with cortisol to increase seawater tolerance, at least partly through the upregulation of gill cortisol receptors. Cortisol under some conditions may promote ion uptake and interacts with prolactin during acclimation to fresh water. The osmoregulatory actions of growth hormone and prolactin are antagonistic. Although a broad generalization that holds for all teleosts is unlikely, our current understanding indicates that growth hormone promotes acclimation to seawater, prolactin promotes acclimation to fresh water, and cortisol interacts with both of these hormones thus having a dual osmoregulatory function.

37

The role of plant and animal 'behavior' in confronting osmotic challenges.
WOLCOTT, T. G.* and D. L WOLCOTT. North Carolina State Univ., Raleigh.

Biologists must remember that physiology is the product of natural selection on organisms interacting with heterogeneous environments. 'Behaving' organisms may alter the osmotic conditions they experience and achieve results unexpected from laboratory studies. Their ability to exploit environmental heterogeneity depends on its temporal/spatial scale relative to that of the organism, and the correspondence beween the osmotic differences and the organism's sensory and osmoregulatory physiology. 'Behaviors' include evasion of stressful habitats, selection among differing microenvironments, changing body characteristics that affect salt/water uptake/loss, manipulating fluids differing in osmolytes, and modification of osmotic microenvironments (especially for vulnerable offspring). To draw 'comparative and integrative' inferences, investigators must strive to understand organisms' actual challenges by 'seeing' the world from their perspective, and then making observations and performing experiments in the context of the 'real world' experienced by that organism.

Topic in Integrative Evolutionary Studies

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The fertilization ecology of three congeneric sea urchins from the northeastern Pacific.
LEVITAN, D.R. Florida State Univ., Tallahasee.

Three species of sea urchins, *Strongylocentrotus droebachiensis*, *S. franciscanus*, and *S. purpuratus*, vary in gamete traits and demography. Female fertilization success was measured in two ways: (1) By releasing gametes from a single male and female into the sea and recapturing them to measure fertilization performance when all else is equal and (2) By inducing natural assemblages of sea urchins to spawn in their natural habitat to estimate levels of fertilization. In the first test, fertilization was correlated with species specific gamete traits. In the second test, fertilization was correlated with the distribution and abundance of males. The species rank performance in these two tests was inversely correlated; species that did the best when all else was equal had the lowest fertilization rates under natural demographic conditions. These data suggest that gamete attributes greatly influence fertilization in the sea and that selection has acted on these gametes to enhance the probability of fertilization in species that are more likely to be sperm limited.

39

A comparative analysis of egg size in marine invertebrates: Relationships with development mode, planktonic period and adult size.
ECKERT, G.L. Univ. of California, Santa Barbara.

I examined variation in egg size for over 600 species of marine invertebrates from 10 phyla to investigate the relationships between egg size and developmental mode, egg size and planktonic period, and egg size and adult size. I used comparative methods to identify the level at which taxa can be considered independent and then conducted analyses at this level. For the species examined in this study, the majority of variance in egg size occurred at the class level, suggesting that considerable evolutionary change occurred in egg size as phyla diverged into classes, but that little has occurred since. Higher nodes analysis and phylogenetic subtraction analysis at the class level revealed that egg size was largest for species with nonplanktonic development, next largest for species with planktonic, nonfeeding development, and smallest for species with planktonic, feeding development. When all development modes were considered at the class level, egg size was significantly negatively correlated with planktonic duration, but egg size was not correlated with adult size.

40

Calculation and interpretation of the level of egg provisioning in marine invertebrate life cycles.
MCEDWARD, L.R. Univ. of Florida, Gainesville.

The resources packaged into the eggs of free-spawning marine invertebrates represent the entire parental contribution towards the energy and material requirements for development. Although the proportion of the required energy that is provided in the egg (**s**) is an important quantity in life history theory, there are extremely few published values in the literature. I used four different methods to calculate **s**. Calculations based on egg volume and average values for energy per unit volume can be applied to a very large database of egg sizes in several taxa. The best estimates of **s** require information on the energy content of eggs and juveniles and the rate of energy metabolism during development, which is rare. Calculated values of **s**, among species of echinoids spanned 5 orders of magnitude ($s < 0.01$ - $s > 1000$). The interpretation of **s** is straightforward for planktotrophic development, but becomes problematic for lecithotrophic development ($s > 1$). Better data and a precise definition of this measure of egg provisioning are crucial to understanding the evolutionary transitions among patterns of larval development.

41

Extended parental care in *Sphaerium striatinum*: Evidence for retention of competent young.
BEEKEY, M.A.*, R.H. KARLSON, and A. GREENBURG. Univ. of Delaware, Newark.

The release of offspring marks a critical turning point in an organism's life history. The timing of offspring release signals the end of parental investment and the beginning of independence for offspring. The amount of time and energy invested in the parental care of young is a shaped by a myriad of both physiological and microevolutionary trade-offs. Feeding young has heavy energetic requirements that may exceed those of egg production or gestation. In many species, a variety of mechanisms exist that reduce the costs of feeding young. In *Sphaerium striatinum*,a freshwater clam, fertilized eggs are brooded within the inner demibranch, undergo direct development, and are retained until the young mature into miniature adults. Juveniles as small as 2.0 mm, independent of the adult, are competent in terms of feeding and survival. Young are retained within the brood pouch until they reach a size of 4.0 mm. Here we present a mechanism for decreasing costs associated with parental care in this species. The retention of competent young in *S. striatinum* will also be discussed in relation to increasing offspring survivorship in response to factors such as predation and environmental instability.

42

Colony allometry and life history evolution in the soft coral genus *Alcyonium*.
MCFADDEN, C.S. Harvey Mudd College, Claremont, CA.

The association between small body size and embryonic brooding has been well documented in a wide variety of solitary marine invertebrate taxa. To date, however, associations between either polyp size or colony size and brooding have not been documented in colonial taxa. The soft coral genus *Alcyonium* encompasses a diversity of colony morphologies and life histories. A partial phylogeny based on ribosomal internal transcribed spacer (ITS) sequences suggests that there is no phylogenetic pattern to the distribution of life histories in this genus: sister taxa often reproduce very differently. There is,