

54.2 APRILLE, J.R., LAGACE, C.J., LEWIS, S.M., MICHEL, T., MODICA-NAPOLITANO, J.S., TRIMMER B.A. AND ZAYAS, R.M.; University of Richmond, Tufts University School of Medicine, Harvard Medical School, Merrimack College. *Role of nitric oxide and mitochondria in control of firefly flash.*

In a recent report (Science 292:2486-88, 2001) we showed that: (1) nitric oxide gas (NO) stimulates light production in *Photuris* sp in the presence of oxygen; (2) NO scavengers block bioluminescence induced by the neurotransmitter octopamine; and (3) NO synthase is present in lantern cells. These findings suggested key roles for NO and oxygen in the mechanism of flash control. We proposed that NO, produced in response to nerve signals, inhibits respiration in photocyte mitochondria. Mitochondria are clustered in the cell periphery, so active respiration would make the interior regions relatively hypoxic. Inhibition of mitochondrial oxygen consumption would allow available oxygen to pass through to the centrally-located peroxisomes where the oxygen-triggered light reaction is sequestered. New data show that NO does inhibit respiration in isolated lantern mitochondria prepared by differential centrifugation. A standard polarographic assay was used to measure oxygen consumption. When an NO donor drug (NOC-7, 4 μ M) was introduced, respiration was completely inhibited. Inhibition was reversed by bright light, and was reinstated when the light was turned off. The results support the idea that NO triggers light production by reversible inhibition of mitochondrial respiration. The data also suggest that the light produced could relieve NO inhibition thus contributing to rapid on/off switching.

3.5 ARENDT, J.; University of California, Riverside. *A preliminary framework for integrating evolutionary ecology and development.*

In order to link development with adaptive evolution we need to ask three questions: 1) What is the developmental basis of a given phenotypic trait? 2) How does variation in this trait depend upon the underlying developmental mechanism? and 3) What are the fitness consequences of different developmental mechanisms? The first question is the focus of developmental biology, which usually ignores intraspecific variation. A few micro-evolutionary studies have considered the developmental source of phenotypic variation, but fitness consequences are usually interpreted in terms of phenotype, not development. If the developmental mechanism is irrelevant for fitness, then development may have little to microevolution. I illustrate use of these three questions in a study of growth rate and swimming speed in anuran tadpoles. Rapid growth and fast burst swimming speed are important for increasing fitness in tadpoles. However, there appears to be a universal trade-off between these traits in aquatic vertebrates. This trade-off can in part be explained by characteristics of muscle development, but different development mechanisms act in different species. In the American toad, delayed differentiation of mature fibers results in fast-growing tadpoles having many, small, young fibers that make them slower swimmers. In the Western Spadefoot toad, production of extra-cellular matrix (connective tissue) means fast-growers have less muscle tissue per unit area of the tail, again making them slower swimmers. The trade-off between growth rate and swimming speed has its own fitness consequences, especially if predators are present. On going research is aimed at determining the effects of different developmental mechanisms for growth in ephemeral ponds and the range of plasticity in growth.

S2.1 ARNOLD, S.J.; Oregon State University. *Multivariate stabilizing selection on morphology and performance.*

Theoretical discussions of morphology, performance and fitness have treated only the case of directional (linear) selection. Under a variety of circumstances it seems likely that (1) morphology has a curvilinear relationship to performance and (2) performance has a curvilinear relationship to fitness. I will discuss the estimation of curvilinear performance and fitness gradients and their implications for the study of morphology, performance and fitness.

8.3 ARONOWSKY, A.; University of California, Berkeley. *Evolution of a complex synapomorphy in naticid gastropods.*

Naticid gastropods are a diverse and ecologically important family of marine snails. Previous morphological phylogenetic analyses of Naticidae have demonstrated the monophyly of the family and its close relationship to more derived caenogastropods such as the cypraeids and lamellarids. Several complex synapomorphies diagnose the clade, including possession of an accessory boring organ on the ventral tip of the proboscis, and the construction of a spiral sediment-impregnated egg mass. The egg masses are of particular interest because they are unique among gastropods. A robust phylogenetic hypothesis and information about construction and function are necessary for elucidating how and why the distinctive egg mass evolved. However, outgroup comparison and the fossil record, two common methods for investigating the evolution of character complexes, provide no insight into the evolution of naticid egg masses. Close sister groups do not share any egg mass characters with naticids, and there is no recognized fossil record of these sedimented structures. Two of the approximately 250 extant naticid species produce sediment-free gelatinous egg masses. Phylogenetic analysis suggests this sediment-free condition is derived in extant naticids and therefore does not shed light on the evolution of this complex synapomorphy. Here, I present new phylogenetic hypotheses obtained with morphological and molecular datasets. Morphological features related to the unique sediment-impregnated egg mass are mapped onto these phylogenetic hypotheses to investigate the evolution and function of egg mass morphology. Characters investigated include the use of sediment, arrangement and packing of eggs within a mass, mean egg diameter, number of whorls, egg-free zones within a mass, and fluting at the basal edge of the mass.

S8-1.3 ARRATIA, G.; Museum fuer Naturkunde, Germany. *Origin and early radiation of Teleostei.*

The Telesotei and its sister-group the Halecomorphi are currently included in the Division Halecostomi. During the last 30 years, fundamental work concerning the monophyly of the Teleostei, as well as of the Halecomorphi, and the phylogenetic relationships among halecostome subgroups has been generated. Although there is apparently no doubt concerning the monophyly of both the Halecomorphi and Teleostei, new investigations on Triassic and Jurassic 'pholidophoriforms' raise important questions concerning (1) the monophyly of these groups, (2) the evolutionary significance of certain features, (3) the age of the Teleostei versus that of the stem-groups, and (4) the content of the halecostome subgroups. For instance, the three characters (e.g. symplectic articulating with lower jaw; one supramaxilla) currently accepted as supporting the monophyly of Halecomorphi turn into homoplasies because they are present in some of the Triassic pholidophorid genera and in stem-group teleosts. The monophyly of the Teleostei stands only on one uniquely derived morphological character (quadrate with long posteroventral process), and all other characters previously proposed in the literature as uniquely derived become homoplastic. The study of Triassic pholidophorids, at the base of the Teleostei in the cladogram, reveals that 'true' teleosts are much older than most of the taxa that have been suggested as stem-group teleosts; thus, the group arose probably in the Middle-Early Triassic (~240 m.y. ago). Although by the Late Triassic the teleosts were represented by several genera, it was in the Jurassic, particularly the Late Jurassic (~151 m.y. ago), when most of the stem and some of the modern teleostean lineages (e.g. elopiforms) arose. In contrast, the osteoglossomorphs do not appear in the record until about 137 m.y. ago.

4.3 ARTHUR, W.; University of Sunderland (UK). *What determines the direction of evolutionary change?*

In this presentation, I examine the deceptively simple question posed in the title. I begin with a historical approach. I look at the views

ABSTRACTS