

**Annual Meeting of the  
American Society of Zoologists,  
American Microscopical Society,  
Animal Behavior Society,  
Crustacean Society,  
Society of Protozoologists,  
and the Society of Systematic Zoology**

**December 27–30, 1981  
Hyatt Regency  
Dallas, Texas**

Papers are listed in numerical order by Abstract Number.  
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Abstracts of papers from the American Microscopical Society  
will be published in 1982  
*Transactions of the American Microscopical Society.*

Volume 101, No. 1, January 1982

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HORMONAL CONTROL OF RENAL FUNCTION IN AMBYSTOMA. D. F. Stiffler, L. Burt\*, B.J. Atkins,\* and S.C. Roach.\* Calif. State Polytechnic Univ., Pomona.

Clearance studies were done on larval Ambystoma tigrinum in order to examine effects of various treatments on glomerular filtration rate (GFR). Treatment with vasotocin reduced GFR from 127 to 92  $\mu\text{l}/10\text{g-h}$ . Mesotocin (MT) restored this to 148. Animals adapted to isosmotic media (IM) reduced GFR from 156 to 57. Hypophysectomized larvae in IM also reduced GFR to 55. The GFR of MT-treated animals in IM remained low at 62. Phentolamine and propranolol ( $\alpha$  and  $\beta$  blockers) did not alter GFR in either tap water or IM. In larvae adapted to IM 10% volume expansion with 0.5 X or 1 X Ringer's increased GFR. Ten percent expansion with 2 X Ringer's decreased GFR. In tap water animals 10% expansion with 2 X Ringer's decreased GFR while 20% expansion with 2 X Ringer's increased GFR. Changes in relative free water clearance paralleled changes in GFR in these expansion studies. Extra-pituitary factors appear to be involved and both volume and concentration of body fluids are important in renal control.

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OXYTOCIN-INDUCED WATER LOSS IN AMBYSTOMA TAIL TISSUE IN VITRO. J. E. Platt and M. J. LiCause\*. University of Denver, Denver, Co.

Previous work had shown that oxytocin (OT) was able to induce water loss when incubated with Ambystoma tail tissue. This phenomenon has been further studied. Neither removal of  $\text{Ca}^{++}$  from the medium nor addition of ouabain altered this response. Amiloride potentiated the effect of OT, but was without effect alone. Both theophylline and dibutyryl cyclic AMP blocked the OT-induced water loss. Arginine vasotocin (AVT) also induced a water loss, but did not enhance the action of OT. Melittin, a peptide from bee venom thought to cause a non-specific increase in membrane permeability, mimicked the action of OT. Prolactin (PRL) had a small, but significant, inhibitory effect on OT action. Pretreatment of animals with PRL did not alter the in vitro response of their tail tissue to OT, although untreated tissue from such animals did maintain a higher water content in vitro than untreated tissue from animals not given PRL. These results suggest a possible mechanism of OT action which may help account for its observed inhibitory effects on other actions of PRL in Ambystoma.

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EFFECTS OF ARGININE VASOTOCIN (AVT) ON WATER BALANCE IN LARVAL, NEOTENIC AND ADULT AMBYSTOMA TIGRINUM. M.F. NORMAN Univ. of Colorado, Boulder.

Fully hydrated larval and neotenic tiger salamanders (Ambystoma tigrinum) lost weight in aged tap water. AVT (Sigma; 3.34 $\mu\text{g}/.05\text{ml}$ ) significantly decreased water loss in both cases, with larvae being more responsive on a relative basis. Subjects were dehydrated at 22°C for 4-6 hours to 85-80% initial body weight. In control animals rates of water loss were as follows: larvae > adults > neotenes. Rates of rehydration were similar in control larvae and adults; neotenes rehydrated very slowly. AVT significantly decreased rates of dehydration in larvae and adults, but not in neotenes. However, during rehydration the response of neotenes to AVT was greater than that of adults or larvae. Mortality due to dehydration was high in larvae (93%) and neotenes (57%), but low in adults (6%). We conclude that larval, neotenic and adult tiger salamanders respond to exogenous AVT in vivo by a decreased rate of water loss and/or increased rate of water uptake

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EFFECTS OF MESOTOCIN ON RENAL FUNCTION IN ADULT SALAMANDERS. H. R. HARTENSTEIN and D. F. Stiffler. California State Polytechnic University, Pomona.

Renal clearance techniques were employed to examine the effects of posterior pituitary hormone mesotocin on renal function in adult salamanders. The species used were Ambystoma tigrinum, Taricha granulosa and Notophthalmus viridescens. Previous studies indicate that this hormone may be diuretic in larval A. tigrinum and neotenic Necturus maculosus, however little is known of its effects in adults. Our studies have shown that Notophthalmus increased GFR from 0.077  $\pm$  0.009 to 0.101  $\pm$  0.012 ml/g-hr following treatment with 5 ng/g mesotocin. Hypophysectomized Ambystoma yielded a GFR of 0.204  $\pm$  0.060 ml/10 g-hr which was not different than sham-operated controls. Treatment with 5 ng/g mesotocin resulted in a GFR of 0.319  $\pm$  0.043 ml/10 g-hr. Taricha shams yielded a mean GFR of 0.136  $\pm$  0.029 ml/10 g-hr. Hypophysectomy did not lower GFR (= 0.151  $\pm$  0.002 ml/10 g-hr). Mesotocin (5 ng/g) did not elevate GFR (= 0.171  $\pm$  0.046 ml/10 g-hr). It appears that there are differences with respect to both habitat and phylogenetic status in responses to this hormone in urodeles.

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ARGININE VASOTOCIN AND OSMOREGULATION DURING EMBRYONIC CHICK DEVELOPMENT. M.J. Murphy, S.C. Brown, and P. Stocking Brown. SUNY Albany, Albany, NY and Siena College, Loudonville, NY.

Arginine vasotocin (AVT) significantly reduced allantoic fluid volume of day 12, but not day 9, chick embryos. A linear dose-response relationship was observed with injections of 0.01mU/g, 0.10mU/g and 1.00mU/g AVT. At the highest dose tested, allantoic fluid volume after 2 hr was reduced by 1.24 ml (13%). The allantois of Ringer-injected animals, by contrast, gained 0.78 ml (8%) in volume during the same time period. The embryonic kidney appears to be at least one target for AVT since urine flow, measured by catheterization of the allantoic stalk, declined by 72% (from 134 to 37uL/hr) after AVT treatment. Since this reduction can account for only 17% of the total decline in allantoic fluid observed in our 2 hr experiments, the extraembryonic membranes must simultaneously be reabsorbing fluid from the allantois. Preparations with blocked allantoic stalks, which completely eliminate urine input into the allantois, confirm these data. (Supported by NSF grant # PCM- 79227930).

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EFFECT OF SALT STRESS ON ELECTROLYTE BALANCE AND CORTICOSTEROID TITER IN THE ALLIGATOR, D. J. LAUREN and V. A. LANCE, L.S.U., Baton Rouge.

Five groups of 8 juvenile alligators each ( $\bar{x}$  weight - 381 gms) were exposed to freshwater, 5, 10, 15 and 20‰ seawater at constant temperature for 4 weeks. Body weight, length, hematocrit, plasma osmolarity, Na<sup>+</sup>, Cl<sup>-</sup>, K<sup>+</sup>, uric acid and corticosterone, as well as urine Na<sup>+</sup>, Cl<sup>-</sup> K<sup>+</sup> and uric acid were measured weekly. No changes were found at 5‰ except an increase in urinary Na<sup>+</sup> and Cl<sup>-</sup> excretion. At 10‰ and greater, urinary Na<sup>+</sup> and Cl<sup>-</sup> did not increase significantly above 5‰ levels, however, plasma osmolarity, Na<sup>+</sup>, Cl<sup>-</sup>, K<sup>+</sup>, uric acid and corticosterone increased significantly. The most striking effect of exposure to 10‰ and greater was an up to 100 fold increase in urinary uric acid. At 10‰ and greater, alligators ceased feeding, and lost up to 28% of their initial body weight within the first week. After 3 weeks, deaths occurred at 15 and 20‰, and a 28-day LD<sub>50</sub> of 17.4‰ was calculated. It was concluded that the immature American alligator is incapable of electrolyte homeostasis and growth at salinities as low as 10‰. When salt stressed, alligators respond by increased corticosterone titer and a switch to uricotelism.

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THE EFFECTS OF THE PARATHYROID AND HYPOPHYSIS ON ION BALANCE IN DESMOGNATHUS QUADRACULATUS. K. Wittig and P.S. Brown, Siena College, Loudonville, NY.

Ion levels were determined 13 and 19 days after hypophysectomy (HX), parathyroidectomy (PX), HX+PX or sham (SH) operations in animals maintained at 18-20°C. Plasma Na dropped from 94 to 69 mEq/l in HX and to 78 mEq/l in prolactin (P) injected HX at 13 days. At 19 days, SH-HX, HX and HX+P levels were 92, 69 and 91 mEq/l respectively. Plasma Na was not altered by PX; HX+PX dropped Na levels to 76 mEq/l at 19 days. Plasma Ca dropped from 3.6 to 2.7 mEq/l at 13 days in HX; HX+P had 3.1 mEq/l. At 19 days HX Ca level was 2.8 while HX+P was 3.6 mEq/l; PX lowered Ca at 13 days to 2.8 but not at 19 days. HX+PX lowered Ca at 19 days to 3.1 but no difference was seen at 13 days. The data demonstrate that in this plethodontid salamander, Ca level is controlled by factors from both the hypophysis and parathyroid while only the hypophysis has significant effects on plasma Na. This follows the same pattern seen in the salamandridae (Oguro et al, 1978). Prolactin is both Na and Ca retaining in adults of this aquatic species.

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SPECTRAL SENSITIVITY INCREASE AND SHIFT WITH DECREASING TEMPERATURE. T.G. WHEELER, SRL, P.O.Box 35313, Brooks AFB TX 78235.

Goldfish spectral sensitivity is shown to be a function of temperature. The spectral sensitivity of goldfish optic nerve responses (compound action potentials) to the onset (ON) and cessation (OFF) of a step stimulus were obtained at 10 and 22°C. At 22°C the ON sensitivity peaked at 460 nm with a secondary peak at 620 nm. The OFF sensitivity had a single peak at 620 nm. The peak sensitivities at 10°C were all shifted to longer wavelengths and red (620 nm at 22°C) sensitivity increased by 300%. At 10°C the ON sensitivity peaked at 500 nm and the secondary peak shifted to 660 nm and was 300% higher than the 22°C data. The red OFF sensitivity at 10°C was also 300% greater than the 22°C sensitivity and was shifted to 660 nm. The peak sensitivity shifts observed between the 22 and 10°C data may be due to a change in concentration of the A<sub>1</sub>- vs A<sub>2</sub>-based visual pigments: At 22°C the A<sub>1</sub>-based pigments predominating and at 10°C the A<sub>2</sub>-based pigments prevailing. The increase in red sensitivity at 10°C for both the ON and OFF data could reflect the increased concentration of O<sub>2</sub> at this lower temperature. Both the shift in peak sensitivity at lower temperatures and the increase in red sensitivity are consistent with survival capabilities.

THERMOPERIOD AND CONSTANT TEMPERATURE RESISTANCE ACCLIMATION IN SALAMANDERS. JACK R. LAYNE, JR. and Dennis L. Claussen. Miami Univ., Oxford, OH.

Temperature tolerance adjustments of urodeles to thermoperiods (cyclic temperature periods) have received little attention. We examined thermoperiodism in three salamander genera (*Desmognathus*, *Eurycea*, and *Plethodon*). We used aquatic test methods to determine the critical thermal maxima and minima (CTMax and CTMin) of salamanders acclimated to 5 C, 15 C, 25 C, or a 5 - 25 C thermoperiod. The CTMax of all thermoperiod groups were acclimated to the maximum temperature, whereas the CTMin were adjusted between the maximum and mean temperatures. This adjustment towards the mean was greater in the more terrestrial species, and was better developed in *D. monticola* during the fall than in the summer. Such differential responses to cyclic temperatures may enhance survival in the natural environment. (Supported by Sigma Xi and Explorer's Club grants).

THE EFFECTS OF COST TO THE LEVEL AND PRECISION OF THERMOREGULATION IN THE DESERT IGUANA. P. C. WITHERS. PORTLAND STATE UNIVERSITY, PORTLAND.

The level of thermoregulation (mean body temperature) and precision of thermoregulation (standard deviation) were examined for the desert iguana (*Dipsosaurus dorsalis*) in a no cost environment (thermal gradient) and a variable cost environment (operant conditioning apparatus). The cost of thermoregulation ( $\text{ml O}_2 \text{ g}^{-1} \text{ h}^{-1}$ ) was calculated. Cost significantly affected the level of thermoregulation but not necessarily the precision. The significance of these data to current concepts of ectotherm behavioral thermoregulation, and of eury- and steno-thermality, are discussed.

THERMOGENIC CAPACITY OF GULL CHICKS. P. McGill-Harelstad\* and T. L. Taigen (Intro. by F. H. Pough). Cornell Univ., Ithaca, N.Y., and Univ. of Connecticut, Storrs.

During the past 50 years, Great Black-backed gulls (*Larus marinus*) have begun displacing Herring gulls (*L. argentatus*) from nest sites on the Isles of Shoals, Maine. Black-backs initiate egg laying 10 to 19 days earlier than Herring gulls. Minimum temperatures during the first 5 days post-hatching are 6 to 9°C for Black-backs and 6 to 14° for Herring gulls. At hatching Black-backs are one-third larger than Herring gulls. We compared the abilities of young chicks to tolerate cold. Oxygen consumption and body temperatures of both species were measured at ambient temperatures between 0 and 30° from hatching until chicks were 10 days old. Black-back chicks tolerated temperatures of 6 to 15° in the first 5 days without becoming hypothermic, whereas 20% of the Herring gulls were unable to maintain normal body temperatures under those conditions. The cold tolerance of young Black-backs may facilitate the early nesting of this species, which is an important factor in its ability to displace Herring gulls.

MUSCLE DEVELOPMENT AND THE METABOLIC RESPONSE TO COLD IN NESTLING BANK SWALLOWS. S.J. WICKLER and R.L. MARSH. University of California, Davis and Irvine.

We examined the transition from ectothermy to endothermy in nestling bank swallows (*Riparia riparia*) by measuring the peak metabolic response to cold (PMR) in groups of nestlings. Aerobic capacity, as assessed by citrate synthase activity (CS), and speed of muscle contraction, as assessed by myofibrillar ATPase activity (mATPase) were measured in the pectoralis and leg muscles. During the first 65% of their growth (from 2-12g) bank swallows do not increase their metabolic rate in response to cold. Between 12 and 16g the PMR increased from 4 to more than  $10 \text{ cm}^3 \text{ O}_2 (\text{g} \cdot \text{h})^{-1}$ . CS increased throughout development, starting at  $20 \mu\text{moles} (\text{g} \cdot \text{min})^{-1}$  and increasing to 160 and 50 U/g in the pectoralis and leg muscles, respectively. In leg muscle mATPase activity is constant throughout growth, but in the pectoralis muscle it undergoes a sharp transition from 5  $\mu\text{moles} (\text{min} \cdot \text{mg protein})^{-1}$  in animals less than 12 g to 9 U/mg in nestlings greater than 15 g. The similar pattern of development of PMR and mATPase suggests a critical role for muscle development in the transition to endothermy in this species.

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THERMOREGULATORY PHYSIOLOGY AND HEAT TRANSFER IN TWO SMALL MAMMALS. K. E. Conley and W. P. Porter. (Intro. by R. Auerbach). University of Wisconsin, Madison.

The relationship between physical heat transfer properties and physiological thermoregulation is examined in the deer mouse, Peromyscus maniculatus and the white rabbit, Oryctolagus cuniculus. Evaluation of the internal and external heat transfer conductances from empirically based, mechanistic regression models reveals that heat transfer is physically limited from the torso, but physiologically limited (by blood flow) from the appendages. The physical heat loss limit results in distinct thresholds for appendage vasodilation for the two animals because of torso conductance differences. The physiological limit, coupled with a smaller relative appendage surface area, results in a greater reliance on evaporative heat loss from the rabbit than from the mouse. Thus, the thermoregulatory differences shown by these two animals reflect differences in their physical heat transfer characteristics.

Supported by EPA R807540, DOE EY-76-S-02-2270 and the U.W. Graduate School.

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THYROID HORMONES IN TEMPERATURE ACCLIMATED DESERT RODENTS. Z. Haghani, and M.K. Yousef (intro. by P.L. Starkweather). Univ. of Nevada, Las Vegas.

Plasma thyroid hormones: total T<sub>4</sub> (T-T<sub>4</sub>), Free T<sub>4</sub> (F-T<sub>4</sub>), T<sub>3</sub>, and TSH were measured in cold (5C) and heat (34C) acclimated D. merriami, A. leucurus and N. lepida. The T-T<sub>4</sub> and T<sub>3</sub> increased in cold acclimated animals but F-T<sub>4</sub> increased only in A. leucurus and D. merriami. TSH decreased in A. leucurus and was relatively constant in other species. The decreased TSH in A. leucurus indicates that the regulatory feedback mechanism between plasma thyroid hormones and pituitary TSH is operative. However, this feedback mechanism may not be as effective in D. merriami and N. lepida. Acclimation to heat had no effect on TSH and T-T<sub>4</sub> levels but F-T<sub>4</sub> and T<sub>3</sub> decreased in all species. This finding suggests that T-T<sub>4</sub> may be an important regulator of the TSH feedback mechanism. Changes in thyroid hormones correlated with similar changes in metabolic rate. Therefore, thyroid hormones play an important role in temperature acclimation of desert rodents.

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PHYSIOLOGICAL STRESS IN THE EURYHALINE GASTROPOD THAIS HAEMASTOMA. W. B. Stickle. LOUISIANA STATE UNIV., BATON ROUGE, LA.

T. haemastoma tolerates salinities above 50/00 in the lab but is not found below 15/00 in estuaries. Snails were acclimated to salinities between 7.5 and 35/00 at 10, 20 and 30°C. Rates of predation on oyster spat, absorption efficiency, rates of oxygen consumption, ammonia and primary amine excretion were determined. Scope for Growth (SG) and Oxygen:Nitrogen (O:N) Ratios were calculated. Consumption of oyster spat was significantly higher at 20°C than at 30 or 10°C across all salinities. Absorption efficiencies varied from 81% to 96%. Caloric expenditure varied directly with temperature with 75-90% attributable to respiration, 6-18% to NH<sub>4</sub> excretion and 4-14% to primary amine loss. Scope for Growth was significantly higher at 20°C than at 30 or 10°C where snails were temperature stressed. O:N ratios varied from 6.5 to 24.5 indicating a protein oriented catabolism. Temperature has a more profound effect on SG in T. haemastoma than salinity. In contrast, SG of the more stenohaline T. lapillus is dramatically reduced at low salinity. Supported by NSF grant DEB7921825.

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ACCLIMATION TO SALINITY CHANGES DURING TIDAL FLUCTUATIONS BY A WEST COAST POPULATION OF MODIOLUS DEMISSUS. R. M. Baginski & R. Garthwaite\* University of California, Riverside

Body fluid osmolarities and ventricular free amino acid (FAA) levels of Modiolus (Ischadium) demissus were investigated throughout a series of salinity changes (during tidal cycles) in Newport Bay, CA. Mantle cavity and pericardial fluids rapidly approached osmotic equilibrium with the external salinity. The composition of the ventricular FAA pool after osmotic pressure increases depended on the time of exposure. Alanine, proline and β-alanine accounted for most of the FAA pool gain during the initial response to hypersaline conditions. Exposure of isolated ventricles to increased osmotic pressure resulted in a similar pattern. In contrast, after long exposure to salinity increases, glycine accounted for the majority of the FAA pool gain. These results confirm earlier reports that the pattern of FAA accumulation in animals is similar to studies on isolated ventricles. A series of hyposaline stresses resulted in lowered levels of most major amino acids, excluding taurine which remained relatively stable throughout the study. (NSF PCM - 7906515)

RESPONSES OF CTENIDIAL CILIA OF THE AMERICAN OYSTER TO CHANGES IN SALINITY AND CATION CONCENTRATION. R. C. Dean and A. A. Paparo.<sup>\*</sup> Dauphin Island Sea Lab, Univ. Alabama in Birmingham and Southern Illinois Univ.

The American oyster Crassostrea virginica is abundant in estuaries experiencing wide fluctuations in salinity. This study examined the effect of salinity change and changes in cation concentration on the ctenidial cilia. Oysters were removed intact from the shells and exposed to test solutions in a dish under a microscope, and ciliary activity was measured over a 140 min. period. Salinities different from the specimens' acclimation salinity had an inhibitory effect followed by recovery. Acclimation responses accompanied by a shift in salinity sensitivity was shown to be a function not of osmotic concentration but the concentration of  $Ca^{2+}$  and  $K^{+}$ . Since ciliary activity is essential to feeding and respiration, these responses may be important in limiting the distribution of this species.

THE CHEMICAL AND STRUCTURAL CHARACTERISTICS OF SQUID STATOLITHS. R. L. RADTKE. Pacific Gamefish Foundation, P.O. Box 25115, Honolulu, HI.

Statoliths of the shortfinned squid, Illex illecebrosus, were surveyed by the Scanning Electron Microscope and analyzed chemically to determine their internal structural patterns and chemical composition. X-ray diffraction data demonstrated that Illex statoliths were composed of  $CaCO_3$  in the aragonite crystal form. The crystals occurred in a protein matrix to form increments which eventuate from the nucleus to the edge of the statoliths. These microstructural growth patterns were interpreted to be daily in formation and subsequent growth estimations were in agreement with known life history information. The protein matrix comprised approximately 5% of the statolith by weight and was principally composed of acidic amino acids. The high abundance of aspartic acid in the protein matrix indicates that the matrix functions as a template in the initiation and acceleration of the crystal growth of  $CaCO_3$ . The stable isotopic composition of Illex statoliths revealed that oxygen was deposited in isotopic equilibrium with the surrounding environment while carbon appeared to be related to biological processes.

EFFECT OF DECEREBRATION ON VOLUME REGULATION IN CLITELLIO ARENARIUS. Joan D. Ferraris & Bodil Schmidt-Nielsen. Mt. Desert Island Biol. Lab., Salsbury Cove, ME

Histological and electrophysiological evidence links cerebral neurosecretion and osmoregulation in marine Oligochaeta. With transfer to 70 or 50%SW, control, sham and decerebrated worms showed hyperosmotic conformity. Two phases of volume regulation were observed. In phase 1 (0-6h) osmolality decreased while  $H_2O$  content (g  $H_2O$  /g solute free dry wt) increased. Tissue osmolality decreased in all worms at similar rates indicating little effect of ablation on integumental  $H_2O$  permeability. At the same time, control groups lost Na and Cl resulting in less  $H_2O$  gain in controls than in ablated worms. Most of the Na and ~50% of the Cl was lost extracellularly (EC). In phase 2 (6-18h) osmolality was constant and all groups showed a slow volume decrease accompanied primarily by losses in Na and unmeasured solute. Na was only lost EC and to a greater degree in control than in ablated worms. The largest solute reduction was an intracellular loss of unmeasured solute with little difference among the groups tested. The primary effect of ablation may thus be delayed onset of EC solute elimination leading to greater  $H_2O$  content in ablated worms. NIH AM15973 (BSN); GMO7047 (JDF).

CELLULAR VOLUME REGULATION IN GLYCERA DIBRANCHIATA COELOMOCYTES: EFFECTS OF DIVALENT CATIONS AND METABOLIC INHIBITION. C. J. Costa and S. K. Pierce. Univ. of Maryland, College Park.

The red coelomocytes of the osmoconforming polychaete, Glycera dibranchiata, regulate cell volume during hypoosmotic stress by reducing the intracellular concentration of osmotic solutes. The initial response to hypoosmotic exposure is a control of cell swelling followed by a regulatory volume decrease (RVD) accomplished by an efflux of free amino acids (FAA) and  $K^{+}$ . Isolated Glycera coelomocytes exposed to  $Ca^{2+}$  - $Mg^{2+}$  free hypoosmotic (600 mOsm) media swell less and show a reduced RVD compared to cells in similar media containing  $Ca^{2+}$  and  $Mg^{2+}$ . Isosmotic deletion of  $Ca^{2+}$  - $Mg^{2+}$  from 1000 mOsm media results in a loss of cell volume. Both abnormal reductions in cell volume are accompanied by an increased efflux of FAA. Either  $Ca^{2+}$  or  $Mg^{2+}$  can maintain normal membrane permeability to FAA but  $Ca^{2+}$  is more effective than  $Mg^{2+}$ . Finally, cell swelling during hypoosmotic exposure is reduced by incubation in 1 mM 2,4-dinitrophenol, but the RVD and the FAA efflux were not affected. (Supported by NIH GM-23731 and TS&GCMBA, Inc.)

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LEVELS OF GLYCINE IN THE PYLORIC CAECA & TUBE FEET AND WHOLE ANIMAL AMMONIUM EXCRETION OF *LUIDIA CLATHRATA* (SAY) (ECHINODERMATA: ASTEROIDEA) EXPOSED TO HYPOSMOTIC AND HYPEROSMOTIC STRESS. W.J. DIEHL AND J.M. LAWRENCE. Univ. South Florida, Tampa.

Concentrations ( $\mu\text{moles/mg}$  dry tissue) of glycine in the pyloric caeca and the tube feet of *L. clathrata* decreased from 0.42 and 0.95, respectively, in individuals at 25°/ooS to 0.22 and 0.60, respectively, in individuals held 1 week at 15°/ooS. The largest rate of glycine decrease occurred during the first 2 days. In a second experiment, concentrations of glycine in the pyloric caeca and the tube feet increased from 0.41 and 0.86, respectively, in individuals at 25°/ooS to 0.65 and 1.16, respectively, in individuals held 1 week at 35°/ooS. The largest rate of glycine increase occurred during the last 5 days. Ammonium excretion rates ( $\text{nmoles/hr/g}$  dry wt) of whole *L. clathrata* were 54.4 at 25°/ooS, and 228.0, 63.4, 68.9 of individuals held at 15, 25, 35°/ooS, respectively, for 1 day.

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HOW DO SPIDERS BREATHE? C. F. Herreid, L. W. Lee and R. Spampata\*. State Univ., New York at Buffalo.

Physiologists have long held that gas exchange in spiders occurs by diffusion via the booklungs. Now we have collected evidence that suggests that tarantulas use active ventilation. (1) Water loss in tarantulas exposed to a helium and oxygen atmosphere was the same as those exposed to a nitrogen and  $\text{O}_2$  mixture; if only diffusion were involved, theoretical arguments suggest that the loss would be twice as much in the He- $\text{O}_2$  mixture as the  $\text{N}_2$ - $\text{O}_2$  mixture. (2) Placing miniature respiratory masks over the spiracles and measuring  $\text{O}_2$  consumption from the separate booklungs indicates the spiracles are all slightly open in the resting tarantula and gas exchange is probably via diffusion. When tarantulas were forced into activity by running on a treadmill, small pulses of  $\text{O}_2$  consumption were recorded. These pulses, precisely synchronized among the four booklungs, may be the result of ventilation.

Supported by NSF grant PCM 79-02890.

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WORK AND POWER ASSOCIATED WITH CRUSTACEAN VENTILATION. A. J. MERCIER and J. L. Wilkens. Univ. of Calgary, Calgary, Alberta, Canada.

Measurements of branchial pressure, ventilation rate and branchial water flow were used to calculate ventilatory work (= stroke volume X pressure) and power (= flow X pressure) in *Carcinus maenas* and *Procambarus clarki*. Work increases linearly with ventilation rate, due mainly to changes in branchial pressure. Ventilatory power increases as an exponential function of ventilation rate. Electromyographic recordings from scaphognathite muscles suggest that work and power requirements are met by appropriate changes in intraburst spike frequency, which serve to increase the force of muscular contraction via facilitation. Biogenic amines induce hyper-ventilation. Possible modulatory roles of these compounds will be discussed.

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AEROBIC RESPONSE TO EXERCISE IN THE FASTEST PEDESTRIAN INVERTEBRATE. Robert J. Full and C. F. Herreid II. SUNY/Bufalo

The ghost crab, *Ocypode quadricaudii* was captured off Naos Island, Panama. Average mass was  $2.78 \text{ g} \pm .61 \text{ S.D.}$  Sprinting velocities up to 8.5 km/hr were recorded on the beach for larger animals. Crabs on a miniature treadmill could run for longer than 20 min at velocities up to .34 km/hr. At .76 km/hr, animals fatigued in less than 5 min. To view aerobic response to exercise, animals were run in a treadmill respirometer at three velocities (.13, .19 and .28 km/hr) while oxygen concentration was monitored. Oxygen consumption ( $\dot{V}_{\text{O}_2}$ ) transient periods at the beginning and end of exercise were extremely rapid with half times from 50 sec to 2.5 min. Oxygen debt was measured at three velocities after 4, 10 and 20 min exercise bouts. Oxygen debt was increased with increasing velocity but showed no change with respect to duration. A steady-state  $\dot{V}_{\text{O}_2}$  was observed. This had not been seen in five other crab species previously tested. Steady-state  $\dot{V}_{\text{O}_2}$  increased linearly with velocity. The minimum cost of transport was  $1.9 \text{ mlO}_2/\text{g.km}$  and is comparable to other animals of a similar size. Supported by NSF Grant PCM 79-02890.

TEMPERATURE DEPENDENCE OF AEROBIC METABOLIC SCOPE IN CALLINECTES SAPIDUS. C.E. BOOTH and B.R. McMahon. Univ. of Calgary, Alberta.

Standard and maximal rates of  $O_2$  uptake ( $MO_2$ ), ventilatory flow ( $V_w$ ), scaphognathite ( $f_{sc}$ ) and heart ( $f_h$ ) pumping, and aerobic metabolic scope (AMS) were determined for C. sapidus acclimated to 13°, 20°, and 28°.  $MO_2$ -std increased from 10 to 40  $\mu\text{mol/kg/min}$  between 13° and 28° ( $Q_{10}=2.5$ ). Routine  $MO_2$  was 1.5-3.0 times  $MO_2$ -std at all temperatures.  $MO_2$ -max was measured immediately (1 min) following severe exercise at 13° and 20°, but at 28°,  $MO_2$  continued to rise for 10-15 min after exercise ceased. The factorial increase in  $MO_2$  after exercise was greatest (7X) at 20°, but AMS was greatest (180  $\mu\text{mol/kg/min}$ ) at 28°. Both std and max values for  $V_w$ ,  $f_{sc}$ , and  $f_h$  showed a  $Q_{10}$  value near 2. The recovery time for  $MO_2$  was fastest at 13° and slowest at 28°. The values for AMS in C. sapidus are among the highest reported for any decapod crustacean, and are comparable to the AMS for many active species of fish at similar temperatures.

ANAEROBIC METABOLISM IN RELATION TO P-CRIT. IN THE TROPICAL FRESHWATER PRAWN MACROBRACHIUM ROSENBERGII. D. G. SPOTTS. Univ. of Miami Marine Lab, Miami, FL 33149-1098

Oxygen consumption measurements of young prawns in a closed respirometer were conducted during declining oxygen tensions both day and night. During the day  $Vo_2$  fell from .25  $\text{ml}O_2/\text{gm/hr}$  to .20  $\text{ml}/\text{gm/hr}$  at 125 Torr, remained steady then fell again at a Pcrit of about 40 Torr. In contrast night responses to hypoxia showed a rise in  $Vo_2$  from .27  $\text{ml}O_2/\text{gm/hr}$  to .31  $\text{ml}/\text{gm/hr}$  with a Pcrit of about 65 Torr. Measurements of whole body lactate on similarly treated but separate groups of prawns showed concentrations of .15 mg lactate/gm at sat. conditions and at 60 Torr rising to .61 mg/gm at 10 Torr. The results show lactate accumulations increase below Pcrit and aerobic metabolism to be more pronounced at all oxygen tensions at night.

ENERGY RESERVES AND METABOLIC EXPENDITURES OF OVERWINTERING MONARCH BUTTERFLIES.

P. H. WELLS and S. B. CHAPLIN. Occidental College, Los Angeles and Univ. of Missouri, Columbia.

Monarch butterflies, Danaus plexippus, have fat reserves which vary with season and may be essential to survival in their overwintering aggregations. We (1) measured depletion of fat throughout the winter, (2) compared this measurement with the expense of daily maintenance, and (3) asked if clustering behavior affected butterfly energetics. Male monarchs are larger than females and weights of both decreased during the winter. Butterflies maintained hydration and lean dry weight throughout the period. Fat content decreased from 65% of lean dry weight in November to 37% in late January. Intra-thoracic temperature of roosting butterflies always approximated air temperature. Intracluster air temperatures were not elevated. Flying or basking individuals had elevated body temperatures. Metabolic rates of butterflies are temperature dependent ( $Q_{10}=3$ ). Energy requirement of roosting butterflies (7.25 cal/day/butterfly, based on cluster temperatures) approximated that available from fat expenditures (6.23 cal/day/butterfly). Clustering apparently aids survival by retarding metabolism of lipid energy reserves.

HORMONAL CONTROL OF HEMOLYMPH LIPID IN ONCOPELTUS FASCIATUS. M.A. Rankin, Univ. of Texas, Austin

Precocene treatment inhibits long duration (presumed migratory) flight behavior of Oncopeltus fasciatus while juvenile hormone (JH) very rapidly stimulates long flight in precocene-treated bugs. Injection of either JH I or III induces a rapid rise in hemolymph lipid which has the same time course as the rapid stimulation of flight activity. Lipid is depleted during long flights in Oncopeltus and seems to be the primary flight fuel. Hemolymph lipid falls to very low levels after precocene treatment although fat body reserves increase. JH replacement therapy causes up to a 300% increase in hemolymph lipid in precocene-treated animals over carrier-injected controls. Saline extracts of corpora cardiaca (CC) have no effect. In vitro incubation of fat body in modified Grace's medium with JH or CC, with or without hemolymph shows that either JH I or III can stimulate the release of lipid in vitro. Since the effect of JH on hemolymph lipid is of short duration while enhancement of flight behavior after JH treatment increases for several days, JH probably has additional effects on the flight system.



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CALCIUM IN AMPHIBIAN GASTRULATION. L.H. TWERSKY & I. BRICK, New York University, New York.

The role of  $Ca^{2+}$  was studied in the initiation and continued cell movement in Xenopus laevis gastrulae. Calcium distribution and changes were determined for specific stages and regions. Ionic  $Ca^{2+}$  levels were determined by the GBHA histochemical test. Stage and area specific differences were seen in  $Ca^{2+}$ .  $Ca^{2+}$  in whole embryos increased just prior to and during gastrulation suggesting high levels of  $Ca^{2+}$ , bound and free, accumulate prior to movement and are related to future movements.  $Ca^{2+}$  increases correspond to initiation and continued invagination indicating  $Ca^{2+}$  mediation of lip formation. At all stages, lip formation is associated with release of  $Ca^{2+}$  from bound to free. Increased  $Ca^{2+}$  initiated gastrulation about 1 hr sooner than std. amounts. Ionophore A23187 initiated lip formation and expansion much sooner than controls, possibly by  $Ca^{2+}$  activation of cortical microfilament systems, an effect enhanced by doubling ionophore concentration. Cytochalasin B delayed gastrulation and *in vivo* and *in vitro* studies indicate  $Ca^{2+}$  binding by cytochalasin B, suggesting this as a mechanism of cytochalasin B action.

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SPECIES AND STAGE-SPECIFIC AGGREGATION FACTOR ISOLATED FROM INTACT SEA URCHIN EMBRYO CELLS. S. B. Oppenheimer and J. T. Meyer. California State Univ., Northridge.

The supernatant obtained from dissociation of Strongylocentrotus purpuratus blastulas in calcium-magnesium-free sea water effectively promoted adhesion of S. purpuratus blastula but not gastrula cells. The supernatant had no aggregation enhancing effect whatsoever upon Lytechinus pictus blastula cells. Glutaraldehyde fixed S. purpuratus blastula cells aggregate in the presence of dissociation supernatant. The results suggest that the isolated component is likely to be functional *in vivo* because: it is isolated from intact cells not exposed to proteases, it is species and stage specific, and it promotes aggregation of cells in their natural medium, sea water. Future biochemical work should be informative because liters of active supernatant containing about 1 mg protein/ml can be obtained. (Supported by NSF grant PCM 8017668 and NCI grant CA 12920 to S. B. O.)

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COMMON PROPERTIES OF MESENCHYMAL CELLS HAVING DISPARATE EMBRYONIC ORIGINS. D.M. NODEN, Cornell University, Ithaca, N.Y.

Mesenchymal cells in vertebrate embryos have 2 origins, mesoderm and neural crest. Traditionally the differences between them are emphasized with less attention given to their many shared properties. This research examines the ability of these mesenchymes to substitute for one another following transplantation in avian embryos.

If somitic tissue is grafted in place of cranial crest, the cells do not migrate but self-differentiate *in situ*. In contrast if pre-somitic segmental plate mesoderm is grafted some of the cells participate in crest migration and contribute to the cornea and periocular skeleton.

Crest cells which normally make a minor contribution to the otic capsule can be experimentally diverted to form nearly half of this structure.

These experiments suggest that some mesodermal and crest cells are indeed similar in their embryonic potential, and that their development may be facilitated by similar mechanisms.

Supported by grant R01 NS16408 from NINCDS

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CELLULAR INTERACTIONS IN A DEGENERATING NERVE. C. Kaars and C.R. Fournier, SUNY/ Buffalo.

The four axons comprising nerve 3B11 innervate the tibial extensor in P. americana. Two, the excitors FETi and SETi, leave the ganglion in nerve 3; the two inhibitors leave in nerve 5. Crushing either nerve 3 or 5 results in degeneration of either the excitors or inhibitors in nerve 3B11. Degeneration, which begins at the lesion site and spreads ortho- and retrograde, is associated with invasion of the axoplasm by protrusions of periaxonal glia. These protrusions subdivide and apparently pinch off the axoplasm. Axonal degeneration is also associated with an increase in the number of periaxonal lamellae and in the number and size of glial lacunae. Selective lesion of inhibitory axons results in their degeneration and also in a glial invasion of the non-lesioned excitors which is transient and does not lead to axonal degeneration. Selective lesion of the excitors leads to an increase in diameter of the non-lesioned inhibitors of as much as 50% of normal 14-21 days after lesioning. This invasive pattern of degeneration is strikingly similar to that observed in vertebrate toxic neuropathies. Supported by NIH Grants #K04 NS 00141 and R01 NS14204.

ANALYSIS OF MEMBRANE GLYCOPROTEINS DURING NORMAL AND BRACHYPOD LIMB CHONDROGENESIS. J. Thomas Wright and W.A. Elmer, Emory U., Atlanta, Ga.

Studies over the past several years on the mouse mutation, brachypodism ( $bp^H/bp^H$ ), have indicated that the abnormal differentiation and development of the appendicular skeleton may be related to membrane alterations in the cells undergoing chondrogenesis. For example, differences in the reactivity of limb mesenchyme with Con A and WGA between normal and brachypod have been demonstrated (Hewitt, A.T., and W.A. Elmer, Differentiation 10:31-38, 1978). Since Con A binds preferentially to mannose, experiments have been initiated to characterize mannose containing plasma membrane glycoproteins during limb development. Using positively charged microcarriers a method has been developed (as shown by chemical and enzymatic analyses) for obtaining purified plasma membranes. Using a chemically defined organ culture system, metabolic studies measuring the incorporation of [ $^3H$ ] mannose into 11-day limb buds suggest no differences between normal and mutant cells are recognizable during the first 48 hr of culture. However, between the 2nd and 6th day a biphasic pattern of incorporation is observed. Although the pattern is similar between both genotypes, the radioactivity is significantly lower in the mutant. This difference can be correlated with the abnormal pattern of cartilage differentiation in the brachypod limb bud. Supported by NIH Grant HD10945 to W.A.E.

THE DEVELOPMENT OF MYONEURAL JUNCTIONS BETWEEN EMBRYONIC CHICK CELLS IN TISSUE CULTURE USING A SERUM-FREE MEDIUM. B. A. Deem\*, H. C. Philpot\*, S. J. Stewart, and S. H. Hamada, West Georgia College, Carrollton.

Single neurons from the spinal cord of four day old chick embryos were co-cultured with muscle cells. A neuron enriched population of cells was obtained using the vertical vibration method (of McCarthy and Partlow) and a differential trypsin treatment. Using both light and electron microscopy, the morphological events occurring during the formation of the myoneural junction of slow tonic anterior latissimus dorsi and the fast posterior latissimus dorsi were studied. The role of cell projections and lysosomes and their enzymes were compared in both types of muscles. (Support of West Georgia Faculty Grant 8210 is acknowledged.)

SYMPATRY AND ALLOPATRY AMONG KENYAN CHAMELEONS. J.J. HEBRARD, University of Nairobi, Kenya.

Spatial overlap between pairs of species varies from geographic replacement through occurrence in adjacent habitats to complete sympatry. Chamaeleo gracilis and C. dilepis both occupy seasonally dry scrub habitats, perch at similar heights, and attain large size. In certain areas they replace each other along elevational gradients that are not marked by abrupt vegetation changes. C. schubotzi and C. höhnelii both occupy ericoid bushland above 3000m on Mt. Kenya and may be found within meters of one another. The former species is found only in areas with shrubs < 2m in height, while the latter perches in shrubs > 2m in height. True sympatry is exemplified by C. jacksoni and C. fischeri which occur together in high forest at 2400m on Mt. Kenya. They perch at similar heights and thus occupy similar microhabitats. Sympatry has been documented at only 5 of 51 sites where chameleons have been found. Four of these 5 have been in forest.

ETHOLOGICAL ISOLATION OF PLANTS: COLOR SELECTION BY HONEY BEES. H. WELLS, P. H. WELLS and D. M. SMITH\*, Univ. of Tulsa, Occidental College, Los Angeles and Univ. of California, Santa Barbara.

The behavior of Apis mellifera foraging in an artificial flower patch was studied under a variety of experimental conditions. Honey bees associated food with a flower color and remained constant to that color; some to yellow and some to blue flowers in our experiments. Individual bees were approximately 97.5% constant to a color, and the occasional mistakes did not change their constancy to the original colour. The presence or absence of odor stimuli did not change the bees' foraging behavior, nor did the volume of nectar obtained per flower. The foraging behavior is a strong isolation mechanism for plants. Since changes in flower color can be caused by single gene mutations, plant speciation often may occur more rapidly than current dogma predicts. Also, sympatric speciation in plants is not as unlikely as previous studies predict. Finally, computer simulations show that the gene regulating ethological isolation and a gene under differential selection in two microhabitats need not be linked in order for divergence in allele frequencies to occur.

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COLORATION PATTERN AND SIZE SEXUAL DIMORPHISM IN THE GIANT KELPFISH, *HETEROSTICHUS ROSTRATUS* GIRARD (FAM. CLINIDAE). C.A. Stepien and K. Rich\*. Univ. of Southern California, Los Angeles, California.

Giant kelpfish, *Heterostichus rostratus*, were aged from otoliths, measured, and sexed. These data were correlated with their coloration patterns and algal habitats. Kelpfish were either red, green or brown, and were found in algae closely corresponding to the color of the fish. When placed on variously colored backgrounds in the laboratory, their color change capabilities were determined to be limited to changes in melanin concentration. Coloration was found to be sexually dimorphic. Adult females were either red, green, or brown while adult males were always brown. Brown males were distinguishable from brown females by different melanin patterns. Males had either "mottled" or "striped" patterns while females exhibited either "barred" or "plain" patterns. These melanin patterns were observed to change rapidly in the field during courtship displays and territorial defenses. Female fish were found to attain a larger size and correspondingly greater age than the male fish. Females were most often found at shallower depths and in different algal habitats than males.

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PREMIGRATORY CHANGES IN TIME BUDGETS OF TERRITORIAL HUMMINGBIRDS.

F. L. Carpenter, M. A. Hixon\*, D.C. Paton\*. Dept. of Ecology and Evolutionary Biology University of California, Irvine 92717.

Rufous hummingbirds migrate south along the California mountains during July and August stopping periodically in flowering meadows where they establish feeding territories. They replenish their fat stores over about 1-2 weeks, spending approximately 20% of the daylight hours feeding and 1-5% defending their territories. Once a bird reaches a weight of about 4.5g (about 40% fat), it will resume migration predictably within 1-3 days. During this premigratory period, most individuals slacken their defense and may relinquish a portion of their territory. Birds resume migration usually in early morning. During the final hour preceding migration they devote 30-50 % of their time to feeding and may stop defending most of their territories. These changes in the allocation of time to defense and feeding apparently maximize the short-term energetic benefit the birds can gain from their territories. Because nectar standing crops are highest in the early morning, devoting most time to feeding and ignoring most intruders may be the energetically most efficient strategy to follow just before abandoning a territory.

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COMPARISON OF REPRODUCTIVE STRATEGIES IN GEORGIA AND MASSACHUSETTS POPULATIONS OF *FUNDULUS HETEROCLITUS*. M. H. Taylor, L. DiMichele, R. T. Kneib\* and S. Bradford\*. Univ. of Delaware, Newark and Univ. of Georgia Marine Institute, Sapelo Island.

Gonadosomatic index (GSI) egg production, and spawning were monitored in natural populations of *F. heteroclitus* on Sapelo Island, Georgia and near Woods Hole, Massachusetts. The Georgia population contained sexually mature fish by early March, while spawning apparently did not occur in the Massachusetts fish until early May. The Georgia population used shells of the Atlantic ribbed mussel (*Geukensia demissa*) and the leaves of *Spartina alterniflora* for egg deposition, while the Massachusetts fish deposited eggs in sand or floating algae mats. A semilunar spawning periodicity was present in females of both populations, but the amplitude of the change in GSI was less than that observed in a Delaware population (Taylor et al., 1979). The Massachusetts population spawned continuously during a six-week observation period, but the number of eggs laid was always greater at the spring tides. This work was supported by NOAA Sea Grant 04-6-158-44025 to MHT.

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VARIATION IN THE MEAN SIZE AT ONSET OF EGG PRODUCTION IN SAND CRABS (*EMERITA ANALOGA*). A. M. Wenner and P. Siegel. Univ. of California, Santa Barbara.

The size at which egg production begins in sand crabs can vary greatly within a population during the reproductive season and between populations which live in different localities. In order to assess the extent and pattern of normal variation of that measure, sand crab populations were sampled throughout the 1980 reproductive season. On Santa Barbara beaches, the mean size at onset of egg production declined from a high of approximately 18.0 mm carapace length in mid-May to a low of 10.5 mm C.L. in early August. That mean then rose again to nearly 13.0 mm C.L. before cessation of egg production in early October. The pattern of variation for populations sampled near Scripps pier (La Jolla) paralleled that found at UCSB, but values were consistently higher at the more southerly locality. The values for Scripps populations were also very similar to those found at that location in 1967. By contrast, females from Southern Calif. beaches were much smaller when they first began producing eggs than Monterey area sand crabs sampled in 1967-69. Studies are underway to determine which factors might be responsible for that variation.

DIURNAL VERTICAL MIGRATION BY THE AQUATIC MITE HYDROZETES BUSHNELLI (ORIBATEI: HYDROZETIDAE). Peter B. LaRochelle, Univ. of Colorado, Boulder.

The aquatic mite Hydrozetes bushnelli is a common inhabitant of the Aufwuchs communities of the plains lakes and ponds near Boulder, Colorado. Adults of this species have a plastron from which they obtain air for respiration. Under certain conditions air from the plastron is swallowed and is accumulated in the midgut. This results in a reduction in density causing individuals to rise into the plankton. I have found this species to undergo nocturnal vertical migration. Maximum densities of planktonic Hydrozetes occur from 2400 to 0300 hrs. and during peak migratory activity exceed 40 adults/liter. The magnitude of vertical migration varies seasonally. Peak vertical migration in late spring coincides with tremendous aggregations of H. bushnelli (> 300 mites/cm<sup>2</sup>) on floating shoreline substrates. This mite cannot swim and is not planktivorous. Vertical migration may be of importance in reproduction, dispersal and escape from unfavorable physiological conditions.

SPECIFICITY OF THE MALE CRICKET, ACHETA DOMESTICUS (L.) REQUIREMENT FOR VITAMIN E. J.R. LITTON, JR. Saint Mary's College, Notre Dame, IN.

Vitamin E is required for spermatogenesis in the house cricket. While selenium and tocopherol quinone cannot substitute for  $\alpha$ -tocopherol, the further specificity of this requirement for vitamin E had not been investigated.

Dietary addition of a variety of tocopherols and analogs, including:  $\beta$ -,  $\gamma$ -, and  $\delta$ -tocopherols,  $\alpha$ -tocopherol,  $\alpha$ -tocotrienol, 5,5'-Bi-tetramethyl-2-(4',8'-dimethylnonyl)-6-hydroxychromane, 2-(4,8,12,16-tetramethyl-heptadecyl)-5,7,8-trimethyl chromanol-(6), 2-(4,8,12,16-20-pentamethyl heneicosyl)-5,7,8-trimethylchromanol-(6), 2-(4,8,12-trimethyl-tridecyl)-2,5,7,8-tetramethyl-6-hydroxyl-1,2,3,4-tetrahydro chinolin, and assorted antioxidants, showed a varied pattern of substitution for d-tocopherol. The compounds evaluated ranged in activity (d-tocopherol =100%) from 0-71% based on assay of egg viability and examination of the testes for the presence of motile sperm. Information on the relative effects of these compounds on larval and adult growth rates was also obtained.

The specificity/pattern of response is compared to rotifers and mammals.

PLEISTOPHORA SCHUBERGI, A MICROSPORIDIUM WITH POTENTIAL AS A MICROBIAL CONTROL AGENT OF FOREST PEST INSECTS. G.G. Wilson, Forest Pest Management Institute, Sault Ste. Marie, Ontario, Canada.

The potential of P. schubergi as a microbial control agent for insects in the order Lepidoptera and Hymenoptera has been demonstrated by laboratory and field studies. In general, P. schubergi is highly effective in killing many insects under laboratory conditions. All Mala-cosoma disstria died when 2nd instar larvae were treated with suspensions of  $5 \times 10^5$  P. schubergi spores/ml. Treatment of 2nd- and 5th-instar larvae of Choristoneura fumiferana with  $2 \times 10^8$  spores/ml resulted in 100 and 70% mortality respectively. Sub-lethal effects of the microsporidium included smaller larvae displaying less vigor, malformed pupae and adults which were unable to copulate and lay eggs. Infection rates after field application of P. schubergi spores have ranged from 40% in Pristiphora erichsonii, to 96% in Choristoneura fumiferana. Although this microsporidian parasite appears to have good potential as a control agent, there is still further research warranted.

TRYPANOSOMA LEWISI: EFFECTS OF TRACE METAL CONTAMINANTS ON IMMUNOLOGICAL RESPONSES. Y.A. HOGAN and C.M. Lee. Howard University, Washington, D.C.

Earlier and higher levels of parasitemia were detected in animals exposed to cadmium, lead, and mercury. The variability in lengths of trypanosome cells in metal exposed animals became constant at a later time and persisted for a longer time indicating a delay in antibody synthesis. Significant weight loss was exhibited by animals exposed to cadmium, while lead exposed animals showed an increase in body weight. Mercury exposed animals demonstrated no essential differences compared to control animals. Infected animals exposed to trace metals showed decreases in total erythrocyte counts, lower hematocrit values and increased total leucocyte counts. Serum levels of IgG and IgM were increased in infected animals exposed to trace metals; however, lower levels were observed compared to infected control animals. Animals exposed to trace metals only showed decreases in serum levels of IgG and IgM.

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TRYPANOSOMA LEWISI: CELL POPULATION AND ANTIBODY FORMATION IN THIAMINE-DEFICIENT RATS. E.N. MOYO AND C.M. LEE. Howard University, Washington, D.C.

A metabolic imbalance technic employing the thiamine-deficient rat and Trypanosoma lewisi was used to measure trypomastigote cell populations and antibody formation. Thiamine-deficient rats had parasitemias about 5 times greater than animals fed a complete diet and 2 times pair-fed controls. Parasitemias lasted longer in thiamine-deficient hosts, and reached a maximum several days later than those from control hosts. The action of the antibody which inhibits reproduction of the trypomastigotes was delayed ten days in thiamine-deficient rats; in pair-fed animals ablastic action occurred slightly earlier than in normal control animals. The actions of the terminal lytic antibody was delayed a sixth longer in metabolically deficient mice than in controls, and about a third longer in pair-fed controls.

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SUSCEPTIBILITY SURVEY OF SCHISTOSOME VECTOR SNAILS FROM NORTHEASTERN BRAZIL Gary E. Rodrick and W. L. Paraense\*, Univ. of South Florida College of Medicine, Tampa and Fundacao Oswaldo Cruz, Rio de Janeiro.

Migration of Brazilian families from coastal foci endemic for Schistosoma mansoni to agricultural colonies in the interior of Northeast Brazil are occurring. Many of these agricultural colonies are in close association with small water ways which serve as ideal habitats for vector snails. The major potential vector snail in Northeast Brazil is Biomphalaria straminea and has recently been shown to be susceptible for S. mansoni. Because of its association with high levels of infection, it was of interest to: 1) investigate under laboratory conditions the susceptibility of various geographical isolates of B. straminea; and 2) delineate geographical areas of occurrence of B. straminea which possess the ability to serve as a vector for S. mansoni. Experiments to determine the susceptibility of B. straminea from over 50 localities to various strains of S. mansoni showed widely varying infection rates. Present results indicates an expansion of schistosomiasis to a wide South American area where B. straminea occurs. (Supported by NIH grant #R21 AI16287-02)

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PREY CHARACTERISTICS AND THE ORIGIN AND ADAPTIVE RADIATION OF EARLY SNAKES. H. W. Greene. Univ. California, Berkeley.

Extensive stomach analyses of two living primitive families and a fossil containing prey were used to address the probable role of diet in the early history of snakes. Aniliids, perhaps the morphologically most primitive living snakes, feed on relatively heavy, elongate vertebrates. As is the case in advanced snakes, large aniliids eat larger prey than do small individuals but they take small items as well. Living booids, structurally intermediate between aniliids and advanced snakes, feed on relatively heavy prey of a much greater variety of shapes than do aniliids. An Eocene booid snake contains a relatively large crocodylian in its gut.

These findings, previous studies, and morphological considerations suggest that very early snakes used constriction and powerful jaws to feed on elongate prey; this would have permitted a shift from feeding often on small items to feeding rarely on heavy items, without requiring major changes in jaw structure relative to a lizard-like ancestor. Subsequent morphological changes allowed booids to utilize a broad range of prey types, including many of those currently eaten by advanced snakes.

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FEEDING STRATEGIES OF INSECTIVOROUS BATS: SENSORY MODALITY IN LOCATION OF PREY. Gary P. Bell. Carleton University, Ottawa, Canada.

I studied 2 species of insectivorous bats, Antrozous pallidus and Macrotus californicus, which glean prey from the ground rather than capturing it in aerial pursuit, using a combination of field observation and lab and field experimentation to determine what sensory modes are used in locating prey, and how prey are captured. Antrozous, a heavy-bodied (30g) relatively unmanoeuvrable species used passive sound (sound produced by the prey) to locate insects and other large arthropods. Echolocation was apparently used only for general navigation purposes, and vision appeared to play little, if any, role in prey location. Macrotus, a smaller (20g), very agile species was able to locate prey using any of these three sensory modes (vision, echolocation, and passive sound) but used echolocation only when light was not sufficient for the use of vision. This may be a behavioral adaptation for circumventing the defensive strategies of acoustically adapted insects. Macrotus is apparently the only species of bat so far studied which relies mainly upon vision for location of insect prey.

ENERGETIC EFFICIENCY OF FORAGING ON VARYING RESOURCES IN WHIPTAIL LIZARDS (*CNEMIDOPHORUS TIGRIS*) P.H. Lehrer and W.H. Karasov. SUNY, Albany, and Univ. Ca., Los Angeles.

It has been proposed that under conditions of nonrandom prey dispersion, a predator may increase its foraging efficiency by using area restricted searching. Several studies have shown behavior to be consistent with this hypothesis but energetic efficiency was not directly measured. We used the doubly labeled water technique to measure field rates of energy cost and feeding for *C.tigris*. Feeders replenished daily with crickets were placed in the foraging area in random and clumped distributions of equal density. The data at this time suggest that under both prey conditions, the hourly energy output for foraging remains the same but the ingestion rate is greater for the clumped prey dispersion. This increased efficiency allows *C.tigris* to spend fewer daily hours foraging for about the same net gain when prey are clumped. These data are consistent with the predictions of area restricted searching

HOST-SPECIFICITY AND EGG DISPERSION BY THE BROOD PARASITIC BROWN-HEADED COWBIRD. R. C. FLEISCHER. Museum of Natural History, University of Kansas, Lawrence.

This study examines the questions of individual female host-specificity and the dispersion of eggs over space by the Brown-headed Cowbird (*Molothrus ater*). I searched for nests over 15 ha of pasture in northeast Kansas during spring, 1981. I found 114 nests of 15 species. About 20% of these contained Cowbird eggs and a total of 32 eggs were found. Parasitism occurred only within nests of Red-winged Blackbirds (43% of the cowbird eggs found), Dickcissels (38%) and Eastern Meadowlarks (19%). I used starch gel electrophoresis to determine "genotypes" of 4 enzyme loci. Because these were of maternal origin, I determined combinations of genotypes and used these to identify individual females (within calculable probabilities). In addition I used multivariate analyses of egg morphology to support these identifications. My data indicate that individual females are not host-specific, but may exhibit host preferences. It appears also that females do not lay in exclusive nesting territories. The relevance of these findings to the evolution of brood parasitism will be discussed.

THE AERIAL FLIGHT OF PENGUINS. C.A. HUI. Naval Ocean Systems Center, San Diego, and U.C.L.A., Los Angeles, Calif.

The "porpoising" leaps of penguins may comprise an important component of their predator-escape behaviors and their locomotion energy conservation. High-speed movies of porpoising behavior of Humboldt penguins at the San Diego Zoo and Adelie penguins in the wild were analyzed. Leap trajectories are not ballistic, indicating control by the bird while airborne. The wings appear to be the primary control structures. Chances for escape from predators may be increased by porpoising since the re-entry points for the leaps are not predictable from launch data available to pursuers. Also, while airborne the bird is invisible to underwater viewers whose line of sight is outside the critical reflection angle and acoustic penetration into the water is very low. An energy-conservation model for the leaping behavior of swimmers predicts launch angles and the swimming speed at which porpoising should begin. Almost all recorded penguin leaps for which speed could be determined occurred above the predicted speed. The observed launch angles were related to energy conservation if the energy-conservation model is expanded to include the energy costs for changes in swimming direction required for leaping.

OLFACTORY IMPRINTING IN LOGGERHEAD TURTLES (*CARETTA CARETTA*). M. A. Grassman and D. W. Owens. Texas A&M Univ., College Station, TX.

"Imprinting" sea turtles as embryos or hatchlings to beaches in an effort to establish new nesting populations is a widely used but unsubstantiated technique. Eggs were exposed to morpholine (M) or 2-phenylethanol (P) in the nest and for 10 mos. post-hatch (MNP- and PNP-turtles respectively). Another group of turtles was untreated (CON) and a fourth was treated with M for 10 mos. after being removed from the nest (MP-turtles). An electronic system was used to monitor the animal's entries into M, P, or untreated (U) compartments. CON animals showed a significantly greater response to M than P but not U, indicating that some chemicals may be attractive while others are avoided. However, an inherent attraction to M was not supported by MP or PNP. MNP turtles showed a significant increase in percent entries to M-treated water while MP and PNP turtles showed no significant response to M, P or U. This result supports the hypothesis that turtles imprint in the nest. Further behavioral and neurophysiological tests are being run on these animals. Texas A&M Univ. Sea Grant College Program (Grant #NA79AA-D-00127).

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ORIENTATION OF YEARLING KEMP'S RIDLEY SEA TURTLES IN THE GULF OF MEXICO. T. R. WIBBELS. University of Houston, Marine Science Program, 4700 Ave. U., Galveston, TX 77550.

Ten yearling Kemp's ridley sea turtles were tagged with radio transmitters and released in the Gulf of Mexico near Homosassa, Florida. Their movements were monitored from an airplane during a 28 day period. Wind and current data were simultaneously recorded for use in the analysis of these movements. The directional movements of individual turtles were random relative to wind, current, and geographical directions. When the data were pooled, significantly nonrandom directional movements were detected relative to current direction.

Consistent with recent theories, the latter data suggests the importance of ocean currents to the movements of young sea turtles.

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THE INFLUENCE OF DEPOTESTOSTERONE CYPIONATE ON THE PHYSIOLOGY OF THE MALE MOUSE. Donn D. Martin. Belhaven College, Jackson, Mississippi.

The objective of this study was to determine the physiological impact caused by temporal patterns of Depotestosterone Cyonate (D. C.) administered to male mice. Groups of male mice were injected at one of three time slots for six weeks. At selected intervals, strength and endurance tests were conducted and body weight determined. Upon sacrificing, autopsies were performed. Anatomical features and dry body weight were catalogued. All mice that received D. C. displayed greater strength, endurance, body weight and organ trauma than oil controls. However, the time of injection determined the degree of response in the experimentals. Therefore, though D. C. exerted a marked influence on all the mice, differential degrees of tissue responsiveness to D. C. were evidently due to intrinsic timing mechanisms.

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PHOTOPERIODIC MECHANISMS SET BY DAILY HORMONE INJECTIONS IN JAPANESE QUAIL. A.C. RUSSO and A.H. MEIER. Louisiana State University, Baton Rouge.

Timed daily injections of corticosterone have stimulatory or inhibitory effects on reproductive indices of Japanese quail as a function of injection time in relation to a daily light-dark cycle or with daily prolactin injections. Daily injections of corticosterone 4 hours after onset of a 16-hour daily photoperiod reduced left testis volume 45% whereas injections at the onset of dark were ineffective. In quail held on constant light, prolactin injections 4 hours after injections of corticosterone resulted in ovary and oviduct weights that were more than twice as large as those in quail injected in a 20-hour relation. Testes weights of the 8-hour group were 4 times as large as those of the 20-hour group. Corticosterone injections are thought to entrain the rhythm of photosensitivity so that the photoinducible phase is set either in the dark or in the light with the subsequent inhibition or stimulation of the gonads depending on the time of the injection. The effects of corticosterone and prolactin injections are thought to involve entainment of two neuroendocrine oscillations that interact to produce photoperiodic effects.

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PHOTOPERIODIC TIME MEASUREMENT IN PEROMYSCUS LEUCOPUS, THE WHITE-FOOTED MOUSE. J.K.SULLIVAN\* and G.R.Lynch. Wesleyan University, Middletown, CT.

In this study, 'resonance light cycles' were used to determine whether a circadian rhythm of light sensitivity is involved in the reproductive and thermoregulatory responses to a short-day photoperiod in P. leucopus. Male mice from Connecticut were exposed to either LD 6:18, 6:30, 6:42, or 6:54 for 19 weeks. A fifth group was maintained on LD 16:8. Animals presented with photoperiods LD 6:18 or 6:42 exhibited short-day-induced responses: gonadal regression, increased daily torpor, and molt to winter pelage. In contrast, animals on LD 6:30 and 6:54 responded as 'long-day' animals (LD 16:8): maintenance of gonadal system, no incidence of spontaneous daily torpor, summer pelage. Photoperiodic time measurement in P. leucopus involves a circadian timer rather than response to duration of light, dark or the ratio of light:dark. (NIH 15503-01).

TRYPTOPHAN INDUCTION OF REPRODUCTIVE SENSITIVITY TO SHORT DAYLENGTHS IN PHOTOREFRACTORY GOLDEN HAMSTERS. J. M. Wilson and A. H. Meier, Louisiana State Univ., Baton Rouge.

Groups of photorefractory male golden hamsters were placed on either short (LD 2:22) or long (LD 14:10) daylengths. One group in each photoregime was provided a diet containing normal concentrations (1% of protein) of tryptophan. Other groups were provided diets containing either 6, 23, 30 or 50% (% of protein) L-tryptophan. Additional diet tryptophan (30 and 50% of protein) significantly depressed both testes and abdominal fat pad weights of photorefractory golden hamsters maintained for 2-4 weeks on short daylengths compared with those of hamsters fed normal concentrations of tryptophan. However, similar tryptophan feeding was ineffective in hamsters maintained on long daylengths. Lesser amounts of diet tryptophan (6 and 23% of protein) were less effective in inhibiting the testes and fat pads of hamsters maintained on short daylengths. Thus, additional tryptophan in the diet of photorefractory male golden hamsters promotes a photosensitive response to the inhibitory effects of short daylengths on reproductive and fat indices.

MELATONIN'S INHIBITION OF REPRODUCTIVE AND ENDOCRINE ORGANS IN MALE GOLDEN HAMSTERS: DOSAGE, ORGAN AND PINEAL DEPENDENCIES. W.B. Quay, A.F. Payer\*, T.A. Parkening\*, T.K. Banerji\* and T.J. Collins\*. Univ. of Texas Med. Br., Galveston, Texas.

This research aimed to improve understanding of mechanisms involved in melatonin's actions in responding photoperiodic mammals. Male *Mesocricetus auratus* in 5 surgical groups [nonoperated (NO), sham operated (S), S+black plastic shielding of pineal region (S+Pl), pinealectomized (PX), (PX+Pl)] were injected subcutaneously daily at L11 in a LD 14:10 photoperiod, with 25 µg melatonin (M), 2500 µg M, or vehicle for 4 weeks. Animals were killed at 55-65 days of age and 32-33 days postoperation. Absolute and relative (/B.W.) weights of testes, pituitaries, adrenal and male accessory glands were significantly depressed by 25 but not 2500 µg M. This effect of low dose M was blocked by PX in all 4 organs, and was blocked also by S only in adrenals. Effects of M and of PX on testes, accessory gland and pituitary weights were reflected in similar changes in plasma FSH, LH and PRL, and pituitary FSH. However, pituitary LH and PRL were depressed by both M dosages. It is suggested that blockade of M's actions by PX may occur possibly at the level of pineal conditioning of M receptors, or more directly at mechanisms within the pineal gland itself.

A BRAIN SITE OF MELATONIN ACTION IN THE WHITE-FOOTED MOUSE, PEROMYSCUS LEUCOPUS. J. DAVID GLASS and G. ROBERT LYNCH. Wesleyan University, Middletown, CT.

There is growing evidence that the pineal gland mediates changes in seasonal breeding through its hormonal product, melatonin. Although the site of melatonin action is unknown, studies have implicated the ovary, uterus, and brain. This study was undertaken to verify a brain site of melatonin action in the white-footed mouse. Melatonin pellets releasing 45ng melatonin/day were implanted into the brain or subcutaneously (SC). Reduction of reproductive tract weight (RTW) in mice implanted with pellets in the suprachiasmatic area was 61%, and retrochiasmatic area 59%, compared to blank-implanted controls. Animals with melatonin implants in other brain areas maintained normal RTW. SC melatonin implants did not elicit gonadal regression. In a second study, mice received daily afternoon injections of melatonin (500 ng, 1.0 µl) in the anterior hypothalamus for 7 wks. These mice showed a 66% reduction of RTW compared to saline injected mice. SC melatonin injections had little effect on RTW. Thus, pineal melatonin mediates the reproductive effects of short photoperiod by acting at a specific neural site. (NIH NS 15503-01).

THE EFFECTS OF BLINDING AND PINEALECTOMY ON GONADAL MATURITY IN FUNDULUS HETEROCLITUS L. J. R. Day and M. H. Taylor. Univ. of Delaware, Newark.

Female *Fundulus heteroclitus* collected from Canary Creek Marsh, Lewes, Delaware, were pinealectomized, blinded, or sham operated during winter, spring, summer, and fall. After six weeks the fish were sacrificed and gonadosomatic index (GSI) was determined for comparison to intact control fish. Neither blinding, pinealectomy, or sham operation caused a significant variation in GSI with respect to controls. Simultaneous blinding and pinealectomy also failed to cause gonadal regression. This evidence argues for the existence of an extraretinal-extrapineal photoreceptor for reproduction in *F. heteroclitus*. Our data demonstrate no significant role for the pineal gland in reproduction in this species. This work was supported by NOAA Sea Grant 04-6-158-44025 to MHT.



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ENVIRONMENTAL EFFECTS ON THE FACULTATIVE AIR BREATHING OF ANCISTRUS CHAGRESI AND HYPOSTOMUS PLEOCOSTOMUS (LORICARIIDAE). T. A. Baird and J. B. Graham, Physiol. Res. Lab. Scripps Inst. of Oceanog. La Jolla, CA. 92093

The sympatric air-breathing loricariid catfish, Ancistrus chagresi and Hypostomus pleocostomus, respond differently to progressive aquatic hypoxia and hypercapnia. Hypostomus begins air breathing when declining  $O_2$  reaches 60 mmHg but Ancistrus does not begin until 33 mmHg and then breathes more frequently than Hypostomus. Hypoxia acclimation reduces air-breathing frequency in both species but does not change threshold. Ancistrus initiated air breathing at a lower  $CO_2$  level than Hypostomus (8.7 vs 12.8<sup>2</sup> mmHg), but both species compensated for  $CO_2$  and ceased air breathing within a few hours of exposure. Combined hypoxia and hypercapnia resulted in lower  $PwO_2$ , air-breathing thresholds for both species and significantly lowered the air-breathing frequency of Hypostomus. Ancistrus and Hypostomus do not breathe air in normoxic water: their air-breathing responses therefore differ from those species that breathe air to some extent regardless of aquatic conditions (Supported by N.S.F. Grant DEB 79-12235).

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INVESTIGATION OF ALTERNATE END PRODUCTS OF ANAEROBIOSIS IN THE GULF TOADFISH, OPSANUS BETA. J. M. Trant. Texas A&M Univ., College Station.

Toadfish are capable of surviving days of severe hypoxia and many hours of complete anoxia, however the exact mechanism of the extreme resistance is not known. The purpose of this study was to determine the possible utilization of typical invertebrate anaerobiosis in an anoxia resistant fish by measuring end product accumulation. *In vitro* and *in vivo* studies demonstrated the major product of anaerobic metabolism in five different tissues was lactate. Succinate and alanine, typical end products of anoxia resistant molluscs, showed no physiologically important accumulation. A  $C^{14}$  tracer incorporated into the *in vivo* anaerobic study demonstrated a dynamic equilibrium within the lactate pool. Lactate radioactivity accounted for about half of the total activity in the tissues. Total activity decreased with time, suggesting lactate was converted into a chemical form that can be excreted by the fish. Tissues of fish exposed to a week of hypoxia or 12 hours of anoxia demonstrated slight or no elevation of lactate concentration. During oxygen deprivation, the fish, *in toto*, prevents lactate from accumulating to toxic levels, thus increasing its anoxia resistance.

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THE EFFECT OF LDH-B GENOTYPE ON SWIMMING PERFORMANCE IN FUNDULUS HETEROCLITUS. D.A. Powers\* and L. DiMichele. Johns Hopkins University, Baltimore, MD.

Erythrocyte ATP levels are highly correlated to LDH-B genotype in Fundulus. ATP is the fish's allosteric modifier of hemoglobin oxygen affinity. Since oxygen delivery to muscle effects swimming performance, fish of each homozygous LDH-B phenotype (LDH-B<sup>a</sup>B<sup>a</sup> and LDH-B<sup>b</sup>B<sup>b</sup>) were swum to exhaustion at 10°C in a stamina tunnel to determine whether *in vitro* differences attributed to the LDH-B phenotypes were manifest *in vivo*. The critical swimming speed of the LDH-B<sup>a</sup>B<sup>a</sup> phenotype was 3.6 body lengths/sec and the LDH-B<sup>b</sup>B<sup>b</sup> was 4.3 body lengths/sec. During the exercise period, blood pH fell dramatically while lactate levels increased. This amplified oxygen unloading differences between the LDH-B phenotypes. Since the LDH-B<sup>b</sup>B<sup>b</sup> individuals could deliver more oxygen to muscle tissue, they swam longer than the LDH-B<sup>a</sup>B<sup>a</sup> phenotype.

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CORRELATIONS BETWEEN GENETIC BACKGROUND AND DEVELOPMENTAL RATE IN FUNDULUS HETEROCLITUS. L. DiMichele, D.A. Powers,\* and M.H. Taylor. Johns Hopkins University, Baltimore, MD and University of Delaware, Newark, Delaware.

Developmental rate, mean hatching time, and  $O_2$  consumption were examined in relation to LDH-B phenotypes and in two subpopulations that had different genetic backgrounds. The time required to reach major developmental stages did not differ between LDH-B phenotypes, but it did differ between the two subpopulations. Mean hatching time was ordered in the sequence LDH-B<sup>a</sup>B<sup>a</sup>, LDH-B<sup>a</sup>B<sup>b</sup>, LDH-B<sup>b</sup>B<sup>b</sup>. Differences in hatching were due to phenotypic differences in metabolic rate. Populations from Woods Hole, Massachusetts and Sapelo Island, Georgia developed at the same rate through the neurula stage, but thereafter eggs from Georgia developed slower. Eggs from Georgia also hatched later than eggs from Massachusetts and exhibited lower metabolic rates. This phenomenon is correlated with an increase in genetic diversity for southern populations.

ACTIVITY METABOLISM OF POISON ARROW FROGS.  
T. L. Taigen and F. H. Pough. Univ. of Connecticut, Storrs, and Cornell Univ., Ithaca, N.Y.

Ecological correlates of activity metabolism were tested with 3 species of dendrobatid frogs. One species (*Dendrobates auratus*) is toxic whereas the others (*Colostethus nubicola* and *C. inguinalis*) are not. All 3 species are active foragers. If the relative dependence on aerobic and anaerobic metabolism during activity is related to the mode of defense against predators, the toxic species should have a lower anaerobic capacity than the 2 nontoxic forms. If predatory mode is important in shaping physiology, all 3 species should have high aerobic metabolic capacity. The 3 species all have high aerobic and low anaerobic capacities, indicating that predatory mode is a better predictor of physiological characteristics than is mode of defense.

RESPONSES TO ACUTE AQUATIC HYPOXIA IN LARVAE OF AMPHIBIANS, *RANA* AND *XENOPUS*.  
M.E. Feder, The University of Chicago, IL

In normoxic water, anuran larvae meet 15-30% of routine oxygen requirements through aerial gas exchange. This proportion increases as the  $P_{wO_2}$  declines. At low  $P_{wO_2}$ , larvae lose oxygen to the water and aerial  $\dot{V}O_2$  exceeds 100% of total routine rates. Responses to acute aquatic hypoxia include tachycardia and increased frequencies of pulmonary ventilation and branchial irrigation. These changes may be due in part to alterations in routine behavior and aversive responses to hypoxic water. *Xenopus* larvae form lactate at low and moderate  $P_{wO_2}$ . *Rana* larvae do not undergo significant anaerobiosis except at very low  $P_{wO_2}$ . Larvae of both species are unable to increase aquatic oxygen consumption sufficiently to compensate for loss of aerial gas exchange. Aquatic hypoxia reduces the  $\dot{V}O_2$  of large larvae no more than the  $\dot{V}O_2$  of small larvae. These patterns are compared to responses of *Bufo* larvae, which lack lungs, and to patterns in other amphibious vertebrates. Supported by NSF Grant DEB 78-23896.

REGULATION OF WHOLE BLOOD  $P_{50}$  BY  $CO_2$  AND pH IN THE LOGGERHEAD (*CARETTA CARETTA*) AND GREEN SEA TURTLE (*CHELONIA MYDAS*).  
R.E. Isaacks, VA Medical Center, Miami, FL 33125 U.S.A.

The  $P_{50}$  of suspensions of erythrocytes from juvenile and adult loggerhead and green sea turtles increased markedly with increasing concentrations of  $CO_2$  (0 to near 15%) or  $H^+$  (pH 7.6, pH 7.4, pH 7.2). The  $P_{50}$ 's were higher with increases in  $pCO_2$ , particularly at pH 7.4, than were the  $P_{50}$ 's with increases in  $[H^+]$  at any given  $CO_2$  concentration. Hemoglobins from the juvenile loggerhead (8-9 mos.) and green sea (10 mos.) turtles responded to 2,3-DPG, ATP, or inositol- $P_5$  when added at molar ratios of phosphate to hemoglobin of 4:1 and 20:1 in 0% and 6.29%  $CO_2$  but showed no increase in  $P_{50}$  at these two  $CO_2$  levels when the ratio was 0.4. These compounds had little effect on the  $P_{50}$  of these hemoglobins in 14.6%  $CO_2$ . The  $P_{50}$  of the adult loggerhead turtle hemoglobin did not increase in the presence of organic phosphates beyond the effect induced by  $CO_2$  alone; the adult green turtle increased only slightly at a ratio of 20:1 and at 0 and 6%  $CO_2$ . Blood  $P_{50}$  and hemoglobin function in these turtles are altered significantly by  $CO_2$  and to a lesser degree by pH.

LIPID COMPOSITIONS AND PERMEABILITY PROPERTIES OF GILLS OF MARINE AND FRESHWATER BIVALVE MOLLUSCS. M. CHENEY\*, J.H. SWINEHART and J.H. CROWE. Univ. of California, Davis.

The lipids present in gills of the marine bivalve mollusc *Mytilus californianus*, and freshwater species *Anodonta californiensis* and *Corbicula* sp. were separated and partially identified. The gills of the marine species contain more lipids with charged functional groups than do those of the freshwater species. The difference in lipid compositions provides an explanation for variations in permeability properties of the gills to glycine, the herbicide 2,4-dichlorophenoxyacetic acid (2,4-D) and parnitrophenol (PNP). The effects of 2,4-D and glycine on each others influxes into gills of *M. californianus* and *A. californiensis* have been measured. The herbicide 2,4-D reduces glycine influx into *M. californianus* gills, while glycine does not affect the 2,4-D influx. Glycine reduces 2,4-D influx into *A. californiensis* gills. Explanations will be offered for these observations.

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NaCl TRANSPORT IN ISOLATED GILLS OF FRESHWATER MUSSELS. T. H. Dietz, and C. Schneider\* and W. Byrd\*. Louisiana State University, Baton Rouge.

The isolated gills of male *Ligumia subrostrata* accumulate Na and Cl from pondwater. The Na transport rate is about  $13 \mu\text{mole (g dry gill} \cdot 10 \text{ min)}^{-1}$  and Cl influx is about 1/3 of the Na influx. The rate of Na and Cl uptake by the isolated gills equals or exceeds the estimated NaCl uptake in intact animals indicating the gills are the principal site of salt accumulation. Na and Cl transport in isolated gills display saturation kinetics which is similar to intact animals. Sodium but not chloride influx in gills is stimulated by 0.1 mM serotonin and 0.5 mM cAMP. Serotonin is present in the gill tissue ( $\sim 2 \mu\text{g/g wet gill}$ ). Na influx is stimulated by nystatin and inhibited by amiloride. Cl influx is inhibited by nystatin and thiocyanate. Supported by NSF grant PCM79-21089.

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GILL cAMP AND ADENYLATE CYCLASE IN A FRESHWATER MUSSEL. J. I. Scheide and T. H. Dietz. Louisiana State Univ., Baton Rouge.

Injections of serotonin (5-HT) and cAMP have been shown to stimulate Na transport in freshwater mussels. Gill cAMP concentrations in *Ligumia subrostrata* were  $205 \pm 13 \text{ pM/g wet gill}$  ( $n=9$ ) and were significantly different ( $P < 0.01$ ) from Na-depleted *Ligumia* ( $138 \pm 15 \text{ pM/g wet gill}$ ,  $n=9$ ). Crude homogenate pellet of gill tissue reveals the presence of a 5-HT sensitive adenylate cyclase (AC). Basal AC activity was  $25.1 \pm 3.9 \text{ pM/mg protein} \cdot 5 \text{ min}$  ( $n=11$ ) while  $60 \mu\text{M/l}$  5-HT stimulated the enzyme to  $45.0 \pm 5.6 \text{ pM/mg protein} \cdot 5 \text{ min}$  ( $P < 0.01$ ,  $n=11$ ) in a halide-free reaction mixture. Serotonin stimulation of AC was evident at  $3.0 \mu\text{M/l}$  with maximal stimulation occurring around  $60 \mu\text{M/l}$ . Other neurotransmitter substances (L-dopa, dopamine, octopamine, noradrenalin and adrenalin) did not cause an increase in AC activity. The presence of a serotonergically sensitive AC further supports the role of 5-HT in freshwater mussel sodium regulation. Supported by NSF Grant PCM79-21089.

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GLYCINE-SERINE METABOLISM IN GILL TISSUE OF A EURYHALINE BIVALVE (*MODIOLUS DEMISSUS*). L.L. Ellis, D.E. Greenwalt, J.M. Burcham, and S.H. Bishop. Iowa State Univ., Ames.

Mechanisms regulating intracellular glycine levels at high salinity are uncertain. Radiotracer studies with glucose, bicarbonate, glycerate, and amino acids at high salinity with and without the inhibitor aminooxyacetic acid (AOA) indicated weak biosynthesis of serine and glycine from glycolytic or TCA intermediates and a blockade of glycine catabolism at high salinity or with AOA. Glycine cleavage enzyme (GCE), serine hydroxymethyl transferase (SHMT), serine-pyruvate and phosphoserine-2-oxoglutarate transaminases, glycerate and 3-phosphoglycerate dehydrogenases, and serine dehydrase were present; no phosphoserine phosphatase was detected. The SHMT and GCE reactions explain glycine-serine exchange and are probably major catabolic routes for both amino acids. During hyperosmotic stress, glycine accumulation results from reduced catabolism and arises from protein turnover rather than *de novo* synthesis. Supported in part by a grant from the NSF.

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ORIGIN OF ALANINE IN GILLS OF A EURYHALINE BIVALVE, (*Modiolus demissus*). S.H. Bishop, D.E. Greenwalt, J.M. Burcham\*, and L.L. Ellis. Iowa State University, Ames 50011

The high levels of intracellular alanine, glycine and taurine aid in regulating cellular osmotic pressure with changing environmental salinities. Flux studies using specifically radiolabelled glucose and amino acids with and without iodoacetic acid, arsenite, and transaminase inhibitors indicate that no more than 30% of the alanine could be derived from glucose and that most amino acids and glucogenic substrates serve as alanine precursors. At high salinities, alanine catabolism is reduced by apparent blockade of pyruvate dehydrogenase and not by inhibition of the aminotransferases or the TCA cycle-oxidative phosphorylation activities. In conclusion, the alanine accumulated in the gill tissue has multiple metabolic origins; accumulation probably results from regulation of the mitochondrial pyruvate dehydrogenase. Supported in part by a grant from the NSF.

MOLLUSCAN CELL VOLUME REGULATION MEDIATED BY NON-AMINO ACID SOLUTES. S. K. Pierce, H. H. West and M. K. Warren. Univ. of Maryland, College Park.

The ascoglossan opisthobranch *Elysia chlorotica* is remarkably euryhaline, surviving a salinity range of at least 3-50‰. Although this shell-less gastropod is an osmoconformer over that salinity range, it is an excellent volume regulator in hypoosmotic salinities. Animals acclimated to 926 mOsm and transferred to 100 mOsm rapidly gained 275% of initial body weight. By 48 hrs from the salinity change, body weight had recovered to within 20% of initial. The amino acid pool of *Elysia* is tiny, 30  $\mu\text{mole/g}$  dry wt in animals acclimated to 926 mOsm, and changes only slightly (to 19  $\mu\text{mole/g}$  dry wt) following acclimation to 245 mOsm. Quaternary ammonium compounds are present in *Elysia* (glycine betaine, homarine, trigonelline), but in small amounts and show only small declines following hypoosmotic acclimation. However, the total non-protein nitrogen pool in *Elysia* is large in animals acclimated to 926 mOsm (~1300  $\mu\text{mole NH}_3/\text{g}$  dry wt) and declines (to ~500  $\mu\text{mole NH}_3/\text{g}$  dry wt) following acclimation to 299 mOsm indicating a role of a novel solute(s) for volume regulation. (NIH GM-23731 and TS&GCMB)

FLUID TRANSFER BY THE BODY WALL OF TERRESTRIAL SLUGS. I. Jeyrup-Olsen, A.K. Martin, and W.H. Sawyer. Univ. of Washington, Seattle, and Columbia Univ., New York.

*In vitro* preparations of the body wall of terrestrial slugs (*Ariolimax columbianus*, *Trionidae*; and other species) respond to mechanical stimulation, under conditions of normal hydration, with a brief flow of fluid across the body wall. This response is absent or greatly reduced in the case of preparations made from dehydrated slugs. Extracts of the head ganglia from hydrated slugs also induce flow of fluid through the hydrated body wall. The responses to such extracts have been compared with the effects of known neurotransmitters and neuroendocrine substances. Among these, only 4 have been shown to initiate significant flow: acetylcholine, 5-hydroxytryptamine, arginine vasopressin (all at threshold concentrations of  $3 \times 10^{-5} \text{M}$ ) and, by far the most effective, arginine vasotocin (threshold about  $3 \times 10^{-9} \text{M}$ ). Ganglionic extracts from dehydrated slugs reduce or block altogether responses to these substances.

QUANTIFICATION OF PROTEIN ABSORPTION AND DEGRADATION IN EMBRYOS OF A VIVIPAROUS GOODEID FISH. J. Lombardi and J.P. Wourms. Clemson University, Clemson, SC.

Embryos of the viviparous goodeid *Ameiops splendens* develop within the ovarian lumen. A 100X increase in embryonic dry weight is due to the absorption of maternal nutrients. Absorption is facilitated by trophotaeniae, a placental analogue. Our previous EM studies demonstrated that cells of the trophotaenial epithelium absorb the tracer protein horseradish peroxidase (HRP) by micropinocytosis and degrade it in the lysosomal system. The rate of uptake and degradation of HRP was determined spectrophotometrically. Trophotaeniae of embryos incubated *in vitro* in HRP-saline absorb HRP at an initial rate of 13.0 ng HRP/mg trophotaenial protein/minute. The system becomes saturated after 3 hours. Trophotaeniae incubated at 4°C show little or no absorption. In trophotaeniae continuously pulsed with HRP for 1 hour, and then incubated in HRP-free saline, absorbed peroxidase activity declined at a rate of 0.5 ng/mg trophotaenial protein/minute. Although there is initial binding to the body surface (probably to mucous) and subsequent immobilization, HRP does not appear to enter the embryo via extra-trophotaenial routes. (Supp. by NIH-BRSG grant 2-S07-RR07180)

STAGE-SPECIFIC CHANGES IN POLYPEPTIDE SYNTHESIS DURING THE EMBRYOGENESIS OF *ILYANASSA OBSOLETA*. J. R. COLLIER. Brooklyn College, Brooklyn, N. Y.

Proteins labeled *in vivo* with  $^{35}\text{S}$ -methionine were extracted from several developmental stages of *Ilyanassa* and fractionated by two-dimensional electrophoresis. Autoradiographs of the dried acrylamide gels showed a pattern of peptide synthesis that demonstrated that each stage of development was characterized by the expression of a unique set of structural genes. Actinomycin D- and alpha-amanitin-treated embryos showed that the changing program of gene expression seen during development results from both translational and transcriptional regulation of protein synthesis.

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ELECTROPHORETIC DISTRIBUTION OF PROTEINS DURING OOGENESIS AND EMBRYOGENESIS IN LIBINIA EMARGINATA. B.S. Komm and G.W. Hinsch. Univ. of S. Florida, Tampa.

A major occurrence during crustacean oogenesis is the accumulation of yolk materials in the oocyte cytoplasm. The ultra-structural changes associated with this accumulation have been documented by Hinsch and Cone (1969). Electrophoretic gels of ovary and embryo supernatants demonstrate a difference in soluble protein patterns from immature to most mature stages. The obvious feature is the appearance and accumulation of up to four high molecular weight proteins (vitellogenin) as the oocytes develop. Conversely, the supernatants from various embryonic stages are initially similar in protein distribution to the most mature oocytes. As the embryos develop, the major protein bands disappear until only three or four soluble proteins remain in the most mature stage examined. This qualitative data demonstrates that the oocytes accumulate a number of proteins or protein conjugates during vitellogenesis. These proteins are apparently utilized and disappear during embryonic development.

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PARTIAL PURIFICATION OF ALCOHOL DEHYDROGENASE IN XENOPUS LAEVIS. M. H. Wesolowski and T. A. Lyerla. Clark Univ., Worcester, MA.

Alcohol dehydrogenase (ADH; E. C. 1.1.1.1) is being purified from Xenopus laevis liver tissue in order to develop antibodies against this protein for cell-free translation studies to better understand its expression in development. A non-destructive liver biopsy technique is used to provide samples for screening sexually mature adults for ADH isozymes by starch gel electrophoresis. This technique avoids freezing of liver tissue which results in significant loss of ADH activity. Livers from adults exhibiting the identical, single ADH isozymic form are pooled for purification of the isozyme. Standard techniques of ammonium sulfate precipitation, gel filtration and ion-exchange gel chromatography were used for obtaining a 100-fold enhancement of specific activity from crude homogenates. This preparation is stable to freezing and thus, can be used to bring isozymes of Xenopus ADH to apparent homogeneity.

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THE AMPHINUCLEOLUS OF THE OOCYTE OF ILYANASSA OBSOLETA. M. McCANN-COLLIER.

The morphology and function of the Ilyanassa nucleolus during oogenesis was investigated by cytochemistry and autoradiography. The development of the complex form of an amphinucleolus begins in the previtellogenic oocyte (late stage 2) with the appearance of a protein-positive, nucleic acid-negative ("fibrillar") addition to the "granular" nucleolus. The amphinucleolus enlarges during vitellogenesis (stages 3-7) and disappears from the postvitellogenic oocyte (stage 8), at which time the oocytes are released from the ovary. The granular part incorporated <sup>3</sup>H-uridine, but <sup>3</sup>H-leucine incorporation was never found in the fibrillar portion. These and other results suggest special roles for the nucleolus in oogenesis.

100

HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY OF NUCLEOSIDES FROM TRANSFER RNA METHYLATED IN VITRO WITH RANA PIPPIENS METHYLTRANSFERASES. J.E. Heady and B. Murphy\*, Univ. of Michigan, Dearborn.

Methyltransferases from growing and regenerating mid-larval and degenerating thyroxine-treated and metamorphic climax R. pipiens tails were used to methylate pure, heterologous tRNAs in order to measure differences in methylation capacities of collagen synthesizing and degrading tissues. The reisolated <sup>14</sup>C-tRNA (S-adenosyl-L-[Me-<sup>14</sup>C] methionine as donor) was enzymatically degraded to nucleosides which were purified on a boronate affinity gel and separated on a reversed-phase  $\mu$ Bondapak C<sub>18</sub> column. Qualitative differences among the developing stages tested for methylation capacities were not observed. However, the methods are applicable and extendable to various developmental studies and the modified nucleosides are not identical to those reported for mammalian tissue extracts.

101

DISTRIBUTION OF SPERM NEURAMINIDASE IN EXTRACTS OF EPIDIDYMAL SPERMATOZOA. A. B. Dudkiewicz and A. Powledge\*. University of Houston.

Mammalian sperm contain acrosomal hydrolases which mediate penetration of egg investments. In order to investigate the biochemical role of these enzymes in fertilization, several extraction methods were utilized to obtain sperm neuraminidase and acrosin from washed rabbit and boar epididymal spermatozoa. A comparison of a sequential method for removing acrosomal membranes and enzymes with sonication-detergent methods indicates the greatest amount of proteolytic activity is extracted by hypotonic (0.5M) salt followed by detergents. Sonication and detergent extraction of rabbit sperm results in a two-fold decrease in acrosin activity compared to a 96% increase of sperm neuraminidase. By contrast boar sperm extracts yield significantly greater amounts of protease and neuraminidase enzymes with detergent-sonication particularly when low pH (2.5) is utilized. Sperm neuraminidase from boar extracts prefers different  $\alpha$ -ketosidic linkages than bacterial forms. It may play a role in altering the sialoglycoprotein nature of the zona pellucida during sperm penetration. (Supported by NIH grant HD 11123).

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NUMERICAL RESPONSE AND HOMING IN CHRYSIDID WASPS. J. C. TREXLER. Florida State Univ., Tallahassee.

The numerical response of chrysidid wasps, parasitoids of mud dauber wasps, was studied during the summers of 1980 and 1981. Chrysidid abundance was estimated by mark-recapture technique at 6 abandoned farm buildings used for nesting by mud daubers. Abundance of chrysidids at these sites was monitored prior to and following both chrysidid transplantation and the removal of mud daubers. Number of mud dauber nests constructed concurrently was also recorded. At unaltered rest sites, only one of several hundred marked chrysidids was observed immigrating between sites although over 20% of transplanted chrysidids displayed homing abilities. Host removal had no marked effect on chrysidid abundance relative to control populations. These results indicate that chrysidids do not immigrate or emigrate in response to changes in host abundance. Instead, there is some attraction to a "home" site irrespective of intragenerational host availability.

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SPATIAL DISPERSION, PREY SELECTION AND FECUNDITY IN THE SESSILE ROTIFER CUEPLOGAGIS VORAX (LEIDY). W. A. EVANS. Union College, Barbourville, Kentucky.

A population of C. vorax living attached to the surface of Elodea leaves was sampled during July and August, 1981. C. vorax densities ranged from 0.35 to 1.32 per leaf during the study. Variations in density over time, among plants and among whorls were not significant. Mean epifaunal densities (rotifers and gastrotrichs) ranged from 3.1 to 6.4 and 0.6 to 4.9 per leaf respectively. C. vorax was found to be contagiously distributed both among and within leaves ( $P < .05$ ) with 88% occurring on leaf bottoms. Comparison of infundibulum contents with epifaunal densities showed that prey are taken selectively ( $P < .005$ ). The rotifers Lepadella and Trichocerca were taken less often and Lecane more often than expected. Gastrotrichs were rarely caught. Mean number of prey and larvae per individual C. vorax varied by position on the leaf (0.2 to 1.4 and 0.2 to 0.5 respectively). The contagious distribution of C. vorax may result from larval settling patterns, or from differential survival due to predation or food availability. Preferences for particular prey could be due to their "catchability" or to active selection by C. vorax in order to maximize energy gain.

104

SELF-THINNING IN POPULATIONS OF SESSILE BARNACLES: DIFFERENCES FROM PLANTS. D. S. Wethey. Univ. of South Carolina, Columbia.

Intrapopulation variation in growth of the barnacle Balanus balanoides was followed in photographs of marked quadrats at Nahant, Mass. The pattern of mortality in barnacle populations undergoing self thinning is consistent with the development of a dominance-suppression hierarchy: small individuals die at higher rates than larger ones. The pattern of intrapopulation variation in growth is not consistent with dominance and suppression. There are reversals in the rank order of body size during growth. The skewing of the size-frequency distributions does not increase during growth. The absence of a dominance suppression hierarchy in relation to growth in these animals, and the presence of such a hierarchy in plants may be the result of differences in the resource structure of the two groups. Plants use resources (light,  $NO_2$ ) whose units are small relative to body size. Animals use food particles which are large relative to body size. One good meal for an animal may allow it to outstrip a similar-sized neighbor in terms of growth.

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PREDATOR AVOIDANCE BY THE MARSH PERIWINKLE *LITTORINA IRRORATA* (SAY). J. H. WARREN  
Florida State Univ., Tallahassee.

*Littorina irrorata* occurs on stalks of *Spartina*, moving onto the substrate to feed at low tide and climbing above the water line at high tide. Snails were tethered to *Spartina* on the substrate and above the high tide mark in caged, open and control treatments. Predator-induced injury and mortality were significantly higher in snails restricted to the substrate level. Intensity of predation varied seasonally, with highest rates in late spring to early fall. Predation events (injury and death) dropped to zero from mid November to April, the period during which two major predators, the blue crab and crown conch move offshore. Newly emptied shells resulting from conch predation, were rapidly occupied by hermit crabs which gathered at the predation sites. Frequently these shells were torn from the tethers and removed from the study area. The frequency of sublethal damage and fate of injured snails were also monitored. In instances where the shell lip was cracked (by crabs) or the operculum rasped from the periwinkle (by conchs), most snails survived and repaired the damage. Periwinkles that had lost opercula were able to regenerate the lost structure in 6-8 weeks.

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EFFECTS OF PREDATION ON BENTHIC INFAUNA IN THE APALACHICOLA BAY ESTUARY, FLORIDA. Bruce M.S. Mahoney. Florida State University, Tallahassee.

Long-term monitoring studies revealed a negative correlation between the abundance of bottom feeding fishes and benthic macrofaunal density, suggesting a causal relationship. To test this hypothesis, large (3x3m) topless predator exclusion cages (mesh opening=6mm) were constructed at two shallow mud bottom oligohaline stations. Two sided control cages and uncaged control areas were also sampled. Experiments were conducted at times of maximum predator abundance. In general, predation was found to be of minimal importance in regulating the densities of most infaunal species. It is postulated that seasonal changes in river flow and salinity, coupled with fluctuations in larval availability, may be responsible for the observed temporal patterns of infaunal abundance. To examine the latter possibility, larval recruitment into azoic sediments is currently being investigated.

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SIZE AND SHAPE IN A NEOTROPICAL BURROWING COLUBRID SNAKE, *GEOPHIS NASALIS*, AND ITS PREY. R. L. SEIB. Univ. California, Berkeley.

2007 stomachs of *G. nasalis* were examined, yielding 392 snakes with 453 measurable prey items. Size and shape relationships between predator and prey were explored using multivariate and univariate statistics. Analysis of predator morphometrics indicates a lack of sexual dimorphism other than total and tail length. Regression analyses show no differences between males (n=180) and females (n=273) in their size relationships to prey. The snakes take a wide range of prey sizes and there is an upper and lower size beyond which prey are not ingested. Large snakes tend to eat worms of a larger diameter than those taken by small snakes ( $r^2=.322$ ,  $p<.01$ ). Small snakes concentrate on small and medium size worms, while large snakes select medium and large worms. Females attain a greater snout-vent length than males, and take significantly more large and fewer small worms than males. This implies a different impact for each sex on the prey populations but does not imply intersexual competition since prey are almost certainly not a limiting resource.

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ZOOPLANKTON IN NORTH INLET ESTUARY, S.C.: IMPORT OR EXPORT? S.E. STANCYK, G. OSENGA and T.L. FERRELL\*. Univ. of South Carolina, Columbia.

To determine whether zooplankton import, export or maintain a zero net flux of biomass across the boundaries of a well-mixed estuary, paired vertical oblique tows with a 153µm mesh, 30cm net were taken from stationary platforms at the three major entrances to North Inlet over 24h periods during spring and neap tides in each quarter of the year. Extrapolation to an annual budget yielded a zooplankton import of  $5.42 \times 10^4$  kg Carbon ( $1.69 \text{ gC} \cdot \text{m}^{-2} \cdot \text{yr}^{-1}$ ) annually, but this value was not significantly different from zero. Zooplankton flux was an order of magnitude greater in spring and summer than fall and winter, but exported in spring and imported in summer. Neap tide fluxes were always 2-3.3x greater than spring tide fluxes. Magnitude and direction of flux also varied with stage of tide and time of day. Some categories (e.g., crab zoeae) always exported, some (e.g., barnacle cyprids, appendicularians) always imported, and some (e.g., *Acartia tonsa*) maintained a zero net flux. Total zooplankton flux across this estuarine-coastal boundary appears to be in balance, but individual species or groups may be produced or consumed by the estuary.

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## FORAGING ACTIVITY PATTERNS AND FOOD ITEMS OF BENTHIC POSTLARVAL SPINY LOBSTERS.

S. Andree and W.F. Herrnkind. Florida State University, Tallahassee, FL.

Field and laboratory investigations of postlarval foraging activity and diet were conducted in 1980-81. Postlarvae inhabited coastal, shallow-water algal communities surrounding Elliott Key, Biscayne National Park, Florida. Different from juvenile and adult den aggregations, postlarvae were only observed as single occupants. Activity began following sunset, peaking prior to midnight, and subsiding before sunrise. All foraging occurred near shelter, whereas juveniles foraged in offshore turtle grass beds. Like juveniles and adults, diet consisted of a variety of benthic, sedentary and slow moving invertebrates (Gastropoda, Crustacea, Pelecypoda, Amphineura, and Algae). Over 20 species of food items were observed. This suggests that food may not be the critical limiting factor. Since very little is known of this life stage, a better understanding of its habitat requirements is needed for efficient management strategies.

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## OSMOREGULATORY ABILITY OF SPIDER CRABS. C. R. BURSEY. Shenango Valley Campus, The Pennsylvania State University, Sharon.

Salinity tolerance and osmotic response were examined in two species of spider crabs, *Libinia emarginata* and *L. dubia*. Both species reached osmotic equilibrium within 6 hr of acute transfer to a new salinity concentration. At equilibrium, the hemolymph of both species was hyperosmotic to the experimental salinities; the mean difference for all salinities tested was 33 mOsm for *L. emarginata* and 8 mOsm for *L. dubia*. Based upon 50% mortality at 24 hrs, both species tolerated a salinity range of 600-1400 mOsm. These results show that neither *L. emarginata* nor *L. dubia* should be described any longer as stenohaline; rather, the term "hyperosmotic osmoconformer" should be used.

111

## MARINE CRUSTACEANS IN A TEXAS SALT SPRING: RELICTS OR INTRODUCTIONS? D. L. Felder and H. R. Spivey. Univ. of Southwestern Louisiana, Lafayette, and Florida State Univ., Tallahassee.

Creel (1964) described a grapsoid crab, *Hemigrapsus estellinensis*, from Estelline Salt Spring in the panhandle of Texas. In description of the habitat, he noted the presence of barnacles, other invertebrates and marine algae. Recently we obtained specimens of the barnacles (*Balanus* sp.), the previously described crabs, and other organisms collected from the spring prior to severe disturbance of the system by a US Army Corps of Engineers salt control project. We also visited the spring in December 1980 to make a post-disturbance assessment of the biota and water quality.

From our systematic re-evaluation of crustacean specimens, the apparent Pacific affinities of these crustaceans, and historical aspects of the collection site, we have drawn evidence which suggests possible origins of the former spring fauna. We also document that morphometry, water quality, and biota of the Estelline Salt Spring have been dramatically altered from that reported by Creel; little or no evidence of a living, indigenous, marine biota remains.

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MATING BEHAVIOR IN *PSEUDODIAPTOMUS* SPP. C. Jacoby. Harbor Branch Inst., Ft. Pierce, FL.

Mating was observed in the copepod species *P. coronatus* (Florida), *P. acutus* and *P. cokeri* (Puerto Rico) to determine if differences effect reproductive isolation. Males of all three species swim a looping path when contacted by water surrounding conspecific females with dark colored oocytes. This search ends when the male grasps a passive female's caudal furca in his right geniculate antennule, rotates to grasp her genital segment in his right fifth leg, and attaches a spermatophore using his left fifth leg. Males do not grasp or will release other males or juvenile females although immature *P. coronatus* and *P. cokeri* have dark oocytes. Females of *P. coronatus* and *P. cokeri* mate and lay eggs the day they mature unlike *P. acutus* females which mate after ca. 5 days and lay eggs ca. 3 days later. Male *P. acutus* take longer to couple but mate faster than other species. All males can produce multiple spermatophores but only the sympatric species add a second one that empties after the female is ovigerous. Initial cross-species pairings suggest that only the allopatric species attempt mating but produce infertile eggs. Isolation appears to result from chemical and tactile cues, behavioral patterns, and physiological barriers.



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BIOMASS, RELATIVE GROWTH RATES AND PRODUCTION OF GAMMARUS TIGRINUS (AMPHIPODA, GAMMARIDAE) AND PALAEONETES PUCIO (DECAPODA, PALAEMONIDAE) IN A TIDAL CREEK OF THE RHODE RIVER WATERSHED, MARYLAND. R.E. BATIE. RADFORD UNIV., VA.

Weekly samples were collected from April 18, 1980 - October 23, 1980 from Muddy Creek in the Rhode River Estuary at the Chesapeake Bay Center for Environmental Studies (Smithsonian Institution) Edgewater, Maryland. Maximum biomass of Gammarus (250 mg-AFDW/ m<sup>2</sup>) occurred during May 15-22. Peak abundance (650/ m<sup>2</sup>) occurred during June 6-12. The increase in the individuals sampled accompanied by the smaller individual size indicated a large population recruitment during late May and early June. Maximum production rates (0.18 mg-AFDW/ m<sup>2</sup>/ day) occurred during May 18-22. Maximum abundance of Palaemonetes (450/ m<sup>2</sup>), and maximum biomass (3,350 mg-AFDW/ m<sup>2</sup>), and maximum production (12.5 mg-AFDW/ m<sup>2</sup>/ day) all occurred during August 21-28. Although amphipods are abundant in early summer and contribute to substrate re-working and detrital breakdown, the grass shrimp, which are more abundant in late summer, apparently have a greater impact on detrital breakdown and nutrient re-cycling.

114

THE ELUSIVE MALE OF CHELODUS FAVIFORMIS (CRUST. CE., CL. DOCTRA). D. G. FREY. Indiana University, Bloomington.

For assessing the claimed conspecificity of several Asian and Australian taxa with C. faviformis from North America, males are necessary, but no functional males of C. faviformis could be recovered from several strongly gamogenetic natural populations. This led to a number of fanciful, and partly facetious, hypotheses to explain what is happening, one being that the male completely loses its spectacular honeycomb pattern on molting to maturity in instar III. This outcome was not expected at all, because functional males of the Asian and Australian faviformis-like taxa, as well as of the even more spectacular and elaborate C. bicornutus from North America, retain their honeycomb pattern. Yet, this is precisely what happens. The story for C. faviformis is complicated further by the simultaneous occurrence in one locality of a gamogenetic population of C. cf. sphaericus, in which the functional males are the same size as those of C. faviformis and closely resemble them. Scanning electron micrographs have been used to help resolve the details.

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CHARACTER ANALYSIS, HOMOLGY, AND PHYLOGENY. N. A. Neff. American Museum of Natural History and City University of New York, New York.

Competing hypotheses of phylogenetic relationship are demonstrated to be primarily the result of disagreement about the identification and distribution of characters (rather than argument about phylogenetic or cladistic methodology *per se*). Even disagreement about the polarity of a character results from a failure to agree on its distribution among the outgroups to the taxa under study. All such disagreements reflect the need for a rigorous method of character analysis to enable explicit testing of character identifications and distributions--i.e. homologies. In cladistic analysis, the characters themselves can only be tested weakly, by inclusion in a cladogram. I propose a hypothetico-deductive method of character analysis that enables stronger tests of hypotheses of homology by using topological and developmental relationships, prior to cladistic analysis. Using my method, a choice among competing hypotheses of character identifications and distributions can be made using a parsimony criterion. A character analysis of the basicranium of the saber-toothed carnivorans (Nimravidae) is presented to exemplify my method.

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PROBLEMS IN LIZARD CLASSIFICATION: ADAPTIVE, PLESIOMORPHIC & HOMOPLASTIC CHARACTERS, BIAS OF PROGRESSIVE EVOLUTION AND BARRIERS OF EXPERT OPINION. S. M. Moody. Ohio Univ., Athens, OH.

Camp's 1923 classification of the lizards is still followed. Transfer of two gekkotan families from his group Autarchoglossa to Ascalabota and review of nasal organ and girdle musculature has not broken confidence in his scheme probably because of barrier of expert opinion. My reanalysis of characters finds plesiomorphs (pore glands, osteoderms, wide clavicle), reversals (amphicoely), losses/reduction (abdominis lateralis, skin glands, intercentra, inscriptional ribs), homoplasms (generational glands in agamids and gekkotas, cutaneous pectoralis in agamids, behavioral/ecological adaptations (dentition, vertebrae, hyoid, throat muscles, limbs). Camp's view that primitive autarchoglossans were slinking, terrestrial, burrowing, olfactory and that advanced ascalabotans were runners, climbers, arboreal, visual is not congruent with outgroup character analysis. His views suggests the prejudice of progressive evolution, i.e. lizards most similar to primates must be advanced. Cladistic reanalysis reveals disagreement with his dendrogram.

EVOLUTION OF THE SAND LIZARDS (LACERTILIA: IGUANIDAE): PHYLOGENY, CONVERGENCE, EVOLUTIONARY RATES, AND HETEROCHRONY. K. de Queiroz. San Diego State Univ., Calif.

Data in the literature on ear morphology and electrophoretically detectable protein variation were analyzed cladistically to test hypotheses of genealogical relationships among the genera of sand lizards. The two data sets are in complete agreement in their support of one hypothesis of genealogical relationships. Based on this set of relationships, there is no evidence that "earlessness" has evolved independently in Cophosaurus and Holbrookia, since the two are sister taxa. The relationships also indicate that Holbrookia has undergone accelerated rates of evolution in both its protein molecules and external morphology. An hypothesis involving paedomorphosis via progenesis is offered to explain the rapid change in the external morphology of Holbrookia and the former uncertainty about the relationships of this genus. There is some evidence that progenesis is related to an *r*-selected life-history strategy in Holbrookia.

HYBRIDIZATION IN SYMPATRY BETWEEN THE TOADS BUFO AMERICANUS AND B. FOWLERI IN SOUTHERN ONTARIO. David M. Green, University of Guelph, Ontario, Canada.

Natural sympatric hybridization between two species of toads was investigated using isozyme electrophoresis. Four of the 26 assayed loci were diagnostic in separating the two species; hybrids were heterozygous at these loci. These natural F<sub>1</sub> hybrids are viable but are uncommon and restricted in occurrence. Backcrossing appears to be negligible.

This hybrid zone is seen as a stable, equilibrium situation in which hybrids may appear at various places and times where and when local conditions may permit. The presence of hybrids does not seem to dictate, necessarily, any long term genetic changes in the parental species. This situation is comparable to similar sympatric hybridization zones but differs in many respects from allopatric zones between more closely related taxa.

HYBRIDIZATION AND INTROGRESSION BETWEEN SMALLMOUTH BASS, MICROPTERUS DOLOMIEUI AND GUADALUPE BASS, M. TRECULI. D. H. Whitmore. Univ. of Texas at Arlington, Arlington, Tx. 76019

Electrophoretic analysis of interbreeding populations of introduced smallmouth bass and native Guadalupe bass have revealed a zone of hybridization with accompanying introgression. Fixed allelic differences in malate dehydrogenase, esterase, xanthine dehydrogenase, isocitrate dehydrogenase and glucose-6-phosphate dehydrogenase were used as diagnostic characters to identify parental types, their F<sub>1</sub> hybrids and backcross individuals. Discriminant function analysis was used to describe the morphological relationships among these genetically distinct groups. Temporal changes in the breeding patterns of smallmouth and Guadalupe bass populations are discussed in terms of genetic and morphological data.

AN EVOLUTIONARY ANALYSIS OF VERTEBRATE VIVIPARITY. Daniel G. Blackburn. Dept. of Anatomy, NYSCVM, Cornell Univ., Ithaca, NY

Phylogenetic and reproductive mode data were superimposed to facilitate 1) estimation of the minimum frequencies with which viviparity (live-bearing) has arisen in various lineages, and 2) analysis of factors hypothesized to influence its evolution. Viviparity has evolved on over 102 separate occasions in vertebrate history. The majority (75) of these origins have been in the Reptilia, with 54 origins in the Scincidae, Iguanidae, Viperidae, and Colubridae alone. Minimum values for other vertebrate classes are as follows: Chondrichthyes, 10; Osteichthyes, 12; Amphibia, 4; Mammalia, 1. Undetected origins are likely in the Serpentes, Scincidae, and Gymnophiona.

The data refute the hypothesis that viviparity is incompatible with female heterogamety, but support arguments that evolutionary constraints are imposed by external fertilization, lack of oviducts (or analogues), epigametic sex determination, absence of mechanisms for egg retention, and reliance upon the eggshell as the source of calcium for development. In reptiles, viviparity has evolved preferentially in cold climates. However, no single set of factors can explain all origins of viviparity.

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INTERRELATIONSHIPS BETWEEN PLANT, ANIMAL, AND FUNGAL PROTISTA. Diana Lipscomb, Univ. of Maryland, College Park.

Traditional classifications have arbitrarily divided the unicellular eukaryotes into plant, animal, and fungal forms and interrelationships between the groups are disclaimed. In this study, 34 taxa of flagellated protists were classified following accepted cladistic and phenetic methods. The results showed more inter-relatedness than indicated by traditional classifications. For example, the euglenoid phytoflagellates were grouped closer to the trypanosomatid zooflagellates. The chitrids were found closer to some phytoflagellate taxa than to other fungi. These findings have a great impact on our basic understanding of the kingdom Protista as well as on the related fields of protozoology, phycology, mycology, and the study of eukaryogenesis. The classifications produced by the phenetic and cladistic methods differ. The phenetic tree has more steps, more convergences and reversals, and less congruence among characters than the cladistic tree. Additional biochemical evidence supports the cladistic classification. For these reasons, the classification produced by cladistic methods is preferred.

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SAFETY FACTORS IN THE SKELETAL DESIGN OF LARGE AND SMALL ANIMALS: ARE THEY UNIFORM? A.A. Biewener (intro. by C.R. Taylor). Harvard Univ., Cambridge, MA.

Scaling arguments based on data for the cross-sectional geometry and length of bones predict that peak locomotory stresses are 14 times greater in the limb bones of large animals compared to small animals (0.05-700 kg). No significant difference was found in the bending strength of cortical bone over this range in size ( $233 \pm 53$  MN/m<sup>2</sup> for small animals compared to  $200 \pm 28$  MN/m<sup>2</sup> for large animals). This implies that large animals have a lower margin of safety to failure than small animals. However, little difference was found in the peak stresses developed during locomotion in the bones of horses ( $55$  MN/m<sup>2</sup>) compared to those acting in ground squirrels and chipmunks ( $43$  MN/m<sup>2</sup>), based on film and force plate data and/or records of *in vivo* bone strain measured by rosette strain gauges. This indicates that a uniform safety factor of about 4-5 is maintained over a range in size. To explain these results and the discrepancy with the predictions of the scaling model, it is concluded that larger duty factors and a closer alignment of the limb to the direction of the ground force vector help minimize peak stresses in larger animals. (NIH Grant # AM18140 & T32 CM07117-05)

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SPEED-CORRELATED CHANGES IN GAIT, LIMB ORIENTATION AND MOVEMENT COMPONENTS IN A GENERALIZED LIZARD. J.A. Peterson, Univ. of California, Los Angeles.

The locomotor behavior of *Dipsosaurus dorsalis* was analyzed from high speed cine films. Speeds ranged from less than 10cm/sec (1 body length/sec) to more than 350cm/sec (35 body lengths/sec and more than 4 body lengths/stride). A few exceptional bipedal performances exceeded this speed significantly. As speed increases the rhythm of limb movement remains relatively constant, but the limbs change "posture". They become more extended, digitigrade, and during the stance phase they operate close to the sagittal plane. The changes in limb orientation occur gradually, and the forelimb reorients at lower speeds. Locomotion becomes bipedal as hindlimb orientation changes. The shift in limb orientation coincides with a decrease in the contribution of undulation to the step, decreased excursion in the elbow and knee and increased sagittal excursion in the shoulder and hip joints. In *Dipsosaurus* progressive changes in limb orientation and in the movement components increase speed by increasing the effective length and excursion arc of the limb. Variation in limb posture rather than gait forms the behavioral "gears" in *Dipsosaurus*.

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WING LOADING IN FLYING FISH. F. E. Fish. West Chester State College, West Chester, PA.

Gliding ability of flying fish (Exocoetidae) was investigated as a function of wing loading. Wing loading of the pectoral and pelvic fins of preserved fish was determined as the ratio of body weight to ventral surface area of the fins. Animals with high wing loads are generally poor gliders. Regression of wing loading to body mass for the genus *Cypselurus* showed an exponential relationship. Fish of high body mass had proportionally higher wing loads than smaller individuals. The high wing loads and morphology of large *Cypselurus* suggest that aerial distance is maximized by a high emergent velocity.

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SOME MUSCULOSKELETAL DIFFERENCES RELATED TO JUMPING IN HETEROMYID RODENTS. M. L. Hyde. Washington State Univ., Pullman.

Quantitative and qualitative observations on more than 100 skeletons of heteromyid rodents led to detailed dissections of the sacrolumbar region of some kangaroo rats and closely-related species. The presence and height of neural spines in the sacrocaudal region are correlated with the extent of attachment of the Sacrolumbar transversospinalis and caudal muscles. The presence of a "sacral notch" and its morphological variation in all members of this family is documented. Ligamentous attachments between the last lumbar, sacral, pseudosacral, and first caudal neural spines vary within this family; some members have interspinous ligaments within the "sacral notch" and others reduce this ligamentous array to a thin fascial sheet. Many quantitative skeletal differences within this family may be related to body size differences. However, some characteristics may be species-specific and reflected in behavioral differences. The presence of the "sacral notch" may be correlated with a characteristic jumping behavior but its morphology may reflect sustained bipedal locomotion and the use of the tail.

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COMPARATIVE STUDY OF THE FORELIMB OF THE SEMIFOSSORIAL PRAIRIE DOG, CYNOMYS GUNNISONI, AND THE SCANSORIAL FOX SQUIRREL, SCIURUS NIGER. ANN STALHEIM SMITH. No. Ariz. Univ., Flagstaff and Kansas State Univ., Manhattan.

Theory suggests that in a digging animal the forelimb is adapted to produce force. In contrast, the limb construction of a scansorial animal is thought to be adapted to increase velocity. To accomplish the latter, theory predicts that the length of the out-lever of a joint should increase while the length of the in-lever should decrease, the opposite of what is predicted for a digger. To test this hypothesis, the out-force and lever arms have been measured in 23 prairie dogs and 8 fox squirrels. Select muscles acting at the shoulder, elbow, and wrist joints were chosen for comparison and the maximum out-force of these muscles was obtained by nerve stimulation. The out-force was determined for a range of joint angles found to be important from films of digging and climbing. Results indicate that in these two species there are more similarities in the out-force produced, as well as the particular joint angle at which the greatest out-force is produced, than was anticipated.

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AN ELECTROMYOGRAPHIC ANALYSIS OF THE FORELIMB MUSCLES OF THE SPOTTED SALAMANDER, AMBYSTOMA MACULATUM.

J.L. Edwards. Michigan State University, East Lansing.

The electrical activity of ten forelimb muscles was studied via bipolar fine-wire electromyography and cinematography in the spotted salamander, Ambystoma maculatum. Large differences were found in the activity of homologous muscles previously studied in the crested newt, Triturus cristatus. In agreement with recent reports on salamander hindlimbs, the activity patterns of A. maculatum forelimb muscles are very similar to those of their mammalian homologs, even when the homologous muscles differ considerably in function. An exception is the salamander supracoracoideus, which has a biphasic firing pattern quite different from that of its presumed mammalian homologs.

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THE FUNCTION OF THE EPIPUBIC BONES IN OPOSSUMS. THOMAS D. WHITE. UNIV. OF CALIFORNIA, LOS ANGELES.

The prevailing hypothesis proposes that a function for epipubic bones in living mammals is the support of the marsupium. Anatomical studies of preserved specimens indicate that in Didelphis the marsupium is rendered support from fascial connections to the linea alba and pubic symphysis medially and the deep layer of the superficial fascia and the panniculus carnosus laterally. The epipubes are only passively involved in the support of the linea alba. The prevailing hypothesis fails to explain the function of epipubes in males or in taxa lacking a marsupium. From paleontological evidence, it is now apparent that epipubic bones were present in advanced cynodonts and are a primitive character of all mammals. This evidence suggests that epipubes were present at the transition from reptilian to mammalian modes of locomotion. It is hypothesized that epipubic bones are functional in locomotion. A biomechanical model of epipubic bone function in opossums is presented.

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METHOD FOR THE STUDY OF THE EVOLUTION OF BEHAVIOR. G. Fiorito. Stazione Zoologica, Naples, Italy.

Today, behavior is considered subject to the evolution rule in the same way of another characters. So, we must enlarge our behavior research out of its individual, phenotypic, aspect. For all this, we assume the existence of genetic variation in behavior caused from the natural selection. We have found some likeness in the single steps of a same behavior of different, but phylogenetically related, species. This is one of the results of the ethograms analysis. We think that comparing single step sequence in behavior of different species, we could know the evolution of behavior in a group. The method is realized with the aid of the computer and it compare the ethograms of related species. The result of this is a matrix of many dimensions. We can utilize the matrices to obtain the phylogenetic tree of behavior. The results of our research consist to know if one of several behaviors affected evolution of a species and of the group, to found a "ancestor" with high probability.

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RODENTS AND MAGNETIC FIELDS: A FREE CHOICE OF VARIOUS TYPES OF SHIELDED HOUSING CONDITIONS. C. J. Sherry and J. P. Mitchell (intro. by L. S. Dillon). Texas A & M Univ., College Station, Tx.

Various organisms seem to be sensitive to steady-state magnetic fields at the intensity of the earth's field or fields whose intensity fluctuates around the intensity of the earth's field. We housed rats in a group of 4 standard plastic rat cages connected together with plastic pipe so that the rat could move freely from one cage to another. The pipes contained photocells that were connected to a polygraph so that we could monitor the movements of the rat and determine the average amount of time spent in each housing condition, the number and sequence of visits to each housing condition, and the total amount of time spent in each housing condition. There were 4 housing conditions: unshielded, solid metal cage, grounded faraday cage, and combination solid metal and grounded faraday cage. The rats (5) spent 45 to 2824 percent more time in the solid metal cage than in the unshielded cage. This seems to suggest that the rats are attempting to shield themselves from the steady-state field.

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EFFECT OF ACTH (1-24) ON THE GROOMING BEHAVIOR OF DOMESTIC CHICKENS. S. Williams, V. Carter\* and A. McMillen\*. Simmons College, Boston, MA.

Under stress, animals often appear to do inappropriate things such as feeding or grooming. Since stress influences the production of ACTH and the mobilization of glucose, and neurons have been described that are sensitive to changes in these, stress induced variation could affect behaviors related to stress. Chickens injected intracisternally with 1  $\mu$ g ACTH (1-24) exhibited significantly more scratching and feeding/pecking but less preening than controls receiving saline alone. Chickens injected intravenicularly with 4  $\mu$ g ACTH (1-24) showed no significant behavioral changes; those receiving 8  $\mu$ g showed a significant increase in pecking when compared to controls. These data suggest that ACTH(1-24) increase some behaviors in chickens but not those involved with grooming.

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'SPITE'; A CONSTRAINT ON OPTIMAL FORAGING IN THE VERVET MONKEY CERCOPITHECUS AETHIOPS SABAEUS IN BARBADOS. J. Horrocks\* and W. Hunte. Biology Dept., Univ. of the West Indies, Barbados.

Optimal foraging theory assumes that foraging animals maximise their net rate of energy intake, but vervets are notoriously wasteful feeders. They destroy, but do not consume, an appreciable proportion of the crops/fruits encountered when foraging. The ratio of destroyed crops to consumed crops increases with increasing distance from the centre of the foraging troop's home range, being highest in fields where the home ranges of competing troops overlap. Furthermore, the ratio is higher in fields of farmers who harass vervets than those who do not. Such 'spiteful' foraging, directed both intraspecifically, and interspecifically in a surprisingly selective manner, may exist because it potentially reduces the fitness of competitors more than it reduces the fitness of the forager.

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SEROTONIN MODULATION OF SALIVARY ACINAR CELL ACTIVITY IN HELISOMA TRIVOLVIS. Jonathan Copeland and Ann Hallanger\*. University of Wisconsin-Milwaukee.

Serotonin acts as a neuromodulator at many conventional effectors in invertebrates and vertebrates. We have examined the effects of serotonin on the activity of a non-conventional effector, the secretory epithelium of the salivary glands of the snail Helisoma trivolvis. An *in vitro* isolated salivary gland preparation was used and serotonin was superfused over the gland. Acinar cells in isolated salivary glands were silent, showing no spontaneous electrical activity. Superfusion with  $10^{-7}M$  serotonin initiated activity, either tonic action potentials or beating activity. Once initiated, such activity continued for up to 30 minutes even in the absence of serotonin. When  $10^{-7}M$  serotonin was added to a spontaneously active preparation, firing frequency decreased, action potential duration increased up to 30% and, in some cases, action potential height decreased up to 80% with no change in resting potential. Such observations are consistent with the hypothesis of modulation of acinar cell excitability by serotonin. Supported by The Graduate School, UW-Milwaukee.

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ARGININE PHOSPHATE AND ATP UTILIZATION AND FORMATION IN THE "SNAP" AND "CATCH" ADDUCTOR MUSCLES OF THE BAY SCALLOP, ARGOPECTEN IRRADIANS CONCENTRICUS. C. P. CHIH and W.R. Ellington. Univ. of S. W. Louisiana, Lafayette, and Florida State Univ., Tallahassee.

The presence of the gastropod, Fasciolaria tulipa, produces rapid escape responses in the bay scallop, Argopecten irradians. We have observed changes in the levels of arginine phosphate and the adenylates in the adductor muscles during and after swimming. The initial response to the gastropod is a swimming sequence consisting of 20-24 contractions of the adductor muscle. A dramatic fall in arginine phosphate (70%) and ATP (44%) was observed in the "snap" muscle after one swimming sequence. The adenylate energy charge fell from 0.94 to 0.83. Animals were stimulated with the gastropod until they were no longer responsive (4-5 swims). Arginine phosphate levels in the "snap" muscle were further reduced to 15% of control levels. Both arginine phosphate and ATP were rapidly replenished after 30 min of recovery. Similar but less pronounced results were observed in the "catch" muscle.

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PROSTAGLANDIN PRODUCTION IN THE FRESH-WATER MUSSEL LIGUMIA SUBROSTRATA. D. G. Sainsting, D. Hwang\* and T. H. Dietz. Louisiana State Univ., Baton Rouge.

Prostaglandins (PGs) are a component of the Na regulatory system in freshwater mussels. Analysis of the fatty acid composition of total lipids from gill indicated that a substantial amount of PG precursors were present. Arachidonic acid (precursor to  $PGE_2$ ,  $PGF_{2\alpha}$ , and thromboxane  $B_2$ ) accounted for  $14.58 \pm 0.80\%$  of the total fatty acids measured. Precursors to  $PGE_1$  and  $PGE_3$  (and related compounds) were present in much lower concentrations ( $0.29 \pm 0.10$  and  $1.31 \pm 0.05\%$ , respectively).  $^3H$ -arachidonic acid was converted to endoperoxide metabolites when incubated with Ligumia gill homogenates. Radioimmunoassay of mussel blood indicated the presence of  $PGE_2$  ( $0.39 \pm 0.30$  ng/ml) and  $PGF_{2\alpha}$  ( $0.54 \pm 0.17$  ng/ml) but no thromboxane  $B_2$ . Injections of PG biosynthesis inhibitors depressed circulating PG levels and stimulated Na transport. Stimulation of Na transport by salt depletion results in a depression of  $PGE_2$  levels but not  $PGF_{2\alpha}$ . Blood  $PGE_2$  levels are inversely correlated with Na transport rates in freshwater mussels ( $r=0.61$ ,  $P<0.001$ ). Supported by NSF grant PCM79-21089.

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PURIFICATION AND CHARACTERIZATION OF LYSOZYME IN THE BAY MUSSEL, MYTILUS EDULIS. S. A. STEINERT. Naval Ocean Systems Center, San Diego, Ca., and Computer Sciences Corp., San Diego, Ca.

A bacteriolytic protein fraction was purified from homogenates of whole mussels. The purified protein was characterized as lysozyme (E.C. 3.2.1.17, N-acetylmuramide glycanohydrolase) which is of a class of enzymes that hydrolyze the  $\beta 1 \rightarrow 4$  linkages between N-acetylmuramic acid and N-acetyl-D-glucosamine, major structural constituents in the cell walls of gram-positive bacteria. Lysozyme activity has not been documented in Mytilus edulis though its presence has been established in other pelecypod molluscs. Characterization of the enzyme consisted of measuring: molecular weight by gel filtration and SDS-polyacrylamide gel electrophoresis; optimal pH of hydrolysis over a pH range of 4-9; thermal stability after incubation at temperatures from  $10^{\circ}$  to  $85^{\circ}C$ ; and making a comparative determination of the apparent affinity constant ( $K_{app}$ ) of the enzyme for substrate. Specific activity values determined for cell free hemolymph preparations and disrupted hemocyte supernatants implied intracellular concentration of lysozyme.

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CONFORMATION CHANGES OF OYSTER (*CRASSOSTREA VIRGINICA*) SOLUBLE MATRIX IN RESPONSE TO CALCIUM. A.P. Wheeler and J.W. George.\* Clemson Univ., S.C.

The soluble matrix (SM) was extracted from oyster shells by dialysis against ethylenediaminetetraacetic acid (10%, pH 7.5). It is a  $\text{Ca}^{2+}$ -binding protein with an average capacity for  $\text{Ca}^{2+}$  of 23  $\mu\text{mol}/\text{mg}$  protein, as determined by a  $\text{Ca}^{2+}$ -specific electrode. The effects of  $\text{Ca}^{2+}$  binding on the conformation of SM were studied using UV difference spectrophotometry. Difference peaks at 235nm and 273nm were observed beginning at  $10^{-5}\text{M}$   $\text{Ca}^{2+}$ . At  $10^{-4}\text{M}$   $\text{Ca}^{2+}$  and above, all active sites were bound, and the conformational state of the SM remained constant. Similar peaks were observed with the addition of 8M urea, suggesting that SM mimics a denatured state upon binding  $\text{Ca}^{2+}$ . Extracellular SM is normally exposed to  $[\text{Ca}^{2+}]$  greater than  $10^{-3}\text{M}$ ; therefore, once secreted it is in a relatively random conformation. However, intracellular SM is presumably exposed to concentrations less than  $10^{-5}\text{M}$ , consequently it maintains a relatively ordered conformation prior to secretion. (Supported by NSF Grant PCM-7916587)

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ORIGIN OF PROLINE IN GILLS OF *Modiolus demissus* DURING OSMOTIC ADJUSTMENT. J.M. Burcham\*, D.E. Greenwalt, and S.H. Bishop, Iowa State University, Ames, 50011

Gill tissue from ribbed mussels acclimated at 12‰, accumulate L-pro during hyperosmotic (32‰) challenge. L-Arg and L-orn but not L-glu serve as precursors for L-pro biosynthesis. The tissue has the complete complement of enzyme for conversion of L-phosphoarginine to L-pro (arginine kinase, arginase, ornithine aminotransferase, and L-pyrroline-5-carboxylate (P5C) reductase) and of L-pro to L-glu (L-pro oxidase and L-P5C dehydrogenase). All activities except arginase and L-P5C reductase are mitochondrial. L-pro oxidase is coupled to the electron transport system at the CoQ level. During hyperosmotic adjustment, L-pro is derived from free and protein bound L-arg and L-pro rather than glucose or glutamate; L-pro accumulation results from increased synthesis rather than decreased catabolism. Supported by a grant from the NSF.

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EFFECT OF REDUCED OSMOTIC PRESSURE ON GLYCINE TRANSPORT IN CRAB MUSCLE FIBERS. W. M. Moran and S. K. Pierce. Univ. of Maryland, College Park.

In response to low salinity stress the volume of *Cancer irroratus* muscle cells is regulated by a decrease in intracellular [glycine]. The influx of  $^3\text{H}$ -glycine into isolated muscle fibers taken from crabs adapted to 100% ASW and exposed to 60% ASW was reduced by 35% compared to controls. Further, exposure of muscle cells to 60% ASW made osmotically equivalent to 100% ASW had no effect on glycine influx. Substitution of  $\text{Li}^+$ , Tris or mannitol for  $\text{Na}^+$  had no significant effect on glycine influx. Thus, cause of the reduced glycine influx is the decrease in osmotic concentration rather than the ionic decrease concomitant with sea water dilution. These results suggest that a portion of the decline in intracellular [glycine] during volume regulation may be due to decreased inward glycine transport. (Supported by NIH GM-23731 and TS&GCCMA, Inc.)

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HISTOCHEMISTRY OF SCORPION LEG MUSCLES. T. M. Root and S. C. Gatwood\*. Middlebury College, Vermont.

Histochemical demonstration of myosin ATPase,  $\alpha$ -glycerophosphate dehydrogenase and succinic dehydrogenase was carried out in the trochanter-femur elevator and trochanter-femur depressor muscles of the scorpion leg to examine their muscle fiber composition. Myosin ATPase staining was observed in a pattern corresponding to the radially-arranges myofibrils described previously.  $\alpha$ -glycerophosphate dehydrogenase and succinic dehydrogenase staining was observed either in the central core of these tubular fibers, or in both the central core and between the myofibrils. Different fiber types were characterized based upon the staining intensity for these three enzymes. Lightly-stained, darkly-stained and intermediately-stained fibers were observed. Generally, the fibers located on the muscle periphery were found to stain stronger than those located centrally. (Supported by a grant from Middlebury College)

WATER EXCHANGE KINETICS OF THE FEMALE TICK AMBLIYOMMA AMERICANUM. T.J. Freda and G.R. Needham. Ohio State University, Columbus.

The unfed female tick was used as a model to study water flux dynamics at 2 water vapor activities. Net movement was measured by use of tritiated water. When exposed to the different humidities, the loss of tritium was used to determine rate constants of transpiration and sorption. Beeswax was used to block the mouth, the rectum, and the respiratory system to determine quantitatively their contribution to water balance. The ticks were equilibrated for approximately 2 weeks in a 93% RH containing 1 mCi/ml of tritium. Above the Critical Equilibrium Activity (CEA), the mouthparts contributed to the active component of sorption. Below the CEA, passive sorption continued but the rate was dependent on humidity. The rate of transpiration was greatly impeded by the cuticle and was independent of humidity. Blockage of the spiracles reduced water loss, while blockage of the rectum had no significant effect on transpiration or sorption. Our quantitative water exchange studies for A. americanum indicate that water balance is maintained by restricting water loss through the integument, closing the spiracles, and by sorbing water from unsaturated air.

COLD-HARDINESS AND RESPIRATORY METABOLISM IN THE ANTARCTIC TICK, IXODES URIAE. R. E. LEE, JR. and J. G. BAUST. Univ. of Houston, Texas.

All life stages of I. uriae were collected beneath rocks in large colonies (1000 + individuals) on the periphery of Adelie penguin rookeries in the vicinity of Palmer Station (64° 46'S; 64° 03'W). I. uriae is freezing intolerant. Engorged adult females supercool to -13.8, while eggs extend supercooling to -28.7° C. Glycerol was accumulated during the transition from austral mid-summer to autumn. The oxygen consumption of females was directly related to temperature from 0 to 30° C. Lab acclimation of females, males and nymphs to 0 and 10° C for two weeks had no effect on oxygen consumption, suggesting that I. uriae lacks the capacity for compensatory acclimation of respiration rate. Metabolic rates of temperate ixodids are similar to those of females of I. uriae indicating that metabolic cold adaptation is lacking in this species.

SECRETORY RESPONSE TO FORMAMIDINE PESTICIDES BY SALIVARY GLANDS OF IXODID TICKS. T. L. Pannabecker and G. R. Needham. Ohio State University, Columbus.

Glands from female Amblyomma americanum were tested for their ability to respond in vitro to chlordimeform (CDM) and demethylchlordimeform (DCDM). The isolated glands were perfused with saline or with saline containing the drug(s) and the rates of fluid secretion were determined. CDM (10<sup>-5</sup>M) did not act as an agonist upon the gland preparations nor was CDM (10<sup>-4</sup>M) able to potentiate the response induced by a subthreshold concentration of dopamine (DA, 10<sup>-8</sup>M). DCDM (10<sup>-5</sup>M) did however evoke a weak response following preincubation of the gland in DA (10<sup>-7</sup>M). Neither CDM nor DCDM were potent antagonists of DA stimulated secretion at concentrations 100-fold that of the catecholamine. DA (10<sup>-5</sup>M) elicited nearly twice the maximum secretory rate induced by a millimolar concentration of octopamine. Formamidines thus do not appear to mimic the dopamine or octopamine mediated responses of the isolated gland system.

SYMMETRICAL CHEMICAL SYNAPSES. W.E. Schwab and P.A.V. Anderson. Virginia Polytechnic Inst. and State Univ. and Whitney Marine Lab., Univ. of Florida.

Transmission of activity between neurons in the motor nerve-net of the jellyfish Cyanea occurs at specialized junctions which, in electronmicrographs, appear as symmetrical chemical synapses. Nerve cells and their synapses can be visualized clearly so that pairs of communicating cells can be impaled with microelectrodes. The action potential waveform is complex since numerous small depolarizing potentials are superimposed on the action potential itself. We class these small potentials as synaptic potentials since they are blocked by high magnesium or repetitive stimulation leaving a clean conventional action potential which is not transmitted to the next cell. The action potential itself is TTX insensitive but has both voltage dependent and Ca<sup>++</sup> activated K<sup>+</sup> currents. These and other observations indicate that the physiology of the neurons is not unusual and that the preparation can serve as an important model system for the study of chemical synapses.



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EFFECTS OF CYCLIC HYDROCARBONS ON TISSUE RESPIRATION AND COMPONENTS OF HEMOLYMPH IN *CALLINECTES SAPIDUS*. L.H. Mantel, S.L. Swendeman\* and M.E. Katz\*. City College, New York and St. John's Univ., New York.

Cyclic hydrocarbons such as benzene (B) and dimethylnaphthalene (DMN) are important contaminants of estuarine waters in the Northeast. We are measuring effects of these compounds on juvenile blue crabs. Animals are collected from Barnegat Bay and maintained at 31 ppt or 10 ppt in a static system, as controls or dosed daily with 5-10 ppm B or 5-10 ppb DMN. Respiration of control gills is higher in crabs from 31 ppt than from 10 ppt. Treatment of gills from 10 ppt crabs with B or DMN *in vitro* reduces respiration by 5-15%, while gills from 31 ppt crabs show elevated respiration with the same treatment. Respiration of midgut gland decreases when treated *in vitro*. Tissues from crabs chronically dosed with DMN show higher respiration than controls, while dosage with B decreases respiration. Concentration of TNPS is higher in crabs from 31 ppt than from 10 ppt while glucose concentrations are the same in both groups. Chloride gradients are reduced in crabs exposed to B, while osmotic gradient is not affected. Both B and DMN affect respiration and regulation of hemolymph but their effects are different.

Supported by CUNY and NSF URPP (to SLS)

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EXPERIMENTAL ECOLOGY OF A CORAL-DECAPOD CRUSTACEAN COMMUNITY. L. G. Abele. Florida State Univ., Tallahassee, FL.

Experimentally defaunated corals (*Pocillopora damicornis*) were colonized within 12 hr and the number of species and individuals increased on corals over time. Colonists were small adults and juveniles and predominately males within the genus *Trapezia*. The specific rank for frequency of colonization cannot be predicted from a species' abundance or frequency of occurrence although more abundant species colonize more frequently. Some corals reached predefaunation species number, but not composition, within 4 days. Experimental communities were assembled by giving defaunated corals "too many" species for their size. These corals lost species and within a few days reached a species number slightly below that originally observed. Caged and uncaged experimental communities lost about the same number of species and both lost significantly more than the controls which were given the "correct" species number. The community is dynamic with movement between corals and regular changes in species composition. The upper limit to species numbers on single corals appears to be affected by behavioral interactions evolved under strong predation pressure.

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ZOOGEOGRAPHY AND SPECIATION OF THE CORAL-BANDED SHRIMP GENUS *Stenopus* (DECAPODA: NATANTIA; STENOPODIDAE). Joseph W. Goy Duke Univ. Marine Lab.; Beaufort, N.C.

The zoogeographic distribution of the seven known species and four new undescribed species of the genus *Stenopus* is reviewed. These species are all found in tropical marine waters, with three species also occurring in warm temperate waters. The tropical Indo-West Pacific is taken as the center of evolution and dispersal of *Stenopus*. Within the proposed lineage, *Stenopus hispidus*, is considered to be the ancestral species. The genus speciated, probably sympatrically, into seven Indo-Pacific species. Following the closing off of the Tethys Sea and formation of the Isthmus of Panama, the genus further speciated into *S. spinosus* in the Mediterranean and two other species in the Western Atlantic. This paper is intended as a review of the presently available information on the genus *Stenopus*, and to provide a stimulus to further work on this interesting group of crustaceans.

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RESOURCE PARTITIONING AMONG THREE SPECIES OF CALLIANASSID SHRIMPS. J. Homziak. University of North Carolina, Chapel Hill.

Three species of callianassid shrimps, *Callianassa californiensis*, *C. gigas*, and *Upogebia* aff. *U. pugettensis*, coexist in the Tijuana Slough, San Diego County, CA. I sampled shrimp populations and sediments in areas where all three species were known to occur. I determined, for each species, sediment types inhabited and size range of food particles ingested. I also estimated the degree of overlap. I identified three habitats, clay banks, sand flats and channels, and intergrading areas between them. *C. californiensis*, was most encountered in the sand flat and channel habitats. *C. gigas* was most frequently collected in the sand flats and in the intergrading areas while *Upogebia* was restricted to the clay bank habitat. Regressions of mean ingested particle diameter on carapace length for all species indicated that each species ingested a unique size distribution of particles. Overlap of ranges was least between *C. californiensis* and *Upogebia* while *C. gigas* overlapped both. *Upogebia* and *C. californiensis* appear to have different habitat and food requirements, while *C. gigas* apparently overlaps both the diet and habitat of *C. californiensis* and the diet of *Upogebia*.

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A TEST OF A DART TAG FOR JUVENILE BLUE CRABS, *CALLINECTES SAPIDUS* RATHBUN

Miller, R.E. Univ. of Maryland, Horn Point Environmental Laboratories, Cambridge.

A small dart tag was applied to the posterior junction between the ventral and dorsal carapace halves of 80 juvenile blue crabs to test for success of molting and tag retention during the molting process. Sixty-one percent of the tagged crabs which began to shed were successful in molting and retained the tag; however, the overall mortality rate for tagged crabs was twice as great as for the untagged control group.

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ULTRASTRUCTURE OF THE METRATERM IN *DICLIDOPHORA DENTICULATA* (OLSSON, 1875)

D. M. DeCarlo. Northeastern University, Marine Science Inst., Nahant, Ma.

*D. denticulata* is a monogenetic trematode parasitic on the gills of pollack. Observations of living worms, egg masses, and hatching data indicate that adults may be retaining egg masses in the metraterm for longer periods than were originally thought. An ultrastructural study of this organ was undertaken to look for modifications consistent with this function. A nutritive interaction seems unlikely, and the secretory structures found appear to be related to tanning of the egg shells and lubrication. Bundles of longitudinal muscle fibers surround the lumen.

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HYDROSTATIC MOVEMENT IN THE PROBOSCIS OF *STYLARIA LACUSTRIS* (LINNAEUS) (OLIGOCHAETA: NAIDIDAE)

R. J. Wolff and P. Schaap. Trinity Christian College, Palos Heights, Illinois.

The coelom acts as a hydrostatic skeleton in all Oligochaeta, with the pressure in each segment regulated by the septa. The prostomium of the first segment of *Stylaria lacustris* (Linnaeus) is prolonged into a proboscis. By SEM and LM the coelom can be seen to extend throughout the length of the proboscis. Compartments are found along the length of the proboscis between the coelom and epithelium and may provide a hydrostatic mechanism for movement of the proboscis. Extension results from a filling of all compartments, while bending occurs when one side of the proboscis is flaccid and the opposite is filled. This allows a highly functional proboscis without proboscal septa and a large muscular mass.

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## RIVER DRIFT AND ZOOGEOGRAPHY OF WEST VIRGINIA POLYGYRIDAE (MOLLUSCA: GASTROPODA: PULMONATA). C. L. COUNTS, III, Univ. of Delaware, Lewes.

Comparisons of zoogeographic distribution from literature reports and new collections and occurrence of snails in the family Polygyridae within seven river drainage systems of West Virginia were made using faunal indices of Czekanowski-Dice, Jaccard, Schilder, Ekard, and Stimpson. Zoogeographic distribution of all polygyrid snail species of West Virginia were compared with their geographic distribution in east-central United States. Jaccard R mode analysis demonstrated that *Triodopsis multilineata* was least associated with West Virginia polygyrid land snail fauna. *Mesodon inflectus* and *Stenotrema barbigerum* also had low faunal affinities to West Virginia polygyrid fauna. Jaccard Q mode analysis demonstrated that seven river drainages of West Virginia were similar in terms of polygyrid land snail fauna, but could be separated into three clusters. High faunal affinities for specific river drainages suggested the hypothesis that river drift was the mechanism responsible for past dispersal and present polygyrid biogeography across West Virginia.

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FUNCTIONAL MORPHOLOGY OF THE SIPHUNCLE OF NAUTILUS. L. Greenwald, C. B. Cook, and P. Ward\*. Ohio St. Univ., Columbus, and Univ. of California, Davis.

The siphuncular tissue of *Nautilus* removes fluid from shell chambers. The epithelial cells possess apical microvilli; the basal ends of the cells communicate with the hemocoel system. Epithelial cells from emptying chambers resemble cells capable of solute-coupled water transport: the baso-lateral borders have numerous small, mitochondria-lined channels draining into a canalicular system of the hemocoel. Apically, abundant septate desmosomes suggest that water and salt diffuse across the brush border and fluid is released into the channel system. In contrast, epithelium from the very youngest chambers (not being emptied) have neither the mitochondrial channels nor the hemocoelic canaliculi, and very few apical septate desmosomes occur. These pre-emptying cells are characterized by abundant endoplasmic reticulum and complex interdigitations.

(Supported by NSF Grants PCM 7823524 and PCM 7816132)

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PHARMACOLOGICAL ASPECTS OF MECHANORECEPTORS WITHIN THE ANTERIOR BYSSUS RETRACTOR MUSCLE (ABRM) OF MYTILUS EDULIS L. J.R. LaCOURSE and R.B. NORTHROP BIO. ENG. LABS., Univ. New Hampshire, Durham, and Univ. Conn., Storrs.

The present experiments were performed to observe the effects of dopamine (DA) and 5-hydroxytryptamine (5-HT) on the muscle-receptor sensory system of the ABRM. While the ABRM was mechanically stimulated, a drug solution was allowed to perfuse into the mounted mussel's chamber, covering totally the mussel. Recording from a portion of the cereropedal connective nerve of the ABRM, neurally isolated except for its innervating visceral nerves, allowed pooled mechanoreceptor firing to be observed. The non-habituation characteristic of the mechanoreceptors allowed us to have an experimental control. It was found that the mechanoreceptors within the ABRM seem to be more sensitive to a topical application of DA than to 5-HT. They totally cease firing in the presence of DA but in the presence of 5-HT, their sensitivity recovers after a few cycles of phasic stimulation. It may be that DA is a specified neurotransmitter used to control the gains of the mechanoreceptors.

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VENOM TOXINS: PLAUSIBLE EVOLUTION FROM DIGESTIVE ENZYMES. E. Kochva. Dept. of Zoology, Tel Aviv University, Israel.

Some hydrolytic enzymes are common to the pancreas, the mammalian salivary glands and the snake venom glands. Phospholipase A, which is found in elapid and viperid venoms and in the mammalian pancreas, shows 29 common amino acid residues out of 120-125 positions. Presynaptic neurotoxins and other venom toxins are composed of 2-3 units or subunits, one of which is a phospholipase. The *Vipera palaestinae* two-component toxin retains its lethality when the enzyme is replaced by heterologous venom phospholipases, but not by the pig pancreatic enzyme. This toxin is neutralized by a factor found in the blood serum of snakes, which binds to the phospholipase and inhibits its activity. The blood serum of snakes also neutralizes the hemorrhagins and inhibits the protease activity of the venom. It is hypothesized that the developing venom glands first produced enzymes that were already secreted by the pancreas and against which inhibitors were present in the blood. These inhibitors facilitated the evolution of enzyme-based toxins by neutralizing any damaging substances that might have escaped from the venom glands.

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COMPUTERIZED INFORMATION RELEVANT TO ZOOLOGICAL RESEARCH. E.M.ZIFF. BioSciences Information Service, Philadelphia.

The use of computer technology to store and retrieve vast quantities of information is making great changes in the way scientists use the literature in advancing their work. All types of literature which have been abstracted and indexed in conventional abstract journals now provide the basis for computer records which are frequently indexed in much greater depth, and give opportunities for retrieval from much larger collections with greater precision. Recent developments make it possible for scientists to approach these files directly by the use of on-line techniques. The existence of these systems and the manner in which they can change will be the focus of this session. Traditional and new methods of information gathering will be addressed and analyzed by a panel of well-known zoologists. Computer demonstrations will be given showing the techniques used to retrieve information.

ZOOLOGICAL LITERATURE: THE AGE-OLD PROBLEM OF HOW TO IMPROVE COMMUNICATIONS, EVEN TODAY WHEN SURROUNDED BY COMPUTERS. John O. Corliss, Univ. of Maryland, College Park.

The Age of the Computer is solidly here and we're grateful. Nevertheless, problems in communication appear to remain. Researchers frequently still seem to be unaware of related studies carried out by others in their field in other countries or even neighboring labs -- at least at the time of preparing papers for publication. Several questions may be asked, and it would be nice to know the answers. (1) Is the problem mainly one of ignorance or simply neglect on the part of such investigators? (2) Is ultra-specialization a main factor? (3) Are we failing to train graduate students properly with respect to knowledge of the literature in general and specifically on methods to obtain needed references and other relevant data? (4) Is "geographical isolation" of workers involved? (5) Is the "language barrier" a major problem (how many American zoologists can read Chinese or even Russian?)? (6) Are library resources and/or funds inadequate? (7) Are existing information retrieval systems too few, too general, too expensive, underutilized, misused, inadequate, undependable, or unavailable? Discussion of such problems -- to be worthwhile -- requires audience participation!

BEING AWARE OF THE LITERATURE OF CRUSTACEAN PHYSIOLOGY. M. Fingerman, Tulane Univ., New Orleans, LA.

When first confronted with a proposed research project, dealing for example with the control of reproduction in a crab, a graduate student is often taken aback by the task of uncovering what is already known about the subject. An established investigator has already conquered that challenge. But, both must also keep abreast of their fields. How can they cope? I strongly suggest getting to know the science librarians. They are aware of the services available and can be a great help. The novice particularly needs to take advantage of secondary services to "get up to speed." I recommend to my own students that they make use both of printed publications from abstracting services and computer searches. Furthermore, the novice and seasoned investigator need to read current journals and continue to search secondary sources for the latest publications. The novice should be advised which journals particularly need to be read regularly, those that would likely have papers of most interest. At scientific meetings one also often learns of a useful publication that was missed. No one can spend enough time searching the literature; unfortunately the line must be drawn somewhere.

THE INFORMATION EXPLOSION: A PROBLEM SOLVED. C. L. Markert, Yale Univ., New Haven.

Since 1969 over three million articles from 120,000 biological journals (10,000 journals per year) have been referenced by BIOSIS and placed on tapes that can be searched within a few minutes to identify the articles requested. The desired abstracts can be presented on TV screens or printed as desired, all this at a cost of less than one dollar a minute. Such comprehensive literature searches are impossible by any other means. All that remains is to "talk" to the computer intelligently both in entering information for later retrieval and in selectively requesting just what is needed with a minimum of unwanted information. Previous forms of library research are obsolescent.

THE ZOOLOGICAL RECORD AS A MACHINE-READABLE FILE. H.E. KENNEDY, BioSciences Information Service, Philadelphia.

In 1980, BioSciences Information Service and The Zoological Society of London became co-publishers of The Zoological Record. At that time, a new computer system was installed which improved the efficiency of production of the printed product, and presented an opportunity for the preparation of magnetic tapes for machine-searchable retrieval. Unfortunately, the cost of making earlier Zoological Record tapes compatible with the new system proved to be prohibitive. Consideration is being given to making the file, from Volume 115 forwards, available on-line for community use. The value of the file as a research tool and the way in which the file can be accessed will be discussed.

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SCENT MARKING IN NATIVE SMALL MAMMALS. F. J. JANNETT, JR., Cornell University, Ithaca, N.Y.

Small mammals of many species possess cutaneous scent glands with which, it is thought, they passively mark objects in their environments. Jannett and Jannett (1974) established resident water voles (Arvicola richardsoni) in terraria and observed active Drum-marking by adult males in response to introduced conspecifics constrained in wire mesh baskets. This technique has been extended to other mammals and active scent gland marking behaviors reported here include the following: Rub-marking, Pelvic Press, and Scooting in A. richardsoni; Pelvic Press, Anal Drag, and Scooting in Microtus montanus; flank gland scratching in Lagurus curtatus; Ventral Rubbing in Onychomys leucogaster; flank gland marking in Blarina brevicauda; and Drum-marking and Rub-marking in Sorex monticolus. When small mammals have scent glands, they also have associated behaviors which presumably increase the efficacy of scent secretions.

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EMIGRATIONS AND DEFENSE BEHAVIOR IN THE ANT PHEIDOLE DESERTORUM WHEELER. R. DROUAL. City College of the City University of New York.

Except for opportunistic nesters and legionary ants, colony emigrations among ants are thought to occur infrequently. However, the ant Pheidole desertorum was found to emigrate frequently in both desert-grassland and oak-juniper woodland habitats. The emigrations of P. desertorum occur in patterns which result in a cluster of nests in a limited area. P. desertorum is subject to heavy predation from the army ant Neivamyrmex nigrescens whose range completely overlaps its own. P. desertorum responds to the presence of N. nigrescens by evacuating its nest. Experiments show that after evacuating the fleeing workers find and use the surplus nests resulting from the emigrations as temporary shelters and centers for colony reorganization. This suggests a hypothesis to explain the ultimate causation of the emigrations. The emigrations of P. desertorum may serve as part of a defense system against predation by N. nigrescens.

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DEPENDENCE ON SOCIAL CONTEXT OF RESPONSE TO MIDDEN PHEROMONE IN THE ANT, POGONOMYRMEX BADIUS (LATREILLE). D. M. GORDON. Duke Univ., Durham, N.C.

Response to oleic acid, a midden pheromone, was found to depend on social context. Social context was specified by citing the percentage of ants engaged in each of five activities. When a large percentage is doing midden work or nest maintenance, papers treated with oleic acid are taken to the midden, as previously reported. But when a large percentage is foraging or convening, treated papers are taken into the nest. These results suggest that social context is a significant factor to be considered in pheromone research.

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AMPHIBIOUS ADAPTATIONS OF THE PEARL BLENNY, ENTOMACRODUS NIGRICANS. C. B. Jones and J. B. Graham. The Carney Hosp., Boston, MA and Scripps Inst. of Oceanog., La Jolla, CA.

Knowledge of the biology of amphibious fishes contributes to an understanding of ecological factors affecting the early evolution of terrestrial vertebrates. For E. nigricans a Caribbean coral reef species, we report its reef distribution pattern, relative abundance and size class distribution, activity cycles, feeding habits, and its capacities for orientation and terrestrial navigation. The pearl blenny depends on amphibious capabilities to move and maintain position in areas of strong wave action. Plastic behavioral responses seem more important in the amphibious life of this species than are its resistance to desiccation and capacity for air breathing which are both reduced compared to more terrestrial species.

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DOMINANCE IN SOCIAL UNITS OF COMMUNAL MEXICAN JAYS. C.P.L. BARKAN, J.L. Craig†, J.L. Brown, A.M. Stewart\*†, & S.D. Strahl. Dept. Biological Sciences, SUNY, Albany, NY 12222 and, † Zoology Dept., University of Auckland, N.Z.

Mexican jays (*Aphelocoma ultramarina*) live in highly cohesive, sedentary social units. Breeding behavior of a marked population consisting of seven social units has been studied for the past eleven years. Social dominance relationships among members of these units were discerned within the units. In general males were dominant to females. Yearlings and older males appeared to be dominant to most others. The high status of yearlings and adult males is probably due to different factors. Yearling status may be a result of the higher value of an easily obtainable resource to an inexperienced forager. Adult male status is probably related to competition for breeding status within units. Female subordination to males may be explained by sexual selection.

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SPECIES-TYPICAL AGGRESSIVENESS AND LEARNING IN FISHES. A. Beulig\*, J. J. Dalezman and R. F. Young. New College of Univ. of So. Florida, Sarasota.

Two sympatric species of Cyprinodont fishes (*Cyprinodon variegatus* and *Fundulus heteroclitus*) were tested in a two-way, shuttle-box avoidance conditioning paradigm. *Cyprinodon* males are very aggressive throughout the year while *Fundulus* males do not show agonistic behavior until the breeding season. At this time *Fundulus* are aggressive to conspecific males but are not territorial. *Cyprinodon* reached criterion (90% avoidance) in significantly fewer days than *Fundulus* (12 da vs 21 da  $p < .05$ ). During training, *Cyprinodon* performed significantly more avoidances than *Fundulus* ( $p < .05$ ). However, *Fundulus* performed significantly more escapes than *Cyprinodon* ( $p < .05$ ) and had a lower mean percentage of failures to respond. It is proposed that these performance differences reflect different strategies to avoid aversive stimuli in the two species. The territorial species is more likely to return to the site of aversive stimulation which it must do to defend a territory and hence is better able to learn a two-way avoidance task than the non-territorial species.

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THE COST OF EXPERIENCE AND THE ONTOGENY OF MALES UNDER CONTEST COMPETITION FOR MATES. S.G. Hoffman and R.R. Warner. Univ. of Houston, Houston, TX., Univ. of California, Santa Barbara.

What are the patterns of reproductive activities of relatively small males under intense sexual selection? Small males may 1) defer reproduction or 2) adopt mating behavior that differs from that of large males. If small males 3) engage in reproductive activities like that of large males, they may a) gain relatively low RS (reproductive success), or b) gain no RS. Case 3b is of interest because it depicts high costs and no apparent benefits. For example, among some protogynous reef fishes, sexually active females change sex and initiate reproductive behavior similar to that of large males. Contest competition for female mates is extreme and individuals accrue little or no RS for relatively long time periods after changing sex. If male mating success requires some experience as a sexually active small male, then the reproductive benefit of this activity may outweigh its cost in terms of lost RS. When experience plays an important role determining male mating success, the onset of male reproductive activities should tend to occur earlier as the intensity of mate competition increases.

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FURTHER EVIDENCE OF THE NORADRENERGIC INVOLVEMENT IN THE HYPOTHALAMIC CONTROL OF GROWTH HORMONE (GH) AND LUTEINIZING HORMONE (LH) IN THE DOMESTIC FOWL. F.C. Buonomo and C.G. Scanes. Rutgers Univ. New Brunswick, N.J.

Evidence exists in mammals and birds to suggest that norepinephrine (NE) is involved in the hypothalamic control of LH and GH secretion. A neuropharmacological approach has been utilized to provide further evidence of NE involvement in the hypothalamic regulation of LH and GH secretion in the domestic fowl. Six week old male chicks exposed to a long photoperiod (16L:8D) were used. Drugs were injected intraperitoneally and plasma levels of LH and GH were measured by homologous radioimmunoassay. NE appears to be involved in the hypothalamic stimulation of both LH and GH secretion. Selective inhibition of NE synthesis or activity by DDC, FLA 63 or phenoxybenzamine ( $\alpha_1$  antagonist) depressed plasma concentrations of both LH and GH. Activation of the  $\alpha_1$  adrenergic system by phenylephrine elevated circulating GH and LH levels. However, clonidine ( $\alpha_2$  agonist) stimulated LH release but inhibited that of GH. (Supported by the NJSES and NSF (PCM 8022727)).

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IMMUNOHISTOCHEMICAL LOCALIZATION OF PITUITARY CELLS IN A JUVENILE OSTEOGLOSSID TELEOST, THE AROWANA. S. Holtzman, O. Gona\*, H. Margolis-Kazan, J.P. Stone, and M.P. Schreibman. Brookhaven Nat'l. Lab., Upton, N.Y., New Jersey Coll. of Med. and Dent., Newark, and Brooklyn Coll., N.Y.

Alternate slides containing serial paraffin sections of hypophyses from 2 Osteoglossum bicirrhosum, were subjected to either polychrome staining or immunoreactions for hypophysial hormones. The gland is compact and shaped like a dorsoventrally flattened spindle, with the pars intermedia (P.I.) at its caudal end. A thin vascular bed separates the dorsal surface of the pars distalis (P.D.) from the anterior infundibulum which runs caudally to contribute to the pars nervosa. The pars nervosa interdigitates with the P.I. only. Zonation of the P.D. is by graded concentration of cell types. Cells were localized with hormone antisera as follows: tilapia GH and human TSH, caudal P.D.; carp GTH $\beta$ , ventral P.D.; human ACTH, dorsal P.D., and P.I.; synthetic  $\alpha$ MSH, P.I. only (same cells as anti-ACTH). The general morphology of the neurohypophysial complex suggests a retention of primitive features of teleostean evolution. Support by the U.S. Dept. Energy Cont. DE-AC02-76CH00016.

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IMMUNOCYTOCHEMICAL LOCALIZATION OF LUTEINIZING HORMONE-RELEASING HORMONE (LHRH) IN PREPUBERTAL AND PUBERTAL PLATYFISH (Xiphophorus maculatus). Leslie R. Halpern-Sebold, and Martin P. Schreibman. Biology, Brooklyn College, N.Y. 11210.

Immunoreactive (ir-) LHRH has been localized in perikarya and neuronal processes of the NPP and NLT and in the caudal pars distalis (CPD) and pars intermedia (PI) of sexually mature platyfish (Schreibman et al., 1979). In neonatal fish, ir-LHRH has been demonstrated in the CPD and PI but not in the brain (Schreibman et al., 1980). In the current study, ir-LHRH is first observed in the brain in fibers of the NPP and NLT of early maturing fish at about 5 weeks of age (immature). These ir-fibers become more numerous as fish approach puberty. At the onset of sexual maturation (puberty), ir-LHRH is also localized in the perikarya. Thus the development of LHRH synthesizing centers in the brain precedes the maturation of the gonadotropic zone and subsequent gonad maturation in platyfish. This sequence of observations is similar, although more protracted, in later-maturing genotypes. (Supported by N.S.F. grant #PCM 77-15981).

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PITUITARIES AND TESTES OF AGED PLATYFISH (Xiphophorus maculatus). Henrietta Margolis-Kazan, Martin P. Schreibman, Judith L. Bloom, and \*K. D. Kallman. Department of Biology, Brooklyn College, Brooklyn, N. Y. and \*N. Y. Aquarium, Brooklyn, N. Y.

Immunocytochemical and/or histological studies were performed on pituitaries and testes of old (2.5 to 4.2 yrs) platyfish (average life span 2.5 yrs) which had been fixed and stored in formalin for up to 8 yrs. Immunoreactive (ir-) gonadotropin (GTH) and luteinizing hormone-releasing hormone (LHRH) had the same cellular distribution in these pituitaries as seen in all sexually mature male fish. The testes of old fish contained all stages of spermatogenesis. There was an apparent increase in the intertubular connective tissue with age and the pattern of organization of the seminiferous acini and spermatozeugmata differed from that found in younger, sexually mature fish. Thus it appears that the potential for GTH and LHRH production and for spermatogenesis persists even in very old male platyfish. (Supported by N.I.A., grant #R01AGO1938)

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SEASONAL VARIATIONS IN REPRODUCTIVE PARAMETERS OF MALE NEOTENIC AMBYSTOMA TIGRINUM. D. O. Norris, M. F. Norman and D. Duvall. University of Colorado, Boulder.

Reproductive parameters were monitored on a monthly basis for a natural pond population of male neotenic tiger salamanders. Regressed testes begin to increase in weight during June and reach maximum size in early August after which spermatozoa are shed and begin to accumulate in the vasa deferentia. Development of new cysts and spermatogonial proliferation occurs in Apr-May, but meiosis does not ensue until late June-July. Mature spermatozoa appear in July-Aug. Following breeding (Feb-May) the cloacal glands (produce spermatophore) regress (May-Jun) to a minimum (Jul) and then slowly redevelop to a maximum at breeding. Vasa deferentia exhibit a parallel cycle to the cloaca. Fat body development is correlated with testis weight and food availability. These data suggest LH-like gonadotropin increases in mid-summer and release is inhibited following breeding. Release of FSH-like gonadotropin may be confined to the immediate post-reproductive period (Apr-Jun). (Supported by PCM 78-22335)

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AMPHIBIAN SEXUAL BEHAVIOR:  
CORTICOSTERONE OPPOSES STIMULATORY  
EFFECT OF ACTH. Larry J. Miller and  
Frank L. Moore. Oregon State Univ.,  
Corvallis.

Observations that stress sometimes inhibits sexual behaviors (amplectic clasps) in male newts (Taricha granulosa) led to experiments with corticosterone (CS) and ACTH. An ip injection of 25 µg CS totally suppresses clasping; an ip injection of 25 µg ACTH suppresses clasping by only 42%. To investigate a brain effect, ACTH was injected into the third ventricle (icv). For males pretested as sexually active, 0% exhibited clasping after an icv injection of saline (stress?), and 100% exhibited clasping after an icv injection of ACTH (0.1 or 10 ng). The stimulatory effect of ACTH on sexual behavior is at the level of the brain and not the adrenal cortex, as evidenced by the high potency of icv injections of ACTH. Additional evidence is that icv injections of ACTH 4-10, a fragment of ACTH lacking adrenocorticotrophic activity, gave results similar to icv ACTH. Based on these studies, we propose that CS can inhibit and ACTH can enhance sexual behaviors in male newts.

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EFFECTS OF SEX HORMONES ON HIBERNATION IN  
MESOCRICETUS AURATUS AND CRICETUS CRICETUS.  
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Experimental Biology, Shrewsbury, MA 01545.

The effect of gonadal hormones on hibernation was examined in 2 hamster species. In M. brandti hibernation did not occur if serum androgen levels were artificially maintained at approximately "breeding season" concentrations. The duration of hibernation could be prolonged by at least 2 months by castration (7/8 castrates hibernated for more than 240 days; 2/8 intact males still hibernating after 210 days). Estrogen had a less marked effect and ovariectomy did not alter the pattern of hibernation. In Cricetus estradiol effectively inhibited hibernation (1/9 estradiol-implanted animals hibernated normally vs 7/9 blank-implanted females). Both species are photoperiodic, undergoing gonadal regression during exposure to a short day photoperiod. These observations suggest that the annual cycles of reproduction and hibernation may be partially coordinated via the effects of seasonal fluctuations in sex hormones. This might provide a mechanism for maximizing reproductive potential, since rising levels of sex hormones in the spring would result in termination of hibernation at the time when the gonads were just reaching competency for breeding.

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OCCURRENCE OF HEMOGLOBIN IN GASTROTRICHA.  
D.W. Kraus\*, P.B. Travis\*, J.M. Colacino\*  
and E.E. Ruppert. Clemson Univ.

The marine gastrotrichs, Neodasys and Turbanella, are small (50 µm x 600 µm) wormlike inhabitants of intertidal beaches. Both animals have numerous 10 µm diam. mesodermally-derived cells (Y-cells) situated in two dorsolateral rows adjacent to the gut and intimately associated with the nerve and muscle cells. The Y-cells appear blood red in Neodasys, but colorless in Turbanella. Absorption spectra of single Y-cells were obtained with a microspectrophotometer. Hemoglobin could not be detected in Turbanella, but was positively identified in Neodasys Y-cells. Intracellular heme concentration was computed to be 18.5 mM. Hemoglobin could provide an O<sub>2</sub> store and/or augmented O<sub>2</sub> transport. We calculated, however, that the Y-cells, which occupy 14% of the body volume, would give less than 4 min of O<sub>2</sub> reserve if the O<sub>2</sub> consumption rate of Neodasys was similar to that of other animals of the same size. The differences between Neodasys and Turbanella with respect to hemoglobin containment may be due to unknown differences in microhabitat or behavior. (Supported in part by NSF grant DEB-7823395)

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O<sub>2</sub>-BINDING PROPERTIES OF HEMOGLOBIN OF  
ARTEMIA SALINA FROM HIGH SULFATE LAKES.

B. J. Davis and A. E. Riggs. San Francisco State Univ., Ca. and Univ. of Texas, Austin.

The extracellular hemoglobins of Artemia salina are essential for survival under low oxygen conditions. Previous studies by D'Hondt *et al.* (Biochem. J. 171: 705-710, 1978) showed that the three unique hemoglobins of shrimp from high chloride salterns have different O<sub>2</sub>-binding properties but no effect of 1M NaCl was found. We isolated Hb-II from a population of shrimp found in high sulfate lakes. The crude hemolymph, obtained in the presence of phenylmethylsulfonyl fluoride and soybean trypsin inhibitor, was precipitated with polyethylene glycol, and chromatographed successively on Agarose and DEAE Sephadex. This Hb-II is functionally similar to that isolated from populations in high chloride salterns. Although high chloride was without effect, 0.5M sulfate increases the P<sub>50</sub> value from 3.7 to 5.1 mmHg at 20°C. These measurements were made with a thin film technique developed by Dolman and Gill (Anal. Biochem. 87: 127-134, 1978). This research was supported by NSF Grant PCM-7904053.



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COLLOID OSMOTIC PRESSURE AND THE CAPACITY FOR HEMOCYANIN-OXYGEN TRANSPORT. C.P. Mangum and G.K. Snyder, Col. William & Mary and Univ. Colorado, Boulder.

Because the hemocyanins (Hcs) are extracellular, they generate a colloid osmotic pressure (COP) and thus influence the distribution of water between extra- and intracellular fluid compartments. In each of the three Hc-containing taxa the COP of the native polymer rises exponentially with concentration within the *in vivo* range. In the crustacean *Callinectes* and the chelicerate *Limulus*, Hc COP nearly equals the average hydrostatic pressure in the blood, suggesting that O<sub>2</sub> carrying capacity is limited by this relationship. Dissociation of the native polymers into their smallest functional subunits results in 5-10 fold increases in COP; thus the advantages of assembling the functional units into large aggregates are clear. In the gastropod *Busycon*, however, the retention of the fluid skeleton is accompanied by much higher hydrostatic pressures and polymerization is greater than in the arthropods. In this case COP is much smaller than hydrostatic pressure, and it neither limits O<sub>2</sub> carrying capacity nor explains why the functional units are assembled into the giant among the O<sub>2</sub> carriers.

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OXYGEN TRANSPORT BY HEMOCYANINS AND ITS RELATION TO BLOOD VISCOSITY. G.K. Snyder and C.P. Mangum, University of Colorado, Boulder & College of William and Mary.

Solutions prepared from the native molecules (N), or their subunits (S), of the hemocyanins (Hcs) found in the chelicerate *Limulus* and the gastropod *Busycon* have viscosities ( $\eta$ ) which increase exponentially with concentration (C). In addition,  $\eta$  for the S are consistently higher than those for N. The potential for O<sub>2</sub> transport (OT), the ratio of O<sub>2</sub> capacity and  $\eta$ , is more complex. For N, initially, OT increases dramatically as C increases, but reaches a peak at approximately 9 g/100 ml for *Busycon* and 11 g/100 ml for *Limulus*, and decreases as C is raised above these values. The OT for S is lower than for N in proportion their higher  $\eta$ . Thus, the extent to which Hcs augment OT is inversely related to the contribution that the pigment makes to  $\eta$ , and the presence of the Hcs in the highly polymerized form of N, over S, is clearly advantageous due to their markedly lower  $\eta$ . The data are consistent with the argument that subunit aggregation which results in the high MWs typical of the extracellular respiratory pigments found in the invertebrates is an evolutionary strategy to minimize the viscosity effects of these oxygen-carrier molecules.

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THE CONFLICT BETWEEN RESPIRATORY AND OSMOREGULATORY FUNCTIONS OF HAEMOCYANIN IN A EURYHALINE CRAYFISH DURING HYPERSALINE EXPOSURE. M.G. Wheatly and B.R. McMahon, Univ. of Calgary, Alta.

The euryhaline species *Pacifastacus leniusculus* which extends into brackish water tolerates salinity stress by hyper/hypo osmotic/ionic regulation of the ECF. Intracellular isosmotic regulation in decapods involves variation in the free amino acid pool (FAA). Measurement of circulating protein, FAA and NH<sub>4</sub><sup>+</sup> demonstrated that in hypersalinity (25/50/75% SW), in addition to *de novo* synthesis by reductive amination, the increase in FAA was due to haemolymph protein degradation, mainly haemocyanin (HCy). In consequence O<sub>2</sub> carrying capacity was reduced, but combining characteristics were altered and so transport unimpaired. Despite reduced tensions and contents, delivery was maintained by an increase in affinity and depletion of the venous reserve increasing the role of HCy in O<sub>2</sub> carriage and release. An accompanying acidosis was insufficiently large to offset the salt effect on affinity. Binding was amplified *in vitro*. Hypersalinity increased cooperativity and affinity whose pH dependence was unaffected. Dialysis techniques demonstrated that these changes were attributable to unidentified co-factor(s) in addition to altered ionic levels. (NSERC grant # A5762).

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LACTIC ACID AS AN ALLOSTERIC MODIFIER OF THE OXYGEN AFFINITY OF BLUE CRAB HEMOCYANIN. B.A. JOHNSON and D.J. BECKER.\* Duke University Marine Laboratory, Beaufort, N.C.

The effect of l-lactate on the oxygen affinity of hemocyanin from the blue crab, *Callinectes sapidus*, was investigated using tonometric methods. Log P<sub>50</sub> of the hemocyanin is decreased 0.25 units by the addition of 10 mM lactate over the pH range 7.5 to 8.0. The lactate effect and the Bohr effect ( $\Delta \log P_{50} / \Delta pH = -1.2$ ) are independent of each other over this pH range. Increased oxygen affinity resulting from lactate addition is greatest at physiological lactate concentrations. Estimates of *in-vivo* oxygen affinity of blue crab blood thus requires knowledge of both lactate and proton concentrations. A preliminary analysis indicates that the results can be explained by a preferential binding of lactate to the oxy-conformation of the hemocyanin, a result in direct contrast to the mechanism of most other allosteric modifiers of oxygen transport proteins.

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## NEW METHOD FOR DETERMINATION OF CONTINUOUS OXYGEN DISSOCIATION CURVES.

M. C. BARNHART. University of California, Los Angeles.

A non-spectrophotometric technique for the measurement of total oxygen capacitance of whole blood or hemolymph is described. Fractional pigment oxygenation and blood oxygen capacity can be derived from the oxygen capacitance curve. The method is based on a single  $P_{O_2}$  electrode and does not require mixing or adulteration of the blood samples. Minimum sample volume is 120 microliters.

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Epithelial-Mesenchymal Interactions In Vertebrate Secondary Palate Development. M.W.J. Ferguson\*, L.S. Honig, P. Bringas\*, and H.C. Slavkin, Anat. Dept., Queen's Univ. Belfast and Lab. Develop. Biol., Univ. Southern California.

When bilateral palatal shelves approximate, their medial edge epithelial cells (MEE) undergo terminal differentiation. In mice MEE fuse & die. In alligators MEE develop numerous microvilli, fuse and migrate from the epithelial seam. In chicks MEE contact each other, neither fuse nor die, but keratinize. We cultured 130 shelf explants (singly & in contact) from embryonic mice (days 12-14) chicks (days 7-9) & alligators (days 18-23) for 2,3,5 & 7 days. Assays for MEE differentiation included vital staining, LM, SEM & TEM. Differentiation of MEE was always identical to that in vivo. Homotypic, heterotypic, homochronic & heterochronic recombinations of palatal epithelium & mesenchyme from mice, chicks & alligators were performed (N=204). Terminal differentiation of MEE was always characteristic of the species from which the mesenchyme originated & independent of epithelial origin. Terminal differentiation of vertebrate palatal MEE is apparently regulated by regional mesenchymal specificity. Supported by grants from The Wellcome Trust, \*IRC(GB) no. G979/386/C, & NIH, #DF-02848.

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INFLUENCE OF REGENERATING TADPOLE LIMB BLASTEMA ON NERVE FIBER GROWTH IN VITRO. M. RICHMOND\* and E.D. POLLACK. Univ. of Illinois, Chicago.

Limb target tissues exert growth influences on elongating spinal nerve fibers *in vitro* (Pollack, et al., '81). Furthermore, developing limbs act optimally when they are largely mesenchymal, both *in vitro* and *in vivo* (Pollack and Richmond, '81). Regenerating limb tissue of R. pi-piens larvae, also mesenchymal, has now been shown to have similar growth effects on spinal nerve fibers in tissue culture, and may serve to explain nerve invasion into regenerating limb tissue. Stage V (Taylor-Kollros, '46) spinal cord explants co-cultured with blastemas of limbs amputated at stages V, IX or XI resulted in a 10-fold increase in nerve fiber outgrowth over control cords. Significantly less outgrowth occurred in the presence of blastemas from older stages when the limb fails to regenerate. Co-cultures of cord/blastemas at varied stages support the notion that blastemal growth influences are limited to stages at which regeneration normally occurs. This study provides additional evidence that limb mesenchyme plays a role in nerve growth, and may be a requirement in the regeneration process. (Supported by NIH grant NS 13814)

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BIOCHEMICAL AND IMMUNOHISTOCHEMICAL LOCALIZATION OF  $\alpha$ - AND  $\beta$ -KERATIN IN AVIAN SCUTATE SCALES. W.M. O'Guin\* and R.H. Sawyer University of South Carolina, Columbia.

Histological, fine-structural and X-ray diffraction studies have demonstrated the presence of only  $\beta$ -type keratin in the outer epidermal surface of avian scutate scales. Alpha keratin was found exclusively in the epidermis of the inner scale surface and hinge region. Here we have reexamined the distribution of  $\alpha$  and  $\beta$  keratins in scutate scales using SDS-PAGE and indirect immunofluorescence with non-cross reacting rabbit antisera which we prepared to both  $\alpha$  and  $\beta$  keratins. Contrary to the previous studies, we find  $\alpha$  keratin in the outer scale surface. In fact, all six  $\alpha$ -keratin polypeptides found in the whole scale epidermis are also present in epidermis taken exclusively from the outer scale surface. Three of these polypeptides demonstrate a specific enrichment when compared to the polypeptides of the entire scale epidermis. Immunofluorescent studies show that the  $\alpha$ -keratins present in the outer scale surface are restricted to the Stratum Basale and Stratum Intermedium while the  $\beta$ -keratins are localized in the Stratum Intermedium and Stratum Corneum. (Supported by NSF Grant #PCM-8011745.)

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## PROXIMODISTAL SPREADING OF LIMB-BUD AND FLANK MESODERM ON LIMB-BUD ECTODERM.

H. M. Phillips. Univ. of Texas, Arlington.

As chick limbs first emerge, limb-bud and adjacent flank mesoderm can adhere and spread on each other without intermixing. What morphogenetic mechanisms keep these two distinct, mobile cell populations appropriately positioned beneath limb and flank ectoderm? In competitive spreading experiments, pairs of tritium-labelled limb-bud and unlabelled flank cell aggregates from stage 19-20 chick embryos were sandwiched together within excised jackets of limb-bud ectoderm in random orientations. Autoradiographed serial sections revealed that, during organ culturing, the limb-bud mesoderm became localized closest to, and the flank mesoderm furthest from, the apical ectodermal ridge, with no signs of *de novo* ridge induction. This preferential distal spreading of limb-bud mesoderm plus proximal spreading of flank mesoderm on the inner surface of limb-bud ectoderm may be responsible for the correct distribution of these tissues during *in vivo* limb budding. (Supported by N.S.F. grant PMC 78-05903.)

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## LOCALIZATION OF FIBRONECTIN DURING NORMAL AND ABNORMAL FEATHER MORPHOGENESIS.

A.R. Haake\* and R.H. Sawyer  
University of South Carolina, Columbia.

The avian mutant, scaleless, undergoes abnormal morphogenesis of its feathers. Since fibronectin (FN) is proposed to play a role in morphogenesis, we have examined the distribution of FN during normal and abnormal feather morphogenesis. Indirect immunofluorescent and immunoelectron microscopic techniques were used to localize the FN. Fibronectin is present along the basement membrane of both normal and scaleless backskin. However, major differences are seen in the dermis when comparing normal and scaleless backskins. In normal feather morphogenesis, anchor filaments, continuous with the basement membrane, extend deep into the dermis. These anchor filaments give intense fluorescence with anti-FN antibody. They are more prominent beneath epidermal placodes than in interplacode regions, and are not present beneath the epidermis of elevated feather germs. Although present in mutant backskin, which lacks placodes and dermal condensations, the anchor filaments occur in a more random distribution. Possibly these FN-associated anchor filaments play a role in organization of the feather germ. (Supported by ACS Grant #IN-107F and NSF Grant #PCM-8011745).

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## KERATINIZATION IN AGGREGATES OF DISSOCIATED NORMAL AND SCALELESS EMBRYONIC SKIN.

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University of South Carolina, Columbia.

Regional differences in the types of  $\alpha$ - and/or  $\beta$ -keratins synthesized in avian skin result from specific tissue interactions between embryonic epidermis and dermis. The morphogenetic and biosynthetic capacity of dissociated skin cells is analyzed by immunofluorescence using anti- $\alpha$  and anti- $\beta$ -keratin antisera. Results show that cellular aggregates of scaleless or normal skin reorganize into epidermal structures which synthesize both  $\alpha$ - and  $\beta$ -keratins. The  $\alpha$ -keratins predominate in aggregates of skin cells derived from scale and feather forming regions of both mutant and normal embryos, while  $\beta$ -keratins are only found in subepidermal cells. The reestablishment of epidermal differentiation in aggregates derived from genotypically, regionally or temporally diverse epidermal and dermal cell population allows us to analyze the role of tissue-specific cell interactions in the regulation of regional differences in  $\alpha$ - and  $\beta$ -keratin synthesis *in vitro*. (Supported by NSF PCM-8011745 to RHS and NIH Biomedical Research Support Grant 2 S07 RR07160 to LWK.)

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## HISTORICAL INDICATIONS OF EPITHELIAL-MESENCHYMAL INTERACTIONS IN FISH SKIN AND SCALE DEVELOPMENT.

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Current anatomical orthodoxy accepts the mesodermal origin of fish scales. Until the mid-nineteenth century, however, most anatomists and naturalists held firmly to the Aristotelian belief that fish scales were homologous to feathers and hair. Perhaps because of an early linkage with tooth development, fish skin and scale literature has been isolated from that of other vertebrate integumental derivatives. In this report, the author summarizes the histological understanding of lepidogenesis and reviews the early literature which gave rise to the traditional view. In light of our current knowledge of tissue interactions, special consideration is given the work of those few early researchers who either supported or supposed an ectodermal origin or contribution during fish scale development. Their work is interpreted as being highly suggestive of the occurrence of epithelial-mesenchymal interactions in fish skin development. Examples of photographs, drawings, and statements taken from traditional and dissident sources are utilized to support this view.

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Fisher, C.J. and R.H. Sawyer. Vassar College and U. of S. Carolina. EFFECT OF VITAMIN A (RETINOIC ACID) ON CHICK SCALE DEVELOPMENT IN OVUM.

Skin grafts of chick metatarsal foot pad (MFP) were grown in chambers on the CAM of host chick embryos. Development of MFP grafts treated with Vit. A was stage and dose dependent: 25-50 µg of Vit. A on day 10, 11 and 12 caused grafts to become stunted by day 14 and to disintegrate by day 19. Host CAM invaded the chamber and covered atrophied metatarsal cartilages. One to 10 µg caused erosion of the surface epithelium with less effect on tissue deep within the graft. Using dimethyl sulfoxide-100% ROH as a diluent, low doses of Vit. A (10-20 ng) prior to reticulate scale formation caused formation of feathers on chick scale epidermis (ptilopody). In sham-injected control grafts, normal scale formation and ossification of metatarsal cartilages occurred. Graft autolysis may result from labilization of lysosomal membranes by high doses of Vit. A, whereas low doses of Vit. A may act as a mitogen, causing ptilopody.

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IN VITRO GROWTH AND UPTAKE OF VITELLIN BY NEREIS OOCYTES. A. E. HEACOX and A. FISCHER. University of Cologne, West Germany.

Oogenesis in nereid annelids takes place while oocytes are floating in the coelomic cavity, free of direct contact with other maternal tissue. This solitary development is somewhat unusual and Nereis oocytes were thought to autotrophize all of the material needed for their growth and development. Recently this laboratory found a vitellin-like antigen in the coelomic fluid of vitellogenic females indicating a possible exogenous source of yolk protein. In order to test the possible utilization of this extracellular protein by the oocytes an in vitro system, which could maintain growing oocytes for several weeks, was designed. This culture system was then used to test the uptake of I-125 labeled vitellin. Our results indicate that vitellin is necessary for normal growth of cultured oocytes and labeled vitellin is preferentially bound to and incorporated by oocytes.

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ULTRASTRUCTURE OF THE OVARY IN THE POLYCHAETE CAPITELLA JONESI. K.J. Eckelbarger and J.P. Grassle. Harbor Branch Foundation, Fort Pierce, FL and Marine Biological Lab, Woods Hole, MA.

The ovaries are paired, sac-like follicles suspended by mesenteries in the ventral coelom throughout the midbody region of the mature worm. Oogenesis occurs entirely within the ovary which is divided into germinal and growth regions. Follicle cells envelope the oocytes in the germinal zone and undergo hypertrophy and ultrastructural changes correlated with the onset of vitellogenesis. Evidence is presented which implicates the follicle cells in the synthesis of yolk precursors for transport to the oocytes. At ovulation, mature oocytes are released from the ovary after overlying follicle cells withdraw. The process is mediated possibly by microfilaments. The ovary of Capitella is compared with those of other polychaetes. A possible scheme for the evolution of ovaries in the Polychaeta is presented.

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FINE STRUCTURE OF THE BROODING APPARATUS IN THE ARCHIANNELED MESONERILLA INTERMEDIA. M.E. Fransen, Harbor Branch Institution, Inc., Fort Pierce, FL.

A study was undertaken to discover how brooded embryos are attached to the maternal body. The brooding hood consists of two layers of epidermal epithelium. Cells of the upper layer are cuboidal, more numerous, and have a thicker cuticle than the flatter cells of the lower layer. The brooding hood is protective, but does not attach to embryos. This function is carried out by specialized maternal cells of the dorsal epidermis beneath the hood. These cells are rich in tonofilaments that are connected to the basal lamina and extend, as a group, to the cellular apex. At the apex, the maternal cuticle is absent, permitting direct attachment of cell processes to the cuticle of the embryo. This is the first detailed report of such connections in polychaetes.

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LARVAL ENERGETICS OF THE SPIONID POLYCHAETE *POLYDORA WEBSTERI*. R.L. DAY. Brigham Young University-Hawaii Campus, Laie, Hawaii.

The ability of the larvae of *Polydora websteri* to acquire energy in the form of energy rich biochemical compounds was assessed. Larvae obtained from oyster shell collected in Tampa Bay, Tampa, Florida were cultured through metamorphosis. Larvae cultured under optimum conditions accumulated lipids during development which decreased significantly at metamorphosis. The greatest loss of lipids was due to the neutral lipid fraction. Larvae which were forced to delay metamorphosis due to lack of a suitable substratum were found to maintain high lipid levels during the extended larval period. Larvae raised under sub-optimum conditions accumulated lipids at a much slower rate and had lower survival rates at metamorphosis.

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FEEDING BEHAVIOR AND INGESTION RATE IN THE POLYCHAETE, *SCOLOPLOS FRAGILIS*. B. Brown. Univ. of Delaware, Lewes.

Feeding behavior and ingestion rate in the deposit-feeding polychaete, *Scoloplos fragilis*, have been studied. Feeding behavior was observed using a Plexiglas view chamber (30x25x6cm) open at the top. Sediments were placed 20 cm deep in the chamber. Worms were then placed in the chamber and allowed to burrow into the sediments. Next, a 1-mm thick layer of carborundum particles was placed on the sediment surface. Change in the sediment surface was monitored. *S. fragilis* produces unconsolidated fecal piles around its burrow opening by depositing 1-2 grains at a time. Fecal piles are not of uniform size. At natural densities, 1.44 ml of sediment/m<sup>2</sup>·day<sup>-1</sup> per worm was deposited on the sediment surface, a rate equivalent to reworking rates of other small polychaetes and bivalves. Worm burrows often contained carborundum while adjacent sediments did not, suggesting either a) the worms actively pull the sediments into the burrow or b) the sediments fall passively into the burrow openings. Ingestion rate (dpm/worm·min<sup>-1</sup>) was determined by labelling sediment bacteria with <sup>14</sup>C-labelled amino acids.

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DEPOSIT-FEEDING BY *ABARENICOLA PACIFICA* (POLYCHAETA: ARENICOLIDAE) FROM ALASKA. J.D. Kudenov, Univ. of Alaska, Anchorage.

The deposit-feeding process of *Abarenicola pacifica* is described in terms of proboscideal morphology and function. The proboscis resembles that described for other arenicolids in being axial, thin-walled, and in having a coarsely papillate buccal mass and a non-ciliated pharynx. *A. pacifica* relies primarily on the mechanical action of papillae, burrow occlusion by both the proboscis and body, drag action, a momentary cessation of the irrigation current, and a decreased dilatancy of head pocket sediments. Intraspecific food-resource partitioning, based on the differential development of papillae, depth of head shaft, and particle size differences in fecal sediments, may be present. The same basic feeding mechanism described here for *A. pacifica* is also present in some maldanid polychaetes. However, arenicolids lack pharyngeal ciliary sorting fields typical of maldanids, and must rely heavily on pharyngeal papillae for sediment compaction, selection and ingestion. It is suggested that arenicolid feeding mechanisms may be more primitive generally than those exhibited by many species of maldanids. (Supported by a Univ. of Alaska, Anchorage, Summer Research Grant.)

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STANDARDIZATION OF IDENTIFICATIONS OF BENTHIC POLYCHAETOUS ANNELIDS FROM THE GULF OF MEXICO OUTER CONTINENTAL SHELF. P. G. JOHNSON. BARRY A. VITTOR & ASSOC., INC., MOBILE, ALABAMA.

A manual is in preparation, concerning the identification and distribution of polychaetes collected on the outer continental shelf of the Gulf of Mexico as part of the Bureau of Land Management's environmental baseline and monitoring studies. This publication will provide taxonomic keys and descriptions for over 600 species of polychaetes, representing 296 genera in 58 families. Illustrations of diagnostic features, distributional maps and habitat information for each species will be provided. An introductory section describes the geographical setting, materials and methodologies, terminology and techniques used in polychaete identifications, and general information on the biology, ecology and zoogeography of Gulf polychaetes. Intended to document and expedite the identification of the diverse, and often unique polychaete fauna of the Gulf of Mexico, this publication will provide a common, comparable taxonomic basis for future benthic macroinfaunal investigations.

STANDARDIZED TERMINOLOGY FOR CRUSTACEA.  
*Z. Zo.* Normandeau Associates, Inc.  
Richardson, Texas.

Alphanumeric expression of crustacean body parts is suggested as a standardized terminology for Crustacea. Abbreviations utilizing the first letter or syllable of the body part names followed by the number for the quantity or location of body parts (or segments) are the base of alphanumeric words. Most of the anatomical terms and a few common descriptive words such as length or width are abbreviated. The alphanumeric expression for body parts are done by progressing from larger anatomical features to smaller ones and using capital letters for all body parts (including a few frequently used words), e.g., "3rd segment of 2nd leg" becomes "P2EN3".

A table of alphanumeric words for crustacean terminology is presented in this paper. The results suggest that alphanumeric words reduce the descriptive parts of taxonomic literature, particularly in taxonomic keys and figure labels. Laboratory efforts are facilitated by the condensation and simplification of detailed descriptive information.

MORPHOLOGICAL VARIATION IN CLONES OF THE CHYDORID CLADOCERAN *EURYCERCUS* SP. F. F. Burchsted. Texas Memorial Museum, Austin.

Variation in 11 meristic and 3 metric morphological traits was examined in 4 laboratory-raised clones of the chydorid cladoceran *Eurycercus* sp. from Dane Co., WI. Since the 4 clones were produced under similar environmental conditions, within-clone variation is nongenetic while differences among clones reflect genetic variation. Coefficients of variation and bilateral correlation coefficients (measuring fluctuating asymmetry, a measure of developmental instability) were analysed using variability profiles and Kendall's Coefficient of Concordance. Different clones show different levels of variability over all the characters, i.e., the variability profiles for the 4 clones are distinct and generally parallel. The results of fluctuating asymmetry analysis were analogous to those for the coefficients of variation: Kendall's coefficient indicated significant concordance of the traits among clones. These results are discussed in relation to experimental work on *Drosophila* which suggests that developmental stability is related to level of heterozygosity and to genetic coadaptation.

THE STRUCTURE AND MOTOR INNERVATION OF THE EYE OF *DAPHNIA MAGNA*. T.R. Consi, G.M. Brody\* and E.R. Macagno\*. Columbia University, N.Y., N.Y.

Three pairs of muscles (dorsal, lateral and ventral) rotate the compound eye of *Daphnia magna*. Each dorsal and ventral muscle is composed of two muscle fibers (2-3  $\mu$ m dia.) and is innervated by two motor axons. Three thinner muscle fibers (0.5-1  $\mu$ m dia.), innervated by one motor axon, comprise each lateral muscle. Motor axons and muscle fibers run in parallel in close apposition. Both extend short processes which contact one another. In these regions of contact numerous chemical synaptic sites are identified morphologically with the electron microscope. The motor neuron cell bodies were identified by tracing their axons from the eye muscles into the central nervous system using serial electron micrographs. The five motor axons on each side of the animal enter the medulla where they form a fiber tract which runs posteriorly along the lateral edge of the medullary connective and into the supraesophageal ganglion. The cell bodies are clustered dorsally on either side of the protocerebrum, ipsilateral to the muscles they innervate.

CUTICULAR MICROSTRUCTURE IN THE AMPHIPOD SUPERFAMILY TALITROIDEA. H. Holman. Ira C. Darling Center, Univ. of Maine, Walpole.

A survey of the cuticular microstructures of selected members of the Hyalidae and Talitridae is given in an effort to assess their variability across familial lines as well as that due to differing habitats (terrestrial or semi-terrestrial vs. littoral). Overall, the micromorphology of both families appears highly conservative and includes features observed in other unrelated families. The more terrestrial species examined, however, show a reduction in the number of certain, presumably current-detecting, receptors per somite. These receptors are predicted, nevertheless, as being present on all amphipods. Some structures which are conservative across these familial boundaries are not conservative at the generic level in other families. Speculation as to which features may prove useful for higher level systematics and phylogenetic investigations within the Amphipoda is presented.

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FUNCTIONAL MORPHOLOGY OF LOCOMOTION IN *DEROCHEILOCARIS TYPICA* (CRUSTACEA, MYSTACOCARIDA). J. Lombardi and E.E. Ruppert. Clemson University, Clemson, SC.

The crustacean class Mystacocarida is restricted to the interstitial marine sand environment. A cinemicrographic analysis of locomotion in *D. typica* was undertaken to expose how this species progresses through the interstitial spaces. Locomotion is dependent on dorsal and ventral substrates. The second antennae ( $A_2$ ) and mandibles (Md) are the force generating appendages. During a locomotory cycle, the exopods of the  $A_2$  and Md are directed dorsolaterally against a dorsal substrate. This creates a downward force enabling the endopods to gain purchase on the ventral substrate. The  $A_2$  and Md undergo cyclic movements. Each cycle results in two power and two recovery strokes. The animals undergo 4 cycles per second. The maximum calculated rate of locomotion is 420  $\mu\text{m/s}$ . The measured rate under test conditions is 250  $\mu\text{m/s}$ . A turning-escape reaction in response to air bubbles and other factors results in a  $180^\circ$  turn in a confined space within 1.5 s. These data are discussed in relation to the morphological conservatism of mystacocarids, their presumed neotenic origin and their observed migration over a tidal cycle. (Supported in part by NSF grant DEB-7823395)

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SCANNING ELECTRON MICROSCOPY OF THE MOLAR SURFACES OF THE MANDIBLES OF THE BRINE SHRIMP. Greta E. Tyson and Michael L. Sullivan\*. Electron Microscope Center, Mississippi State University.

The molar surfaces of the two mandibles of a brine shrimp are similar in size and surface structure. Each molar area has three basic regions: (1) The anteroventral region possesses complex, parallel furrows and ridges that are specializations for clasping masses of fine, particulate food; the general surface of this ridged area is flat, except at the ventral and anterior edges, where there is a fringe of long projections that probably serve to retain food in the space between the apposed mandibles. (2) The postero-dorsal region has simpler, more sparse projections and is adapted for reception of food; the general surface of this region is sloped and forms a cleft for accommodating maxillular setae that push food forward onto the mandibles. (3) The transition zone has features that are morphologically intermediate between those of the other two regions. Three types of pores, possibly openings of glands or sensilla, were found in the cuticle of the molar surface.

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MOUTHPART MORPHOLOGY AND FEEDING BEHAVIOR IN THE AMPHIPOD FAMILIES ANAMIXIDAE AND LEUCOTHOIDAE. J.D. Thomas. Newfound Harbor Marine Inst., Big Pine Key, FL.

Recent investigations of amphipod mouthpart ultrastructure and feeding behavior on two commensal amphipods, *Anamixis hansenii* and *Leucothoides pottsi*, have shown similarities in mouthpart composition and feeding strategies. *A. hansenii* has been shown for the first time to possess a full complement of mouthparts, though much reduced in size and complexity. Feeding in both species is accomplished by passive filtration and entrapment of minute food particles on a filter net of setal tufts located on the medial carpal lobes of the enlarged second gnathopods. Ascidians and sponges are the preferred hosts. Constancy of the microhabitat rather than a specific host species appears to be the major factor in host selection.

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BODY TEMPERATURE AND ENERGY BALANCE IN WANDERING GARTER SNAKES. C. R. Peterson. Washington State University, Pullman.

Mathematical models of metabolic and digestive rates were used to evaluate the effects of thermoregulatory behavior on energy balance in snakes under varying conditions of prey availability. The models were constructed with ecological and physiological data from field studies of *Thamnophis elegans vagrans* in eastern Washington and from the literature. Energetic considerations indicate that an average adult garter snake should be able to fast for over one year if it selects low temperatures (e.g.  $10^\circ\text{C}$ ), a situation that may occur during periods of low prey availability, such as droughts. When prey is readily available (e.g. during periods of amphibian metamorphoses), thermoregulation within the preferred temperature range should enable snakes to more rapidly digest prey and thus increase their chances for obtaining more energy. The rates of prey capture and processing required for the maintenance, growth, and reproduction of active snakes were also calculated.

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Ontogeny of water snake foraging ecology, H.R. Mushinsky, J.J. Hebrard, and D.S. Vodopich.\* Univ. of South Florida, Tampa, Univ. of Nairobi, Kenya and Baylor Univ., Waco, Tx.

Using an index of relative importance we analyzed the stomach contents of over 300 water snakes (*Nerodia* spp.). Ontogenetic changes in prey are most striking in *Nerodia erythrogaster* (N=44) and *N. fasciata* (N=72). Prey of these species changes from fish to frogs as the snakes approach a snout-vent length of 60 cm. *Nerodia rhombifera* (N=159) and *N. cyclopion* (N=65) eat fish throughout their life. However, as body size increases both species change portions of their diets. *Nerodia rhombifera* eats larger fish which occupy deeper water habitats when the snakes exceed 60-70 cm. *Nerodia cyclopion* preys upon centrarchid fish as its body size increases. The largest individuals are typically female which eat a different array of prey than smaller conspecific males. The data indicate a twofold significance of the liberated mandible in the feeding ecology of water snakes. This feeding adaptation is important in very young snakes and again in the large reproductive females that have different physiological needs than smaller males.

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ALLOMETRIC GROWTH OF THE SKULL OF *THAMNOPHIS ELEGANS VAGRANS*: ADAPTIVE POTENTIALS. David W. Jansen. Wash. St. Univ., Pullman.

Field studies have shown the prey preference of the wandering garter snake shifts during the ontogeny of the snake. Small snakes feed exclusively on small prey while only the largest snakes feed on the largest prey, although small prey are available to large snakes. Is this behavioral shift reflected in the cranial morphology of *T. e. vagrans*? This hypothesis was tested by measurement of 37 features for 14 skulls of the species. The presence of allometric growth was tested, multivariate techniques and morphological integration were applied to the data sets as well. The growth of major members of the skull and their relationships with other components is thus elucidated. The gape of the snake is greatly increased during ontogeny, a similar increase occurring in a number of mechanically allied bones and bony processes. The reduced morphological data have interpretable significance. More than proportionate increase in gape may be a major factor in the ability of large specimens to feed upon large, active prey items. The ecological implications of the growth and form of the skull during ontogeny are discussed. The data are also interpreted in light of questions regarding the evolution of the Caenophidia.

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DUVERNOY'S GLAND SECRETION MECHANISM IN *THAMNOPHIS SIRTALIS*. R.C. Foehring. Wash. State Univ., Pullman.

The venom glands of proteroglyph snakes are thought to have evolved from the Duvernoy's gland of colubrid ancestors. In proteroglyphs elements of the external adductor musculature have a direct association with the gland. These muscles, upon contraction, cause release of gland contents by increasing gland pressure. In *Thamnophis sirtalis*, a colubrid, there is no direct connection between Duvernoy's gland and the adductor musculature. However, the anatomical arrangement of the gland, skull, M. adductor externus superficialis, and the integument is such that contraction of this muscle may facilitate gland emptying. This hypothesis was tested by electrical stimulation of the muscle, which resulted in significantly greater release of secretion than elicited by controls. Additional experiments, testing the effects of mechanical pressure on the gland surface and electrical stimulation elsewhere on the body, were also performed. This mechanism suggests a possible early step in the evolution of a more intimate association between venom glands and adductor musculature in proteroglyph snakes.

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ELECTROMYOGRAPHY OF THE JAW MUSCULATURE OF ALLIGATOR *MISSISSIPPIENSIS*. A. B. Busbey, III. Univ. of Chicago, Chicago.

A microcomputer assisted electromyographic analysis of the jaw musculature of four alligators (.8 to 1.2 meters) was performed both to evaluate current hypotheses regarding the specific roles of various jaw muscles and to provide data for activity pattern comparisons with other reptiles.

In crocodylians oral food processing is minimal; food/prey is mainly held or crushed. Muscle activity patterns show greater correlation with prey hardness and size and bite position than with gape angle. Three electromyographically distinct feeding events are recognized, these are rapid jaw closure, holding, and crushing. Coincident depressor mandibulae and adductor activity in these akinetic reptiles during crushing suggests that similar activity patterns reported in squamates ascribed to streptostyly may be only partly correct.



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PETERSON, E.H. & M. YEOW Motorpools innervating cervical musculature in *Pseudemys scripta*. School Anatomy U. New South Wales

Movements of the cervical vertebral column play a fundamental role in postural adjustments and orientation of cranial sense organs, but few data are available on cervical spinal cord organization. We have begun to examine motor pools supplying neck musculature, using the turtle *P. scripta* as a model. Four columns of cervical motorneurons can be recognized and HRP data suggest that each supplies a distinct group of muscles. 1) Dorsal Group neurons (C1-C2) innervate superficial neck flexors. Two types of cells are labelled: large stellate cells and fusiform cells with horizontally oriented dendrites which run together in bundles, sites of potential dendrodendritic interactions between motorneurons. 2) Ventral Group neurons (C1-C8) supply dorsal musculature. Two parallel sub-columns can be recognized: muscles lying close to the midline are innervated by more dorsomedial neurons. 3) A Medial Group (C1-C8) innervates deep, prevertebral muscles. Their dendrites form bundles which extend into the lateral and ventral funiculi and cross the midline in the ventral commissure. 4) Ventrolateral Group neurons (C5-C8) were never labelled following neck injections and presumably supply forelimb musculature.

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ERECTILE TISSUE AND SMOOTH MUSCLE IN THE SNOUTS OF TURTLES, R.M. Winokur Univ. of Nevada, Las Vegas

The snout of the pitted shelled turtle, *Carettochelys insculpta* possesses a complex arrangement of smooth muscle fibers which lie in the internarial tissue. Morphological data suggests that the muscle fibers function antagonistically to a mass of cavernous tissue surrounding the nostrils. The smooth muscle pulls the medial walls of the nostrils toward each other dilating the narial openings, while the highly vascular tissue, when engorged, tends to narrow the nostril openings. There also exists a dorsal, longitudinally arranged mass of smooth muscle, the arrector rostri, which controls the precise angle of the snout in the vertical plane. The snout is highly innervated and probably acts as a mechanoreceptor during foraging. Thus the snout of *Carettochelys* is a complex organ in which the diameter of the nasal cavity and the angle of the snout with respect to the head can be minutely adjusted. *Trionyx* and other trionchids have similar muscle arrangements. Smooth muscle fibers which are probably homologous to those in *Carettochelys* and trionchids have also been observed in the snouts of *Chelodina longicollis* and *Podocnemis unifilis*.

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ALTERNATIVE CONCEPTS OF REPRODUCTIVE EFFORT, COSTS OF REPRODUCTION, AND SELECTION IN LIFE-HISTORY EVOLUTION. J. Tuomi, T. Hakala\* and E. Haukioja\*. Univ. of Turku, Turku, Finland.

Alternative logical paths for optimal reproductive tactics and five definitions of reproductive effort are compared. Reproductive effort, defined as the proportion of resources invested in reproduction, and reduced levels of somatic investment do not automatically result in survival costs. The conditions under which survival costs result as well as those under which they do not are specified. Compensation and threshold hypotheses are put forward which allow weaker correlations between reproduction and survival than does the trade-off hypothesis assuming direct impacts of effort on survival costs. Life-history theory as well as evolutionary theory in general can be developed in the original Darwinian sense along alternative logical lines depending on the role of selection as described by the three hypotheses: unconstrained and constrained optimization, and coarse filters.

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ENVIRONMENT AND THE EVOLUTION OF VARIATION IN THE LIFE CYCLE OF THE TIGER SALAMANDER. J. P. COLLINS. Arizona State University, Tempe.

Two subspecies of the tiger salamander have a distinctive polymorphic life history that can include four adult morphs as well as typical and cannibalistic larval morphs. The effect of environment on development of larval morphology was evaluated in a series of laboratory experiments. Occurrence of the cannibalistic morph was correlated with larval density and independent of two food levels; larval size and rate of development depended on food level. In natural populations cannibals are always larger than typical larvae. This relatively larger body size appears to have several advantages within the larval and early adult portions of the life cycle.

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THE ROLE OF POPULATION STRUCTURES IN THE EVOLUTION OF SOCIAL BEHAVIORS. F. Breden (intro. by R. Wassersug) Univ. of Chicago

Recent empirical and theoretical studies have shown that small amounts of within-group mating increase between-group variance and can affect the evolution of social behaviors. This contrasts with the view that small amounts of migration, or random mating, will destroy between-group differences and therefore diminish any potential for between-group selection. I have used (with M. Wade) a family-structured model to investigate the effect of inbreeding on the evolution of social behaviors by varying levels of inbreeding, number of foundresses, and number of inseminations per foundress. Small amounts of inbreeding greatly change the relative frequencies of family types, and thus can increase the relative strength of between-group selection compared to within-group selection, favoring the evolution of social behaviors. Also, literature reports on several laboratory and field populations show significant genetic differentiation among subpopulations, even with high levels of migration. Thus, empirical and theoretical results suggest that between-group selection may be important in natural populations.

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MATING BEHAVIOR IN THE GASTROPOD MOLLUSC *AEOLIDIA PAPPILLOSA*: A QUANTITATIVE DESCRIPTION. R. D. Longley and A. J. Longley (intro. by Gretchen Lambert). Pacific Sciences Institute and Friday Harbor Laboratories, Friday Harbor, WA.

Spontaneous mating in the hermaphroditic nudibranch *A. papillosa* tends to be random and non-circadian. Arousal of these animals by handling reliably elicits mating in the laboratory (90% success, n=133). Mating pairs first orient head-to-head, eventually making mouth contact. Orientation is followed by mutual alignment of the penial and vaginal openings and then reciprocal copulation. For 15 pairs in 9 trials, average times of these three behavioral segments are 14.6 min, 5.3 min, and 7.1 min, respectively. In 80% of these elicited matings, a single copulation terminated the mating behavior. In animals separated during alignment prior to copulation, a continuing sequence of orientations can be elicited, with the behavior terminating when copulation is allowed. These results suggest that the probability of mating tends to be depressed by copulation, and, after a recovery period of about 24 hours in this species, mating can be triggered again by non-specific arousal.

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THE ROLE OF THE FEMALE IN THE INITIATION OF THE REPRODUCTIVE CYCLE OF THE SNAKE, *THAMNOPHIS MELANOGASTER*. W.R. Garstka\* and D. Crews, Harvard University, Cambridge, MA

*T. melanogaster* is an abundant garter-snake found on the Mexican Plateau. Several brief, explosive breeding periods occur each year. Female *Thamnophis* possess an attractiveness pheromone related to vitellogenin, the circulating precursor of yolk. Both estrogen treatment and ad-libitum feeding result in female attractiveness and an increase in the relative weight of the liver, the site of vitellogenin synthesis. On exposure to attractive females, males immediately exhibit courtship behavior, and will court for 6-8 days, then becoming refractory. E-treated females released into a natural population can initiate a breeding period in which untreated females are also mated. Gametogenesis is of the postnuptial type and after the courtship period, serum androgens increase tenfold and testes size and spermatogenic activity peak. Thus, the male reproductive cycle depends on the presence of attractive females. Research supported by grants from NIMH and NICHD.

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VISUAL INFLUENCES ON PHONOTACTIC ORIENTATION TO MODEL CALLING SONGS BY CRICKETS - A COMPARISON OF TECHNIQUES. J. F. Stout and I. Weber. Andrews University, Berrien Springs, MI. and Max-Planck-Inst. für Verhaltensphysiol., Seewiesen, W. Germany

In an orientation arena, female *Acheta domestica* phonotactically responded most directly to model calling songs (CSs) that reproduced the modal parameters of the conspecific male's CS. Using the Kramer treadmill, females phonotactically tracked model CSs with a wider range (45-90 ms) of syllable periods (SPs) when orienting in the dark. In the arena, model CSs with a 50 ms SP (the modal value for the natural call) were most attractive to females, while on the treadmill, females orienting in the dark were most attracted to CSs with SPs of 60-80 ms. In further testing, the provision of visual reference points near to the treadmill resulted in a restriction of the range of model CS SPs that were phonotactically attractive. The 50 ms SP also was equally or more attractive than the longer SPs, that were more effective in the dark. In general, the phonotactic responsiveness by females to CS SP on the treadmill in the light, with visual reference points, became more similar to their responsiveness in the arena.

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THE AFFECT OF SYRINGEAL STRUCTURE ON VOCAL PLASTICITY. A. S. GAUNT AND S. L. L. Gaunt. Ohio State Univ., Columbus

Students of syringeal function have known for a decade that the anatomically complex syringes of song birds (oscines) seem to confer no acoustic abilities not enjoyed by birds with much simpler structures, i.e., simple syringes can produce complexly modulated sounds. Various authors have proposed several, usually physiological, "advantages" for complex syringes. Recent studies of syringeal function in doves suggest that controlling a simple syrinx to produce a specific kind of sound may be difficult. Tactics to surmount that problem, e.g., stereotyped calls, tend to place severe restrictions on behavioral plasticity and information content. Extreme anatomic simplicity, as in parrots, simplifies control by reducing the number of interacting components. The anatomic complexity of the oscine syrinx isolates components and provides the possibility of precision control, thereby permitting the development of extensive and/or learned repertoires.

(Supported by NSF grant DEB-7911774.)

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OPTIMAL BROOD SIZE IN THE BLUE TIT: EVIDENCE AGAINST LACK'S HYPOTHESIS. N. Nur. Tel Aviv University, Israel.

Lack (1954) suggested that in altricial avian species, brood size is determined by the number of young which can be adequately fed by the parents. However, in many cases breeding birds produce smaller broods than predicted by Lack's hypothesis. Williams (1966) refined Lack's hypothesis: large broods will not be favored by natural selection if the cost to the parent of rearing a large brood (reduced probability of subsequent survival) outweighs the benefits. I manipulated the brood sizes of a population of blue tits Parus caeruleus nesting near Oxford, England; each breeding pair was assigned a brood of 3, 6, 9, 12 or 15. Broods of 12 produced the greatest number of young surviving to the next year; however, the mean natural brood size in the population was ca. 9. Though females rearing larger broods showed reduced survival, a model of optimal brood size indicates that a female could maximize the number of surviving young produced over the course of her lifetime by rearing broods of 12 young. Why then do blue tits not produce broods of 12 on the average? Evidence is presented that both energetic and time constraints limit clutch size.

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PERFORMANCE OF DAIRY COWS ON DISCRIMINATION TASKS AND SIGNAL DETECTION PROCEDURES. C. W. Arave, L. R. Mathews\*, W. Temple\*, J. V. Leman\*, and R. Kilgour. Utah State University, Logan, Waikato University and Ruakura Agricultural Research Centre, Hamilton, N.Z.

Twelve cows were trained to press nose plates for food reward in an operant chamber. Right and left plates of the apparatus were coupled with milking machine parameters; viz., high and low vacuum, wide and narrow pulsation ratios. In choice experiments left presses activated low and right presses high machine parameters with feed reward on an average of 30 sec interval (VI30). Response to this procedure was random. During discrimination trials only one of two stimuli was presented; i.e., a wide pulsation ratio signaled feed available via right plate (FRI schedule), a narrow ratio signaled left. Departure from random response to stimulus occurred only when a correction procedure (same stimulus repeated following incorrect response) was in effect. Cows either could not discriminate or had no preference between stimuli. Thus it appears milking machines may be adjusted for peak efficiency of milk removal with little concern that cow comfort will be jeopardized.

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PRODUCTION OF ANDROGENS AND ESTROGENS BY OVARIAN TISSUES OF KING MACKEREL IN VITRO. R. MacGregor III. University of Alabama in Birmingham.

Tissue slices of ovaries of king mackerel, Scoromorus cavalla, from the northeast Gulf of Mexico were incubated for 4 hours at room temperature to assess the quality and quantity of androgens and estrogens produced. Both media and tissues were extracted separately with ether and 70 % methanol (following the procedures of Fortune and Tsang, GCE 43, 234, 1981). Aliquots of the methanol extract were assayed for androgens and estrogens by radioimmunoassay. Other aliquots were chromatographed on LH-20 and fractions containing DHT, Testosterone, 11-Ketotestosterone, 11- $\beta$  Hydroxytestosterone, Estradiol-17 $\beta$  and Estrone were assayed by specific RIA. Androgen concentrations in the media were 4 to 8 times greater than estrogens. This ratio of androgens to estrogens (A:E ratio) approximates the range of the A:E ratio in serum of female mackerel with developing ovaries. However, the A:E ratio in the tissue was 1.5 to 4. Therefore 2x's more androgen was secreted or released into the media compared with estrogens from these ovarian tissues.

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RELATIONSHIP OF PLASMA ESTRADIOL-17 $\beta$  LEVELS TO GSI AND STAGE OF OOCYTE DEVELOPMENT IN LEPTOCOTTUS ARMATUS. V. deVlaming, R. Fitzgerald\* and M. Barkley\*. University of California, Davis, CA

The dynamics of oocyte development and plasma estradiol-17 $\beta$  levels (determined by RIA) were examined in the staghorn sculpin, Leptocottus armatus. Oocyte development in this estuarine cottid fish is in synchronous groups (clutches). Specifically, there are 2-3 clutches of oocytes in fish with developing ovaries; oocyte diameter in each clutch is relatively uniform. The spawning period in this species appears to be protracted, extending from December through March. Plasma estrogen levels vary seasonally and are elevated (2-19 ng/ml) in fish collected during the December to March period. Of particular note is that plasma estrogen levels during this period are not related to either GSI or to the stage of oocyte development (i.e., size of oocytes in the clutch with the largest diameters) as demonstrated by regression analysis.

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FEMINIZATION OF CHANNEL CATFISH (ICTALURUS PUNCTATUS) GONADS BY ORAL ANDROGEN AND ESTROGEN TREATMENT.

B. D. Redner and C. A. Goudie (intro. by B. A. Simco). Memphis State Univ., TN.

Oral administration of 17-alpha-ethynyltestosterone (ET) and 17-beta-estradiol (ES) at 60 and 600 ugET/g of diet and 60 ugES/g of diet resulted in 100 % feminization of male gonads. Two separate experiments were conducted at Texas A & M Univ. and the Southeastern Fish Cultural Laboratory at Marion, AL. Hormones were dissolved in ethanol, mixed with the feed and dried. Immediately following yolk sac absorption, channel catfish fry were fed the treatment diets for 21 days. Sex identification of 10-15 cm fingerlings by dissection revealed a 1:1 female to male ratio for controls while all treated fish possessed ovaries similar to controls. Histological examination of gonads from female controls and all treated fingerlings showed similar ovarian structures, all of which contained oocytes. These concentrations of ET must have stimulated the enzyme system for conversion of testosterone to estrogen.

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STEROIDOGENIC ACTIVITY IN LEYDIG AND SERTOLI CELLS OF THE SNAPPING TURTLE, CHELYDRA SERPENTINA. I. Y. Mahmoud, R. V. Cyrus and Michael Woller\*. Univ. of Wisconsin, Oshkosh.

Plasma testosterone levels in the sexually mature snapping turtle, Chelydra serpentina were measured throughout the testicular cycle and are compared with the activity of  $\Delta^5$ -3 $\beta$ -hydroxysteroid dehydrogenase ( $\Delta^5$ -3 $\beta$ HSD) and the occurrence of steroidogenic ultrastructural features (smooth endoplasmic reticulum and mitochondria with swollen, tubular cristae) in the Sertoli and Leydig cells. The testosterone level is highest (6.03ng/ml) in the Spring (mating) when the Leydig cells contain  $\Delta^5$ -3 $\beta$ HSD and have well developed steroidogenic features. Sertoli cells at this time have degenerated. During Summer (spermatogenesis) Leydig cells are not steroidogenic while the Sertoli cells have the steroidogenic ultrastructural features and give a strong positive reaction for the enzyme. Leydig cells remain in a state of regression until the Fall whereupon they also develop the steroidogenic features and are again positive for the enzyme. Testosterone drops significantly from early Summer (0.95ng/ml) to late Summer (0.68ng/ml) and remains low throughout the Fall and Winter (0.52ng/ml).

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TESTOSTERONE IN THE IMMATURE KEMP'S RIDLEY SEA TURTLE. Y. A. Morris, D. W. Owens and J. P. McVey\*. Texas A&M Univ., College Station and NMFS Lab., Galveston, TX.

The sex ratio of a captive "head-started" population was evaluated by a testosterone (T) radioimmunoassay. The three-year old Kemp's ridleys (Lepidochelys kempi) were hatched on Padre Island. Some (set A) were sent to Miami to be raised, while others (set B) were raised in Galveston. Set A had an estimated sex ratio of 17M:5F based on T levels for the males of 1281.4 $\pm$ 167.4 pg/ml and for the females of 7.6 $\pm$ 1.0 pg/ml. Set B showed a ratio of 4M:7F with T levels of 315.3 $\pm$ 31.5 and 12.9 $\pm$ 0.9 pg/ml for the males and females respectively. Sex was not verified by examination of the gonads. Evidence indicates some of the set B "females" may be yet undifferentiated males. The significantly different T levels in sets A and B ( $\alpha=0.01$ ) suggest that environmental conditions play a major role in the initial testis recrudescence of these sea turtles. In addition, a corticosterone radioimmunoassay is presently being evaluated for use in sea turtles. Texas A&M University Sea Grant College Program (Grant #NA79AA-D-00127).

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ECDYSTEROID LEVELS IN *CALLINECTES SAPIDUS* THROUGHOUT THE MOLT CYCLE. C. Soumoff and D. M. Skinner. UT-OR Grad. Sch. Biomed. Sci. and Biol. Div., ORNL, Oak Ridge, TN.

Ecdysteroid titers in Malacostraca follow a similar cyclical pattern. They rise to a peak in late proecdysis, and decline at or before ecdysis. The reported values for *Callinectes* are the only ones to deviate from this pattern. Therefore we measured the ecdysteroid concentration of sera and carcasses of male and female blue crabs using a RIA. Total ecdysteroids were calculated as 20-hydroxyecdysone equivalents. Basal serum concentrations of less than 10 ng/ml were seen in anecydysial crabs. Serum levels rose in early proecdysial crabs (green) to 16 ng/ml, reached a peak of 44 ng/ml in late proecdysial crabs (peeler) and declined to 12 ng/ml in postecdysial crabs (soft). A similar pattern was seen with methanol extracts of whole animals. Peak ecdysteroid titers of 163 µg/kg F.W. in late proecdysial crabs declined to 25 µg/kg F.W. in postecdysial crabs. Titers were similar in males and females. Thus we find that the pattern of ecdysteroid titers measured throughout the molt cycle of blue crabs does not differ significantly from that of other crustaceans. (Supported by sbcnt 3322 from Biol. Div. of ORNL to UT. Operated by UCC for USDOE.)

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COMPARISON OF SERUM ECDYSTEROID TITERS IN INTACT AND EYESTALKLESS FIDDLER CRABS. P. M. Hopkins. Univ. of Oklahoma, Norman.

The fiddler crab, *Uca pugilator*, can complete several "normal" intermolt cycles in the lab. These normal cycles and the proecdysial cycles of eyestalkless crabs were compared by means of radioimmunoassay (RIA) of serum ecdysteroid titers. The general pattern of changes and the total amount of RIA active material in the hemolymph of eyestalkless *Uca* differed from the pattern and titers in intact crabs. Titers of serum ecdysteroid increased steadily during proecdysis in intact crabs. In eyestalkless crabs there was a more rapid rise followed by a fall in hormone titer immediately before ecdysis. Highest titers of ecdysteroids in the hemolymph of intact proecdysial crabs rarely exceeded 50 pg/ul, whereas in eyestalkless crabs, the ecdysteroid titers reached concentrations of 120 pg/ul or greater. Postecdysial levels of ecdysteroids in intact crabs were less than 10 pg/ul of hemolymph. In eyestalkless crabs, the postecdysial hemolymph titers were 30 pg/ul. These data suggest that at least one site of control of circulating ecdysteroids is located in the eyestalk and this site has an inhibitory effect on circulating ecdysteroid concentrations.

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AEROBIC AND ANAEROBIC METABOLISM OF FREELY-DIVING LOGGERHEAD MUSK TURTLES. R.E. GATTEN, JR. Univ. of North Carolina, Greensboro.

This study was designed to determine the relative importance of pulmonary and non-pulmonary oxygen uptake and of anaerobic metabolism during voluntary, unrestrained dives by 10 *Sternotherus minor* at 22°C. Aerial and aquatic oxygen consumption were measured simultaneously during 174 h of routine diving. Anaerobiosis was assessed by measurements of total body lactate concentrations of turtles in air and of turtles diving for up to 24 h. The overall mean values ( $\pm$  SD) for aerial, aquatic, and total oxygen consumption were  $0.02415 \pm .00928$ ,  $0.00269 \pm .00065$ , and  $0.02684 \pm .00951$  ccO<sub>2</sub>g<sup>-1</sup>h<sup>-1</sup>, respectively. Thus aquatic oxygen uptake provides only 10% of the oxygen utilized during voluntary dives. Anaerobiosis does not appear to supply a significant amount of energy during unrestrained submergence. Resting dives in this species are therefore powered largely by aerobic metabolism supported almost entirely by pulmonary ventilation.

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ARTERIAL PRESSURE AND HEMODYNAMICS IN SEA SNAKES. H.B. Lillywhite and F.H. Pough. Univ. of Kansas and Cornell Univ.

Cardiovascular responses to head-up tilt, hemorrhage and pharmacological stimulation were studied in the aquatic snake, *Aipysurus laevis*. Arterial pressure varied inversely with tilt angle and blood volume deficit in unanesthetized snakes out of water. Pressures at head level typically became negative at tilt angles  $\geq 30^\circ$ , and snakes usually died if tilted steeply or for periods longer than a few minutes. Arterial pressure (corrected for water pressure) did not change when snakes were tilted in water. Data for heart rate and drug-induced changes of pressure demonstrate the presence of reflex adjustments to hemodynamic disturbance, but the degree of intrinsic cardiovascular control is poor in comparison with terrestrial species of snake. Systemic and pulmonary arterial pressures of aquatic sea snakes are relatively low (10-30 mm Hg). Vertical movements out of water are potentially lethal apparently due to cerebral stagnant anoxia and/or pressure disturbances within an elongate pulmonary vasculature. (Supported by NSF grant PCM 79-18393 and NIH grant HL 24640. Laboratory facility was provided by Heron Island Research Station, Queensland, Australia.)

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NEST ENVIRONMENT OF THE AMERICAN CROCODILE EGG (*CROCODYLUS ACUTUS*). A. Dunbar-Cooper\* and Peter L. Lutz. Rosenstiel School of Marine and Atmospheric Science, University of Miami, Miami, FL 33149.

The Everglades population of *C. acutus* builds nests in marl and sand substrates. The chambers of selected nests were monitored throughout two incubation seasons for oxygen and carbon dioxide levels, soil water and temperature. As incubation proceeded there was a progressive fall in  $PO_2$  (min. value 116 torr) and rise in  $PCO_2$  (max. value 20 torr). The oxygen diffusivity of the marl soils was more strongly dependent on soil water content than that of the sand. There was a gradual increase in temperature as the season progressed but the temperature profiles were variable, ranging from 30-36°C. The greatest difference measured between nest and surrounding soil was 1.6°C. All eggs lost weight over the incubation period (mean of 15% loss of initial weight) which may assist hatching. Crocodile eggs appear to be similar to those of birds in several aspects of water loss regulation. Supported by NPS contract no. CX5280-9-2129.

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EFFECTS OF THYROXINE ( $T_4$ ) SUPPLEMENTATION ON AEROBIC CAPACITY IN THE LIZARD *DIPSOSAURUS DORSALIS*. H.B. John-Alder. Univ. of California, Irvine.

Metabolic and enzymatic correlates of  $T_4$  supplementation were determined in lizards (*Dipsosaurus dorsalis*) maintained on 40C days:35C nights. Standard (SMR) and maximal ( $\dot{V}O_2max$ ) rates of  $O_2$  consumption and citrate synthase (CS) activity were measured at 40C before and after experimental treatment. Two weeks of daily  $T_4$  injections (0.2  $\mu$ g  $T_4$ /g body wt.) resulted in a 60% increase in SMR [+0.10 ml  $O_2$ /(g·h)] and a 16% increase in  $\dot{V}O_2max$  [+0.23 ml  $O_2$ /(g·h)]. CS activity in  $T_4$ -injected lizards was 78% above control in liver, 29% greater in gastrocnemius muscle, and 24% greater in red iliofibularis muscle. Plasma  $T_4$  in controls averaged 2.32 ng/ml. Plasma  $T_4$  in experimental lizards reached peak levels two orders of magnitude above control within 2 hours of  $T_4$  injection and declined at a constant rate to an average 9.00 ng/ml prior to the next injection; average plasma  $T_4$  was in the mammalian range.  $T_4$  supplementation causes an increase in aerobic capacity under these conditions. However, this often-used injection protocol leads to nonphysiological plasma  $T_4$  concentrations. (Supported by NSF Grant PCM 77-24208 to A.F. Bennett.)

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ENERGETIC COST OF INCUBATION OF THE BARN OWL: A PRELIMINARY REPORT. K.L. Hamilton and J.A. Gessaman\*. Utah St. Univ., Logan.

Avian physiologists are still accumulating data to determine whether incubation is energetically costly to an adult bird. Avian metabolism studies are difficult to conduct in the field, but birds that use nest boxes are subject to investigation. In February 1981, metabolism chamber nest boxes were erected in abandoned grain silos in northern Utah. Metabolic rates ( $CO_2$  production) of incubating barn owls were monitored with a modified Haldane method. Ten to 15  $CO_2$  determinations were conducted on each bird during the incubation period over temperatures varying from 0 to 20 C. Near the end of the incubation period the female barn owls were captured and brought to Utah State upon which they were held in environmental chambers. Resting metabolic rates of these birds were measured and compared to the metabolic rates determined in the field. The preliminary results obtained appear to suggest that barn owls can properly incubate eggs at their resting metabolic rates. More field experiments will be conducted during the 1982 field season. This study was supported by the Welder Wildlife Foundation.

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ADULT-SPECIFIC ENERGETICS OF TWO ENDOTHERMS. Randy Webb. Wash. State. Univ., Pullman, WA.

Adult Yellow-bellied marmots rarely had to raise their metabolism above basal; juveniles always had to elevate their metabolism to maintain homeothermy, and spent longer times foraging than adults. Juveniles sometimes encountered conditions beyond their metabolic abilities; adults never did. Adult White-Crowned Sparrows never had to raise their metabolism above the summit value during the breeding season. In contrast, nestlings usually are unable to maintain an offset body temperature until 5 days of age and cool towards air temperature after the female leaves the nest. This interaction of nestling food requirements and inability to thermoregulate results in two types of compensation by the adults: scheduling of foraging trips during more moderate temperatures, and limitation of the length of those trips to avoid complete cooling of the brood. Similar strategies prevail during the egg phase while the female is foraging for her own self-maintenance. However, these compensations are not sufficient during prolonged periods of stormy weather at one site in the Cascade Mountains, and every year some nestlings die of cold stress.

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TIMING AND ENERGETICS OF REPRODUCTION AND DEVELOPMENT IN YELLOW PINE CHIPMUNKS *EUTAMIAS AMOENUS*. G.J. Kenagy, H. Biebach\*, R.D. Stevenson, and B.M. Barnes. University of Washington.

At our field site *E. amoenus* gave birth about May 1 to an average of 4.9 young (range 3-6), followed by 7-8 weeks of lactation. Mothers field-caught while pregnant showed a steady increase in body mass for 40 days following parturition in the lab, and then declined until weaning. Total daily food consumption (FC) increased 2½ fold over these 40 days, while mass-specific FC doubled. Total resting metabolic rate (RMR) of mothers increased by 60% at the plateau of 25-45 days, while mass-specific RMR increased by only 10%. Following a linear growth phase over days 0-40, the pups attained homeothermy and the capability to use solid food at age 40 days, whereafter growth rate increased 2½ fold for days 40-60. Mass-specific RMR of pups decreased over the first 20 days but increased again during the rapid growth phase of days 40-60. Growth rate for a litter of 6 falls below normal, suggesting limitation by the mother's performance. Pups in the smallest litters cannot apparently accelerate developmental rate above normal. Supported by NSF DEB 80-05906.

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PRECOCIOUS MIGRATION OF PRIMORDIAL GERM CELLS TO THE GONADAL RIDGES IN *RANA PIPPIENS* EMBRYOS. J. E. Penkala and S. Subtelny. Rice Univ., Houston, Tx.

Germ cell-containing endoderm regions were grafted from stg 17 tail bud embryos into 3-day older, u-v irradiated, sterile, stg 20 embryos. Direct gonadal germ cell counts were made in host stg 25 larvae (or later), at which time donor germ cells normally would be in the endoderm. Heterochronic grafted animals possessed limited gonocyte numbers (most were sterile), representing an overall mean of 2% of the unoperated control gonocyte numbers. Thus a restricted number of germ cells emerged from the endoderm precociously. Isochronic grafts between stg 17 embryos and between stg 20 embryos yielded 70% and 20% gonocytes, respectively, relative to the controls. Since stg 20 germ cells are localized near the dorsal endodermal crest whereas at stg 17 they are situated deep in the endoderm, the restricted germ cell migration in heterochronic grafted animals is interpreted to mean that donor germ cells fail to attain the dorsal endodermal crest before host dorsal mesentery formation and gut retraction, precluding their exit from the endoderm.

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PRIMORDIAL GERM CELL COMPETENCE TO MIGRATE IN *RANA PIPPIENS* EMBRYOS FOLLOWING TRANSFER TO YOUNGER HOSTS. J. E. Penkala and S. Subtelny. Rice Univ., Houston, Texas.

By hatching (stg 20) in *R. pippiens* embryos, the majority of primordial germ cells have completed their intraendodermal migration and are located in the posterior dorsal-most region of the endoderm. When these stg 20 germ cells were transferred via endodermal grafts into UV-irradiated, sterile, tailbud hosts (stg 17), migration, as assessed by direct counts of germ cells in the host genital ridges at stg 25, occurred at a mean level of 20% of the fertilized control gonocyte number. Isochronic grafts between stg 20 embryos showed a comparable degree of germ cell migration (20%). These results indicate that stg 20 germ cells retain full competence to migrate when transferred into 3-day younger stg 17 embryos. Histological studies showed that donor germ cells did not exhibit precocious migration from the endoderm, but behaved, in this respect in accordance with the host development. This finding supports the notion that the emergence of germ cells from the endoderm in *R. pippiens* is a passive process, mediated by local morphogenetic movements, particularly the infolding of the lateral plate mesoderm and formation of the dorsal mesentery.

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MATERNAL-FOETAL RELATIONSHIP IN THE POECILIID *HETERANDRIA FORMOSA*. B.D. Grove and J.P. Wourms. Clemson Univ., S.C.

Embryos of the viviparous poeciliid, *Heterandria formosa*, develop completely in the ovarian follicle. A 4000% increase in embryonic dry weight indicates maternal nutrient transfer via a follicular placenta. During development, the pericardial somatopleure folds on itself to form a chorion-amnion that invests the anterior end of the embryo until close to term. SEM reveals that early embryos are entirely covered with a microvillar epithelium which in later embryos is reduced except on the pericardial chorion-amnion. Ultrastructurally, the microvillar epithelial cells of the pericardial chorion-amnion are squamous and possess coated pits, vesicles, and a well developed RER. Endothelial cells of adjacent c-a capillaries contain coated pits and vesicles. The pericardial chorion-amnion is closely apposed to the follicular epithelium to form the follicular placenta. Follicular epithelial cells are squamous and contain RER and two classes of large vesicles. Protein absorption by the chorion-amnion epithelium was examined ultrastructurally using horse radish peroxidase (HRP) tracer, but evidence for HRP absorption is presently inconclusive.

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THE EFFECT OF TEMPERATURE AND SALINITY UPON THE POST CLEAVAGE EMBRYONIC DEVELOPMENT OF LOLLIGUNCULA BREVIS BLAINVILLE. J. A. DERRENBACHER (intro. by J. L. Simon). Univ. of South Florida, Tampa, FL.

The study was undertaken to determine and to evaluate the extent to which temperature and salinity effect survival and growth rate of post cleavage embryological development of Lolliguncula brevis. Collected eggs were maintained in aquaria at three temperatures; 15 C, 22.5 C and 30 C and three salinities; 15 ‰, 22.5 ‰ and 30 ‰. Survival and growth rates were recorded at each temperature and salinity combination. Survival and morphological abnormalities were examined through response surface analysis and S.E.M. Temperature and salinity effected growth and survival of Lolliguncula brevis. Data analysis indicate stenohaline and stenothermal requirements for successful embryological development of this estuarine cephalopod.

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SURFACE MORPHOLOGIC CHANGES IN AMBYSTOMA MEXICANUM EMBRYOS. J. LeBLANC and I. BRICK New York Univ., N.Y.

Our SEM observations show regional differences in the development of embryos from the two cell stage through initial blastopore formation. Surface variations, in addition, are not only a function of the area of the embryo but also of developmental stage. The blastomeres of the vegetal hemisphere exhibit topographies with evenly distributed surface protrusions throughout these early developmental stages, though by early gastrula the number of surface projections is reduced. In contrast, surface organization of animal blastomeres undergoes extensive rearrangement during this early developmental period. Differences in furrow formation during cleavage is evident between the animal and vegetal hemispheres which may well be the result of differences in the cytoplasm-yolk ratio. In both hemispheres, however, the impression from SEM photographs is that surface protrusions infold with the deepening of the furrow and that in formed furrows, in both hemispheres, surface projections extend the distance of the furrow gap 'interconnecting cells.'

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HETEROGENEITY OF SYMPATHETIC CELLS IN AVIAN PARAVERTEBRAL GANGLIA. L. Luckenbill-Edds. Ohio University, Athens, Ohio.

I have processed paravertebral ganglia from adult (30 day) chickens for formaldehyde-induced fluorescence (FIF) using a solution of formaldehyde-glyoxylic acid with hypertonic  $MgSO_4$  (FAGA) as a fixative (Lorén et al., 1976), and have observed two types of principal neurons (PN). One type, also seen in previous studies, exhibits weak FIF, while the other type has an intensely histofluorescent cell body and processes that ramify in the neuropil. The brightly histofluorescent adult neurons are too large to be comparable to mammalian small intensely fluorescent (SIF) cells. Preincubation with norepinephrine does not alter the pattern of FIF. Ganglia from embryonic day 15 chicks also contain PN with different intensities of FIF when fixed with FAGA. These results are interpreted to mean that FAGA has interacted with the population of PN of embryonic and adult avian sympathetic ganglia so that physiological or developmental differences emerge within the population of PN. Supported by a grant from the American Osteopathic Association.

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AN EMBRYONIC STUDY OF FIVE ANOLIS SPECIES USING GROWTH CURVES AS A BASIS FOR INTER-SPECIFIC COMPARISONS AND STAGING. L. LEVINSON. New York University, N.Y.C.

Staging of lizard embryos is often difficult as the developmental rate is temperature as well as time dependant. Anolis females lay single egg clutches. Females often retain the egg in the oviduct, and so the developmental state of each female's egg at oviposition varies. To compensate for this time-developmental disparity, a new scale for embryonic comparisons between five Anolis species was constructed. Growth curves for each species were determined by plotting ratios of quantitative measurements (e.g. snout-vent:femur lengths) in embryos, hatchlings, juveniles, and adults. Each curve was normalized to a single axis, making similar points on all curves comparable. Adults of the five species were kept in breeding conditions, and resulting embryos were measured for the ratio, and placed on the respective species' growth curve. The embryonic development of each species was then compared.



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RESPIRATORY ASPECTS OF VERTICAL ZONATION IN TWO SPECIES OF HAWAIIAN LIMPETS (GASTROPODA:PATELLIDAE). Gladys C. Corpuz. University of Hawaii, Honolulu.

The observed zonation between and within species of Cellana exarata and C. sandwicensis suggests that individuals are subjected to varying degrees of aerial exposure, desiccation, and temperature fluctuations. To determine the degree of adaptation to aerial exposure, rates of oxygen consumption in air and in water were measured. Comparisons were made between species, and between individuals of varied sizes within each species, at varied temperatures. All measurements are expressed at standard temperature and pressure (STP).  $Q_{10}$  values calculated between 20°C and 30°C were 1.11 in air and 1.03 in water for C. exarata; 1.07 in air and 1.04 in water for C. sandwicensis. Respiration rates did not differ significantly between species. However, a trend suggesting a higher rate of respiration in water as opposed to that in air is seen for smaller individuals while a higher rate in air as opposed to that in water is seen in larger individuals for both species. This project was supported by a contract from the State of Hawaii with E. A. Kay.

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LOCOMOTOR ACTIVITY AND HOME SELECTION IN THREE SPECIES OF HAWAIIAN OCTOPODS. B.A. Houck. Univ. of Portland, OR.

Octopus cyanea Gray, Octopus ornatus Gould and the taxonomically undescribed crescent octopus can be collected on the same fringing reefs on the south shore of Oahu, Hawaii. In the laboratory, the three species demonstrate distinct species-specific patterns of locomotor activity under light regimes similar to those in the field. Observations indicate differences in preferred home sites on the reef flats for use during periods of inactivity. The temporal spacing and observed differences in microhabitat may serve to limit interspecific competition for food and homes and reduce the incidence of cannibalism among the three shallow-water species.

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POPULATION GENETICS OF ISCHADIUM (MODIOLUS) DEMISSUM IN SOUTHERN CALIFORNIA: EVIDENCE FOR THE SELECTIVE IMPORTANCE OF LEUCINE AMINOPEPTIDASE. R. Garthwaite\* and R. M. Baginski. U. C. Riverside.

During the winter of 1980-81 collections of the estuarine bivalve mollusk Ischadium demissum were made at five sites in Newport Bay and at one site in Alamitos Bay, both in Southern California. The collections were surveyed electrophoretically for variation in leucine aminopeptidase (LAP) and other enzymes. LAP exhibited three zones of activity, the fastest of which (designated LAP-1) contained three common and at least three rare alleles. Of the loci surveyed only LAP-1 showed significant heterogeneity in allele frequencies within Newport Bay ( $p < .01$ ) and these frequencies were found to correlate well with the average salinity at the sites during the winter months. While genotype frequencies differed from Hardy-Weinberg expectations in only one instance, there was a deficiency of LAP-1 heterozygotes in all but one of the collections. These results are consistent with a large body of literature in suggesting that natural selection plays a major role in determining LAP allele frequencies in bivalve mollusks. The data suggest that salinity stress is one of the selective factors. NSF PCM-7906515.

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CATCH TENTACLE ULTRASTRUCTURE IN THE SEA ANEMONE HALIPLANELLA LUCIAE (VERRILL). Glen M. Watson and Richard N. Mariscal. Florida State University, Tallahassee, FL

Catch tentacles, specialized for competitive aggressive interactions in sea anemones, were studied using TEM. The tentacle tip is filled with two size classes of mature holotrich nematocysts and a new type of gland cell loaded with vesicles. Vesicle development is restricted to middle and distal tentacle regions, whereas holotrich development is restricted to proximal tentacle regions. Occasional feeding tentacle cnidae (basitrichs and microbasic p-mastigophores) are found in proximal portions of catch tentacles, but are phagocytized by granulocytes and transported to the gastrodermis for further degradation. No feeding tentacle cnidae occur distally in catch tentacles. Likewise, mucous gland cells found in proximal tentacle regions are excluded from distal regions of the catch tentacle. Perhaps, feeding tentacle cnidae and gland cells are carried in replacement structural tissues which might migrate from the oral disc into catch tentacles following tentacle tip autotomy during aggression.

THE BIOCHEMICAL BASIS FOR THE COLUMN COLOR POLYMORPHISM IN THE SEA ANEMONE *BUNODOSOMA*. R.D. LEBOEUF, S.A. MCCOMMAS, and J.D. TAUBER.\* Univ. of Houston, Mar. Sci. Prgm., Galveston, TX., and †McNeese State Univ., Lake Charles, LA.

The biochemical basis of the red, orange-red and orange column color morphs of *Bunodosoma* was investigated by quantitative techniques. This analysis showed that the observed column color polymorphism is based primarily on the proportions of 3 carotenoids: astaxanthin diester, 2'-norastaxanthin diester and actinioerythrin. The varying proportions of these 3 carotenoid diesters are interpreted as representing genetic differences in the carotenoid biotransformation pathway. Samples of *B. granulifera* from Curacao and Puerto Rico differed in their mean carotenoid proportions and consequently in the frequencies of these 3 morphs. Interspecific comparison with *B. cavernata* showed differences from the above populations in the mean percentages and frequency distributions of the major carotenoids. This method allows quantitative description of color morphs in sea anemones. The distribution of actinioerythrin may be a useful taxonomic character.

DIFFERENCES IN TEMPERATURE SENSITIVITY OF FISSION KINETICS AMONG CLONES OF THE SEA ANEMONE *HALIPLANELLA LUCIAE* (VERRILL) IN DIFFERENT GEOGRAPHIC REGIONS.

L.L. MINASIAN, JR. AND S.A. MCCOMMAS, Univ. of Houston, Mar. Sci. Prgm., 4700 Ave. U, Galveston, TX 77550\* and Dept. Biol. Sci., Florida State Univ., Tallahassee, FL 32306

Three clonal cultures of *Haliplanella (=Diadumene) luciae* were isolated from each of three geographic regions: Delaware and southeast Florida (Atlantic coast) and northwest Florida (Gulf coast). The nine clones were amplified and reared *in vitro* at temperatures of  $17 \pm 1^\circ\text{C}$  and  $24 \pm 1^\circ\text{C}$  to determine the sensitivity to temperature of asexual reproductive parameters: fission rate ( $k$  and  $k_{adj}$ ) and the delay period prior to fission. Significant differences in both parameters at both temperatures exist among clones within each region. In addition, significant differences in  $k$ ,  $k_{adj}$ , delay and  $Q_{10}$  for  $k$  and  $k_{adj}$  exist among geographic regions. Highest values of  $k$  were exhibited by northern clones; lowest values were exhibited by southern clones. Very high  $Q_{10}$  values among clones exhibiting small  $k$  indicates that mechanisms other than decreased metabolic rate act to depress  $k$  below  $20^\circ\text{C}$ .

\*Authors' present address

GEOGRAPHIC PATTERN OF ELECTROPHORETIC VARIATION IN THE SEA ANEMONE, *Haliplanella luciae*. S.A. MCCOMMAS and L.L. MINASIAN, JR. Univ. of Houston, Mar. Sci. Prgm., 4700 Ave. U, Galveston, TX 77550† and Dept. Biol. Sci., Florida State Univ., Tallahassee, FL 32306

Three clones from each of 3 geographic areas (Delaware, southeast Florida Atlantic coast, and northwest Florida Gulf coast) were assayed using horizontal starch gel electrophoresis for 14 loci. For these 9 clones, 7 loci (phosphoglucosyltransferase, peptidase, phosphoglucose isomerase, glycerate-2-dehydrogenase, superoxide dismutase, hexokinase, and 6-phosphogluconate dehydrogenase) were polymorphic. A dendrogram, expressing the degree of relatedness of the clones, was constructed using Nei's standard genetic distance values. It was found that clones within a geographic area are more similar to each other than to clones from other areas; clones from the two Florida areas are more similar to each other than to the Delaware clones. Sexual reproduction is the most likely basis for the observed pattern of genetic similarity. This is the first evidence of sexual reproduction found for this species.

†Authors' present address

THE FOREGUT OF MALACOSTRACAN CRUSTACEA: FUNCTIONAL MORPHOLOGY AND EVOLUTIONARY TRENDS. Janet C. Kunze. Scripps Institution of Oceanography, La Jolla, Ca.

The presence of a specialized foregut (proventriculus) characterized by various triturative spines and teeth, cuticular folds, ossicles and filtratory mechanisms is a unifying feature of the Malacostraca. The present study, which incorporates data on musculature and function in addition to gross morphology, disagrees with previous investigations that focussed on homologous structures within the foregut and their evolutionary significance. Representatives of the Leptostraca, Stomatopoda, Syncarida, Peracarida and Eucarida have been examined to ascertain evolutionary trends in gastric specialization and the relationship between gastric functional morphology and diet. A sequence of increasing structural and functional complexity characterizes the leptostracan-syncaridan-eucaridan assemblage. Stomatopods illustrate an independent trend in gastric specialization associated with a unique mode of feeding and digestion. The Peracarida exhibit a diversity of modifications of the foregut which partly reflect diet but which also reflect divergent trends in adaptive radiation.

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Color pattern polymorphism in the caridean shrimps *Heptacarpus pictus* and *H. paludicola*. R.T. Bauer, University of Puerto Rico, Rio Piedras.

Polymorphic color patterns, formed from subcuticular chromatophores, are found in *Heptacarpus* spp. The expression of color pattern varied significantly in *H. paludicola*. In *H. pictus*, frequencies of the different color morphs varied significantly in an apparently cyclic manner over a year's sampling. The color patterns have the form of disruptive coloration, and apostatic selection by fish predators may account for the changes in morph frequency. Experiments showed that rapid color change during the day was of little importance in controlling color morph expression or frequency. Behavioral experiments indicated that color morphs do not select backgrounds which (to the human eye) might best camouflage them.

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SEXUAL DIMORPHISM AND INTERSPECIFIC VARIATION IN THE MORPHOLOGY OF COXAL GILLS IN THE FAMILY AMPELISCIDAE (AMPHIPODA: GAMMARIDEA). JOHN J. DICKINSON, National Museum of Natural Sciences, Ottawa, Canada.

The gills of over 30 species of Ampeliscidae representing the genera *Ampelisca*, *Byblis*, and *Haploops* were examined and illustrated to evaluate the usefulness of gill structure as a phyletic and taxonomic tool. Although interspecific differences existed, all species examined could be grouped into one of two basic types. The two different types of gill structure could be designated as either plesiomorphic or apomorphic, and proved a useful character in studying phyletic relationships within the family. Sexual dimorphism occurred in the gill structure of all species examined. Mature females always have longer, narrower, thinner and less pleated gills than males of the same size and species. The thinner, unpleated gills of mature females are most likely an adaptation allowing more space for the brood pouch.

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SEXUAL SIZE DIMORPHISM AND REPRODUCTION IN PACIFIC MOLE CRABS. S. R. Haley. Univ. of Hawaii, Honolulu.

Male Pacific mole crabs attain a maximum carapace length only about 50% that of females. The significance of this sexual size dimorphism, a result of differential growth rates, may be to reduce intersexual competition for food. Reproductive rate is food-limited, and large crabs are competitively dominant for nutritional resources. The crabs demonstrate zonation by size on the beach, with large individuals occupying the lower half of the wave wash zone, where food-bearing waves cover the sand more often. Mean maximum size of males approximates mean minimum size at reproduction in females (about 13.5 mm carapace length). Although mean fecundity is directly proportional to carapace length in reproductive females, reproductive effort is maximal for females larger than the mean maximum size of males (carapace length >15 mm). Immature females possess high growth rates which advance them quickly through the prereproductive size classes, effectively establishing a size refuge for large reproductive individuals competitively dominant for nutritional resources. Males do not grow this large even when fed *ad libitum* in the laboratory.

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FOOT-LOOSE BARNACLES: IMPLICATIONS OF THE RETENTION OF MOBILITY INTO THE POSTMETAMORPHIC STAGES OF THE GOOSE BARNACLE. Daniel L. Hoffman, Bucknell University, Lewisburg, PA.

The cyprids of the goose barnacle, *Pollicipes polymerus*, are purported to settle preferentially on the peduncles of adult barnacles resulting in the formation of aggregates that are typical markers of the exposed rocky midtidal zone of the Pacific Coast of North America. Field observations and statistical analyses of counts made on attached juveniles during different times of the year give evidence that it may be maladaptive for these juveniles to remain attached to the adult peduncles which constitute secondary and non-preferential substratum. The juveniles appear to be able to detach themselves from these peduncular perches expanding their attachment disk into a bulb-like organ. Held in place by entwining their serpent-shaped peduncles around adjacent peduncles, these "foot-loose" barnacles extend the bulbs downward, reattaching when they contact the primary substratum. Such behavior may also be significant in the dispersion of postmetamorphic barnacles and the establishment of new aggregates.

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INTERMOLT EXPANSION DURING GROWTH OF MYSIDOPSIS BAHIA (CRUSTACEA: MYSIDACEA). A. DAVID SCARFE and Don C. Miller. W. Florida Univ., & U.S. EPA, Narragansett, R.I. 02882

Arthropods, including crustacea are known to expand in size in a discontinuous pattern during their growing period: remaining essentially the same size between molts and expanding during ecdysis. However, using a photographic technique to monitor the size of individual laboratory cultured mysid shrimp every eight hours, over a period of about 400 hours, it was discovered that at least 90% of the expansion in total length occurred between molts and not during ecdysis. No difference in growth models between sexes was observed. A second experiment, sampling and measuring over 100 individuals at different stages of early growth showed that predominant intermolt expansion occurred in the abdomen due to stretching of the intersegmental arthropodial membranes, although some expansion of the cephalothorax indicated flexibility of the cuticle. These results suggest that mysids may differ from other crustacea in their growth patterns. In addition, ecdysis was highly synchronous with the dark phases of L/D : 16/8 and 21/3 diurnal cycles suggesting a considerable influence of diurnal cycles on the molting process.

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CARIDEAN SHRIMPS INHABITING ANCHIALINE CAVE WATERS OF BERMUDA. C. W. Hart, Jr., Raymond B. Manning, and Thomas M. Iliffe\*. Smithsonian Institution, Washington, D.C., and Bermuda Biological Station, Bermuda.

Four caridean shrimp species have recently been found to inhabit two of the 11 caves of Bermuda. One represents a new genus and species; one a new species. A range extension is recorded for Barbouria cubensis, and Automate dolichognatha is reported from the cavernicolous anchialine habitat for the first time. The relationships of these shrimps to the same or closely related species inhabiting anchialine waters of oceanic islands is discussed. The presence of these shrimps on Bermuda is discussed in relation to the four theories that have been advanced to explain the transoceanic distribution of marine cave faunas -- plate tectonics, stranding of species on the shoreline of receding seas, interconnection of coastal species by abyssal ones, and passive distribution by drifting.

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BUFO MARINUS FLIP THEIR TONGUE USING SYMPHYSIAL MUSCLES. G. C. Gorniak and C. Gans. The Univ. of Michigan, Ann Arbor.

Marine toads flip and stretch their normally flacid tongue past the mandibular symphysis and onto prey. High speed cinematography synchronized with electromyography during the flip shows that the tongue is then supported by the stiffened M. genioglossus medialis. Stiffening of the Mm. submentalis, genioglossus basalis, and geniohyoideus lateralis forms a lifting wedge and depresses the mandibular symphysis; the wedge then raises and rotates the stiffened medialis around the symphysis, carrying along the soft tissues of the tongue on its free tip. Lingual retraction involves the elongate, parallel fibers of the M. hyoglossus; retraction of the lingual sulcus holds the prey by a suction cup effect. Protraction of the hyoid facilitates extension of the M. hyoglossus. The Mm. depressor mandibulae, sternohyoideus, petrohyoideus and omohyoideus do not assist tongue protrusion. The coefficients of variation show maximum stereotypy for the stiffening muscles during the flip, and the M. hyoglossus during retraction. (Supported by DEB 80-03678 and DHEW 1R01DE05112-03.)

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TONGUE PROPULSION IN RHINOPHRYNUS: A MECHANISM UNIQUE IN FROGS. L. Trueb and C. Gans. Univ. of Kansas, Lawrence, and Univ. of Michigan, Ann Arbor.

Most frogs have a projectile tongue that can be everted from the mouth for varying distances. Almost all such tongues are propelled by the combined action of genioglossal and submentalis muscles. Thus, they differ fundamentally from the tongues of salamanders in which force transmission occurs via the hyoid skeleton.

The Mexican ant-eating frog, Rhinophrynus dorsalis, represents an unique exception. In this species, the tongue is erected by contraction of intrinsic muscles that distend it by action on the fluid-filled base. The distended tongue is then pushed beyond the symphysis by protraction of the hyoid plate on which it is firmly based. This protrusion proceeds through a palatal groove; hyoid retraction induces a suction that enhances the adhesive action of the tongue and pulls prey into the buccal cavity. Other ant-feeding specializations include the presence of single-celled, conical keratinizations on the snout (Trueb & Gans, 1982), the enormous buccal lubricating glands, and the uniquely folded esophageal lining. The propulsive mechanism of Rhinophrynus is reminiscent of that of some primitive salamanders. Supported by NSF DEB 80-03678.

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PATTERNS OF MUSCLE ACTIVITY DURING PREY MANIPULATION AND PHARYNGEAL TRANSPORT IN THREE CENTRARCHID FISHES. G. V. Lauder. University of Chicago.

An electromyographic study of 14 pharyngeal, hyoid and mandibular arch muscles was conducted of prey capture, manipulation and transport in *Micropterus*, *Ambloplites* and *Pomoxis*. A statistical analysis of muscle activity duration reveals four distinct patterns of symmetrical activity: the initial strike, buccal manipulation, pharyngeal manipulation, and pharyngeal transport. Pharyngeal transport occurs by alternating movements of the upper and lower pharyngeal jaws as indicated by the distinct and rhythmic alternation of activity in the retractor dorsalis and pharyngocleithralis internus. Asymmetrical activity between the right and left sides has been observed in the pharyngohyoideus, levator externus four, adductor five, and the pharyngocleithralis internus, and relates to rotational movements of the pharyngeal jaws about a sagittal axis. The phylogenetic history of (1) the musculoskeletal couplings involved in prey transport and (2) the muscle activity patterns producing alternating pharyngeal jaw movement are discussed in the context of recent hypotheses of euteleostean phylogeny.

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CONDYLE MOVEMENTS DURING MASTICATION IN THE HYRAX. H.A. Franks, Harvard Univ.

Implantation of metal markers, cine-x-ray and EMG techniques were used to determine what condyle movements occur during mastication and what role heterogeneous muscle activity in jaw elevators contributes to those movements. Hyraxes were used as experimental animals. A chewing cycle begins at maximum gape with both condyles at their most forward position. During Fast Close both condyles move posteriorly. The active condyle moves back a greater distance than the balancing condyle, so the jaw shifts to the active side. In the Power Stroke, the active condyle moves forward. The balancing condyle remains stationary or shifts slightly back. These movements shift the jaw medially. The same condyle movements and medial jaw movement continue during Slow Open. During Fast Open the active condyle remains stationary or moves slightly forward. The balancing condyle moves a relatively greater distance forward during Fast Open, and this causes the jaw to begin to return to the active side. As the cycle ends, both condyles are again at their most forward position. Heterogeneous activity in parts of the superficial masseter and medial pterygoid is important to produce these movements.

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FUNCTIONAL INFLUENCES ON MANDIBULAR CONDYLAR SIZE. S. W. Herring. Univ. Illinois Medical Center, Chicago.

In dorsal view, the relative size of the mandibular condyles can vary greatly among related taxa. Examples include peccaries (*Catagonus* vs *Tayassu*), pigs (*Hylochoerus* vs other genera), and selenodont artiodactyls (camelids vs bovids). In each example the small size of the condyles in the first-named group is associated with muscular patterns causing decreased vertical loading of the jaw joint, i.e., lowered muscle activity for grinding mastication as opposed to crushing (*Catagonus* and *Hylochoerus*); use of the temporalis as a principal muscle on the balancing side (*Hylochoerus* and camelids); and reorientation of the temporalis (*Catagonus*). A similar but more dramatic decrease in relative condylar dimensions can be produced intraspecifically via a mutation in mice, *muscular dysgenesis*, which causes prenatal degeneration of striated muscle. Presumably the small condyles here are also due to decreased vertical loading in the absence of muscular forces. Condylar size may be epigenetically determined by mechanical factors and should not be used as an independent character for systematics.

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THE INTERACTION OF MUSCLE CONTRACTION AND FORCE AT THE MAMMALIAN CARNIVORE JAW JOINT. Dean Dessem.

Univ. of Illinois at the Medical Center, Chicago

Wire resistance strain gages were used to measure bone strain at various locations adjacent to the craniomandibular joint in mammalian carnivores. A gage was applied to the lateral surface of the zygomatic arch superior to the attachment of the joint capsule. Experiments performed with a pressure transducer inserted within the joint capsule show that tensile and compressive bone strain measured adjacent to the joint correlates with tension and compression within the joint. An initial test of Bramble's (1978) bifurcated jaw joint model was done by placing fulcra at various locations along the tooth row in a freshly killed specimen and simulating muscle forces during jaw closure by applying an adducting force to the jaw. The results show that either tensile or compressive forces exist at the jaw joint depending upon the orientation of the adducting force. Additional experiments are being planned to electrically stimulate the temporalis, masseter and pterygoid muscles while simultaneously recording the bone strain adjacent to the joint.

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READING MICROFRACTURE PATTERNS OF ABRASIVE WEAR STRIATIONS ON THE TEETH OF ODOBENUS. K. R. GORDON. Univ. of Illinois at the Medical Center, Chicago.

Scanning electron micrographs of experimental and naturally occurring wear striations were examined to determine if the directionality of abrasive wear can be determined. Sections of teeth were polished to eliminate all existing irregularities. Teeth were then abraded in a known direction with several different sizes of grit both fixed and loose. Microfracture patterns of wear striations were then correlated with grit type and the direction of abrasion. Both fixed and loose abrasives made striations with similar strain and fracture patterns at the margins of the abraded area. The fracture pattern formed incomplete chevrons with the apices facing in the direction of movement of the abrasive. Striations on the occlusal surface of the teeth of Odobenus caused by the movement of the tongue were compared to the experimental striations and found to be similar enough in many cases to determine directionality. The nature of fracture mechanics is such that for a wide range of materials, fracture patterns of wear striations can be used to determine the direction of movement of the abrasive material.

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DYNAMICS OF MEIOFAUNAL COLONIZATION OF AZOIC ESTUARINE SEDIMENT IN LOUISIANA.

G. T. Chandler and J. W. Fleeger. Louisiana State Univ., Baton Rouge.

Colonizing meiofauna were sampled quantitatively from 40 replicates of four designs of azoic sediment boxes. After two tidal cycles mean harpacticoid copepod and naupliar densities were not significantly different from control densities in sediment boxes open to colonization exclusively by meiofauna in suspended transport. Sediment boxes allowing colonization exclusively via holobenthic migration through the sediment contained mean densities that were significantly less than densities in controls and suspension colonized boxes. Pseudostenhelia wellsi (70/10cm<sup>2</sup>), Paronychocamptus huntsmani (40/10cm<sup>2</sup>) and Microarthridion littorale (22/10cm<sup>2</sup>) were the most abundant harpacticoid species in the controls. In the suspension colonized boxes however, P. huntsmani (76/10cm<sup>2</sup>) was the dominant species. Mean nematode density was significantly greater in controls than in suspension or migration colonized boxes but was not significantly different between the latter two. Meiofauna community establishment occurs within two tidal cycles in this system; with the copepod component dispersing most importantly via suspended transport, and the nematode component dispersing equally well via suspension or migration.

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EFFECTS OF THE DEGREE OF WAVE ACTION UPON INTERTIDAL MEIOFAUNAL ABUNDANCES. H. K. Dean. University of Delaware, Lewes, Delaware.

The meiofaunal populations of two sandy beaches differing in degree of exposure to wave action were sampled quarterly and environmental factors most important to meiofaunal group abundances identified. Meiofaunal group abundances in vertical cores were correlated with environmental measurements made at the time of sampling for the same depth in the sediment. On the more exposed beach group abundances were significantly correlated with factors that reflected the degree of sediment disruption (sorting coefficient, median grain size, bacterial number). Meiofaunal abundances were significantly correlated with those factors which were a result of the reduced drainage on the more protected beach.

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THE EFFECT OF NEMATODE (DIPLOLAIMELLA SHIEWOODI) PRESENCE ON DENSITY OF MARINE SEDIMENT BACTERIA. R. MILLTON. Univ. of South Florida, Tampa.

Marine sandy sediments obtained from an estuarine area near Tampa Bay, Florida were freeze-thawed and washed to remove endogenous meiofauna. Experimental treatments consisted of controls (no addition of cultured D. shiewoodi), addition of nematodes to approximate natural densities (1500/10 cm<sup>2</sup>), and addition of nematodes to elevated densities (3500/10 cm<sup>2</sup>). Bacterial numbers in these treatments were monitored over 6, 12, and 24 days. The acridine orange direct count method was used to enumerate sediment bacteria from all treatments. Results indicated a significant effect of nematode presence on bacterial number but no significant difference in bacterial density was observed between natural and elevated nematode densities. The results support a hypothesis of bacteria growth stimulation by meiofauna (Gerlach 1978). A second set of experiments to verify the above results is currently in progress.

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ECOLOGICAL ADAPTATIONS AND OCCURRENCES OF ACOCHLIDIACEAN MOLLUSCS IN FIJI. M. P. Morse. Mar. Sci. Inst., Northeastern Univ., Nahant, Ma.

Opisthobranch molluscs are marine except in the order Acochliadiaea where several freshwater species are described from mountain streams on Pacific and Atlantic tropical islands. In a study of the interstitial molluscs of Fiji, four marine species were collected. One of these appears intermediate between described freshwater species occurring on the undersides of rocks, and the three other meiobenthic forms. Species characteristics suggest that larger size, well-developed heart, kidney and reproductive organs are adaptations for the mountain stream environment. In contrast, small size, reduction in reproductive structures, loss of the heart are adaptations for the marine interstitial environment. It is further suggested that flooding and hurricane conditions observed in Fiji may have influenced dispersal of the species and that the ancestral form of freshwater benthic and marine interstitial species may have resembled the intermediate species. (Supported by a Fulbright-Hays Fellowship at the University of the South Pacific, Fiji.)

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EFFECT OF DECOMPOSING MACROALGAL DETRITUS ON THE DISTRIBUTION OF NEMATODES AND HARPACTICOID COPEPODS. D.V. Shaw and L. Watling. Univ. of Maine at Orono, Walpole.

The selective aggregation of nematodes and harpacticoid copepods with respect to macroalgal detritus has been investigated in laboratory microcosms which contained undisturbed sections of estuarine sediment. Centrally located plugs of phenol-leached *Ascophyllum nodosum* served as the source of macroalgal detritus. Results indicated that nematodes and harpacticoid copepods exhibited short-term distributional responses with respect to the decomposing *A. nodosum*. The correlation between sediment protein content and free H<sub>2</sub>S evolution in the sediment with nematode and harpacticoid copepod abundances will also be discussed.

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PARTIAL CHARACTERIZATION OF GIH AND MIH FROM THE SPINY LOBSTER, PANULIRUS ARGUS. L.S. Quackenbush and W.F. Herrnkind. Florida State Univ., Tallahassee, FL.

An extract of the eyestalks of the spiny lobster, *Panulirus argus* was chromatographed on Sephadex G-25, and bioassayed for chromatophore dispersion, molt inhibition and gonad inhibition in *Uca pugnator*. The peak of gonad inhibition had an rf=.45, and the peak of molt inhibition occurred at rf=.39. Polyacrylamide gel electrophoresis of the Sephadex fractions found that GIH had a molecular weight near 5000 D, and MIH had a weight less than 3485 D. GIH can disperse melanophores, but MIH does not. Intact fiddler crabs show a significant correlation between chromatophore dispersion and gonad inhibition. Pigment dispersing hormone from *Uca* eyestalks has the same molecular weight as the lobster GIH, and also inhibits gonad growth in *Uca*. It is concluded that GIH and the chromatophorotropins are related peptides, but distinct from MIH. Supported by NSF #BNS 17944 to WFH, and Psychobiology Program at FSU to LSQ.

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EVIDENCE FOR A COMMON PRECURSOR FOR ACTH- AND  $\beta$ -ENDORPHIN-RELATED PEPTIDES IN THE PITUITARY OF ANOLIS CAROLINENSIS. R. M. DORES. Univ. of Colorado School of Medicine, Denver, CO.

In the mammalian pituitary, ACTH and  $\beta$ -lipotropin are synthesized in a coordinate manner from a common precursor. This biosynthetic pathway was investigated in the reptile, *Anolis carolinensis*. Immunohistochemical staining by the PAP procedure detected ACTH- and  $\beta$ -LPH-related immunoreactivity in the rostral anterior lobe and intermediate lobe. To determine which forms were detected immunohistochemically, intact intermediate lobes were incubated in complete culture medium containing [<sup>3</sup>H]-phenylalanine. Acid extracts were immunoprecipitated with antisera to the NH<sub>2</sub>-terminal of ACTH, COOH-terminal of ACTH, or  $\beta$ -endorphin, followed by SDS-PAGE gel analyses. Labeled peptides corresponding to  $\beta$ -LPH,  $\beta$ -endorphin, ACTH, CLIP, and  $\alpha$ MSH were identified. Cross immunoprecipitation experiments detected a molecule which may represent the common precursor for  $\alpha$ MSH, CLIP, and  $\beta$ -endorphin in this lobe. Similarly, a potential common precursor to ACTH and  $\beta$ -endorphin was detected in the anterior lobe. Supported by NIH grants AM-19859, -18929, -06363, and NS-07083.

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AGGLUTININ PRODUCING HEMOCYTES IN THE ASCIDIAN *Styela clava*. R. K. WRIGHT and E. L. COOPER. Univ. of California, Los Angeles.

Hemolymph from *S. clava* contains a hemagglutinin (HA) for sheep erythrocytes (SRBC). The HA can be inhibited by bovine submaxillary mucin (BSM) but not by BSM carbohydrate subunits or other mono-, di-, and trisaccharides. The HA is non-dialyzable, heat labile (45°C/30 min) and loses its activity after 48 - 72 hrs storage at -15°C to +15°C. Hemolymph cells mixed with SRBC can be divided into 1) non-reactive cells, 2) phagocytic cells and 3) secretory rosette (SR) cells which appear to contain or produce HA. In contrast to hemolymph HA, SR formation can be inhibited not only by BSM but also by galactose (GAL), mannose (MAN), glucose (GLU), GAL-amine, MAN-amine and GLU-amine. No inhibition occurs with 2-deoxy-GLU, 6-deoxy-MAN, 2-, or 6-deoxy-GAL, N-acetyl-GAL-amine or  $\alpha$ -methyl-mannoside. These results suggest that SRBC bind to the surface of SR cells via receptors for carbohydrates containing hydroxyl or amine groups at carbons 1, 2 and 6 of the glucopyranosyl ring. After binding, HA is released. Modifications at carbons 1, 2 or 6 prevents SRBC binding and subsequent HA release. (Supported by NIH Grant HD 09333-06.)

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SIALOGLYCOPROTEIN-BINDING LECTINS IN THE SERUM OF THE FRESHWATER PRAWN MACROBRACHIUM ROSENBERGII. G.R. VASTA, G. WARR AND J. J. MARCHALONIS. Medical University of South Carolina, Charleston.

Macrobrachium serum agglutinates untreated (U), pronase (P) and neuraminidase (N)-treated erythrocytes (RBC): human (Hu):U:128 P:1024, N:128; horse (Ho):U:250, P:32, N:256; rabbit (Rb):U:32, P:64, N:64; sheep (Sh) U:32, P:64, N:32; goose: U:256, P:512, N:64; duck: U:128, P:2048, N:32. Except with Sh and Rb prozone phenomena are observed for all RBC tested. Crossed absorption experiments suggest the presence of more than one lectin (agglutinins for Hu RBC can be completely removed without modifying titers for Ho RBC and viceversa). Two agglutination units for Hu RBC are inhibited with 50 mM of NANA, NGNA, GalNAc, GNAC or ManNAc, 25 mM of methoxyneuraminic acid, 12.5 mM of sialolactose, 0.0002% (w/v) bovine submaxillary mucin (BSM) 0.06% fetuin and 0.12% thyroglobulin. Agglutination of Ho RBC is inhibited only by NANA, NGNA, sialolactose, methoxyneuraminic acid and BSM. Ovomuroid does not inhibit and asialoglycoproteins behave as weak inhibitors. Sialic acid content of glycoconjugates and their inhibitory capabilities for Macrobrachium agglutinins appear to be correlated.

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PARTIAL CHARACTERIZATION OF AGGLUTININS FROM THE EARTHWORM, LUMBRICUS TERRESTRIS. E.A. Stein, A. Wojdani, and E.L. Cooper. Univ. of California, Los Angeles.

The elimination of microorganisms is one of the main functions of the immune system. Several mechanisms have evolved that prevent infections including cells and humoral products. Invertebrates possess humoral products referred to as agglutinins. Hemagglutinins contained in the coelomic fluid of *Lumbricus terrestris* increase in titer after injecting earthworms with erythrocytes (E) of several vertebrate species. As determined by Sephadex G-200 gel filtration, coelomic fluid from injected worms contains 4 different agglutinin peaks, with apparent molecular weights ranging from approximately  $8 \times 10^3$  to  $4 \times 10^5$ . Heat inactivation patterns vary among the 4 fractions. Coelomic fluid from uninjected worms contains 3 agglutinin peaks but of lower titers than the corresponding fractions from injected worms, and is lacking one of the peaks found in injected worms. Coelomic fluid also agglutinates several species of bacteria, reacting with 3 of 7 strains isolated from *Lumbricus* as well as with stock cultures of *Escherichia coli* and *Aeromonas hydrophila*. (Supported by NIH Grant AI 15976-02).

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RECEPTORS FOR ANTIGEN-BOUND IMMUNOGLOBULIN ON XENOPUS LAEVIS SPLEEN CELLS. T.L. Koppenheffer and B.K. Stadig\*. Trinity University, San Antonio, Texas.

The presence of functionally heterogeneous lymphocyte populations in lower vertebrates has been demonstrated by prolongation of allograft survival and production of antibody to bacterial lipopolysaccharide in early thymectomized animals. Moreover, additional levels of heterogeneity are suggested by the differential responses of spleen and thymus lymphocytes to various mitogens.

We have demonstrated further evidence of cellular heterogeneity in the amphibian *Xenopus laevis* by noting the presence of spleen cells that form rosettes when incubated with sheep erythrocytes (SRBC) coated with *Xenopus* anti-SRBC antibody. These cells constitute about 10% of the spleen leucocytes and a small proportion of thymus cells (about 1%). The use of heat-inactivated antisera (56° for 30 minutes) to coat SRBC did not appreciably affect rosette formation. We conclude that amphibians possess spleen cells capable of binding antigen-bound immunoglobulin, although we cannot yet characterize these rosetting cells as possessing  $F_c$  receptors.



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IMMUNE RESPONSE OF TROUT TO DNP CONJUGATED TO KLH, FICOLL, OR AN O-ANTIGEN GIVEN BY INJECTION OR FLUSH CONTACT.

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Rainbow trout (*Salmo gairdneri*) gave an immune response to dinitrophenyl (DNP) hapten when it was conjugated to carriers keyhole limpet hemocyanin (KLH), Ficoll, or an O-antigen of the fish pathogen, *Yersinia ruckeri*. Antigen delivery was by i.p. or by flush contact in ambient tank water. Sheep red blood cells (SRBC) labeled with DNP by a tripeptide linkage were used in the Jerne assay to monitor antibody-producing cells (APC) and in passive hemagglutination tests for humoral antibody. Other SRBC labeled with the O-antigen were similarly used. Immune responses were observed when fish were injected with the hapten conjugated to these carriers. When the DNP-O-antigen was given either by injection or contact, the APC numbers and antibody titers were higher for the DNP hapten than for the O-antigen carrier.

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CORTICOSTEROIDS AND THE IMMUNE SYSTEM OF CYPRINID FISH.

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The Netherlands.

The effect of stress on the immune system of fish was studied by injecting dexamethasone (DM) into carp (*Cyprinus carpio*) kept at 22°C. During the first days after injection a striking decrease in the thymus was observed followed by a recovery period of several weeks. The humoral response to sheep red blood cells (SRBC) was normal or increased when the antigen was given with or immediately after DM. Injection of DM several days after SRBC resulted in a lower antibody response. The cellular immune response as measured by allogeneic scale rejection was not influenced by DM. However, *in vitro* the addition of DM to normal pronephros cells did inhibit the leukocyte response induced by phytohemagglutinin. The effect of DM during the later phase of the response may be explained by an inhibitory effect upon cell proliferation or antibody release. It is tempting to speculate that the generation of suppressor (T?) cells during the early phase of the response is relative sensitive for DM.

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THYMIC MACROPHAGES IN THE INVOLUTING RAT THYMUS: IN VITRO STUDIES OF THEIR RELATIVE ABUNDANCE AND ACTIVITIES. Daniel C. Tsui. Raymond Walters Coll. of Univ. of Cincinnati, Ohio.

The concentration of active macrophages in cultures of thymic cells varies with the age of the thymus. Differential cell counts indicate a significantly higher number of active macrophages in the involuting thymus. Many of these macrophages contain lipid vacuoles and transform into large lipid cells. However, this transformation is seldom observed in cultures of cells from young, developing thymuses. Interactions between thymic macrophages and thymic reticulo-epithelial (RE) cells were studied with time-lapse photomicrography. A macrophage migrating towards an RE cell monolayer first contacts the monolayer with a uropod. Retraction of the uropod is followed by the macrophage migrating towards the point of contact with a wide lamellipodium as its leading edge. Upon entry into a monolayer, a macrophage dislodges and phagocytizes RE cells. This kind of macrophage and RE cell interaction was observed to occur only amongst cells obtained from involuting thymuses. These studies suggest that thymic macrophage activity is a factor in the involution of the rat thymus.

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ANALYSIS OF SYRIAN HAMSTER MHC USING XENOANTISERA. A.G.DARDEN and J.W.STREILEIN\*  
UTHSCD, Dallas, Tx.

Since previous studies have shown that Syrian hamsters lack serologically detectable class I alloantigenic variations, a series of xenoantisera were developed to identify putative invariant class I molecules (murine K/D-like). Antisera, raised in rabbits, mice, rats and Kurdistan hamster lymphoid cells, were analysed following immunoprecipitation of radiolabeled, unstimulated hamster lymph node cells by SDS-PAGE. Results indicate none of these antisera recognize class I-like molecules on hamster tissues. Similar studies using xenoantisera directed against rat and mouse lymphoid tissue and tested on the respective lymph node cells, were able to identify both class I and class II(Ia) molecules. When Con A stimulated hamster lymph node cells were metabolically radiolabeled, immunoprecipitated by the same anti-hamster xenoantisera, a 46kd, B<sub>2</sub>-microglobulin associated molecule was detected. Hamster alloantisera did not detect a similar molecule on hamster Con A blasts. These results suggest that Syrian hamsters may indeed possess class I like molecules. The activation requirement may be indicative of a population of immature T cells in the periphery. (Supported by USPHS Grant RR01133)

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EFFECT OF INHIBITION OF CELL SURFACE TUPNOVER ON PROTEIN SYNTHESIS DURING DESMOSOME FORMATION. Richard Adler\* and Jane Overton, Dept. of Biology, University of Chicago, Chicago, Illinois.

We have investigated synthesis of membrane proteins when desmosomes form in aggregating chick corneal epithelial cells. After cell dissociation, desmosome components are internalized. Cytochalasin B (CB) blocks internalization and increases the rate of new desmosome formation. Therefore, with CB some membrane components enhance desmosome formation. To identify these components, cells dispersed and then allowed to aggregate either with or without CB, were labeled 30 min with <sup>3</sup>H-leucine during the 1st and 6th hr of aggregation. During 1st hr, cells treated with CB incorporate label into TCA precipitable protein at approximately 60% of the control level. SDS-PAGE of membrane fractions of aggregates labeled at this time shown increased synthesis of some high molecular weight proteins in cells incubated without but not with CB. CB had no major effect on protein synthesis during the 6th hr of aggregation. This suggests that without CB, the synthesis of those proteins during the first hour is necessary to replace the internalized components and thus they may be involved in initiating desmosome formation. Aided by GM-24041-01A1, HD07136-03.

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CLOSURE OF LATERAL BODY FOLDS AND AXIAL ROTATION IN CHICK EMBRYOS. S.A. Miller, E.E. Price, S.A. Stewart\* and M.A. Pasch\*. Hamilton College, Clinton, N.Y.

Morphometric analysis quantified phenomena associated with formation of lateral body folds in 20-somite chick embryos. Data were standardized by adjusting sample level according to angle of rotation. A "typical" embryo used in further analysis was constructed by averaging standardized data from 11 embryos. An index of closure for somatopleure folds was superimposed on graphs of standardized data to correlate events. Folding is an epithelial phenomenon, so ectoderm was emphasized. A posterior to anterior sequence is also a temporal sequence of events. Folding started first. Fold ectoderm was thicker than body or amnion, left ectoderm was thicker than right and proliferation was greater in folds. As folding progressed, closure occurred. Rotation happened last and helped complete closure of folds. Greatest thickness differential (fold-body) correlated with initiation of rotation in levels where folding was well underway. Ectoderm thickness in folds dropped off anterior to initial rotation, although folding continued. Differential growth, cell shape changes, constraint of extraembryonic membranes and cranial flexure are implicated as contributors to lateral folding and rotation.

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ADENOSINE-3';5'-CYCLIC MONOPHOSPHATE (cAMP) AXIAL GRADIENT DURING EARLY ORGAN-GENESIS IN CHICK EMBRYO. D.R. Bjorkman\* and G.W. Kalmus, East Carolina Univ., Greenville, N.C.

Cyclic AMP has been found to be an intracellular regulator of a multitude of processes. It is present in the chick embryo at the primitive streak stage and may play a determining role in subsequent chick gastrulation and organogenesis. Chick embryos were examined for cAMP concentration and distribution during neural tube formation at stage 8, when neural tube closure is nearing completion at the mid brain while still continuing both anteriorly and posteriorly. Cyclic AMP concentrations in the developing embryo were determined by radioimmunoassay (RIA) of sequential areas along the axis of the embryo. An axial gradient of total cAMP was found: low in the forebrain to high along the posterior axis. Membrane bound cAMP was localized in frozen sections by a fluorescent antibody which demonstrated a gradient of cAMP along the developing neural tube: high anteriorly, low medially and high posteriorly. Differences between the observed gradients appear to result from cytoplasmic cAMP, suggesting that cAMP may be selectively transferred between cell membrane and cytoplasm during morphogenesis.

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THE EFFECT OF DEXAMETHASONE DOSAGE ON CHICK MORTALITY. R.V. Blystone and D.W. Cromey.\* Trinity University, San Antonio, Texas.

Dexamethasone accelerates latter stages of lung development in avian embryos; however, the distinction between pharmacologic and toxic dose levels is unclear. By single dose injections of dexamethasone into different aged chick embryos, percent mortality at hatch and two weeks post-hatch was recorded in an effort to define toxic parameters of this glucocorticoid.

Dexamethasone was injected into the chorioallantoic space of white leghorn chick embryos on one of five incubation days. The highest consistent dose for which more than 50% of the animals hatched for each day injected was as follows: 14 days (336 hrs) - 0.25µg; 15 days - 0.5µg; 16 days - 2µg; 17 days - 2µg; and 18 days - 4µg. Data for 50+ % survival (expressed in terms of initial number of eggs injected) of 2 week post-hatched chicks were as follows: 14 days - 0.25µg; 15 days - 0.5µg; 16 days - 2µg; 17 days - 1.0µg; and 18 days - 2µg.

The dexamethasone treated chick embryos demonstrate a mortality relationship between dose size and age when injected. Increased post-hatch mortality was observed in the older injected embryos.

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SPERM TRANSPORT AND STORAGE IN THE OVIDUCT OF THE FEMALE RED-SIDED GARTER SNAKE, *THAMNOPHIS SIRTALIS PARIETALIS*.

A. Halpert\* and D. Crews (intro. by R. Tokarz). Harvard Univ., Cambridge, MA

*T. s. parietalis* store sperm from both fall and spring matings until ovulation in summer. To study sperm transport and storage from fall matings, we sacrificed field mated females during artificial low temperature dormancy. Before dormancy, females had sperm stored only in the vaginal portion of the oviduct, 3-5 cm. anterior to the vent. After 6 weeks, sperm were still found in the vaginal lumen. The epithelial cells lining these vaginal areas were hypertrophied and reacted strongly when stained with PAS. In some of these caudal areas, the PAS positive epithelial border had sloughed and engulfed sperm. These PAS positive-sperm masses were also found in the infundibular area where sperm are stored until ovulation. After 20 weeks, most sperm were found in infundibular storage areas. We suggest that these PAS positive-sperm masses not only facilitate the transport of sperm anteriorly from vaginal to infundibular regions but also function nutritionally. Research supported by grants from NIMH and NICHD.

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MORPHOLOGIC EVIDENCE FOR SEASONAL CHANGES IN THE PINEAL ORGAN OF THE GOLDFISH, *CARASSIUS AURATUS*.

John A. McNulty. Loyola Univ., Chicago.

The pineal organ of fishes is hypothesized to have photoneuroendocrine functions and thereby mediates the effects of daylength on seasonal reproductive patterns in temperate species. The morphology of the pineal organ in the goldfish was examined over 12 months in which temperature and daylength fluctuated according to natural conditions. Pineal organs of 55 specimens (5/month, except July) were processed for electron microscopy and the volume of photoreceptor cells and nuclei, and nucleolar diameter quantified using either point-counting stereology or a Zeiss Videoplan image analyzer. Statistically significant differences were found in each variable (cell volume  $p < 0.001$ ; nuclear volume  $p < 0.01-0.05$ ; nucleolar diameter  $p < 0.001$ ), with the peaks occurring during the winter months (Oct-Feb). The troughs occurred between the months of May and July, when the gonads reach their maximum size in nature. These seasonal changes are similar to those reported in other vertebrates and support a functional relationship between the pineal organ, photoperiod and temperature, and reproduction in this species.

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FUNCTIONAL ASPECTS OF FOOD INTAKE AND MASTICATION IN OSCAR (*ASTRONOTUS OCELLATUS*). Dutta, H.M., and L. Lowery.\* Kent State Univ., Kent, Ohio

Teleosts mostly engulf their prey creating a negative pressure in the buccal cavity which is caused by its quick expansion. Impression of the expanded bucco-pharyngeal cavity can be made by a paraffin mold technique. The volume of the expanded buccal cavity has not been reduced once the prey has been engulfed for accommodating the prey and allowing contraction of the pharyngeal muscles which promote mastication of food by pharyngeal jaws. The motion picture recordings indicate retraction of premaxillae at the beginning of food intake followed by a maximum attainment of mouth gape and mastication. The premaxillae are protruded and dentaries are at maximum depression. These events are followed by activities such as bucco-pharyngeal cavity expansion, bulge on the ventral surface of the head, and prominent curvature on the ventral surface anterior to the urohyal. Maximum mouth gape is caused by the depression of the lower jaw. Depression of the lower jaw is caused by the sternohyoid-hyoid-interopercular-mandible coupling, not by the opercular apparatus-mandible coupling as it acts after the full descent of the lower jaw.

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## MUSCULAR FORCES DRIVING THE UPPER CANINES IN CATS. Stuart G. Landry Jr., State University of New York, Binghamton.

A widespread method of killing in carnivores is the "nape bite"; that is, driving the upper canines between the atlas and skull into the medulla. In doing this, the mandible is moved against the skull only enough to set the lower canines in the neck muscles. The actual penetration of the upper canines is effected by rotating the skull around the jaw condyle. The contribution of the various segments of the temporalis mass and the mandibular sling to the turning moments of both the mandible and skull is calculated in cats.

Note: 1. The mouth gape is not wide; 2. The stroke is completed well before occlusion (the tips of the upper and lower canines have not even reached the same frontal plane); 3. The upper canines are parallel to the sagittal plane, the lower canines form an angle of  $20^\circ$  to it; 4. Contraction of the sterno-cleido mastoids opposes the penetration of the upper canines, rather than assisting it.

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STRUCTURE AND FUNCTION OF THE PRIMARY WRIST FLEXOR MUSCLES IN THE CAT. W. Gonyea, D. Sale\*, J. A. Dixon\*, N. Lewandos\* Univ. Tx. Health Science Cent. Dallas

Recently English has shown that the palmar flexor muscles of the cat were most active while the wrist was being extended (J. Exp. Biol. 1978). In our study both the flexor carpi radialis (FCR) and flexor carpi ulnaris (FCU) had sharply peaked length-tension curves, and the peak tension corresponded to the fully extended position of the wrist joint. However, the FCU had a significantly longer time to peak tension ( $37.0 \pm 2.2$  vs.  $23.2 \pm 0.85$  ms) and half relaxation time ( $73.5 \pm 6.5$  vs.  $30.5 \pm 2.6$  ms) for a single isometric twitch than the FCR. The peak tetanic tension was similar for both muscles ( $2.15 \pm 0.34$  kg FCU vs.  $2.23 \pm 0.29$  kg FCR); but the FCU weighed three times that of the FCR (3.30 vs. 1.04 g). These differences reflected in part the higher percentage of slow-twitch fibers in the FCU (42.4 vs. 35.4). However, the FCR had a greater quantity of total muscle connective tissue (hydroxyproline 60.3 vs. 37.3 mg/g). The long insertion tendon (about 1/3 the muscle length) of the FCR was the major reason for the difference in connective tissue between the two muscles, and may serve as an important series elastic component for providing stored energy during locomotion.

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IDENTIFICATION OF SUBTYPES OF TYPE I FIBERS IN THE DOG RESPIRATORY DIAPHRAGM. G. C. Ericsson and M. B. Reid\*. Ohio Univ. College of Osteopathic Medicine, Athens, and Harvard School of Public Health, Boston, Mass.

Muscle samples from selected regions of the diaphragm of 5 dogs were processed histochemically for alkali- and acid-stable ATPase, NADH-TR, and SDH activity. Muscle fibers were classified as type I, IIA, or IIB. Type I fibers of the dog diaphragm could be subdivided into two distinct groups. One subtype, type Ia, stained intensely for NADH-TR and had a fine intermyofibrillar honey-combed pattern of diformazan with peripheral clumping. The second subtype, type Ib fibers, stained somewhat less intensely for NADH-TR than type Ia fibers and the intermyofibrillar network had a particulate appearance of diformazan with only occasional peripheral clumping. The type IIA fibers stained moderately for NADH-TR and the diformazan aggregates were more concentrated in the periphery of the fiber. No type IIB fibers were observed. Type Ia fibers were larger in diameter ( $54 \pm 10$   $\mu$ m) than type Ib ( $35 \pm 9$   $\mu$ m) and type IIA ( $35 \pm 10$   $\mu$ m) fibers. The percentages of Ia fibers ranged from 4 to 9% while Ib fibers ranged from 40 to 55..

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COMPARTMENTALIZATION IN A NON-COMPARTMENTALIZED MUSCLE. A. W. English, W. D. Letbetter\*, and J. Tiggess\*, Emory Univ., Atlanta, GA.

To examine the anatomical organization of gastrocnemius and plantaris muscles in squirrel monkey (*Saimiri* spp.), the histochemical profiles of fibers in different parts of each were determined. Staining for myosin ATPase and for oxidative and glycolytic enzymes allowed fibers to be classified as fast-twitch glycolytic, fast-twitch oxidative-glycolytic, or slow-twitch oxidative. In all parts of each muscle a mosaic of the three types was found in which differences in composition were not significant, suggesting no histochemical compartmentalization. The innervation patterns of individual primary muscle nerve branches were studied by stimulating them until the muscle fibers they innervated were depleted of glycogen. Subsequent glycogen staining revealed that each branch supplies a discrete subvolume of muscle, suggesting an aggregation of muscle units into compartments. It is concluded that compartmentalization into discrete subvolumes about primary muscle nerve branches is a fundamental organizing principle in the design of vertebrate skeletal muscle. Supported by USPHS AM19916.

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PIGMENTS AND MUTATIONS AS A MEANS OF EXAMINING THE DEVELOPMENTAL GENETICS OF PIGMENTATION IN AMPHIBIANS. S. K. Frost. University of Kansas, Lawrence.

Amphibians provide a variety of mutations and color variants useful in understanding how pigments and pigment cells originate and develop. Techniques used to demonstrate how pigment defects might be used to understand these processes include thin layer and column chromatography of pteridine and purine pigments, transmission electron microscopy of the ultrastructural organization of pigment cells, and radioisotope incorporation studies of the time course of synthesis of pigments during development. Two organisms that have been examined in this way are the Mexican axolotl (*Ambystoma mexicanum*) and the fire-bellied toad (*Bombina orientalis*). Each of these animals has a distinctive developmental pattern of pigmentation as well as one or more obvious pigment mutations. Both the normal and mutant patterns of pigmentation have been examined by the above techniques. The results demonstrate that mutant genes in both animals result in severe alterations in pigment synthesis and/or pigment organelle formation. The implications of such alterations will be discussed in terms of the proposed specific effects of pigment genes.

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DESTABILIZATION OF PIGMENT CELL MICROTUBULES IN THE CATFISH RETINA. D.G. Spencer\*, E.Z. Osborne\*, and H.D. Potter. Indiana University, Bloomington.

Through electron microscopic examination, we found cellular processes in the catfish retina to contain microtubules, neurofilaments, and microfilaments arranged in characteristically organized arrays. The appearance and numerical density of these organelles in response to warm and cold incubation and fixation was examined. Cold fixative was found to decrease the number of microtubules in pigment cell processes, relative to warm fixative. Temperature variations in the incubation solutions, however, had no effect. The results were compared to those of similar studies and were related to the environmental demands on the species.

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BEHAVIORAL CORRELATES OF VERTICAL BANDING EVOKED BY ELECTRICAL STIMULATION OF THE BRAIN IN FREE-SWIMMING BLUEGILLS, (LEPOMIS MACROCHIRUS). D. H. Bauer and L. S. Demski, Univ. of Michigan, Ann Arbor, and Univ. of Kentucky, Lexington.

Sites in the brain from which vertical banding, an agonistic color display, were evoked previously in anesthetized bluegills (J. exp. Biol. 84:149-160, 1981) were tested in free-swimming fish using chronically implanted monopolar electrodes. The criterion for selection of a test site was that banding could be evoked at a latency of 10 sec or less using stimulus frequencies of 5 and 50Hz in the anesthetized fish prior to electrode implantation. Full lateral display (vertical banding with dorsal, anal and pelvic fin erection) and escape (rapid undirected swimming) were evoked from points in the dorsal hypothalamus near the third ventricle at the level of the tuberal nuclei and sites in and near the torus semicircularis. Stimulation in the midbrain tegmentum near the midline above the nucleus prerotundus pars medialis at the level of the oculomotor complex produced banding and escape. Results suggest that some brain areas related to banding are probably involved in control of complex agonistic activities of which banding is a component. (The study was part of a PhD dissertation by DHB, Univ. of New Mexico.)

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HEAD FORMATION DURING AGGREGATION AND REGENERATION IN HYDRA ATTENUATA, A SCANNING ELECTRON MICROSCOPE STUDY. P.L. Mayerson, Univ. of California, Irvine, Ca.

Head regeneration was studied both in aggregates, where new heads arise from disorganized tissue and in decapitated hydra where the tissue remains organized and polarized. Hydra were decapitated by cutting just under the tentacles. Aggregates were made by dissociating decapitated, budless hydra into a cell suspension and centrifuging into pellets. Each pellet formed one or more complete hydra.

Aggregates and head regenerates show similar regeneration timing: new hypostomes begin forming at 2 days and tentacles first appear at 3 days. Decapitated hydra show a unique regeneration morphology not found in aggregates. Wound ectoderm forms a cap of cells which appear small and round with numerous short microvilli. This cap varies in size and always forms a discrete boundary with underlying non-wound ectoderm.

Aggregates form a two-layered (ectoderm + endoderm) hollow sphere by 24 hrs. New hydra emerge head first from the aggregates. Pre-hypostomal cells are small, round and smooth surfaced.

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NEURAL ORGANIZATION IN FLY C.N.S. TRANSPLANTS DIFFERENTIATED IN VIVO WITH OR WITHOUT PERIPHERAL INPUT. \*D.R. Nassel, Univ. of Lund, Sweden, and P. Sivasubramanian, Univ. of New Brunswick, Canada.

To study the influence of afferent innervation on neuronal organization in c.n.s. during differentiation in the fly Sarcophaga bullata, we transplanted larval c.n.s. tissue with or without eye discs into freshly pupariated animals. Special attention was paid to the eye discs which give rise to the adult retina and thus the afferents to the optic lobes. Two types of transplants were made: (1) one larval brain hemisphere with eye disc attached, and (2) the entire c.n.s. with all the discs detached. After the metamorphosis of the host fly the transplant was recovered and examined histologically. In experiment (1) the retina differentiated normally; the lamina and medulla had almost normal patterns of nerve cells although some misrouting of retinotopic axon bundles occurred. The lobula and lobula plate were less orderly arranged. In (2) the lamina and medulla were missing; the lobula and lobula plate, although slightly reduced in size, appeared to contain most of their centrally projecting nerve cells and much of the neuropil architectonics was normal. Our experiments confirm the notion that afferent innervation strongly influences normal differentiation in the peripheral parts of the optic lobes, whereas more central neuropil regions are much less dependent on the periphery.

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HYALURONATE DETERMINES THE POSITION OF BLOOD VESSELS IN THE CHICK WING BUD.

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An avascular zone is present in the peripheral mesoderm of the embryonic chicken limb bud. Previous results have shown that the ectoderm is responsible for the formation and maintenance of this avascular region. Various embryonic epithelia were implanted into the wing buds of stage 18-22 chicken embryos. Some of these tissues formed avascular zones in the normally-vascularized mesoderm, while others did not. Tissues that form avascular zones incorporated a large amount of <sup>3</sup>H-glucosamine into hyaluronic acid (HA) while those that did not form avascular zones made little HA. We hypothesize that, during development, mesoderm containing large amounts of HA remains avascular while regions with less HA become vascularized. Slow-release polymer implants containing purified HA caused the formation of avascular zones in the mesoderm. Polymer implants alone or implants containing heparin sulfate or chondroitin sulfate had no effect on the vascular system. This suggests that the vascular pattern in the embryo is partly determined by overlying ectoderm and that HA produced by the ectoderm may create the subectodermal avascular zone.

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DIFFERENTIATION OF EMBRYONIC CHICK EPIDERMIS GROWN TRANSFILTER FROM DERMIS. C.A. Peterson\* and R.M. Grainger, Univ. of Virginia, Charlottesville.

We have developed a system to characterize macromolecules which may be important as signals during embryonic tissue interactions. Chick skin from both feather forming and scale forming regions is separated by mild trypsinization into dermis and epidermis prior to differentiation. These tissues are subsequently placed adjacent to one another, but separated by a Nuclepore filter, and grown in culture 8-10 days. During this culture period the epidermis undergoes morphogenesis forming recognizable, though morphologically abnormal, feathers or scales, depending on the origin of the dermis. Two-dimensional gel electrophoresis of proteins from differentiated epidermis indicates that keratins are synthesized in the cultured epidermis. We conclude that our culture system allows relatively normal differentiation to proceed in these tissues, enabling us to study the interaction of dermis and epidermis *in vitro*. We are attempting to determine what, if any, molecules are transferred from dermis to epidermis by using density labelling methods.

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HERITABLE AND ENVIRONMENTAL COMPONENTS OF DEVELOPMENT AND REPRODUCTION IN RANID FROGS. K. Berven. Univ. of Maryland, College Park.

One critically important problem in evolutionary biology is the distinction between heritable and environmentally induced components of variation in life history traits within and among species. Precise partitioning of the cause of the variation presupposes discussions of the adaptive significance of various character states or of the variation itself. The variation in life history traits of two ranid species, the green frog, *Rana clamitans* and the wood frog *P. sylvatica* were examined along an altitudinal gradient in Maryland and Virginia. The extent of the variation in life history traits including age and size at first reproduction, egg size, clutch size, larval development and adult and juvenile survivorship were determined. Reciprocal transplant experiments of larvae and juveniles in the field and a biometrical analysis of life history traits were performed in the lab to dissect the components of the observed altitudinal variation. The results suggested that both ambient environment and genetic background were important in determining development and reproductive patterns, and that the magnitude of the variation attributable to genetic or environmental sources varied dramatically both between species and among specific traits within each species.

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IN VIVO DEFENSE REACTIONS OF PENAEID SHRIMP TO CARMINE PARTICLES. C. A. Foster. Univ. of Washington, Seattle.

Host reaction to carmine was examined in the gills and heart of the brown shrimp, *Penaeus aztecus*, by light and electron microscopy. A 1.4% carmine-saline solution was injected into the sternal sinus and the shrimp were sacrificed for microscopic preparation at intervals up to 8 days post-injection. Within 1 hr. many of the carmine particles were clumped in the hemolymph and phagocytized and/or encapsulated by hyaline and semi-granulated blood cells; granulocytes were less phagocytic. As the exposure times increased, hemocytic aggregations, multi-layered encapsulations, and melanized nodules were more common than single cellular inclusions. No carmine was observed in the branchial podocytes, but their large dense vacuoles appeared to increase in size and number. A population of non-circulating cardiac cells was weakly phagocytic for carmine, which accumulated in large cytoplasmic vacuoles. The differential recognition and sequestration of 'non-self' apparently depends upon the size and surface properties of foreign substances, resulting in a 'division of labor' among phagocytic cells of *P. aztecus*. (Supported by the Gulf Coast Research Laboratory, Ocean Springs, Mississippi.)

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STUDIES OF *MERCENARIA CAMPECHIENSIS* HEMOCYTES Sheri A. Ulrich and Gary E. Rodrick, Univ. of West Florida, Pensacola and Univ. of South Florida College of Medicine, Tampa.

The edible pelecypod, *Mercenaria campechiensis* is well known for its ability to concentrate microorganisms of public health importance. The handling and consumption of such contaminated clams can pose a potential public health problem. The molluscan response to such foreign material is thought to be primarily cellular. Therefore, the role of clam hemocytes in handling such foreign materials is of great economic and public health importance. For these reasons, the hemocyte behavior was noted at both the light and electron microscopy levels at three different temperatures. Total cell counts, differential counts and hemocyte-bacterial association indices were determined at various temperatures. The hemocyte-bacterial association index was affected by temperature and varied over time. (Supported by Florida Sea Grant No. 125 720073/257\*73)

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RAPID PLASMATOCYTE DEPLETION IN AN INSECT FOLLOWING EXPERIMENTAL INFECTION. B. M. Chain\* and R. S. Anderson, Sloan-Kettering Institute for Cancer Research, Rye, N.Y.

Plasmatocytes and granulocytes, the principal hemocytes of the wax moth (*Galleria mellonella*), were differentiated in this study on the basis of their *in vitro* spreading patterns. Plasmatocytes rapidly assume elongated or stellate forms, and exhibit many characteristics of cells engaged in amoeboid movement. Granulocytes spread more slowly, retaining a rounded configuration with radiating filopodia. Injection of the bacterial pathogen, *Bacillus cereus*, into larval *Galleria* resulted in a very rapid, dose-dependent disappearance of plasmatocytes from the hemolymph. Similar, but less complete, plasmatocyte depletion followed injection of 7 of 8 other bacterial species tested. There was no obvious correlation between bacterial pathogenicity and the intensity of the response. It is likely that plasmatocyte loss from the circulation is part of a primitive inflammatory response. In natural infections the cells may adhere to the hemocoel lining, migrate to the site of infection, and phagocytize or encapsulate the bacteria.

Supported by a grant from the Whitehall Foundation.

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CELLULAR BASIS OF INFLAMMATION IN THE EARTHWORM *EISENIA FETIDA*. Ph. Roch, P. Valembois\* and N. Davant\* CNRS, Univ. of Bordeaux I, Talence (France).

<sup>3</sup>H-thymidine incorporation into the coelomocytes, measured after 16 hours *in vitro* culture, evidenced that both wounds and grafts induced important DNA-synthesis. In both cases, 2 categories of coelomocytes were labelled: small leukocytes ( $\phi < 10 \mu\text{m}$ ) and large ones ( $\phi > 15 \mu\text{m}$ ). Numerous investigations performed in histology, autoradiography and radioactivity counting, have led to conclude that the small L. were specially concerned with graft antigens whereas the inflammation reactions acted on large L.. The percentages of stimulated large L. were similar when compared a first wound (6.6 %) to a first xenograft (10.8 %) or a second wound (4.1 %) to a second xenograft (3.3 %). On the opposite, the percentage of graft stimulated small L. was always 3 times higher than in the case of wounds.

The large L. possessed all the capacities of vertebrate macrophages: phagocytic properties, glass adhesiveness and degradation of foreign proteins. Large L., isolated by spreading on glass, were incubated *in vitro* with <sup>125</sup>I-human serum albumin. The radioactivity released by the cells was only associated with small peptides, indicating a protein destruction.

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PRELIMINARY IMMUNOGENETICS OF *LEPTOGORGIA VIRGULATA*. R.O. Adams, Florida State Univ., Tallahassee.

Tissues of gorgonians fuse with tissue taken from their own colony, but do not fuse with tissues from unrelated colonies. This response is assumed to be inherited and a single locus/multiple allele model has been proposed, but is untested due to difficulty in rearing or maintaining octocorals under controlled conditions. Recently, a few colonies of *L. virgulata* of known parentage have become available for study. Isografts and allografts between related or unrelated tissue were set up to obtain the timing and sequence of events for fusion or non-fusion. All isografts fused with neither scar nor seam within 48 hours. Most allografts failed, but the level of non-fusion ranged from non-reactive tolerance to a highly reactive blister formation combined with tissue loss. The tolerance reaction was typical of parent/progeny grafts and probably represents a dose effect resulting from shared alleles. An occasional allograft fusion suggests either an inbred population or a relatively low degree of allelic variation.

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ANALYSIS OF BOTRYLLUS BLOOD AND TISSUE CELLS WITH MONOCLONAL ANTIBODIES. J.M. SCHLUMBERGER, I.L. Weissman\*, and V.L. Scofield. Stanford University School of Medicine, Stanford, California.

In studies of the primitive histocompatibility system in the colonial tunicate Botryllus, we have produced monoclonal antibodies which bind to cells which participate in colony specificity (allo-recognition). By immunofluorescence and radioimmunoassay, several of these reagents show specific activity against different classes of gradient-separated blood cells, thus allowing use of the fluorescence-activated cell sorter (FACS) to separate cell types, to determine their relative proportions in Botryllus blood, and to further define binding specificities for the antibodies. Isolation and characterization of the corresponding antigens is in progress.

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HOST-PARASITE RELATIONSHIP OF CARDIODECTES MEDUSAEUS (COPEPODA) AND MESOPELAGIC LANTERN FISHES (MYCTOPHIDAE). P.S. Perkins. Univ. of California, Los Angeles.

Cardiodectes medusaeus is a heart-dwelling parasitic copepod with a complex life cycle. Larval development and copulation occur within the mantle cavity of gastropod intermediate hosts. Only post-mated female copepods infest the final fish host. After boring into the pericardial cavity, the parasite lodges on the external wall of the bulbus arteriosus. Growth activity in the copepod's rostral area produces numerous dichotomously branched frontal processes which gradually push their way into the bulbus as development continues. Simultaneously, the parasite's trunk elongates and ruptures through the hosts' body wall. Immunologically, C. medusaeus is an enigma. Copepod death however, does evoke a host response characterized by fibroblast encapsulation of the parasite's remains. TEM observations of healthy parasites reveal a bilayered acellular envelope completely enclosing each frontal process. Collectively, the frontal processes form a large syncytial mass containing an extensive endoplasmic reticulum. ER products may contribute to the immunological unresponsiveness of the fish host. This system may be an ideal model to study host-parasite relationships and the immune system.

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FACULTATIVE ANAEROBIOSIS IN ANTHOZOANS. H. S. Bolton and R. S. Blanquet. Georgetown University, Washington, D. C.

The capability for anaerobic metabolism was investigated in the anthozoans, Bunodactis stelloides and Pachycerianthus americanus, through respiration studies and enzyme analyses of aerobically and hypoxically prepared homogenates. Both species deplete respiratory chambers of measurable oxygen and subsequently demonstrate an oxygen debt after a two hour anoxic excursion. The presence of significant pyruvate kinase (PK), malic dehydrogenase (MDH) and phosphoenolpyruvate carboxykinase (PEPCK) activity indicates that these species may utilize both aerobic and anaerobic pathways. The low activity of lactic dehydrogenase (LDH) found in Bunodactis, and its apparent absence in Cerianthus is consistent with facultative anaerobiosis. Changes in the apparent Km and Vmax activity for PK and PEPCK in hypoxically prepared homogenates, compared to aerobic preparations, especially in Cerianthus, suggest the presence of anaerobically-generated modulators. Activity profiles for PK and PEPCK for both species indicate the simultaneous utilization of aerobic and anaerobic pathways over a significant pH range.

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A BIOCHEMICAL AND MORPHOLOGICAL STUDY OF ASCARID MITOCHONDRIA S. D. Long and G. E. Rodrick, University of South Florida College of Medicine, Tampa, Florida.

Present evidence indicates that the parasitic intestinal nematode Ascaris suum undergoes an aerobic-anaerobic transition during its life cycle. Dramatic changes in both mitochondrial morphology and energy metabolism may occur during this metabolic transition. For these reasons, mitochondria were isolated from 1-celled egg, 10-day embryo, 21-day larvae and adult body muscle and compared both morphologically and biochemically. Results indicate that dramatic mitochondrial morphological changes involving the number of cristae and subunit frequency. These morphological changes may be correlated with changes in the efficiency of oxidative phosphorylation potential especially in phosphorylating sites II and III. In addition, differences in sensitivity to respiratory poisons were noted. (Supported by NIH grant AI 16163-02 and 5 S07 RR0574907)



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RESPIRATORY RESPONSES OF AN ESTUARINE GASTROPOD TO DECLINING OXYGEN TENSION M.A. KAPPER and W.B. STICKLE. Louisiana State University, Baton Rouge.

*Thais haemastoma* acclimated to 10, 20, and 30‰, and 20 and 30°C were allowed to deplete the oxygen in a closed respirometer. Snails (n=60) extracted all detectable oxygen from the respirometer. Movement of snails usually stopped when PO<sub>2</sub> reached 75 torr. The siphon and tentacles always remained extended, even when no oxygen was left in the respirometer. In general, as PO<sub>2</sub> fell due to oxygen uptake by the snail,  $\dot{V}O_2$  remained constant or decreased slightly. Pc's were in the range 50-90 torr, where  $\dot{V}O_2$ 's started to fall more rapidly. When PO<sub>2</sub> fell below 8-10 torr,  $\dot{V}O_2$  decreased dramatically, decreasing by as much as 2-3X in a 10 torr span. B2, the quadratic coefficient in the second-degree regression of standardized  $\dot{V}O_2$  vs. PO<sub>2</sub>, used as an index of regulatory ability, ranged from  $-1.1 \times 10^{-5}$  indicating poor regulation to  $-11 \times 10^{-5}$ , indicating good regulation. B2 values were not related to acclimation temperature or salinity. The ability of *Thais* to regulate its  $\dot{V}O_2$  in declining PO<sub>2</sub> shows great intraspecific variation. Supported by NSF grant DEB7921325.

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AERIAL OXYGEN CONSUMPTION IN THE INTRODUCED FRESHWATER CLAM, *CORBICULA FLUMINEA* MÜLLER. R. F. McMahon and C. J. Williams. Univ. of Texas at Arlington, Arlington, Texas 76019.

*Corbicula fluminea* displays a unique mode of aerial gas exchange. While other freshwater species respire across closed valves, the valves of *C. fluminea* are parted and the mucus sealed mantle edges exposed directly to air. This behaviour is alternated with longer periods of valve closure (mean mantle exposure=49.1 min, mean valve closure=426.2 min). Aerial O<sub>2</sub> consumption rate ( $\dot{V}O_2$ ) at 20°C with valves shut averaged 0.049  $\mu\text{l O}_2/(\text{mg}\cdot\text{hr})$ . During mantle edge exposure it was 0.876  $\mu\text{l O}_2/(\text{mg}\cdot\text{hr})$ . Over the entire exposure period it averaged 0.057  $\mu\text{l O}_2/(\text{mg}\cdot\text{hr})$  or 21.8% of aquatic  $\dot{V}O_2$ .

Aerial  $\dot{V}O_2$  during mantle edge exposure is 3.4 times the aquatic rate, indicating that O<sub>2</sub> is not absorbed directly into body fluids. Rather, mantle respiratory gases appear to be exchanged with the external atmosphere across the mantle edge renewing pallial O<sub>2</sub> stores before valve reclosure and reducing evaporative water loss. *C. fluminea* has a short freshwater fossil history and is intermediate between freshwater and estuarine bivalves in many aspects of its biology. Its mode of aerial respiration is similarly intermediate between the aerial gaping of marine species and the direct diffusion of gases across the shell in freshwater species.

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DIRECT AND INDIRECT CALORIMETRIC MEASUREMENT OF METABOLIC RATE IN BIVALVE MOLLUSCS DURING AERIAL EXPOSURE. J. M. SHICK and J. WIDDOWS\*. Univ. of Maine, Orono, and Inst. for Mar. Envir. Res., Plymouth, U.K.

Subtidally-acclimatized *Mytilus edulis* had a higher rate of heat production ( $\dot{Q}_H = 0.83 \text{ J}\cdot\text{g}^{-1}\cdot\text{h}^{-1}$ ) in air than did intertidal individuals ( $\dot{Q}_H = 0.50$ ). While 38% of total  $\dot{Q}_H$  was aerobic in intertidals ( $\dot{Q}_{OX} = 0.19$ ), subtidals were fully anaerobic. These facts are related to the higher ration, valve closure, and greater activity during acute emersion in subtidals. An increased energy demand during aquatic recovery from aerial exposure was indicated both by  $\dot{V}O_2$  and  $\dot{Q}_H$ . Both intertidally ( $\dot{Q}_H = 4.63$ ;  $\dot{Q}_{OX} = 5.20$ ) and subtidally ( $\dot{Q}_H = 7.67$ ;  $\dot{Q}_{OX} = 7.20$ ) acclimatized *Cardium edule* were fully aerobic during 5 h of aerial exposure. The higher rate in subtidally-acclimatized *Cardium* was due to increased activity during acute emersion and not to ration, as subtidal specimens on as low a ration as intertidals had a metabolic rate ( $\dot{Q}_H = 7.07$ ;  $\dot{Q}_{OX} = 7.33$ ) as high as fully fed subtidals. After 5 d without food,  $\dot{Q}_{OX}$  was zero in *Mytilus* and 3.17 in intertidal *Cardium*, indicating that a portion of aerobic metabolism in air is due to the "specific dynamic effect" of food. (Supported by NSF grants PCM79-11027 and SPI80-13119.)

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BODY SIZE, THERMOPHYSIOLOGY, AND TERRITORIALITY IN MALE WESTERN CICADA KILLER WASPS (*Sphecius grandis*). Jon Hastings, Univ. of New Mexico.

Cicada killers are large aggregatory wasps. Individuals of both sexes are endothermic and regulate thoracic temperature fairly precisely. Males emerge from underground nest cells before females and establish breeding territories in the nesting area. Females emerge throughout the day, and males active on territories during times of female emergence obtain most copulations with the emerging females. Larger males win most direct contests over territories. Small males, possibly because of their superior ability to dissipate metabolic heat, tend to replace large males on territories when ambient temperatures are high.

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RELATIONSHIP BETWEEN METABOLIC RATE AND AGEING IN THE HOUSEFLY, *MUSCA DOMESTICA*. R.S. SOHAL. Southern Methodist Univ., Dallas, Texas.

The metabolic rate of houseflies was altered by varying the levels of physical activity and ambient temperatures. Physical activity of male flies was altered by manipulating sex ratios of populations, wing removal and varying the size of housing containers and was measured by radar-Doppler instrumentation. Life spans were significantly prolonged in response to conditions which decreased physical activity. Individual differences in life spans between flies of the same group corresponded to the differences in levels of physical activity. The total amount of oxygen consumption till average life span was nearly equal in the short-lived, high activity flies and the long-lived, low activity flies. The results strongly support the concept that ageing rates may be modulated by the rates of oxygen consumption. (Supported by the N.I.H. grant 5 R01 AG00171.)

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FERTILIZATION EFFECTS AND LOCALIZED BINDING OF LECTINS IN THE ASCIDIAN PHALLUSIA. T. G. Honegger. Univ. of Zürich, Switzerland.

The effect of concanavalin A (Con A), fucose binding protein (FBP) and wheat germ agglutinin (WGA) on fertilization of the ascidian *Phallusia mammillata* egg was investigated. Con A and FBP have no influence on fertilization and no binding to the chorion or sperm was detected either with FITC-conjugated Con A or with gold-labelled FBP by EM. Eggs treated with WGA (100 ug/ml) were not fertilizable by sperm in concentrations which gave 100% fertilization in the controls. The effect of WGA is abolished in the presence of N-acetyl-glucosamine (5mg/ml). Investigations with FITC-conjugated and gold-labelled WGA reveal binding sites on the chorion but not on follicle cells nor sperm. Fine structural analysis shows that WGA gold-markers are bound to the fibrillar network forming the outer layer of the chorion and that WGA inhibits fertilization by interfering with sperm-binding to the chorion. Two mechanisms may be visualized to explain this effect: 1) the chorion surface sperm receptors are masked or 2) as a result of crosslinking of specific saccharide residues the chorion becomes resistant to sperm enzymes.

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THE CORTICAL CYTOPLASM AND SITES OF SEQUESTERED CALCIUM IN THE TELEOST EGG. J. Nugent\*, N.H. Hart and M. Schalkoff\*. Rutgers University, New Brunswick, N.J.

The mature egg of *Brachydanio* shows a distinct, organelle-rich layer of cytoplasm (cortex) beneath the oolemma. Polarity in the structural organization of the cortex is marked by the site of sperm penetration. The cytoplasm at the sperm entry site is populated with numerous miniature cortical vesicles (1.5 to 5.2  $\mu$ m in diameter) but is devoid of the large cortical vesicles typically found throughout the rest of the cortex. Other organelles found in the cortex include mitochondria, Golgi, microbodies and endoplasmic reticulum (ER). The ER forms an extensive network, appearing in single planes of section as membrane-bound tubular profiles and isolated vesicles. Using the technique of antimonate precipitation to determine sites of calcium distribution, deposits have been found to be associated with mitochondria, plasma membrane and cortical vesicles. Electron probe microanalyses of these deposits confirm the presence of significant concentrations of calcium. Experiments with ionophores suggest that stored calcium is a requirement for the exocytosis of cortical vesicles. (Busch Fund Supported)

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STUDIES OF THE REJECTION REACTION IN *BOTRYLLUS* OOOZOOIDS. L. NAGASHIMA and V. L. Scofield. Stanford University School of Medicine, Stanford, California.

The rejection reaction following ampullar contact between genetically incompatible *Botryllus* oozoids shows distinct forms: ampullar bleeding, amputation, or disintegration, as well as systemic vascular changes, occur separately or together for different oozoid pairs. Genotypic differences between different oozoid pairs may determine the nature of the rejection response. Communication of rejection signals to distant areas in the oozoid may affect the whole animal response to an incompatible neighbor. These findings suggest possible mechanisms for *Botryllus* histocompatibility discrimination.

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SPERM CHEMOTAXIS OCCURS IN ECHINODERMS.  
R. L. MILLER. Department of Biology, Temple University, Philadelphia, PA 19122.

Sperm of the asteroids *Pisaster ochraceus*, *Orthasterias koehleri*, *Evasterias troschellii*, *Dermasterias imbricata*, *Pteraster tesselatus*, *Henricia leviuscula*, and the holothuroid, *Parastichopus californicus* are attracted chemotactically to alcoholic extracts of eggs and ripe female gonads. Similar extracts of tube feet and other body parts are ineffective. The chemotactants induce a sudden change in direction of swimming in both thigmotactic and suspended spermatozoa such that they swim toward the attractant source. The initial reorientation involves an increase in the diameter of the normal helical path and may not be precise. Subsequent reorientation may not occur, but the response is reversible in some species. Sperm agglutination does not occur except in *Dermasterias* and then only at the highest concentrations of the homotypic attractant. There is little or no genus-specificity between tested members of the order Forcipulata, while genus-specificity is generally complete between the tested members of the order Spinulosa and between all the asteroids and the Aspidochirotid holothurian. The chemical nature of the attractants remains to be determined. (Supported by a grant from Temple Univ.)

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REGIONALIZATION OF THE EGG CYTOPLASM OF THE LOWER CHORDATES BEFORE FERTILIZATION. H. C. Tung, S. C. Wu, and W. F. Yen. (Intro. by C. C. Lambert) Institute of Oceanology, Academia Sinica, Tsingtao, CHINA.

Eggs of *Amphioxus*, *Branchiostoma belcheri* and *Ascidian*, *Ciona intestinalis* were cut meridionally or latitudinally before fertilization. Both fragments were fertilized. Embryos raised from those cut meridionally were similar to those obtained from isolated blastomeres at the 2-cell stage. When cut latitudinally, the two halves were similar to those separated at the 8-cell stage: the animal half was an ectodermal vesicle whereas the vegetal half was an embryo containing only mesoderm, chord and endoderm. These results were also checked by means of antibody technique for the distribution of the muscle protein, tropomyosin. It is clear that the egg cytoplasm was already segregated along its A-V axis before fertilization.

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FECUNDITY OF THE TIDEWATER SILVERSIDE *MENIDIA BERYLLINA* (COPE) FROM TAMPA BAY, FLORIDA. BRANDT F. HENNINGSEN. University of South Florida, Tampa, Florida.

Females of *Menidia beryllina* (Cope) containing mature or maturing ova were examined to estimate their annual fecundities. Fishes were collected via seine from March 1979 through January 1980. Ova size frequency distributions delineated developing modes. Fecundities as estimated by the gravimetric method ranged from 4-10327 ova/female ( $\bar{x}$ =2851 ova/female); relative fecundities ranged from 2-1493 ova/g soma ( $\bar{x}$ =692 ova/g soma). Females were fully mature at about ten months of age. Gonad indices coupled with fecundity estimates indicated an extended spawning season of at least March through August 1979, with a peak in May-June 1979. An earlier and second peak was indicated in January 1980. Subsequent samples indicate a potential spawning season of January through August. This research was partially funded by the Stone and Webster Engineering Corporation, Mote Marine Lab, and the Department of Biology, University of South Florida.

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THE SPERMATOZOON OF THE TERRESTRIAL MOLLUSC, *ANGUISPIRA ALTERNATA*, James W. Atkinson, Michigan State Univ., East Lansing, Michigan.

Sperm were extracted from the hermaphroditic duct of adult snails throughout the year and examined using various techniques of light and electron microscopy. The spermatozoon is a dextral spiral of approximately 557  $\mu$ m in length of which 13  $\mu$ m is head, 4-5  $\mu$ m is tail and the remaining 540  $\mu$ m is midpiece. A thin layer of moderately electron-dense material lies along one side of the anterior tip of the nucleus. The neck contains 9 coarse fibers and a peculiar coiled fiber in the core of the axoneme. The axoneme pattern is 9+2 just below the head grading into a 9+2 pattern for most of its length. The outer coarse fibers possess peculiar clefts or channels aligned with the 9 inner fibers. Extracted sperm are not motile. Trypsin treatment does not induce motility; rather it produces a step-wise destruction of the nucleus. The observations are compared with those in the literature describing the spermatozoa of other pulmonates.

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HERITABILITY OF LIFE HISTORY TRAITS IN A MICHIGAN AND FLORIDA COPEPOD POPULATION. G.A. WYNGAARD Univ. Maryland, College Park.

The genetic and environmental contribution to life history variation in Michigan and Florida populations of Mesocyclops edax (Crustacea:Copepoda) were quantified using heritability estimates. Each population was reared in a defined environment for two generations. Means and variances of fitness traits including developmental time, body size, clutch size, and egg size were measured. Both half sib analyses and parent-offspring regressions were used to estimate heritability of life history traits. These estimates are used to evaluate the usefulness of the heritability approach in assessing the adaptive significance of such traits and the nature of past selection pressure upon them.

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"IS HERITABLE LIFE-HISTORY VARIATION SELECTIVELY MAINTAINED?", M.R. ROSE, Dalhousie University, Halifax, Nova Scotia.

Data indicates that abundant heritable variation in life-history traits is maintained by antagonistic pleiotropy. The variability could be neutral or maintained by selection. These alternatives were tested with artificial selection on Drosophila melanogaster populations. After using artificial selection to perturb the frequencies of genes affecting early egg-laying, I ascertained whether natural selection brought the populations back to the initial selective equilibrium. Artificial selection increased the value of early egg-laying by 30-40%, and realized heritability was about 40%, replicating earlier measurements. After the initial increase due to artificial selection, inbreeding depression reduced the trait in both selected and controlled lines. When lines were crossed within treatments, the effects of inbreeding depression disappeared, and there was no subsequent evidence of a return to an initial selective equilibrium in relaxed-selection lines. This result is consistent with neutral genetic polymorphism. It is also consistent with small to moderate effects of selection in populations of finite size.

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GENETIC CORRELATIONS AMONG COMPONENTS OF AN ADAPTIVE SYNDROME. C. B. LYNCH, M. S. Connolly and D. S. Sulzbach\*. Wesleyan Univ., Middletown, CT, and U. C. S. D., La Jolla, CA.

Evolutionary constraints on and biological mechanisms underlying specific trait expression can be deduced from genetic correlations. We estimated additive genetic correlations among traits representing behavioral, morphological and physiological aspects of thermoregulation in Mus musculus in 2 experiments: a diallel analysis of 4 inbred strains, and a parent-offspring comparison in a random-bred population synthesized from the 4 strains. Correlations due to dominance, maternal, and other environmental effects were also estimated from diallel data. Nesting (weight of cotton used to build a nest) was the trait involved in the largest number of significant correlations, being positively correlated with body weight and body temperature, and negatively correlated with food consumption. Weight, temperature and food consumption, as well as fertility traits all exhibited correlated responses to selection for nesting. The inbred and outbred stocks both produced similar correlation patterns although the diallel apparently overestimated the magnitude of the values.

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VARIATION IN LIFE HISTORY TRAITS INDUCED BY ALTERATION OF ENERGETIC ENVIRONMENT. F.A. MARSTELLER, P. Batchelder\* and C.B. Lynch. Wesleyan Univ., Middletown, CT.

Critical tests of life history theory require species which can be ecologically classified into "r" and "K" types and for which mortality and birth rate patterns can be experimentally modified. We conducted experiments on Mus musculus at warm and cold temperatures and with ad libitum and restricted diets in order to study variation in reproductive tactics. Mice in the harshest environment showed reduced mating, fertility and offspring survivorship. There was also a pattern of correlations among traits indicating an increasing reproductive cost associated with increased litter size which was absent in mice in milder treatments. Reduction in the proportion of males in litters of cold restricted females was also observed, indicating an adaptive reduction in litter size in harsh environments. These results in combination with previous studies of the genetics and ecology of the mouse suggest that this species is a good mammalian model for both experimental and comparative tests of life history theory.

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FERTILITY CHARACTERISTICS AND ENVIRONMENTAL RESPONSIVENESS IN CROSSES OF CONNECTICUT AND GEORGIA MICE H.A. WICHMAN, C.B. Lynch and G.R. Lynch. Wesleyan Univ., Middletown, CT.

Genes are described as coadapted if high fitness depends on specific interactions between loci. Coadaptive breakdown may occur in crosses between organisms from differentiated gene pools, and often appears in the  $F_2$  as a deficit in a fitness character. Although assumed to be widespread, coadaptation has not been demonstrated in mammals. In crosses of Peromyscus leucopus from Connecticut (C) and Georgia (G),  $F_1$  CG females showed a tendency toward heterosis for several fertility traits (number of successful matings, latency to first litter, litter size, number of pups weaned). Coadaptive breakdown in fertility of  $F_2$  females was not apparent. In contrast, several traits did show non-adaptive deviations from typical polygenic inheritance in some of the  $F_2$  mice. All of these traits involved responses to environmental changes in photoperiod or temperature. Lack of response occurred in  $F_2$  mice with C maternal grandmothers, but not in the genetically equivalent class of  $F_2$  mice with G maternal grandmothers. Supported by NIH grant no. GM21993 to CBL.

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PREDICTING EVOLUTIONARY CONSTRAINTS BY INVERSE OPTIMIZATION TECHNIQUES.

R.A. Myers. Biology Dept., Dalhousie University, Halifax, N.S., Canada.

A method for predicting the constraints on the evolution of life history traits of iteroparous species is presented. Inverse optimization techniques were used to determine the values of natural mortality, reproduction mortality tradeoffs, and energy conversion efficiencies that would be needed to make observed life histories evolutionarily stable. It was found that for an iteroparous species which continues to grow after reproduction commences, there must either be a tradeoff between reproduction and mortality or the conversion efficiency of energy into eggs must be a concave function. Both deterministic and stochastic analyses were conducted using a large number of fish and crustacean species, and it was shown that temporal environmental stochasticity drastically alters the predicted life histories. Sensitivity analysis was used to determine the robustness of the predictions.

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PAEDOMORPHOSIS AND DIFFERENTIAL GROWTH IN MORPHOLOGICAL EVOLUTION OF SALAMANDERS.

H.B. Shaffer. Univ. of Chicago, 1103 E. 57th St., Chicago, Il. 60637.

On the basis of a recently completed electrophoretic study, the relationships of a group of 15 species of Mexican salamanders, many of which fail to complete metamorphosis, has been elucidated. The biochemical evidence suggests that the retention of the larval morphology has occurred repeatedly during the phylogeny of the group. Using these proposed relationships, the hypothesis that the bizarre external morphology of these larval forms simply represents an extension of the primitive larval growth trajectory of related, transforming populations is explored using both bivariate and multivariate techniques. In several cases (Ambystoma rosaceum, A. tigrinum) the above hypothesis is substantiated. In others (A. dumerilii, for example) a shift from the primitive pattern has apparently occurred, yielding a radically different adult morphology. The biochemical evidence suggests that these shifts in growth rates can occur rapidly in evolutionary time, thus representing a means for extremely rapid morphological change within this lineage.

428b

EGG SIZE AND THE TIMING OF REPRODUCTIVE EFFORT IN FISHES. D. POLICANSKY (Intro.

by S. Stearns). Harvard Univ., Cambridge.

There is a great difference in the variation of body sizes and egg sizes in teleost fishes. Some families have great differences in both egg and body sizes, others differ in one or the other. For example, the mackerel family (Scombridae) has fish with body sizes of a few hundred g to a few hundred kg, but egg sizes vary little. The sunfish family (Centrarchidae) by contrast has fish with body sizes of from about 100g to about 2000g, and the egg sizes range from about .25ml to about 5.5 ml. Thus the ranges of egg and body sizes are about equally large in this family. The mackerels broadcast their eggs, thus there is no post-zygotic reproductive effort. The sunfishes have well-developed parental care, thus they do have post-zygotic reproductive effort. I suggest that an analysis of the timing and nature of reproductive effort in fishes helps to understand why there is great variation in egg size in some groups, and relatively little in others.

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SOME FEATURES OF THE LARVAL AND SETTLEMENT STAGES OF THE SEA STAR, *PATIRIA MINIATA*. R. Andrew Cameron, Dept. of Marine Sciences, University of Puerto Rico, Mayaguez, Puerto Rico.

Larvae were reared through metamorphosis in the laboratory and experiments were conducted on these larvae to ascertain the substrate specificity at settlement. Using the morphology of the bracholarian arms observed in laboratory cultures, larvae were identified from plankton samples. Identifiable *Patiria* larvae were found at two stations in Northern Monterey Bay, California, from July to September. However, younger, unidentifiable sea star larvae occur in June. Larvae develop to metamorphic competence in approximately 45 days. In the laboratory, larvae settle on surfaces with a bacterial film. Larvae will select shaded undersides of surfaces if available; however, undersides are not necessary for settlement to occur. The completion of metamorphosis to a crawling juvenile requires several days. Supported by Center for Coastal Marine Studies, University of California, Santa Cruz.

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EFFECT OF TEMPERATURE AND SALINITY ON LARVAL DEVELOPMENT OF TWO ECHINASTER (ECHINODERMATA: ASTEROIDEA) MORPHS AND THEIR HYBRIDS. S. A. Watts, R. E. Scheibling, A. G. Marsh and J. B. McClintock. Univ. South Florida, Tampa.

Two similar morphs (Types I and II) exhibit different patterns of embryonic development. Responses of the morphs and their hybrids to temperature and salinity combinations (20, 25, 30°C; 25, 32, 39‰) were investigated. Response surface contours using larval development time indicated different T-S interactions between Type I and II. Minimal time until metamorphosis, maximal radial size, and maximal rate of development in Type I, Type II, and their hybrids occurred at 30°C and 32‰. The rate of development was directly related to temperature. Individuals developed more rapidly at 25‰ than 39‰. At 39‰ Type II developed more rapidly than Type I. Type I hybrids developed more slowly than Type I wild at 25‰ while developing faster at 39‰. Type II hybrids developed either equal to or lower than Type II wild at all salinities. Morphological variants (3 and 4 arms) occurred with Type II at 39‰. These results support the suggestion that the morphs are separate species.

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ATTACHED STAGES OF *CYANEA* (SCYPHOZOA) ON NATURAL SUBSTRATES. R.H. BREWER. Trinity College, Hartford, CT 06106.

Shells dredged from the Niantic River, a shallow estuary of Long Island Sound, were examined to determine the number and distribution of the benthic stages of *Cyanea*: polyps, podocysts, and recently settled planulocysts. A total of 10% of 2539 shells of 10 mollusc species possessed one or more of these stages, varying between 1% and 18% according to shell type. The dispersion of the 2051 individuals found is clumped; the maximum number of polyps, podocysts, or planulocysts was 28, 50, and 33, respectively. The distribution of 1200 individuals on scallop shells shows that 65% of polyps and podocysts occur on the highest 25% of the shell when naturally oriented on the bottom, while only 33% of the planulocysts are found there. All polyps and 99% of both podocysts and planulocysts are attached underneath, and on the concave face, of shells; 99% of planulocysts (all of the other stages) are found on the smoother portions of shells. The different attachment sites of planulae (planulocysts) compared with the position of polyps on shells may indicate post-settlement survival. The orientation of stages agrees with laboratory results; their occurrence on smooth surfaces does not.

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DEVELOPMENTAL CHANGE IN OOCYTES FOLLOWING PARTHENOGENIC REPRODUCTION IN THE FRESH-WATER GASTROTRICH, *Lepidodermella squammata*. M.R. Hummon, Ohio University, Athens.

*L. squammata* in culture survives for 2-4 wks following a 3-6 day period of parthenogenic reproduction (PR). Sperm of uncertain function are known to form shortly after completion of PR. This report describes simultaneous changes in the remaining oocytes. Animals cultured singly from eggs were monitored twice daily during PR, and then were examined with Nomarski optics. Animals fixed for TEM were of known age and stage (1-4) of spermiogenesis. In animals of stages 3 and 4, the most anterior of each bilateral group of oocytes has a fine structure similar to a growing parthenogenic egg, with large nucleus and nucleolus, little ER, and densely packed ribosomes. In contrast, posteriorly adjacent oocytes have small nuclei and nucleoli, much RER, and extensive Golgi stacks often filled with a finely granular secretion. The most posterior oocytes are almost occluded by the secretion, which is membrane bound and may include smaller spheres of differing density. The densest accumulation is ventral to the posterior gut, and extends laterally; with Nomarski, it would be identified as X-organ bodies. The function of the secretion is unknown.

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INTERSTITIAL NEMERTINES AND THEIR DISTRIBUTION. Jon L. Norenburg (intro. by J.D. Ferraris). Northeastern Univ., Boston, MA

Some faunal groups in the interstitial environment of marine sands appear to be quite old and presently have wide, geographic distributions. Among these, interstitial nemertines and other groups frequently display confounding, morphological homogeneity among geographically distant and disjunct taxa members. Interstitial nemertines of New England and the Pacific Northwest were studied in detail, with complementary observations of Florida and Caribbean species. Several new species and important geographic, range extensions of genera were discovered. Some of Sterrer's (1973) predictions are supported: Ancestral stocks were established and dispersed before break-up of Pangaea; subsequent plate tectonics may account for amphi-Atlantic "sister-species". However, divergence appears to have stopped at the generic level, and along-shore dispersal alone cannot explain all of the distributional sympatry. Zoogeography of *Ototyphlonemertes* confirms morphological evidence for at least two, distinct monophyletic lines in this genus.

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ULTRASTRUCTURE OF THE NEMERTINE CIRCULATORY SYSTEM: BLOOD VESSELS OR COELOMIC CHANNELS? J.M. Turbeville and E.E. Ruppert. Clemson Univ., S.C.

Classical investigations of the nemertine circulatory system revealed that the principal vessels are situated laterally, and that they are lined by a continuous endothelium. This organization contrasts sharply with that of the majority of metazoans where blood vessels are situated dorsally and ventrally and lack lining endothelia. The organization of nemertine blood vessels is consistent with interpreting them as either coelomic channels with peritoneal lining or as true blood vessels lined secondarily by an endothelium. Ultrastructural data regarding the sequence of overlying muscle layers in three orders of Nemertea support the interpretation of the system as a true blood vascular system. Out-group comparisons establish unlined blood vessels as the plesiomorphic design among Metazoa. This result is inconsistent with the Planuloid-Schizocoel theory of metazoan evolution which proposes a plesiomorphic design for nemertine blood vessels. (Supported in part by NSF Grant DEB-7823395)

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THE ULTRASTRUCTURE OF STYLET FORMATION IN NEMERTEANS. Stephen A. Stricker. University of Washington, Seattle, WA.

Nemerteans belonging to the order Hoplonemertea capture prey by using a proboscis that is armed with a calcareous, nail-like stylet. Stylet formation was examined in seven species of hoplonemertean by light and electron microscopy. Stylets are composed of an organic matrix surrounded by a calcified cortex, and are formed in large epithelial cells, called styletocytes. In *Emplectonema gracile*, stylets first appear in 4 day old larvae and reach 15  $\mu$ m in length within 3 days. In adult nemerteans, three stages in stylet formation are recognizable: 1) a membrane-bound stylet vacuole (SV) is formed in the styletocyte, apparently by the STR; 2) Golgi bodies become associated with the SV, and a periodically-banded organic matrix develops in the vacuole; 3) mitochondria line the outside of the SV and presumably contribute the calcium that crystallizes on the organic matrix. The ultrastructure of the organic matrix is species specific, and the shape of the cortex corresponds to that of the matrix, suggesting that stylet morphology is determined by the organic matrix that is deposited. (Supported by NIH grant GM 07270)

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LARVAL DEVELOPMENT OF THE SPIDER CRAB *MITHRAX VERRUCCOSUS* MINE EDWARDS, REARED IN THE LABORATORY (DECAPODA: BRACHYURA: MAJIDAE). J. BOLAÑOS AND M.A. SCELZO. Centro de Investigaciones Científicas. Univ. Oriente, Isla Margarita, Venezuela.

The complete larval development of the spider crab *Mithrax verrucosus* from hatching to first crab stage, obtained by culture in the laboratory are described and illustrated. Best survival for zoeal stages occurred at 25°C and 35‰ of salinity and 30°C for the megalopa. Duration from hatching to first crab was 15-16 days at 25°C, 11-15 days at 25° and 8-12 days at 30°C. The first zoea has the antennule with 4 aesthetascs and 1 short and 2 long single setae on the basipodite of second maxilliped. Second zoea with coxal endite of maxilla with 4+5 setae. Endopodite of second maxilliped with 0,1,5 setae. Morphological characteristics of *M. verrucosus* larvae compared with other species already described show more similarities with *M. forceps* and *M. pleuracanthus* than *M. spinosissimus*.

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LARVAL DEVELOPMENT OF *UCA SUBCYLINDRICA*.  
N. N. Rabalais and J. N. Cameron, Univ.  
of Texas Marine Science Inst., Port  
Aransas Marine Laboratory.

The larval development of *Uca subcylindrica*, an inhabitant of semi-arid environments of south Texas and north-eastern Mexico, is described based on laboratory-reared larvae. The anomalous features of this life cycle are compared to other members of the genus *Uca*. *U. subcylindrica* produces few ( $\bar{X}=522$ ), large ( $\bar{X}=1.1$  mm, diameter) eggs compared to other *Uca* which produce from 4,500 up to 300,000 0.3-mm eggs. *U. subcylindrica* passes through 1 zoeal, compared to 5 for other *Uca*, and 1 megalopal stage. The duration of the zoeal stage ranges from 1 to 6 days ( $\bar{X}=3.3$  d) and the megalopal stage ranges from 2 to 7 days ( $\bar{X}=4.1$  d). Thus, development to the first crab stage is complete within 3 to 13 days ( $\bar{X}=10$  d). Other temperate, western Atlantic *Uca* larvae require 1½ weeks to 2 months for complete development. Survivorship in conditions of 15 ‰ is greater than in 30 ‰. Zoeae in 45 ‰ did not metamorphose into megalopae and failed to survive past 8 days. Zoeae and megalopae have been found in nature in temporary pools (20 ‰) but not as yet in the burrow water, a suspected nursery area, nor in more permanent sources of water.

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DEVELOPMENT AND POPULATION STRUCTURE OF *UCA SUBCYLINDRICA*. C.L. Thurman and J.R. Thurman\*. The Medical College of Ohio, Toledo.

Since very little is known about the living crab, *U. subcylindrica* has been considered a challenging species. Six hundred-thirty specimens of the fiddler crab were collected from twenty-five localities in the Laguna Madre of Texas and Mexico.

Larval development in the crab is anomalous with respect to other *Uca*. Ovigerous females were taken from freshwater and hypersaline habitats. Clutches from these consisted of about 1000 eggs. The 1.0 mm ovum correlates with dimensions of the genitalia. After a large, spineless zoeal stage, a megalops emerged in three days. In less than 30 days, the first crab stages (3.0 mm) were observed.

In a sample of 417 specimens ( $\mu = 8.1 \pm 0.8$  mm-carapace length), sexes were equal. Two distinct subpopulations were evident. Subadults were between 4.0 and 8.0 mm,  $\mu = 5.9 \pm 0.6$  mm ( $n = 245$ ). Adults range from 8.5 to 16.0 mm,  $\mu = 10.4 \pm 0.8$  mm ( $n = 172$ ). Although populations were physically discontinuous, there was no indication of systematic variation between demes. Rather this biology reflects specific adaptations to an unusual terrestrial environment for fiddler crabs.

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LIFE HISTORY STRATEGIES OF SPIDER CRABS (MAJIDAE). Anson H. Hines. Chesapeake Bay Center, Smithsonian Institution, Edgewater, MD.

Complete life histories from egg to sexual maturity were compared for 5 spp. (*Loxorhynchus crispatus*, *Pugettia producta*, *P. richii*, *Mimulus foliatus*, *Scyra acutifrons*), which range an order of magnitude in size at maturity. Incubation periods from egg deposition to hatching ranges from 5-8 wk. Larval development through 2 zoea & megalops to 1st crab takes 3-4 wk. for all spp., but sizes of eggs and larvae range an order of magnitude between spp. Molt increments increase slightly from 22-28% from smallest to largest spp. No. of molts to maturity ranges from 7-10 for tiny *S. acutifrons* to 15-18 for large *L. crispatus*. Growth rates measured by instantaneous molt frequencies indicate time to maturity is 4-6 mos. for small spp. to 12+ mos. for large spp. Reproductive effort is proportionally the same for all spp., but fecundity increases greatly with size. 'Costs' of no. molts and time to maturity for increased size at maturity are partly compensated for by increased egg size, settlement size and molt increment.

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FUNCTIONAL MORPHOLOGY AND SHELL USE IN THE GASTROPOD SHELL-INHABITING TANAIIDACEAN *PAGURAPSEUDES LARGOENSIS* MCSWEENEY. C. G. Messing. Univ. of Miami, Coral Gables.

Members of the genus *Pagurapseudes* occupy vacant microgastropod shells. Morphological and behavioral convergence with shell-inhabiting paguridean decapods is treated (including SEM and histological analyses). *Pagurapseudes* exhibits five pairs of thoracic legs modified for shell support and only one for "walking." Pads of "contact surface" scales are less consolidated than in pagurideans examined. Apparent preference of *P. largoensis* for certain shells is discussed with respect to shell morphology and availability. Shells most frequently occupied (*Rissoina* and *Bittium*) are not most abundant forms found alive in same place.



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HERMIT CRAB SHELL SELECTION PATTERNS AS A FUNCTION OF SAMPLING TECHNIQUE. S. L. Gilchrist, Florida State University, Tallahassee, Florida.

Shell use patterns of four common north-eastern Gulf of Mexico hermit crabs were examined with two sampling techniques, a transect method and a predation site method. The transect method yielded large animals in relatively undamaged shells of a few gastropod genera while the predation site method yielded a wide size range of individuals in largely damaged shells of many gastropod genera. Differences in sizes and species of animals attracted to the sites were related to treatment, type and amount of bait, and site duration. Biases of the sampling techniques are not complementary, thus conclusions using either or both of the methods must be made with extreme caution.

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SHELLS TRAVELLING FROM SNAILS TO HERMIT CRABS: A RAPID TRANSIT SYSTEM? W. Herrnkind, P. Wilber and J. Loftin. Florida State University, Tallahassee.

Gastropods preying predominantly on other gastropods are both numerous and diverse on the shallow, particulate substrates underlying most of the nearshore waters of the northern Gulf of Mexico. There, the effectiveness of gastropod predation sites (i.e., where one gastropod preys upon another) in attracting hermit crabs and subsequently providing them a new shell, suggests constant and dynamic transfer of shells into the hermit crab populations. This perception stands in contrast to that generally held; i.e., that shells become available via occasional or sporadic processes and are obtained as a hermit chances upon a shell lying empty on the substrate. We monitored the daily rate at which shells, marked while inhabited by gastropods, appeared among hermit crabs in the same area. Our preliminary data show a maximum measured rate exceeding 5% new shells per day in certain locations. Our data strongly infer the mechanism of shell transfer to be heterospecific gastropod predation events.

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A PROBABILITY MODEL FOR CLADISTIC ANALYSIS OF MITOCHONDRIAL RESTRICTION ENZYME DATA. R.W. DeBry. University of Kansas, Lawrence, KS.

A model is developed to describe the probability of a restriction enzyme cleavage site "character" evolving concordantly with the speciation history of a group. A computer simulation compared two types of characters - shared site gains and shared site losses. It showed that if the speciation events were evenly spaced both types of characters evolution closely followed phyletic evolution, but that in cases involving near trichotomies shared site gains were considerably more likely to correctly resolve the trichotomy.

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MEIOTIC STUDIES OF HYBRID POCKET GOPHERS (GEOMYS BURSARIUS). P. K. Tucker\*, R. C. Dowler, and J. W. Bickham. Texas A&M Univ., College Station.

Zones of contact among three chromosomal races of Geomys bursarius, designated E (2n=74, FN=72), F (2n=70, FN=74), and G (2n=70, FN=72), occur in Burleson County of east Texas. Previous investigations of standard karyotypic data suggest that race E and races F-G interact as biological species where they contact, although races are morphologically indistinguishable from one another.

Analysis of meiotic prophase in males from these populations using a silver staining technique suggests that irregular pairing occurs during pachynema in an E X G hybrid individual. A loop configuration in pachytene spreads of F X G hybrids may represent heterozygosity for a paracentric inversion in this individual. Pairing of the X and Y chromosomes can also be observed in pachynema and appears as an end to end association in all individuals examined.

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SPECIATION AND HYBRIDIZATION AMONG THREE CHROMOSOMAL RACES OF POCKET GOPHERS (*GEOMYS*). R. C. Dowler. Texas A&M Univ., College Station.

Over 400 pocket gophers (*Geomys bursarius complex*) representing three karyotypic races were collected from two zones of contact in eastern Texas. A narrow hybrid zone (one km) occurs where the  $2n=74$  form (race E) interacts with the  $2n=70$  forms (races F and G). A wide zone (over 50 km) occurs between races F and G, the chromosomal forms differing only by fundamental number. Chromosomal banding studies reveal that the narrow hybrid zone occurs between forms that are quite distinct chromosomally and this is associated with reduced fertility. The broad hybrid zone is between two forms that are not as distinct and there appears to be less of a reduction in fertility. Thus, the process of speciation is at two different stages in these two instances.

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PRELIMINARY ANALYSIS OF CHROMOSOMAL VARIATION WITHIN THE GENUS *HETEROMYS* (RODENTIA: HETEROMYIDAE). Duke S. Rogers. Univ. of California, Berkeley.

Chromosomal variation among five species of *Heteromys* was examined using standard and differentially stained mitotic preparations. The diploid number ( $2N$ ) ranged from 42 (one species) to 60 (three species) and the number of autosomal arms ( $FN$ ) varied from 66 to 84. One species (*H. desmarestianus*) was found to be polytypic chromosomally, with six cytotypes recognized from 12 populations examined. Results from differential staining indicate that heterochromatin (C-band positive condensed DNA sequences) is restricted to the centromere or arranged as interstitial bands. These data suggest that chromosomal evolution has most likely proceeded via pericentric inversions. The possible functions of interstitial bands in this process are discussed.

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GENIC VARIATION AMONG WESTERN CYTOTYPES OF *PEROMYSCUS MANICULATUS*. I. F. Greenbaum, S. W. Calhoun\*, and K. P. Fuxa\*. Texas A & M Univ., College Station.

Despite its wide distribution, large number of recognized subspecies, and ecological and karyotypic plasticity, available electrophoretic data indicate that *Peromyscus maniculatus* maintains a remarkable degree of genic homogeneity across its range. In an effort to elucidate the apparent contradiction between genic variation and these other parameters, we have analyzed karyotypic and electrophoretic data for 158 *P. maniculatus* collected from Baja California Norte to Oregon. Sampled individuals are referable to 10 populations, 5 ecotypes and 3 subspecies. Karyotypic variation ranged from  $FN = 72$  to 84, and electrophoretic data at 21 loci are consistent with earlier reports indicating overall homogeneity. It is apparent that neither the karyotypic variation nor ecological discontinuity among these samples serve as effective barriers to gene flow.

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THE INDEPENDENCE OF KARYOTYPIC AND MORPHOLOGICAL EVOLUTION IN MAMMALS. L.M. Cherry and A.C. Wilson (intro. by F.F.B. Elder). Univ. of Texas M.D. Anderson Hospital, Houston and Univ. of California, Berkeley.

The empirical testing of hypotheses about the mechanisms of evolutionary change has been made possible by the discovery that the number of amino acid differences between homologous proteins can be used to elucidate the phylogenetic relationships among species. These differences can be used to generate phylogenetic trees, and any type of evolutionary distance data can then be mathematically apportioned onto specific lineages of the trees. An important hypothesis which has been tested using this approach is whether there is a direct relationship between chromosomal and morphological change. Using difference in chromosome number and chromosome arm number as an indicator of karyotypic change, and a shape difference parameter as a measure of morphological distance, we have found that there is no correlation between the lineages which have experienced rapid chromosomal change and those which have experienced rapid morphological change. This finding can be interpreted using a model which proposes that different types of founder events may lead to very different types of evolutionary change.

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NICHE/PHENOTYPE RELATIONSHIPS IN FRESHWATER FISH: A CRITICAL TEST. M.E. Douglas and W.J. Matthews. Rutgers Univ., New Brunswick, NJ and Okla. Biol. Sta., Lake Texoma, OK.

Can morphometric data be used as an index of community structure or niche width? Only if a significant relationship exists between phenotypic measures and microhabitat parameters, for species-segregation is primarily by habitat specificity in both terrestrial and aquatic communities. To find out, we generated pairwise distances between 17 freshwater fish species (in 8 genera and 4 families) using the following data: (1) within-group regression residuals for 41 measures, (2) % occurrence of 23 food items in gut analyses, and (3) microhabitat parameters. Matrix comparisons were performed using the Mantel Test. Morphology was significantly related to microhabitat (but not to foods) when comparisons were made within families. The niche/phenotype relationship breaks down when large scale community assays are done over several genera in different families (the usual practice when such analyses are performed).

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ORIGINS OF ERYTHROCYTES AND THYMOCYTES IN XENOPUS LAEVIS. D. Dunn\*, D. Rein-schmidt†, E. P. Volpe, and R. Tompkins. Tulane University, New Orleans.

Both erythrocytes and thymocytes originate in the region of the mesonephric anlage in the early tailbud stage embryo. Tetraploid and triploid embryos were used to mark reciprocal grafts with diploid embryos and microdensitometry was used to identify the ploidy, and hence the origins, of the erythrocytes and thymocytes. The pronephros was excluded as a source for either cell type. The distributions of prospective thymocytes and erythrocytes revealed by cell marked orthotopic grafts become different at late tailbud stage, suggesting that these cell lineages diverge during early development. Supported by NSF grant PCM-7903827.

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TOLERANCE INDUCTION AND BREAKDOWN IN XENOPUS LAEVIS. C. KAYE, J. Schermer\*, K. Kershaw\*, and R. Tompkins. Tulane Univ., New Orleans, LA.

Tolerance induction was studied in two systems using albino homozygous histocompatible strains. Tolerance was induced in one group of animals by embryonic transplantation of allogenic tail tissue, which is naturally lost at metamorphosis. Adult toads were seen to reject skin allografts from donors of the genotype of the tail tissue donors in typical first set fashion. In another series of animals, tolerance was induced with whole eye grafts performed at stages 31-49. In most animals, the grafted eyes were permanently accepted and the hosts were seen to accept skin allografts from toads of the same genotype as the eye donor. A small number of eye grafted animals lost the grafted eye at the time of metamorphosis. These animals subsequently rejected skin allografts from donors of the genotype of the eye donor. The observations indicate that tolerance maintenance is dependent upon the continued presence of the tolerizing antigen. Supported by NSF grant PCM 7903827.

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E-ROSETTES IN AMPHIBIA: ORGAN DISTRIBUTION ONTOGENY AND SIGNIFICANCE. A. E. Klempau and E. L. Cooper. Univ. of California, Los Angeles

The presence of spontaneous E-rosettes was studied in normal unimmunized larval stages and adults of *Rana pipiens* and in normal and one-year-thymectomized *Xenopus laevis* young adults. AET(2-aminoethylisothiouonium bromide) sheep erythrocytes (SRBC) were used to obtain E-rosettes. Results were expressed as % rosetting lymphocytes. Only premetamorphic tadpoles showed E-rosettes. Standard E-rosettes (4-16 SRBC) at 1% in spleen only; weak E-rosettes (<4 SRBC) in lymph gland 23%, thymus 46%, liver 48%, spleen 30% and mesonephros 40%; giant E-rosettes (multilayers of SRBC) in all organs at about 0.1%. Adult frogs standard E-rosettes in jugular bodies 1.4%, blood lymphocytes (PBL) 8.3%, thymus 0.8%, spleen 2.5% and bone marrow 3.2%; weak E-rosettes between 20-30%; giant E-rosettes only in PBL at 1%. Thymectomized *X. laevis* showed a 88% decrease in the percentage of standard E-rosettes when compared to controls in both PBL and spleen, suggesting that E-rosetting is also a T-cell marker in anurans. Giant E-rosettes indicate the presence of activated T-cells and weak E-rosettes the existence of immature thymus derived lymphocytes. (Supported by NIH Grant HD 09333-6).

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BASOPHILS OF THE TURTLE, *CHELYDRA SERPENTINA*, HAVE SURFACE IMMUNOGLOBULIN AND RELEASE HISTAMINE WHEN TREATED WITH RABBIT ANTI-TURTLE IMMUNOGLOBULIN SERUM. K. F. Mead, M. Borysenko, and S. R. Findlay.\* Tufts Univ., Boston.

Surface immunoglobulin was detected by indirect immunofluorescent assay using rabbit anti-turtle Ig serum at 4°C. Basophil number, as determined by Wrights stain and neutral red counts, decreased dramatically in samples incubated with this antiserum at 22°C. This morphologic degranulation was directly proportional to the antiserum concentration. Degranulation also correlated with cell histamine release (R=0.73). Turtle basophils were found to express antigen-specific surface Ig after immunization with SRBCs. *In vitro*, washed basophils from immune turtles formed basophil-SRBC rosettes. Basophils from control turtles did not. In other experiments normal turtle basophils were induced to form SRBC rosettes by preincubation with SRBC immune turtle serum. These experiments indicate that the immune response of the turtle, *Chelydra serpentina* may involve the basophil and its cytophilic antibody.

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ONTOGENY OF ANTIBODY PRODUCTION IN NEONATAL TURKEYS. F. M. MCCORKLE and J. P. THAXTON. North Carolina State University, Raleigh.

The ability of young Nicholas and Hybrid turkeys to mount a primary antibody response to cellular antigens was investigated. *Brucella abortus* (BA), a T-cell independent antigen, along with sheep red blood cells (SRBC) and chukar red blood cells (CRBC), a T-cell dependent antigens, were studied.

At hatch neither strain was able to respond to SRBC or CRBC but could respond to BA by Day 10 postimmunization. At three weeks of age Nicholas turkeys produced a significantly higher response to both SRBC and CRBC than Hybrid turkeys but no difference was detected with BA. Humoral immune competence in young turkeys appears to begin between 7-15 days of age.

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ADOPTIVE IMMUNE ENHANCEMENT BY BONE MARROW AND BURSA OF FABRICIUS CELLS OF JUVENILE CHICKENS. Frank Seto University of Oklahoma, Norman.

Enhancer cells (EC) are defined operationally as immunocompetent cells that are incapable of adoptive immune responses in embryonic chick hosts but are able to amplify the immune responsiveness of newly hatched chick recipients. The occurrence of these cells in the bone marrow and bursa of unprimed and mouse erythrocyte (MRBC) primed birds was investigated. Weak immune enhancement was obtained with bursal cells from unprimed and primed donors whereas modest to strong amplification was observed with bone marrow cells, especially from MRBC-primed donors. The EC capacity was detectable by the 4th week of age in bone marrow of unprimed donors and earlier in primed donors. The EC frequency declined in the bone marrow during the first two days after priming and then increased to peak levels by day six. They occur transiently in the bursa the second month of age but appear in increasing numbers in the bone marrow with age. Their immune behavior resembles that of thymocytes described earlier and may be comparable to T helper cell activity.

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SIMULTANEOUS EXPRESSION OF THY 1 AND Ig ON SYRIAN HAMSTER LYMPHOID CELLS. P.L. WITTE and J.W. STREILEIN. UTHSC, DALLAS.

We have examined hamster lymph node and thymus cells with a goat anti-hamster thymocyte serum, monoclonal anti-murine Thy 1 antibodies, and rabbit anti-hamster Ig utilizing the fluorescence activated cell sorter (FACS), a microcytotoxicity assay, and a cellular ELISA. The putative anti-T cell reagents all specifically deplete T cell function in this species and can be absorbed with hamster or mouse brain tissue, indicating that they detect the hamster Thy 1 homologue. The 90% of peripheral lymph node cells that are Thy 1<sup>+</sup> comprise two sub-populations that differ quantitatively in surface expression of Thy 1. By examining these populations on the FACS simultaneously with FITC labeled anti-Thy 1 and anti-hamster Ig, the cells expressing higher amounts of Thy 1 also bear surface Ig; they represent the majority of Ig<sup>+</sup> lymph node cells. These findings suggest that either (a) hamster B lymphocytes express Thy 1 transiently during a maturational stage prior to activation, or (b) hamster lymph node cells contain excessive numbers of T cells, a portion of which express Fc receptors for Ig. Successful resolution of this issue may aid in understanding known aberrancies in hamster T cell responses. (SP45 Grant RR01133.)

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PIT-TRAPPING AS AN OPTIMAL FORAGING STRATEGY BY ANT LIONS. M.J. Eppstein and B. Heinrich. Univ. of Vermont, Burlington.

The larvae of many myrmeleontids capture their prey by digging and using pit-traps, unlike any other nonhuman animal. We conducted field and laboratory studies to try to determine whether ant lions minimize the cost-to-benefit ratio of foraging by appropriate variations in behavior. Pit size and the vigor of larval response to prey varied predictably between instars, but were independent of larval mass within instars. Capture success also varied between instars, but was independent of both larval mass and pit size within instars. Pits were enlarged and/or relocated with the same frequency by fed and unfed larvae. These results contradict past assumptions, and we question previous arguments for the 'optimality' of ant lion foraging. Nevertheless, we present evidence that the net effect of cumulative 'suboptimal' behaviors by ant lions is an overall strategy of optimization.

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INDUCTION OF SEMILUNAR RHYTHMS OF REPRODUCTIVE INDICES IN FUNDULUS GRANDIS. C.A. Miller, J.M. Wilson, and A.H. Meier. Louisiana State University, Baton Rouge.

A semilunar rhythm of reproductive readiness was induced in the Gulf killifish, Fundulus grandis, by simulated tidal changes in water temperature. The fish were maintained at 28°C except for a 4-hour daily interval (cryophase) during which the temperature was decreased to 23°C. The cryophase occurred 0.8 hour later each day so that a complete cycle of temporal relations between cryophase and a 24-hour light-dark regimen was completed in 29.5 days (lunar month). Semilunar rhythms of gonadosomatic indices [GSI: (gonad weight/body weight) X 100] were induced in both male and female fish during the 6-7 week experimental periods. In females, the GSI at the times of the semilunar peaks was 3.1 times that of the troughs. In addition, 50% of the fish examined at the times of GSI peaks contained mature (ripe) eggs compared with 6% at the times of the troughs. Our results suggest that semilunar rhythms of reproductive readiness in Fundulus grandis may result from the daily interaction of solar day (light-dark cycle) and lunar day (tidal temperature change) cues. Supported by NSF grant POM-7717878

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CIRCADIAN FLUCTUATIONS IN THE DISTRIBUTION OF LEUKOCYTES IN LABORATORY MICE. Miriam F. Bennett and Gregory C. Pomeroy\* Colby College, Waterville, Maine.

During twelve, 8-day periods of 1980 and 1981, groups of ten adult laboratory mice were maintained at a constant temperature of +22°C. and under one of the following light: dark regimens: L: 600-1800 :: D: 1800-600; L:L; or D: 600-1800 :: L: 1800-600. At 600, 1200, 1800 and 2400 hours of the ninth day or at those times during day nine and one-half or day ten, blood smears were made and stained with Wright's stain. A differential blood cell count based on 100 leukocytes was determined for each mouse. The average patterns of distribution of lymphocytes and neutrophils during 24-hour periods were the same for animals living under L:D or L:L conditions, and were characterized by peak neutrophilic counts at 2400 and the peak lymphocytic counts at 600. The average patterns of distribution of the two types of leukocytes from the mice maintained under the D:L regimen were inverted relative to those of the other groups of animals. The least number of the neutrophils was found at 2400; the least number of lymphocytes was seen at 600.

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BURROWING AND AMPHIBIOUS LIFE OF THE SWAMP EEL SYNBRANCHUS MARMORATUS. J. B. GRAHAM Physiol. Res. Lab., Scripps Inst. Oceanogr. La Jolla, CA.

Synbranchus marmoratus, a Neotropical teleost fish, is ecologically similar to lungfish. It can respire aerially and endure prolonged exposure in mud burrows, with limited access to water, for the full extent of the tropical dry season. Its numerous specializations for burrow confinement include the capacity to produce and store small amounts of urea and to maintain a fully hydrated state, even in the absence of free burrow water. Synbranchus can tolerate over 9 months of burrow confinement and starvation but loses nearly 50% of its mass and reduces its metabolism to about 60 percent of routine. During this time the fish remains fully responsive and quickly becomes active if disturbed. Thus, unlike lungfish, Synbranchus does not adopt a torpid estivating state in its burrow. An inverse correlation exists between burrow water availability and RE, and fish exposed to air elevate the CO<sub>2</sub> content of their urine. The urinary bladder is capacious and may be used to concentrate urine (via strong ion exchange) and resorb H<sub>2</sub>O. For a fish in air, this organ may be able to resorb 0.1 ml H<sub>2</sub>O kg<sup>-1</sup> h<sup>-1</sup>. Supported by NSF DEB 12235.

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EFFECTS OF NALOXONE AND DEXAMETHASONE ON INDUCED TORPOR IN PEROMYSCUS. E.B. Pivorun and M.G. Tannenbaum. Clemson Univ.

The endogenous opioid,  $\beta$ -endorphin, induces hypothermia in some rodents. The effects of naloxone (an opioid binding inhibitor) and of dexamethasone (an inhibitor of the release of  $\beta$ -endorphin from the pituitary) were evaluated on the incidence depth and duration of diurnal torpor bouts in Peromyscus maniculatus. The mice, implanted with  $T_b$  telemeters, were subjected to 9L:15D, water *ad lib* and a restricted food ration. This ration induced daily torpor bouts which were constant per individual during consecutive days. Naloxone (10-20mg/kg), dexamethasone (.5mg/kg) or saline was injected IP between 8-11PM (4-8 hrs after the termination of a torpor bout but 8-11 hrs before the initiation of the next predicted bout. Naloxone and dexamethasone either shortened the duration of the subsequent bout or completely eliminated the bout. Since naloxone is degraded within 1-2 hrs, the results suggest that the neuromodulatory events controlling torpor are initiated 8-12 hrs before the onset of torpor.

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THERMOREGULATORY SET POINTS IN HIBERNATING TAMIAS STRIATUS AND TORPID PEROMYSCUS MANICULATUS. E.B. Pivorun. Clemson Univ.

Water perfused thermodes which straddle the hypothalamus (PO/AH) were surgically implanted in Tamias striatus and Peromyscus maniculatus. Thermoregulatory set points were determined during hibernation ( $T_b = 6.5^\circ\text{C}$ ) in the chipmunks and during daily torpor bouts ( $T_b = 24^\circ\text{C}$ ) in the mice. Thermoregulatory set points ( $T_{set}$ ) were noted in only 2 of 7 chipmunks. Below  $T_{set}$  ( $3.9^\circ\text{C}$ ) these individuals displayed a proportional thermoregulatory response that averaged  $-3.48 \times 10^{-3} \text{Wg}^{-1} \text{C}^{-1}$ . No  $T_{set}$  was noted in 15 monitoring sessions. Only an alarm ( $T_{alarm}$ ) level response was evident. When  $T_{alarm}$  ( $T_b = 2.4^\circ\text{C}$ ) was reached, no proportional thermoregulatory response was noted; only a full arousal response. Thermode heating to a  $T_{hyp} = 8^\circ\text{C}$  during these arousals resulted in a reversal of the arousal and a reentry to the hibernation state. Thermoregulatory set points were noted in all 4 mice monitored. Below  $T_{set}$  ( $23^\circ\text{C}$ ) these individuals displayed a proportional thermoregulatory response that averaged  $-2.15 \times 10^{-3} \text{Wg}^{-1} \text{C}^{-1}$ . A  $T_{alarm}$  response was noted at a  $T_{hyp} = 19^\circ\text{C}$ . Reversal of the evoked arousals occurred when  $T_{hyp}$  was raised to  $23-26^\circ\text{C}$ .

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THE BIOCHEMICAL BASIS OF GLUCOSE SPARING DURING HIBERNATION IN THE BAT, EPTESICUS FUSCUS. M.E. YACOE. Univ. of Michigan, Ann Arbor.

Carbohydrate oxidation must be minimized during hibernation in order to spare muscle protein. This study examines the biochemical adaptations which contribute to glucose sparing during hibernation. Homogenates of the pectoralis muscle from summer bats have equal capacities for the oxidation of pyruvate ( $9733 \pm 722 \mu\text{l O}_2/\text{g}\cdot\text{hr}$ ) and palmitate ( $9546 \pm 633 \mu\text{l O}_2/\text{g}\cdot\text{hr}$ ). However, in hibernating animals the capacity for pyruvate oxidation ( $8411 \pm 474 \mu\text{l O}_2/\text{g}\cdot\text{hr}$ ) is lower ( $P < .001$ ) while palmitate oxidative capacity ( $10468 \pm 616 \mu\text{l O}_2/\text{g}\cdot\text{hr}$ ) is higher ( $P < .01$ ) than in summer animals. Hibernating bats have a significantly higher capacity for palmitate oxidation than pyruvate oxidation ( $P < .001$ ). In addition, fatty acid oxidation was found to competitively inhibit pyruvate oxidation in isolated muscle mitochondria. The presence of 0.2mM palmitoyl-L-carnitine reduced pyruvate oxidation by 80% with no change in  $\text{O}_2$  uptake. The seasonal adaptations of the oxidative pathways of pectoralis muscle described here may function to spare glucose during hibernation.

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SEASONAL WATER BALANCE IN DESERT HONEY BEE COLONIES. P. D. Cooper and W. M. Schaffer.\* University of Arizona, Tucson.

Changes in total daily water input in two colonies of honey bees were monitored monthly. Hourly estimates of flight activity were made and simultaneously some foraging bees were captured and the quantity of fluid carried was measured by honey stomach analysis. The product of these values was an estimate of hourly water input. The values ranged from approximately  $500 \text{ g d}^{-1}$  during June for a strong colony ( $\sim 40,000$  bees) to only about  $20 \text{ g d}^{-1}$  for a weak colony ( $\sim 16,000$  bees) in July. Estimates of evaporative water loss and colony fecal water loss were assessed in the laboratory and indicated that evaporative water loss constituted the major route of water loss, the amount of loss increasing with ambient temperature. The ecological implications are discussed in relation to temperature regulation and the trade-off between nectar and water foraging.

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EFFECTS OF WATER STRESS ON HEMOLYMPH VOLUME, OSMOTIC POTENTIAL, AND CHEMICAL COMPOSITION IN MEGETRA CANCELLATA. A.C. Cohen. U.S.D.A., ARS, Tucson, AZ.

Rates of water loss in M. cancellata were very high compared to other xeric arthropods. Hemolymph weight in hydrated animals was 43.0% of the total body weight while it was 24.7% in animals that had lost 16.1% of their body weight as water. Hemolymph osmotic potential increased from 438 to 514 mOsm/kg in desiccated beetles, but osmotic regulation was evident. Total hemolymph protein mass and concentration decreased in desiccated beetles while amino acid concentrations remained constant (at about 70 mM). Na and  $-PO_4$  concentrations increased in desiccated beetles. Cl and K concentrations in desiccated beetles were equal to those in undessicated beetles.

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STRUCTURE AND VARIATION OF THE CEMENT LAYER OF TIGER BEETLES. T. D. SCHULTZ. Univ. of Texas, Austin.

Structural colors exhibited by the genus Cicindela result from the ultrastructure of the cement layer. The structure of the cement was examined with SEM in 4 species of adult tiger beetles. Treatments with 8% KOH were used to distinguish this layer from the underlying cuticle. Cement can extend up to 5.1 $\mu$ m in thickness and is composed of laminations, parallel to the surface, which suggest a  $\frac{1}{2}$  multilayer interference reflector. The fact that isolated fragments of cement were optically inactive and approximated a R. I. of 1.5 $\lambda$  by the Becke test, further supports this hypothesis. Color differences between Cicindela species and races of C. scutellaris, match differences in lamina width. C. splendida and C. formosa exhibit thinner interior laminations than those near the surface. Developmental changes in color are correlated with a progressive deposition of wider laminae. The reverse sequence of colors appears through KOH treatments. Both abrasion and dehydration are high risks in tiger beetle habitats, perhaps requiring extensive cement layers to insure against water loss. Cement contains water in early adulthood and dehydration will produce shorter wavelengths due to shrinkage of laminae. Color variation in Cicindelids is likely due, in part, to environmental factors.

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CHANGES IN K TRANSPORT ACROSS THE ISOLATED INTEGUMENT OF THE TOBACCO HORNWORM MANDUCA SEXTA. John C. Cornell & A. M. Jungreis. Univ. of Tennessee, Knoxville, TN 37916

Prior to the larval-pupal molt, the integument secretes molting fluid (MF) into the exuvial space beneath the cuticle. Then, just before the molt, MF (K=100 mM) is reabsorbed (haemolymph K=35 mM). In isolated integuments (K=32 mM in each half chamber) of animals in the secretory phase the net flux ( $J_{net}^K$ ) was .27  $\mu$ eq  $cm^{-2} h^{-1}$ , the short-circuit current was 7.5  $\mu A cm^{-2}$ , and the potential difference (PD) was 5.6 mV. In the reabsorptive phase, the values were .37  $\mu$ eq  $cm^{-2} h^{-1}$ , 13  $\mu A cm^{-2}$ , and 14 mV ( $P < .001$  for all three comparisons). In both cases  $J_{net}^K$  was in the haemolymph to exuvial direction and the PD was exuvial side positive.  $K_m$  and  $J_{max}$  for K in animals from the secretory phase were 18 mM and .43  $\mu$ eq  $cm^{-2} h^{-1}$ , respectively. The values for animals from the reabsorptive phase were 29 mM and .69  $\mu$ eq  $cm^{-2} h^{-1}$ . Between the secretory and reabsorptive phase there was a reduction in the apparent size of the K transport pool, from about 3.0 to about 1.0  $\mu$ eq  $cm^{-2}$ . At present we can not completely relate the differences between the secretory and reabsorptive phases which were found in vitro with the changes in vivo. Supported by NIH Grant AI-12779.

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ISOLATION OF SEPARATE APICAL, LATERAL AND BASAL MEMBRANE FROM CELLS OF TOBACCO HORNWORM LARVAL MIDGUT. M. Cioffi and M. G. Wolfersberger\*. Temple Univ., Philadelphia.

The midgut epithelium is a single layer of goblet and columnar cells resting on a thin muscle layer. We have developed methods to separate from this tissue four plasma membrane fractions; columnar cell apical membrane, goblet cell apical membrane, basal membranes and lateral membranes. Preparation of apical and basal membranes is based on the light microscopic observation that an ultrasonic probe disrupts the epithelium in layers, starting at the apical surface. The top layer consists of columnar cell microvilli, the next contains the invaginated goblet cell apical membrane and the final layer is the basal membranes. As each layer is stripped off it is collected, purified by differential or gradient centrifugation and its composition verified by electron microscopy (EM). Lateral membranes are obtained by a different method made possible because the septate junctions between long segments of adjacent membranes remain intact during tissue homogenization. These segments are isolated by gradient centrifugation and identified by EM. With certain modifications we expect that these methods could be applied to other epithelia.

(Supported in part by NIH grant AI-09503.)

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K-STIMULATED AND  $\text{HCO}_3^-$ -STIMULATED ATPases IN THE LARVAL MIDGUT<sup>3</sup> OF THE TOBACCO HORN-WORM, Manduca sexta. Lewis E. Deaton and Arthur M. Jungreis. University of Tennessee, Knoxville.

Microsomal preparations of midgut tissue from feeding fifth instar M. sexta larvae contain K-stimulated and  $\text{HCO}_3^-$ -stimulated ATPase activity. The K-stimulated enzyme activity is about 100 nmole  $\text{PO}_4$ /hr/mg protein, with an apparent  $K_m$  of 6 mM and a pH optimum of 7.5. Ouabain and Na had no effect on the K-stimulated enzyme. Rb and K were interchangeable as substrate. The  $\text{HCO}_3^-$ -stimulated activity is about 50 nmole  $\text{PO}_4$ /hr/mg protein, with an apparent  $K_m$  of 10 mM and a pH optimum of 7.5. Chloride concentrations above 5 mM inhibit the  $\text{HCO}_3^-$ -stimulated enzyme by 20-50%. The enzyme is also strongly inhibited by 10 mM SCN. The isolated M. sexta midgut actively transports K at high rates, and the K transport is accompanied by alkalization of the lumen side of the tissue. The presence and characteristics of these two ion specific ATPases provide a possible mechanism for both the K transport and the pH gradient observed in the isolated midgut.

supported by NIH grant AI-12779

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CYCLIC AMP INDUCES CHANGES IN FLUID SECRETION BY THE MALPIGHIAN TUBULES OF THE MOSQUITO, Aedes Aegypti. J. C. Williams, Jr. and K. W. Beyenbach. Cornell Univ., Ithaca, NY.

Fluid secretion was studied using Malpighian tubules isolated from adult females into an artificial medium (technique similar to Ramsay's, 1954). The K and Na content of the medium was varied and the secreted fluid analyzed using electron probe microdroplet techniques. It was found that K or Na alone could support fluid secretion in the absence of the other ion. Even when K is present in low concentration (3 mM), the principal solute in the secreted fluid is KCl (averaging 110 mM). Upon addition of dibutyryl cAMP (1 mM) to the medium, secretion rates are increased from an average of 0.8 nl/min to 3.4 nl/min. cAMP causes the Na concentration of the secreted fluid to increase and K to decrease. The rate of K secretion, moreover, is reduced by 70% while the Na secretion is increased by 1200%. cAMP changes the tubular function from primarily K to primarily Na secretion. (Supported in part by NIH AM26633.)

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REGENERATION OF TAILFIN LEPIDOTRICHIA AND PEDUNCULAR MUSCLE AFTER PARTIAL TAIL ABLATION IN CARASSIUS AURATUS. Norman E. Kemp, The Univ. of Michigan, Ann Arbor.

Portions of the tailfin and muscular peduncle were excised from the tails of goldfish 80-100 mm long. Wound healing and regeneration were followed in live fish, alizarin-stained specimens or sections of tails fixed at intervals up to six months after operation. After excision of the tailfin distal to the peduncle, regeneration of lepidotrichia readily occurs from the stumps of old rays and a typical bilobate fin develops. After complete excision of the tailfin, including the basal stumps of its lepidotrichia embedded in peduncular muscle, skin, connective tissue and muscle heal to cover the exposed urostyle bony rays. Subsequently a new tailfin with lepidotrichia originating by elongation of regenerated scale primordia may develop. After transection of the tail through the peduncle, healing of muscle and skin and development of scales inhibit outgrowth and regeneration of a tailfin fails to occur. After removal of dorsal or ventral fin lobe and adjoining distal half of the peduncle, conditions for caudal outgrowth are favored; hence there may be partial regeneration of the lobe.

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LATERAL VOLTAGE GRADIENTS NEAR MAMMALIAN SKIN WOUNDS. A. T. Barker<sup>2</sup>, L. F. Jaffe, and J. W. Vanable, Jr. Purdue University, Lafayette, Indiana.

Transcutaneous voltages of 30 to 100 mV (inside positive) are maintained across glabrous (and gland-free) regions of guinea pig skin. In the case of hairy skin, transcutaneous voltages are lower: 0 to 10 mV. When glabrous skin is wounded, the epidermis in the vicinity of the wound drives a current of up to 300  $\mu\text{A}/\text{cm}^2$  across itself. These currents are sensitive to amiloride, which suggests that they are sodium-dependent. In the vicinity of such wounds, lateral intraepidermal voltage gradients of the order of 100 to 200 mV/mm are generated. It appears, therefore, that glabrous skin of the guinea pig has a battery that is comparable to that found in amphibian skin. In the case of amphibians, there is evidence that the skin battery may be involved in initiating regeneration. We would propose that the substantial lateral voltage gradients generated near mammalian skin wounds might be involved in guiding the cell movements that effect wound closure. Supported by NIH NS 11545.



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SIMILAR MECHANISMS FOR PATTERN REGULATION IN LIMB DEVELOPMENT AND REGENERATION. K. Muneoka and S.V. Bryant. Developmental Biology Center and Dept. of Developmental & Cell Biology, Univ. of California, Irvine, CA.

Developing hindlimb buds and forelimb regeneration blastemas of axolotl limbs were reciprocally exchanged to investigate whether the two can interact in an orderly fashion. Experimental grafts were made contralaterally to oppose anterior and posterior positions of host and graft. Control grafts were made ipsilaterally with all positions of host and graft aligned. Control grafts developed normally and autonomously. Experimental grafts of blastemas to limb bud stumps and limb buds to blastema stumps formed supernumerary structures in about 70% of the cases. These results indicate that regenerating and developing limbs can interact in a predictable fashion to form supernumerary outgrowths suggesting that developing and regenerating limbs utilize the same mechanisms for pattern regulation.

Supported by Grant No. HD-07029 from the National Institutes of Health, DHEW.

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THE EFFECT OF IMPOSED FIELDS ON URODELE LIMB REGENERATION. M. E. McGinnis, L. L. Hearson, L. F. Jaffe, and J. W. Vanable, Jr. Purdue University, West Lafayette, Indiana and Wabash College, Crawfordsville, Indiana.

In order to test how relevant endogenous electrical fields are to limb regeneration, we have imposed artificial fields along the stumps of amputated axolotl larvae. When these fields are in the same direction as the endogenous ones, augmenting them, regeneration occurs more rapidly than normal. When the imposed fields are in a direction opposite to the endogenous fields, diminishing or even reversing them, regeneration is inhibited. We are extending these studies to include newts, as well as to vary the length of time of field imposition and the time elapsing between cessation of field imposition and histological assessment of the effect. Early results suggest that in newts, it takes more than two weeks after amputation to detect a significant effect of imposed fields. Supported by NIH NS 11545.

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THE MORPHOLOGY OF REGENERATED CRAYFISH LEGS DEPENDS ON PHASE OF THE MOLT CYCLE WHEN GRAFTING OCCURS. J. MITTENTHAL<sup>1</sup> and W. TREVARROW<sup>2</sup>, Biology, U. Oregon, Eugene. After proximo-distal grafting in crayfish legs, the extent to which intercalation restored deleted structures varied with the phase of the molt cycle at operation. Operation 1: After grafting the distal  $\frac{1}{2}$  dactyl (D) to the proximal  $\frac{1}{2}$  propodus (Pr) early in the post-molt cycle, most legs regenerated the missing structures: proximal  $\frac{1}{2}$ D, joint, distal  $\frac{1}{2}$ Pr. In most legs having this operation in mid-cycle, the D graft fused to the Pr host; the missing structures were permanently deleted. Operation 2: Grafting distal  $\frac{1}{2}$ Pr to proximal  $\frac{1}{2}$  merus (M) deleted the proximal  $\frac{1}{2}$ Pr, the carpus (Ca), and the distal  $\frac{1}{2}$ M. This operation, performed late in the cycle, yielded legs with only one regenerated segment: proximal to the Pr graft, a mosaic of Ca and Pr; a joint; and a mosaic of M and Ca distal to the host M. These results suggest that the segmentally repeated morphogenetic field which ignores segmental identity (Mittenthal, Develop. Biol., in press) acts to restore intrasegmental continuity only during mid-cycle, and the limb field can intercalate new segments only during the rest of the cycle. (<sup>1</sup>How: Anat. Sci., U. Illinois, Urbana. support: NSF.)

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AXIAL DETERMINATION OF URODELE LIMB REGENERATION BLASTEMAS. D.L. STOCUM. Univ. of Illinois, Urbana.

It is generally accepted that the prospective form and structural pattern of the urodele limb regenerate is determined in the early blastema. However, there is some evidence that the polarity of the transverse axes of the undifferentiated blastema may be labile and subject to reversal by interaction with the limb stump (Iten and Bryant, Dev. Biol. 44:119, 1975). To test this notion, undifferentiated blastemas were exchanged between contralateral limbs of A. maculatum and A. mexicanum, with reversal of the anterior-posterior (AP) or dorsal-ventral (DV) axes. Species-specific pigmentation and size differences were used together as markers for regenerate tissue. The percentages of grafts developing with their axiation of origin were: after AP reversal, 50%; after DV reversal, 58.8%. The remainder of the grafts in both categories resorbed. These results demonstrate that the AP and DV axes of early blastemas are fully determined.

CELLS IN PREDENERVATED FORELIMBS OF AMBYSTOMA LARVAE INITIATE CYCLING ACTIVITY AFTER AMPUTATION. Cherie L. Olsen\* and Roy A. Tassava, The Ohio State University, Columbus, Ohio.

Various reports in the literature have suggested that, during limb regeneration, nerves are necessary for G<sub>1</sub>, S, and/or G<sub>2</sub> cell cycle events. To test which phase of the cell cycle is influenced by nerves, we examined labeling (LI) and mitotic (MI) indices in predenervated limbs. Forelimbs of larval A. maculatum were completely denervated 7 days prior to amputation and re-denervated at the time of amputation. On days 4 through 6, the LI of pre-denervated limbs was lower than that of control innervated limbs, but still represented a significant number of cells (LI=20%). The few mitotic figures that were observed occurred among perichondrial cells rather than among dedifferentiated cells of the stump. It is concluded that, after amputation, most cells in the injured area of a pre-denervated limb dedifferentiate morphologically and replicate their DNA, but few subsequently complete mitosis.

Supported by NSF.

STANDARD OPERATIVE TEMPERATURES AND THE ACTIVITY SCHEDULE OF A SURFACE-DWELLING DIURNAL DESERT ENDOTHERM, GAMBEL'S QUAIL D. L. Goldstein. Univ. of California, Los Angeles.

Standard operative temperature--a direct index to heat flux--was measured for Gambel's quail, Callipepla gambelii, during the summertime of the Colorado Desert of Southern California. Time-activity budgets are examined in relation to these temperatures. The non-fossorial diurnal habits of these animals place them at the limits of their physiological tolerance to heat stress. Solar and thermal radiation have a profound influence on the ecology of this species in the summertime desert.

THERMAL AND TEMPORAL VARIATIONS IN THE ONSET OF FLIGHT IN DRAGONFLIES. F. D. Vogt and B. Heinrich, Univ. of Vermont, Burlington.

Thoracic temperatures ( $T_{th}$ ) of dragonflies were monitored at the onset of flight. Spontaneous flight by "perchers" was dependent on ambient temperature ( $T_a$ ) and occurred at  $T_{th}$  well above the minimum required for flight. Small perchers flew at lower  $T_a$  (and with lower  $T_{th}$ ) than larger individuals. Perchers flew earlier and had higher  $T_{th}$  when in sun vs. shade. Rate of warm-up during shivering in "fliers" was affected by  $T_a$  with no clear correlation to body size. Fliers were able to take off at lower  $T_a$  than perchers and at the onset of flight their  $T_{th}$  were generally much higher. Spontaneous flight by fliers appears to be less dependent on  $T_a$  than it is for perchers. The data also indicate that these perchers from a temperate latitude are able to fly at lower  $T_{th}$  than those reported from warmer climates.

ENVIRONMENTAL ASSESSMENT: SIGNIFICANCE OF LONG-TERM ECOLOGICAL STUDIES. Laurie J. Vitt and Raymond D. Semlitsch, Savannah River Ecology Laboratory, Aiken, S.C.

Long-term ecological studies on reptiles and amphibians in wetland habitats in the SE US demonstrate that; community structure varies monthly and yearly and breeding success of certain species varies yearly. These results suggest that spot-sample species inventories in SE wetlands are of little value for environmental assessment. A long-term perturbation experiment compared reproductive success of amphibians between an undisturbed (control) and disturbed (experimental) Carolina bay. Even though breeding migrations of adults, oviposition and larvae production remained unaffected by perturbation, larvae in the experimental bay failed to metamorphose. Thus a critical stage in the life history of these amphibians was affected and this effect would not have been detected with standard spot inventory studies. A more sophisticated approach to environmental assessment should include long-term monitoring of populations and detailed life history studies such that natural sources of variation can be separated from variation caused by man.

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FUNCTION AND ENERGETICS OF AUTOTOMIZED TAIL THRASHING IN LYGOSOMA LATERALE (SAURIA: SCINCIDAE). B. E. DIAI. Texas A&M University, College Station.

To examine the effect of autotomized tail movement on predator handling, I compared handling time components of snake predators ingesting autotomized, thrashing and autotomized, exhausted tails of L. laterale. Tail movement significantly increased the time required to subdue a tail ( $\bar{x}$   $S_t$ : thrashing = 27s; exhausted = 1s). Ingestion times were equivalent in experimentals and controls. Total handling time was significantly greater in thrashing ( $\bar{x}$   $H_t$ =120s) than in exhausted tails ( $\bar{x}$   $H_t$ =87s). Tail movement was supported energetically by anaerobic metabolism. Lactate production was significantly greater after 60s of thrashing ( $\bar{x}$  mg lactate/g body mass=2.71) than in either intact tails at rest ( $\bar{x}$  mg/g=0.12) or intact tails used in locomotion ( $\bar{x}$  mg/g=0.32). Lactate production and anaerobic capacity (=AC) of autotomized tails after 60s of thrashing were significantly greater in L. laterale, a species with maximal tail thrashing ( $\bar{x}$  mg/g=2.71; AC=2.59), than in Anolis carolinensis, a species with minimal tail thrashing ( $\bar{x}$  mg/g=1.61; AC=1.24).

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USE OF SPACE BY BREEDING TUFTED TITMICE. C. R. PRESTON. UNIV. OF ARKANSAS, FAYETTEVILLE.

The activity space was determined for 3 pairs of breeding titmice (Parus bicolor) during prenesting, incubation, and nestling periods. The activity space was largest in the prenesting period and smallest in the nestling period for both sexes. Spatial overlap by adjacent pairs occurred only in the prenesting period. During this period, titmice activities were concentrated primarily near territorial boundaries. Later in the season, when insect density increased, the birds concentrated their activities near the nest. Use of space by titmice varies throughout the breeding season with changes in energy requirements and in food supply.

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THE EFFECTS OF MANDIBLE MORPHOLOGY AND PHOTOSYNTHETIC PATHWAY ON SELECTIVE HERBIVORY IN GRASSHOPPERS. D. E. BENNACK. Michigan State Univ., East Lansing.

Grasshoppers with different mandibular patterns were offered  $C_3$  and  $C_4$  plants in controlled feeding experiments to test the following hypotheses: 1) Selective herbivory is influenced by the photosynthetic pathway of plants, 2) Selective herbivory is influenced by the mandible morphology of herbivores. Mandible morphology was found to be significantly associated with energy assimilation and feeding frequency. Grasshoppers with herbivorous mandibles had greater assimilation efficiencies and fed significantly less often than grasshoppers with forbivorous mandibles. These results indicate grasshoppers (with comparable caloric requirements) feed with a frequency determined, in part, by the functional morphology of their mandibles. Photosynthetic pathway also influenced the foraging behavior of grasshoppers tested. As predicted by the  $C_4$  avoidance hypothesis (Caswell et al., 1973),  $C_4$  plants were fed upon significantly less often than  $C_3$  plants. These results suggest grasshoppers may discriminate between  $C_3$  and  $C_4$  plants, but apparently not on the basis of available energy.

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AN ULTRASTRUCTURAL STUDY OF SPICULE FORMATION IN THE GORGONIAN LEPTOGORGIA VIRGULATA (OCTOCORALLIA, GORGONACEA). R.J. KINGSLEY and N. WATABE. Univ. South Carolina, Columbia.

Calcite spicule formation begins in the mesoglea with aggregation of scleroblasts. Golgi vacuoles form, and incorporate organic matrix. Crystal deposition follows. Vacuole size increases while matrix incorporation and subsequent crystal deposition continue, filling the vacuole. At approximately this time, the scleroblasts dissociate and "wart" formation begins. Further spicule growth stretches the cell into a thin envelope of cytoplasm. Fusion of the vacuole and cell membranes followed by breach formation during spicule growth, as well as scleroblast atrophy and/or migration from mature spicules, result in the transition of the spicule from the intracellular to the extracellular environment. This transition is a new and significant finding. The results also revealed a close association between crystals and matrix; and the presence of aborted spicules and digestive bodies containing crystalline material, implying possible relationships between calcification, detoxification and waste management.

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NON-FLAGELLAR MOTILITY IN THE PHYLUM PLACOZOA: ULTRASTRUCTURAL ANALYSIS OF THE TERMINAL WEB OF TRICHOPLAX ADHAERENS. M.D. Klauser and E.E. Ruppert. Clemson Univ., S.C.

Direct observations and cinemicrographic analysis of living Trichoplax adhaerens reveal two forms of motility: multidirectional flagellar locomotion and a general contractility of the organism. The predominant non-flagellar movements are shape changes resembling amoeboid movement and a buckling of the organism towards its lower surface. Buckling is presumed to be related to feeding. It also can be induced by the addition of  $MgCl_2$ . Both these movements are also multidirectional. Although contractility in Trichoplax has previously been attributed to the so-called fiber cells between the upper and lower epithelia of the organism (Grell, *Cytobiol.* 4:216, 1971; Z. *Naturforsch.* 29c: 790, 1974 and Ruthmann, *Zoomorph.* 93:59, 1979), our TEM data indicate an absence of any contractile material associated with these cells. Alternatively, we suggest that an extensive terminal web situated only in the lower epithelium of Trichoplax is responsible for the observed movements. (Supported in part by NSF Grant DEB-7823 395).

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CHARACTERIZATION OF THE ALIMENTARY CANAL OF GREATER WAX MOTH, GALLERIA MELLONELLA, LARVAE. C. A. IRONS and D. H. WHITMORE. The Univ. of Texas at Arlington.

Descriptions are based on gross dissections, light microscopy, and SEM. The foregut and hindgut are characterized by longitudinal folds of epithelium. These regions exhibit pronounced transitions in cellular arrangements and morphology. The epithelium is surrounded by a thin layer of longitudinal muscle and an outer layer of circular muscle. The chitinous intima which lines the epithelial layer is frequently porous. In some regions of the foregut and hindgut the intima is modified to form spines or denticles.

Characteristically, the midgut epithelium consists of villous columnar cells, secretory goblet cells, and two types of regenerative cells. The musculature arrangement of the midgut is the reverse of the foregut and hindgut, and the lumen surface is lined by a delicate peritrophic membrane. Structural and functional relationships are assessed for each region of the alimentary canal.

Supported in part by a grant from Sigma Xi, matched by UTA.

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COMPLEX BASEMENT MEMBRANES IN THE MIDGUT OF SEVERAL DECAPOD CRUSTACEANS.

Jan Robert Factor, Cornell University, Ithaca, New York.

Histological and ultrastructural studies have shown the basement membrane underlying the midgut (intestinal) epithelium of several decapod crustaceans to be unusually complex. In the lobster (Homarus americanus), this basement membrane has three layers and processes of the central layer extend into the connective tissue. The basement membrane in the midgut of the stone crab (Menippe mercenaria) also has three layers, and extensions of an outer layer protrude into the connective tissue. The structure of these complex basement membranes is considered in light of their possible functions. The basement membranes in the midgut of the lobster and stone crab are compared to those found in several other crustaceans, as well as to the basement membranes reported in a variety of insects.

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ELECTROPHORETIC AND ELECTRON MICROSCOPIC EXAMINATION OF THE SMOOTH ADDUCTOR MUSCLES OF AN ARTICULATE BRACHIOPOD. M. J. Cavey and J. L. Wilkens. Univ. of Calgary, Alberta, Canada.

The smooth adductors of Terebratalia transversa are tonic muscles which slowly eliminate the gape between the valves to completely close the shell. Unregistered arrays of myofilaments form the contractile apparatus of the smooth adductor cell. Thin myofilaments, averaging 7 nm in diameter, mingle with very large, axially banded thick myofilaments. The thick myofilaments are fusiform in shape, ranging in diameter from 108 nm near their midpoints to 19 nm near their tapered ends. The protein paramyosin, detected in large amounts by SDS-polyacrylamide gel electrophoresis, is manifest in the thick myofilaments. The major axial period of the thick myofilaments is approximately 70 nm. Relatively sparse, vesicular cisternae of sarcoplasmic reticulum situate between the contractile apparatus and the sarcolemma. Near the origins of the smooth adductors, contractile cells merge with the flagellated epithelial cells of the mantle. The smooth adductor muscles are, in fact, coherent aggregations of myoepithelial cells which span between the lining cells of the mantle and the tendons of the ventral valve.

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ELECTROPHORETIC AND ELECTRON MICROSCOPIC EXAMINATION OF THE STRIATED ADDUCTOR MUSCLES OF AN ARTICULATE BRACHIOPOD. M. J. Cavey and J. L. Wilkens (intro. by M. N. Arai). Univ. of Calgary, Alberta, Canada.

The striated adductors of *Terebratalia transversa* are phasic muscles which quickly close the shell but leave a narrow gape between the valves. Cross-striated sarcomeres, delimited by tortuous Z-lines, form the contractile apparatus of the striated adductor cell. Thin myofilaments, averaging 7 nm in diameter and 1  $\mu$ m in length, span the sarcomeric I-bands and interdigitate with the thick myofilaments of the A-bands. The thick myofilaments average 24 nm in diameter and 1.8  $\mu$ m in length. The protein paramyosin, detected in small amounts by SDS-polyacrylamide gel electrophoresis, is not manifest in the thick myofilaments, since they are relatively small in diameter, quite uniform in shape, and axially unbanded. A plexiform network of sarcoplasmic reticulum appears between the contractile apparatus and the sarcolemma. Near the origins of the striated adductors, contractile cells merge with the flagellated epithelial cells of the mantle. The striated adductor muscles are, in fact, coherent bundles of myoepithelial cells which span between the lining cells of the mantle and the tendons of the ventral valve.

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ULTRASTRUCTURE OF THE FUNICULUS OF PHYLACTOLAEMATE BRYOZOA: A BLOOD VESSEL HOMOLOGUE. K. J. Carle and E. E. Ruppert. Clemson Univ., S.C.

Comparative data on blood vascular systems of coelomate invertebrates indicate that such systems are modifications of the general extracellular matrix for nutrient transport and/or gas exchange. In most coelomates, including the Phoronida and Brachiopoda, principal blood vessels exist as tubes formed by outfolding of the peritoneum and are lined only by the basal lamina of the overlying cells. The vessels are closely associated with both the gut and the gonads. Light microscopic and TEM data indicate that the funiculus of phylactolaemate Bryozoa is a tube formed of peritoneal and longitudinal muscle cells and is lined by the basement membranes of these cells. It is the site of formation of the testes and statoblasts. Histochemical data of Bobin (1971, Arch. Zool. Exp. Gen. 112, p 771) implicate the funiculus in nutrient transport. We propose the interpretation of the funiculus as a true blood vessel homologous to those of other coelomate Metazoa. (Supported in part by NSF grant DEB-7823395)

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FIELD EXPERIMENTAL TRANSFERS OF AN EXTERNAL CYMOTHOID ISOPOD, *ANILOCRA CHROMIS* WILLIAMS AND WILLIAMS, ON BROWN AND BLUE CHROMIS. E. H. Williams, Jr. and L. B. Williams. Univ. of Puerto Rico, Mayaguez.

*Anilocra chromis* occurs commonly on either the brown chromis, *Chromis multilineatus*, or the blue chromis, *C. cyaneus*, in different parts of the Caribbean Sea, but never on both host species in one locality. With the use of "HydroLab" Underwater Habitat (NOAA), *Anilocra chromis* were transferred from infested brown chromis to 74 non-infested brown or blue chromis in St. Croix U.S.V.I., in October 1979 and April 1981. The majority of isopods survived on the brown chromis while none survived on the blue chromis. The population of brown chromis may be behaviorally predisposed to the presence of this parasitic isopod.

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GEOGRAPHIC DISTRIBUTION OF NINE NEW SPECIES OF *ANILOCRA* (CYMOTHOIDEA) PARASITIC ISOPODS OF CARIBBEAN REEF FISHES. L. B. Williams and E. H. Williams, Jr. Univ. of Puerto Rico.

*Anilocra acanthura* parasitizes *Acanthurus chirurgus* in the northeastern Caribbean and Florida, and *A. bahianus* in the northwestern Caribbean. *Anilocra holocentra* parasitizes *Holocentrus ascensionis* in the northeast Caribbean and Florida and a similar closely related species, *Anilocra myripristis*, parasitizes *Myripristis jacobis* in the northwestern Caribbean. *Anilocra haemulona* parasitizes grunts and groupers in Puerto Rico and the U.S. Virgin Islands, grunts only in Trinidad and Tobago, and groupers only in the Dominican Republic, Barbados, and Colombia. *Anilocra chromis* parasitizes *Chromis multilineatus* in the northeastern Caribbean and *C. cyaneus* in the northwestern Caribbean. *Anilocra holocantha* parasitizes *Holocentrus tricolor* in the northern Caribbean. *Anilocra chaetodontis* parasitizes butterfly fishes in the northern Caribbean, Bahamas and Florida. *Anilocra abudedefdufa* parasitizes *Abudedefdufa saxatilis* on the Caribbean coasts of Panama and Colombia. *Anilocra partita* parasitizes *Eupomacentrus partitus* in Jamaica.

ZOOGEOGRAPHICAL AFFINITIES OF THE SHALLOW-WATER CARIDEANS OF THE GULF OF CALIFORNIA. M.K. WICKSTEN, Texas A&M Univ., College Station.

Seventy-one species of caridean shrimps occur in the Gulf of California and adjacent fresh waters at depths of 185 m or less. Most of these are wide-ranging species. Five species and subspecies are known only from the Gulf. These 5 and 27 other species and subspecies are endemic to the tropical eastern Pacific. Fifteen species occur on both sides of the Panamic land mass. Ten species range west into the Indo-Pacific region. Nine species range north to California, U.S.A. Two species range south to Chile, two are pan-tropical, and one freshwater shrimp has been introduced from the eastern U.S.A. Considerable taxonomic confusion has caused difficulties in studying the fauna of the area.

DISTRIBUTION AND DISPERSAL OF CRAYFISH IN A SECOND ORDER STREAM. Robert C. Taylor, University of Georgia, Athens.

Baited minnow traps were used to obtain crayfish samples for marking and release. Two 8-trap sets, each 44 meters long, were separated by 50M. The majority of the adults appeared transient. They 1) were recaptured so seldom that home ranges could not be determined, 2) tended to show a net downstream movement. The remaining adults composed a resident population, with 0 meter homeranges and, except for spring, no net movement. The residents occupied "optimum sites" of > 25cm. depth. Riffles and shallow pools were occupied by juveniles. During the spring ALL movement was downstream; while no net movement occurred during summer and fall. Adult winter activity was nearly zero. It appears that reproduction by residents and slow moving transients in low order feeder streams provide sufficient animals for downstream transport while maintaining the size of the upstream population. The higher order streams exhibit a diminished production of young and populations of large (possibly older) adults.

ADULT DIGENETIC TREMATODE PARASITES OF PROCAMBARUS CLARKII AND P. ACUTUS (DECAPODA: ASTACIDAE) IN SOUTH LOUISIANA. H.M. Turner, McNeese State University, Lake Charles, Louisiana 70609

Red crayfish, *Procambarus clarkii* and white crayfish, *P. acutus* were collected throughout South Louisiana. Antennary glands of both were examined for infection with adult trematode parasites. *P. clarkii* harbored infections with *Allocorrigia filiformis* while *P. acutus* hosted *Alloglossoides caridicola*. Specificity of parasites for their hosts was maintained even when both species of crayfish occurred in sympatry. High numbers of spinous tegumented *A. caridicola* caused obvious damage to host antennary gland tubules. Low numbers of worms per organ and a non-spinous tegument probably contributed to absence of obvious pathology associated with *Allocorrigia filiformis* infection. Distribution of *A. filiformis* appears to be restricted to South Central Louisiana including the Atchafalaya River Basin. Infected crayfish occurred in a wide variety of natural habitats but were absent from rice fields and most commercial crayfish ponds.

SUPPORTED BY GRANTS FROM THE LOUISIANA BOARD OF REGENTS' RESEARCH AND DEVELOPMENT PROGRAM AND NSF PRM-8111529

LARVAL SPINES AS AN ANTI-PREDATOR DEVICE IN *Rhithropanopeus harrisi* (DECAPODA, XANTHIDAE). Steven G. Morgan, Duke Univ. Marine Lab., Beaufort, N.C.

To determine if the spines of *Rhithropanopeus harrisi* larvae serve as an anti-predator device, the rostral, dorsal and antennal spines of the zoeae were amputated. Spineless and spined zoeae were fed to larval silversides (*Menidia menidia*), a predator upon the crab larvae. Fish 9-12 mm long were able to eat spineless Stage I zoeae, but not until the fish attained a length of 13 mm did they prey upon spined zoeae. Silversides 13-15 mm long had difficulty eating spined zoeae and avoided them even when starved. Spineless Stage II zoeae were preferred over spined Stage I zoeae by 11-15 mm silversides. When disturbed, *R. harrisi* zoeae extend their antennal spines at right angles to the plane formed by the dorsal and rostral spines creating spars, making themselves more difficult to ingest. The zoeae also extend a pair of spines on the 5th pleomere to form a 90° angle with the telson spines. The presence of spines on *R. harrisi* zoeae reduces predation by selective planktivorous organisms on the larvae; whether or not they also aid in flotation is currently under investigation.

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TIDAL-ASSOCIATED FEEDING IN THE MANGROVE TREE CRAB, ARATUS PISONII. Kim A. Wilson University of Pennsylvania, Philadelphia, PA.

The estuarine grapsid crab, Aratus pisonii, commonly occurs on the prop roots, pneumatophores, and branches of the red (Rhizophora) and black (Avicennia) mangrove found in south Florida. Field observations indicate that the crabs eat a wide variety of plant material including living green mangrove leaves, mangrove root epiphytes, as well as undetermined material in the substratum. They also capture and eat small arthropods. These observations are supported by gut content analysis of crabs captured and preserved in the field. Feeding habits seem to change in conjunction with the tidal cycle. At high tide the crabs are found in the upper branches of the mangrove, whereas at low tide the crabs are most often found among the prop roots and pneumatophores. Laboratory studies show that most Aratus, whether captured in red or black mangroves, prefer to eat Rhizophora rather than Avicennia leaves. These preliminary studies indicate that Aratus pisonii is a major consumer of mangrove leaves and is an important component in the mangrove ecosystem.

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PROTEIN PATTERNS IN NEMATODE SYSTEMATICS. V. R. FERRIS and L. L. MURDOCK\*. Dept. of Entomology, Purdue Univ., West Lafayette, IN.

Protein maps for 3 taxa indicate that high resolution 2-dimensional gel electrophoresis may be a useful technique for nematode systematics. Nematodes tested included saprophagous Panagrellus redivivus (Nematoda: Secernentea: Rhabditida), maintained in xenic culture; and 2 predaceous species assigned to Labronema (Nematoda: Adenophorea: Dorylaimida), also maintained in laboratory culture (on P. redivivus). Nematode proteins obtained by homogenization were labeled *in vitro* by reductive methylation with formaldehyde and sodium borohydride ( $^3\text{H}$ ). Following separation in 2 dimensions by combined isoelectric focusing and SDS-PAGE electrophoresis, labeled proteins were located on gels by fluorography. Reproducible patterns were obtained over time for different cultures of the same taxon. Numerous proteins with identical electrophoretic properties were detected for the 2 species of Labronema. No proteins in common were detected between P. redivivus and either species of Labronema.

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PHYLOGENETIC RELATIONSHIPS IN MITES OF THE FAMILY TROMBIDIIDAE (ACARI). W. Calvin Welbourn. Ohio State University, Columbus.

A cladistic analysis of 23 genera of Trombidiidae (*s. str.*), based on characters of the parasitic larval instar, was undertaken. The 23 genera form five major monophyletic groups. One group, consisting of Ceuthothrombium, Neothrombium, and a recently discovered new genus, is entirely parasitic on grasshoppers and crickets (Orthoptera). A cladogram of these mites based on morphological characters of the larva will be compared with host-relationships and other aspects of their biology. Ceuthothrombium has characters consistent with the hypogean existence of its host while the other two genera are generalized epigeal forms.

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KARYOTYPE VARIATION IN SOME SOUTHEASTERN U.S. CAMPELOMA (MESOGASTROPODA: VIVIPARIDAE). B. J. DOUGHERTY. Florida State Univ., Tallahassee.

Dioecious and parthenogenetic populations of Campeloma were compared with respect to chromosome number and gross morphology. The diploid number was 28 for all populations examined although endopolyploidy occurred in the digestive gland of the parthenogens. Both interspecific and intraspecific variation in karyotype was evident primarily in the form of pericentric inversions. Comparison of the species karyotypes suggests a hybrid origin for the parthenogens. It is postulated that pericentric inversions could be important in maintaining reproductive isolation between species and could lead to isolation within species.

CYTOGENETIC STUDIES ON INTERSPECIES HYBRIDS OF *ASHMUNELLA* (GASTROPODA: PULMONATA). N. Babrakzai and W. B. Miller. Central Missouri State Univ., Warrensburg, and Univ. of Arizona, Tucson.

Twenty interspecies hybrids of *Ashmunella proxima albicauda* Pilsbry & Ferriss X *A. lenticula* Gregg were reared in terraria under laboratory conditions. After reaching maturity the ovotestes of the hybrids were examined cytologically. The hybrids are intermediate in shell morphology. Karyotypes of the parental species were constructed from developing embryos of the parental species populations. *A. proxima albicauda* has four distinct chromosomes with large C-band positive heterochromatic long arms in the mitotic metaphase. Such chromosome markers are absent in the *A. lenticula* karyotype. The hybrids have half of the *A. proxima* chromosome markers in both meiosis and mitosis. The meiotic behavior of chromosomes in hybrids ranged from complete synapsis to signs of asynapsis in pachytene. Chromosomal aberrations were observed in all stages of meiosis. It is therefore concluded that *A. proxima* and *A. lenticula* are two closely related species, with significant cytological and genetic differences.

HISTORICAL ASPECTS OF AGASSIZ'S LECTURES ON HOMOLOGIES AND CLASSIFICATION OF THE RADIATA (1860-61). R.W. Dexter. Kent State Univ., Kent, Ohio.

In 1860-61, Louis Agassiz (1807-1873) gave a series of weekly lectures to his special students at the Museum of Comparative Zoology on the homologies and classification of the Radiata. Excerpts have been selected and annotated to illustrate Agassiz's concept of the radiates at that period of time, just one year after the publication of Darwin's *Origin of Species by Natural Selection* and three years after the publication of his own famous *Essay on Classification*. These lectures expanded and updated some he had given at the Lowell Institute (Boston, Mass.) in 1849, but included personal notes and advice not found in the formal publications. He was especially concerned with showing the presumed relation of coelenterates to echinoderms, and the necessity of comparing parts with parts of animal structure, only after comparing region with region.

BIOCHEMICAL TECHNIQUES FOR SPECIES DETERMINATION IN THE DINOFLAGELLATE (PYRROPHYTA) GENUS *HETEROCAPSA*. D.A. WATSON\*, S.A. MCCOMMAS, A.R. LOEBLICH, III, and R.D. LEBOEUF. Univ. of Houston, Mar. Sci. Prgm., 4700 Ave. U, Galveston, TX 77550

Several species and isolates of the marine dinoflagellate genus *Heterocapsa* were raised. Isozyme systems of the resulting cells were resolved using horizontal starch gel electrophoresis and subsequent histochemical analysis of the gel slices. Each species, or a particular isolate thereof, showed unique banding patterns in response to given enzyme substrates. In addition, the genus was separable into 2 groups, based on whether the crude cell extract was orange or yellow. Clearly different electronic spectral patterns were observed for yellow and orange extracts. The peridinin-chlorophyll *a*-protein complex was dissociated using acetone and carotenoids were then removed with diethyl ether. Qualitative densitometric scans indicated a greater percentage of peridinin to other carotenoids in orange than in yellow specimens. These methods provide supplementary taxonomic characters with a degree of resolution suitable for distinctions at the level of genus or lower.

TROPICAL BENTHIC DINOFLAGELLATES. A.R. LOEBLICH, III, L.A. LOEBLICH, and E.G. BESADA.\* Univ. of Houston, Mar. Sci. Prgm., 4700 Ave. U, Galveston, TX 77550.

Cultures of *Coolia monotis*, *Gambierdiscus toxicus* and *Ostreopsis siamensis* were initiated from the Caribbean Sea and *G. toxicus* from the Florida Keys. This is the first report of these three species from the Caribbean Sea; we also document overwintering of *G. toxicus* in the Florida Keys.

Thecae stained by the chloral hydrate-hydriodic acid-iodine method and scanning electron microscopy of *O. siamensis* reveal the thecal plate tabulation to be: lpp, 4', 6", 6c, 8s, 5" and 2". Variations in number of thecal plates and the path of a fission line that partitions *O. siamensis* in cytokinesis are also reported. Thecal plate assignments based on plate homologies demonstrate gonyaulacoid affinities.

Transmission electron micrographs of sectioned cells of each of the three species reveals a unique feature of the cytoplasm of all three: spirally coiled fibrous material enclosed in vesicles. There is an astral aggregation of these vesicles (=pusule) near the sulcal region. The tethered habit of these species is discussed in relation to the spiral bodies.



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ACOUSTIC ENERGY DETECTION BY GOLDFISH. R. Fay\* and S. Coombs, Parmlly Hearing Institute, Loyola University of Chicago.

Classical conditioning techniques were used to measure threshold detectability of both pure tone and noise signals as a function of background noise level and signal duration. In the presence of background noise, the sound pressure level necessary for detection of 200 and 800 Hz tone bursts was approximately 12 dB less for a 320 msec signal than for a 20 msec signal. This is consistent with the notion that acoustic pressure is integrated over time such that acoustic energy remains constant (i.e. independent of signal duration). Somewhat less temporal integration was observed for noise signals. Under quiet conditions (ambient noise), considerably less temporal integration occurred for both tone and noise signals indicating that the energy required for the detection of short duration signals is actually less than that for longer signals. These results show that in terms of energy, short duration signals are as detectable, if not more detectable, than longer duration signals. Neurophysiological correlates of these results will also be presented.

(Work supported by NIH grants)

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TEMPORAL FEATURE DETECTION IN TWO TREEFROG SPECIES. C. M. Hillery, Dept. of Anatomy, Univ. of Chicago, Chicago, Il. 60637.

The sensitivity of *Hyla chrysoscelis* and *Hyla versicolor* to temporal features of synthesized acoustic stimuli was examined using average evoked potentials from the midbrain and whole nerve action potentials from the 8th nerve. Particular stimulus features were varied, including rise-fall time, interpulse interval, pulse period in the presence and absence of broadband noise and frequency and depth of amplitude modulated sound. High temporal resolution to call structure found at the periphery is maintained and sometimes enhanced centrally. In high levels of background noise, central neurons code pulse periods as short as 10 ms. Response to amplitude modulated sound showed band-pass characteristics between 60-200 Hz and detection of modulation depths as small as 6%. Seasonal differences in midbrain auditory responsiveness were documented, however there was no evidence of any population of neurons serving as mating call detectors in either species. It is suggested that while frequency sensitivity is dependent upon peripheral specializations for filtering input to the central nervous system, selective processing of temporal information occurs only in higher auditory centers.

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ELECTROMYOGRAPHY OF THE OPERCULARIS MUSCLE OF *RANA CATESBEIANA*. T.E. Hetherington and R.E. Lombard. Univ. of Chicago, Chicago.

The opercularis muscle of anuran and caudate amphibians originates on the operculum element of the otic capsule and inserts on the suprascapular cartilage of the shoulder girdle. It is composed of about 80% class-5 tonic fibers and about 20% class-3 phasic fibers. The presence of an opercularis muscle and operculum is correlated with terrestriality, and both appear to function in reception of low frequency sound (<1 kHz). Electromyographic analysis shows the opercularis muscle of *R. catesbeiana* to be active only when a frog is in air and actively respiring. Underwater the muscle is inactive and begins activity upon emergence of the snout and nostrils and about 1 sec before respiration starts. The opercularis muscle shows continuous firing activity when in air, although bursts correlated with respiratory activity of other muscles can be discerned. Activity patterns of other shoulder girdle muscles, such as the closely associated levator scapulae superior, are distinct from the opercularis pattern. Supported by NIH postdoctoral fellowship 1 F32 NS06531-01 and NSF grant DEB-8002619.

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BIOPHYSICS OF UNDERWATER HEARING IN AMPHIBIANS. T.E. Hetherington and R.E. Lombard. Univ. of Chicago, Chicago.

A standing wave tube was used to determine the biophysical basis of underwater hearing in adult *Rana* and *Xenopus* and larval and adult *Ambystoma*. A speaker inside the base of a 3 m steel pipe filled with water produced standing waves with particle motion and pressure components of sound 90° out of phase along the length of the tube. Microphonic responses were recorded from specimens lowered through the standing wave. All species utilize pressure for hearing above 0.2 kHz. The middle ear cavity of *Rana* and *Xenopus* appears responsible for pressure sensitivity, and the tympanum and stapes act as the pathway of sound energy, although at resonant frequencies of the middle ear cavity, pulsations of the cavity alone may stimulate the ear. In *Ambystoma* larvae and adults, the air-filled mouth and lungs appear to act as pressure transducers, apparently stimulating the ear via near-field displacements. Particle motion at frequencies above 0.2 kHz produces effects only at intensities 30-40 dB above levels producing pressure responses. Supported by NIH postdoctoral fellowship 1 F32 NS06531 01 and NSF grant DEB-8002619.

CELLULAR MORPHOLOGY AND MITOTIC ACTIVITY IN AVIAN COLUMELLA FOOTPLATE DEVELOPMENT. S. Bank. Biology, Brooklyn College, NY 11210

The Avian columella is of neural crest origin being derived from the hyoid arch. Footplate (FP) and annular ligament (AL) development in the fenestra ovalis region (FO) is very distinctive (TFJ&PFAM Anat. Rec. 1978). Investigation and analysis of this developmental process might elucidate the regulatory factors involved. TFJ&PFAM suggest that the development of the AL and FP results from inductive interactions between the cells of the proximal columellar shaft and those of the otic capsule producing a delay in chondrocyte maturation in the FP region. Avian embryos of HH stages 28-40 were serially sectioned and stained with H&E or Alcian blue. Preliminary observations suggest that although capsular and columellar cells around the FO appear morphologically similar, the cells of the presumptive AL can be distinguished at HH stage 32, lying perpendicular to the otic capsule. Further observations suggest a differential distribution of mitotic activity in the FP region at HH stages 32-33. The process of Avian FP development differs from that of other amniotes, raising the question as to why related lineages differ in such a fundamental respect. (NIH NS-13924).

DEVELOPMENTAL-FUNCTIONAL COMMENTS ON PUNCTUATION AND GRADUALISM. P.F.A. Maderson, Biology, Brooklyn College, NY 11210.

Thomson's (1966, Amer. Zool.) protadaptive model for the hyomandibular-columellar transition exemplifies Gans "excessive construction" (1979, Evol.). The correlated appearance of a fenestra ovalis is a classic example of a macroevolutionary phenotypic change. Ongoing studies of the development and cytology of the tetrapod columellar footplate emphasize the importance of the variety of skeletogenic capabilities of embryonic mesenchymal cells. Induced or spontaneous changes in these capabilities produce anomalies with dysfunctions which would be disadvantageous, if not lethal, in Nature. Morphological features result from embryonic processes and any constituent tissue or organ part arises via continuous modulation of developmental capacities. Some phenotypic variation is always seen but produces only minimal deviation from a functional mean. Major deviations, usually associated with deleterious pleiotropisms, would preclude successful reproduction. It is reasonable to assume that such phenomena have characterized all evolution. Thus gradualism is the only possible mechanism for producing phenotypic change: specific macroevolutionary changes cannot be seen by Selection, only identified a posteriori, and are therefore merely epiphenomena. (S13924)

STOPPING RULES FOR OPTIMAL FORAGERS.

R. F. Green. University of Minnesota, Duluth.

An important decision for animals foraging for food distributed in patches is when to leave a patch. Charnov's (Theor. Pop. Biol. 9:129-136, 1976) "marginal value theorem" tells when an animal should leave a patch but it does not tell how an animal can decide when to leave a patch. In this paper a stochastic model is described in which animals forage systematically in superficially similar patches which vary randomly. A number of leaving rules are considered, including the "giving-up time" rule, a "naive" rule, and the best possible rule. The average rate of finding prey is calculated for each rule for a variety of environmental conditions. It is possible to compare the performances of the various rules under various conditions. It is seen that the best rule, while quite simple, is substantially better than other rules which have been suggested. The robustness of the rules to misspecification of the environmental conditions can also be investigated.

ARE LARGEMOUTH BASS OPTIMAL FORAGERS?

Owen Anderson. Michigan State Univ., E. Lansing.

In the laboratory, largemouth bass were given the opportunity to forage in environments in which the amount of physical structure varied. Structural complexity significantly influenced the rate at which bass encountered prey and the time required to handle prey. Thus, prey value depended on structure, and ultimately the bass developed different diets in the various environments. Prey selection by the bass was compared with predictions based on optimal foraging theory. Optimal foraging models must be used cautiously to predict bass foraging behavior because of problems associated with determining prey values and non-independent prey encounter rates.

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FORAGING IN A PATCHY ENVIRONMENT: SOMETIMES OPTIMAL, SOMETIMES NOT. Roger L. Mellgren. Univ. of Oklahoma, Norman, Oklahoma.

Optimal foraging theory was tested by allowing Wistar-strain rats to earn their daily food and drink in a large room containing 9 food patches. Each patch contained pellets of food which were buried in sand. The room itself was sufficiently large to insure a substantial amount of travel time between patches. The amount of food available in a patch was held constant for the first phase of 12 hour foraging sessions and then the amount available was varied, but the locations of different amounts were constant. The amount of time available for foraging was also varied to be 12 hours or 1 hour. Finally, the amount available and locations of different amounts were both varied. Significant deviations from optimal foraging theory were evident because low availability patches were over-utilized and high availability patches were under-utilized, but when environment constraints were salient (restricted time, variable food locations) predictions conformed to optimal foraging theory. The subjects tended to show a conservative foraging strategy in the absence of pressures from the environment.

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SUBOPTIMAL FORAGING STRATEGIES FOR A PATCHY ENVIRONMENT: A COMPARISON OF CAPTURE RATE MAXIMIZATION AND RISK MINIMIZATION. J. E. BRECK.\* Michigan St. Univ., E. Lansing.

For an environment with prey in discrete patches, two strategies are analysed for allocating a predator's search time: Time Expectation (constant total search time per patch) and Constant Giving-Up Time. Two proximate goals are considered: maximization of capture rate and minimization of the risk of finding no prey while foraging. For each goal the optimal time to leave a patch is found, given search within a patch is a Poisson process. For both strategies the optimal leaving times for these goals converge at low prey densities. Thus, a capture rate maximizing predator need not switch goals at low prey densities, when risk is high, in order to maximize fitness (the ultimate goal). The risk of starvation may be more effectively reduced by other adaptations than by a choice of the risk minimizing leaving time.

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PREY HANDLING TIME AND GROWTH RATES IN THE BASEMENT SPIDER, TEGENARIA. LYNN HOLMES, University of Iowa, Iowa City.

According to optimal foraging models, animals should minimize food-handling time per unit of food, that is, they should minimize the time spent capturing and ingesting each food item. The time minimizers should be more fit than the slower animals. Data from studies on the basement spider, Tegenaria domestica, do not support this view. Ingestion time was defined as the period from the moment the spider captured a Drosophila until the spider deposited the ingested prey ball outside the web funnel. Ingestion rates were correlated with spider weight; larger spiders finished sooner than smaller ones. Fast ingestion rates within any weight class are not associated with high growth rates (the measure of fitness).

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CARUNCULINA (BIVALVIA: UNIONACEA): MANTLE-PULSER AND CARUNCLE-TWIDDLER. Louise Russert Kraemer, University of Arkansas, Fayetteville.

In this study, some details of spawning behavior in Carunculina texasensis (Lea, 1857) are presented for the first time. The spawning complex of C. texasensis involves (1) at least two kinds of paired pulsing movements of the mantle edges immediately antero-ventral to the branchial siphon; and (2) co-ordinated, opposing angular movements of the single pair of large caruncles on the mantle edges. The unionacean subfamily, Lampsilinae, includes both Carunculina and Lampsilis. Comparison of behavior of C. texasensis with the mantle-flapping, behavioral complex of female Lampsilis allows the conclusions that (1) similar portions of the mantle adjacent to the branchial siphon are implicated in both kinds of animals; and (2) while the posterior pallium of both bivalves has complex innervation, there are no mantle ganglia in Carunculina spp. comparable to those which evidently co-ordinate movements of the mantle flaps in Lampsilis spp. Status of Carunculina as an at least partly hermaphroditic genus, in contrast with the strictly dioecious genus Lampsilis, must also be considered here. (16 mm. film).

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A THEORY OF EVOLUTIONARILY STABLE SEARCH BEHAVIOUR AND ITS APPLICATION TO MATE CHOICE IN A GAMMARIDEAN AMPHIPOD.

W. Hunte and R.A. Myers. Biology Dept., Univ. of the West Indies, Barbados, and Biology Dept., Dalhousie Univ., N.S., Canada.

A general theory of biological search is presented that allows reformulation of mate choice, habitat selection and foraging patterns in the context of evolutionarily stable strategies (ESS). An ESS approach is appropriate whenever the distribution of resources is altered by the behaviour of the searchers, a condition which is probably typical of biological searches. It is shown that if the best behaviour for a rare searcher is characterized by a switchpoint (the search continues if the resource quality is below a threshold value and stops if above), the evolutionarily stable search behaviour can be explicitly calculated. The theory was used to predict search behaviour for mates in males of *Gammarus lawrencianus*. The prediction compares favourably with observed behaviour in populations of different sex ratios.

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CALCIUM ROLE IN VERTEBRATE MELANOPHORE CONTROL. M. E. Hadley, T. K. Sawyer and V. J. Hruby. Univ. of Arizona, Tucson.

A number of chemical messengers stimulate melanosome dispersion and aggregation within vertebrate (frog, lizard) melanophores.  $Ca^{2+}$  is required for melanophore dispersion in response to MSH but not for the actions of PG's or ISO. These results demonstrate a receptor-specific requirement for MSH action and reveal that melanosome dispersion per se does not require  $Ca^{2+}$ .  $Ca^{2+}$  is specifically required for transduction of signal between the MSH receptor and adenylate cyclase. Verapamil and trifluoperazine inhibit the action of MSH but, in contrast, usually enhance melanosome dispersion in response to other agonists. Ionophores (A23187, ionomycin) stimulate melanosome dispersion but only in the presence of  $Ca^{2+}$ , suggesting that their actions involve activation of adenylate cyclase rather than melanosome dispersion. Thus,  $Ca^{2+}$  participates in a bifunctional, but compartmentalized role in the control of melanophore activation and melanosome movements. The role of cyclic AMP may be to remove  $Ca^{2+}$  from the cytosol. A model for the role of  $Ca^{2+}$  in melanophore control is provided. Supported, in part, by NSF and NIH grants.

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AN IN VITRO CULTURE OF GUPPY CHROMATOPHORES. E. A. Powers and K. R. Rao. Univ. of West Florida, Pensacola.

A cell culture system using Ham's F-12 medium was developed for the melanophores, erythrophores, and xanthophores of female and male guppies (*Lebistes reticulatus*). The cells remained alive, retained their pigmentation, and displayed pigment movements (in varying degrees) up to 16 weeks in culture, although they stopped replicating after the first three weeks. Each cell had two or more extended processes; these processes remained unchanged during reversible pigment movements. Both  $\alpha$ -MSH and dibutyryl cAMP evoked pigment dispersion in the cultured melanophores and erythrophores; epinephrine induced pigment aggregation in these cells. Studies are underway to determine the nature of the receptors and the mode of action of hormones and other compounds on these cells.

(Supported in part by EPA Grant CR-807417)

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CHROMATOPHORES AND COLOR STASIS P.A. Schwalm, U. of Chicago, Ill.

Chromatophore ultrastructure and organization were examined in three species of tropical tree-frogs not capable of rapid color change. A layer of xanthophores lies under the basal lamina of the epidermis in each species. The green color of *Centrolenella fleischmanni* (Centrolenidae) is due to a combination of alcohol-soluble pigments in xanthophores and in chromatophores of unusual ultrastructure layered deeper in the dermis. A blue-green pigment in the bones of *Hyla phyllognatha* (Hylidae) produces a pale green color when viewed through the xanthophores of the skin. In these two species, melanophores are reduced in number or absent. Aggregations of iridophores with large reflecting platelets form white spots. Beneath the xanthophores in the orange skin of *Hyla leucophyllata* (Hylidae) a layer of pigment cells with moderately electron-dense organelles (0.3  $\mu$ m) were found. These lipid-like inclusions are larger and more dense than carotenoid vesicles. Thus, three species have replaced structural coloration with a system based on colored pigments.

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THYROTROPIN RELEASING HORMONE AUGMENTS DARK BACKGROUND ADAPTATION: EVIDENCE FOR DIRECT ACTION AT THE NEUROINTERMEDIATE LOBE. R.H. Selinfreund\*, L.C. Saland, and S.P. Mennin, Dept. of Anat., Sch. of Med., Univ. of N.M., Albuquerque, NM 87131

We have examined the effect of thyrotropin releasing hormone (TRH) on both *in vivo* and *in vitro* secretion of melanocyte stimulating hormone (MSH) in *Rana pipiens*. *In vivo* TRH 20 and 40 µg/Kg significantly augmented dark background adaptation. In contrast, identical doses were without effect when administered to frogs maintained on a light background. Injection of TRH directly into the foot web had no effect on the melanophore. Neurointermediate lobes (NIL's) were then incubated in the presence of dopamine (DA  $10^{-7}$ M), DA plus TRH ( $10^{-6}$ M), DA plus TRH ( $10^{-7}$ M) or medium 199 alone. Aliquots were collected and bioassayed for MSH-like activity. Dopamine significantly inhibited *in vitro* production of MSH-like activity. TRH overcame dopaminergic inhibition in a dose related manner. These data suggest: 1) TRH augments MSH secretion *in vivo* during dark background adaptation. 2) TRH stimulates MSH secretion from the NIL. 3) There is a complex interaction of TRH and DA at the level of the NIL.

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INHIBITORY EFFECT OF HISTAMINE ON THE RELEASE OF MELANIN-DISPERSING HORMONE IN THE FIDDLER CRAB, *UCA PUGILATOR*. M. M. Hanumante and M. Fingerman. Tulane Univ., New Orleans, LA.

Histamine (H), a stimulator of H<sub>1</sub> and H<sub>2</sub> receptors, produced dose-dependent inhibition of melanin dispersion. The H precursor histidine and H<sub>2</sub> receptor agonist 4-methyl histamine (4-MH) also inhibited melanin dispersion; but the H<sub>1</sub> agonist 2-methyl histamine (2-MH) did not. The H<sub>1</sub> receptor blockers mepyramine and SA-97 antagonized 2-MH. Effects of H and 4-MH were inhibited by the H<sub>2</sub> receptor blocker metiamide but not by H<sub>1</sub> receptor or α-adrenoceptor blockers, melanin-dispersing hormone (MDH) release being triggered mainly by α<sub>1</sub>-adrenoceptors. H-induced inhibition of melanin dispersion was potentiated by the noradrenergic neuron blocker bretylium. In crabs pretreated with 6-hydroxydopamine, a catecholamine neurotoxin, H did not affect melanin dispersion. None of these drugs affected melanophores directly. We hypothesize that H<sub>1</sub> and H<sub>2</sub> receptors are present on noradrenergic neurons involved in triggering MDH release and administered H inhibits impulse-mediated MDH release by decreasing norepinephrine secretion through stimulation of H<sub>2</sub> receptors. (Supported by NSF Grant PCM-8108864.)

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DEVELOPMENTAL PHYSIOLOGY OF OMMOCHROME PIGMENTS IN HELIOTHIS ZEA. S. FERNANDEZ R. KAMAS, G. BHASKARAN AND R. MEOLA. Texas A&M Univ., College Station.

During the feeding stage of last instar *Heliothis*, the xanthommatin content of the epidermis increases rapidly and reaches a maximum before wandering. The wandering stage is divided into two periods: early wanderers are pigmented, late wanderers are blanched. By the time of ocellar retraction, there is no xanthommatin left in the epidermis. During depigmentation of the epidermis, there is a transient increase of pigment in the hemolymph followed by its appearance in the gut. The gut pigment is finally excreted in the meconium at eclosion. Results show that xanthommatin metabolism is under developmental regulation and that color changes can be used as physiological markers for stages of the last instar. Preliminary studies also show that head and thoracic ligations affect depigmentation, while injections of ecdysone, and brain fragments counteract these effects. Starvation of larvae prevents depigmentation, while JHA interferes with normal pigment synthesis. These studies suggest that 20-hydroxyecdysone and juvenile hormone may be involved in pigment metabolism.

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COMPARISON OF THE Y-ORGAN AND CEPHALIC GLAND IN CONTROL OF MOLTING IN CRAYFISH. T. C. JEGLA and R. KELLER. Kenyon College, Gambier, OH., and Rheinische Friedrich-Wilhelms Univ., Bonn, FRG.

Y-organs and cephalic glands from intermolt and some premolt stages of *Orconectes limosus* were cultured *in vitro* for 20 - 24 hr. and ecdysteroid levels in the medium were subsequently measured with an RIA. Hemolymph ecdysteroid levels were low in normal intermolt animals and only small amounts were secreted by a pair of y-organs. No ecdysteroids were secreted by their cephalic glands. Crayfish 6-8 days after eyestalk ablation had increased hemolymph ecdysteroids and their y-organs produced large amounts of ecdysteroid; still none were detectable in cultures of their cephalic glands. Y-organless, eyestalkless crayfish that definitely had not regenerated y-tissue maintained low hemolymph ecdysteroid levels over a 50 day period. Although we have more experiments in progress our results to date indicate that only the y-organ produces ecdysteroids which lead to increased hemolymph titers during premolt, gastrolith formation and molting.

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ISOLATION OF GIANT SMOOTH MUSCLE CELLS FROM THE CTENOPHORE *Mnemiopsis*. M.-L. Hernandez-Nicaise\*, G. Nicaise\*, and P.A.V. Anderson. Université Claude Bernard, Villeurbanne, France and Univ. of Florida, Gainesville.

In the ctenophore *Mnemiopsis leydi* two bundles of longitudinal giant (up to 30  $\mu$ m in diameter and 2 cm in length) smooth muscle fibers extend the length of the animal from the statocyst to the mouth. Each bundle consists of from 30 to 50 fibers. After dissection of the bundle and subsequent enzymatic digestion of the surrounding mesoglea, individual fibers can be isolated. To ensure that the isolation procedure had not damaged the cells, they were examined ultrastructurally and no abnormalities suggestive of damage were found. Similarly, the resting potentials (average = -56 mV), membrane impedances and action potentials of isolated and *in situ* fibers were measured and no significant difference was observed between the two. The fact that functional giant smooth muscle cells can be isolated from an animal as readily available as *Mnemiopsis* presents a rare opportunity for investigators interested in smooth muscle physiology.

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SOME *IN VIVO* EFFECTS OF ACETYLCHOLINE (ACh) AND 5-HYDROXYTRYPTAMINE (5-HT) ON THE CIRCULATION OF THE PINTO ABALONE, *HALIOTIS KAMTSCHATKANA* JONAS, 1845. K.G. KRAJNIAK\* & G.B. BOURNE. Bamfield Marine Station, British Columbia & Univ. of Calgary, Alberta.

Simultaneous aortic and ventricular blood pressure measurements were made from unrestrained pinto abalones by way of Statham P23Db blood pressure transducers coupled to the circulatory system by fine bore polyethylene catheters. Blood pressure information was displayed on a Gould 2400 recorder. ACh and 5-HT dissolved in filtered sea water were administered via the ventricular catheter and dose response relationships were established. ACh at levels of 2-3  $\mu$ g/kg wet body weight caused a decrease in aortic pulse pressure with an additional decrease in heart rate at higher levels (200  $\mu$ g/kg). 5-HT at levels of 0.05-0.10  $\mu$ g/kg caused an increase in aortic pulse pressure. This study indicates that these two putative molluscan neurotransmitters may influence the circulation in the pinto abalone, *Haliotis kamtschatkana*.

(Supported by NSERC grant #A0452.)

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CHORDOTONAL REFLEXES IN PERIPLANETA AMERICANA. P. Brodfuehrer\* and C.R. Fournier. Univ. Virginia and SUNY/Bufalo.

Proprioceptors in insect appendages provide sensory information and modulate centrally coordinated motor outputs. We have investigated limb reflexes evoked by mechanical activation of identified chordotonal organs (CO) located in the coxa (CCO) and femur (FCO). CO stimulation produced classical resistance reflexes. Lengthening FCO (tibial flexion) reflexively activates the slow extensor motor axon (SETi), two common inhibitors (CI's) or all axons concurrently. The CI's are activated at low FCO stimulation frequencies (0.1-2.0 Hz); SETi, between 0.1 to 7.0 Hz. FCO strongly activates the flexor tibialis at stimulation frequencies from 1.0 to 8.0 Hz. Lengthening CCO (femoral extension) reflexively modulates three flexor units in nerve 6Br4 (axons 4, 5 and 6). Axons 4 and 6 respond at stimulation frequencies between 2.0 and 25.0 Hz, with axon 4 being predominantly more active at low frequencies. Shortening CCO produced no observable reflexes in the femoral extensor or flexor. Postural adjustments and rhythmic leg movements may be influenced by FCO while CCO may play a role in flight. Supported by NSF # BNS 77-24452; NIH #K04 NS 00141.

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PARTITIONING OF THE HONEYBEE COMPOUND EYE FOR MOTION DETECTION. DARRELL MOORE. University of Texas, Austin.

Selected eye regions were tested for their ability to mediate an optomotor response to horizontal motion of a vertically striped drum, using head-turning behaviour as an assay combined with various occlusions of the ommatidial array. The eyes were found to be functionally compartmentalized for directional sensitivity, lateral regions being specialized for the detection of anterior-to-posterior movements and medial regions for posterior-to-anterior movements. Lateral regions yielded significantly higher response values than did medial regions, suggesting a greater role in the optomotor reflex. Stimulation in the "non-preferred" direction of either medial or lateral regions alone yielded response values lower than blinded controls, perhaps indicating a subtle influence on motion-detecting units which is masked when the entire eye or both eyes are stimulated. The topographical division of the compound eyes into functional subsystems is not obviously correlated with external or retinal anatomy and therefore is presumed to be the result of specific asymmetries in the underlying visual neuropile.

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ULTRASTRUCTURAL EXAMINATION OF THE CARDIAC GANGLION IN THE AMERICAN LOBSTER. R. G. Sherman and P. M. Morganelli\*. Miami Univ., Oxford, Oh.

The cardiac ganglion in Homarus americanus consists of four pacemaker neurons and five motoneurons. We have initiated an ultrastructural examination of this ganglion in adult lobsters. Sampling the ganglion at various levels shows that it consists mostly of layers of connective tissue and glial cell processes. The neuron somata occur singly and are displaced dorsally. Axons course longitudinally throughout the ganglion. Either one or two areas of neuropile may occur in a given section, each with its own investment of glia. Numerous axon terminals heavily laden with synaptic vesicles occur in the neuropile. In most terminals, nearly all of the synaptic vesicles are electron-lucent. However, some contain large numbers of both electron opaque and electron-dense synaptic vesicles. The vast majority of the synapses appear to be chemically mediated. Presumptive electrical synapses also have been seen. As yet, no major differences in ultrastructure have been discerned between the region of the ganglion containing the pacemaker cells and that containing the motoneuron somata.

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INFLUENCE OF THE EYES AND PINEAL GLAND ON LOCOMOTOR ACTIVITY PATTERNS OF CHANNEL CATFISH, ICTALURUS PUNCTATUS. C. A. Goudie, K. B. Davis and B. A. Simco. Memphis State University, Memphis, Tennessee

Locomotor activity was measured in normal, blinded, pinealectomized, and pinealectomized-blinded channel catfish exposed to a 12:12 LD photoperiod of decreasing light intensities (7500, 175, and 0.7 lux). Normal, blinded and pinealectomized fish exhibited nocturnal activity patterns which corresponded with the exogenous photoperiod. Fish without lateral eyes and pineal gland did not entrain to the photoperiod, but had arrhythmic activity patterns. Neither treatment nor light intensity affected total locomotor activity. Blinding or pinealectomy decreased the level of dark period activity at low light intensities, but the effect of light intensity was not observed in normal and pinealectomized-blinded fish. Normal and blinded fish under constant light or constant dark exhibited arrhythmic activity. The pineal gland functions as an extra-retinal light receptor in channel catfish.

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THE pH OF TRACHEAL MUCUS: CHOLINERGIC STIMULATION AND BLOCK. Louis A. Gatto and Pamela Fenstemacher\* Department of Biological Sciences SUNY College at Cortland, New York, 13045.

New Zealand white rabbits were anesthetized (50 mg·kg<sup>-1</sup> Nembutal®) and the pH of mucus was measured *in vivo* through a tracheal window. Following a period of stabilization pH ranged between 7.56 and 7.81 ( $\bar{x}$ =7.70±0.04SD) units. The regression line of pH on time had a mean slope of -0.00056 over a period of 0.5 hours. Cholinomimetic doses of pilocarpine (5.0 mg·kg<sup>-1</sup> IP) were followed by a significant (*t*-test, P<0.01) decline in pH to a mean of 7.59±0.06 units. This response was temporary and, in time, pH returned to initial values. In another group of rabbits, an anticholinergic dose of atropine (2.0 mg·kg<sup>-1</sup> IP) preceded pilocarpine to test susceptibility of the stimulation to pharmacological block. Combined atropine and pilocarpine caused no immediate change in pH; however, about 0.5 hours later there was a significant (*t*-test, P<0.01) decline in pH. A second dose of atropine was followed by a recovery to initial pH. These findings support the postulate of a nervous mechanism to modulate mucociliary transport by modifying the composition of mucus to affect its interactions with cilia. (Support: SUNY Foundation Grant #223-7218A)

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IONIC ACCLIMATION IN SALINE-WATER MOSQUITO LARVAE. T.J. Bradley and A. Shepley. Univ. of California, Irvine.

The larvae of saline-water mosquitoes are found in waters showing a wide range of ionic ratios. The larvae of coastal species encounter waters of marine origin rich in NaCl. Inland species face waters of greater diversity, often high in Mg<sup>++</sup>, SO<sub>4</sub><sup>-</sup> or HCO<sub>3</sub><sup>-</sup>. We have conducted a comparative study of osmoregulatory capacities in Aedes taeniorhynchus, a coastal species, and A. dorsalis, an inland one. Larvae reared in 50% seawater were stressed with various levels of MgSO<sub>4</sub>. Increasing levels of MgSO<sub>4</sub> reduced hatching efficiency and larval survival identically in both species. Previous workers have shown an inducible SO<sub>4</sub><sup>-</sup> pump in the Malpighian tubules of A. taen. We reared four groups of A. taen larvae in steadily increasing levels of various salts. Fourth instar larvae from each group were then identically stressed with a solution containing 300 mM MgSO<sub>4</sub>. Survival was high (84%) in MgSO<sub>4</sub>-reared larvae and low in larvae reared in MgCl<sub>2</sub> (30%), Na<sub>2</sub>SO<sub>4</sub> (13%) or NaCl (18%). These results indicate that resistance to MgSO<sub>4</sub> stress is better correlated with the previous ionic environment of a larva than with the ecological range of its species. (Supported by NIH GM27919.)

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OSMOREGULATION IN SOLDIER FLY LARVAE, (*ODONTOMYIA CINCTA*). L. F. Gainey, Jr. University of Southern Maine, Portland, Maine.

Larvae tolerate salinities ranging from fresh water to 190 o/oo (3 to 5,800 mOsm). Hyperosmotic regulation occurs below an external salinity ( $\pi_e$ ) of 275 mOsm; the change in hemolymph osmotic pressure ( $\pi_i$ ) is described by the equation:  $\pi_i = 230 + .1911 \pi_e$ . Hypoosmotic regulation occurs above 275 mOsm; the change in hemolymph osmotic pressure is described by the equation  $\pi_i = 266 + .0254 \pi_e$ . The significantly smaller slope for the equation describing hypoosmotic regulation indicates that the larva is a more effective hypoosmotic regulator. The increase in the concentration of hemolymph amino acids as a function of ambient salinity is adequately predicted by the concomitant increase in hemolymph osmotic pressure. Thus, unlike other insects, hemolymph free amino acids are not regulated with changes in hemolymph osmotic pressure. There is no difference in the concentration of intracellular free amino acids in larvae adapted to fresh water and 190 o/oo. Cellular volume regulation is not mediated by changes in intracellular amino acid concentrations.

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OSMOTIC SOLUTE IN *LIMULUS*: WHOLE ANIMAL AND ISOLATED TISSUE RESPONSE TO LOW SALINITY. M. K. Warren and S. K. Pierce. Univ. of Maryland, College Park.

The total non-protein nitrogen (NPN) content of heart tissue of the horseshoe crab, *Limulus polyphemus*, decreases on acclimation to low salinity. This NPN decrease is due mostly to a decrease in the concentration of the quaternary ammonium compounds glycine betaine and, to a lesser extent, homarine. A small free amino acid pool plays only a minor role. In addition, glycine betaine and homarine appear in the blood 6 to 12 hrs after *Limulus* are placed in low salinity (930 mOsm  $\rightarrow$  235 mOsm). The blood concentrations of these compounds reach a peak between 48 and 72 hrs, and gradually decline over several days. Glycine betaine and homarine in the heart tissue of acclimating crabs begin to decrease between 24 and 48 hrs, with a rapid decrease between 72 and 96 hrs. Isolated heart tissue exposed directly to low salinity responds differently. Osmotic swelling reaches a peak in 2 hrs, and is slowly reduced by half within 24 hrs. However, this volume recovery is not due to glycine betaine and homarine, which remain constant throughout the 24 hr period. (Supported by NIH GM-23731 and TS&GCMB, Inc.)

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THE ONTOGENY OF OSMOREGULATORY ABILITY OF *MACROBRACHIUM ROSENBERGII*. K.E. Harrison, P.L. Lutz, and L. Farmer. \*Rosenstiel Marine School, Univ. of Miami, Florida.

The catadromous prawn, *M. rosenbergii* has changing salinity requirements over its life cycle. Hemolymph Na concentration and transepithelial potential were measured in larvae, newly-metamorphosed postlarvae and 8-day postlarvae over a range of salinities. The osmoregulation curves define the transition from brackish water dependent larvae to fresh water adults. Larvae are hyperregulators below 324mM Na to their lower lethal limit,  $\sim$ 150mM Na. Newly-metamorphosed PL's and 8-day PL's can hyperregulate from 287 and 252mM Na, respectively, to  $\sim$ 0mM Na. Two important ontogenic changes are evident: a decrease in the slope of the regulation curves and a decrease in the isosmotic value, indicating increased adaptation to fresh water. Transepithelial potential measurements suggest high Na permeability and electrogenic Cl uptake at all stages. Structural changes in possible salt transporting areas are described that may explain this changing ability.

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ACID-BASE BALANCE AND CO<sub>2</sub> EXCRETION IN TWO LITTORAL CRABS *HEMIGRAPUS NUDUS* AND *PACHYGRAPUS CRASSIPES*. B.R. McMahon and L.E. Burnett. U. of Calgary, Alberta, and U. of San Diego.

Compensation for air exposure (emersion) is compared in these morphologically similar crabs from cool (*Hemigrapsus* 11 $^{\circ}$ ) and warm (*Pachygrapsus* 21 $^{\circ}$ ) littoral areas. Generally acid-base status varied predictably with increase in temperature ( $\Delta$ pH  $\Delta$ t = 0.20) and a slight increase in both PO<sub>2</sub> and CCO<sub>2</sub> occurred. Compensatory responses to air exposure were qualitatively similar. PvCO<sub>2</sub> rose but the associated acidosis was rapidly (<30 min *Pachygrapsus* >120 min *Hemigrapsus*) fully compensated by increase in hemolymph HCO<sub>3</sub><sup>-</sup>. Both species retain branchial water during emersion. Branchial water [CO<sub>2</sub>] rises in air but is not an important CO<sub>2</sub> 'sink'. No significant fall in pH had occurred 2h after acetazolamide treatment (by immersion) despite elevation of PvCO<sub>2</sub>. Hemolymph HCO<sub>3</sub><sup>-</sup> increased rapidly perhaps allowing compensation for the resp. acidosis. In emersed treated animals hemolymph [CO<sub>2</sub>] rose above, then declined towards emersed control values. Branchial water [CO<sub>2</sub>] was significantly reduced and rate of CO<sub>2</sub> efflux on reimmersion diminished, confirming that acetazolamide reduces the effectiveness of CO<sub>2</sub> removal in these crabs.



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THE ROLE OF BRANCHIAL CARBONIC ANHYDRASE IN ION REGULATION, ACID-BASE BALANCE AND CO<sub>2</sub> EXCRETION IN THE EURYHALINE BLUE CRAB, *CALLINectes Sapidus*. R.P. Henry and J.N. Cameron. The Univ. Texas, Marine Sci. Inst., Port Aransas, Tx.

A sensitive pH-stat assay was used to study the inter- and intrabranchial distribution of carbonic anhydrase (CA) in *C. sapidus* acclimated to 29 and 8ppt. The enzyme is primarily associated with the osmoregulatory patches in the lamellae of the posterior gills. There is both an induction of CA and activation of the enzyme at the low salinity. *In vivo* inhibition of CA by an injection of Diamox in crabs at 8ppt causes a metabolic alkalosis characterized by elevated pH and HCO<sub>3</sub><sup>-</sup> at constant PCO<sub>2</sub>. Blood Na and Cl were significantly lowered, with Cl being lowered proportionally more than Na, thus altering the strong ion difference (SID). Diamox had no effect on crabs at 29ppt, and it did not alter O<sub>2</sub> uptake or CO<sub>2</sub> excretion at either salinity. We conclude that gill CA functions in hydrating CO<sub>2</sub> to HCO<sub>3</sub><sup>-</sup> and H<sup>+</sup> for counterions in Cl<sup>-</sup> and Na<sup>+</sup> uptake in low salinity. Acid-base balance is a function of the SID and CO<sub>2</sub> excretion is driven solely by the PCO<sub>2</sub> gradient from blood to water.

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ELECTRICAL POTENTIALS AND FLUXES OF SODIUM AND CHLORIDE IN PENAEID SHRIMP. F. L. Castille and A. L. Lawrence. TAMU Shrimp Mariculture Project, Port Aransas, TX.

The electrical potential between the hemolymph and external solution, and the unidirectional sodium and chloride fluxes were determined in *Penaeus aztecus* and *P. stylirostris*. The mean potential of the hemolymph was -19mV relative to 25ppt seawater and increased to -34mV in 10ppt seawater and to -29mV in 40ppt seawater. Rate constants for steady state sodium exchange ranged from .36 to .45 hr<sup>-1</sup> at 10 ppt, from .42 to .51 hr<sup>-1</sup> at 25ppt and from .61 to 1.16 at 40ppt. For chloride, rate constants ranged from .38 to .46 hr<sup>-1</sup> at 10ppt, from .34 to .81 hr<sup>-1</sup> at 25ppt and from .37 to .87 hr<sup>-1</sup> at 40ppt. Exchange diffusion may account for up to 26% of the sodium flux at 25ppt, 63% of the sodium flux at 40ppt, 55% of the chloride flux at 10ppt and 32% of the chloride flux at 40ppt. The results are consistent with the hypothesis that at low salinities the electrogenic uptake of chloride produces a negative electrical gradient that passively maintains sodium balance, and at high salinities electrogenic sodium efflux produces a negative gradient that passively maintains chloride balance.

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NON-FREEZABLE WATER IN AN ANHYDROBIOTIC NEMATODE. JOHN H. CROWE, LOIS M. CROWE, AND STEVEN J. O'DELL. University of California, Davis.

Anhydrobiotic nematodes, *Aphelenchus avenae* were shown to survive freezing provided that their H<sub>2</sub>O content was < 0.25 g H<sub>2</sub>O/g dry wgt (g/g). Survival of the worms was shown to be independent of cooling rate or minimal temperature to which they were exposed. Thermal analysis and calorimetric determination of the worms' ice contents at various H<sub>2</sub>O contents suggested that ice formation did not occur in worms containing < 0.25 g/g. Thermal analysis also permitted preparation of a temperature-dependent phase diagram for the H<sub>2</sub>O in the worms. This diagram showed a discontinuity in the region of 0.25 g/g. Assessment of damage due to ice formation was made by measuring leakage of ions from freeze-thawed worms. Significant leakage did not occur from worms exposed to low temperatures with < 0.25 g/g. The conclusion we draw from these data is that bulk, freezable H<sub>2</sub>O does not exist in anhydrobiotic nematodes containing < 0.25 g/g. (Supported by grants PCM-80-04720 from the National Science Foundation and RA/41 from the National Sea Grant).

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COLD HARDINESS IN THE WOODLAND SNAIL, *ANGUISPIRA ALTERNATA*. W. A. RIDDLE. Illinois State Univ., Normal

Mean Supercooling point (SCP), an estimate of lower lethal temperature, was significantly depressed in dormant snails in winter. Thermal acclimation of snails in August to 5°C was associated first with a reduction in water content and later with a significant depression in SCP. Laboratory exposure of March animals to +5°C and -5°C lowered SCP below that found in field animals in March (-13.5°C) to a level approaching that found in February animals maintained outdoors (-15.5°C). Snails were killed by freezing at the SCP. Polyhydric alcohols (glycerol, sorbitol or mannitol) were not detected in the hemolymph of animals collected in December and acclimated to 0°C or to -8°C. Gut evacuation and reduced water content in the fall with the development of winter dormancy coupled with thermal acclimatization during the overwintering period were tentatively considered to be important determinants of SCP.

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THERMAL ACCLIMATION OF THE CELLULAR DEFENSE MECHANISM IN THE BIVALVE MERCENARIA CAMPECHIENSIS D. E. Brock\*, G. E. Rodrick and N. J. Blake\*, University of South Florida.

The molluscan bivalve line of defense against invading pathogenic bacteria is thought to be primarily cellular. The southern quahog, Mercenaria campechiensis was tested to ascertain whether the hemolymph cell population and associated hydrolytic lysosomal enzyme activities are influenced by temperature. Three groups of bivalves were acclimated for four weeks at 8°, 19° and 30°C. Hemolymph was withdrawn from the anterior adductor muscle sinus and total hemocyte counts, differential counts, cell sizes and hydrolytic lysosomal enzyme activities were determined at the three experimental temperatures. Results indicate that temperature may influence both total hemocyte number and the numbers of granular and agranular hemolymph cells. (Supported in part by a Sigma Xi Grant-In-Aid-of-Research Award and Florida Sea Grant No. 125 720073/257\*73)

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CELL MATRIX ASSOCIATED ICE NUCLEATORS IN AN OVERWINTERING INSECT. J. G. BAUST and K. E. ZACHARIASSEN. Univ. of Houston, Texas and Univ. of Trondheim, Norway.

A category of heat labile, seasonally "active" ice nucleating agents not associated with gut content is described for the first time in an insect. Rhagium inquisitor is an overwintering species that relies upon extensive supercooling to avoid freezing and survive. However, it contains high levels of nucleator agents associated with the cellular matrix of certain tissues. This nucleator activity is masked during winter but "activated" following warm acclimation. The masking action is not effected by either low molecular weight (polyhydric alcohols) or THF (thermal hysteresis factors) antifreezes.

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THERMAL ENERGETICS OF PREDATORY SNOWFIELD ARTHROPODS. M. A. CHAPPELL. Univ. of California, Riverside.

Microclimate variables and body temperatures ( $T_b$ ) of carabid beetles and lycosid spiders (body mass 4-125 mg) were measured on 2 snowfields in the Sierra Nevada (elevation 3145-3360 m).  $T_b$  was continuously monitored by attaching very thin thermocouples (.025 mm) to live animals. On the snow surface both beetles and spiders maintained fairly constant  $T_b$ 's of 12-27 C on sunny days, despite small body size, low air temperatures (5-15 C), and the cold substrate.  $T_b$ 's on nearby rocks and soil were 25-35 C. High  $T_b$  on snow is primarily due to intense direct and reflected solar radiation. When animals were shaded,  $T_b$ 's dropped to 2-3 C in still air and 8-12 C when windy. Elevation of the body above the snow surface is also important for maintaining high  $T_b$ , even for the smallest body sizes. Animals actively avoid shaded and windy regions and areas where the surface is wet; these behaviors may be adaptive because walking speed increases with increasing  $T_b$ .

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THERMAL PHYSIOLOGY OF THE CICADA, Tibicen duryi. Stacy A. Kaser\* and Jon Hastings (intro. by Eric C. Toolson). Univ. of New Mexico.

Thoracic and abdominal temperatures of T. duryi were measured at various ambient temperatures. Thoracic and abdominal temperatures were maintained above ambient at temperatures of 18°-34°C; at 36°C and higher, abdominal temperatures were significantly lower than ambient. Individuals of T. duryi feed on the xylem fluid of piñon trees and therefore have access to a constant supply of water. Denial of access to water, at high ambient temperatures, resulted in abdominal temperatures significantly higher than normal. These data suggest there are some physiological mechanisms for thermal regulation, including evaporative cooling. The interaction between the thermal physiology and the activity cycle of this cicada will be discussed.

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EFFECTS OF DECLINING OXYGEN CONCENTRATION, TEMPERATURE AND BODY SIZE ON THE OXYGEN CONSUMPTION OF *PENAEUS AZTECUS* IVES. S.Y. WANG. LOUISIANA STATE UNIV., BATON ROUGE.

Brown shrimp, *P. aztecus*, were capable of oxyregulation from air saturation down to a critical oxygen concentration ( $P_c$ ) that was independent of body weight but was influenced by temperature at  $10^\circ/00S$ . The mean  $P_c$  was 1.98, 2.32 and 3.27  $mgO_2/l$  at 18, 25 and  $32^\circ C$ , respectively. The range of  $P_c$  was 1.75-2.50  $mgO_2/l$  at  $18^\circ C$ , 2.00-3.00  $mgO_2/l$  at  $25^\circ C$  and 3.00-4.00  $mg_2/l$  at  $32^\circ C$ . Shrimp oxygen consumption ( $VO_2$ ) was strongly influenced by temperature.  $VO_2$  of a 1.24 g shrimp was 0.39, 0.91 and 1.92  $mgO_2/hr$  at 18, 25 and  $32^\circ C$ , respectively. When tested at temperatures other than acclimation temperature, *P. aztecus* no longer maintained stable  $VO_2$  and responded to declining  $PO_2$  as oxyconformers.  $VO_2$  increased significantly when shrimp were subjected to a 7 or  $14^\circ C$  increase in test temperature. A  $7^\circ C$  decrease in test temperature did not decrease  $VO_2$  significantly but a  $14^\circ C$  decrease did. The regression coefficient,  $b$ , relating  $VO_2$  to body weight was 0.79 at  $18^\circ C$ , 0.79 at  $25^\circ C$  and 0.66 at  $32^\circ C$ .

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IN VITRO & IN VIVO AMPHIBIAN GASTRULA CELL DEVELOPMENT. ARE THEY SIMILAR?

J. LeBLANC & I. BRICK. New York Univ., N.Y.

Do *Rana pipiens* gastrula cells differentiate in vitro as in vivo in respect to rate, morphology and spreading behavior? Comparisons were made between germ layer cells isolated at late blastula for 24 hr and those cell types isolated from late gastrula for 1 hr. Such cells are chronologically similar after their respective culture periods and should be morphologically similar if in vitro and in vivo differentiation are in the same direction and rate. 5 hr isolates in std medium were compared to 1 hr isolates in medium with enhanced  $Ca^{2+}$  to determine if  $Ca^{2+}$  modulates cell spreading, projection formation and rates. Data and inferences are as follows: Some late blastula and gastrula cells differentiate similarly in vitro as in vivo. In vitro differentiation is autonomous indicating determination prior to isolation. Presence of 2 sub-populations in some cultures suggests determinative interactions prior to isolation. Morphologic similarity of 5 hr cultures to 1 hr cultures with enhanced  $Ca^{2+}$  suggests  $Ca^{2+}$  modulation of cell spreading, projection formation and their rates. Upper cell surfaces may provide adhesive sites for cell projections from adjacent cells.

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VITELLOGENESIS IN *HOMARUS AMERICANUS*, THE ROLE OF SERUM VITELLOGENIN DURING SECONDARY VITELLOGENESIS. P. DEHN, D. AIKEN\*, and S. WADDY\*. Fisheries & Oceans Canada, St. Andrews, New Brunswick.

In crustaceans evidence exists for both an auto- and heterosynthetic origin of lipovitellin, the major yolk protein. In the lobster a female-specific serum lipoprotein is electrophoretically & immunologically identical to lipovitellin. This lipoprotein, vitellogenin, is assumed to be the precursor to or to be lipovitellin, and is presumably sequestered by the ovary. In vivo incorporation of  $^3H$ -leucine into serum vitellogenin was demonstrated using PAGE. In actively vitellogenic females the label was visible 12 hrs after injection, but rates of incorporation were variable. Total serum protein levels decreased throughout secondary vitellogenesis and reached low levels prior to extrusion. Lipovitellin fractions isolated from ovaries of injected animals contained the label. In vitro incubation of ovaries in male serum and  $^3H$ -leucine showed incorporation of label into non-specific ovarian proteins, but not in lipovitellin fractions after 24-48 hrs. These data suggest that during secondary vitellogenesis lipovitellin is derived from an exogenous source, and is transported to the ovary via the hemolymph.

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DEVELOPMENT OF THE NERVOUS SYSTEM IN THE LEECH, *Haemopsis marmorata*. R.R. Stewart and E.R. Macagno\*. Columbia University, N.Y., N.Y. 10027

We characterized the embryonic development of the leech, *Haemopsis marmorata*, so that questions concerning segmentation, cell number, and the appearance of specific antigens in the nervous system can be addressed. To do this we computer-3-D reconstructed segmental ganglia from serially sectioned embryos taken at different stages during development. Embryos were fixed, embedded, and serially sectioned at a thickness of one to two micrometers. After toluidine blue staining, the sections were photographed on 35mm film. The micrographs were then aligned with respect to one another and rephotographed onto a 35mm filmstrip. Using the CARTOS system various features were drawn from each section into the computer. The features recorded were ganglion boundaries, glial packet boundaries, cell body locations and major tracts and processes. A 3-D map of the major landmarks of segmental ganglia will be generated.

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ROLE OF THE SECOND POLAR LOBE IN APICAL TUFT FORMATION IN SABELLARIA CEMENTARIUM.  
J. RENDER. Univ. of Texas, Austin.

Embryos of Sabellaria cementarium form polar lobes at each of the first two cleavage divisions. The first polar lobe contains determinants for the apical tuft and the post-trochal region of the trochophore larva. The second polar lobe is smaller than the first and contains determinants only for the post-trochal region. In blastomere isolation experiments, isolates containing C but not D macromeres form apical tufts whereas isolates containing D but not C macromeres do not form apical tufts. When second cleavage is equalized such that both C and D receive polar lobe material, no apical tuft is formed. When the second polar lobe is removed and the C and D macromeres are separated, each can form an apical tuft. These results suggest that the apical tuft determinants are distributed to both the C and D macromeres at second cleavage but that the second polar lobe contains an inhibitor for apical tuft formation in the D quadrant.

This work was supported by a Sigma Xi Grant in Aid of Research.

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METAMORPHOSIS IN THE HYDROZOAN MITROCOMELLA POLYDIADEMATA. V. J. MARTIN, F. S. CHIA, and R. KOSS. Univ. of Louisville, Ky., and Univ. of Alberta, Edmonton, Canada.

Ultrastructural examination of pre-metamorphic planulae reveal the presence of 9 cell types. Particular emphasis is focused on the supportive cells of the ectoderm. These cells are columnar in shape and extend from the free surface of the planula to the mesoglea. Foot processes containing bands of randomly-arranged microtubules insert on the mesoglea. Post-settled planulae shorten and change from a club shape to an ovoid form. The supportive cells are cuboidal in shape. Further development is represented by a unidirectional elongation to assume a thread-like shape. The supportive cells are greatly reduced in height and are closely applied to the mesoglea. The foot processes are drawn out along the mesoglea into long extensions which contain numerous bands of microtubules oriented parallel to the mesoglea. The elongating portion of the thread-like stage transforms into a bulb which gives rise to the hypostome of the primary polyp. The supportive cells are spindle-shaped.

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THE ROLE OF MICROTUBULES IN HYDRA BUDDING. D.L. Roth and D.L. West. Sangamon State Univ., Springfield, IL.

The morphogenetic activity of hydra budding has been suggested to reside either in the active locomotory movement of epitheliomuscular cells or in cytoskeletal elements which effect cell shape changes thus deforming tissues. To test the latter hypothesis, hydra were exposed to the microtubule disrupting agents vinblastine sulfate and podophyllotoxin. Electron microscopy indicates that both drugs significantly reduce the number of observable microtubules. Both drugs inhibit bud initiation and suppress bud elongation in early stages (1-3) but do not appear to affect late stages (7-10). The effects of both drugs are reversible; however, established buds exposed to podophyllotoxin show retarded basal disc formation. It is suggested that initial bud formation may be a result of cell shape changes, mediated through microtubules, which deform a tissue region resulting in outpocketing and bud formation. (Supported by a CAP grant from SSU.)

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REPOPULATION OF EPITHELIAL HYDRA: NERVE CELLS AND RECOVERY OF FEEDING BEHAVIOR. B. Marcum, Millersville St. Col., Pa. and P. Tardent, Univ. Zürich, Switzerland.

Epithelial hydra lack all nerve cells and exhibit none of the typical behavior patterns associated with the feeding response in hydra. Nerve cells can be reintroduced by grafting with normal tissue. We have analyzed the recovery of feeding behavior as a function of time after grafting and of nerve cell concentration and distribution. Feeding normally involves 1) capture of prey by the tentacle, 2) coordinated tentacle motion toward the mouth, 3) opening of the mouth, and 4) swallowing of the prey on contact with the mouth. Complete recovery of feeding behavior requires 3 days, occurs stepwise, and follows the normal sequence. Our observations include the following: nematocyte discharge is independent of nerve cells; the hypostome protrudes before the mouth is capable of opening; and swallowing does not automatically result when prey contacts an open mouth. Normal feeding is directly related to the number and location of nerve cells and may reflect local specializations in nerve cell function. Funded by the Swiss NSF No. 88-766-1-79

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EMBRYONIC OOPHAGY AND ADELPHOPHAGY IN SHARKS. J.P. Wourms, W.C. Hamlett and M.D. Stribling.\* Clemson Univ., S.C. and Med. Univ. So. Carol., Charleston.

During gestation of the sand tiger shark, *Eugomphodus taurus* and most lamnoid sharks, only one embryo/oviduct survives to term. Each oviduct initially contains 40-60 egg cases with 7-17 small (1 cm) eggs/eggcase. Most eggs begin to develop, e.g. a ♀ contained 7 hatched 2-10 cm embryos in one oviduct and 4 hatched 6-8.5 cm embryos in the other, as well as unhatched developing eggs and embryos. Early embryos are lecithotrophic. Yolk sac resorption, noticeable at 5 cm, is complete by 9.0 cm. Precocial slashing dentition develops coincidentally. The dominant embryo grows to term (100 cm) by ingesting eggs and siblings. Ovulation seems to continue during gestation. When the dry weights of egg (162 mg) and full term embryo (1920 g) are compared, oophagy-adelphophagy appear to be the most efficient ( $1.6 \times 10^6\%$ ) modes of nutrient transfer in sharks. They are primitive adaptations for embryonic gigantism that provide efficient trophic transfer with minimal morphological and endocrinological modification. (Supported by South Carolina Sea Grant).

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LIFE HISTORIES OF THE COLONIAL ASCIDIAN BOTRYLLUS SCHLOSSERI. R. K. Grosberg. Yale Univ., New Haven, CT. Colonies of *Botryllus* in the Eel Pond at Woods Hole, MA are characterized by two types of life history patterns. Type I colonies grow rapidly, reproduce when small, make many ova/zooid, and die young. Type II colonies grow slowly, reproduce when large, make few ova/zooid, and live long. This variation is genetically based and is correlated with experimentally demonstrated constraints: (1) colonies which make many ova/zooid suffocate and die, (2) Type I colonies cannot allocate energy from growth to reproduction (and vice versa), and (3) Type II colonies can reallocate energy. The maintenance of this variation is related to the introduction of a competitor, the colonial ascidian *Botrylloides leachii*. *Botrylloides* always overgrows Type I colonies, but not Type II colonies. Prior to the introduction of *Botrylloides*, the Eel Pond contained mostly Type I colonies. Presently, the frequencies of Type I and II colonies vary according to *Botrylloides* abundance. Field and lab selection experiments with cloned *Botryllus* confirm the influence of *Botrylloides*. Thus, the data show that the introduction of a competitor has profoundly influenced life history patterns within a population of a resident species.

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STUDIES OF COMMUNITY SUCCESSION IN AN URCHIN BARRENS AREA FOLLOWING SEA URCHIN REMOVAL. Larry G. Harris. Zoology Dept. Univ. of New Hampshire, Durham.

Populations of the sea urchin *Strongylocentrotus droebachiensis* have been removed from two large (surface area <20 m<sup>2</sup>) boulders in a subtidal (depth - 8 m) urchin barrens at Cape Neddick, Maine since October, 1979. Urchins are mashed, which stimulates a flight response in nearby urchins, at least twice monthly to keep the rocks free of large (test diameter <1 cm) urchins. Algal succession is progressing as previously documented, though limpet surfaces of the encrusting coralline alga *Lithothamnion* sp. Blue mussel, *Mytilus edulis*, settlement and clump formation has been facilitated by the algal cover and asteroid removal. Mussel clump persistence is low due to disturbance and predation by crabs and lobsters. Urchin removal has had significant effects on populations of amphipods, herbivorous gastropods, small crabs and fish.

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SPECIES-AREA STUDY ON A MARINE FOULING COMMUNITY IN BOCA CIEGA BAY, FLORIDA. William E. Bros. Univ. of South Florida, Tampa.

The species-area relationship of a marine fouling community was examined over an 8 wk. period. The slope of the species-area curve increased at a constant rate over time. The slope increase occurred because motile species accumulated at a greater rate on larger areas as time passed. The number of species per unit area (species density) also increased with time but was independent of area. The results suggested that the species-area effect is primarily a function of random recolonization rather than differential extinction rates.

The experimental design was evaluated and it was determined that a randomized complete-block design should be used for quantitative evaluations of experiments on marine fouling communities. Blocks would consist of racks with all treatments randomized within racks. In this study there were no differences in species density along the horizontal dimension within a rack but there were differences in the vertical dimension and highly significant differences among racks. The vertical differences were factored out in the design of the racks.

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SEDIMENT REWORKING BY *BALANOGLOSSUS AURANTIACUS* IN BOGUE SOUND, N.C. (CHARACTERISTICS, DISTRIBUTION, SEASONALITY, AND IMPACT) P. B. Duncan. Univ. of North Carolina-Institute of Marine Sciences, Morehead City.

The distribution and abundance of the enteropneust *B. aurantiacus* were assessed. At one densely populated site, reworking activity was recorded periodically in order to estimate the time required to completely rework surface sediment (0-3cm, the mean depth of feeding funnels). Surface sediment falls into funnels, is ingested and processed, and then cast back onto the surface. Fecal sediment has more fine particles (>4 $\phi$ ) and less coarse particles (<1 $\phi$ ) than surface sediment. *B. aurantiacus* relocates the funnel and rear openings of its U-shaped burrow to new positions within a few tidal cycles, and often uses former funnels for subsequent casting. Casting sites reach maximum abundance (4-6/m<sup>2</sup>) on sand flats near inlets, but decrease away from the inlets and are absent from muddy areas. In winter, funnel and mound density, rate of casting, and weight per cast decrease. Turnover time of the surface sediment ranges from 1.8 months in July to 38.8 months in January. The potential for sediment reworking to affect particle size distribution and infaunal abundance of macrofauna and meiofauna is greatest in summer.

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SIMULATION OF THE NORTH ATLANTIC DRIFT OF ANGUILLID EEL LEPTOCEPHALI. J. H. Power. University of Maine, Orono.

A two-dimensional computer model of larval fish drift has been developed and used to simulate the poorly understood drift migration of anguillid eel leptocephali. Objectives were model development and its use to investigate the effects of variations of model parameters on the eel's spatiotemporal distribution, including presumed Sargasso Sea spawning locations and times, surface current vectors, possible directed swimming, and turbulent diffusion. The model is mathematically formulated as a finite-difference approximation to the advection-diffusion equation. Graphical presentations of model output demonstrate the following: 1) Long-term maintenance of a patch of leptocephali outside the Gulf Stream east of Florida and the continuous contribution of larvae from this patch to the Gulf Stream. 2) Rapid Gulf Stream transport, which assuming no swimming or inshore transport yields trans-Atlantic transport and small numbers of larvae near the coast. 3) Wide-spread north-south distribution of larvae from the same cohort. 4) Limited entry of leptocephali into Caribbean and Gulf of Mexico waters.

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PAINT-MARKING OF LIZARDS: DOES IT AFFECT SURVIVORSHIP? C. A. Simon & B. E. Bissinger. City College of City University of NY.

Researchers have been using unique markings to individually identify members of animal populations for decades. Some methods can make the animal very conspicuous to humans and other species including predators. We investigated whether the technique of painting colorful symbols on lizards would affect their survivorship. Juvenile and adult *Sceloporus jarrovi* captured on the field site in the Chiricahua Mts. of SE Arizona during the summers of 1979 and 1980 were randomly painted one of either 3 conspicuous colors (white, yellow or red) or 3 cryptic colors (dark green, navy blue or wood tan). Daily sightings of lizards were conducted during both years of marking as well as during 1981. Individuals recorded in years following their original marking were considered survivors and all others non-survivors.  $\chi^2$  tests showed no significant difference between the ratio of lizards marked (conspicuous vs cryptic colors) and the ratio of lizards that survived for both adults and juveniles. Thus, it appears that painting lizards bright colors does not significantly affect their survivorship, and probably doesn't make them more conspicuous to such visually guided predators as birds.

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INTERPOPULATION VARIATION IN THE SHELL MORPHOMETRICS AND THERMAL TOLERANCE OF *PHYSA VIRGATA* GOULD (MOLLUSCA PULMONATA). J. A. Ibarra and R. F. McMahon\*. Univ. of Texas at Arlington.

Specimens of the freshwater snail, *P. virgata* were collected from 31 populations in Texas and in portions of Arkansas and Oklahoma over an area 612 km N by 924 km W. Thermal tolerance values as mean heat coma temperatures (HCT) after acclimation to 20°C, and shell morphometrics as ratios of shell length to aperture length (SL/AL), shell length to aperture width (SL/AW), and aperture length to aperture width (AL/AW) were determined for each population.

Significant (P<0.05) interpopulation variation was recorded in all four parameters. Mean HCT ranged from 38.7°C to 42.6°C. There was no difference between lentic and lotic populations but HCT increased significantly (P<0.05) in more southerly and westerly distributed lotic populations.

Mean SL/AL and SL/AW ratios were significantly smaller in lentic populations (P<0.05) while no significant differences occurred in mean AL/AW ratios. The mean SL/AL ratio significantly decreases (P<0.05) with increase westerly distribution in lotic populations.

Such interpopulation variation in *C. virgata* can be related to both microenvironmental differences and to founder effect and subsequent genetic drift.

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REPRODUCTION AND LARVAL GROWTH OF A PROSOBRANCH MOLLUSC ASSOCIATED WITH A CORAL. J.L. BELL. Univ. of Hawaii, Honolulu.

The occurrence of the wentletrap, Epitonium ulu, on the underside of the solitary coral, Fungia scutaria, varies considerably; many Fungia lack snails, but as many as eight Epitonium have been found on one coral. In the laboratory, adult snails produce 3-40 egg capsules per day with 500-600 ova per capsule. Uncleaved ova have a mean diameter of 78  $\mu\text{m}$  and complete intracapsular development in six days. Embryos hatch as bilobed planktotrophic veligers. Newly hatched larvae were fed Isochrysis galbana, which was supplemented with Pavlova (Monochrysis) lutheri beginning on the 30th day of feeding. At 40 days post-hatching, larvae have a shell length which equals the protoconch length measured on adult shells. Larval shell length is a linear function of age and increases at a rate of 6.8  $\mu\text{m}$  per day. Other larval cultures, fed a mixed diet of Isochrysis and Pavlova beginning on day one, show a more rapid shell growth. Growth of shell mass and tissue mass is related to shell length. All larval cultures were reared at temperatures ranging from 25-27  $^{\circ}\text{C}$ .

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CHARACTERIZING DELAY OF METAMORPHOSIS FOR LARVAE OF TWO MOLLUSCAN SPECIES, Jan A. Pechenik. Tufts University, Medford, MA

Larvae of the gastropod Crepidula fornicata were reared at 18 $^{\circ}\text{C}$  and at 24 $^{\circ}\text{C}$ . Larvae reared at 24 $^{\circ}\text{C}$  developed more rapidly, became competent to metamorphose sooner, delayed metamorphosis for a shorter period of time, and metamorphosed at a smaller mean shell length than larvae reared at 18 $^{\circ}\text{C}$ . Faster-growing larvae at 18 $^{\circ}\text{C}$  metamorphosed sooner than slower-growing larvae in the same cultures although spontaneous metamorphosis occurred at the same mean shell size for both groups. An inverse correlation between developmental rate and duration of the delay period was also obtained for larvae of the chiton, Mopalia muscosa. In addition, incidence of spontaneous metamorphosis was temperature-dependent for the chiton larvae. The results suggest that delay potential is regulated by both developmental (genetic) and environmental factors in a predictable way for larvae of both species.

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HATCHING IN ILYANASSA OBSOLETA IS A TWO STEP PROCESS. C.H. Sullivan. University of Maryland, College Park.

For the majority of the embryos of Ilyanassa, hatching occurs on day 8 when the capsule plug is dissolved following release of a hatching substance. The release can be initiated by incubating pre-hatch capsules in 280 mM KCl for 20'. Using this technique, it was found that hatching is actually a two step process. Initially, the plug loses contact with the capsule wall and can drop out intact. With longer exposure to the hatching substance, the plug dissolves. When released plugs were compared by SDS-PAGE to plugs dissected from one day old capsules, they showed the same band pattern. The three major plug proteins have molecular weights of 24K, 29K, and 49K Daltons. It is not until later that these proteins are digested. The two step hatching process was confirmed when capsules were examined by TEM and SEM. The first change is a loosening of the tightly packed  $\alpha$  keratin-like fibers of the capsule wall adjacent to the plug. Only after an hour do the 8-10 nm filaments of the plug become dispersed and reduced in number. Therefore, the hatching substance works first at the plug edge possibly dissolving some plug "cement", then will digest the plug, allowing veligers to escape from the capsule.

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CHEMOATTRACTANTS OF OYSTER DRILLS, UROSALPINK CINEREA. D. Rittschof, R. G. Shepherd, and K. Mopper. College of Marine Studies, Univ. of Delaware, Lewes.

Specific chemoattractants were purified from the media bathing living, intact prey. Biological activity was rigorously monitored through each purification step. Stimulus was glass fiber filtered and batch adsorbed to amberlite XAD-7 resin. After elution of all salts and nonadsorbed material the stimulus was eluted with methanol. Methanol fractions were ( $P < 0.005$  active) at dilutions of 1:500 to 1:10000. Active fractions were combined, the methanol percentage reduced to less than 20% and sized by pressure dialysis. Molecular weight fractions of 5000-10000 and 1000-5000 Daltons were active. Freeze-dried stimulus was active at  $10^{-8}\text{M}$ . HPLC resolved the 1000-5000MW stimulus into three UV adsorbing peaks, the middle of which was active. Amino acids and sugars contained in the HPLC purified material were determined by hydrolysis and HPLC techniques. Macromolecular components were displayed on polyacrylamide gels stained for protein and carbohydrate.

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PREDATOR REPELLENTS OF BENTHIC MACRO-INVERTEBRATES. R. S. Prezant, G. Gruber and C. L. Counts. Univ. of Southern Mississippi, Hattiesburg, and Univ. of Delaware, Lewes.

Antipredation secretions have been found in several species of soft-bodied, benthic marine invertebrates from along the North American mid-Atlantic coast. Repulsive secretions are produced by the enteropneust Saccoglossus kowalevskii, all phyllodocid polychaetes tested (4 species), the nemertean Lineus ruber, the polyclad turbellarians Stylochus zebra and S. ellipticus, and the sipunculid Phascoleopsis gouldi. The active repellent for most of these species is carried in a mucoid matrix produced by epithelial mucocytes. In the enteropneust the carrier matrix is composed principally of a sulfated mucopolysaccharide. The repellents are active against several species of small predatory fish and crabs. A closer look at predator-prey interactions in the marine benthos will likely reveal many other organisms with selective or generalized chemical defenses bound in mucoid matrices.

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THE TUNIC OF THE ASCIDIAN, CIONA INTESTINALIS. W.E. Robinson, K. Kustin\* and C.C. McLeod.\* Brandeis Univ., Waltham, Ma. 02254 and New England Aquarium, Boston, Ma. 02110.

C. intestinalis tunic is composed of cellulose-like fibers and numerous blood cells embedded in a PAS(+) ground substance. Tunic composition and formation were studied histologically and biochemically to determine whether fibers are produced by the underlying epidermal cells of the body or by the inclusive blood cells. The tunic consists of both protein and carbohydrate (C:H:N:O 41:6:6:41) plus approx. 96% water. The ground substance can be easily removed by mild acid refluxing, leaving a predominantly carbohydrate residue (C:H:N:O 37:6:0.4:39) which is PAS(-). The supernatant contains reducing sugars and Ninhydrin(+) material.  $^{14}\text{C}$ -glucose is taken up from the surrounding seawater by both the tunic and body within 2 h. The tunic accounts for the majority of accumulated glucose (47-96%). Of this, 84-94% is found in the supernatant following acid refluxing. It is concluded that most of the label is associated with the tunic ground substance produced by the epidermal cells and not with the fibers as reported by other workers.

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STUDIES OF DIPNOAN (LUNGFISH) SKULLS. W.E. Bemis. Univ. of California, Berkeley.

Although some morphological features of dipnoans show stability throughout the evolutionary history of the group, the skulls of the three living genera show many departures from the basic plan of Paleozoic dipnoans. For example, the reduction in endochondral ossification appears to be correlated with paedomorphosis in post-Paleozoic dipnoans. Other features illustrate changes less directly attributable to paedomorphosis, and which probably constitute special, adaptive changes. An example is the reduction and modification of the skull roofing elements of Lepidosiren and Protopterus. Homologies of these bones have long been debated but the functional significance of such modifications has received less attention. The basic consequence of the reduction in the amount of dermal bone covering the adductor fossa is that the adductor musculature may expand, both during function and phylogeny. Lepidosirenids exert powerful bites, and the skull, tooth plates and jaw muscles generate large static pressures. Reductions in skull roofing elements correlate with enlarged adductor muscles in several other groups of vertebrates, and indicate a common pattern of convergence. Supported by an NSF Fellowship, Sigma Xi, and NSF DEB 80-05905 to M.H. Wake.

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CAECILIAN ANCESTRY: RECONSIDERATION OF A CLAIM OF RECAPITULATION. J. Hanken and M. H. Wake. Dalhousie University, Halifax, Nova Scotia, Canada, and Univ. of California, Berkeley.

We examined skull development in the terrestrial caecilian Dermophis mexicanus (Amphibia: Gymnophiona) using an embryonic, fetal, and adult ontogenetic series of more than forty specimens which were cleared and differentially stained for bone and cartilage. Dermophis mexicanus lacks many primary ossification centers described for other caecilians, and whose presence has been presumed indicative of a primitive skull morphology derived with little modification from that of archaic amphibians, particularly microsaurids. Many prominent features of fetal skull development, including cranial kinesis and precocious ossification of jaw suspension elements, are functionally related to the intra-oviducal feeding specialization of this viviparous species. Aspects of early skull ontogeny cannot be used to support the hypothesis of direct descent of caecilians, independent of other modern amphibians, from any known early amphibian taxon.



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TOOTH IMPLANTATION PROCESS ON THE UPPER PHARYNGEAL JAWS OF HAPLOCHROMIS ELEGANS (TELEOSTEI:CICHLIDAE). A.Huysseune<sup>o</sup> and W.Verraes. State University of Gent, Belgium.

The microscopical study of prominent stages in tooth development and of the implantation process and eruption of teeth on the upper pharyngeal jaws of H. elegans throughout several postembryonic stages has revealed some relationships between these phenomena. Fully developed teeth are able to invade the cartilage of their endoskeletal support, after which they start to build up a bony socket. As a result, tooth bearing dermal bone may take the place, previously occupied by the cartilage of the infrapharyngobranchials. Finally, eruption is not attained before a tooth is sustained by a solid bony support. Individual teeth on the common infrapharyngobranchials III-IV of successive young developmental stages could be followed as the pattern of tooth implantation remains highly constant. Teeth are newly formed only on their lateral and rostral side.

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A COMPARATIVE STUDY OF GUT ULTRASTRUCTURE IN TWO SPECIES OF SCAPHIOPUS LARVAE. Sue Justis and E.J. DeVillez. Miami University Oxford, Ohio.

Larvae of two species of spadefoot toads (Scaphiopus multiplicatus and S. bombifrons, subgenus Spea) exhibit an anatomical and behavioral polymorphism associated with a carnivorous or omnivorous diet. In order to determine whether or not this polymorphism extends to the physiological and ultrastructural levels, gross, light, and electron microscopic analyses of the esophagus, posterior foregut, anterior intestine, and pancreas have been conducted. Initial results indicate that although the prey-seeking and voracious feeding habits of the carnivorous larvae are more adult-like, the histological and physiological developments of the foregut follow the same basic patterns as the omnivores. In extreme carnivores and extreme omnivores, the foregut is composed of columnar epithelium and mucous cells until emergence of the front legs when secretory glands containing oxyntic cells begin to form.

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HEPATIC ULTRASTRUCTURAL SPECIALIZATION IN ANTARCTIC FISHES. J.T. Eastman. Ohio University, Athens.

As teleosts occupy every conceivable aquatic habitat, it would not be surprising to encounter variability in hepatic structure and function. There is, however, no reported evidence of ultrastructural specialization in teleost livers. My study indicates that Antarctic fishes, especially Dissostichus mawsoni, are a notable exception. The livers of these fishes have a unique type of perisinusoidal (Ito) cell. These cells are more numerous and have a distinctly different ultrastructure than the PS cells of other vertebrates. PS cells are found throughout the liver, have long cytoplasmic arms and, in Dissostichus, contain many lipid droplets. The extensive rough endoplasmic reticulum and prominent nucleolus are ultrastructural characteristics indicating that these cells are engaged in protein synthesis. An evolutionary specialization related to hepatic function at low temperature, PS cells may be partially responsible for the elevated levels of protein synthesis characteristic of notothenioid fishes in the Antarctic marine environment. (Supported by NSF grant DPP 79-19070).

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OBSERVATIONS ON THE REGIONAL ANATOMY OF BOWHEAD WHALE SKIN. J. T. Haldiman, W.G. Henk, F. K. Al-Bagdad<sup>\*</sup> and T. F. Albert<sup>\*</sup> Louisiana State Univ., Baton Rouge and University of Maryland, College Park.

Bowhead skin is smooth and black with a cream colored area on the chin. The epidermis ranges in thickness from 1 mm (eyelid) to 19-24 mm (dorsal, lateral and ventral trunk) or about 6-8 times the thickness of other cetaceans. Flipper epidermis is 10-15 mm thick and fluke epidermis is 8-13 mm thick. The 0.25-1 mm thick stratum corneum is normally parakeratotic with up to 60 + layers of keratinized cells with pyknotic nuclei. The very thick stratum spinosum has numerous desmosomes connecting highly folded adjacent cell membranes. The stratum basale is typically mammalian. The dermis is dense irregular connective tissue only 2-4 mm thick. Dermal papillae interdigitate with the epidermis to within 0.07 mm (eye), 3.75 mm (ventral fluke) and 10.25 mm (dorsal trunk) of the corneal surface. Each papilla is irregularly oval basally and gives rise to a variable number of secondary papillae containing nerves and vessels. Basale cells give rise to epidermal rods at the tips of all dermal papillae. (Supported by DOI/BLM, AA851-CT0-22)

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STRUCTURE OF SHELLS OF EGGS OF ZEBRATAIL LIZARDS (*CALLISAURUS DRACONOIDES*). M. J. Packard, L. R. Burns\*, K. F. Hirsch\* and G. C. Packard. Colorado State Univ., Fort Collins, and Univ. of Colorado Museum, Boulder.

Female zebra-tail lizards lay roughly oval eggs with thin, highly extensible shells. The outer surface of the egg-shell is covered by a thin, calcareous crust of calcium carbonate in the calcite morph. Immediately beneath the crystalline matrix is a shell membrane composed of multiple layers of fibers organized into an undulating series of troughs and crests, apparent in both cross section and surface view. The outer surface of the shell membrane is differentiated into a tightly woven fibrous mat that may serve to anchor the calcareous layer to the membrane. Organization of the shell membrane into a series of crests or troughs serves to increase the surface area available for contact with the substrate and, presumably, to increase the capacity of the eggshell to stretch as the egg absorbs water.

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#### HISTORY OF BIOLOGICAL ABSTRACTS.

E. M. Zipf, Biosciences Information Service, Philadelphia, Pa.

The world's largest life sciences abstracting and indexing publication is regarded internationally as an indispensable reference source by major educational and research institutions. For 55 years, BIOSIS has kept abreast of the vast literature of biology, medicine and applied disciplines. Over four million documents have been edited, indexed and entered in the data base since 1927. Hundreds of thousands of journals have been covered. This secondary service has grown from a few employees in 2 back rooms in the Zoology building of the U. of Pa., to over three hundred dedicated personnel housed in an 8-story building in Philadelphia, currently being renovated with an 8-story addition. There are several hundred biological and medical expert volunteers who aid BIOSIS located in the United States and Canada. Over the years, manual efforts, used to compile the monthly now bi-weekly issues of the publications, have been replaced by complex and sophisticated computer techniques.

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THE EVOLUTION OF AN IDEA  
F. R. VOORHEES. Central Missouri State University.

Recent adoption of a "Creation-Science" law in Louisiana and active consideration of such laws elsewhere makes it interesting to examine the origins of groups supporting such ideas and legislation. The development of these Creationist groups illustrates many processes familiar to evolutionists, and can be used to illustrate many evolutionary concepts.

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MAMMARY GLAND DNA SYNTHESIS IN LACTATING MICE. D. W. Borst and B. W. McNulty\*. University of Connecticut, Storrs.

DNA synthesis in mammary tissue from BALB/c mice (15-18 wks) was investigated during the first 10 days of lactation. Explants of this tissue were incubated with <sup>3</sup>H-thymidine for 2 hours and incorporation into TCA-precipitable material determined. DNA synthesis rose during the first day of lactation (day 1), reaching a peak about 24 hours later. Thereafter incorporation declined to low levels by day 10. Ovariectomy on day 1 had no effect upon the level of incorporation 24 hours later. In contrast, removal of young during day 1 caused a decrease in DNA synthesis; after 24 hours, incorporation was 10% of normal levels. If young were then returned on day 2, incorporation remained low for 12 hours but rose to normal levels by 24 hours. Treatment with CB-154 when the young were returned inhibited this rise in incorporation. These results indicate that DNA synthesis in lactating mammary tissue can change rapidly. This process does not appear to require the presence of ovarian steroids. Suckling is a major stimulus for this process, the effect of which appears to be mediated at least partly by the secretion of prolactin. (Supported by grant BC-344 from the American Cancer Society.)

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MORPHOLOGICAL LOCALIZATION OF PROLACTIN RECEPTORS IN THE BULLFROG KIDNEY. Ophelia Gona (intr. by A.G. Gona). CMDNJ-New Jersey Medical School. Newark, NJ.

Autoradiographic studies have revealed  $^{125}\text{I}$ -prolactin (PRL) binding by bullfrog kidney tubules. Premetamorphic tadpoles, metamorphic tadpoles and froglets (E+45) were injected with  $^{125}\text{I}$ -PRL (NIH-P-S12), labelled by the lactoperoxidase method. Kidneys were fixed 5 or 15 min later in Bouin's fluid. Paraffin sections, coated with Kodak NTB-3 emulsion, were exposed in the dark for 5 weeks. Kidney tubules were labelled in all animals sacrificed at 15 min, the most intense labelling being in froglets. At the five min interval, labelling was evident only in froglets. The intensity of labelling was greatly reduced by an excess of cold PRL, but unaffected by GH or LH. These findings show that PRL receptors are located in the bullfrog kidney tubules, are present in small numbers in the pre-metamorphic stage, and proliferate during the later stages of metamorphosis. The change in receptor density involves both an increase in the number of tubules having receptors and in the tubular density of the receptors. Supported by NIH grant # 2 S07 RR 5393.

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ANTAGONISM OF PROLACTIN TO TRIIODOTHYRONINE-INDUCED TAIL REGRESSION IN ANURAN LARVAE: A PROPOSED LEVEL OF ACTION. E.C. Krug. Univ. of Virginia, Charlottesville.

The temporal requirements for prolactin (Pr1) antagonism to triiodothyronine (T3)-induced tail height regression was investigated in *Rana p. pipiens*. Larvae were injected with saline or T3 (100 ng/g) on day 0, and Pr1 (20 ng/g) on days 0 and 1 (0+1) or days 1 and 2 (1+2). By day 4 the tail height of the T3 treated group was reduced by 37%, and in the saline treated group it was reduced by 7%. The group receiving T3 and Pr1 (0+1) was indistinguishable from the saline injected controls. Tail regression of animals receiving T3 and Pr1 (1+2) was less than that of the T3 only group ( $P < .001$ ), but greater than the T3 with Pr1 (0+1) group ( $P < .001$ ). That the tail fin regression induced by T3 can be antagonized by Pr1 given 24 hours later suggests that a major component of Pr1-T3 antagonism occurs after T3 has had sufficient time to reach the nuclei of target cells.

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EFFECTS OF OVINE PROLACTIN ON THYROID HORMONE LEVELS IN *FUNDULUS HETEROCLITUS*. C.L. Brown and M.H. Stetson. University of Delaware, Newark, Delaware

Treatment with 12 IU of ovine prolactin over four days reduced  $\text{T}_4$  levels in TSH-stimulated fish. No significant differences were found in the plasma  $\text{T}_3$  levels of the same fish. Consequently, an increased plasma  $\text{T}_3/\text{T}_4$  ratio was observed following prolactin treatment. Kinetic studies showed that prolactin did not influence the  $\text{T}_4$  turnover rate or the proportion of plasma  $\text{T}_3$  generated from a tracer dose of  $\text{T}_4$ . Our data suggest that ovine prolactin exerts a direct effect on either thyroid hormone secretion or synthesis. The hypotheses that prolactin alters serum thyroid hormone levels mainly by promoting rapid  $\text{T}_4$  clearance or enhanced deiodination to  $\text{T}_3$  do not appear applicable to this species.

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THRESHOLDS AND RESPONSE RATES TO THYROXINE STIMULATION OF HYPOPHYSECTOMIZED *RANA PIPIENS* AND *R. SYLVATICA*, WITH EMPHASIS ON THE LATERAL MOTOR COLUMN. Jerry J. Kollros. Univ. of Iowa, Iowa City, Iowa.

Hypophysectomized *R. pipiens* and *R. sylvatica* of about ten weeks of age were placed together as pairs in 1 liter of water, with DL thyroxine at concentrations of from 1 to 100  $\mu\text{g}/\text{l}$ . All animals had had one leg amputated at the thigh. The *pipiens* were initially at about stage VI whereas the *sylvatica* were at about stage X+ (*pipiens* rarely proceed beyond stage VII; *sylvatica* usually go to stage XI or XI+, given enough time). For all pairs, at all dosage levels, *sylvatica* began to show stimulation earlier than *pipiens*, and to proceed through the changes more rapidly. They also showed more rapid limb regeneration, and showed the impact of amputation and regeneration upon the development of the lateral motor column in the spinal cord earlier and to a greater degree. Cell degeneration of lateral motor column cells after amputation is initially slowed, but reverses earlier in *sylvatica* than in *pipiens*. Supported by NIH grant NS 15350.

DAILY RHYTHMS OF PLASMA THYROTROPIN (TSH), THYROXINE (T<sub>4</sub>), AND TRIIODOTHYRONINE (T<sub>3</sub>) IN RATS ARE PHASE-SHIFTED BY INVERTING THE LIGHT DARK-CYCLE. J.E. Ottenweller and G.A. Hedge\* West Virginia Univ. Med. Ctr., Morgantown.

We examined the effect of inverting the light-dark (LD) cycle on daily rhythms in the pituitary-thyroid axis. Female rats were maintained on either a normal 12:12 LD cycle or an inverted 12:12 DL cycle with food and water available *ad libitum*. After 3 weeks rats were decapitated every 4 hr., and plasma was stored frozen until assayed for TSH, T<sub>4</sub>, T<sub>3</sub>, corticosterone (B), and prolactin (PRL). Daily rhythms were detected in the plasma levels of all hormones on both LD and DL cycles ( $P < 0.5$ ; ANOVA). Both B and PRL rhythms were phase-shifted by inverting the LD cycle with peak levels near the onset of darkness in LD and DL groups. Plasma rhythms of TSH, T<sub>4</sub>, and T<sub>3</sub> had broad periods during the day when levels were elevated rather than sharp peaks. Nonetheless plasma TSH, T<sub>4</sub>, and T<sub>3</sub> levels were higher during the light than the darkness on both the LD and DL cycles. These data indicate that the LD cycle can act as a zeitgeber to set the phase of plasma TSH, T<sub>4</sub>, and T<sub>3</sub> rhythms, as well as plasma B and PRL rhythms. (Supp. NIH AM 07312 and 21348).

Nuclear Binding Sites for Triiodothyronine in Quail Liver, Richard T. Weirich and F.M. Anne McNabb, Va. Polytech. Inst. and State U., Blacksburg.

Binding studies were conducted using <sup>125</sup>I-T<sub>3</sub> and isolated quail liver nuclei incubated in 0.32 M sucrose, 1 mM MgCl<sub>2</sub>, 5 mM dithiothreitol and 10 mM Tris-HCl. Non-specific binding (1000 x excess cold T<sub>3</sub>) was < 15% of total. Specific binding was maximal at pH 7.4. Maximal equilibrium binding occurred after 60-120 min at 20 C. Reversibility was examined by displacing specific bound <sup>125</sup>I-T<sub>3</sub> with excess cold T<sub>3</sub>. Association rates were 5-8 X dissociation rates suggesting quasi-reversible binding. Scatchard analysis indicated a single class of high affinity ( $K_d = 1.12 \pm 0.30 \times 10^{-9}$  M;  $\bar{X} \pm SD$ , N=11) limited capacity ( $B_{max} = 5.68 \pm 2.29$  fmoles/ $\mu$ g DNA) binding sites. Compared to L-T<sub>3</sub> other mean binding affinities were 400% (Triac), 69% (D-T<sub>3</sub>), 23% (L-T<sub>4</sub>) 11% (D-T<sub>4</sub>), 0.9% (L-T<sub>2</sub>) with 0% for MIT and DIT. No significant differences were found in binding specificity between quail and rat liver nuclei. Thus binding of T<sub>3</sub> to quail liver nuclei *in vitro* is very similar to the nuclear T<sub>3</sub> - receptor binding characteristics described in mammalian tissues.

ECDYSTERONE TRIGGERS CUTICLE DEPOSITION IN THE SPERMATHECAL ACCESSORY GLAND OF TENEBRIO CULTURED IN VITRO. Teresa M. Szopa and George M. Happ. Univ. of Vermont, Burlington.

Over the nine days between pupal and adult ecdysis, the spermathecal accessory gland of females transforms from a stubby sac into an elongate cylinder of secretory cells drained by a system of ductules. Development takes place in three phases: cell division, cellular morphogenesis, and cuticle deposition.

Glands from pupae were cultured in Landureau S-20 medium with or without ecdysterone. When tissues had been exposed previously to ecdysterone *in situ*, they differentiated normally *in vitro*, including pseudocilium formation, cell retraction, and cuticulogenesis in the ductules and the central duct (whether or not ecdysterone was present). Younger glands not previously exposed to ecdysterone *in situ* failed to differentiate *in vitro* unless ecdysterone (5  $\mu$ g/ml) was added. With ecdysterone, partial differentiation took place. Cuticle was deposited but pseudocilia did not form. Cuticulogenesis requires ecdysterone for its initiation but not its completion.

Supported by NIH grant GM 21640.

20-HYDROXYECDYSONE INHIBITS LEG REGENERATION IN THE PREPUPA OF TENEBRIO MOLITOR. J.-J. Lenoir Rousseaux\* (intro. by T. M. Szopa). Univ. of Paris XII, France.

During the last larval instar, the whole epidermis of the larval leg is transformed into the anlage of the imaginal leg. If one part of the anlage is implanted into an early last instar larva it may regenerate or duplicate. Neither occurs if the anlage had started deposition of its pupal epicuticle. Epicuticle deposition *in vivo* begins just after the major peak of 20-hydroxyecdysone.

Anlagen from larvae may be cultured *in vitro* and then implanted into larval hosts. If cultured for 3 days *in vitro* without hormones, the anlage does not develop, but when implanted thereafter into a larva, it can regenerate or duplicate. When exposed to 20-hydroxyecdysone *in vitro* (10<sup>-6</sup>M, 72 hrs), an anlage follows its normal course of development and deposits epicuticle, but upon implantation thereafter, it can neither regenerate nor duplicate.

Our *in vitro* experiment mimics what happens *in vivo* when the levels of 20-hydroxyecdysone increase. Molting hormone inhibits mitotic activity, induces cuticle deposition, and causes a loss of regenerative activity in the prepupa.

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AN EDNH-RELEASING FACTOR FROM THE OVARIES OF MOSQUITOES FED BLOOD. A. O. LEA and E. Van Handel. Univ. of Georgia, Athens and Univ. of Florida, Vero Beach.

Egg development neurosecretory hormone (EDNH) is released from the corpus cardiacum (CC) after a blood meal, and vitellogenin (VG) synthesis begins within a few hours. When either the ovaries or CC were removed before feeding, VG was not synthesized.

Using a bioassay for EDNH in the CC, we found that the CC of ovariectomized blood-fed females did not release EDNH, whereas the CC did release EDNH, if an ovary was implanted before the blood meal. Apparently, the ovaries secrete an EDNH-releasing factor. This factor and EDNH must both be in circulation before VG synthesis begins.

Using a bioassay for EDNH-releasing factor in the ovary, we showed that a Culex ovary, implanted in an ovariectomized Aedes, released the host's EDNH and sequestered its VG, while an Anopheles ovary released EDNH but did sequester aedine VG, and that the aedine ovary at eclosion was not competent to secrete the releasing factor. This releasing factor is the rate limiting process that controls the onset of vitellogenesis and is part of the mechanism regulating cyclic reproduction.

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ON AND OFF SIGNALS FROM THE OVARY REGULATING EGG MATURATION IN AEDES AEGYPTI. E. Van Handel, U. of Fla. Vero Beach and A.O. Lea, U. of Georgia, Athens.

In the anautogenous mosquito, blood induces the ovary to secrete a factor responsible for the release of EDNH from the cardiacum and egg maturation (Lea and Van Handel, *Am. Zool.* 21,4 1981). Several days after the blood meal VG synthesis has ceased. Even after a second meal, a young ovary implanted in the presence of mature oocytes does not grow. This is due to an inhibitory hormone from the mature ovary. VG synthesis is nearly maximal 16 hr after a blood meal and, if the ovaries are then removed to prevent the subsequent secretion of the inhibitory hormone, the fat body does not require a new hormonal stimulus to continue synthesizing Vg as long as precursor (blood) is provided. This was proven in mosquitoes decapitated before a second blood meal (enema), by immunological techniques and by the growth of a young implanted ovary. We concluded that cyclic egg maturation in mosquitoes is regulated by two ovarian hormones: a start signal (EDNH releasing factor) that turns the system on, and a stop signal (from mature oocytes) that turns the system off.

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NEUROENDOCRINE REGULATION OF TRANSPARENT ACCESSORY REPRODUCTIVE GLAND (TARG) PROTEIN OF MALE RHODNIUS PROLIXUS.

J.F.BARKER AND K.G.DAVEY. York University, Downsview, Ontario, Canada.

*In vivo* studies involving ablation of the corpus allatum or brain neurosecretory cells showed a significant reduction in TARG protein synthesis. Topical application of a synthetic juvenile hormone (JH) stimulates a dose dependent protein synthesis in allatectomized males but will not restore TARG protein synthesis in medial neurosecretory cell ablated animals. *In vitro* studies in which the TARG are incubated with  $^3\text{H}$ -Leu,  $^3\text{H}$ -Leu with brain extracts and/or JH have demonstrated gland proteins are synthesized in the TARG and a direct influence of the brain and corpus cardiacum (CC) on TARG protein synthesis. A direct influence of the corpus allatum, however, remains to be demonstrated.

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NEUROENDOCRINE CONTROL OF PROTEIN SYNTHESIS IN LOCUSTA. J. A. CARLISLE and B. G. LOUGHTON (intro. by A. S. M. SALEUDDIN). York University, Ontario, Canada.

Protein synthesis increased in locusts within the first hour after feeding. *In vitro* incubations showed that fatbody from fed animals had a higher rate of protein synthesis than that from fasting locusts. Aliquots of haemolymph from fed locusts increased protein synthesis by tissues of fasting animals both *in vitro* and *in vivo*. Homogenates of brain or corpus cardiacum (CC) did not increase the synthesis of protein, however, ion exchange chromatography of brains or CC storage lobes yielded a fraction which stimulated protein synthesis both *in vivo* and *in vitro*. Gel filtration separated this fraction into several small peptides, one of which stimulated protein synthesis. This newly discovered neurohormone together with adipokinetic hormone, which inhibits protein synthesis, may provide a short-term fine control of protein synthesis in the locust.

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SOLDIER DETERMINATION IN THE ANT PHEIDOLE BICARINATA: EFFECTS OF A JUVENILE HORMONE ANALOG ON CASTE AND SIZE WITHIN CASTES. D. E. Wheeler and H. F. Nijhout. Duke University, Durham, N. C.

The genus Pheidole is characterized by two distinct worker castes: soldiers and minor workers. In Pheidole bicarinata, topical application of juvenile hormone analog (JHA) to larvae during a specific JH-sensitive period induces soldier development. Within both worker castes, magnitude of the dose also affects timing of metamorphosis and adult size. In minor workers, larger doses produce longer metamorphic delays and correspondingly larger adults. During extended delays, larval growth slows. In soldiers, a high dose of JHA produces a metamorphic delay and large soldiers. However, the lowest effective dose for soldier induction produces early metamorphosis and small adults. These results support a model of worker caste determination that involves a reprogramming of critical size, the size at which metamorphosis will be triggered.

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DEHYDROGENASES AT THE PYRUVATE BRANCH-POINT IN TISSUES OF THE WHELK, BUSYCON CONTRARIUM. W.R. Ellington, Florida State Univ., Tallahassee and R.A. Foreman III, Univ. of British Columbia, Vancouver.

The activities of lactate dehydrogenase (LDH), octopine dehydrogenase (ODH), and alanopine dehydrogenase (ADH) were determined in extracts of the ventricle, radula muscles, foot and gill of Busycon contrarium. All 3 dehydrogenases were present in the tissues investigated. Starch gel electrophoresis showed that there appears to be no tissue-specific isoenzymes of ODH and ADH. ODH and ADH activities in the ventricle and radula were 1-2 orders of magnitude greater than corresponding activities in the foot and gill. ODH activities in the radula retractor and protractor (507 and 375 EU per g wet wt, respectively) are in the same range as those in the mantle muscles of cephalopods. The presence of high activities of ODH and ADH in the same tissues of B. contrarium indicates that there is the potential for competition between these two dehydrogenases. However, *in vitro* preparations of all four tissues incorporated pyruvate-1-<sup>14</sup>C under anoxic conditions into alanine and what appears to be alanopine with only trace amounts of radioactivity in octopine.

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COMPARATIVE STUDY OF SUCCINATE DEHYDROGENASE IN SEVERAL INVERTEBRATES. S. D. Long, F. E. Freidl and G. E. Rodrick, University of South Florida Departments of Biology and Comprehensive Medicine, Tampa.

Under anaerobic conditions, succinate dehydrogenase is presumed to catalyze the NADH-dependent reduction of fumarate to succinate, acting as a fumarate reductase. Most metabolic studies using molluscs and parasitic helminths have investigated suspected end products and fumarate reductase activity. This study investigated several kinetic properties of the forward reaction of SDH in three bivalves and Ascaris suum. The Km's for succinate for all tissues of M. campechiensis and A. couperiana were higher than for aerobic organisms. In mantle and gill of M. campechiensis, A. couperiana and E. buckleyi, fumarate strongly inhibited SDH activity. Malonate inhibited at low concentrations. These data indicate that in mantle and gill of these three bivalves, SDH may act in an anaerobic capacity. In Ascaris suum, the Km for succinate in the adult was higher than in the larval stages and fumarate inhibition was greater in adult muscle. Malonate inhibited strongly in all stages. These data indicate that the larval stages have an aerobic SDH while the adult muscle has an SDH with anaerobic characteristics. (Supported in part by NIH grant AI 16163-02)

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DIGESTIVE ENZYMES OF THE HORSESHOE CRAB, LIMULUS POLYPHEMUS. M. J. Ray, K. R. Rao, and J. P. Riehm\*. Univ. of West Florida, Pensacola.

Digestive enzymes obtained by saline washings of the gut lumen of live, adult Limulus were studied. The enzymes in saline solution were precipitated with 70% ammonium sulfate and then purified by a series of steps: filtration through Sephacryl S-200, reprecipitation with ammonium sulfate, filtration through Sephadex G-75, and ion exchange chromatography (DEAE and CM-cellulose). During the course of the separation, protease activity (assayed by azocasein hydrolysis) was resolved into two peaks. The molecular weight of the enzyme in one of the peaks is estimated to be 6000 daltons. The material in the other peak had a higher molecular weight. Both enzymes were found in fed and starved animals, although their quantities were lower in the unfed animals. Additional enzyme characterization studies that are underway include the determination of: thermal optimum, substrate specificity, pH dependence, and inhibitor action. (Supported in part by EPA Grant CR-807417)

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COMPARATIVE BIOCHEMISTRY OF THE SABLEFISH *ANOPLLOPOMA FIMBRIA*. K.M. Sullivan. Scripps Inst. of Oceanography, UCSD, La Jolla, Ca.

The changes in biochemical characteristics over broad latitudinal and bathymetric distributions were examined for specimens of the sablefish, *A. fimbria* is a common benthopelagic fish along the Pacific coast of North America, occurring off California from 100 to 1550 meters in depth, and off British Columbia between 50 and 600 meters. Water, protein and lipid contents in white skeletal muscle and liver, and lactate dehydrogenase (LDH) and pyruvate kinase (PK) activities in white skeletal muscle were determined for *A. fimbria* collected from California to Alaska. Deep-living fish from the southern end of the species range exhibited high muscle water content, low muscle protein and lipid content and a six-fold range of muscle enzyme activities. Shallow-living fish from northern areas showed lower muscle water content, higher muscle protein and lipid content, and less variation in muscle enzyme activities. Genetic variation between populations was examined electrophoretically. Variation in biochemical parameters suggests that *A. fimbria* can adjust physiologically to a range of diet, temperature and depth regimes.

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HEPATIC AMMONIOGENESIS IN THE CATFISH, *ICTALURUS PUNCTATUS*. P.L. Aster, C.A. Casey\*, J.E. Vorhaben\*, and J.W. Campbell. Rice University, Houston, Texas.

The mechanisms of ammonia production in teleosts were investigated using hepatocytes and isolated liver mitochondria from catfish. In the presence of ADP, mitochondrial  $\text{NH}_3$  production from exogenous substrates was greatly enhanced (glutamine>glutamate>alanine>aspartate>serine). Addition of FCCP, an uncoupler, increased  $\text{NH}_3$  production from glutamate, but not from alanine and aspartate. With both coupled and uncoupled mitochondria, more than 99% of the ammonia was released into the medium. Rotenone inhibited  $\text{NH}_3$  production from all substrates. Amino-oxyacetate, a transaminase inhibitor, inhibited deamination of alanine and aspartate, but not glutamate.  $\text{NH}_3$  release from mitochondria was equal to that from intact hepatocytes indicating that deamination is primarily a mitochondrial process. Rates of hepatic in vitro  $\text{NH}_3$  production accounted for more than 50% of whole animal  $\text{NH}_3$  release. Our results are consistent with the hypothesis that transdeamination is the major pathway of ammonia production in teleosts.

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EFFECTS OF OSMOREGULATORY SOLUTES ON THE STRUCTURE AND FUNCTION OF VERTEBRATE PHOSPHOFRUCTOKINASES. S. C. HAND and G. N. SOMERO. Scripps Institution of Oceanography, UCSD, La Jolla, Ca.

In view of the wide diversity of organisms that contain intracellular organic osmolytes in the range of 0.5 to 3 M, it is important to establish how these solutes affect cellular regulatory proteins. At pH 6.7 and 25°C, as little as 25 mM urea promoted inactivation of phosphofructokinase (PFK) purified from muscle of the thornback ray *Platyrrhinoidis triseriata*, an elasmobranch which normally maintains 0.5 M urea in its muscle cells. The pH-dependent inactivation by urea was slightly reduced in the presence of purified F-actin, while the osmolyte trimethylamine-N-oxide (typically a protein stabilizer) was without effect. Rabbit muscle PFK was equally urea-sensitive, and measurements of PFK light scattering showed that inactivation was correlated with reversible tetramer dissociation. In contrast to urea perturbation, the loss of PFK catalytic activity under conditions of pH-induced cold lability was greatly reduced by methylamines. Synergisms among osmolytes, pH and temperature may provide a means for metabolic regulation via effects on PFK. (NSF-PCM 80 01949)

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AGE-RELATED CHANGES IN THE NTP LEVELS OF TROUT ERYTHROCYTES. Hugo C. Lane. Wake Forest Univ., Winston-Salem, N.C.

The nucleotide triphosphates level of the average rainbow trout peripheral erythrocyte rose in fed and starved fish seven days after a 15% blood loss. Although the increase in the NTP pool was significant in the starved group it was less dramatic than that of fed trout. Trout starved for 30 days also showed a significant rise in the NTP/red cell level. Both responses suggest that the maturing erythrocyte in adult rainbow trout possesses a smaller pool of NTP than does the adult cell. Since velocity sedimentation at unit gravity was found to segregate red cells of rainbow trout according to ultrastructural and mensurational characteristics enriched fractions of maturing, adult and older cells were harvested and their NTP/cell levels tested for. Young red cells were found to possess 37% less NTP/cell than older cells and 15% less than their mature counterparts. Thus the NTP pool of developing erythrocytes of trout is low but increases during life.

INTESTINAL GLUCOSE TRANSPORT VARIES WITH TAXA AND DIET. W.H. Karasov and J.M. Diamond\*. Physiology Dept., UCLA Med. Ctr.

We compared intestinal active transport of glucose in similar-sized representatives of three vertebrate classes and, within each class, in animals with different diets. Measured tracer fluxes were corrected for adherent fluid and passive uptake. Total glucose transport by the whole small intestine was greater in the mammals studied (range 860-1500 nmoles  $\text{min}^{-1}$ ) than in the lizards (120-490). Much of this effect was due to the longer intestines of the mammals since, in some cases, uptake per  $\text{cm}^2$ , or  $\text{mg}$  was similar in the lizards and mammals. Uptake rates were much lower in the fish studied. Total intestinal transport, and uptake per  $\text{cm}^2$ , or  $\text{mg}$  dry tissue appeared to be correlated with the expected glucose level in the diet. Uptake rates (nmoles  $\text{cm}^{-1} \text{min}^{-1}$ ) at the intestinal position where transport was highest were: granivorous kangaroo rats,  $63 \pm 6$  (SEM); laboratory mice fed laboratory chow,  $31 \pm 4$ ; mice fed meat,  $22 \pm 3$ ; among the lizards, herbivorous *Dipsosaurus dorsalis*,  $82 \pm 3$ ; insectivorous *Sceloporus magister*,  $20 \pm 3$ . Supported by NIH grants GM 14772 and AM 17328.

Na AND Cl ABSORPTION BY THE INTESTINE OF SOME MARINE FLATFISH  
W. C. MACKAY. Univ. of Alberta, Edmonton

The mechanism of Na and Cl absorption by the intestine of three species of flatfish; the lemon sole (*Parophrys vetulus*), the flathead sole (*Hippoglossoides elongatus*) and the Dover sole, (*Microstomus pacificus*), was investigated. All fish were adapted to sea water and either  $36 \text{ Cl}$  or  $22 \text{ Na}$  fluxes were measured *in vitro* under short circuit conditions. Electrogenic chloride transport occurred in the intestine of all fish examined and it represented between 32 and 67 % of the total chloride absorbed by the intestine of these fish. The remainder of the active chloride transport was linked to Na absorption.

PHARMACOLOGY OF EPINEPHRINE (EPI) STIMULATED SHORT CIRCUIT CURRENT (Isc) IN TOAD URINARY BLADDER (TUB). J. T. Higgins\*, C.L. Thurman and J.E. Burke\*. The Medical College of Ohio, Toledo.

The ability of EPI to increase ion transport in TUBs is mediated by adrenoceptors. With a standard Ussing apparatus, agonist and antagonist were used to define the electrophysiological role of EPI in TUB epithelia.

Serosally applied EPI ( $10^{-5} \text{M}$ ) increased Isc by 200% above basal values. The positive, serosally-directed Isc was reduced by  $10^{-4} \text{M}$  amiloride (A). Any reverse Isc expressed by the tissue was not affected by EPI. Propranolol ( $5 \times 10^{-5} \text{M}$ ) did not inhibit Isc. Prazosin ( $5 \times 10^{-5} \text{M}$ ) reduced EPI-Isc to basal levels in one hour.

Prazosin is believed to inhibit  $\alpha$ -adrenoceptors that require GTP. The analog 5'-guanylylimidodiphosphate (GppNp) was found to increase Isc by 200% in 45 minutes. Methylene-GTP analogs had no effect. Both phentolamine ( $5 \times 10^{-5} \text{M}$ ) and prazosin prevented GppNp stimulation. However, cAMP increased Isc in phentolamine-better than prazosin-treated tissue.

Portions of cation transport in TUBs are regulated by sympathomimetic  $\alpha$ -adrenoceptors. Since prazosin eliminated most EPI- and GTP-stimulated Isc, a majority of the receptors can be classified as  $\alpha_2$ .

INFLUENCE OF THE HYDRIC ENVIRONMENT ON GROWTH RATES OF EMBRYONIC SNAPPING TURTLES. G. C. Packard, K. A. Morris\*, G. L. Paukstis\*, M. J. Packard, and T. J. Boardman\*. Colorado State Univ., Fort Collins.

Flexible-shelled eggs of snapping turtles (*Chelydra serpentina*) were incubated under conditions known to elicit different patterns of net water-exchange between eggs and surrounding air and soil. Embryos used energy reserves in the yolk faster and grew more rapidly when their eggs were incubated in wet environments (where water balance presumably was positive) than they did when eggs were incubated in drier settings (where water balance presumably was negative). The availability of water in the environment may therefore exercise a passive control of metabolism in turtle embryos comparable to that exercised by ambient temperature and respiratory gases.

Supported by the NSF.



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EFFECTS OF TEMPERATURE ON INTRACELLULAR ACID-BASE REGULATION IN DESERT IGUANAS. P.E. BICKLER. Univ. Calif., Los Angeles.

Mean whole body and tissue intracellular pH's ( $pH_i$ ) were measured in vivo in *Dipsosaurus dorsalis* by the DMO technique.  $pH_i$  was measured in animals at constant  $T_b$  (18, 25, 35, 42°C) and in animals undergoing changes in  $T_b$  between 18-42°C. Constant temperatures maintained for 24 or more h produced a whole body  $\Delta pH/\Delta T_b$  of -0.015. The  $\Delta pH/\Delta T_b$  for venous blood (-0.012), cardiac muscle (-0.0114) and skeletal muscle (-0.010) were not different statistically from that of whole body or arterial  $\Delta pH/\Delta T_b$ . Intracellular water contents did not vary with  $T_b$ . In these tissues,  $pH_i$  is apparently regulated in such a way that at all  $T_b$ 's the  $\Delta pH$  between cells and blood is constant. Brain  $pH_i$  did not change between 25-35°C. Whole body  $pH_i$  during gradual warming and cooling between 25 and 42°C (about 2 h elapsed time for each direction) closely corresponded to steady state values. Upon cooling to 18°C, tissue and whole body  $pH_i$  often fell 0.1-0.2 units below that expected; in each case this was correlated with an extracellular acidosis. A gradual recovery of  $pH_i$  occurred with the recovery of the extracellular acidosis.

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BOTH RESPIRATORY AND CUTANEOUS WATER LOSS OF LIZARDS ARE CORRELATED WITH HABITAT ARIDITY. W. J. MAUTZ. University of California, Irvine.

Respiratory and cutaneous components of evaporative water loss were measured in 5 xantusiid lizard species to determine whether adaptations for water conservation were present in one or both compartments. These species represented the range of arid to mesic habitats occupied by the Xantusiidae. Both respiratory water loss (mg H<sub>2</sub>O per ml O<sub>2</sub> consumed) and cutaneous water loss (mg H<sub>2</sub>O·cm<sup>-2</sup>·h<sup>-1</sup>) exhibited parallel correspondence to habitat aridity. Adaptations for reducing water loss from the skin involved an increased skin resistance to water flux while reduction of respiratory water loss was probably the result of increased oxygen extraction efficiency.

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URINARY BLADDERS IN LIZARDS: ONTOGENETIC CHANGES IN STRUCTURE AND FUNCTION. C.A. BEUCHAT, D. VLECK, and E.J. BRAUN. Cornell University, Ithaca, NY and University of Arizona, Tucson.

Newborn *Sceloporus jarrovi* possess a well-developed urinary bladder. At birth, urine accounts for about 10% of total body mass, and is very hypo-osmotic (67 mOs) to adult blood (340 mOs). The bladder begins to degenerate within 2-4 weeks of birth, and in individuals only two months old is reduced to a vestigial bladder stalk. Dilute bladder urine in newborn *S. jarrovi* may be potentially important as a buffer against dehydration in the first few days after birth.

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CHANGES IN HEMOLYMPH:TISSUE ION BALANCE IN THE CRAYFISH *ORCONECTES IMMUNIS* IN RESPONSE TO EXPOSURE TO SELENIUM. T. M. SHORT. Colorado State Univ., Ft. Collins.

Crayfish were exposed to sodium selenite concentrations (0.01-1.00 mg/L) for a period of 30 days. Hemolymph osmotic concentrations were not markedly affected in the selenium exposed organisms; however, considerable structural damage to the branchial filaments was observed at all selenium exposure levels. Consequently, the observed fluid ionic homeostasis might be associated with shifts in ionic components from one body compartment to another. Analyses of hemolymph, exoskeletal tissue, and muscle tissue revealed significant changes in hemolymph:tissue ratios of sodium, potassium, calcium, and magnesium. Specifically, the selenium exposed organisms demonstrated significant increases in the hemolymph:muscle tissue concentration ratios of sodium and potassium, and, corresponding decreases in the hemolymph:muscle tissue concentration ratios of calcium and magnesium.

ROUTES OF UPTAKE OF POLYCYCLIC AROMATIC HYDROCARBONS (PAH) BY DAPHNIA MAGNA. J. F. McCARTHY<sup>1</sup>. Oak Ridge National Laboratory, Oak Ridge, TN. 37830

The effect of sorption of PAH's, potentially mutagenic components of synfuels, to suspended organic particles on their bioavailability to and bioaccumulation by D. magna was studied. Bioaccumulation kinetics of <sup>14</sup>C-benzo(a)pyrene (BaP) and anthracene(A) were examined in the presence and absence of yeast cells. Dissolved PAH were rapidly taken up, with BaP bioaccumulated more than A. The presence of sorptive yeast particles greatly decreased the uptake rate and bioconcentration in D. magna. The magnitude of the decrease was related to the hydrophobicity of the PAH, the concentration and sorptive affinity of the particles, and the feeding rate of Daphnia. Direct uptake of dissolved PAH is the major route of uptake of PAH. Although some PAH is accumulated by ingestion on yeast, the primary effect of particles was to reduce the bioavailability of PAH.

<sup>1</sup>Research sponsored by the Office of Environmental Research, U.S. Department of Energy, under contract W-7405-eng-26 with Union Carbide Corporation.

RESPONSE OF NEOMYSIS AMERICANA (SMITH) TO NAPHTHALENE IS MODIFIED BY SEASON AND TEMPERATURE. C.Q. Thompson and B.R. Hargreaves. Lehigh Univ., Bethlehem, PA.

Mysid shrimp were collected monthly and tested, in the laboratory, at one of two temperatures (constant 20°C or ambient) for ability to survive acute exposures to the petroleum-derived hydrocarbon, naphthalene (96hr. static exposures, test medium changed daily). At ambient temperatures, 96hr-LC50 (concentration at which 50% of the animals die) decreased from 1.3ppm (mg/l) in December to 0.8ppm in July. During the same period, time to 50% mortality decreased 4-fold at all concentrations. Time to 50% mortality also decreased as naphthalene concentrations increased at a rate described by the function,  $\text{Log} Y = \text{Log} C - a \text{Log} X$  ( $Y = \text{time}$ ,  $X = \text{concentration}$ ,  $C = \text{toxicity Index}$  and  $a = \text{a constant}$ ). At 20°C, 96hr-LC50 did not vary significantly from 1.25ppm between March and July. Seasonal differences in sensitivity to naphthalene were significant at the .05 level and may be explained in part by environmental temperature. This project was supported by a NOAA SEA GRANT through the New Jersey Marine Science Consortium (Project R/F-6) to Dr. B.R. Hargreaves and Dr. S.S. Herman.

THE ROLE OF PRIMARY AMINES IN THE ASSIMILATION OF CADMIUM FROM THE INTESTINE OF THE STRIPED BASS, MORONE SAXATILIS. L.V. SICK and P.H. Fair, National Marine Fisheries Service, Charleston, S.C. 29412

The role selected amino acids may have in mucosal transport of cadmium was investigated by examining organo-cadmium complexes in digestive products. Organo-cadmium complexes were quantitated by high pressure liquid chromatographic fractionation using gel permeation columns and submitting appropriate fractions to atomic absorption spectrophotometric analyses. After one hour of oyster tissue digestion, the majority of detectable cadmium was in the stomach and associated with two fractions having molecular weights between 6,000 and 10,000. In contrast, after 12 hours of digestion, most of the detectable cadmium was in intestinal digests and associated with free amino acids. If oyster tissue were labelled with <sup>109</sup>Cd and subjected to the same digestive processes, labelled cadmium detected by thin layer chromatographic and liquid scintillation analyses, was associated with free glycine, alanine, histidine, aspartic acid, proline and phenalalanine in intestinal walls and blood serum.

SEASONAL VARIATIONS IN HEMATOLOGY OF THE WINDOWPANE FLOUNDER, SCOPHTHALMUS AQUOSUS, AT THREE STATIONS IN LONG ISLAND SOUND. M. A. Dawson (intro. by F. P. Thurberg), NOAA, National Marine Fisheries Service, NEFC, Milford Laboratory, CT 06460.

This study attempts to determine seasonal changes in a variety of hematological parameters in the windowpane flounder, Scophthalmus aquosus, and to distinguish these changes from differences related to levels of pollution at the sites sampled. We are sampling blood from flounder monthly at three stations in Long Island Sound: one very polluted, one relatively clean, and one intermediate as indicated by analyses of sediment metal levels. Two-way analysis of variance indicates that significant variation can be attributed to season for all hematological parameters measured, namely, hematocrit, hemoglobin, plasma osmolality, sodium, potassium, and calcium. Station location had significant effects on all of these parameters except hemoglobin and potassium. Results of 60-day laboratory exposures of the same species to heavy metals indicated that 10 ppb mercury affected sodium and calcium, while exposure to 10 ppb cadmium changed calcium only.

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EVALUATION OF ADRENAL FUNCTION AND MORPHOLOGY IN MICE DRINKING KRAFT PAPER MILL EFFLUENT. M. H. Peaslee, C. K. Cox\*, and B. L. Palmer\*. Louisiana Tech University, Ruston.

Laboratory mice of both sexes were maintained for 3 generations drinking a 1:1 dilution of Kraft paper mill effluent in tap water. Control mice drank tap water and both groups were fed Purina lab chow ad lib. Because of the role the adrenals play in stress, these glands were examined functionally and structurally. Fifty-four F<sub>2</sub> mice were sacrificed and the adrenal glands removed. One gland was used to assay for ascorbic acid level and the other was prepared for histological study. A comparison of adrenal weight and overall size of cortex and medulla between test and control animals revealed no significant differences. Histopathological examination found no abnormalities. Ascorbic acid, however, was significantly reduced in test females. Further work is necessary to determine which endocrine pathways might be affected. (Supported in part by a grant from Enviro-Med Laboratories, Inc., Ruston, LA)

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SPUR FORMATION IN OUCHTERLONY'S DOUBLE IMMUNODIFFUSION TEST. M. L. Pan. Department of Zoology, University of Tennessee, Knoxville, Tennessee 37916

In the Ouchterlony's double immunodiffusion analysis of cross-reacting antigens, the closer their relationship to the homologous antigen, the shorter, more deviated toward the antibody well and less dense will be the resulting spur between the precipitin lines. This phenomenon can be explained as follows: The closer their relationship to the homologous antigen, the more common antigenic determinants they share. During immunodiffusion, the cross-reacting antigen will absorb out, on its side, the antibodies to the common determinants and allow only the antibodies to the unique determinants of the homologous antigen to diffuse beyond the precipitin line to react with the homologous antigen and form the spur. These unique antibodies will be much less in amount and therefore the homologous antigen will be in much greater excess in comparison to the balanced system before absorption. Thus, the resulting precipitin line, the spur, will shift its position more toward the antibody well due to the solubilization of the antigen-antibody complexes; it will be shorter, more deviated and less dense. When two cross-reacting antigens differ by only one determinant, the spur should not be formed in immunodiffusion tests.

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INTRACELLULAR CHANGES ASSOCIATED WITH ONSET OF MIGRATION IN NEURAL CREST. C. Weinberger, Seton Hall University, So. Orange, N.J.

Acetylcholinesterase (AChE) activity is known to be present in various motile cell types including neural crest. AChE activity, relative differences in ionic Ca concentration and stress fiber morphology were studied in relation to onset of migration in the chick and amphibian. Preliminary data indicate neural crest acquire AChE activity just prior to neural fold closure and retain it for the extent of migration observed. At the same time there is an increase in intracellular ionic Ca demonstrated cytochemically with GBHA and a rearrangement of stress fibers, seen in glycerol extracted cells stained with Commassie blue, which distinguishes neural crest cells morphologically as they begin to migrate from the neural tube. Experiments are in progress to show effects of AChE and ACh inhibitors on Ca concentration, migration and stress fiber morphology. It is thought AChE or ACh may be associated with changes in the amount of ionic Ca available for binding to cytoskeletal elements of locomotor organelles.

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ULTRASTRUCTURAL ANALYSIS OF PHAEO-MELANOGENESIS IN HAIR-BULB MELANOCYTES OF LETHAL YELLOW (C57BL/6J-A<sup>y</sup>/a) MICE. N. H. Granholm and J. R. Duimstra. South Dakota State Univ., Brookings, S.D.

The lethal yellow gene (A<sup>y</sup>) alters normal melanogenesis resulting in the synthesis of yellow melanin (phaeomelanin) and the ontogeny of yellow rather than black melanosomes. This study was undertaken to determine when and how the A<sup>y</sup> mutation affects the normal program of melanogenesis in hair-bulb melanocytes. We have identified classical ontogenetic stages in the differentiation of eumelanosomes (Quevedo et al., 1975) and phaeomelanosomes (Jimbow et al., 1979). Elliptical phaeomelanosomes, some of which contained lamellar components resembling stage II and III eumelanosomes, were also observed in genetically yellow (A<sup>y</sup>/a) melanocytes. However, lattice-like components typical of eumelanosomes (90 Å fibers, 35 Å cross links, and/or distinct lattice patterns) were not observed in phaeomelanosomes of A<sup>y</sup>/a mice. These preliminary observations which suggest that A<sup>y</sup> expression within hair-bulb melanocytes is quite labile, underscore the value of agouti locus mutations to investigate genetic regulation of differentiation. (Supported by S. D. Agr. Exp. Sta. Project SD050)

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UNIQUENESS OF THE POLARIZING REGION OF THE EMBRYONIC CHICK LIMB BUD. Lawrence S. Honig. Univ. of Southern California, Los Angeles.

Different developmental mechanisms suppose that all regions of the limb bud equally have morphogenetic capabilities or that certain parts are special. At the posterior margin of the limb bud, the 'polarizing' region has been ascribed a special role, since when grafted anteriorly it alone causes full limb duplication. However, Iten & Murphy have shown that anterior regions of the wing bud also can cause duplicated digits, when grafted heterotopically. I find that such extra digits are almost exclusively composed of graft-derived cells. I have used lethally  $\gamma$ -irradiated donor wedge grafts to determine if the operations represent graft signalling, or self-differentiation under the influence of new environment. Low doses of radiation (1200 rad) were sufficient to abolish the activity of quail and chick anterior (opposite somites 16/17) grafts placed opposite somites 18/19 and 19/20, while doses over 20X greater are necessary to attenuate the activity of polarizing region grafts. Unlike the polarizing region, anterior grafts required cellular contribution by the graft tissue; the grafts do not signal.

Supported by Anna Fuller Fund Fellowship #487, the Middlesex Hospital Medical School, and the MRC of Great Britain.

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Balloon: a Recessive Mutation Producing a Transient Edema in Larvae of Xenopus laevis. E. Ratner, D. M. Krotoski and R. Tompkins Tulane Univ., New Orleans.

The balloon mutation was first identified in 30% of the gynogenetic progeny of a wild-caught Xenopus laevis female, and is inherited as a typical Mendelian recessive gene. Twenty-five percent of the offspring of heterozygous crosses and 100% of the offspring of bn/bn x bn/bn crosses are balloon in phenotype. Affected tadpoles develop a transient abdominal edema first apparent at stage 44-45 (Kieuwkoo-Faber). The edema reaches a maximal distension at stage 49 after which it begins to diminish. Mutant animals appear completely normal by forelimb eruption (stage 57), metamorphose normally and are fully fertile. Both the timing of the onset and the disappearance of the syndrome suggest a pronephric disturbance which cannot be ameliorated by modifications in the ionic environment. Histological sections also demonstrate pronephric pathology. Supported by NSF grant PCM-7903827 and a Biomedical Research Support Grant.

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MAPPING OF POLYGENIC MODIFIERS OF A SIMPLE PATTERN IN DROSOPHILA. J.S. KENNEDY\* and J.N. THOMPSON, JR. University of Oklahoma, Norman.

Quantitative geneticists often disagree about the complexity of the traits they study. We have mapped polygenic effects to determine the number and magnitude of genes affecting quantitative expression of a simple pattern. We began by selecting for a change in the length of the second long vein (L2), which is altered by the mutant radius incompletus (ri) in D. melanogaster. Response was rapid for both Long and Short lines. An analysis of heterozygous whole chromosome effects identified the third chromosome as having the largest phenotypic effect in both lines. Homogeneity in the Long line was confirmed in an assay of three single third chromosomes isolated on an inbred Canton-S wild type standard background. Polygene mapping was done by recombination followed by intensive progeny testing of recombinant chromosomes. Polygene mapping within the Long third chromosome revealed two major regions affecting L2 length. Thus, the genetic basis of this trait appears to be comparatively simple. Mapping on the Short third chromosome is being done to test allelism between loci in the two selection lines. (Supported by NIH grant R01-CM-24809-03).

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CHIRONOMID COMMUNITY STRUCTURE IN A PHYSICALLY CONTROLLED STREAM. J.G. RAE. Ohio Univ., Athens (present address: Florida Inst. Tech., Jensen Beach).

For a period of two years, a community of 25 species of larval chironomid midges (Insecta) was studied in a sandy-bottom portion of a large natural fourth order stream in Ohio. ANOVA indicated significant temporal variation in community abundance ( $p < .001$ ); density range 0.1 to 110. chironomids per 10 sq. cm. An inverse log-linear relationship exists between maximum flow rates of water and  $r_d$ , the actual rate of increase of abundances ( $p < .005$ ). The structure of this physically controlled habitat was simplified from 10 original habitat variables to 3 new significant orthogonal derived variables by means of principal components analysis. These were interpreted as "sediment size," "sediment heterogeneity" and "organic deposition." Species abundances were loaded on these new axes and strong differences in habitat preference were demonstrated for these species on each component axis by analysis of the niche parameters, width, overlap, location and shape.

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DISPERSION PATTERNS OF BENTHIC MACROINVERTEBRATES IN A STREAM RIFFLE. D. Bass (intro. by M. K. Wicksten). Texas A & M Univ., College Station, Tx.

Dispersion patterns of the macrobenthic population in a stream riffle were determined by taking 64 systematic core samples from a quadrat. Dominant taxa which were collected included Dugesia dorotocephala, Limnodrilus, Cheumatopsyche, Stenelmis, Chironomidae, and Corbicula fluminea. Analysis of dispersion patterns to determine the presence and size of aggregations was done using the mean-square method. The benthic community exhibited a clumped distribution within the quadrat, caused by the non-homogenous conditions of the stream bottom.

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THE ROLE OF DISTURBANCE IN AN ASSEMBLAGE OF MARINE FREE-LIVING NEMATODES.

K.M. Sherman, J.A. Reidenauer\* and D. Thistle\*. Florida State University, Tallahassee, Fl.

Natural disturbances have been implicated in structuring hard-bottom benthic communities, but their importance has not been conclusively demonstrated in soft bottom benthos. One of the predictions of theoretical investigations is that if disturbance is responsible for the persistence of a species in a community, such a species should become disproportionately abundant in recently disturbed patches. We investigated this prediction using nematode species in subtidal sediments off the Florida panhandle which were frequently disturbed by stingrays. Nematode densities gradually increased in disturbed samples taken over four days until they slightly exceeded those of background sediments 96 hours after the initial disturbance. No species became disproportionately abundant during recolonization. Therefore, we have no evidence to suggest that small-scale disturbances are responsible for the maintenance of nematode species in this community.

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EFFECTS OF DIFFERENT INTENSITIES, PATCH SIZES, AND FREQUENCIES OF LOCAL DISTURBANCE ON THE STRUCTURE OF TWO INFAUNAL COMMUNITIES LOCATED AT DIFFERENT POINTS ALONG A WAVE ENERGY GRADIENT. C. E. Profitt and J. L. Simon. Univ. of South Florida, Tampa, Fl.

Experiments revealed that in a community situated at a higher point on a wave energy scale, resident species recovered local (small-area) perturbations slower than in a corresponding community subjected to lower wave energy. In both systems, increasing the frequency of disturbance produced greater community changes than expanding the area disturbed at one-time only. Increasing the area of one-time disturbance mainly affected the composition of numerical dominance and core units in both systems, while the largest area and biweekly and weekly frequencies of perturbation tended to increase the simplicity of both systems by decreasing the number of numerical dominants from 3 to 2. Despite identical total areas of disturbance, different patch sizes of discreet disturbance events allowed different species to attain dominance.

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DENSITY AND THE ESTABLISHMENT OF BENTHIC COMMUNITIES - AN EXPERIMENTAL STUDY.

R.C. FITZHARDINGE (intro. by J. Brock). Univ. of Hawaii, Honolulu.

An experiment was conducted to investigate the effect of different seagrass densities and leaf lengths on the establishment of benthic communities. Faunal assemblages were established in buckets "planted" with different leaf lengths and densities of artificial seagrass, resembling the seagrass Zostera capricorni. Variation in leaf length and density were both found to influence the fauna established. The highest number of species and individuals were found in buckets with the highest density and longest seagrass. Epifaunal species responded most strongly to increases in leaf length and density of the artificial seagrass. The mean abundance of the amphipod Megamphopus sp. ranged from 0.8 individuals in samples without artificial seagrass, to 79.8 individuals in samples with the highest density and longest artificial seagrass. The results indicate that habitat complexity can influence the establishment of benthic communities. This research was supported by the University of New South Wales, Australia, and grant 12-045-16 to Dr. R.J. MacIntyre from the Electricity Commission of New South Wales.

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DENSITY DEPENDENCE IN A MARINE INFAUNAL COMMUNITY. W. Herbert Wilson, Jr. The Johns Hopkins University, Baltimore and Friday Harbor Laboratories, Washington.

Abundance data for the spionid polychaetes, Pygospio elegans and Pseudopolydora kempfi, in Puget Sound suggest that the determination of competitive outcomes is density-dependent. This hypothesis was tested concurrently in the field and laboratory by manipulations of density. Contrary to prediction, all field experimental treatments converged to ambient densities. Each species was affected more by its own density than by heterospecific density with Pygospio having no measurable effect on Pseudopolydora. Results from the laboratory experiment, where emigration was not allowed, differ from the field results. Pygospio was affected more by Pseudopolydora density than by its own density. Laboratory observations showed that Pygospio emigrates from normal densities of Pseudopolydora but not from normal conspecific densities. I propose an avoidance hypothesis in which Pygospio frequently relocates to minimize contact with Pseudopolydora and therefore, by choice, interacts more strongly with conspecifics in the field. The results of these experiments emphasize the importance of the consideration of behavior in interpreting competition experiments.

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MICRO-SPATIAL PATTERNS IN SPIONID POLYCHAETES: IMPLICATIONS OF COMPETITIVE INTERACTIONS? R.B. Whitlatch, Univ. Connecticut, Noank, CT

Nearest-neighbor distances of six species of spionid polychaetes collected from a variety of intertidal and shallow subtidal marine habitats were examined to detect small-scale patterns of intra- and inter-specific association. All the species of spionids displayed characteristic dispersion patterns and were typically aggregated, except where densities were low. Most of the species exhibited aggregations of individuals on scales of 1-15 cm<sup>2</sup>. Patch sizes of the aggregations generally differed depending upon size of organism and density. Nearest-neighbor distances of several species found over a wide range of densities indicated that limits may be imposed in spacing. Also, small-scale patterns of inter-specific segregation were found in certain species pairs, and the intensity of segregation apparently was correlated with organism density. A series of laboratory experiments suggested that competitive for space, which ultimately was governed by food availability, may be an important mechanism in controlling intra-individual spacing patterns.

Supported by NSF grant OCE-8018447.

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PROTON MICROPROBE STUDY OF ONTOGENETIC DISTRIBUTION OF ELEMENTS IN SHELL OF LIVING OYSTERS. M. R. Carriker and C. P. Swann. University of Delaware and Bartol Research Foundation, Newark, Delaware.

Monitoring of chemical elements in shell of living young Crassostrea virginica is reported. The probe scanned a rectangle 2.5 x 0.5 mm and analyzed a spectrum of 16 elements from Na to Sr to few ppm. Results standardized against curves of known concentrations of elements found in shell mixed in pure CaCO<sub>3</sub>.

Three experimental and 6 control oysters, cultured in controlled laboratory conditions, were analyzed 4 times in three months. Although considerable fluctuation in concentration of elements occurred in individuals at different stages, variations for any one element were generally nominal. Overall, S, Mn, Fe, and Zn increased slightly in concentration in successive ontogenetic stages, whereas Na, Mg, Al, Si, Cl, K, Ca, Ti, Cr, Cu, Br, and Sr remained relatively constant when present. These results indicate promise for the approach and suggest longer range studies in different types of experimental environments.

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REDUCED EMBRYONIC SHELL IN AN AEOLID NUDIBRANCH. Linda S. Eyster, Northeastern University, Boston, MA

Nudibranch gastropods typically produce a well-formed protective shell during early development and discard it at metamorphosis. The poorly formed shell of a species with reduced capsular development is described. This is the first report of such a shell in aeolid nudibranchs. Coryphella salmonacea was found to produce a thin cupshaped shell that, if calcified, is only weakly so. The shell exhibits no birefringence with polarized light and collapses against the embryo following standard preparations for scanning electron microscopy. The shell is present externally during the entire latter half of the developmental period (days 35-55) and is not covered by reflexion of the mantle. At hatching, the shell is shed within the capsule as a wrinkled sheet. Failure to produce a protective shell may be related to the absence of a planktonic stage in the development of this species.

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TRANSMISSION AND SCANNING ELECTRON MICROSCOPY OF GASTROPOD SHELL REGENERATION. C. Reed-Miller. Florida State University, Tallahassee.

A 4x4 mm window was cut in the first body whorl of shells of three species of the marine snail, Tegula. Changes in the ultrastructure of the foot, mantle and hepatopancreas were followed by transmission electron microscopy and electron diffraction. The regeneration of new shell was observed by scanning electron microscopy and energy dispersive X-ray analysis. Initial shell deposition appeared as small ( $1\mu\text{m}^2$ ) crystallites which increased in size and coalesced until there was a thin (1mm) layered sheet of  $\text{CaCO}_3$  which covered the window. During shell regeneration there was an initial increase followed by a decrease in the number of several intercellular components; calcium vesicles (which usually gave an aragonitic diffraction pattern), dense-staining droplets, and mitochondria and lamellar organelles. This study correlates the ultrastructural changes in the soft tissues of Tegula with the deposition of regenerated shell. Supported by grant DEO-5491 from the National Institutes of Health.

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ULTRASTRUCTURE OF THE OSPHRADIUM OF THE OYSTER DRILL Thais haemastoma. D. W. Garton, J. T. Caprio\* and R. A. Roller. Louisiana State Univ., Baton Rouge.

The osphradium in Thais haemastoma is typical of prosobranchs, being bipectinate and containing 60-100 lamellae. Each lamella is divided into two morphologically distinct regions by a groove 10-15  $\mu\text{m}$  wide and 5  $\mu\text{m}$  deep running parallel to the dorsal edge of the lamella. The dorsal third of the lamella is covered by dense cilia and microvilli. The ventral two-thirds is primarily secretory epithelium with a random distribution of ciliary tufts. These tufts are located in small clefts and are associated with the presumed chemoreceptor cells. A thin tract of cilia borders the ventral edge of the lamella. Dense cilia and ciliary tufts were also observed lining the siphonal canal. The dorsal portion of the lamella is probably nonsensory in function, responsible for generating currents about the osphradium. The ventral portion is both secretory and presumably chemosensory in function. The gross morphology and regional specialization of the osphradial epithelium in prosobranchs are similar to the olfactory mucosae of some teleosts.

698

FUNCTIONAL MORPHOLOGY OF THE VENTRAL PEDAL GLAND OF THE MURICID GASTROPOD EUPLEURA CAUDATA ETTERAE. G. L. Gruber. College of Marine Studies, Univ. of Delaware, Lewes.

Dissections, histology, histochemistry, and polarizing microscopy were used to examine the structure of egg capsules and ventral pedal glands (VPG) of spawning females sampled before, during, and after ventral pedal gland activity (VPGA). Egg capsules before VPGA are soft and ovoid, but after VPGA are attached to a hard substratum, molded, and hardened into final shape. The apical plug, embryo chamber, and multilayered fibrous wall of egg capsules before and after VPGA have similar structures. The VPG has a tall, columnar epithelium, numerous tightly packed subepithelial gland cells, and a thin layer of circular muscle between the epithelium and these gland cells. These cells may secrete a non-protein, non-carbohydrate substance that hardens the wall of the egg capsule. The VPG shapes, hardens, and attaches the egg capsule to the substratum, but does not secrete any layers of the wall of the egg capsule.

699

FUNCTIONAL SIGNIFICANCE OF THE DIGESTIVE DIVERTICULA OF OPISTHOBRANCH LARVAE. S. C. KEMPF. University of Hawaii, Honolulu.

The digestive diverticula of larvae of 5 opisthobranch species were examined by light and electron microscopy. In Aplysia juliana, the left diverticulum is composed of at least 3 cell types and its lumen is ciliated. Most cells serve as sites of intracellular digestion. Their ultrastructure indicates that partially digested material is taken up by pinocytosis with further digestion occurring in a typical cytoplasmic lysosomal system. Interspersed between some of the digestive cells are pyramid-shaped cells containing dense, rough endoplasmic reticulum, active Golgi bodies and apical vesicles composed of electron dense material. These cells appear to be secretory in function. Also situated between some digestive cells are "thin" cells whose purpose is unclear. The right diverticulum contains a lumen and is composed of cells similar in appearance to the secretory cells of the left diverticulum. The morphology of these cells, in both diverticula, suggests that they manufacture enzymes involved in extracellular digestion. The larvae of 4 other species of opisthobranchs have diverticula of similar structure with modifications that may relate to their plankto- or lecithotrophic life styles.

700

PHAGOCYTOSIS AND DEGRADATION OF ISOCHRYSIS GALBANA BY MERCEMARIA MERCENARIA HEMOCYTES. C.A. MOORE, Mar. Sci. Inst., Northeastern Univ., Boston, Ma.

Hemocytes which had phagocytized *I. galbana* were examined by TEM. Individual algae were observed within a phagosome in varying stages of degradation. In some cases, the hemocyte's cytoplasm and a few blunt vesicles were seen inside the phagosome. TEM confirmed earlier fluorescence microscopy work in which algal degradation products were shown to be transferred to blunt vesicles. These products appeared to accumulate with the concomitant loss of the homogeneous electron-dense contents of the vesicles. Ultimately, many blunt vesicles became filled with material which was morphologically identified as glycogen. Discontinuous bounding membranes were observed around some blunt vesicles and free glycogen packets were frequently seen in the hemocyte's cytoplasm. These observations suggested that algal degradation products were resynthesized into glycogen within blunt vesicles and released into the cytoplasm. A phagocytosis/degradation/synthesis model has been proposed.

701

MECHANICAL PROPERTIES OF MOTOR UNITS IN A PRIMITIVE MAMMAL. S. PETERS, R. MULKEY, S. RASMUSSEN, and G. GOSLOW, JR. Univ. of North Carolina, Charlotte and Northern Arizona Univ., Flagstaff.

The North American opossum (*Didelphis virginiana*) is generally considered to be among the most primitive living mammals. Hence, valuable information about the evolution of locomotor mechanisms may be gained by its study. This preliminary report describes the mechanical properties of motor units from the medial gastrocnemius (MG) muscle of the opossum. Motor units were isolated via ventral root splitting. Such properties as twitch contraction time, axonal conduction velocity, twitch and tetanic tension, and fatigability were determined for the motor units in our sample. Using twitch contraction time and the unfused tetanus test (sag), the motor units of opossum MG were separable into slow and fast twitch units. As in another primitive mammal, the striped skunk, none of the fast twitch units in our sample were fatigable. Based on this sample, the lack of fast-fatigable units typical of cat MG suggests that the physiological property of fatigue resistance may be primary, and that a lack of oxidative capacity in some motor units may be the more derived state found with locomotor specialization.

702

FIBER TYPES AND MEAN FIBER LENGTHS OF LIMB MUSCLE PAIRS IN RACCOONS, *PROCYON LOTOR*. Deedra McClearn. Harvard Univ., Cambridge

To assess possible functional differences between limb muscles with similar origins and insertions, muscles of raccoons were divided into 7 pairs: flexor carpi ulnaris (2 heads), flexor digitorum profundus (2 heads), palmaris longus (2 heads), extensor digitorum lateralis and communis, extensor carpi radialis longus and brevis, gastrocnemius and soleus, peroneus longus and brevis. Muscles from one side of the body were stained for myosin ATPase (Guth & Samaha, 1970); on the contralateral side 24 fascicles/muscle were measured. In all cases mean fascicle length differed significantly between members of a muscle pair. In most cases the muscle with longer fibers had more  $\alpha$  fibers (alkali stable; dark-staining at pH 10.4); i.e., high intrinsic rate of shortening ("fast" myosin) is apparently correlated with high overall rate of shortening (more sarcomeres in series). Splitting of muscles where different fiber populations are maintained could affect such parameters as the range of lengths over which muscle groups could develop force, recruitment of motor units, and fine control of movement. Research supported by NSF DEB 79-09797 & NIH 5T32 GM07117-05.

703

ELECTROMYOGRAPHY OF DOWNSTROKE MUSCLES IN BATS. J.W. Hermanson and J.S. Altenbach\*. Univ. of Florida, Gainesville, and Univ. of New Mexico, Albuquerque.

The primary downstroke musculature of *Artibeus jamaicensis* (Chiroptera: Phyllostomatidae) was studied to assess the temporal activity in flight. Fine silver wire electrodes were implanted intramuscularly. Myopotentials were recorded from an oscilloscope. Activity patterns in the pectoralis muscle were not significantly different from those previously recorded in *Antrozous pallidus* (Vespertilionidae). Recordings were obtained from six locations along the anterior posterior axis of the pectoralis muscle to assess the potential for intramuscular division of labor. The differences between adjacent recordings were statistically insignificant. The serratus ventralis and subscapularis muscles were each implanted in single locations. Data for the subscapularis were suggestive of a continuous fine control role during the wingbeat. The serratus ventralis was active approximately 3 msec before the pectoralis, an observation contrary to our recordings from *Antrozous*. For *Artibeus*, the data are suggestive of a pattern utilizing the "locking mechanism" described by Vaughan in bat flight.



704

"CROSS-TALK" IN ELECTROMYOGRAMS: A CAUTIONARY NOTE. G.R. Mangun, R.M. Mulkey, Barbara Young and G.E. Goslow, Jr. No. Arizona Univ., Flagstaff.

"Cross-talk" in an electromyogram (EMG) refers to myoelectric activity recorded from muscles other than that in which the recording electrode is located. The objective of this study was to determine if and to what extent cross-talk is a problem in electromyography utilizing conventional recording equipment and fine wire bipolar electrodes. Electromyograms were recorded before and after denervation of ankle extensor muscles in adult cats during unrestrained locomotion. EMG's were also recorded before and after denervation of the pubotibialis muscle in adult salamanders. Chronic bipolar electrodes were implanted to assure an identical recording paradigm before and after denervation. Raw EMG signals of similar amplitude could be recorded before and after denervation at the same amplification settings. Further, EMG's were recorded from cat popliteal fat pads implanted with bipolar electrodes. These findings suggest that electromyography is capable of recording not only motor unit action potentials from within the implanted muscle but also from motor units in neighbor muscles.

705

THE FUNCTIONAL MORPHOLOGY OF THE STERNO-CORACOIDAL AND SHOULDER JOINTS OF THE PIGEON DURING TAKE-OFF. S. Simpson. Ohio Univ., Athens, OH.

Although there are many morphological descriptions of the myology and osteology of the avian shoulder in the literature, little attempt has been made to correlate the anatomy of the joints of the pectoral girdle with the aerodynamic requirements of divergent modes of flight such as slow flight during take-off and landing, hovering, and fast level flight. A model of the function of the joints of the pectoral girdle was developed based upon three sources of information: an examination of the type and amount of movements occurring at these joints during the manipulation of fresh dead specimens and ligamentary preparations, an examination of radiographic material, and the observation of the movements that occur at the shoulder joint during take-off by high-speed photography. Both the shape of the articular surfaces and the extracapsular ligaments restrict the movements of the bones of the pectoral girdle. For instance, the ligaments acrocoracohumerale and coracohumerale dorsale limit anterior and posterior rotation of the humerus, respectively.

706

RELATIONSHIPS BETWEEN TOE ARRANGEMENTS AND DEEP PLANTAR TENDONS IN BIRDS. R. J. Raikow. University of Pittsburgh, Pittsburgh, Pa.

Toe arrangements and interconnections of the deep plantar tendons have long been used in avian classification. Each has also been given some functional analysis, but despite their relevance to an understanding of the mechanics of the foot, their interrelationships have hardly been considered. Most birds have one of 8 basic foot types and 11 basic tendon types, but only 22 of the 88 possible combinations occur. Of those that do not occur fewer than one-third are obviously functionally incongruous. The rest appear to be mechanically possible, and their absence may be due to historical rather than functional constraints. Most combinations that do occur are structurally appropriate to their functions, but the third most common arrangement is functionally incongruous, having a toe without a tendon. This is a stage in the loss of the hallux, where the tendon is lost while a vestigial digit remains. Curiously, the opposite condition does not occur. Supported by N.S.F. grant DEB-8010898.

707

MORPHOLOGICAL FOUNDATIONS OF THE BILL HONING BEHAVIOR IN PARROTS (PSITTACI). D. G. Homberger. Louisiana State Univ., Baton Rouge.

Bill honing, a characteristic behavior of parrots, results from a synchronized combination of lateral and upwards movements of the lower mandible which rubs its cutting edge against the corrugated inner surface of the upper rhamphotheca which is pushed against the lower mandible. The upwards movement of the lower mandible and the lowering of the upper mandible is produced by a coordinated contraction of the pterygoid and adductor muscles. The lateral movements of the lower mandible are produced by unilateral contractions of the *M. adductor mandibulae externus*. Because the elongated, simple Art. quadrato-mandibularis is oriented diagonally towards apico-medial, the lower mandible cannot perform a purely lateral translation but rotates from latero-caudal to medio-apical (and vice-versa) around the quadrato-mandibular joints. The lateral excursions of the lower mandible are limited by the blade-like, vertically oriented palatine bones lying along the medial surfaces of the mandibular rami. The function of bill honing is to maintain the corrugations on the inner surface of the upper rhamphotheca and to sharpen the cutting edge of the lower mandible.

708

HISTOCHEMICAL LOCALIZATION STUDY OF ADENYLATE AND GUALYLATE CYCLASE ACTIVITY IN THE CONE CELLS OF GOLDFISH RETINA. K. OSMAN\* and H.R.C. FERNANDEZ. Wayne State Univ., Detroit, Michigan.

Cyclic GMP and its related enzymes play an important role in the receptor function of vertebrate rods. In contrast, very little is known about the role of cyclic nucleotides in cone photoreceptors. The presence of cyclase activity has been investigated in cone cells of the goldfish Carrasius auratus by using a modification of the histochemical localization technique of Howell and Whitfield (1972). The results indicate a positive reaction in the outer segment membranes, particularly in the peripheral regions of the membrane folds and in some areas of the plasma membrane. The reaction was evident when the imido derivative of ATP (AMP-PNP) was used and it seemed stronger when the cones were exposed to light. When the imido derivative of GTP (GMP-PNP) was used, the reaction was either not detectable or very minimal. These findings suggest that in cones cyclic AMP may play a role analogous to cyclic GMP in rods. This research was supported by NIH Grant 1S06 RR08167-03

709

CAPILLARITY AND DIFFUSION DISTANCES IN SKELETAL MUSCLE OF VARIOUS MAMMALS. S.R. Kayar, A.J. Lechner and N. Banchoero\*. Univ. of Colorado Sch. Med., Denver.

The distance from capillaries to tissues (D) is a critical parameter of O<sub>2</sub> diffusion to tissues. Capillary density (CD) is commonly used as an index of D which may not be accurate depending on the geometry and homogeneity of capillary distribution. Cross-sections of frozen gastrocnemius of growing dogs, guinea pigs and rats were stained by the ATPase method for capillaries. The ecologist's "transect point-to-nearest-individual" method was used to analyze capillary distribution: capillaries tend toward an ordered array (significant positive kurtosis) which would maximize their dispersion. Mean distance to the nearest capillary was 9 to 23  $\mu\text{m}$  and maximal distance was 15 to 42  $\mu\text{m}$  as CD varied from 1800 to 400 caps/mm<sup>2</sup>. The combined data from these three species showed that these distances are related to CD as:  $CD = a + b/D$  ( $r = 0.98$ ). Because CD decreases hyperbolically with body weight in rats and guinea pigs but does not change in dogs, D increases in growing rodents, but is constant in dogs. Estimates of D from CD were consistently greater than measured mean D by 1-5  $\mu\text{m}$ . Supported by NIH grant HL-18145.

710

THERMAL DEPENDENCE OF CONTRACTILE PROPERTIES OF LIZARD MUSCLES. R.L. MARSH, R.W. PUTNAM, and A.F. BENNETT. Univ. of California, Irvine.

The thermal dependence of the force-velocity curves of the iliofibularis (IF) muscle was measured at 5 C intervals from 15 to 45 C in the lizard Dipsosaurus dorsalis [preferred body temperature (PBT) = 40 C]. At 40 C the IF muscle has a maximal shortening velocity ( $V_0$ ) of 19 fiber lengths $\cdot\text{sec}^{-1}$  and a maximum power ( $P_{\text{max}}$ ) of 500 W $\cdot\text{Kg}^{-1}$ . The temperature dependence of  $V_0$  and  $P_{\text{max}}$  is uniform from 20 to 40 C ( $Q_{10} = 1.9$ ). Isometric contractile properties were examined at temperatures from 10-50 C in the IF and gastrocnemius muscles from four lizard species. Of the isometric properties measured, maximum rate of force development (dF/dt) showed the best correlation with the isotonic parameters. In all species studied, except for Gerrhonotus multicarinatus, dF/dt is maximized at PBT. The behavioral performance of the animals is less temperature dependent than the isotonic or isometric contractile properties. (Supported by grants NSF PCM 81-02331 and NIH K04AM00351 to AFB and a Fellowship from MDA to RWP.)

711

CRITICAL THERMAL MAXIMA IN MICE (MUS MUSCULUS). D.J. ERSKINE and V.H. HUTCHISON. University of Oklahoma, Norman.

The critical thermal maximum (CTM) was used to assess thermal tolerance in Mus musculus acclimated to two photoperiods (LD 12:12, 18:06) and four thermal regimes (15, 25, and 30°C; 15 to 30°C daily cycle).

Mice acclimatized to 25°C  $\pm$  1°C and LD 12:12 had a unimodal diel cycle in CTM while mice exposed to 25°C  $\pm$  1°C and LD 18:06 displayed a bimodal cycle. Acclimatization to constant temperatures (15°C, 25°C, and 30°C; LD 12:12) had no effect on CTM but acclimatization to a cycling thermal regime (15°C to 30°C; LD 12:12) significantly increased the CTM. These data support the suggestion of susceptibility-resistance cycles to heat stress and indicate that the CTM's of endotherms can be altered by internal and external modifying factors similar to results obtained previously with ectotherms.

712

STUDIES ON THE EVOLUTION OF FIBRONECTIN: COMPARISON OF AMINO ACID COMPOSITIONS FROM VERTEBRATE TAXA. L.K. DUFFY and D.H. COPPENHAVER. University of Texas Medical Branch, Galveston, Texas.

We have started a phylogenetic survey of plasma fibronectin and present in this study the results obtained for different groups of vertebrates. The gelatin binding property attributed to fibronectin was used to isolate by affinity chromatography a functionally homologous protein from the plasma of representatives of the classes Mammalia, Aves and Reptilia. Among the Mammalia, species from five different orders (Primates, Rodentia, Lagomorpha, Artiodactyla and Carnivora) were studied. A fibronectin like protein was found in every class; similarities in amino acid compositions for these fibronectins indicate that fibronectin has evolved slowly. Interspecies variations, however, are also detectable in the fibronectin amino acid compositions. Immunochemical and electrophoretic comparisons also suggest that the structure of fibronectin is largely conserved in evolution. (Supported by NIH grant GM 29039.)

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COMPARISON OF ENAMEL EXTRACELLULAR MATRIX PROTEINS IN VERTEBRATES. E. Graham, M. Zeichner-David, M. MacDougall, and H.C. Slavkin, University of Southern California.

Phylogenetic advances amongst vertebrates are associated with significant changes in dental morphology. We hypothesize that these morphological evolutionary adaptations are concomitant with changes in enamel-like matrix proteins. To test this hypothesis, proteins were extracted from selected vertebrates and then characterized by their relative molecular weights and antigenic determinants. Studies were conducted in the Pacific Hagfish (*Polistotrema stouti*), Blue Shark (*Prionace glauca*), American Alligator (*Alligator mississippiensis*), and New Zealand White Rabbit (*Oryctolagus cuniculus*). SDS-polyacrylamide gel electrophoresis and cross-reactivity with rabbit anti-mouse enamel proteins serum demonstrated a dichotomy that indicates one evolutionary advance between lower vertebrates, hagfish and shark, and higher vertebrates, alligator and rabbit. Higher vertebrates contain both enamelines (70,000 daltons) and amelogenins (20-30,000 daltons). Lower vertebrates contain a major 55,000 dalton enamel protein and no amelogenins. This research was supported by research grant DE-02848 and training grant DE-07006 (NIH, U.S.P.H.S.).

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METABOLIC AND IONIC EFFECT OF LONG NOSE GAR ROE TOXIN ON MOUSE MITOCHONDRIA AND HEART TISSUE. T.A. BURNS AND L.L. LIN\*. NORTHWESTERN STATE UNIV. NATCHITOCHE, LA.

No significant change ( $P > .05$ ) in oxygen consumption was observed when isolated mouse liver mitochondria were subjected to roe homogenates which had or had not been dialyzed or denatured.

Isolated mouse hearts incubated in the roe homogenates showed a significant change ( $P < .05$ ) in their intracellular  $\text{Na}^+$  and  $\text{K}^+$  but not their  $\text{Ca}^{++}$  concentration, when compared to hearts which had been incubated in Krebs-Henseleit sol. Intracellular  $\text{K}^+$  averaged  $254.55 \pm 17.55$  Meq/kg, dropped to  $176 \pm 18.20$  when incubated in roe homogenate and to  $165.36 \pm 25.02$  in dialyzed roe. Denatured roe had a significant effect but the value declined to only  $228.80 \pm 21.00$ . Intracellular  $\text{Na}^+$  averaged  $138.77 \pm 25.70$  Meq/kg in the controls and declined to  $87.68 \pm 63.51$ ,  $81.59 \pm 11.44$ , and  $82.00 \pm 11.04$  Meq/kg under the above roe treatments. The effect of the roe homogenate explains the negative ionotropic and chronotropic effects of the roe on heart tissue.

715

UTILITY OF VARIOUS INDICES IN ASSESSING HYPOSMOTIC STRESS IN AN ASTEROID. T. C. SHIRLEY and W. B. STICKLE. Louisiana State University, Baton Rouge.

Indices of physiological stress were determined for *Leptasterias hexactis* that had been stepwise acclimated to 30, 20 and 15 o/oo S at 13°C and fed mussels *ad libitum* for 21 days. Scope for growth (SG), the caloric balance after expenditures, was 13.3, 4.1 and -7.2 cal·starfish<sup>-1</sup>·day<sup>-1</sup> at 30, 20 and 15 o/oo, with significant differences between the means of all salinities. Growth rates (GR) predicted from SG approximated actual GR at 30o/oo but not at lower salinities. Oxygen:nitrogen utilization ratios (O:N) varied directly with salinity; significant differences existed between O:N at 30o/oo and the two lower salinities. No significant differences existed between the means of either gross or net growth efficiency at 30 and 20o/oo, but both were significantly higher than the means at 15o/oo. The activity coefficient at 30o/oo, 10.2, was significantly higher than at 20o/oo, 6.8, and 15o/oo, 4.9. Brief periods of exposure to salinities as low as 20o/oo do not seriously limit the distribution or bioenergetics of *L. hexactis* in SE Alaska. Supported by NSF grant DEB7921825.

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AMMONIA EXCRETION IN THE FW CATFISH: THE ROLE OF DIFFUSION. G.A. Kormanik & J.N. Cameron. Univ. of Texas, Port Aransas Marine Lab.

Branchial fluxes of ammonia, Na and acid were examined in the FW channel catfish (*Ictalurus punctatus*) to assess the role of exchange processes and diffusion in ammonia excretion. During resting conditions, when the ammonia gradient was directed from the blood to the bath, catfish excreted ammonia and base. Addition of ammonia to the bath (1mM) resulted in a net uptake of ammonia by the fish. Blood ammonia, by the first sampling period after ammonia addition (ca. 45 min) was elevated, such that a blood to bath ammonia gradient was still maintained. However, the partial pressure gradient of NH<sub>3</sub> was reversed from that of the control period, such that the ammonia flux and pNH<sub>3</sub> gradient are correlated. The unidirectional influx of Na did not change, nor did the direction of acid flux. These data indicate that the bulk of ammonia movements occurs by the diffusion of NH<sub>3</sub>. (Supported by NSF PCM80-20982 to J.N.C.)

717

MECHANICS OF AIR VENTILATION IN SOME ADVANCED TELEOST FISHES. K.F. LIEM, Harvard University, Cambridge, MA.

This study deals with the biomechanics of air ventilation in three air-breathing teleosts: *Gymnotus carapo*, *Osphronemus goramy* and *Channa striatus*. I have analyzed the physiological and evolutionary origins of air ventilation by use of high speed cine (200 frames sec<sup>-1</sup>), high speed cineradiography (150 frames sec<sup>-1</sup>), pressure transducers and electromyography. In *Osphronemus* and *Channa*, air in the suprabranchial chamber is ventilated completely by creation of a reversed flow of water. Flow reversal is caused by characteristic pressure changes in the buccal and opercular cavities which, in turn, is correlated with specific electromyograms. In *Osphronemus* the pressure and electromyographic profiles during air ventilation resemble those during the cough or spit. *Channa* exhibits a different mechanism involving different pressure and electromyographic patterns. In *Gymnotus* the hypertrophied pneumatic duct and esophagus represent the driving apparatus during both inhalation and exhalation. Based on this comparative physiological analysis, I conclude that the mechanisms of air ventilation in advanced teleosts are diverse, and have multiple independent evolutionary origins. (Supported by NSF Grant PCM 80-03874).

718

ONSET OF AMILORIDE-SENSITIVE NA<sup>+</sup> TRANSPORT IN LARVAL BULLFROGS. S.D. Hillyard, W. Zeiske\* and W. Van Driessche\*. Univ. of Nevada, Las Vegas and K.U.L. campus Gasthuisberg, Leuven, Belgium.

The onset of cutaneous Na<sup>+</sup> transport was studied as amiloride-sensitive short-circuit current (ASCC) during late metamorphosis in larval bullfrogs (*Rana catesbeiana*) treated with 1.3 x 10<sup>-8</sup> M thyroxine. A small ASCC was first noted when the tail had shortened to 60.7% of the animals' length (stage XXI-XXII). By the time the tail had shortened to 50.0% of the animals' length ASCC values were comparable to those observed in later developmental stages. Fluctuation analysis (Lindemann and Van Driessche, Science 195: 292-294) revealed no significant correlation between the magnitude of ASCC and the density of Na<sup>+</sup> channels or single channel current in the apical membranes of the epithelium. Rate constants for amiloride binding and unbinding to the tissue suggest that the onset of ASCC involves a very rapid conversion of a larval channel with a low probability of conducting Na<sup>+</sup> (Po) to the adult Na<sup>+</sup> channel with a much higher Po.

719a

ACID-BASE REGULATION IN FW CATFISH: THE CONTRIBUTION OF GILLS AND KIDNEYS. J. N. Cameron & G. A. Kormanik. Univ. of Texas, Port Aransas Marine Laboratory.

A two-part study of acid-base regulation in the FW channel catfish, *Ictalurus punctatus*, has been carried out to assess the contribution of gills and kidneys in response to 1) infused acid and base loading, and 2) temperature change. In the first part, loads of 2mM/kg of either NH<sub>4</sub>Cl or NaHCO<sub>3</sub> were infused into the dorsal aorta, and subsequent excretion of the load via gills and kidneys was monitored. The bulk of excretion took place within 8 hrs, and was partitioned approx. 2:1 gills to kidneys. A significant portion of the acid or base load did not appear to be excreted in 24 hrs. The kidney, then, does play a significant part in acid-base regulation. In the second part of the study, only a small response to temperature change was observed. The catfish has a larger temperature dependence of PCO<sub>2</sub> than most fish, and so the change in total CO<sub>2</sub> content is rather small. Most of the change that was observed occurred across the gills. Results from both parts suggest that some part of the intracellular compartment may act as a sink for H<sup>+</sup>. Confirmatory experiments with DMO are in progress. (Supported by NSF PCM80-20982)

719b

## RESPIRATORY VARIABLES OF INDIAN AND AFRICAN ELEPHANTS.

Frank V. Paladino, James R. Spotila, and D. Pendergast\*, Departments of Zoology, Biology and Physiology, Miami University, Hamilton, Oh., S.U.C. at Buffalo, and SUNY at Buffalo, N.Y.

End expiratory gas samples of Indian and African Elephants were analyzed for O<sub>2</sub> and CO<sub>2</sub>. At rest the mean measured O<sub>2</sub> deficit for Adult Indian Elephants was 3.0% O<sub>2</sub> with a CO<sub>2</sub> increment of 3.18% CO<sub>2</sub> (R.Q.=1.06). Immediately after 10 minutes of exercise the 3 adult Indian Elephants had a mean 4.75% O<sub>2</sub> deficit and 5.2% CO<sub>2</sub> increment (R.Q.=1.1). One juvenile Indian Elephant had a resting O<sub>2</sub> deficit of 4.12% O<sub>2</sub> and a 4.6% CO<sub>2</sub> increment (R.Q.=1.12) indicating a slightly higher resting metabolic rate. One adult African Elephant had a resting 4.2% O<sub>2</sub> deficit and 4.33% CO<sub>2</sub> increment (R.Q.=1.03)

720

THE MOVEMENT OF THE PROSPECTIVE EYE CUP FROM THE NEURAL PLATE INTO THE NEURAL FOLD IN AMBYSTOMA MEXICANUM. Rudolf B. Brun Texas Christian Univ. Fort Worth, Texas.

Excision experiments performed on the amphibian neurula by Spemann(1901) and Lewis(1907) have localized the eye primordium in the anterior neural plate. This was confirmed by the dye mapping studies (Manchot,1929;Woerdeman,1929). Spemann (1938) published a figure which might suggest that the prospective eye vesicles are still located there when the neural folds are present. To localize these primordia during neurulation, grafting experiments between albino and wild type neurulae were performed. 1/3 ant. neur. plate (and archenteron roof) exchanged between genetically marked neurulae at the pre-fold stage produced two albino eyes in the wild type and two wild type eyes in the albino embryo. The eye primordia can also be grafted at neural fold stages (e.g. 16). At this stage a piece of antero-lateral neural fold has to be selected to transfer the eye cup. In addition neur. pl. ectomy at stage 16 (and later) does not prevent the eyes to form. These data provide strong evidence that the eye primordia are moving from the ant. neur. plate into the forming neural fold.

Supported by NSF grant PCM 8003373.

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ULTRASTRUCTURE OF URODELE SKELETAL MUSCLE FOLLOWING LIMB AMPUTATION. G.L.A. HORBAY and R.A. LIVERSAGE. University of Toronto, Toronto, Ontario, Canada.

Larval urodele limb skeletal muscle was observed at intervals to 24h post amputation to determine the morphological responses to traumatic injury. Presumably, such injury initiates a state of anoxia and ischemia. Some alterations are noted at 2h; by 12h a general picture emerges. Not all fibres are affected; those affected show changes throughout their observed length. Intermyo-fibrillar spaces enlarge and are filled with distended vesicular sarcoplasmic reticulum (SR). Mitochondria display varying degrees of swelling, cristal disruption and matrix density. Giant mitochondria have been noted; their cristal configuration suggests a fusion mechanism. Lipid droplets are closely associated with membrane elements, often appearing enveloped by SR or wedged between mitochondria. The results are similar to those noted in other studies of anoxic and ischemic skeletal muscle. Lipid accumulations especially, suggest a shift from aerobic to anaerobic metabolism as a result of the injury.

Supported by NSERC of Canada grant A-1208.

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SEX LINKAGE OF PEPTIDASE-C AND SUPEROXIDE DISMUTASE-1 IN THE LEOPARD FROG. D. A. WRIGHT & C. M. RICHARDS, Univ. of Texas System Cancer Center, Houston and Univ. of Michigan, Ann Arbor.

Crosses involving one heterozygous parent were set up to test the inheritance of enzymes in Rana pipiens. After metamorphosis, offspring were sexed and tissue extracts analyzed by gel electrophoresis. In 35 of 37 cases, enzyme genotype and sex showed independent assortment. Among the offspring of males heterozygous for Pep C or SOD 1 however, the males tend to inherit one paternal allele while females tend to inherit the other. For example, in one cross of a Pep C a/b male with a Pep C b/b female, there were 21 a/b males, 19 b/b females (parentals) and 3 b/b males, 5 a/b females (recombinants). Data from 7 different crosses with normal sex ratios yield recombination frequencies of 8.6% between sex and SOD1, 6.9% between SOD1 and Pep C and 12.1% between sex and Pep C. This suggests that in Rana pipiens sex is determined by a small number of genes on otherwise identical X and Y chromosomes.

(Supported by NSF Grant PCM80-Q3774).

723

SPERM-EGG INTERACTIONS DURING FERTILIZATION OF *CIONA INTESTINALIS*, AN SEM STUDY  
W.R. BATES (intro. by G.M. KIDDER) Cell Science Laboratories, Dept. of Zoology, Univ. Western Ont., London, Ont., Canada.

Complex fertilization events in urochordates can not be understood without a detailed knowledge of gamete ultrastructure. The SEM is a very useful tool in such studies. *Ciona* eggs were fixed in glutaraldehyde, critical point dried and coated with a heavy metal for observation with an Etec Autoscan SEM. The SEM demonstrates the complex structure of this egg. Clefts are found between the bases of adjacent follicle cells. Presumably the clefts would permit sperm cells to interact directly with the species-specific fucosyl sites on the vitelline (chorion) surface as described by Rosati and De Santis (Nature 283: 762, 1980). Inter-follicular clefts are partially occluded by interdigitating blebs of adjacent follicle cells. Blebs may function in the regulation of sperm cell passage through the follicle cell-vitelline layers. Eggs manually dechorionated then fertilized demonstrate that sperm cells with attached mitochondria are capable of fusing with the oocyte. This suggests that mitochondrial shedding is not a prerequisite for sperm-oocyte fusion.

724

MORPHOGENESIS AND PATTERN FORMATION IN MIRROR-IMAGED DOUBLETS OF THE HYPOTRICH CILIATES *STYLONYCHIA* AND *PLEUROTTRICHA*.  
Christina M. Goldsmith-Spoegler\*, Gary W. Grimes, Elizabeth A. Knaupp-Waldvogel\*, Hofstra Univ., Hempstead, N.Y. 11550.

A complex array of developmental competencies is revealed by microscopic analysis of morphogenesis under different physiological conditions (e.g., nutritional status) in induced mirror-imaged doublets of the ciliates *Stylonychia* and *Pleurotricha*. The pattern of morphogenesis generally is mirror-imaged - binary fission usually results in true-to-type reproduction, whereas cells with anomalous cortical patterns often result from starvation-induced reorganization. Development in *Pleurotricha* is highly variable, and the 2 cirral fields remain quite distinct; *Stylonychia* is morphogenetically more conservative, and the mature cirral fields are more conjoined. Global cortical patterning and local assembly of ciliature have been shown to be independent processes; they are, however, interrelated in ways which we do not yet fully understand. Continued analysis of this morphogenetic variability should help elucidate underlying mechanisms controlling these processes. Supported by NSF grant PCM 79-08992 to G.W.G.

725

THE SETTLEMENT BEHAVIOR, LARVAL ANATOMY AND REPRODUCTIVE MORPHOLOGY OF TWO CO-OCCURRING SPECIES OF HALCYONELLOID ECTOPROCT. C.J. HURLBUT. Univ. of New Hampshire, Durham.

In Great Bay, N.H., *Flustrellidra hispida* occurs mainly on *Ascophyllum nodosum* while *Alcyonidium polyoum* encrusts rock, *Fucus vesiculosus*, *Chondrus crispus* and *A. nodosum*. This distribution may result from substrate selection by the larvae or differential mortality after random settlement. The purpose of this study is to describe the morphology of adult reproductive structures, to determine if a substrate preference exists, and to describe larval nervous and sensory structures that may be involved in substrate selection. Histological examination of reproductively active adults has shown the size, structure and location of spermatozoa, ova and brooded larvae. Larval anatomy has been observed with light and electron microscopy. The behavior of the larvae at settlement was investigated by offering several substrates. Although *F. hispida* does not normally occur there, both species chose *F. vesiculosus*, *C. crispus* and bare rock. My preliminary conclusion is that adult distribution is not the result of larval substrate selectivity.

726

POLYGENIC ANALYSIS OF DIFFERENCES IN GENETIC EXPRESSION IN *DROSOPHILA* MEASURED AT TWO TEMPERATURES. F.B. SCHNEE and J.N. THOMPSON, JR. University of Oklahoma, Norman.

The genome can respond to selection in different environmental conditions by involving different genetic loci or by modifying genetic interactions. The genetic architecture of two sternopleural bristle selection lines in *Drosophila melanogaster* (High and Low) was studied at two temperatures (25° and 29°C). The analysis of bristle variation was done both by biometrical scaling tests and by whole chromosome assays as used in polygene mapping. At both temperatures, the scaling tests revealed a strictly additive system for both the High and the Low selection lines. On the other hand, when tested at 25°C, the whole chromosome assay of the High line revealed a significant interaction ( $p < 0.05$ ) between chromosomes 2 and 3. This interaction is lost when the assay of the same line is done at 29°. In all cases, the largest effect was associated with chromosome 3. These results indicate that the relationships among genes can change with environment and point out the discrepancies which can occur between biometrical analyses and polygene mapping. (Supported by NIH grant R01-GM-24809-03).

727

QUANTITATIVE GENETICS OF LIFE HISTORY PARAMETERS IN THREE POPULATIONS OF DROSOPHILA MELANOGASTER. P.A. MURPHY and J.T. Giesel. Univ. of Florida, Gainesville. (intro. by J. Anderson).

The effects of rearing temperature on several indices of reproductive performance was studied in three populations of Drosophila melanogaster. Inbred (F=5) flies and outcrosses of the inbred lines were analyzed by ANOVA separately. For inbred flies population contributed significantly to the variance for age of death and last third fecundity. Outbred flies had significant population effects for age of death and peak reproduction. Lines and temperature were highly significant in both inbred and outbred flies. Temperature effects had both linear and quadratic components for inbred and outbred flies, but different characters were affected in the two groups.

731

GENOME COMPOSITION AND ITS RELATIONSHIP TO THE EVOLUTION OF AMPHIBIANS. S. W. Klomann and J. C. Vaughn. Miami Univ. Oxford, Ohio.

The genome compositions of three species of the genus Desmognathus (Urodela: Plethodontidae) have been examined by the kinetic analysis of DNA reassociation. The genomes of these urodeles have been divided into components of highly repetitive, intermediately repetitive and single copy sequences expressed as a) percent of the genome and b) absolute quantity of DNA per haploid genome. Little variation in genome composition is evident between the more closely related species (D. fuscus and D. ochronchaeus), a potentially significant variation is noted in a more distantly related congener (D. quadrimaculatus). A component of intermediately repetitive sequences is absent. A comprehensive model of the evolution of genome origin and genome composition in the urodeles and in amphibians in general is presented in light of data compiled on genome compositions of urodeles and anurans. Evidence now suggests that large variations exist in all classes of DNA when comparing primitive and advanced urodeles. A progressive streamlining of the genome is postulated to parallel advancing specialization.

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CONGRUENCE BETWEEN CYTOGENETIC AND MORPHOLOGICAL CHARACTER DATA FOR TWO GENERA OF GERRIDAE. D.M. CALABRESE. DICKINSON COLLEGE, CARLISLE, PA.

Meiotic figures visible in squashes prepared from testes of Nearctic species of Gerris and Limnoporus were photographed. Study of chromosomes reveals that the mechanism of sex determination varies among subgroups, m chromosomes are consistently absent and kinetochore activity is restricted to the terminal ends of chromosomes during meiosis. The coefficient of similarity between a phylogenetic reconstruction (classification) based on cytogenetic data and a reconstruction based on adult morphological data demonstrates congruence between the two types of character data.

738

UNITY VS. DISUNITY IN THE CRUSTACEAN SUPERORDER PERACARIDA. Les Watling. Univ. Maine, Walpole.

In an earlier paper, Watling (1981) listed a series of features that appeared to unite the Peracarida. In this paper these features are reviewed to determine their uniqueness, either by themselves or in combination, to sufficiently define the Peracarida as a monophyletic unit. In addition, other features such as the structure of the eyes, the development of the carapace in the orders where it occurs, and the structure of the blood vascular system are also considered. Current evidence suggests that the Peracarida is an artificial taxonomic unit that should be dissolved and the component Orders removed to at least 3 other Superorders: Amphipoda, Mancoida (containing the Isopoda, Tanaidacea, Cumacea, and Spalaeogriphacea), and Schizopoda (containing the Mysida and Euphausiacea, and perhaps the Pygocephalomorpha).

PHYLOGENY OF TANAIIDACEA. J. Sieg, Universität Osnabrück/Abt. Vechta, Germany.

Systematic position of the order within Peracarida is shortly discussed. This leads to the reconstruction of an architype of the Tanaidacea. A short overlook of comparative morphology of the appendages shows that there are four different phylogenetic lines, each represented by a suborder: Anthracocaridomorpha, Apseudomorpha, Neotanaidomorpha, and Tanaidomorpha (Sieg, 1980). Because our knowledge upon morphology and anatomy of the Apseudoidea is very bad, there is only given a first attempt of an arrangement which may show the "natural system" of this subfamily. There exist much more information for the Tanaidomorpha. Therefore, phylogenetic relationship is discussed in detail. The established system also allows an interpretation of several other information as vertical and horizontal distribution as well as phylogenetic development of sexual dimorphism.



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