast, larvae of the teleplanic species *Cymatium parthenopeum* have a much greater capacity for delayed metamorphosis, and appear to cease growth during their trans-Atlantic transport. All results are consistent with the hypothesis that length of larval life is determined by the rate of development towards a preprogrammed end point. (Supported by NSF OCE-8121643 [J.P]).

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THE RELATIONSHIP BETWEEN PHOTOTAXIS AND METAMORPHIC COMPETENCE IN *PHESTILLA*.

M. G. Hadfield and S. E. Miller*, Kewalo Marine Lab, Univ. of Hawaii, Honolulu.

The percentage of larvae of the nudibranch *Phestilla sibogae* that is positively phototactic declines with larval age at about the same rate as the percentage that is metamorphically competent increases. To determine if positive phototaxis disappears with the onset of competence, sibling groups of larvae were tested daily from hatching through maximal competence for photopositive swimming in a half-blackened, elongate, horizontal chamber. Larvae in the dark and light halves were then separately exposed to metamorphic inducing conditions. The percentage of photopositive larvae declined from 99+ to less than 20 between 1 and 5 days after hatching, with the biggest change occurring between days 3 and 4. The biggest increase from pre-competence to competence also occurred between days 3 and 4. However, larvae from the dark and light halves tended to show similar percentages of metamorphosis at all stages. We thus conclude that the developmental changes in a larva that render it competent to metamorphic induction are not the same as those dictating the switch from photopositive to photonegative swimming.

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PRE-SETTLEMENT BEHAVIOR OF THE HAWAIIAN INTERTIDAL LIMPETS, *CELLANA EXARATA* AND *CELLANA SANDWICENSIS*. Gladys C. Corpuz. University of Hawaii, Honolulu.

Laboratory experiments were conducted on *Cellana exarata* and *C. sandwicensis* larvae to determine the effects of the incidence and direction of light source in 20-cm water columns and 0.8-cm horizontal vessels. The results suggest that settlement and metamorphosis near the water surface is pre-empted by the position of larvae near the water surface after metamorphic competence is achieved. Although metamorphically competent veligers of both species appear to have well-developed eyes, positional changes in the water column as a function of age is effected primarily by a negative geotactic response and secondarily by a positive phototactic response. These behavioral responses effectively bring the larvae near the water surface where settlement and metamorphosis occur. In the field, this behavior may facilitate the search of a suitable settlement site on the rocky intertidal, awash with well-aerated water. I thank Dr. Michael G. Hadfield for guidance and discussions on experimental design and Dr. John S. Stimson for statistical analyses of the data.

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DEPOSITION OF INCREMENTS IN THE STATOLITHS OF GASTROPOD LARVAE: EFFECTS OF ENVIRONMENTAL CONDITIONS. J. L. Bell. Univ. of Hawaii, Honolulu.

In gastropod larvae, the statolith, an integral part of the sensory apparatus of the statocyst, may provide accurate age and growth data for wild populations. Statoliths from laboratory cultured larvae demonstrated a one-to-one correspondence between increment number and age in days after hatching. Deposition of layers in the statolith was not influenced by feeding periods. Larvae fed every other day demonstrated the same daily layers as those fed every day. Furthermore, when larvae were reared in constant light or constant darkness, increments in the statoliths were indistinguishable or non-existent. Thus increments may be deposited in response to a daily stimulus, possibly the light-dark cycle. Statoliths now can be used to assess field growth rates with some confidence that increments are deposited daily and not in response to discrete feeding episodes. (Supported by Sigma Xi, Lerner-Gray Fund for Marine Research, and Hawaiian Malacological Society)

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CHANGES IN SECRETION RATES AND pH IN MALPIGHIAN TUBULES OF WATER BOATMEN (Cenocorixa blaisdelli H.) P.D. Cooper and G.G.E. Scudder*. Univ. of British Columbia, Vancouver, B.C.

Water boatmen (Cenocorixa sp.) inhabit saline lakes, which characteristically contain high concentrations of $\text{HCO}_3\text{-CO}_3$ with the pH of the lake often exceeding 9. Earlier work with the isolated 4-segmented tubules of C. bifida showed that during secretion of saline isosmotic with hemolymph, the pH would change from 7.1 to 8.2. We have found that this phenomenon is more general, also occurring in C. expleta and C. blaisdelli. By isolating various segments, the pH change, measured with both phenol red and pH sensitive microelectrodes, was found to occur only in the second segment of the four segmented Cenocorixa tubules. The change in pH only occurred following stimulation with cAMP; the associated increase in secretion rate was up to thirteen times the unstimulated rate. We believe that excretion of HCO_3 through this avenue aids in regulation of the hemolymph when inhabiting alkaline lakes.

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SPIN-LABELED AMILORIDE: A MARKER FOR THE LOCALIZATION OF THE AMILORIDE BINDING SITE IN SODIUM TRANSPORTING EPITHELIAL MEMBRANES. C. J. Costa, L. B. Kirschner, and E. J. Cragoe, Jr. Washington St. Univ., and Merck, Sharp and Dohme Research Lab., West Point, PA.

An electron spin-labeled derivative of amiloride (ASp) is detectable by electron paramagnetic resonance (EPR) at 10^{-6} M and the signal is linear with concentration. In frog skin, ASp (3×10^{-6} M) reduced short circuit current (SCC) by 85% within 20 min. SCC was restored in 45 min following removal of ASp. Membrane fractions obtained from homogenates of trout gill and kidney were resuspended in 5×10^{-6} M ASp. The EPR signal was damped most (indicating bound ASp) in the 10K x g fraction of both tissues. Less ASp binding was present in 27K x g and 100K x g fractions. Addition of excess amiloride (10^{-3} M) reversed the signal damping, especially by the 10K fraction. The binding constant of ASp for kidney membranes is 1.4×10^{-6} M. Membranes from trout skeletal muscle bound ASp but signal damping was not reversed by amiloride. ASp and EPR spectroscopy can be useful for identifying apical cell membranes in subcellular fractions. (Supported by NIH F32 AM06818 to CJC and NSF PCM 8003800 to LBJ).

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AN ANTIBODY AGAINST THE ORGANIC MATRIX OF GILL CALCIUM CONCRETIONS FROM THE FRESHWATER MUSSEL, LIGUMIA SUBROSTRATA, CROSS-REACTS WITH GILL CONCRETIONS OF OTHER UNIONID GENERA. H. Silverman, W.L. Steffens, and T.H. Dietz. Louisiana State Univ., Baton Rouge.

Previous work has indicated 25-30% of the gill dry weight in the freshwater mussel, Ligumia subrostrata is made up of calcium concretions. Similar appearing calcium concretions exist in numerous invertebrates. To determine if the organic matrix, serving as the framework of these concretions, is similar in different organisms, we prepared an antibody to this material for the gill of L. subrostrata. Isolated concretion material was decalcified by soaking in 0.1M succinic acid; the remaining material was injected into mice. Antibody containing serum was reacted against tissue sections from mussels of three different genera: Anodonta, Carunculina, and Ligumia. Indirect immunofluorescence was applied using a rabbit antimouse antibody conjugated to fluorescein. Antibody reacts with intact concretions in the gills of all animals tested. The organic matrix of the calcium concretions are antigenically similar in the mussels of the family Unionidae. Supported by NSF-PCM 79-21089-02.

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EFFECT OF CHLORINE DIOXIDE ON GLUCOSE UPTAKE BY DEVELOPING RAT BRAINS. R. Pfohl and D. Taylor. Miami Univ., Oxford, Oh.

Since chlorine dioxide is currently being considered for the purpose of disinfecting drinking water, its potential health effects are of major interest. We have examined the effects that postnatal exposure to ClO_2 have on the uptake of glucose by brain cells of neonatal rats. Pups were intubated daily with 14 mg ClO_2 /kg body weight or water only from day-5 postpartum until day-11 or day-21 when the animals were sacrificed. Five to 60 min prior to sacrifice the pups were injected i.p. with 200 μCi of ^3H -2-deoxyglucose/kg body weight. Brain homogenates were analyzed for 2-DG content. In 11-day rats, the rate of uptake during the first 20 min post-injection is similar in both treated and control animals. At 45 min, however, the level of 2-DG taken up by brains of ClO_2 -exposed animals is significantly lower than in control animals. A reduced uptake is also apparent in the cerebella and hippocampi of these brains. In 21-day old rats, the decreased levels of 2-DG in brains of treated rats compared to water controls approached significance at 45 min post-injection. These results suggest that ClO_2 or a by-product reduces the ability of brain cells to take up glucose.

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ACIDIC GLYCOPROTEINS OF THE TUNICATE ENDOSTYLE. Frank Hohenleitner and Louis V. Caso* Temple University Health Sciences Center, Philadelphia, PA.

Acidic glycoproteins are the single most important determinant of the flow behavior of mucoid epithelial secretions. Yet references to the tunicate endostyle suggest that very little acid glycoproteins are present in the cytoplasm of these tissues as determined by Alcian blue (AB) staining after aqueous-based fixation. To further evaluate the endostyle we fixed endostyles of *Ciona intestinalis* by the non-aqueous cyanuration method of Goland, and stained with acidic glycoprotein stains Alcian blue (AB) or high-iron-diamine (HID). We also tested for sensitivity to acid hydrolysis (AH). The border of zone 1 was + to HID and AB, but was insensitive to AH. The cytoplasm of zone 3 and the basal $\frac{1}{2}$ of zone 6 were AB+ and AH sensitive. We conclude that heretofore unrecognized acidic glycoproteins are present in the tunicate endostyle and that cyanuration fixation is a useful tool for their demonstration.

(supported by Temple University Grant-In-Aid).

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SITE SPECIFICITY OF CHRYSAORA (SEA NETTLE) NEMATOCYST TOXIN IN THE ELECTRON TRANSPORT PATHWAY OF RAT LIVER MITOCHONDRIA

S. Hudome* and J. Watrous, St. Joseph's University, Philadelphia, PA

Chrysaora nematocyst toxin is a complex proteinaceous material affecting a number of membrane associated events including the oxygen consumption of mitochondria. The toxin has properties like those of classical uncouplers, although its exact mode of action is unknown. This investigation deals with the hypothesis that Chrysaora toxin might affect electron transport by acting as a site specific blocker. Difference spectra of the cytochromes from intact and coupled rat liver mitochondria were examined in the presence of known blocking agents, as well as in the presence of whole toxin and bovine serum albumin. Changes in the difference spectra of toxin exposed mitochondria were dose dependent and observed at 441.4 nm, 534.3 nm, 554.8 nm, 590.4 nm and 610.1 nm. The initial segment of the difference spectrum closely resembles an oxidized-oxidized sample while the latter part resembles an oxidized-reduction sample. These studies using whole toxin suggest some degree of site specificity in electron transport pathway.

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HEPATIC EFFECTS OF AN EXPERIMENTAL INFECTION OF SCHISTOSOMATIUM DOUTHITTI IN MICE. G.B. Raiczuk and J.C. Hall. Rutgers University, Newark, New Jersey.

The biochemical and morphological changes that occur in the livers of mice infected with Schistosomium douthitti were studied. Animals were killed weekly for a total of 13 weeks. Liver homogenates, serum samples, and histological sections of liver tissue were prepared. Liver weight/body weight ratios, liver glycogen content, and alkaline phosphatase activity increased while total liver lipid content, transaminase activity, and hematocrit values were reduced in parasitized animals. Histologically, infected livers contained granulomas with 1-40 schistosome ova, but liver architecture remained intact. Schistosome pigment was observed. These effects were compared to those produced by CCl_4 -induced cirrhosis. Animals with cirrhosis had livers with distorted morphology and enlarged hepatocytes. Liver weight/body weight ratios, total liver lipid content, and alkaline phosphatase activity increased, but glycogen accumulation was depleted. Liver transaminases remained near control levels.

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LIPID AND AQUEOUS FACTORS IN HEMOLYSIS BY SCHISTOSOMA MANSONI. M.R.Kasschau and M.H.Dresden*. Univ. of Houston-Clear Lake and Baylor College of Medicine, Houston, TX.

We have found that the hemolytic activity of *S. mansoni* is found in the particulate fraction of homogenates made from adult worms. The particulate fraction can be separated into lipid and aqueous components by extraction in isopropyl ether: 1-butanol (60:40 v/v). Little activity was found in either fraction when tested alone, but 80% of the activity was reconstituted with both factors. Boiling the aqueous fraction did not slow hemolysis while boiling the lipid fraction slowed hemolysis significantly. The lipid fraction appears to contain the major hemolytic component, but reconstitution with the protein fraction is necessary for activity. The addition of small carbohydrates to the assay slowed hemolysis by 20%. Disaccharides were more effective than monosaccharides, while the trisaccharide, maltotriose, was the most effective. RBC glycoporphins were reduced by pretreatment with trypsin or chymotrypsin, the rate of hemolysis increased by 10-15%. These results suggest that sugar moieties on the RBC's or in the reaction mixture interfere with hemolysis by *S. mansoni*. Work supported by NIH AI 15864 and UH-CL Organized Research Funds.

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THE DAILY RHYTHM OF AN ENDOCRINE PARAMETER CAN BE MEASURED AT A SINGLE TIME B.H.White*, K.Mosher*, S. Binkley, Temple U., Philadelphia, PA

We validated a technique for measuring daily cycles in endocrine function by sampling at a single time point utilizing the rat pineal gland. Pineal N-acetyltransferase activity (NAT) in 29-36 day old rats exhibited a 314-fold rhythm in LD14:10. The rhythm freeran with reduced peak amplitude (75% of LD14:10 in constant dark and 6% of LD14:10 in constant light). We measured a dark-time NAT profile by keeping rats on six LD14:10 light-dark cycles with lights-out beginning at midnight, 2am, 4am, 6am, 8am, or 10am and killing all the rats at 10am. We measured the 24h NAT profile in LD2:22 and LD22:2 by keeping the rats on twelve different cycles and killing all the rats at one time.

Supported by grants to S. Binkley: NSP PCM 80-20798 and NINCDS 16048-01.

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DISTRIBUTION OF ECDYSTEROIDS IN HEMOLYMPH AND TESTES OF LAST INSTARS, PUPAE AND PHARATE ADULTS OF THE EUROPEAN CORN BORER *OSTRINIA NUBILALIS*. D. B. GELMAN and C. W. WOODS. IRL, USDA, BELTSVILLE, MD.

Ecdysteroid titers of hemolymph and testes from last instars, pupae and pharate adults were similar, peaking sharply just before pharate pupal formation and again just prior to pharate adult formation. Titrers were 6-7X higher in insects with fused testes than in those whose testes were separate. HPLC followed by RIA revealed the presence of 4-6 major ecdysteroid peaks. Fifth instar hemolymph contained ecdysteroids that comigrated with 20-hydroxyecdysone (β) and ecdysone (α), and 3 ecdysteroids that were more polar than 20-hydroxyecdysone (P). All peaked upon testes fusion, but only α and β decreased sharply in the pharate pupa. P peaks were highest on the 4th day post pupation while α peaked on the 2nd day and β the 3rd. A peak that comigrated with 26-OH ecdysone was detected on days 2 and 3 postpupation. Prepupal and pharate pupal testes extracts contained P peaks, β but no α peak. Only β decreased on pharate pupal formation. Pupal and pharate adult testes contained P peaks, β and α with maximum titers 3 days postpupation.

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DIETARY SULFUR AMINO ACID (SAA) AVAILABILITY AND MOLT DYNAMICS IN WHITE-CROWNED SPARROWS (WCS). M. E. Murphy* and J. R. King. Washington State Univ., Pullman.

To examine the potential role of dietary SAA availability as a proximate regulator of molt dynamics in nature we fed 7 groups of WCS 7 isocaloric, isonitrogenous semi-synthetic diets ranging in SAA concentration from 2.8 - 8.3 g per Kg dry wt. diet (2.15 - 6.43% of dietary protein) continuously through a 1-2 week premolt period and for the duration of feather synthesis. This range of dietary SAA concentrations approximates that found in nature and the WCS is among the most rapidly molting avian species. The birds in all test groups maintained normal body weights and regenerated normal plumages. No significant correlations were found between aspects of postnuptial molt (growth rates and shedding intervals of remiges, duration of molt, or new feather mass) and dietary SAA concentration. Contrary to prevailing hypotheses, if dietary supplies of SAA, under conditions of adequate caloric nutrition, affect molt at all in nature, the results appear to be too small to be ecologically significant. (NSF Grants DEB 8116206 and 8207511)

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VARIATIONS IN REPRODUCTIVE AND METABOLIC RESPONSES TO WATER TEMPERATURE INDUCED IN GULF KILLIFISH BY DAILY INJECTIONS OF 5-HTP AND DOPA IN DIFFERENT RELATIONS.

A. C. Emata and A.H. Meier.

Louisiana State Univ., Baton Rouge.

Daily injections of 5-hydroxytryptophan (5-HTP), a precursor for serotonin, and L-dihydroxyphenylalanine (DOPA), a catecholamine precursor, induce gonadal and body fat responses in Gulf Killifish, *Fundulus grandis*, that differ as a function of injection times. Injections of DOPA twenty hours after 5-HTP (20-hour relation) stimulate gonad weights and body fat stores whereas an 8-hour relation has inhibitory effects in fish kept at 20°C. However, the effects of timed-drug treatments are reversed in fish held at 28°C. These results indicate that an endogenous mechanism responsible for seasonal changes in responsiveness to water temperature is composed of two circadian neuroendocrine oscillations that can be set into different seasonal patterns by timed daily injections of neurotransmitter precursors.

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ANNUAL CYCLE IN SYRIAN HAMSTERS RESET BY NEUROTRANSMITTER PRECURSORS. J.M. Wilson and A.H. Meier. Louisiana State Univ., Baton Rouge.

Syrian hamsters undergo an annual cycle of reproductive responsiveness to daylength. Short days are inhibitory to scotosensitive hamsters in winter but not to scotorefractory hamsters in summer. Daily injections of 5-hydroxytryptophan (5-HTP:serotonin precursor) and L-dihydroxyphenylalanine (DOPA: catecholamine precursor) given at the same time of day for 8 days induce uterine regression in scotorefractory hamsters maintained for 4.5 weeks on LD 10:14, whereas daily injections of DOPA at 12 hours after 5-HTP (12-hour relation) have no inhibitory influence. Conversely, in scotosensitive hamsters in winter, the 12-hour relation induces uterine recrudescence and the 0-hour relation has no effect. These results indicate that the mechanism for the annual cycle of responsiveness to daylength is composed of two circadian neuroendocrine oscillations that vary seasonally in their phase relations.

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PREGNANT GOLDEN HAMSTERS CANNOT TELL TIME. M.H. Stetson. University of Delaware, Newark, DE.

Under natural conditions the reproductive cycle of hamsters is synchronized to and driven by annual changes in daylength. The mechanism for measuring day length employs an endogenous rhythm of photosensitivity driven by a circadian oscillator. This oscillator also times LH and FSH release in cyclic and anovulatory females. Only during pregnancy is clock-timed gonadotropin release not observed. Cyclic photosensitive and refractory hamsters were mated and transferred to short (sensitive) or long (refractory) days a) immediately, b) at parturition or c) at weaning. Unmated animals served as controls. Sensitive females transferred to short days at mating required an additional 3 weeks to induce anestrus. Similarly, refractory females transferred to long days at mating failed to terminate refractoriness during the 12 weeks of long-day treatment. Pregnant hamsters seem unable to discriminate day length for gonadal regression or for termination of refractoriness.

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PINEAL REGULATION OF SENSITIVITY TO EXOGENOUS MELATONIN IN THE GOLDEN HAMSTER. M. Watson-Whitmyre and M.H. Stetson. Univ. of Delaware, Newark.

The pineal rhythm of melatonin is thought to be an important signal for short-day induced testicular regression in the golden hamster. Exogenous melatonin can cause regression in males kept on long days; experiments in pinealectomized hamsters suggest that sensitivity to exogenous melatonin may be dependent on the pineal melatonin surge. To test this hypothesis, we injected melatonin daily into 4 groups of hamsters housed on very long daylengths, which have previously been reported to abolish the nocturnal increase in pineal melatonin. As expected, 100% of the injected hamsters on LD 16:8, in which the melatonin rhythm is undisturbed, underwent gonadal regression by 11 wks of treatment. However, varying percentages of hamsters housed on longer days also showed regression, as follows: LD 18:6 - 95%; LD 20:4 - 71%; LD 22:2 - 59%. Our data indicate that a prolonged nocturnal increase of pineal melatonin is not essential for the expression of sensitivity to exogenous melatonin.

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NEONATAL ANDROGEN BLOCKS CYCLIC GONADOTROPIN RELEASE IN THE PREPUBERTAL FEMALE HAMSTER. R. S. Donham and M. H. Stetson. University of Delaware, Newark, DE.

Prior to initiation of 4-day estrous cycles, daily cycles in levels of LH, FSH, and progesterone (P) occur in serum of developing golden hamsters. These daily rhythms are not measurable in the male. Administration of androgen to neonatal female rodents results in behavioral, anatomical, and physiological masculinization. We tested whether or not neonatal androgenization also alters the prepubertal cyclicity of reproductive hormones. Two-day old females were injected (sc) with 100 µg testosterone propionate (TP). When samples were collected in the late prepubertal period, levels of LH, FSH, and P were cyclical in controls with maxima at about 1700 h each day. In contrast, levels of these hormones in TP-injected females were low and did not vary. This effect of neonatal androgen persisted into adulthood. These results are consistent with the hypothesis that circadian oscillator function, as reflected by cyclic gonadotropin secretion, is a critical element in the process of sexual maturation.

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EFFECTS OF DAY LENGTH ON TESTICULAR FUNCTION IN TURKISH HAMSTERS. S.M. Hong and M.H. Stetson. University of Delaware, Newark.

In Syrian and Siberian hamsters, the critical daylength for maintaining gonadal function is 12.5 or 13 hr of light per day. That is, photoperiods of greater duration maintain gonadal function and those of lesser duration promote gonadal regression. This experiment was designed to determine if Turkish hamsters have a similar photoperiodic response. Adult Turkish hamsters were exposed for 10 weeks to photoperiods of 6, 8, 12, 16, 18, 20, 22 or 24 hr/day. Animals in short photoperiods (6, 8 and 12 hr light/24 hr) underwent testicular regression in 10 weeks. In addition, those exposed to 18, 20, 22 and 24 hr light/24 hr demonstrated the same response. These results indicate that Turkish hamsters have a very narrow range of photoperiods effective for gonadal maintenance; the critical daylength is centered at about 16 hr of light per day. The natural geographic range of these animals must therefore be restricted to a narrow band of latitudes for maintenance of the summer breeding condition.

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CHANGES IN GnRH SENSITIVITY IN FEMALE GOLDEN HAMSTERS INDUCED BY PHOTOPERIOD AND GONADAL FEEDBACK. M.N. DiPinto and M.H. Stetson. Univ. Delaware, Newark.

Intact and ovariectomized (ovex) hamsters exposed to long (LD 14:10) or short (LD 10:14) days received synthetic GnRH ranging from 0 to 1000 ng 30 min prior to the naturally occurring afternoon surge of LH and FSH. All animals received 100mg/kg bw of phenobarbital at 1330 h to block the gonadotropin surge that afternoon. Proestrous hamsters (long days, intact) were the most insensitive group, giving a significant response to 50 ng GnRH. Long day ovex animals responded to 5 ng GnRH. Intact and ovex short day hamsters responded to 5 and 10 ng GnRH, respectively. These data show that ovarian hormones function at the level of the anterior pituitary to decrease the response of this organ to GnRH. Removal of the source of these hormones by ovex or short day exposure increases the GnRH sensitivity of the anterior pituitary to GnRH.

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ALTERATIONS IN ENDOCRINE AND BEHAVIORAL COMPONENTS OF REPRODUCTION IN AGING MALE JAPANESE QUAIL. M. A. Ottinger¹, J. Balthazart^{2*}, and R. Turek^{1*}. Univ. of Maryland, College Park, MD, and Univ. of Liege, Liege, Belgium.

The reproductive endocrinology of the Japanese quail undergoes a sharp decline between 1½-2 yrs of age as evidenced by a highly significant reduction in the fertility and hatchability of eggs produced by paired quail. Experiments were conducted to compare endocrine and behavioral variables in male quail of several ages. A significant decrease in mating behavior occurred by 1½ yrs of age which could be reversed in a number of males by exogenous testosterone. Further experiments were conducted with males of several age groups classified as behaviorally positive or negative. Results showed a behavioral decline that occurred prior to a decrease in plasma testosterone concentrations. Plasma LH increased with lowered plasma testosterone with the exception of older inactive males. Exogenous LHRH administration stimulated LH release with a reduced response in older behaviorally inactive males. Results implicate functional changes at both the levels of the gonads and the hypothalamus and pituitary that contribute to the reproductive decline.

NOETIA PONDEROSA ERYTHROCYTES USE INTRACELLULAR IONS FOR INITIAL VOLUME REGULATION DURING HYPOSMOTIC STRESS. L.H. Smith & S.K. Pierce, Univ. of Maryland, College Pk., MD. 20742

Cell volume regulation (CVR) by Noetia ponderosa erythrocytes in hypoosmotic media (560 mosm) occurs within 2 HR, *in vitro* and is accompanied by an efflux of intracellular free amino acids, principally taurine. However, CVR occurs with the onset of exposure to reduced salinity, and before significant amounts of taurine have effluxed indicating that other solutes must be involved initially.

Intracellular Na^+ content (55 nmoles/ 10^6 cells) does not change during a 1 HR exposure to hypoosmotic stress. However, K^+ content (100 nmoles/ 10^6 cells) declines by 18% within 10 min of exposure to hypoosmotic stress. Similarly, Cl^- content (65 nmoles/ 10^6 cells) decreases by half with exposure to hypoosmotic stress.

Therefore, the initial phase of CVR by N. ponderosa erythrocytes uses an efflux of K^+ and Cl^- . In addition, the efflux of K^+ and Cl^- , unlike taurine, is not effected by extracellular Ca^{2+} . Thus, N. ponderosa erythrocytes use a two component solute system to regulate cell volume in hypoosmotic media. (Supported by NIH #GM-23731)

NITROGEN EXCRETION PATTERNS IN ELYSIA CHLOROTICA EXPOSED TO LOW SALINITY. L. M. Rowland and S. K. Pierce. Univ. of Maryland, College Park.

Tissue hydration in Elysia chlorotica exposed to low salinity (155 mosm) increases and levels off within 24 h. During this time tissue concentrations of an acid reineckate-precipitable compound (ARP) (measured as glycine betaine equivalents) declined from 715 to 510 $\mu\text{moles/g}$ dry wt accompanied by an appearance of these compounds in the blood. Ammonia nitrogen excretion rates are low (0.7 $\mu\text{moles/g}$ dry wt/12 h) and increase only slightly (6.9 $\mu\text{moles/g}$ dry wt/12 h) following transfer of Elysia to low salinity. However, the decline in tissue concentrations of ARPs is accounted for by an increase in the excretion of these compounds from 0 to 280 $\mu\text{moles/g}$ dry wt after 24 h. The intracellular pool of ARPs consists of one major compound (thin layer chromatography) and the same compound is excreted unchanged after efflux from the cell. These results indicate that cell volume regulation in Elysia occurs by an efflux of an intracellular ARP compound into the blood which is then excreted unaltered from the animal. (NIH GM-23731).

THE ORIGIN OF MEMBRANE POTENTIAL CHANGES IN HYPOSMOTICALLY STRESSED NEURONS FROM ELYSIA CHLOROTICA. R. H. Quinn, S. K. Pierce, and D. J. Prior. Univ. of Maryland, College Park, MD.

The membranes of most neurons respond to a hypoosmotic stress by depolarizing followed by some degree of repolarization. Elysia neurons are typical of this pattern. Identified cells in the abdominal ganglion respond to a 920 to 460 mosm reduction in osmolarity by depolarizing about 30 mV from the mean resting potential of 63 mV and then repolarizing after about 20 min. The depolarization produced by the reduction in osmolarity is not affected by changes in external Cl^- (using propionate as a substitute). Ca^{++} free 50% SW produces a sustained depolarization that does not repolarize. The low salinity depolarization is reduced by Na^+ free 50% SW (460 mosm) (replacement with Tris or choline) to 20 mV and is further reduced in Na^+ - Ca^{++} free 50% SW (460 mosm) to 13 mV. These results indicate that the depolarization caused by reduced osmolarity results in part from an influx of Na^+ and Ca^{++} rather than a volume regulating solute efflux. (NIH Grant GM-23731).

ELYSIA USES A NOVEL MOLECULE FOR CELL VOLUME REGULATION. S. K. Pierce, P. H. Mazzocchi*, L. J. Klingler* and S. C. Edwards. Univ. of Maryland, College Park.

Elysia chlorotica is an extremely euryhaline osmoconformer with a tiny intracellular amino acid pool. Instead of amino acids, Elysia utilizes a substance which precipitates with acid reineckate treatment and reacts with Dragendorff's reagent, both suggestive of a quaternary ammonium compound (QAC). However, the compound does not co-chromatograph with any common QAC in several thin layer chromatographic (TLC) systems. Therefore, to identify the compound, we have purified it by a combination of solvent extractions, ion exchange chromatography and TLC. The IR, UV, proton NMR and ^{13}C -NMR spectra of the purified material were determined. The results of these analyses suggest that the molecule utilized for cell volume regulation by Elysia is not a QAC as our preliminary tests suggested. The tentative identity is N,N-dimethyl,5-hydroxy norvaline. The substance is found in several tissues of Elysia, including the brain. It is not present in the slug's diet and may be a compound unique to Elysia. (Supported by NIH grant GM 23731 and TS&CCMBA.)

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PROTEIN AS A SOURCE OF AMINO ACIDS IN CELL VOLUME REGULATION. T.J. Hilbish*, L.E. Deaton, and R.K. Koehn*. SUNY, Stony Brook, NY.

Allozymes of the peptide hydrolase, AM-I, in Mytilus edulis differ in their catalytic properties; genotypes with the Lap-94 allele have 20% greater activities than other genotypes. We therefore predict Lap-94 genotypes to have greater rates of free amino acid (FAA) accumulation during adaptation to high salinity (HS). Transfer from 15 to 30‰ resulted in increases of FAA that were genotype dependent. Individuals with Lap-94 accumulated FAA more rapidly. Return of mussels to 15‰ resulted in excretion of ammonia and amines that were genotype dependent. N_2 excretion accounted for 87% of the amino nitrogen accumulated during adaptation to HS. The results indicate a minimum of 32% of the total FAA elaborated during HS acclimation are derived from the hydrolysis of proteins. The function and localization of AM-I preclude any role for this enzyme in either de novo synthesis or transport of FAA from the medium.

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BOTH ARGININE VASOTOCIN AND ANGIOTENSIN II CAN INDUCE WATER UPTAKE IN THE TERRESTRIAL SLUG, LIMAX MAXIMUS. M.E. MAKRA and D.J. PRIOR. Univ. of Kentucky, Lexington.

To examine the possibility of hormonal control of water balance in the slug, the effects of arginine vasotocin (AVT) and angiotensin II (AII) were studied. Hydrated slugs (n=15) were injected with AVT, AII, saline or 1.0 molal mannitol. One hour after injection the slugs were placed on wet pads of tissue paper for 15 minutes. Following injection of $5 \times 10^{-6} M$ AVT the rate of water uptake was $1.36 \pm 0.35 \mu l/cm^2 \cdot min$ and after injection of $3-8 \times 10^{-5} M$ AII the rate was $1.02 \pm 0.37 \mu l/cm^2 \cdot min$. There was a slight loss of water following the saline injections ($-0.16 \pm 0.24 \mu l/cm^2 \cdot min$). The water uptake observed after injections of the two peptides differed significantly ($p < 0.01$) from the uptake following saline injection. Injection of a hyperosmotic mannitol solution, which initiates drinking behavior in slugs, resulted in water uptake at a rate of $3.48 \pm 0.39 \mu l/cm^2 \cdot min$. These results suggest that AVT or AII or related peptides may be involved in the control of water balance in terrestrial slugs. (Supported by an N.I.H.-R.C.D.A. to D.J.P. and the Whitehall Foundation.)

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WATER AND ION BALANCE IN THE SIX-ARMED STARFISH, LEPTASTERIAS HEXACTIS AS A FUNCTION OF SALINITY. M.A. Kapper, R.C. Chauvin, and W.B. Stickle. Louisiana State Univ., Baton Rouge.

Survival, distribution of body water and the intra- and extracellular concentrations of NPS, Na^+ , K^+ , and Cl^- were measured in the six-armed starfish, Leptasterias hexactis acclimated to 10, 15, 20, and 30‰. The 28-day median tolerance limit (TLM) was 11‰. Concentrations of all ions in the perivisceral fluid were not significantly different from the ambient seawater. Intracellular NPS varied directly with acclimation salinity expressed in terms of either dry weight or intracellular water. Intracellular ion content per mg dry tissue was constant across salinities, but ion concentration per ml intracellular fluid increased with increasing salinity. Total body water showed little variation, ranging from 78.85% at 10‰ to 75.43% at 30‰, while water content of soft tissues (pyloric ceca) increased from 69.2% at 30‰ to 80.2% at 10‰. (Supported by the Petroleum Refiners Environmental Council of Louisiana).

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FAILURE OF PLATYFISH, XIPHOPHORUS MACULATUS, TO ADAPT TO CALCIUM-DEFICIENT DILUTE ARTIFICIAL SEA WATER. S. Cassidy* and S. Holtzman. Southampton College and Brookhaven, National Laboratory, N.Y.

The platyfish, which is a freshwater teleost, can also live in 1/3 sea water (SW). The effects of individual ambient elements, such as Ca, on environmental adaptation have not been described for this species. Young mature female platyfish were placed into artificial fresh water (FW), with or without Ca, or into artificial 1/3 SW, with or without Ca. Distilled deionized water was used to make the four media. No differences were noted between fish in the two FW environments for a period of 10 days. In Ca-deficient 1/3 SW, the fish exhibited physiological deterioration, with a progression of symptoms starting from two hr post-immersion. All the fish died 54-72 hr after exposure to the Ca-deficient medium. Platyfish in 1/3 SW with Ca appeared to be normal during the course of the experiment, and were killed at 72 hr. The role of the pituitary gland in these observations is being investigated. Research supported by the U.S. Dept. of Energy under Contract DE-AC02-CH00016

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EFFECTS OF SIZE, AGE AND PHOTOPERIOD ON HYPOSMOREGULATION IN BROOK TROUT, *Salvelinus fontinalis*. S. D. McCormick. Woods Hole Oceanographic Institution, Woods Hole.

In 11 experiments over 1.5 yrs, brook trout were gradually exposed to 32 ppt seawater for 20 d to investigate the ontogeny of salinity tolerance. Size was the primary determinant of seawater survival ($r^2 = 0.77$); the effect of size on seawater survival slowed after fish reached a fork length of 14 cm. The effect of age on seawater survival ($r^2 = 0.65$) was through its covariance with size. Photoperiod affected seawater survival only through its influence on the timing of male maturation, which decreased salinity tolerance. Hyposmoregulation of plasma osmolarity, $[Na^+]$, $[Cl^-]$, $[K^+]$, $[Mg^{2+}]$ and hematocrit increased linearly with size over the entire range of sizes (6-32 cm). Gill Na^+, K^+ -ATPase activity after 20 d in seawater decreased with increasing size of brook trout, possibly reflecting decreased demand for active ion transport in larger fish. Size dependent survival and osmoregulatory ability of brook trout is compared to other salmonids and a conceptual model is developed.

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Na:H EXCHANGE IN FROG SKELETAL MUSCLE: ITS ROLE IN RECOVERY OF INTRACELLULAR pH (pH_i) FROM ACID LOADING. Robert W. Putnam and A. Roos*. Washington University School of Medicine, St. Louis, Missouri 63110.

The pH_i was followed with pH-sensitive glass microelectrodes in semitendinous fibers, depolarized to ~ -20 mV (50 mM K). After acidification with the NH_4Cl prepulse technique (pH_o always 7.35, CO_2 -free), pH_i recovered briskly at a rate of $\sim 0.3 \Delta pH_i/h$ ($pH_i \sim 6.85$). This recovery was completely inhibited in Na-free medium (substituted with N-methyl-D-glucamine) 88% inhibited by 1 mM amiloride, and only 18% inhibited by 0.1 mM SITS, suggesting that recovery is largely due to Na-H exchange. The recovery rate increased linearly between pH_i 7.2 (no recovery) and 6.4 ($0.63 \Delta pH_i/h$). Recovery also varied with extracellular Na concentration ($K_m \sim 10$ mM). The depolarized frog muscle fiber, acidified by prepulsing with NH_4Cl , is a useful model for studying Na:H exchange.

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A SERUM COMPONENT WHICH INDUCES MELANIZATION IN A GOLDFISH TUMOR LINE. C. M. Richards, and T. J. Lynch*. Wayne State Univ., Detroit.

A cell line (GEM-81) established from a red-pigmented goldfish tumor (erythrophoroma) is essentially colorless when maintained in medium supplemented with fetal bovine serum. However, serum from the gold carp, *Cyprinus carpio*, induces some GEM-81 cells to melanize.

The melanizing activity of the fish serum is dialysable and heat stable (60°C for 30 min.). Preliminary separations by gel filtration, ion exchange and affinity chromatography indicate that the activity is apparently due to a discrete factor. Efforts to purify and characterize this factor are underway.

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MECHANISM OF STIMULATION OF ALBUMIN SYNTHESIS BY GLUCOCORTICOID AND DIBUTYRYLcAMP IN MOUSE HEPATOMA CELLS. V. L. Shellman* and J. Papaconstantinou. Univ. of Texas Medical Branch, Galveston, TX.

Mouse hepatoma cells (BW7756) have been established in culture, and several clones from this maintain regulatory and differentiated functions characteristic of the liver. In one clone, Hepa-2, the level of albumin synthesis is significantly decreased, but is restored to *in vivo* levels by the synergistic action of hydrocortisone (HC) and Bt_2cAMP . Quantitation of albumin mRNA (alb-mRNA) levels by hybridization has shown that HC and Bt_2cAMP mediate increases in these mRNA sequences in direct proportion to the increased rates of albumin synthesis. Our aim is to determine whether the increase of alb-mRNA levels is due to an increase in the rate of transcription. By hybridization to alb-cDNA, we have shown that the rate of appearance of (3H)alb-mRNA in the cytoplasm is increased by HC and Bt_2cAMP . We conclude that the mechanism of stimulation involves an increase in the mRNA pool, and that this may be due to an increase in the rate of transcription of the albumin gene.

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Effects of the plant lectin, Phytohemagglutinin, on morphology and prolactin production in pituitary tumor cells. E.R. Oldham and B.A. Brennessel (intro. by S.L. Beck).

Phytohemagglutinin (PHA) was found to have a marked effect on the morphology of cultured rat pituitary tumor cells. Treatment of cells with 5 ug/ml PHA caused an alteration in the appearance of the cultures and a higher proportion of spherical cells after 3 to 4 h. 4 days after removal of PHA from the culture medium, cells regained the appearance of those in control cultures. PHA treatment also caused an alteration in the production of a peptide hormone, prolactin (PRL), by these cells. PRL production, which was in the range of 20 ug/mg protein/day in control cultures, decreased by 50% by 24 h of PHA treatment. Further decreases in PRL production were observed after continued exposure of the cells to PHA.

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Recovery of a Normal Phenotype in the Epidermis of the Pupoid Fetus (pf/pf) Mutant Mouse.

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 2) Depts. of Periodontics and Medicine, U. of Wash., Seattle, WA 98195

The pf mutation of the mouse is recessive and lethal at birth. Mutants develop a thickened epidermis which fails to form a s. corneum and synthesizes insignificant amounts of the keratin matrix protein, filaggrin. In an effort to localize expression of the pf gene, reciprocal heterotypic recombinations were constructed with mutant and normal dermis and epidermis. All recombinations, grafted to the anterior chamber of the eye of adult hosts from the pf colony, were found to recover a histologically normal phenotype. Subsequent experiments revealed that within 7 days explants of whole pf/pf skin recovered a normal phenotype as determined by histological and electron microscopical appearance and by immunofluorescent localization of filaggrin. These results suggest that the pf gene acts systemically and that abnormalities of the mutant skin are secondary to the action of the gene.

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CYTOSKELETAL ORGANIZATION IN CULTURED EPITHELIAL CELLS. W. M. O'Guin, L. W. Knapp, and R. H. Sawyer. Dept. of Biology, Univ. of South Carolina, Columbia.

Alterations in the distribution of cytokeratins in cultured epithelial cells elicited by treatment with various combinations of microfilament and microtubule inhibitors show that the cytoplasmic organization of keratin is dependent upon both microfilament and microtubule organization as well as the distribution and stability of membrane associated keratin organizing sites. Indirect immunofluorescence microscopy suggests that actin may co-distribute with keratin filaments and keratin organizing sites after drug treatment. Neither tubulin nor vimentin co-distributes with keratins under these conditions. Further, we have shown that the formation of keratin organization sites observed after drug treatment involves the redistribution of desmosomal polypeptides into discrete membrane associated foci not seen in untreated cells. The complexity of the organization, and ultimately the function, of the vertebrate cytoskeleton involves not only the individual elements, but the coordinated interactions among them as well. (Supported by NSF PCM8011745 and ACS IN107G)

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DIFFERENCES IN KERATIN CYTOSKELETAL ORGANIZATION AMONG CLONED HUMAN SOMATIC CELL HYBRIDS. L.W. Knapp, W.M. O'Guin, F.A. White*, R.H. Sawyer, and C.L. Bunn*. University of South Carolina, Columbia.

Human somatic cell hybrids made between cytokeratin producing HeLa cells and nonkeratin producing normal fibroblasts were used to investigate stability in the organization of the keratin cytoskeleton after cell fusion. The hybrids have two possible growth potentials, one of fibroblast-like limited lifespan, suggesting suppression of the HeLa genome, the other HeLa-like unlimited lifespan. Distinct differences in expression and organization of keratin were observed between independently isolated hybrid clones. Hybrids fell into 3 categories: those with abundant, well organized keratin, those with reduced and poorly organized keratin and those with little or no keratin. Differences in cell morphology and cytoskeletal organization of these hybrids, both transformed and untransformed, provide a new means to study the regulation and utilization of keratin and may provide clues to the genomic interactions involved in the potential for a limited or unlimited cellular lifespan. (Supported by NSF PCM8011745 to RHS & NIA-AG02664 to CLB).

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THE ROLE OF MICROTUBULE-NEUROFILAMENT "COUPLERS" IN TRANSPORT OF VESICULAR ORGANELLES IN NERVES. R.G. NAGELE*, M.C. KOSCIUK*, and H. LEE. UMDNJ-N.J. School of Osteopathic Med., and Rutgers Univ., Camden, N.J.

We have recently described a new structure coupling microtubules to neurofilaments in nerve fibers (Brain Res. 253: 82, 1982). In an effort to elucidate the possible role of these couplers in the generation of motive forces for the intraxonal transport of vesicular organelles, we have studied the morphology and distribution of couplers and their relationship to vesicular organelles in the axonal processes of cultured chick dorsal root ganglia (DRG). DRG from day 8½ chick embryos were cultured for 48 hours on glass coverslips coated with poly-L-lysine in medium supplemented with nerve growth factor. Cultures were quick-frozen and freeze-substituted, rather than fixed by slower conventional methods, to facilitate the "capture" of those structures that actually participate in axonal organelle movements. Electron microscopy revealed that couplers directly attach to the surfaces of vesicular organelles (mitochondria, dense-core vesicles, and multivesicular bodies), further suggesting the important role for couplers in axonal transport.

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THE FORMATION OF A GREY CRESCENT IN THE UNACTIVATED EGG OF RANA PIPIENS. I.D. Zimmerman and M. Mason (introduction by M. DiBerardino). The Medical College of Pennsylvania, Phila., and West Chester State College, West Chester.

A grey crescent (G.C.) can be produced in a virgin, unactivated, untreated Rana egg simply by placing the cell into a dilute Ringer's solution (< 50% normal). The crucial parameter appears to be the overall tonicity of the bath since the formation of the GC is not promoted by the deletion of any specific ion, or indeed of all ions if the osmolarity of the solution is otherwise maintained. The visage of the crescent formed in this system is a bit darker and more striate than usual but otherwise resembles that seen in the activated egg. Its time course of formation is distinctly non-linear and slow; its clear appearance being delayed by some 18 hr compared to the fertilized cell. Neither diplo-tene oocytes nor *in vitro* progesterone matured oocytes show GC formation in this system. As usual in a reduced system the formation, size, and position of the GC can be accounted for by a model in which an inner region of cytoplasm rotates relative to the cortex under the influence of gravity.

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NERVE GROWTH FACTOR (NGF) INDUCES NEURAL DIFFERENTIATION IN UNDIFFERENTIATED CELLS OF EARLY CHICK BLASTODERMS. H. LEE, R.G. NAGELE* and F.J. ROISEN*. Rutgers Univ., Camden, N.J., UMDNJ-N.J. School of Osteopathic Med., Camden, N.J., UMDNJ-Rutgers Med. School, Piscataway, N.J.

NGF induced post-nodal pieces (PNPs) of stage 4 chick blastoderms to develop into neural tubes with ultrastructural features closely resembling neuroepithelial cells of early chick embryos. This induction was specific for NGF and could be abolished by anti-NGF. The simultaneous addition of a subeffective dose of NGF (5 ng/ml) with either theophylline (90 µg/ml) or cyclic AMP (35 µg/ml) resulted in an increase in intracellular cyclic AMP levels and number of PNPs showing differentiation, while each of these agents, when applied alone, had no effect. Both NGF (60 ng/ml) and cyclic AMP (175 µg/ml) were able to elicit neural differentiation, but the latter also induced other tissues. Overall results suggest that (1) cells from chick embryos at developmental stages much earlier than previously thought are responsive to NGF, (2) NGF induces neural differentiation in PNPs through a cyclic AMP-mediated process, and (3) NGF may serve as the neural inducer in the chick. Supported by NIH NS11299.

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THE EYELESS MUTANT AXOLOTL (*AMBYSTOMA MEXICANUM*) PRODUCES SMALL AND DELAYED OPTIC VESICLES. R. B. Brun. Texas Christian University, Fort Worth, Texas.

The recessive gene *e* causes eyelessness in homozygous Axolotl larvae. However, small eye rudiments without lenses are occasionally seen in juveniles and adults. A total of 24 eight weeks old larvae, from 5 different spawnings, were histologically analyzed. Small optic vesicles were found in all *e/e* larvae. Some of the rudimentary eyestructures had developed into small cups, with sensory and pigmented retina. In embryos fixed 48 hours following neural fold closure (16°C), three classes were found: In the first class, no optic vesicle were formed. In the second class small vesicles were present. In the third group, vesicles of normal size were found. The added numbers of individuals in class one and two corresponded to 25% of all (50) analyzed embryos. I conclude from these observations that optic vesicles are formed in eyeless larvae. However, they are generated too late, remain very small (less than 1/10 of normal eye diameter) and do not establish contact with the epidermis. This is probably the reason why I could not find any lens rudiments in *e/e* larvae.

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PERTURBATION OF HEPATIC MORPHOGENESIS BY PREDNISOLONE. G.K. Sherer and D.C. Sgroi† Bowdoin College, Brunswick, Me.

We have hypothesized that the interactive requirement for mesenchyme during hepatogenesis is based upon this tissue's provision of a vasoproliferative stimulus, and have tested this hypothesis by challenging the permissive influence of hepatic mesenchyme with prednisolone, a potent inhibitor of angiogenesis. Hepatic rudiments of 2½-day chick embryos were grafted, with mesenchyme intact, to the chorio-allantoic membranes of 9-day hosts, in the presence of up to 1.5mg. of hormone, and were prepared for paraffin histology after an incubation of up to 5 days. With hormone doses of 375µg. or more, characteristic sinusoids were replaced by a single, massive sinus, in which hepatic endoderm proliferated as undifferentiated trabeculae lacking canalicular lumina. These structures frequently lacked a subjacent endothelium, and where this endothelium occurred its discontinuity was suggested by extensive diapedesis. These observations are consistent with the hypothesis presented above, although the possibility that prednisolone acts directly on hepatic epithelium cannot yet be ruled out. (Supported by grants to GKS from the AHA-Maine Affiliate and the Research Corp., and by an AHA Summer Fellowship to DCS.)

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A DUAL SOMATIC MOTOR INNERVATION IN URODELE AMPHIBIA. F.J. Carey (intro. by B.M. Carlson). Univ. of Michigan, Ann Arbor.

The motoneurons in the spinal cord of urodele amphibia possess an organization unique among tetrapod vertebrates, as revealed by horseradish peroxidase (HRP) histochemistry, motoneurons innervating limb axial and caudal musculature are arranged in two morphologically distinct and anatomically separate populations.

The development of these neurons has been investigated in Ambystoma mexicanum and Pleurodeles waltlii. The two populations appear to develop at different times. At late embryonic and early larval stages, HRP labeling of axial muscle and limb buds reveals two types of neurons. At present, it is not known if the neurons seen at early larval stages persist and contribute to the formation of one of the two populations seen in older larvae and adults.

Supported by NIH HD 17228 grant to Bruce M. Carlson and a Bourse Chateaubriand to F. J. Carey.

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"TROPIC" EFFECT OF TRANSFERRIN ON LIMB REGENERATION BLASTEMAS. A.L. Mescher and S.I. Munaim*. Indiana University, Bloomington.

Recent work has shown that a peripheral nerve factor which promotes muscle development *in vitro* is a neuronal form of the iron transport protein, transferrin (Tf). As a first step in determining whether a similar protein may be involved in the neurotrophic control of growth in early limb regenerates, we tested the effects of Tf on newt forelimb blastemas in organ culture. Addition of Tf to medium containing 1% fetal bovine serum prevented the decline in DNA labeling and mitotic activity which occurred upon explantation to medium with 1% serum alone. Blastemas maintained for 24 h in medium with 1% serum were stimulated to increased levels of DNA synthesis by the addition of Tf and this response was dose-dependent. Varying the levels of iron and Tf in the medium indicated that the protein's trophic effect is apparently due to its ability to deliver iron to the cells in an appropriate manner. The results suggest that blastema cell proliferation could be promoted by transferrin-like factors released from nerves. (Supported by NIH grant GM31080-02.)

720

THE IMPORTANCE OF WOUND EPITHELIUM IN REGULATING NEWT STUMP CURRENTS.

M.E. McGinnis and J.W. Vanable, Jr. Purdue University, West Lafayette, Indiana.

After amputation, currents of the order of 50 µA/cm² leave the cut surface of N. viridescens forelimb stumps. On subsequent days, these currents become considerably reduced. Whether this decrease is due to the skin batteries drastically reducing their output, or whether skin battery output is maintained, and the resistance of the wound epithelium limits current flow has not been determined. Therefore, measurements of stump current density and wound epithelium resistance were made at intervals after amputation. Our data suggest that even quite early wound epithelium covering the stump has a substantial resistance, probably enough to account for the drop in the density of the current leaving the end of the stump. Therefore, a major portion of the potential drop in the circuit through the stump occurs across even the early wound epithelium. Since currents probably act via potential drops associated with them, this finding makes the wound epithelium an attractive target for stump currents. Supported by NSF PCM-8104657 and NIH NS17387.

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REGENERATED URODELE TAIL SEGMENTS BEAR MULTIPLE HETEROTOPIC DORSAL ROOT GANGLIA. C. E. Dinsmore, Rush Medical College, Chicago, IL

Limb and tail regenerates in urodele amphibians are virtually perfect morphological replicas of the original structures. However, it was occasionally observed in an earlier study that the dorsal root ganglia of tail regenerates were displaced or heteromorphic. This report is a retrospective analysis of tail regenerates of various ages in two urodele species: *Notophthalmus viridescens* and *Plethodon cinereus*. Serially sectioned tails and tail regenerates from previous work show that multiple, heterotopic dorsal root ganglia are normally regenerated in each segment while the normal distribution of ganglia in naive tail segments is a symmetrical pair. Additional data show that the abnormal number and distribution of ganglia is not resolved during terminal differentiation of the regenerate. Thus, they provide a convenient and stable marker for determining whether or not a urodele tail has previously regenerated and also demonstrate that caudal dorsal root ganglion regeneration is independent of control mechanisms which regulate the normal regeneration of segmental pattern in urodele tails.

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TERRITORY SIZE AND WEIGHT GAIN IN MIGRANT HUMMINGBIRDS. F.L. Carpenter, D.C. Paton*, and M.A. Hixon. Univ. of California, Irvine.

Rufous hummingbirds periodically establish and defend territories along their summer southward migration route. Using artificial perches attached to spring or electronic balances in the field, we were able to measure daily weight changes in undisturbed, individually marked birds. The territory size (number of flowers) of individual birds varied from day to day. Four of 5 intensively studied birds adjusted their territories to that size which eventually was associated with the fastest sustained rate of weight gain attained at any stable territory size. The one exception was explicable on the basis of its unusually high weight. These results are not inconsistent with the assumption of optimization theory that animals are capable of assessing when their behavior (e.g. territory size) is suboptimal and of then making adjustments toward an optimum. The results also suggest, although not conclusively, that these birds are attempting to maximize their rate of weight gain on the stopover prior to resuming migration.

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RELATIVE BODY SIZE AND COMPETITION BETWEEN LOBSTERS (*HOMARUS AMERICANUS*) AND JONAH CRABS (*CANCER BOREALIS*). R.A. Richards* and J.S. Cobb. Univ. Rhode Island.

The purpose of this study was to investigate how two factors, species identity and individual size, interact to determine the outcome of competition for shelter between lobsters and Jonah crabs.

Experiments were carried out in 12 ft. diameter pools containing a predatory fish and either an excess of shelters or half as many shelters as animals. Although lobsters are dominant over crabs of equal size, an inverse relationship between the proportion of lobsters obtaining shelter and the size of competing crabs was seen. This trend was evident for both small and medium size lobsters, however the overall reduction in shelter use was less pronounced for medium size lobsters. Mortality and injury rates were higher for both species when shelters were limited, indicating that shelter is a vital resource. When shelters were limited, overall mortality rates increased more for lobsters than for crabs. Preliminary results indicate that mortality rates are higher for lobsters competing with larger crabs than for lobsters competing with smaller crabs.

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INTERSPECIFIC COMPETITION FOR SHELTER SPACE AMONG AMERICAN LOBSTERS AND JONAH CRABS. Denis Wang. University of Rhode Island.

Ethological laboratory experiments using animals in large pools with artificial shelters showed that aggressive interactions for possession of limited shelter space occurs among *Homarus americanus* and two cancerid crabs, *Cancer borealis* and *C. irroratus*. Interspecific agonism was ritualized and stereotypic. Lobsters were dominant in obtaining shelters from the crab species, among the sizes of animals used in the tests, and monopolized more than one shelter, thereby limiting shelter as well as habitat space. Field experiments in which lobsters were periodically removed from quadrats showed that *C. borealis* density increased with competitive release from lobsters, as compared with crab density in untouched quadrats. These results suggest that present lobster harvesting practices may actually increase competition between small lobsters and crabs.

725

SPATIAL PATTERNING IN INTERTIDAL HERMIT CRABS: COMPETITION OR HABITAT PREFERENCE? S. Gilchrist. New College of U.S.F., Sarasota, Fl.

Studies of the strength and influence of interspecific competition on hermit crab assemblages provide classical examples of how limiting resources affect population dynamics. In Pacific Panama, three hermit crab species which use nearly identical resources coexist in the rocky intertidal. In some areas, these species appear spatially segregated through a dominance hierarchy. In this study, I examine the hypothesis that separation is related to competition. Data do not support interspecific competition as a major factor determining the observed distributions. Experimental evidence suggests that segregation patterns can be explained by differential habitat use and adaptations to physical stress from the environment by the three crab species.

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VARIATION IN COMPETITION: MUDSNAILS AND PERIWINKLES. G.A. Branchley. U.C. Irvine.

Competition between native Ilyanassa obsoleta and exotic Littorina littorea on tidal flats in Barnstable Harbor, MA is a function of snail age and habitat. Juveniles exploit epiflora on sand and marsh plants; aggressive behaviors are absent; exploitation efficiencies are unaltered by interspecific competition. Although diet and habitat usage diverge as snails mature, interference competition intensifies. With age mudsnails develop (probably garden) a rich shell epiflora on which they and L. littorea graze. Depending on size, littorines cause mudsnails to topple over, interrupting especially reproduction. By twisting mudsnails attempt to shake off L. littorea (or lead weights) but rarely do; they force large littorines off with proboscis and radula. On sand flats I. obsoleta avoid large areas where densities of L. littorea exceed about 8 / m². On cobble littorines are less mobile; herds of mudsnails migrate through these habitats but lose their garden when inactive at low tide to littorines. Lacking shell epiflora, immature I. obsoleta co-occur in marshes with L. littorea, which prefer the other plentiful solid substrata.

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THE IMPORTANCE OF COMPETITION, PHYSICAL DISTURBANCE, AND MUTUALISM IN MAINTAINING THE DEPTH ZONATION OF KELP AND MUSSELS.

J.D. Witman. Univ. of New Hampshire, Durham.

Subtidal mussels (Modiolus modiolus) dominate space on upper rock surfaces at intermediate depths (10-25m), but not at shallow depths (1-10m) that are dominated by the kelps Laminaria digitata and L. saccharina. Experimental manipulations were conducted at an exposed site in the Gulf of Maine to test the hypothesis that interference competition with kelp limits the upper distribution of Modiolus. Results indicate that dislodgement of mussels following kelp overgrowth is the mechanism reducing the ability of Modiolus to hold space in the kelp beds. A mutualistic interaction between sea urchins, S. drobachiensis, and Modiolus facilitates the persistence of mussel beds in shallow areas normally dominated by kelp. By grazing kelp off mussel shells, urchins increase Modiolus survivorship by decreasing the risk of dislodgement. Field experiments indicate that sea urchins benefit from the interaction because they are protected from predation by crabs, lobsters, and fish while in the mussel beds. A conceptual model of the interaction will be presented and discussed.

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INTERSPECIFIC DOMINANCE AND THE STRUCTURE OF WOODCREEPER GUILDS. N. Pierpont.^{*} Princeton Univ., Princeton, N.J.

Two guilds of insectivorous, trunk-climbing woodcreepers (Aves: Dendrocolaptidae) were studied at a rain forest site in southeastern Peru. There are pronounced differences between the two guilds in the ecological, morphological, and spatial relationships of their member species. Within one guild, the "Pickers," overlap in food and microhabitat is extremely high, and spatial separation, maintained by interspecific aggression, is nearly complete. Larger, behaviorally dominant species are more abundant, defend smaller territories, and forage on richer substrates than do smaller species. In the other guild, the "Salliers," interspecific relationships fit the more conventional pattern: member species differ in prey preferences, tolerate interspecific spatial overlap, and do not fight between species. These differences may be traced to a fundamental inter-guild contrast in the energetics of prey capture.

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ECOLOGICAL IMPLICATIONS OF CRANIOMANDIBULAR MORPHOLOGY IN TROPICAL CAT ASSEMBLAGES.

R. A. Kiltie. Univ. of Florida, Gainesville.

Extending an earlier study on neotropical felids, I report results of a morphological analysis of African and Asian cat assemblages to test presumptions and predictions of coevolutionary theory. Multivariate analyses indicate that most interspecific variation is explained by size instead of shape; thus trophic ecological differentiation is likely to be well reflected in size differences. Intraspecific morphological variation is constrained, a prerequisite for coevolutionary divergence. Constant size ratios are not statistically verifiable for any complete cat assemblage. However, for the largest 4-5 species in South America and Asia, jaw length (gape) ratios are more even and minimum jaw length ratios are larger than expected by chance; "d/w" ratios exceed 2 in all cases; and species with a given size rank within an assemblage are larger when the largest species of that set is larger. Size differences among coexisting species do not apparently correspond to "nodes" in the distribution of available prey sizes. These results imply a role for interspecific competition in structuring ecological assemblages of larger cats.

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INVESTIGATING SPECIES TRANSFER USING LABORATORY MESOCOSMS. J. R. Pratt and J. Cairns, Jr. Virginia Polytechnic Inst. and State Univ., Blacksburg.

Transport of species to barren islands may require critical timing rather than constant provision of potential colonists. This study examined the effect of interruption of propagule transport from sources of differing composition on the colonization of nearby islands. Protozoan communities developing on polyurethane foam (PF) substrates were removed from natural systems and used as species sources in laboratory tanks containing PF islands. Sources were removed after exposures of 1, 6, 24, and 96 h and island colonization was compared to that in tanks where species sources were always present. Islands were sampled over a 28 d period. Results showed that increasing source exposure produced increasing numbers of colonizing species. Sources in early, non-interactive phases of colonization transferred greater proportions of species to islands than sources which had reached species equilibrium. All systems developed equilibria suggesting that these communities may have multiple stable states. The continuous supply of new colonists may not be necessary for effective community development on islands.

731

AN EVALUATION OF THE EFFECTS OF PREDATION AND FOOD ABUNDANCE ON DENSITIES OF LARVAL YELLOW PERCH AND DAPHNIA. W.M. Starkel* and R.M. Dawley. Univ. of Connecticut, Storrs.

The impact of larval yellow perch predation upon *Daphnia* size classes in a small lake is determined using population densities, measured predation rates, and estimates of *Daphnia* mortality and recruitment. The relationship between *Daphnia* densities and seston biomass is similarly analyzed. The young perch feed predominantly on small *Daphnia*, at a rate equivalent to recruitment. Cohort density declines precipitously in May, resulting in a short-lived effect upon *Daphnia*. This decline occurs after the density of small *Daphnia* has begun to increase. *Daphnia* abundance closely tracks the biomass of grazeable seston in spring and early summer. Thus, changes in vernal *Daphnia* populations are most closely related to the abundance of their food supply, even though the effect of perch predation is briefly apparent. On the other hand, the decline of larval perch is not easily attributable to scarcity of prey.

732

THE ZOOLOGY OF EPIPHYTIC LICHENS: FOOD WEBS IN AN ALGA-BASED SYSTEM. R. W. Fredrickson. St. Joseph's University, Philadelphia, PA.

The lichenized alga-fungus union is an autotroph-heterotroph system regularly supporting a food web of considerable taxonomic-ecologic diversity. Most conspicuous are Arthropoda, but also present may be a variety of invertebrates and even protists. These represent many trophic niches, including mycophagy, phycophagy, predation, parasitism, and detritivory. Current studies deal with arthropods, usually overwhelmingly mites (Acari), but including Insecta of several orders and occasionally other Arthropoda. Arboreal lichens are collected and identified; arthropods are collected, identified, and live samples maintained in microchambers for food preference study and observations on other facets of the interaction. Current studies are qualitative but will be supplemented by quantitative studies. It is suggested that at least some lichen-invertebrate associations may be more intimate than supposed—dissemination of propagules, fungal utilization of secretions, excretions, detritus, etc.

733

MACROINVERTEBRATE DRIFT ASSOCIATED WITH A DIKE FIELD IN THE LOWER MISSISSIPPI RIVER. R.E.Bowles*, C.H.Pennington and F.C.Howell. Univ. of Southern Mississippi, Hattiesburg, and Waterways Experiment Station, Vicksburg, Ms.

Surface drift samples were collected monthly from April to October, 1980, in the Cracraft Lower Dikes and the adjacent main channel of the Mississippi River south of Greenville, Ms. The monthly densities and spacial distribution of drift taxa within the area of the dike field are described. Major components were Hydra (60%) and Cordylophora (21%). The data suggest a seasonal trend in diversity and density that is high in the spring months and low in the fall. Dissimilarities among locations within the dike field, as well as the monthly differences, indicate that the annual fluctuation in river stage may be an important factor affecting the seasonal density and diversity of the drift community and the distribution of these organisms within the dike field.

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DISTRIBUTION OF POLYCHAETOUS ANNELIDS IN FOUR MICROHABITATS IN A SUBTROPICAL SEAGRASS MEADOW. B.M.S. Mahoney and F.G. Lewis, III*. Florida State Univ., Tallahassee and Harbor Branch Inst., Fort Pierce, FL.

Studies comparing the benthic macrofaunal communities of vegetated and un-vegetated sediments rarely sample specific microhabitats within the vegetated sites. In this study, core samples were taken on three dates (9/79;5/80;9/80) in four microhabitats in a seagrass bed in Apalachee Bay, FL. The sampling site consisted of a bare sand patch (5 x 10m) surrounded by a zone of Halodule wrightii, located in a dense bed of Thalassia testudinum. Cores (10cm depth) were taken a) directly on Thalassia shoots, b) in small sandy patches between Thalassia shoots, c) on Halodule shoots, and d) in the large sand patch. Highest densities and number of species were found in the vegetated microhabitats. Intermediate values were found in the between-blade sand patches, and lowest numbers occurred in the bare sand patch. The implications of these findings to previously collected seagrass samples require consideration.

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THE ROLE OF BEHAVIOR AND FLOW IN THE DISPERSAL OF MARINE MEIOFAUNA. M.A.Palmer Wabash College, Crawfordsville, Indiana

Counter to traditional concepts of meiobenthos, recent studies have shown that these animals occur regularly in the water column. This could be due to active (behavioral) processes or to passive (erosional) processes. A series of lab experiments were performed that showed meiobenthos of an intertidal mudflat did not behaviorally emerge in significant numbers. Field experiments demonstrated that the occurrence of meiofauna in the water was the result of mechanical removal due to currents scouring the bottom. The abundance of meiofauna in the water was determined primarily by the magnitude of the friction velocity (u^*), which is a measure of the erosive force of water flow at the sediment/water interface. The emerging concept is that in habitats where water currents are strong enough to cause sediment suspension, meiofauna dispersal may be a passive process of erosion that is modified by behavior patterns which make some species more or less susceptible to erosion. Experimental results suggest that in habitats with little flow or an abundance of aboveground structure (e.g., grass beds) behavioral emergence may be more common.

736

BIOTURBATION BY CALLIANASSID SHRIMP: REDISTRIBUTION OF RADIOACTIVE FALLOUT AT ENEWETAK AND BIKINI ATOLLS. T.H.Suchanek, West Indies Laboratory, Fairleigh Dickinson University, St. Croix, U.S. Virgin Islands. During feeding and burrowing, several species of ghost shrimp (Crustacea; Thalassinidea) process massive amounts of carbonate sediment (for some species nearly 1000cc/m²/day) and can dig to depths of over 2.0m below the sediment/water interface in the lagoons of Enewetak and Bikini Atolls. Layers of radioactive particles including ⁶⁰Co, ¹³⁷Cs, ²⁰⁷Pb, ²³⁹⁺²⁴⁰Pu and ²⁴¹Am (which have resulted from nuclear weapons testing during the 1950's) are concentrated at sediment depths of 60-80cm. Callianassids actively sort sediments at these depths, storing coarse-grained particles (>ca. 1.0mm) below the sediment surface. Finer-grained material (<ca. 1.0mm) is either incorporated into tunnel walls or pumped to the surface, forming mounds up to 20cm high. Once on the surface, radionuclides may be acted on by mobile invertebrates (over 50 spp. from 7 phyla) and/or fishes (over 60 spp. from 15 families) that disrupt the soft benthos. This redistribution of entrained radionuclides may facilitate their entry into (and possible concentration by) trophic pathways of invertebrates and/or vertebrates (including humans).

737

Biological and Contaminant Baselines in Oil and Gas Drilling Areas of Georges Bank and its Submarine Canyons. A.W. Hulbert, R.A. Cooper, J.R. Uzman. Univ. of New Hampshire, Durham, NH, and National Marine Fisheries Service, Woods Hole, MA.

In response to the possibility of exploratory oil and gas drilling on Georges Bank and the realization of a dearth of detailed information relative to potential drill sites, the National Marine Fisheries Service initiated an effort to establish critical habitat benchmarks. The result, part of the Northeast Monitoring Program (NEMP), has been the establishment of long-term site-specific stations which are studied in-situ by the use of the research submersibles Alvin and Johnson Sea-Link. A stratified monitoring program has been developed to establish habitat benchmarks, and track key indicators over a projected seven to ten years. Megabenthic community structure, abundance and contaminant body burdens are measured as are sediment characteristics. Calibrated camera systems quantitatively survey 10,000 to 18,000 m² of ocean floor at each of the present nine stations each year. Preliminary analyses of the results show stability of the individual habitats over the four years of study and low levels of contaminants.

738

PHYSICO-CHEMICAL FACTORS INFLUENCING TOXICITY OF ORGANOTIN COMPOUNDS TO CRAB ZOEAE, *Rhithropanopeus harrisi*. R. B. Laughlin, Jr., University of California, Berkeley, Naval Biosciences Laboratory, Berkeley, California.

This study was undertaken to determine which, if any, physico-chemical parameters would describe the toxicity of organotin compounds dissolved in seawater to crab zoeae, *Rhithropanopeus harrisi*. Zoeae were exposed for the duration of development to a series of di and triorganotin compounds. Toxicity was highly correlated with the Hansch parameter, an index of hydrophobic behavior. Thus, it appears that toxicity is mediated primarily by partitioning behavior rather than electronic effects of the tin atom.

739

ORGANIC LEVEL AND CALORIC CONTENT OF EGGS OF BROODING ASTEROIDS AND AN ECHINOID FROM KERGUELEN (SOUTH INDIAN OCEAN). J. M. Lawrence, J. B. McClintock, and A. Guille* Univ. of South Florida, Tampa, and Muséum National d'Histoire Naturelle, Paris.

Egg diameters (mm) of the asteroids *Diplasterias meridionalis*, *Anasterias perrieri*, and *Anasterias rupicola* and of the spatangoid echinoid *Abatus cordatus* were 2.79, 1.75, 1.37 and 1.34, respectively. The ratios (% dry wt) of soluble protein: lipid: carbohydrate were 44:36:0.4; 29:35:0.9; 37:26:1.0; and 33:35:2.1, respectively. The calories/egg were 38; 2.45±1.75; 4.69; 3.70±0.98, respectively. Brooded juvenile *A. perrieri* (1.46 mg dry weight, R=1.47 mm) had 7.85±1.5 cal/ind. Brooded juvenile *A. cordatus* (1.76 mg dry wt, LD=2.02 mm) had 4.17±0.06 cal/ind. There was little change in the amount of organic material during development in either species, but the amount of ash increased 5X in *A. perrieri* and 3X in *A. cordatus*. The significance of the large eggs in these echinoderms may be in the production of a large juvenile, and not in the provision of a large amount of energy for development. Supported by NSF grant DPP-8108992 to the senior author and by the Territoires Australes et Antarctique Français.

740

ASEXUAL REPRODUCTION BY A SYMBIOTIC SEA ANEMONE : SIGNIFICANCE OF ZOOXANTHELLAE. William S. Clayton, Jr. State University of New York at Buffalo.

Pedal laceration by symbiotic and aposymbiotic *Aiptasia pallida* was studied in the laboratory. Lacerates produced by symbiotic individuals had a significantly greater dry weight than lacerates produced by aposymbionts. This difference can be largely attributed to the presence of zooxanthellae in symbiotic lacerates. Development time and survival of lacerates to juvenile anemones was not significantly different for symbiotic and aposymbiotic lacerates and lacerate dry weight did not change during development. Pedal laceration was directly related to anemone density and inversely related to feeding regime. Zooxanthellal effects on pedal laceration were dependent on feeding regime and anemone density. These results suggest that zooxanthellae had no effect on lacerate development and that pedal laceration was related more to feeding regime and anemone density than to the presence of zooxanthellae in the lacerating anemone.

741

AN UNUSUAL MODE OF COPULATION IN THE NUDI-BRANCHS *POLYCERA ZOSTERA* AND *P. DUBIA*.

B.R. Rivest. SUNY at Cortland, New York.

The Pacific *Polycera zostera* and Atlantic *P. dubia* are perhaps unique among the hermaphroditic, reciprocally copulating nudibranchs in their reproductive tract morphology and mechanism of copulation. The vaginal duct, the normal entry point for exogenous sperm, is incomplete and appears vestigial in these species. This contrasts with the complete vaginal ducts found in three congeneric species. Copulation in *P. zostera* and *P. dubia* involves penetration of the body wall with a spined eversible penial cirrus. Successful insemination occurs when the cirrus penetrates through to the ovotestes and sperm are pumped into an accinus. The exogenous sperm pass anteriorly within the hermaphroditic duct, past the opening to the ampulla where the endogenous sperm are stored, and into the receptaculum seminis. Since copulations frequently result in sperm being pumped into the haemocoel where they are broken down by blood cells, the selection pressures resulting in this mode of copulation by hypodermic injection into the gonad remain enigmatic.

742

OVARIAN CONTROL OF VITELLOGENESIS AND OOSORPTION IN *CAPITELLA* - IMPLICATIONS FOR REPRODUCTIVE CYCLE REGULATION. K.J. Eckelbarger, P.A. Linley and J.P. Grassle. Harbor Branch Found., Ft. Pierce, FL and Marine Biological Lab, Woods Hole.

The ovary of *Capitella* is the most complex yet described in a polychaete. Two types of somatic cells are present in the ovary which probably have separate functions. Peritoneal cells which resemble podocytes of the mammalian glomerulus may play a role in the uptake of yolk precursors from the coelomic fluid. Follicle cells appear to synthesize yolk precursors for use by developing oocytes and to be involved in resorption of gametes. Follicle cell changes occurring during oocyte resorption are described. The ovary of this highly opportunistic polychaete may play a significant regulatory role in reproduction by controlling the uptake and production of yolk precursors and by resorbing mature oocytes in response to stress. The possible ecological consequences of oosorption in *Capitella* are discussed.

743

PROTO-OOGAMY, EMBRYOGENESIS AND HETEROCHRONY IN *Corbicula fluminea* (BIVALVIA: CORBICULACEA). Louise Russert Kraemer, Univ. of Arkansas, Fayetteville.

Unlike other hermaphroditic bivalved mollusks, *C. fluminea* initiates oogenesis before spermatogenesis, in its ontogeny. During seasonal reproductive cycles of *C. fluminea*, oogenesis is nearly continuous, but spermatogenesis is episodic and times the cycle. Embryological development follows both self-fertilization and cross-fertilization, and includes trochophore, veliger, pediveliger and juvenile stages, all of which occur within the inner gills. Byssus formation follows spawning. It is argued that the foregoing embryological sequence constitutes a "reverberating" reproductive pattern in which thousands of fully differentiated, tiny (250 μ m) juveniles are produced. When contrasted with the reproductive and developmental mode in the Pisidiidae (Corbiculacea), it appears that heterochrony is importantly involved in the ubiquitous distribution and large biomass of *C. fluminea* in the disturbed habitat of U.S. rivers.

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COELOMIC BROODCARE BY A PSOLID HOLOTHURIAN FROM BERMUDA AND THE CARIBBEAN. J.E. Miller. Harbor Branch Foundation, Inc., Ft. Pierce, FL.

Coelomic broodcare is reported for the first time in *Lissothuria antillensis* Pawson, the only psolid holothurian known to incubate its young internally. Large lecithotrophic eggs are retained in the ovarian tubules up to an average diameter of 400 μ m at which size the ovarian wall breaks down releasing the eggs into the coelom. The process by which fertilization occurs is unknown. Fully developed embryos hatch out as pentactulae which are brooded with more-advanced "juveniles". Adult females, 13-15mm total length (TL), may brood as many as 80-90 young simultaneously. The smallest adult found to be incubating young measured 6mm TL. The release of young has not been observed, but it appears that juveniles are expelled through the anus; adults known to have released young show no sign of external rupture and have tentacular crowns intact. Additionally, juveniles have been found in the cloaca of dissected specimens. At release, juveniles measuring 1.0-1.5mm TL have 8 tentacles, 3 pairs of tube feet and a well-developed skeleton of imbricating plates. Broodcare may be continuous; brooding adults have been found at Puerto Rico during February, May, July and October.

745

LIFE HISTORY OF ANOLPODIUM HYMANAE, A TURBELLARIAN FLATWORM FROM THE COELOM OF THE HOLOTHURIAN STICHOPUS CALIFORNICUS. G.L.Shinn. Univ. of Washington, Seattle.

Anoplodium hymanae is a member of the turbellarian family Umagillidae - the largest family of Turbellaria whose members are routinely symbiotic. A. hymanae has a direct life cycle with encapsulated embryos as the infective stage. Egg capsules are produced at a maximum rate of about 15/day and are released into the perivisceral coelom of the host. The capsules become encapsulated by host coelomocytes and then accumulated into large masses of coelomocytes. These masses pass out of intact hosts through any of a series of pores that were found connecting the coelom to the posterior end of the rectum. Some brown bodies with egg capsules may also be released if the host eviscerates, but evisceration is not required for completion of the life cycle. Embryogenesis lasts 30-35 days at 9-12 C, and may be completed before or after the capsules reach sea water. Fully developed embryos remain quiescent in their capsule until the capsule is ingested by a sea cucumber. Hatching is stimulated by some component of the host digestive fluids. Larvae penetrate the wall of the lower intestine of respiratory trees to reach the coelom.

746

TUBE-BUILDING IN A MARINE, BENTHIC COPEPOD. J.W. Fleeger and G.T. Chandler. Louisiana State Univ., Baton Rouge.

Previously, no confirmed reports of tube-building existed for copepoda (Crustacea). However, we have recently observed tube-building and tube-dwelling behavior in Pseudostenhelia wellsi, a meiobenthic harpacticoid inhabiting muddy, estuarine sediments. We placed P. wellsi in laboratory treated sediments packed into plexiglass chambers which were observed through side walls and above with a stereomicroscope. Regardless of sex or age, all individuals including nauplii were observed to begin tube-building within 30 min. Within 2 hr, tubes proliferated throughout the upper 0.4 cm of the chambers greatly altering sediment structure. The tubes are elongate (0.39 mm), narrow (0.27 mm) in diameter and have a tube cap extending 0.32 mm above the sediment-water interface. The tubes are a matrix of fine silt, sand and detritus cemented with mucus apparently secreted from glands in the ventrolateral margin of the cephalothorax. P. wellsi regularly moves through the tube, perhaps "working" or smoothing the mucus with its mouthparts and swimming legs.

747

A NEW MUTUALISM? THE SYMBIOSIS OF MOLGULID TUNICATES WITH THE PROTIST NEPHROMYCES. H.B.Saffo, Swarthmore College, Swarthmore, PA.

The physiological and morphological intimacy of endosymbioses has often limited experimental resolution of the nature and biological consequences of particular endosymbiotic interactions. In nature, all adult molgulid tunicates thus far examined possess a fungus-like endosymbiont, Nephromyces, in the renal sac. In the laboratory, however, we have been able to raise parallel populations of Nephromyces-infected and Nephromyces-free Molgula mannattensis, from early fertilization through sexual maturity. This long-term, developmentally oriented, comparative system provides the opportunity for critical analysis of the effects of Nephromyces on the biology of Molgula. Molgula acquires Nephromyces only after metamorphosis. When raised on phytoplankton diets, infected and symbiont-free Molgula show no significant difference in post-metamorphic growth or survivorship -- but Molgula may depend upon Nephromyces for normal reproduction. Preliminary evidence suggests that Nephromyces may catalyze the urate-containing concretions of the molgulid renal sac.

748

EFFECTS OF PREDATION BY THE NUDIBRANCH CUTHONA NANA ON INTRASPECIFIC COMPETITION IN HYDRACTINIA ECHINATA (HYDROZOA). N.C. Folino. Univ. of New Hampshire, Durham, N.H.

Hydractinia echinata is found primarily encrusting the shells of hermit crabs (Pagurus spp.). Each colony consists of a basal mat and stolons. When different strains of H. echinata come in contact, they do not fuse but produce hyperplastic stolons. This competitive interaction most often leads to one colony overgrowing the other. Field observations show that Cuthona nana preys specifically upon H. echinata. This study's objective is to determine if predation affects the growth patterns and competitive abilities of H. echinata. Hydractinia colonies were collected at Gosport Harbor, Maine and established in the laboratory on black plexiglass slides. All possible pair combinations were established among six strains to determine a competitive hierarchy. By using a camerulucida, growth patterns for two strains were determined. The effects of predation by Cuthona on the growth patterns and competitive abilities of the strains will be discussed.

749

THE OCCURRENCE OF THE SCALE WORM, *LEPIDONOTUS SUBLEVIS*, IN HERMIT CRAB-OCCUPIED GASTROPOD SHELLS FROM AN INTERTIDAL REGION OF N.J. N.A. Mercado. Pennsylvania State Univ., Ogontz Campus, Abington.

Periodic sampling of an intertidal area of Townsends Inlet, Cape May Co., N.J. was conducted to investigate the occurrence of the polynoid worm, *Lepidonotus sublevis*, with the hermit crab *Pagurus longicarpus*. Although *L. sublevis* is frequently cited in taxonomic literature as occurring with *P. pollicaris*, its occurrence with *P. longicarpus* has not been noted. Ten shell species were collected over a two-year period. The scale worm was not evenly distributed among these species. From 50-60% of such "large-shell" species as *Busycon* spp, *Lunatia heros*, and *Polinicies duplicatus* contained at least one *L. sublevis*. The worm was rarely collected in the "small-shell" species, i.e., *Llyanassa obsoleta* and *Nassarius trivittatus*. *L. sublevis* was found most frequently in shells occupied by male crabs. Over 50% of the male *P. longicarpus* occupied a shell containing at least one *L. sublevis*; while about 2% of the female crabs shared their shell with a worm. This relationship appears to be related more to crab size than to crab sex.

750

THE ROLE OF MEIOFAUNA IN AMMONIA REGENERATION AND NITRIFICATION. F.R. Cantelmo. St. John's University, Department of Biological Sciences, Jamaica, N.Y. 11439.

The influence of meiofauna populations on ammonification and ammonia oxidation rates has been investigated in incubated estuarine bottom water and sediment samples from Raritan Bay, Jamaica Bay and in model laboratory systems. By using selected inhibitors of ammonia oxidation (nitrapyrin) and nitrite oxidation (chlorate), it is possible to measure ammonia and nitrite accumulation in the incubated samples. Ammonification rates in water samples containing natural sediments with meiofauna are 3-4 times greater than either bottom water or sediment controls. In samples without nitrapyrin, the ammonia is rapidly oxidized to other nitrogenous species. Ammonia oxidation rates measured with chlorate indicate that there is some enhancement of nitrite production due to the presence of meiofauna but the main influence of meiofauna appears to be related to ammonia regeneration. (Supported by N.J. Sea Grant Proj. R/E/-6, NOAA Grant NA 81 AA-D-00065, Office of Sea Grant, Dept. of Commerce. The N.J. Sea Grant Program is managed by the N.J. Marine Sciences Consortium)

751

SAND DOLLAR AND SEA PANSY EFFECTS ON MEIOFAUNAL ABUNDANCE. E.L. Creed* and B.C. Coull, Univ. South Carolina, Columbia.

A field study was done on the effects of disturbance on meiofauna by sand dollars (*Mellita quinquesperforata*) and sea pansies (*Renilla reniformis*). Samples were sorted to major taxon including copepods, nematodes and gastrotrichs. Nematode and *Apodopsyllus unguiformis* (Copepoda:Harpacticoida) abundances were significantly decreased in the presence of *Mellita*. Harpacticoid copepod abundances decreased in the presence of *Renilla*. Planting of real and artificial (100% black silicone caulk) *Renilla* in the field indicated that the absence of copepods around *Renilla* was due to both physical and biological factors. Sediment displacement by the sea pansies primary polyp and peduncle and the varying depth of the redox layer required volumetric analysis to be used for quantifying meiofauna abundance. This is the least biased estimator when studying the effects of a structure (e.g. *Renilla*) in the sediment on meiofauna abundance and species composition.

752

EFFECT OF α -TOCOPHEROL (VITAMIN E) ON THE LIFESPAN OF THE BDelloID ROTIFERS *PLEURETRA*, *ROTARIA*, *HABROTROCHA*, AND *PHILODINA*. James R. Litton, Jr. Saint Mary's College, Notre Dame, IN.

Clones of the above bdelloid rotifers were studied to determine whether or not α -tocopherol extends their lifespan. α -tocopherol was solubilized in Tween-80 and dissolved in an aqueous culture medium. The addition of α -tocopherol to the culture medium at concentrations of 10^{-4} to 10^{-6} M resulted in a significantly larger lifespan in all genera. *Rotaria* and *Philodina* also showed a higher percentage of survival at a later age as compared to control groups. There was no significant difference in maximum longevity in the species studied. All four species showed an increased fecundity. Comparisons are made with other invertebrate and vertebrate organisms which have had vitamin E added to their diets.

753

COELOMATE ANIMALS ARE MONOPHYLETIC. J. G. Engemann. Western Michigan Univ., Kalamazoo.

Deuterostomes and protostomes are generally thought to be linked near the acoelomate flatworms. One phylum, the Pogonophora, has characteristics of both coelomate lines (chitin, a segmented posterior with setae, and anterior cephalic ganglia linked by two connectives; versus, deuterostome embryology and larval types nearly identical to hemichordate larvae), but was thought to be an aberrant, dead-end phylogenetically. The contradictory approaches, wherein some authors relate Pogonophora to deuterostomes, whereas others relate them to protostomes, are resolved by using them (or their near ancestors) as the link between the two coelomate lines.

Temporary loss of the digestive system and a vertical, tube-dwelling orientation were necessary intermediate steps taken by the Pogonophora from annelid ancestors to allow deuterostomes the (1) new embryological origin of the gut, (2) fusion of ganglia forming the brain, and (3) reversed relative position of the main nerve cord as well as aortic circulatory direction.

The close relationship of coelomate protostomes to deuterostomes makes them better prototypes for medical research. (The aid of a Western Michigan University Faculty Fellowship/Grant is acknowledged.

754

MOVEMENTS OF THE TONGUE OF THE WALRUS DURING SUCTION FEEDING: A NOVEL OR A FUNDAMENTAL MAMMALIAN FEEDING MECHANISM? K.R. Gordon. Florida International University, Miami.

Movements of the tongue of the walrus during suction feeding were inferred using observed behavior, the mechanics of extrinsic musculature, and the patterns of tongue-generated tooth wear. Movements of implanted markers in the tongues of the pig and dog during suckling (Procter-Gray and Crompton, 1981), and of natural markers in the tongues of infant and adult humans during suckling and suction drinking (Ardran and Kemp, 1955; Ardran, Kemp and Lind, 1958) were described from cineradiographs. The tongue is not moved in the same manner at the same times during suckling or suction drinking within the mammals studied. Tongue markers moved in clockwise orbits in the walrus, human and pig, and counterclockwise orbits in the dog. Further, dorsal-ventral movements of the middle and posterior markers were in phase in the walrus, human and dog, and out of phase in the pig. Suction feeding in the walrus appears most similar to suckling in the infant. Suckling appears to have a great amount of intraspecific and interspecific variation, and appears to be mostly a learned behavior.

755

COMPARATIVE ANATOMY AND EMG OF THE MASTICATORY MUSCLES OF WOODCHUCKS AND MOUNTAIN BEAVERS. R.E. Druzinsky. Univ. of Illinois, Health Sci. Cntr., Chicago.

The mountain beaver, *Aplodontia rufa*, is often considered the most primitive living rodent because it lacks both the sciuromorphic extension of the m. masseter lateralis onto the maxilla anterior to the zygomatic arch and the hystricomorphic portion of the zygomaticomandibularis (m. masseter medialis) that runs through the infraorbital foramen. Even so, the masticatory muscles of *A. rufa* and the sciurid rodents are strikingly similar. The topographic relationships of the origins and insertions of the m. masseter superficialis, m. masseter lateralis, and zygomaticomandibularis are virtually identical. Electromyographic studies have been performed on the masticatory muscles of mountain beavers and woodchucks (*Marmota monax*) during feeding. The results demonstrate that the timing of activity of anatomically similar muscles during masticatory cycles is the same in *A. rufa* and *M. monax*. (Supported by grants from Sigma Xi and NIH 1 R03 DE 6279.)

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MAXIMUM ISOMETRIC FORCE IN THE MASTICATORY MUSCLES OF RABBITS. P.C. Dechow, P. Guelinckx*, S. Riolo*, D.S. Carlson* and J. A. Faulkner*. The University of Michigan, Ann Arbor.

The masticatory apparatus in 8 young adult rabbits was evaluated through a multifaceted approach including studies of (1) craniofacial structure, (2) maximum isometric muscle force, and (3) histochemical muscle structure. Isometric force was evaluated by stimulating all masticatory muscles maximally and measuring interincisal occlusal force, and by measuring contractile properties of individual whole masticatory muscles.

Average stimulated occlusal force was 67.5 N (s=22.5). Mean isometric forces were 76.4 N (s=7.8) for combined unilateral masseter and medial pterygoid muscles and 3.9 N (s=2.0) for superficial temporalis. Interincisal occlusal force was predicted from force measurements taken from individual muscles and craniofacial dimensions. Predicted occlusal force readings underestimated actual measured values by an average of 26% although a strong linear relationship was found between them ($r=.82$).

Supported by NIH grants DE05271, DE05232 and NS17017.

757

ONTOGENY OF COMPLEX ACTIVITY PATTERNS IN MASTICATORY MUSCLES. L.E. Wineski and S.W. Herring. Morehouse School of Medicine, Atlanta, GA, and Health Sciences Center, Univ. of Illinois at Chicago.

Differential activity occurs within the masticatory muscles of a variety of adult herbivorous mammals and is usually associated with grinding mastication. Infant mammals have complex muscle architecture, but suckling and other early oral activities presumably require only simple jaw movements. A longitudinal EMG study of the Mm. masseter and temporalis in 8 domestic pigs aged 9 days to 5 weeks revealed: (1) sucking and drinking are fast (3.5-4.0 cycles/sec) and involve slight jaw closing movements produced by uniform activity in all parts of the adductor muscles; and (2) chewing is slower (2.0-2.7 cycles/sec) and involves transverse jaw movements produced mainly by alternating contractions of right and left side muscles, rather than by intramuscular differential activity as in older pigs. Muscle activity became gradually more heterogeneous with age, correlated with increased rate of mastication (2.5-3.0 cycles/sec at 6-8 weeks) and grinding of harder food items.

Supported by PHS DE 5905.

758

COMPARISON OF JAW MUSCLE USE AND SKULL SHAPE IN TWO TYPES OF CANINE USE IN CARNIVORES. Stuart O. Landry. State Univ. of New York, Binghamton.

The canine is employed in killing by carnivores in two different ways. In one group, typified by cats or mustelids, the prey is killed by the "nape bite", in which the canine is driven through the neck into the medulla. In a second, typified by dogs and hyenas, the canines are used to rip and tear.

Specimens of cats, dogs, and minks were dissected, the jaw muscles divided into six or seven masses, whose cross-sectional areas were measured. Direction of pull of each mass was established as well as the angle of pull with the lever arm of the upper canine. From this was calculated the relative force contributed by each mass to the bite. In all cases, the deep temporal contributed the most force, but in the dog forms, this muscle was short and long in the cat forms. The cat canine must be driven some distance, while the dog canine is merely held by the temporal while other muscles do the work of tearing.

759

EVOLUTION OF A NOVEL MASTICATORY APPARATUS IN A LINEAGE OF CERCOPIITHECOID PRIMATES. N.G. Jablonski. Univ. of Hong Kong, Hong Kong.

The evolution of species of *Theropithecus* during the African Pliocene was coupled with the evolution of a masticatory apparatus characterized by relatively high-crowned and complex molars, a temporomandibular joint placed high above the occlusal plane, and a large and anteriorly situated temporalis muscle. One of the lineages that evolved from a short-muzzled ancestral form of *Theropithecus* comprised three longer-muzzled species, *T. baringensis*, *T. quadratiostris*, and *T. brumpti*. The increase in muzzle length during the evolution of this lineage was accompanied by changes in the relative sizes and importance of the temporalis and masseter in the three species. Compensating for a reduction in the mechanical advantage of the temporalis were an increase in the size and an anterior shifting of the origin of the masseter (as reflected by the robustness and anterior flaring of the zygomatic arches). This is viewed as a novel solution to the problem of maintaining, as muzzle length increased, high occlusal pressures over the anterior molar row.

760

SKULL DEVELOPMENT AND ROOFING PATTERNS IN AUSTRALIAN CERATODONT LUNGFISH. A. Kemp. Queensland Museum, Australia.

Taxonomy of Australian fossil ceratodontids has been based on tooth plates and associated jaw bones only. Relationships with the recent Australian lungfish *Neoceratodus forsteri* and with other lungfish material are difficult to determine. The calvarium of *N. forsteri* has a pattern of two medial bones, flanked by a single centrolateral bone and by two lateral bones of unequal size of which the more posterior carries the jaw articulation. Similarly patterned centres of ossification occur in larvae. Recent finds of Miocene fossils from Australia reveal that *N. gregoryi* (White 1925) has a roofing bone pattern similar to that of the recent species but the shapes of the bones are different. The anterior median rostral bone is pentagonal with numerous projections on its external surface. *Gosfordia truncata* (Triassic, New South Wales) has two medial bones, flanked by three centrolateral and two lateral bones, all of roughly equal size. The more anterior of the lateral bones carries the jaw articulation. Analysis of skull roofing patterns and comparison with published work show that the calvaria of ceratodont lungfish are simpler than once thought, and may help to reduce the plethora of described genera.

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KINEMATICS AND ELECTROMYOGRAPHY OF FEEDING IN THE LUNGFISH LEPIDOSIREN PARADOXA. W.E. BEMIS and G.V. LAUDER. Univ. of Chicago, Chicago.

Small *Lepidosiren* feeding on earthworms show extensive variation in 4 kinematic measurements. The average strike took .30 s; cranial elevation peaked at .16 s, gape at .19 s, and hyoid depression at .27 s. Interlocking upper and lower lips limit lateral water influx. Strike kinematics are comparable to those of other fish and salamanders. The depressor mandibulae is the first cranial muscle active in a strike, and is the only muscle used in the initiation of slow strikes. Chewing consists of a series of 2-5 chewing bouts with interposed pauses. Crushes, in which food is masticated between the tooth plates, are the predominant cyclic activity within a chewing bout. Between successive crushes, food may be moved out of or into the mouth to position it between the tooth plates. Such movements of the food result from constriction and suction. Constriction is correlated with interhyoid activity; this behavior is also used to push food into the esophagus when chewing is completed. Suction during a chewing bout is kinematically similar to a strike. This hydraulic food transport system has a function analogous to the food positioning role of tetrapod tongues. Support by PHS 1 F32 DE-05352-01 to W.E.B.

779

INSULIN EFFECTS *IN VITRO* ON PROTEIN METABOLISM AND GLYCOGEN CONTENT IN HEPATOCYTES OF JUVENILE SALMON. E. Plisetskaya, S. Bhattacharya, W.W. Dickhoff and A. Gorbman.

Hepatocytes isolated from coho salmon *Oncorhynchus kisutch* were incubated for 24 hr at 20° in isotonic salt solution containing glucose, albumin, antibiotics, 19 amino acids without leucine. C¹⁴-leucine (0.5 μ Ci, specific activity 342 mCi/mmol) was added to each incubation dish containing about 10⁶ hepatocytes in 1.5 ml of medium. Salmon (*O. gorbuscha*) insulin was added 3hr after the start of incubation. TCA-precipitable and TCA-soluble radioactivity was measured in cells and medium. Glycogen and glucose contents were determined enzymatically in cells incubated without C¹⁴-leucine. Insulin (10⁻⁷ M) caused a significant increase in TCA-precipitable radioactivity in cells and medium. The maximal effect appeared at a hormone concentration of 10⁻⁷ M. Uptake of C¹⁴-cycloleucine by hepatocytes was also stimulated by insulin. Increased glycogen content was observed at 10⁻⁷ M insulin. The results suggest that salmon insulin stimulates protein and glycogen metabolism by salmon hepatocytes. (Supported by NSF Grant PCM 8215041 and Washington Sea Grant Project R/A -18)

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HORMONAL REGULATION OF LIPID MOBILIZATION IN FISH: EFFECT OF EPINEPHRINE AND NOREPINEPHRINE ON FREE FATTY ACID RELEASE FROM COHO SALMON (*ONCORHYNCHUS KISUTCH*) LIVER INCUBATED *IN VITRO*. M.A. Sheridan. University of California, Berkeley.

Free fatty acid release was measured continuously by pH-stat titration from 0.1-0.2 mm thick coho salmon liver slices incubated *in vitro*. Basal release, and the effects of two catecholamines: epinephrine (EP) and norepinephrine (NE), were determined. All measurements were performed on fish fasted for 72-96 h, and tissues were removed from all animals between 0900 and 1200. Basal free fatty acid (FFA) release was constant during the course of the 20-min incubation and averaged 0.037 \pm 0.009 μ mol FFA released/g/min. NE stimulated FFA release in a dose-dependent manner, with a minimum effective dose of 2ng/ml. ED₅₀ was 50 ng/ml; maximal stimulation, increasing FFA release to 2.32 \pm 0.29, occurred at 500 ng/ml. EP did not significantly increase FFA release above basal levels at any concentration tested. These results suggest that coho salmon possess a hormone-sensitive lipase system in the liver that is preferentially activated through β -adrenergic receptor interactions. (Aided by Calif. Sea Grant R/F-78 and NSF grant PCM 81-10111 to H.A. Bern)

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CIRCADIAN RHYTHMS OF INSULIN AND HIGH DENSITY LIPOPROTEIN-CHOLESTEROL IN THE BLOOD OF GOLDEN HAMSTERS. A.H. Cincotta and A.H. Meier. Louisiana State University, Baton Rouge, LA.

Plasma concentrations of high density lipoprotein-cholesterol (HDL-C) and immunoreactive insulin were determined at six times of day in golden hamsters (light: 0800-1800). A dramatic bimodal rhythm of HDL-C was observed with peaks at 1200 and from 2400-0400. Plasma HDL-C levels varied by 5-fold (from 26.7 to 141.7 mg%) during the day. Plasma insulin levels were low (21 uU/ml) during the light and a single peak (44uU/ml) occurred during the dark (2400-0400). These data suggest that 1) assay of plasma HDL-C concentrations without regard to time of sampling is an inappropriate methodology, and that 2) insulin alone cannot account for the daily variations in plasma HDL-C.

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INSULIN DEGRADATION BY MAMMARY EXPLANTS.

D.W. Borst. Univ. of Connecticut, Storrs.

The degradation of insulin by mammary tissue was studied by incubating mammary explants in Waymouth medium supplemented with low doses (1-10 ng/ml) of the hormone. The presence of immunoreactive material was measured after various culture periods by RIA. In the absence of tissue, insulin levels were not changed after 12 hours. The presence of tissue from mid-pregnant mice caused the rapid loss of insulin from the culture medium, with less than 20% remaining after 12 hours. This drop was only partly decreased by the presence of protease inhibitors (pepstatin, trypsin inhibitor), was dependent upon the continued presence of explants, and was not reduced in explants that were extensively rinsed before incubation. To maintain low insulin levels relatively constant, the culture medium was changed every three hours. Under these conditions, 3 ng/ml of insulin caused a rise in explant DNA synthesis to 80% of the maximum, a ten-fold greater sensitivity than that of explants maintained without changing the medium. These data indicate that degradation may be partly responsible for the hyperphysiological doses of insulin required for the stimulation of mammary explant DNA synthesis. (Supported by grant BC-344 from the American Cancer Society).

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VITAMIN D DEPENDENT INTESTINAL CALCIUM BINDING PROTEIN IN THE RAT. W. B. Rhoten,¹ M. E. H. Bruns*² and S. Christakos.*¹

¹ UMDNJ-New Jersey Med. Sch., Newark, and ² Univ. of Virginia Med. Center, Charlottesville.

A vitamin D dependent calcium binding protein (CaBP) from rat intestine (10,000 Mr) was characterized and localized by immunocytochemistry. The amino acid composition of RiCaBP was similar to that of bovine and porcine intestinal CaBPs. Rat intestinal (RI) CaBP was not an activator of brain phosphodiesterase, similar to rat renal CaBP but unlike calmodulin. RiCaBP was localized using an antiserum prepared against highly purified RiCaBP and the unlabeled antibody peroxidase - antiperoxidase technique. RiCaBP was localized specifically to the cytoplasm of the absorptive cells of the intestine. Reaction product was greatest at the apical end of the absorptive cells. Goblet cells and submucosal glands were negative. RiCaBP was present in intestine from fetal rats. Although the physiological role of the vitamin D dependent CaBPs is unknown, this study indicates that the rat intestine may be a useful model to explore the function of CaBPs, e.g. regulation of enzyme activity.

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AVIAN CARDIOVASCULAR RESPONSES TO ANGIOTENSIN AND VASOTOCIN. J.X. Wilson, Univ. of Saskatchewan, Saskatoon, Canada

The effects of age and sympathetic nervous activity on cardiovascular responses (cardiac frequency, fH; arterial pressure, Pa; ischiatic arterial blood flow, Qi) to 1-norepinephrine (NE), angiotensin II (ANG II) and arginine vasotocin (AVT) were studied in conscious Pekin ducks (*Anas platyrhynchos*). Resting Pa and hematocrit were higher, and fH lower, in adults (6-9 months post-hatch) than in immature (14-39 days post-hatch) ducks. NE and ANG II exerted a more potent pressor action in adults. Adults also showed a greater tachycardiac response to AVT (0.1 - 1 nmol/kg i.v.). Chemical sympathectomy (6-hydroxydopamine hydrobromide, 50 mg/kg/2 days i.p. for 19-36 days) in immature ducks enhanced the pressor response to NE (10 nmol/kg i.v.). Responses to ANG II (1 - 10 nmol/kg i.v.) in sympathectomized ducklings were biphasic: a depressor phase, accompanied by elevated fH and diminished Qi, preceded the normal pressor phase. These results demonstrate the influences of age-dependent changes in cardiovascular reactivity and sympathetic nervous tone on responses to ANG II and AVT.

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CIRCULATING CATECHOLAMINES: EVOLUTIONARY ASPECTS. L. Dashow, B. Nibbio and A. Epple. Thomas

Jefferson University, Philadelphia, Pa.

While it appears that dopamine (DA), norepinephrine (NE) and epinephrine (E) occur in all vertebrates, variations of their functions are poorly understood. In the lamprey (*P. marinus*), the CAs are messengers of an intrinsic cardiovascular control system, in which E stimulates the release of DA and NE. In the eel (*A. rostrata*), both E and NE stimulate the release of the other two CAs. Fast cardiovascular actions of the CAs are known for all groups of vertebrates. However, the glycemic response to physiological doses of E seems to have evolved in three steps: no response (lamprey stage); late response (lower gnathostomes); fast response (homeotherms). In both lamprey and eel, the reported effects of E depend on a spurt-like increase of its plasma titer. Supported by NIA grant AGO 1148 and NSF grant PCM 8209263.

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THE ADRENAL MEDULLA AND RELATED TISSUES: A PHYLOGENETIC REVALUATION. A. Epple and L. Dashow. Thomas Jefferson University, Philadelphia, PA.

Though many authors refer to the adrenal medulla as a modified sympathetic ganglion, there can be little doubt that this organ evolved directly, without a nervous "interstage", by accumulation of paraneurons. The ancestral condition is exemplified by the scattered, noninnervated chromaffine cells of the cardiovascular system of the cyclostomes. Among the gnathostomes, there is a trend to (a) remove these cells from the heart and large blood vessels, (b) aggregate them in distinct locations, (c) take them under nervous control. In mammals, this results in three distinct types of organs: (1) interoceptors (aortic, carotid and supracardiac bodies); (2) paraganglia; (3) adrenal medulla. Our recent studies suggest that, in gnathostomes, the adrenal medulla becomes integrated in a neuroendocrine circuit for stress responses. Supported by NIA grant AG0 1148 and NSF grant PCM 8209263.

787

IONIC AND OSMOTIC REGULATION IN FRESHWATER MUSSELS. J. I. Scheide and T. H. Dietz, Louisiana State Univ., Baton Rouge.

Sodium transport is stimulated by a serotonin (5-HT) sensitive adenylate cyclase system. 5-HT (0.1 mM/l) in pondwater (PW) not only stimulates Na transport, but results in mussels gaining water 1.42 ml H₂O (g dry tissue)⁻¹ above controls during a 4 hour exposure. Stimulated Na transport rates are similar to those reported for sodium ion depleted mussels. Amiloride (0.5 mM/l) inhibited approximately 90% the Na influx stimulated by 5-HT (0.1 mM/l in pondwater) and dibutyryl₁cAMP (injected, 0.98 μM (g dry tissue)⁻¹). Isolated gill (the site of Na transport) cAMP levels were increased significantly above basal with 1 min incubations of 5-HT, dopamine, norepinephrine or epinephrine and remained elevated above basal after 20 min. Maximal monoamine stimulation of gill tissue cAMP occurred at 0.1 mM/l, however tissue levels were significantly increased by 5-HT and dopamine at 0.01 mM/l. A serotonin-cAMP mechanism regulates sodium and water homeostasis in freshwater mussels. Supported by NSF-PCM 79-21089-02.

788

EVIDENCE FOR AN AMILORIDE SENSITIVE Na⁺/NH₄⁺ EXCHANGE MECHANISM IN OSMOCONFORMING MARINE INVERTEBRATES. Hunter, K. C. and L. B. Kirschner. Southwestern College, Winfield, KS, Washington State University, Pullman.

The presence of an extrarenal amiloride-sensitive ion transfer mechanism was investigated in 4 species of marine invertebrates. Net NH₄⁺ outflux, net H⁺ outflux and total Na⁺ influx (J_{in}^{Na}) were measured in 100% seawater and 100% seawater + 1 x 10⁻⁴ amiloride. In the porcelain crab, Petrolisthes cinctipes, and the rock crab, Cancer antennarius, NH₄⁺ outflux was significantly reduced by treatment with amiloride (57% and 32% reductions, respectively). H⁺ outflux however, was not affected by amiloride in either crab. J_{in}^{Na} was determined in Petrolisthes; the flux was relatively high (50-350 mM g⁻¹ h⁻¹) and was reduced (~15%) by amiloride. NH₄⁺ outflux in both the mussel, Mytilus californianus, and the errant polychaete, Nephtys caecoides, was the same in control and amiloride-treated animals. H⁺ outflux in Nephtys was also unaffected by amiloride treatment. The 2 osmoconforming crabs studied appear to have a Na⁺/NH₄⁺ exchange system, whereas the mussel and the polychaete may lack such a system. (Supported by NSF, PCM 8003800)

789

AMINO ACID INHIBITION OF INTESTINAL ALKALINE PHOSPHATASE IN THE RAINBOW TROUT. K. W. Gasser and L. B. Kirschner. Washington State University, Pullman.

Alkaline phosphatase from the intestine of rainbow trout appears to function in the salt and water transport mechanism. The specific activity of intestinal alkaline phosphatase in saltwater adapted trout is four-fold higher than freshwater trout. Inhibition of alkaline phosphatase by incubation with 30 mM phenylalanine in saline significantly reduces water absorption in everted intestine bags. All amino acids (19) tested in alkaline phosphatase assays exhibit at least 50% inhibition at a level of 20 mM. The magnitude of enzyme inhibition is strongly correlated with the affinity of each amino acid for Zn²⁺, a required metal cofactor. Addition of Zn²⁺ to the reaction mixture or preincubation of Zn²⁺ with the amino acid completely suppresses the inhibition due to the amino acid. The level of Zn²⁺ required for restoration of activity varies with the amino acid. The inhibition may take the form of an Enz · Zn²⁺ - A.A. complex as dialysis of an enzyme - amino acid mixture removes the amino acid and restores the activity without the addition of Zn²⁺. (Supported in part by NSF Grant PCM 8003800)

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db-cAMP INCREASES THE BASOLATERAL Na CONDUCTANCE IN Aedes MALPIGHIAN TUBULES. K.W. Beyenbach, Cornell Univ., Ithaca, N.Y.

Dibutyryl-cAMP stimulates fluid secretion 250% in isolated Malpighian tubules of Aedes aegypti by increasing Na and Cl secretion with no change in K secretion. Concomitantly the transepithelial voltage (V_T) increases (44→99 mV, lumen-positive) and the resistance falls (21→14 K Ω cm) consistent with stimulation of active Na transport via transepithelial conductance changes. The present study was conducted to probe the basolateral membrane for db-cAMP induced conductance changes. The basolateral membrane potential (V_{b1}) of principal cells only was measured with conventional microelectrodes with respect to ground in the bathing Ringer. Control V_{b1} measured -74.5 \pm 1.5 mV SE (87) and was promptly depolarized to -34.8 \pm 3.3 mV (15) in the presence of bath db-cAMP (10^{-4} M). Replacement of bath Na (Δ 120 mM) with TMA hyperpolarized V_{b1} by 10.3 \pm 0.6 mV (7) in the absence and by 22.7 \pm 1.5 mV in the presence of db-cAMP. db-cAMP had only minor effects on V_{b1} changes resulting from either bath K or Cl replacements. These results demonstrate that db-cAMP selectively increases the basolateral membrane conductance for Na. Consequently V_{b1} depolarizes and V_T hyperpolarizes consistent with stimulation of active Na secretion. Supported in part by NIH AM 26633 and NIH AM 31291.

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PRELIMINARY ISOLATION OF DIURETIC FACTORS FROM MOSQUITO HEAD EXTRACT. D.H. PETZEL, H.H. HAGEDORN, K.W. BEYENBACH, Cornell University, Ithaca, N.Y.

We reported previously (J. Comp. Physiol. 149: 511, 1983) that a crude head extract (HE) of Aedes aegypti stimulates fluid secretion in isolated Malpighian tubules (MT) by increasing active Na and K secretion in parallel with the fall of the transepithelial voltage (V_T) to 0 mV. We have now used reverse-phase HPLC columns (0 to 60% acetonitrile, CH₃CN) to identify the diuretic factor(s) present in HE. Three fractions eluting at 24, 27 and 30% CH₃CN had effects on isolated MT's. The first two (24 and 27% CH₃CN) depolarized V_T to 0 mV identical to the crude HE effect. The factor present in 24% CH₃CN has a MW=2400 daltons. It also stimulated fluid secretion in isolated MT's and in intact mosquitoes after injection. Diuretic activity was lost after Pronase E treatment. The factor present at 30% CH₃CN hyperpolarized V_T . This effect is similar to the effects of cAMP which stimulates fluid secretion by stimulating Na secretion and not K secretion. The data support the hypothesis that crude HE contains at least two possible diuretic factors that may increase fluid secretion by stimulating different ion transport mechanisms.

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THE ULTRASTRUCTURE OF THE TICK SALIVARY GLAND ACINI RESPONSIBLE FOR THE SECRETION OF THE HYGROSCOPIC FLUID AND LOCALIZATION OF Na⁺,K⁺-ATPase. G.R. Needham, L. Greenwald, T.J. Freda*, & L.B. Coons. Ohio State Univ., Columbus, and Memphis State Univ., TN.

Unfed ticks utilize saliva to absorb vapor from unsaturated air and to maintain hemolymph homeostasis. We redescribed the ultrastructure of the agranular acini of the female A. americanum. The central lamellate cell (formerly the central cell) extends from the hemolymph to the acinus lumen and is likely responsible for the primary secretion. Peripheral lamellate cells (formerly pyramidal cells) interdigitate with the central lamellate cell, and is located on the hemolymph side but does not contact the lumen. It may create local ion and osmotic gradients for the concentration of ions in the saliva. Na⁺, K⁺-ATPase was localized in the basal infolds of both cell types. We also analyzed dopamine-stimulated saliva and the hemolymph, finding the saliva to be hyperosmotic and ion concentrations (Na, K, Cl) to be 23-46% higher in the saliva. The role of the saliva in vapor absorption remains unclear, but the dopamine-stimulated fluid does not have ion concentration and the O.P. necessary to lower the vapor pressure to the CEH for this tick. The characterization of 'natural' saliva will be necessary before a definitive model for vapor absorption by ticks can be made.

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ELECTROPHYSIOLOGY OF THE ALLANTOIC MEMBRANE OF THE CHICK EMBRYO. B. E. Dunn and S. C. Brown, Yale Univ., New Haven and SUNY @ Albany.

A technique has been developed to remove the chorionic portion of the composite chorioallantoic membrane in Days 9 to 19 chick embryos. When a functionally isolated allantoic membrane is placed in a Ussing chamber and bathed on both sides with Eagle's minimal essential medium or avian Ringer, it develops an electrical potential (serosa positive) of 5.2 \pm 0.7 (Day 9) to 13.6 \pm 2.2 mV (Day 19). Short circuit currents (SCC) in these preparations range from 14.7 \pm 1.6 to 23.9 \pm 0.8 μ A \cdot cm⁻², with resistances of 361 \pm 41 to 597 \pm 90 Ω \cdot cm². Amiloride (10^{-4} M) applied mucosally, ouabain (10^{-4} M, 10 min exposure) applied serosally, or replacement of media with sodium-free solutions all reduced SCC by 87% or more. Nystatin (mucosal) increased SCC in a concentration-dependent fashion. These data suggest that the avian allantoic membrane actively transports sodium from the allantoic fluid and may be an important site for salt regulation in the developing embryo.

(Supported in part by NSF grant PCM-79-22793.)

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THE EFFECT OF SALINE ACCLIMATION ON WATER AND SODIUM TRANSPORT ACROSS THE SMALL INTESTINE OF DUCKLINGS, GULLS AND QUAIL. J.R. Roberts and M.R. Hughes, Univ. of British Columbia.

The uptake of water and sodium across everted sacs of jejunum and ileum of freshwater and saltwater acclimated Pekin ducklings, nestling Glaucous-winged gulls and adult Japanese quail was measured. Saline acclimation significantly increased the uptake of water and sodium across some middle regions of small intestine of larger ducklings and across the posterior small intestine of gulls. Apparent increases in mean values for saline acclimated smaller ducklings and decreased uptake in saline acclimated quail were not statistically significant. These data suggest that an increased uptake of water and sodium following saline acclimation is correlated with the presence of functional salt glands. Adult ducks and gulls were stomach loaded with $^{22}\text{NaCl}$ and the uptake of ^{22}Na in the blood monitored when birds were freshwater then saltwater acclimated. Saline acclimation had no consistent effect on the rate of uptake of isotope or on the equilibrated specific activity of the blood. The avian small intestine may be of minor importance in maintenance of salt and water balance.

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COHO SALMON GILL MORPHOLOGY DURING SMOLTIFICATION. N.H. Richman, S. Tai de Diaz[†], R.S. Nishioka and H.A. Bern. Univ. California, Berkeley.

Anadromous salmon in fresh water develop seawater (SW) osmoregulatory mechanisms during smoltification. Changes in gill chloride cells were studied during development of these mechanisms. Gill filaments were examined by scanning electron microscopy (SEM) biweekly from mid-February to the end of May. Selected filaments were further examined by light and transmission electron microscopy (LM and TEM). SEM and TEM examination of pre-smolts showed degenerating mitochondria-rich (MR) cells protruding from the surface of the secondary lamellae. In April, a change from a sparse to a dense population of MR cells was observed by LM and TEM. SEM revealed extensive infolding in the secondary lamellar epithelium in May. The MR cells in February were less electron-dense with spheroidal mitochondria, whereas the MR cells in April were more electron-dense with rod-shaped mitochondria. Increased gill Na^+, K^+ -ATPase levels (analyzed by W. Zaugg) in April are consistent with the change in MR cell density and suggest that SW adaptability is greatest during this period. (Supported by Calif. Sea Grant Project R/F-78 and NSF grant PCM 81-10111)

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BIOLUMINESCENCE DURING DEVELOPMENT IN THE HYDROZOAN PHIALIDIUM. C. Freeman and E.B. Ridgway. Univ. of Texas, Austin and Medical College of Virginia, Richmond.

The Phialidium egg contains a Ca-activated photoprotein. Spontaneous light production during development was measured with a photomultiplier. Pieces of ovary show a transient increase in light emission just prior to spawning. Embryos produced little or no light from prior to the first cleavage to gastrulation. During gastrulation short light bursts (SLBs) of variable magnitude begin to appear. Initially the SLBs are sporadic, however as the planula forms they occur more and more frequently. During metamorphosis of the planula there is a dramatic increase in the magnitude and frequency of the SLBs. The light producing potential at different days of development has been measured following detergent or DMSO treatment. There is a linear decrease in light producing potential as a function of developmental age. Following metamorphosis there is a steep decline in light producing potential. After metamorphosis green fluorescent photocytes begin to appear in the base and stalk of the polyp. Supported by NIH grants GM20024 and NS10919.

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AN SEM ANALYSIS OF EARLY DEVELOPMENT IN PENNARIA TIARELLA. V. J. Martin and M. B. Thomas, Univ. of Louisville, Louisville, KY and Univ. of North Carolina, Charlotte.

Observation of a previously undetected indentation at one pole of live gastrulae prompted a reexamination, using scanning electron microscopy (SEM), of early development in the hydroid Pennaria tiarella. Embryos were fixed during cleavage, gastrulation, and early and mature planular stages. Examination of cleavage stages revealed that the surface of the blastomeres was either bumpy or smooth, depending presumably on the stage in the mitotic cycle. In late gastrulae an indentation at one pole was clearly detectable. By immobilizing living embryos and monitoring their development it was determined that the indentation at gastrulation occurred at the prospective anterior end of the planula. Examination of young planulae showed no indication of the continued presence of the indentation, thus demonstrating that it is not the same structure as the indentation seen at the anterior end of the planula just prior to metamorphosis. Mucus cells, previously reported to appear in the young planula, were seen by SEM to occur in small numbers in the late gastrula. Sectioned material will be used to investigate further the processes revealed by SEM.

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THE TRANSLATIONAL CONTROL OF ACTIN SYNTHESIS DURING ILYANASSA EMBRYOGENESIS. J. R. Collier. Brooklyn College, N. Y.

The synthesis of the actins has been studied by two-dimensional electrophoresis during the early development of the marine mud snail Ilyanassa obsoleta. None of the isoforms of actin were detectably translated by 4-cell embryos, but all were translated by 25-cell embryos (24 hours), actinomycin D treated 25-cell embryos, 24 hour-old unfertilized eggs, and isolated polar lobes "aged" for 24 hours.

These findings suggest that the Ilyanassa egg contains inactive maternal actin mRNAs that are activated by cytoplasmic factors for translation in the 25-cell embryo, and that this activation is independent of fertilization, cleavage, and embryonic transcription.

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RADIALIZATION OF A SPIRALIAN EMBRYO (LYMNAEA) FOLLOWING ABNORMAL CELLULAR INTERACTIONS AT THE 24-CELL STAGE. C.Q. Doe, Stanford Univ.; M.Q. Martindale, Univ. Texas, Austin; and J.B. Morrill, New College, Sarasota, FL

The dorsoventral axis is first established at the vegetal pole when a cross furrow macromere extends internally (becoming the dorsal macromere) and contacts the animal pole micromeres. Subsequently, division asynchronies in these micromeres adumbrate the dorso-ventral axis in the head region. We tested the theory that animal pole dorsoventrality requires macromere-micromere contact by using Cytochalasin B (CB) to delay and misroute the elongating blastomeres at the 24-cell stage. CB treatment inhibited cell contacts from being made within the embryo. After treatment blastomere elongation occurred but no one macromere established a central position and the micromere contacts were not restricted to a single macromere. CB treated embryos developed partially or fully radialized (e.g. four vegetal quadrants), whereas normal embryos have bilaterally symmetrical animal pole quadrants identified by cell size, cleavage planes, and ciliary patterns. Our results support the theory that a spatially and temporally precise mechanism of cell interactions at the 24-cell stage is required for the development of bilaterality in Lymnaea.

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DEMONSTRATION OF COVERT ADULT PATTERN IN THE LARVAL EPIDERMAL CELLS OF DROSOPHILA. Mekkara M. Madhavan and Kornath Madhavan*. Holy Cross College, Worcester, Ma. 01610

Third instar larvae of Drosophila were exposed to different dosages of γ -radiation and were allowed to undergo metamorphosis. When the diploid histoblasts which are the precursors of adult abdominal epidermal cells are deleted by γ -radiation, the polytene larval epidermal cells (LEC) which die during metamorphosis survive and secrete cuticle and cuticular outgrowths. A comparison of this cuticle in the tergal, intertergal, pleural, sternal and intersternal regions of the abdominal segments to that secreted by the adult epidermal cells (AEC) in the corresponding regions of the control animals suggests that the LEC contain genetic information for the pattern of landscape of adult abdominal cuticle. It is possible that the LEC could provide this information to the AEC during the ontogeny of the fly. (Supported by Whitehall Foundation and Monsanto Company).

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RELATION OF ABDOMINAL CUTICLE AND HYPODERM IN DROSOPHILA. W. R. Allen* and R. Hillman. Temple University, Philadelphia Pa.

The mutation A53g transforms the abdominal tergites and sternites into white hairless cuticle. Madhavan showed that larval cells persist which may secrete this cuticle. Histological exam of the mutant abdomen reveals that an interplay between adult and larval cells regulates cuticular expression. Normal adult cuticle is sometimes expressed over larval cells; in such cases there is a layer of adult cells beneath the larval cells. Abnormal cuticle does not always indicate the presence of larval cells; sometimes adult pattern fails to emerge when the density of adult cells is low, though in such cases hairs may be present. The abdominal pleura rarely shows any effect of the mutation; larval cells also exist here, however they are beneath a layer of adult cells. The pattern of the cuticle depends on the degree of adult hypoderm development. Larval cells that do persist respond to adult pattern by tanning cuticle where it abuts a population of tanned adult cells. Supported by NIH grants GM18080 and RR 07115.

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THE TIMING OF ECHINOID MICROMERE DIVISIONS IN RELATION TO CELL SIZE. R.E. Langelan and A.H. Whiteley. Univ. of Washington, Seattle.

The division cycles of cleavage stage sand dollar (Dendraster excentricus) embryos were investigated using time-lapse video microscopy and Feulgen-stained whole mounts. Micromere cell cycles at the 32-cell stage were longer than macromere and mesomere cell cycles. In contrast, giant micromeres, produced by equal cleavage after brief surfactant treatment, cleaved synchronously with the other blastomeres at the 6th and 7th cleavages. Embryos with experimentally altered micromere cell cycles and sizes nonetheless developed normally. When either control or treated micromeres reached a diameter of 15-17 μm , their rate of cleavage slowed drastically. Thus the long micromere cell cycles are correlated with the size of the micromeres but are not essential to their developmental program. This work was supported by NIH Training Grant HD 07183.

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FOOD QUALITY, GROWTH, AND SIZE-FREQUENCIES OF TWO TROPICAL SEA URCHINS. B.D. Keller. Yale Univ., New Haven, Conn.

Median size of Tripneustes ventricosus and Lytechinus variegatus differs by about 2 cm in two seagrass (Thalassia testudinum) meadows in Discovery Bay, Jamaica. Rates of increase in test diameter were measured for both urchins at the two sites and in aquaria provided with Thalassia from each site. Differences in growth rates were caused mainly by differences in the composition and amount of epiphytes, particularly encrusting coralline red algae, on Thalassia leaves and appear to be sufficient to shift the size-frequencies of these urchins. Growth of Tripneustes, which grazes Thalassia and epiphytes, decreased when Lytechinus, an epiphyte grazer, was present.

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GERM CELL RENEWAL IN THE TESTES OF FUNDULUS GRANDIS. M. S. Greeley, Jr., K.R. Marion* and R. MacGregor III. Univ. of Alabama in Birmingham.

Germ cells were observed "migrating" through the testes of adult gulf killifish, Fundulus grandis, collected at frequent intervals throughout the annual reproductive cycle. Mitotic figures in the primary spermatogenic layer of the testes were uncommon and possibly represented only the proliferation of secondary spermatogonia. Thus, there may not be a permanent germinal epithelium in the testes of this cyprinodontid.

Although observed only in a minority of the total samples, when present these amoeboid germ cells were abundant both in individual samples and other samples collected concurrently. This suggests that germ cell renewal is a rapid and transitory process occurring frequently but at discreet intervals throughout the year.

The origin of the renewal germ cells is currently unknown. Some light micrographs suggest an origin via the undifferentiation of certain modified sertoli cells in the walls of the efferent duct systems. However, the possible existence of a cord of primordial germ cells outside the testes was not discounted by the present study.

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ANALYSIS OF DELAYED PRIMORDIAL GERM CELL MIGRATION IN RANA PIPIENS. S. Subtelny and K.S. Vogel. Rice Univ., Houston, TX.

UV-irradiated embryos are sterile at feeding stg 25. However, during larval development a proportion may possess minimal numbers of gonadal germ cells. Also when normal pgcs from stg 17 tailbud embryos are grafted to uv-irradiated hosts at stg 20, the graft embryos at stg 25 are sterile or possess minimal numbers of gonadal gcs (Penkala and Subtelny, 1982). To determine if delayed pgc migration occurs in these animals, gonadal gcs were counted in graft embryos at stg 25 and at later larval stages. The results reveal that the proportion of graft larvae with sterile gonads at stg 25 is similar to those at Taylor and Kollros larval stgs I-V. Similar determinations made between uv-irradiated controls gave comparable results. Thus, pgcs in graft embryos and in uv-irradiated controls do not undergo delayed migration during the larval stages studied. The apparent "delayed" gc migration in uv-irradiated larvae reported earlier during these larval stgs seems due to inadequate irradiation procedures resulting in selected embryos that escape complete gc inactivation and elimination.

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INCUBATION TEMPERATURE AND SEX DIFFERENTIATION IN A SEA TURTLE. M. T. Dimond and P. Mohanty-Hejmadi*. Trinity College, Washington, DC, and Utkal Univ., Bhubaneswar, India.

A clutch of eggs was removed from a new nest of the olive ridley turtle, *Lepidochelys olivacea* (Eschscholtz), and brought to the laboratory for incubation. The eggs were buried in moist sand or kept between two layers of moist cotton at three temperatures until hatching. Sex was determined post mortem by gross morphology of the gonads. Results as to temperature of incubation / time to hatching / sex are as follows: 31-32° / 45-46 d / female // 29-30° / 53-55 d / female // 26-27° / 75-78 d / male. Embryonic mortality was highest in the coolest group. Several female hatchlings were reared for a month in 50% sea water and fed with freshwater clams (*Unio* sp.). The olive ridley is like most other turtle species that have been studied in that high incubation temperature gives rise to females and low, to males. The work was supported in part by a grant from the American Philosophical Society.

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HORMONAL CONTROL OF YOLK SYNTHESIS IN THE HEPATOPANCREAS OF *CARCINUS MAENAS*.

J.E. Paulus and H. Laufer. University of Connecticut, Storrs.

Removal of the X-organ/sinus gland complex of the crustacean eyestalk stimulates spawning and ovarian growth by the elimination of the ovarian inhibiting hormone (OIH). We tested the effect of eyestalk removal and also leg autotomy (a molt inducer) on yolk synthesis by the hepatopancreas (HP), which produces vitellogenin in the reverse inclusion cells. Fragments of HP from operated and intact crabs were cultured in 10% Medium 199 and Pantin saline for 16 hours at 17 C. The percentage of total incorporation of ³H-amino acids into yolk protein (% incorporation) was determined by double immunoprecipitation with a lipovitellin-specific antiserum. The % incorporation by intact animals increased from May (15%) to June (29%). Eyestalk ablation caused a rise in the % incorporation, reaching 23% and 34% after one week during May and June, respectively. Leg autotomy during June decreased the % incorporation to 16% after one week, a level similar to that observed in intact animals during May. These results suggest that eyestalk ablation may stimulate vitellogenesis by removal of OIH, while autotomy may inhibit this process by increasing the ecdysterone titer.

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BRANCHIAL PLACENTA AND EMBRYONIC GROWTH IN THE VIVIPAROUS FISH, *JENYNYSIA*. J. Richter,* J. Lombardi and J.P. Wourms. Univ. of North Carolina, Chapel Hill and Clemson Univ., SC

In *Jenynsia*, fertilization is intrafollicular while development to term occurs in the ovarian lumen. Embryos undergo a 24,000% increase in dry weight from a 0.024 mg zygote to a 5.8 mg (11.8mm) near term embryo due to maternal nutrient transfer. During development, folds of ovarian tissue extend into an enlarged opercular cleft on one side of the embryo and fill the mouth and pharynx. SEM and LM reveal an intimate association of maternal ovarian and embryonic bucco-pharyngeal tissues (= branchial placenta) at which nutrient transfer is postulated. A low columnar-cuboidal epithelium lines the pharynx. Microvilli occur only on the dorsal surface of the mouth and pharynx. Ovarian tissue folds comprise a simple squamous epithelium surrounding a hypertrophied connective tissue core. Epithelial cells have a smooth non-amplified apical surface and appear to function in transport rather than secretion. Precocious head development in 3 mm embryos precedes accommodation of maternal tissues. Branchial placenta have evolved convergently in some anablepids, ophidioids, and rays.

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THE ROLE OF THE FOLLICLE IN MATERNAL-EMBRYONIC NUTRIENT EXCHANGE IN THE VIVIPAROUS FISH, *HETERANDRIA FORMOSA*. B.D. Grove and J.P. Wourms. Clemson Univ., SC.

Embryos of *H. formosa* develop to term in the ovarian follicle and undergo a 4000% dry weight increase indicating transfer of maternal nutrients. The follicle probably regulates nutrient transfer through selectivity, posttranslational modification or synthesis from nutrient precursors. TEM reveals microvilli-like processes at the apical surface of follicle cells and tightly interdigitating cellular processes at the basal surface. Capillaries investing the follicle are separated from the follicle cells only by a basal lamina. Follicle cells have many Golgi complexes, SER, numerous mitochondria, two classes of vesicles, and a sparse RER which suggests that the follicle transports rather than synthesizes nutrients. Ferritin and iron dextran were injected into females to assess the ability of follicle cells to absorb macromolecules. After 24 hrs., the tracers were localized in the basal lamina and vesicles of the follicle cells. SDS-PAGE of follicular fluid reveals several protein bands that co-migrate with serum proteins, suggesting follicular transport of nutrient proteins from the maternal serum.

(Supported by NSF grant #PCM8208525)

BIOCHEMICAL ANALYSIS AND CELLULAR ORIGIN OF UTERINE HISTOTROPHE DURING EARLY GESTATION OF THE VIVIPAROUS BUTTERFLY RAY, J.P. Wourms and A.B. Bodine*. Clemson Univ, S.C.

Embryos of the aplacental, viviparous butterfly ray, Gymnura micrura undergo a 4900% increase in dry weight during gestation. Direct maternal-fetal connections are absent. Yolk reserves (0.2g) are exhausted in early development. Growth to term (10g) is effected by histotrophe ("uterine milk") transported or secreted by trophonemata, viz. long, villiform extensions of the uterine epithelium. Histotrophe from late (20-25mm) tailbud embryos is a dilute (1-2% total organic content), translucent white fluid with pH 7.4 and 2.38 mg/ml of total protein. PAGE reveals 3-4 bands of proteins with mol. wt. of 68 to 350-400K, tentatively assigned to serum albumin, immunoglobulin M, and macroglobulin. Analysis of free amino acids revealed significant amounts of phosphoethanolamine (26mg/100ml) and urea. Taurine, GABA, citrulline, alanine, glutamine, and valine are present. Proline and aromatic A.A. are absent. Lipid content is 0.5-0.6%. GLC analysis of fatty acids reveals: 19% C₈-C₁₀ F.A.; 15% myristic; 26% palmitic; 8% palmitoleic; 7% stearic; 17% oleic; 7% linoleic; and 2.3% arachidonic. There are trace amounts of 5 phospholipids. Total sugar as glucose is 0.54%.

COMPOSITION OF EGGS AND NEWBORN OF THE VIVIPAROUS SNAKE, NERODIA RHOMBIFERA. J.R. Stewart and R.E. Castillo*. Univ. Tulsa.

Oviducal incubation of eggs by reptiles provides a variety of possible ecological advantages and the lengthy intimate association between female and embryo results in an opportunity for an extra-vitellogenic supply of nutrients to the developing embryo. Recently ovulated eggs and their newborn siblings of the snake, Nerodia rhombifera, were analyzed for organic (nitrogen, lipid) and inorganic (total ash, Na⁺, K⁺, Ca⁺⁺, Mg⁺⁺) content. Newborn snakes contain larger quantities of H₂O, Na⁺, and K⁺ than that provided during vitellogenesis suggesting a maternal source in addition to the provision to yolked follicles. A substantial reduction in total lipid occurred indicating that lipid catabolism provides an important source of energy during development. (Supported by a Cottrell College Science Grant from Research Corporation)

FEEDING ECOLOGY AND THE ROLE OF BIOLUMINESCENCE IN PREDATION IN THE SUBTIDAL SAND-DWELLING BRITTLE-STAR OPHIOPSILA CALIFORNICA, L.V. Basch. University of California, Los Angeles, and Catalina Marine Science Center, Avalon, CA.

Ophiopsila californica is a nocturnally active, sand-dwelling ophiuroid that is locally common off the California coast and Channel Islands. Ophiopsila is polyphagous, exhibiting a diversity of feeding methods, including suspension, surface deposit, and carrion feeding. At water velocities (ca. 5-9 cm/sec, Ophiopsila relies on surface deposit, carrion, and active suspension feeding using sweeping arm movements. At current velocities > 9 cm/sec, Ophiopsila switches almost exclusively to passive suspension feeding. In this mode, and depending on prey taxon, size, and/or ability to escape, suspended prey and seston are captured by acus covered spines and podia, tentacular scales, or rapid helical arm coiling. Results indicate that successful prey capture is a function of prey type and size, current velocity, and ambient light level. Ophiopsila ingests more prey at night because 1) it is more active, 2) prey species richness and diversity is greater, and 3) bioluminescence aids in prey capture. Ophiopsila activity patterns may be an adaptation to parallel prey activity periods, and to provide temporal refuge from diurnal predation. Bioluminescence is demonstrated to function in food capture by stunning and thereby subduing motile, photoreceptive zooplankton when they physically contact Ophiopsila.

BROWSING PREDATION: EFFECTS ON INFAUNAL ACTIVITY RATES. S. A. Woodin. Univ. of South Carolina, Columbia.

The effects of tissue loss were measured in the laboratory for three species of infaunal polychaete annelids: an arenicolid, Abarenicola pacifica, a maldanid, Axiiothella rubrocincta and a spionid, Spiophanes bombyx. Abarenicola and Axiiothella commonly are regenerating their tails in field collections while individuals of Spiophanes are often regenerating tentacles. Defecation frequency and fecal amounts were negatively affected in ablated individuals of all three species. In Spiophanes loss of one tentacle negatively affected weights of tubes. Loss of both tentacles had no significant negative effect although total tube weight was less than in the controls. In Axiiothella tail loss did not negatively affect total tube weight. In none of the three species was burrow depth or percent organic content of feces affected. Tissue loss is a common phenomenon, so the changes in defecation frequency and fecal amounts with tissue loss suggest that secondary productivity and biogenic alteration of sediments can be influenced by such tissue losses and the subsequent periods of relative inactivity of the damaged individuals.

Supported by NSF grant OCE 81-09596.

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AGE-SPECIFIC PATTERNS OF FEEDING AND PREDATOR AVOIDANCE IN YELLOW-BELLIED MARMOTS. H.V. Carey, University of Nevada, Reno, Nevada.

Yellow-bellied marmots (*Marmota flaviventris*) in the White Mountains of California spent about 10% of their foraging time scanning for predators. Vigilance time was reduced when marmots fed in groups, and in areas with low vegetation and high densities of safety burrows. These findings suggest that the time marmots invest in vigilance varies with the risk of predation. Juveniles and yearlings were more vigilant while foraging than were adults, and juveniles were more sensitive to the factors that influenced vigilance than were older animals. The use of foraging areas was positively correlated with food plant availability and negatively correlated with structural characteristics that may restrict visual range. Juveniles, and to a lesser degree adult females exhibited the strongest relationships between foraging area preferences and habitat characteristics. Differences among age classes in the risks associated with predation and inadequate nutrition may be responsible for these age-specific variations in foraging patterns.

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FACTORS EFFECTING THE ACTIVITY PATTERNS OF URBAN CATS, *FELIS CATUS*. Carol Haspel, City College, N.Y.

Activity patterns of free-ranging urban cats were examined during Fall 1981, Spring 1982, and Fall 1982 in two adjoining neighborhoods in B'klyn., N.Y., one an area of multiple-dwellings, the other of brownstone rowhouses. Feeding stations were maintained during the Fall 1982. Significant differences in cat activity by neighborhood were found even though the cat populations shared common backyards. Mean activity in the Spring and the Fall were not significantly different; however Fall 1982 activity was significantly greater than either previous season. This increase is attributed to the food supplementation. Fall activity started out high and gradually decreased to significantly lower levels by the end of the season, Spring activity went from low to high. An analysis of covariance in which temperature was removed revealed that temperature alone could not account for these seasonal changes. Nightly activity gradually increased from 2100 hours EST to reach its significantly highest levels around sunrise. Sex differences in activity were not found to be significant. The urban cat has been found to be highly responsive to environmental factors.

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DIFFERENTIAL SELECTION FOR VEGETATIVE STRUCTURE BETWEEN JUVENILE BROWN (*PENEAEUS AZTECUS*) AND WHITE (*P. SETIFERUS*) SHRIMP AND POSSIBLE IMPLICATIONS IN PREDATOR-PREY INTERACTIONS. T. J. Minello and R. J. Zimmerman, NOAA/NMFS, Galveston, Texas.

Behavioral differences between juvenile (57-72 mm) brown and white shrimp in relation to artificial vegetation were examined under laboratory conditions. Brown shrimp selected for vegetative structure during the day. White shrimp showed no strong selective preference for structure during the day or night. Densities of the two species in a Galveston Bay, Texas salt marsh were consistent with the behavioral differences observed in the laboratory. Selective predation experiments were also conducted using Atlantic croaker as predators. In half-vegetated cages there was a strong selection for white shrimp over brown shrimp by the fish. In nonvegetated cages there was no significant selection for either species of shrimp. The presence of vegetative structure, therefore, appears to shift prey selection by Atlantic croaker away from brown shrimp, which may have important implications in the survival of the two species of shrimp in estuaries.

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DESTABILIZING EFFECTS OF PREY REFUGES ON PREDATOR-PREY INTERACTIONS. J. N. McNair, Purdue University, W. Lafayette, Indiana.

Conventional wisdom holds that prey refuges (i.e., physical locations where prey either live or temporarily hide) exert a stabilizing influence on predator-prey interactions. This conclusion emerges from the theoretical literature and, as speculation, from the empirical literature. The effects of refuges were reexamined using a simple continuous-time model. Two classes of refuges were considered: where prey protected by the refuge are not encountered by predators, and where all prey can be encountered, some escaping to temporary hiding places. In each class, constant number and constant proportion refuges were examined. The results show that an equilibrium point which is stable when the prey have no refuge can be destabilized by adding a refuge. This effect occurs over a broad range of parameter values for all but one of the refuge types studied and is therefore not a mere curiosity. For this reason, and because solid empirical evidence is lacking, it is naive to think of prey refuges as stabilizing factors.

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STABILITY OF HONEY BEE FORAGING PATTERNS UNDER VARYING CONDITIONS.

P. H. WELLS and H. WELLS. Occidental College, Los Angeles, CA and University of Tulsa, OK.

Two types of artificial flower patches, each having two color morphs, were used to study stability of honey bee foraging patterns: one simulated a population of flowers, the other a single complex inflorescence. We found that (1) honey bees were individually constant to flower morph when the population model was used, (2) bees failed to optimize to quality, volume or frequency of reward on the population model, (3) they changed to random visitation on the inflorescence model, (4) most bees became fixed to the higher molarity, but not the higher reward volume or frequency flower morph on the inflorescence model, and (5) bees reverted to individual constancy when offered the population type artificial flower patch.

819

FLOWER MORPH FREQUENCY AND DISTRIBUTION: EFFECTS ON THE RECRUITMENT OF NAIVE HONEY BEES AND ON THE BEHAVIOR OF CROP ATTACHED BEES.

H. WELLS, P. H. WELLS, and D. CONTRERAS. University of Tulsa, OK, and Occidental College, Los Angeles, CA.

Reported are experiments on naive honey bee recruitment, and on the behavior of crop attached bees, when flower morph frequency and distribution were varied systematically in an artificial flower patch. Two flower morphs were used (blue and yellow). Experiments involved first, changing the frequency of flower morphs, but having flowers placed randomly on the grid as to morph, and second, placing the flowers nonrandomly into patches according to morph. 1) Naive recruits exhibited one-trial learning, becoming individually constant to the first flower morph visited (some to yellow and some to blue). 2) Data showed that there were both a flower morph preference effect and a frequency effect on the recruitment of naive bees. 3) Neither frequency nor distribution of flower morphs affected the behavior of crop attached bees. Bees were still individually constant to a flower morph, regardless of the frequency or distribution of flower morphs.

820

THE ROLE OF EXPERIENCE AND PREY DENSITY IN PREY SELECTION BY MOSQUITOFISH.

J. BENCE. Univ. of California, Santa Barbara.

The predatory behavior of *Gambusia* was observed in the laboratory and inferred from stomach content data. Fish collected from different locations behaved differently. There was also variability among fish within a location. Differences between locations were related to prey availability. The temporal patterns within locations suggest that differences between locations arise by gradual changes in the frequency of individuals employing different foraging strategies. The results qualitatively fit several predictions of optimal diet theory. However, combined with results from laboratory training experiments, they show that lack of experience can place limitations on adaptive responses in feeding behavior.

821

SUBSTRATE SELECTIVITY BY BRYOZOAN LARVAE. C. J. HURLBUT.

Univ. of New Hampshire, Durham.

Successful recruitment is a key determinant of the distribution of populations of sessile organisms, and can be divided into three phases: availability of larvae, settlement and metamorphosis, and juvenile mortality. I examined these phases in populations of two bryozoans co-occurring in Great Bay, N.H. *Flustrellidra hispida* occurs mainly on *Ascophyllum nodosum* while *Alcyonidium polyoum* encrusts rocks, mussels and several algal species. *F. hispida* reproduces during the summer, while *A. polyoum* is reproductively active throughout the year. Laboratory experiments indicated some substrate selectivity at settlement. Field recruitment was documented by inspecting substrata for the presence of ectoprocts. On some rare substrata, the density of recruits was higher than expected. Ancestrulae and young colonies of both species were found on a wider variety of substrata than were adults. My general conclusion is that the adult distribution of *F. hispida* and *A. polyoum* is the result of both substrate selectivity by the larvae and differential mortality after settlement.

822

SPATIAL PATTERN IN BARNACLE SETTLEMENT: DAILY CHANGES DURING THE SETTLEMENT SEASON. David S. Wethey. Univ. South Carolina, Columbia.

Spatial pattern of settlement of cyprids of the barnacle *Balanus balanoides* was examined from photographs taken every low tide during the first 20 days of the settlement season. Cyprids settled in aggregations with respect to other cyprids. There was less specificity of settlement near to newly metamorphosed spat. Settlement in cracks was ten times greater than would be expected if there were no preference for cracks. There was no survival advantage associated with settlement in cracks and pits. There was no evidence of enhanced settlement on the locations of the bases of detached adults which had been killed in winter storms two months prior to the settlement season. These results indicate that chemical cues related to aggregated settlement behavior are short lived in the field and may not be important influences on choice of settlement sites unless the settlement season occurs very soon after the death of adults on the site.

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823

Reproductive patterns in sympatric morphs of a colonial marine invertebrate: Coexistence through alternative life histories. R.R. Olson. Harvard Univ., Cambridge, Ma.

Although recently described as the same species, the sympatric brown and white color morphs of the colonial ascidian *Didemnum molle* differ drastically in their life histories at Lizard Island, Australia. White colonies have higher fecundity, greater variation in colony size and shape, and a wider distribution. Brown colonies have whole colony division rates four times higher than white, and form large aggregations of colonies of nearly equal size. The coloration of the symbiotic algae of the two morphs is different throughout the life cycles, permitting identification of larvae under a microscope. Within each color morph are several "sub-color morphs" which differ in color but have the same life history patterns. At the 14 sampling stations examined around Lizard Island representatives of both color morphs were found occupying the same microhabitat, but no more than one sub-color morph of each was found. It is suggested that the different life histories of the morphs permit their coexistence, while the similarity of life histories of the sub-color morphs prevents the coexistence of more than one at a given site.

824

FUNCTIONAL SIGNIFICANCE OF LARVAL BEHAVIOR IN AN INTERTIDAL POPULATION OF THE ASCIDIAN *PYURA HAUSTOR*. C.M. Young. Florida State University, Tallahassee.

Pyura haustor, the most common subtidal ascidian in the San Juan Islands, Wa., extends to 0.6 m above MLLW in the intertidal zones of some quiet bays. Most adults occur in dense aggregations on the north sides of boulders, and most small juveniles are attached directly to the adults. These patterns of distribution may be explained partially by larval behavior; tadpoles are gregarious and photonegative at settlement. During low tide, the ascidians remain relaxed and flaccid, dripping water and thereby creating a cooler and moister microhabitat in the clumps than on adjacent portions of the rocks. Juveniles transplanted from the laboratory to the field during the first week after settlement suffered lower mortality in ascidian clumps than on rocks. Adults transplanted up the shore survived in shaded sites as high as 1.2 m above MLLW, suggesting that mortality occurring during the juvenile stage may limit vertical as well as horizontal distribution. Because adult *P. haustor* mitigate the effects of heat and desiccation, the presence of adults may reliably indicate settlement sites where juveniles are likely to survive.

825

COST OF REPRODUCTION IN THE MALDANID POLYCHAETE *AXIOTHELLA MUCOSA*. W.H. Wilson, Jr. Harbor Branch Institution, Fort Pierce, FL.

Females of *AxiotHELLa mucosa* deposit gelatinous egg masses on the sediment surface and anchor them to the surface openings of their tubes. The demersal larvae crawl from the egg masses between the eight and twelve setiger stages. At Sebastian Inlet, FL, hatching occurs after seven or eight days. Cohorts of egg masses laid on the same day were marked and their "survivorships" calculated. For a given cohort, between 69% and 100% of the egg masses became detached before hatching occurred. Detached egg masses become abraded and frequently torn open as they are wafted across the sediment surface by tidal currents. Consequently, the embryos are released prematurely. Laboratory observations indicate that few embryos survive when released from the egg masses before the normal hatching stage. Egg masses which remain attached in the field are less likely to be torn open and consequently hatching success is much higher. Thus, detachment of egg masses from the adult tubes represents a significant and measurable cost of reproduction.

826

ASYNCHRONOUS ANNUAL REPRODUCTIVE CYCLES BETWEEN THE ATHERINIFORM TELEOSTS FUNDULUS GRANDIS (CYPRINODONTIDAE) AND POECILIA LATIPINNA (POECILIIDAE). H. J. Grier, J. S. Smith and C. Zahnow*. Department of Biology, University of South Florida and Florida Department of Natural Resources, St. Petersburg, Florida.

Annual reproductive cycles of F. grandis and P. latipinna were monitored in a St. Petersburg estuary. Peak reproductive activity in F. grandis occurred from March through April and ceased by the end of May. Only nonreproductive F. grandis were sampled during the summer and fall. Reproduction in P. latipinna began between January and March, extended through the summer and ceased during late August and September. Reproductive activity in P. latipinna coincided with annual changes in daylength whereas that of F. grandis did not. Laboratory experiments indicate long photoperiod (16L:8D) stimulate reproduction in P. latipinna while short photoperiod (8L:16D) inhibits reproduction. Temperature is the apparent major environmental cue controlling reproduction in F. grandis. In closely related teleost species, annual reproductive cycles may be controlled by different environmental factors.

827

ROCKY TIDEPool REPRODUCTIVE ECOLOGY OF THE THREESPINE STICKLEBACK. H.J. Weeks. Cornell University, Ithaca, N.Y. The threespine stickleback (Gasterosteus aculeatus) reproduces in a number of upper and supralittoral rocky tidepools of Appledore Island, Gulf of Maine. Adults enter, but do not breed in a number of similar pools. Pools of the sheltered, western side of the island receive less wave action, are therefore warmer and are colonized by reproducing adults earlier than pools on the exposed, eastern side. Tidepools with and without reproducing sticklebacks were studied for two summers with respect to incident wave energy, inorganic nutrient concentrations, primary productivity, zooplankton abundance and numbers and growth rate of juvenile Gasterosteus. Pools with reproducing sticklebacks were subject to less energetic wave action and to have higher levels of primary productivity than pools without them.

828

DIFFERENTIAL REPRODUCTIVE SUCCESS AMONG CLONES OF UNISEXUAL FISH: GENETIC FACTORS AND RARE-FEMALE ADVANTAGE.

V. Keegan-Rogers. Univ. of Conn., Storrs.

Interspecific hybrids within the fish genus Poeciliopsis are all female. At many sites in the rivers of northwestern Mexico, numerous clones of the unisexual hybrids have continued to coexist for over twenty years. I present evidence of a mechanism that might allow for the successful coexistence of these clones that are so seemingly similar to each other. The all-female biotypes must be inseminated by males of the parental species. However, males discriminate against them, leaving a significant proportion unfertilized. Behavioral observations and pregnancy analyses demonstrate that two factors contribute to differential reproductive success: (1) at equal female densities, unisexuals of some clones are genetically superior at attracting mates and becoming pregnant; (2) an unfamiliar-female mating advantage exists such that males are more likely to court and impregnate unisexuals of clones unfamiliar to them than individuals of familiar clones; thus, at unequal female densities, it appears that a frequency-dependent mating advantage operates, providing unisexuals of a rare clone an increased likelihood of becoming pregnant.

829

THRESHOLD GEOMETRY, OLEFACTION AND SEXUAL COMMUNICATION IN MIDWATER FISHES. R.C. Baird and E.E. Gallaher. University of South Florida, St. Petersburg and The Academy of Natural Sciences, Philadelphia.

Sexual dimorphism in the anatomy of the nasal rosettes and associated CNS structure occurs in several related genera of mesopelagic fishes. A pheromone system of sexual communication is strongly implicated. A simple three dimensional diffusion model is used to explore time dependent threshold geometries under various assumptions of threshold concentration, emission frequency, molecular fadeout times, eddy diffusivity, and patterns of organism distribution and relative movement. Eddy diffusivity varies nonlinearly with depth and strongly effects the dimensions of the threshold envelope. An elaborate chemical communication system is considered in relation to fish distribution, depth of occurrence, water column stability and patterns of daily fish movement.

830

HISTOMORPHOLOGY OF BLOOD GLANDS OF *PHRETTIMA POSTHUMA*. P.K. Dinda and S.G. Pal.* University of Calcutta, India.

Blood glands of *P. posthuma* are paired clusters of round follicles lying anteriorly over the pharynx. Solitary follicles are also observed in the pharyngeal gland cells and nephridial tufts. The epithelial cells of follicular capsule show electron dense granules, mitochondria, Golgi apparatus and the nucleus with three types of chromatin granules. Below this are muscles and connective tissue and a few collagen fibres. Follicular matrix is feebly Perl-blue positive. The follicular cells and the cells of connecting vessels are provided with a meagre amount of cytoplasm, with its usual components and nucleus with three types of chromatin granules. Exfoliation of cells is observed mainly into the connecting vessels and occasionally into the coelom. There remains dispute regarding the follicular origin (vascular-, nephridial-, connective tissue-). This study shows neither of them is absolute. They may have some connective tissue components during growth and differentiation (Supported by the University Grants Commission, New Delhi).

831

DEVELOPMENT OF SENSORY ORGANS IN THE GIRDLE OF THE CHITON *MOPALIA MUSCOSA*. E. M. Leise. Univ. of Calif., Davis.

The mantle epidermis surrounding the shell plates of adult *M. muscosa* is covered by a cuticle and secretes chitinous hairs and calcareous spicules. Stalked nodules, extensions of epidermal papillae, occur separately within the dorsal cuticle, within the dorsal hairs and at the bases of marginal and ventral spicules. Stalked nodules contain the dendrites of epidermal sensory neurons and are proposed to be mechanosensory. The integuments of larval, juvenile and adult *M. muscosa* are dissimilar. I examined juveniles raised in the laboratory for one year to determine the sequence of events that occurs as the epidermis develops its adult characteristics. The first juvenile spicules have no associated stalked nodules and are not innervated. However, juvenile hairs become the tips of adult hairs. As a hair grows it develops more spicules and stalked nodules and hence more sensory cells. Marginal nodules first appear after the juvenile is about 2 months old, followed by ventral nodules at about 6 months and dorsal nodules at about 1 year.

832

FINE STRUCTURE OF THE FRONTAL ORGAN IN *DIOPISTHOPORUS* SP. (TURBELLARIA ACOELA). J.P.S. Smith, III, and S. Tyler. Univ of Maine, Orono.

At the anterior tip of the body in acoel turbellarians is a voluminous glandular organ called the frontal organ, commonly assumed to be a glandulo-sensory complex. This organ in *Diopisthoporus* sp. has a relatively simple fine structure, comprising 2 (rarely 3) mucus gland cells of a single histochemically-demonstrable type, with their cell bodies situated subepidermally at the level of an anterior nerve ring. Secretion granules in these glands are morphologically and histochemically (Alcian-Blue negative) like granules in other mucus glands in the body wall. At least six morphologically distinguishable types of epidermal sensory receptors are associated with these glands; all are similar to sensory receptors of the general body wall. In comparison, other acoel species have more complex frontal organs, often with two types of large, Alcian-Blue-positive mucus glands and up to six other types of accessory glands. (Supported by NSF grant BSR 81-16894.)

833

CENTRAL COMPONENTS OF THE PALLIAL NERVE OF OCTOPUS. William M. Saidel and Edwin M. Monsell, Georgetown University School of Medicine, Washington, D.C. and Northwestern University Medical School, Chicago.

The Pallial Nerve of octopus connects the central brain with the stellate ganglion. This ganglion, located within the body cavity (mantle), is considered the major somatic peripheral motor ganglion. A minimum of five fiber systems pass within this nerve and two originate within the central brain. We have localized the cell bodies of these two systems to several central regions by using retrograde axonal transport of horseradish peroxidase (HRP) and axonal diffusion of cobalt ions. Cell bodies of axons passing within the Pallial Nerve were localized to the Superior Buccal Lobe, the Anterior and Posterior Chromatophore Lobes, the Magnocellular, Pallial, Pedal, and Visceral Lobes. This set of lobes suggests that the Pallial Nerve is not just part of the somatic motor system, but also has other components. These results also confirm some previously hypothesized connections and more importantly, show entirely new connections whose existence emphasizes the currently limited understanding of the brain of octopus. (This work was supported in part by N.A.T.O. Research grant 136.82.)

834

FUNCTIONAL ASPECTS OF THE HEART-KIDNEY COMPLEX OF MERCENARIA MERCENARIA WITH REFERENCE TO HEAVY METAL POLLUTION. E. Meyhöfer, M.P. Morse and W.E. Robinson. Mar. Sci. Lab., Northeastern Univ., Nahant and New England Aquarium, Boston.

Preliminary experiments indicate that quahogs exposed to 100 ppm of cadmium for 10 days accumulate metal in the tissues of the pericardial glands and the kidneys. To determine possible cytological sites of metal deposition, a study of the heart-kidney complex of unexposed molluscs was undertaken. Two pathways are possible for elimination. One is via the blood to the kidney cells and then to the kidney lumen. Another is by filtration into the pericardial cavity as primary urine which is propelled via the renopericardial opening into the lumen of the kidney where further modification is possible. Initial ultrastructural studies indicate the pericardial glands which are associated with the pericardial lining are sites of ultrafiltration as evidenced by the presence of podocytes with ultrafiltration slits. Cell inclusions of the kidney and pericardial glands are described. (Supported by Department of Energy Contract #DE-AC02-77EV04580)

835

RATE OF PRODUCTION OF EXTERNAL RIDGES IN THE BAY SCALLOP, ARGOPECTEN IRRADIANS. N. E. Helm and R. E. Malouf (Intro. by C. Decker). State Univ. of NY, Stony Brook

External ridges are produced on the shell of the bay scallop, Argopecten irradians, by periodic changes in the direction of calcification. These ridges are thought to be formed on a daily basis and have been suggested as a means of determining growth rates. During the peak summer growing season 18 of 20 scallops maintained under controlled field conditions produced 17 ridges in 17 days. Mean increase in shell length for this group was 0.55mm per day. During other periods of the growing season scallops produced less than one ridge per day and grew at an average rate of 0.15mm per day. It is suggested that when rate of shell growth is low Argopecten irradians produces less than one ridge per day due to a minimum required distance between successive ridges.

836

BROWN CELLS OF TRIDACHIA CRISPATA ARE NOT ZOOXANTHELLAE, BUT WHAT ARE THEY? K. B. Clark and C. Fermin*. Florida Inst. of Tech., Melbourne.

Brown-pigmented cells in the parapodia of the ascoglossan opisthobranch slug Tridachia crispata were originally described as zooxanthellae. The cells are concentrated in a band adjacent to the chloroplast-containing digestive gland diverticula and form a brown pigment band in the distal parapodia. Cells are abundant in older animals but absent in juveniles. The spherical cells range from 10-30 μ m in diameter, have a rigid fibrillar wall, lack chlorophyll, and are located within hemocoelic sinuses. Small cells are nucleate, while larger cells are highly vacuolated, with cytoplasm displaced into a thin periphery and nuclei are rarely found. Older cells are almost completely filled with a fine granular material. On preliminary diagnosis, these cells appear to be protist symbionts of unknown function, which store materials originating as photosynthates produced by symbiotic chloroplasts.

837

RADULAR REGENERATION OF THE SOUTHERN OYSTER DRILL THAIS HAEMASTOMA (GASTROPODA: PROSOBRANCHIA) AFTER AMPUTATION. R.A. Roller, D.W. Garton and W.B. Stickle. Louisiana State University, Baton Rouge, LA.

The proboscis and complete radular mechanism was amputated from seventy adult oyster drills (average shell length = 61.6 mm). The regenerative ability of Thais haemastoma was determined by observing original and regenerated structures with scanning electron microscopy. All snails completely recovered from the surgery and were moving about the aquarium within one day after amputation. All snails regenerated a normal appearing proboscis with complete radula, radular sac and odontophoral cartilage within 4-5 weeks after amputation. The regenerated structures were similar in appearance to the original structures. The drills resumed feeding and produced normal appearing boreholes in the oysters only after a complete radula was regenerated. This research was supported in part by a grant from the Petroleum Refiners Council of Louisiana and from NSF Grant No. DEB-7921825.

838

A NEW METHOD FOR STUDY OF URINE PRODUCTION AND EXTRARENAL PROCESSES IN UNRESTRAINED CRABS. T. G. Wolcott. N.C. State Univ., Raleigh.

We have developed a backpack device which allows us to collect urine as it is released and to simultaneously eject an equivalent volume of labelled "pseudo-urine" at the nephropore of free-ranging crabs. The substitution of this known fluid in the pathway of extrarenal urine modification simplifies interpretation of post-modification composition, and avoids uncertainties associated with injection of conventional filtration markers. The devices consist of rigid capsules which are coated internally with liquid silicone resin. The silicone cures into a flexible rubber bladder. A tube ending near the nephropore communicates with the bladder lumen, which is precharged with "pseudo-urine". A cannula sealed over the nephropore delivers urine to the space between the bladder and the capsule wall, progressively collapsing the bladder. Since the capsule is rigid, the volume of "pseudo-urine" expelled is equal to the volume of urine collected. The technique was developed to determine how terrestrial crabs are able to produce dilute excretory fluid extrarenally, but may have other applications.

839

TWO POPULATIONS OF HEMERYTHRIN-CONTAINING CELLS IN THE SIPUNCULAN THEMISTE DYSCRITUM. N.B. Terwilliger, R.C. Terwilliger and E. Schabtach. Inst. of Marine Biology, Univ. of Oregon, Charleston and Eugene.

Hemerythrin-containing cells of sipunculans are found within two compartments, the coelomic cavity and the contractile vessels. Light, transmission and scanning electron microscopy studies of T. dyscritum cells provide morphological evidence that they exist as two distinct populations. The coelomic cells range in diameter from 19-32 μm , are nucleated and contain a limited number of organelles including unusual membranous lamellae or tubules. The contractile vessel cells are smaller (16-21 μm) with many more small vacuoles than the coelomic cells. Although the contractile vessel cells have nuclei and a few organelles, membranous lamellae are notably absent. In other sipunculans the two compartments contain two different hemerythrins (Manwell, CBP, 1960, Klippenstein et al., J. Biol. Chem., 1972). The question of whether the hemerythrin-containing cells of T. dyscritum belong to genetically or chronologically separate populations is worthy of further study. Supported by NSF Grant PCM 82-07548.

840

STRUCTURAL COUPLINGS BETWEEN THE SARCOPLASMIC RETICULUM AND THE SARCOLEMA IN LARVAL MUSCLE CELLS OF A POLYCLINID ASCIDIAN. M. J. Cavey and H. D. Strecker*. Univ. of Calgary, Alberta, Canada.

The larval muscle cells of Apidium constellatum exhibit spiral myofibrils, invested by anastomosing cisternae of the sarcoplasmic reticulum (SR). Near the sarcomeric Z-lines, the sarcoplasmic reticulum adheres to the sarcolemma, forming either interior or peripheral couplings. The interior coupling consists of a perifibrillar cisterna of the SR and a tubular invagination of the sarcolemma. Interior couplings are prevalent along the myofibrils in the subcortical and medullary sarcoplasm. The peripheral coupling is composed of a subsarcolemmal cisterna of the SR and a sarcolemmal sector on the surface of the cell. Each subsarcolemmal cisterna is confluent with the underlying perifibrillar cisternae. Peripheral couplings are common along the myofibrils in the cellular cortex, especially near the half-I-bands of their terminal sarcomeres. The interior and peripheral couplings share several ultrastructural attributes. The apposed membranes assume parallel orientations, separated by a narrow sarcoplasmic gap. An electron-dense plaque occupies the sarcoplasmic gap, lying equidistant from the facing membranes.

841

CATCH PHENOMENON IN THE ANTERIOR BYSSUS RETRACTOR MUSCLE OF THE ATLANTIC RIBBED MUSSEL, GEUKENSIA DEMISSA. Anthony J. Amato. Clemson Univ., S.C.

The ultrastructure and physiology of the non-striated anterior byssus retractor muscle (ABRM) in Geukensia demissa was studied to elucidate the general mechanism of prolonged contraction known as catch. TEM reveals that the ABRM consists of muscle fibers surrounded by a matrix which contains fibrils 28 nm in diameter that are presumed to be collagen. Muscle fibers possess thick filaments that have a maximum diameter of 120 nm and exhibit diagonal banding with a 35 nm periodicity. Thin filaments randomly surround thick filaments; they have a diameter of 8 nm and aggregate at dense bodies located on the sarcolemma and throughout the sarcoplasm. Preliminary measurements of isotonic contraction in preparations with applied forces of 10 and 20 g were made. The ABRM contracts and enters catch after addition of acetylcholine. When preparations are rinsed with seawater and then treated with serotonin, the ABRM relaxes and catch terminates. (Supported by NSF grants # DEB-8120409 and DEB-7823395 to E. E. Ruppert)

842

CYTOCHEMICAL DEMONSTRATION OF SELECTED HYDROLASES IN HEMOCYTES OF MERCENARIA MERCENARIA. C.A. Moore and S.R. Gelder. Massasoit Community College, Brockton, Ma., and Univ. of Maine at Presque Isle.

Enzymes known to be associated with phagocytosis/degradation processes have been sought. Five acid hydrolases have been previously reported (Moore and Gelder, in press). The present study has demonstrated an additional lysosomal enzyme, aryl sulfatase and three other hydrolases, peroxidase, alkaline phosphatase and γ -glutamyltransferase. These techniques were performed on two types of hemocyte preparations; those exposed to algae and those unexposed to algae. Aryl sulfatase and peroxidase were visualized in dot-like granules within the cytoplasm and on the periphery of phagosomes; peroxidase positive granules were also observed around phagosomes. An intense alkaline phosphatase reaction was generally observed around phagosomes. Very few cells demonstrated γ -glutamyltransferase and these positive reactions were observed only in rounded-up cells containing algae. The presence of these enzymes is in keeping with the phagocytic role of hemocytes and is reminiscent of the enzymatic profile of mammalian phagocytes.

843

DIFFERENCES IN MITOCHONDRIAL ULTRASTRUCTURE BETWEEN A THIOTBIOTIC AND AN OXYBIOTIC TURBELLARIAN. J.E. Duffy and S. Tyler. Univ. of Maine, Orono.

Stereological analysis of mitochondria in two acoel turbellarians, one of which inhabits an anoxic environment and the other a well oxygenated environment, reveals significant quantitative differences between the two species. Volume density and surface density of mitochondria are significantly higher in epidermis and muscle of the thiotbiotic acoel Solenofilomorpha funilis than in the corresponding tissues of the oxybiotic acoel Otocelis sp. Surface densities of mitochondrial cristae are higher in all three tissues (epidermis, muscle, and parenchyma) of Solenofilomorpha than in Otocelis. These results indicate that the mitochondria-dependent pathways of anaerobic energy production found in euryoxic invertebrates are paralleled by a high density of mitochondria and suggest that mitochondria in anaerobic tissues are different in structure and biochemistry from their aerobic counterparts. (Supported in part by NSF BSR 81-16894.)

844

MORPHOLOGICAL AND HISTOLOGICAL BASIS OF DISC AUTOTOMY IN A BRITTLE STAR. W. E. Dobson and R. L. Turner. Florida Inst. Technol., Melbourne.

Disc autotomy in Ophiophragmus filograneus is neurally mediated (Dobson, 1982. Amer. Zool. 22:904). In addition to gross dissection, normal and autotomized animals were studied by light microscopy, TEM, and SEM to determine how autotomy occurs at the major region of disc attachment. Each of 10 genital bars is attached to an arm by a broad ligament consisting of a thick outer layer of collagenous connective tissue and an inner layer of neurosecretory cells innervated by a lateral ectoneural branch of the radial nerve. Neurosecretory-cell processes extend into the collagenous layer. During autotomy the collagenous fibers separate, weakening the ligament near its insertion along the genital bar. Separation is probably caused by neurosecretions. There is no evidence of ossicle dissolution. Histological organization of the genital bar ligament is similar to that of arm ligaments in ophiuroid and other echinoderms, and disc autotomy occurs similarly by neurally mediated histolysis. Supported in part by a grant from the William Bowers Estuarine Research Fund to W.E.D.

845

OCULAR INVASIVENESS OF THE INFECTIVE LARVAE OF ANCYLOSTOMA BRAZILIENSE AND A. TUBAEFORME IN A RODENT PARATENIC HOST. J. W. Vinson, Jr. Univ. of Southern Mississippi, Hattiesburg.

Infective larvae of either Ancylostoma braziliense or A. tubaeforme were administered orally to 120 mice to test ocular invasiveness. Mice were divided into groups and inoculated either one time, four times or eight times each to assess the affect of intensity and duration of infection. Mice were given approximately 25 larvae per gram of body weight per inoculation. In mice that were inoculated more than once, successive inoculations followed a ten day interval. The duration of infection for the different groups was 90 days, 120 days and 160 days. Eyeballs were removed from the sockets and examined by a tissue press technique. No ocular infections were observed leading to the conclusion that larvae of A. braziliense and of A. tubaeforme do not normally or even predictably enter the eyes of the mouse, a model mammalian paratenic host.

846

THE DYNAMICS OF SEED-EATING IN THE CHARACIFORM FISH *COLOSSOMA*. F. J. Irish. Harvard University, Cambridge, Ma.

Laboratory studies of variation in the feeding mechanism of the omnivorous teleost *Colossoma* reveal that discrete, consistently different kinematic and electromyographic patterns are elicited by different types of prey. Large seeds (shelled whole almonds) are anchored against the premaxillary teeth while a shearing force is applied by the mandibular teeth. Small pieces are thus sequentially broken off and sucked back into the orobranchial chamber while the body of the seed is passively held between the fleshy lips. Adductor muscle activity during the power stroke is an extended rapid train of pulses. In contrast, adductor activity during processing of soft prey (earthworms and thawed smelt) is rarely pulsed and is of significantly shorter duration. Pulsed adductor activity presumably applies cyclic loading to hard prey and may cause fatigue damage at lower loads than would be required for a single force application. Presence of such a mechanism in other durophagous animals (e.g. crabs and sunfish) suggests it may be a widespread method of dealing with hard food items. Supported by NIH 5 T32 GM07117-08.

847

FUNCTIONAL CONSTRAINTS AND PLASTICITY: CASE STUDY OF TOOTH ONTOGENY IN FISHES. L. S. Kaufman. Harvard Univ., Cambridge MA
Ecologists often assume that trophic specialization requires niche narrowing, since all organisms must operate within functional constraints. It can not be assumed, however, that organisms with similar specializations need answer to the same constraints. For example, a species with a versatile jaw mechanism can have highly specialized teeth while retaining a broad functional repertoire. Versatility could also allow one jaw mechanism to utilize a variety of tooth forms, increasing the opportunities for developmental and individual variation. A survey of tooth ontogeny in bony fishes indicates that ontogenetic and individual variation are greatest in clades with mechanically versatile buccal and/or pharyngeal jaws. The appearance of adult tooth forms in early life history is typical of clades with highly constrained jaw movements. Thus, constraints inherent to a body plan could limit epigenetic plasticity, the variability of species interactions, and the potential for evolutionary radiation through heterochrony.

848

SKULL SHAPE IN FROGS= S. B. Emerson. Field Museum of Natural History, Chicago.

Skull shape was studied in 120 species (64 genera) of frogs. Measurements were taken to test predictions of a biomechanical model relating prey characteristics to morphological variables of the jaws and skull. Frogs which eat small, slow prey have relatively short jaws and a symmetrical feeding cycle, while frogs which eat large, slow or large, fast prey have long jaws and an asymmetrical feeding cycle.

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FANGS, GROOVES, AND POSTERIOR MAXILLARY TEETH: THE EVOLUTION OF THE ELAPIDAE. D. W. JANSEN. Washington State University, Pullman, WA.

The venomous snakes of the families Viperidae and Elapidae evolved from nonvenomous colubrid ancestors. The posterior maxillary teeth of colubrids evolved into the fangs of venomous snakes, remaining at the posterior of the maxillary in vipers, but "migrating" through the maxillary to attain their forward position in elapids. The latter event may have been the genetic basis for the grooves that result in the neomorphic teeth of the elapid posterior maxillary. These grooves and teeth were investigated for their possible functions in elapids: holding prey and conducting venom. This was accomplished through manipulation of the venom gland, and study of feeding behavior and cross-sections of elapid heads. The morphological, functional, and genetic data offer an integrated insight into the evolution of elapid snakes from colubrids.

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FUNCTIONAL MORPHOLOGY AND EVOLUTION OF THE CHAMELEON TONGUE TIP. K. Schwenk. Univ. of California, Berkeley.

Gross anatomical, histological, and photographic data have been used to infer the mechanism of prey prehension by the chameleon tongue tip. The tongue tip is glandular and concave. Crypts of epithelial glands open into its internal cavity. With impact, the inner surface is splayed, contacting the prey surface. Mucus might be forcibly discharged at this time. Free cells extending from the epithelium may interdigitate with prey surface irregularities, enhancing the sticking effect of the mucus. Paired retractors draw the glandular region back into its original concave shape, effectively grasping the prey item during tongue retraction. If the prey item is large and smooth relative to the tongue tip, suction is possible. A comparison of the chameleon tongue tip to the tongues of other lizards suggests an evolutionary derivation from an agamid-like ancestor.

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THE MORPHOLOGY AND FUNCTION OF THE TONGUE IN LIZARDS. K. K. Smith. Duke Univ. Med. Center, Durham, N.C.

In lizards, the tongue is used in a variety of behaviors, most importantly in collection of particles for chemosensation and for food transport. The importance of this organ in systematic analysis is evidence of the diversity of tongue morphology seen in lizards. However, there has not yet been a survey of the mechanical significance of this diversity. Following a brief outline of the principles of movement in structures lacking typical systems of skeletal support, preliminary data on the organization of the intrinsic tongue muscles in lizards will be presented. Information on members of the Agamidae, Iguanidae, Gekkonidae, Scincidae, Lacertidae, Teiidae, Anguidae, and Varanidae will be included. The morphological diversity will then be discussed in relation to a number of features of functional significance including the specific mechanism of tongue protrusion employed and the relative development of protrusibility versus complex mobility. The morphology and function of the lizard tongue will be briefly compared with the mammalian tongue.

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CORRELATIONS BETWEEN DENTITION, DIET AND PREY CAPTURING BEHAVIOR IN Tupinambis. Dean Dessem. Univ. of Illinois, Health Sci. Center, Chicago, Ill.

The tegu lizard (Tupinambis) possesses a dentition which is variable both in tooth size and shape. There is an ontogenetic change from a dentition consisting of conical and blade-shaped teeth in younger individuals to one consisting of both conical and blunt, peg-shaped posterior teeth in older individuals. Digestive tract analysis of 58 wild caught individuals show that there is no dietary change correlated with the change in tooth morphology. In addition, the results do not support the previously proposed hypothesis that the blunt posterior teeth in larger individuals are used for crushing snails. Observations of prey capturing behavior show that smaller individuals use the blade-shaped teeth to puncture prey and then to shear it into smaller pieces before ingestion. In larger individuals, prey is punctured with the conical teeth, crushed by the blunt teeth and then swallowed whole. Differences in the tooth morphology of Tupinambis appear to be related to different types of prey handling and not to dietary differences.