arched or planar systems by means of two morphological events which occurred independently, producing two major clades. One event was the development of nymphae, ridges formed from the inner surface of the shell which serve to enhance arching. Nymph-bearing systems, to which the term *parivincular* is restricted, are exclusively opisthodetic and occur in the Solemyidae and throughout the subclasses Anomalodesmata, Paleoheterodonta, and Heterodonta. The other event was the development of *pseudonymphae*, which consist of modified ostracum and serve as fillers between ligaments and shell. Pseudonymph-bearing systems, termed herein *planivincular*, are exclusively opisthodetic and are taxonomically restricted to the subclass Isofilibranchia. Planivincular systems are also characterized by discontinuous ontogeny of fibrous ligament, the initial portion being a tiny fibrous resilium. In *Dacrydium*, only this early part remains, the remainder of the ligament system being truncated by neoteny. Multivincular and duplivincular systems can be derived from planivincular systems by similar truncation and by the reestablishment of adult ligament systems through repetition of either fibrous or nonfibrous ligament. The Pectinacean ligament system, with its unique centrally nonfibrous resilium, would appear to be derived from a duplivincular system.

The parivincular clade originated by middle Ordovician time in forms such as *Ctenodonta nasuta* (Hall). The planivincular clade likely originated from the Protobranchia even earlier.

**SHELL MICROSTRUCTURAL VARIATION REFLECTS HABITAT INFLUENCE IN *GEUKENSIA DEMISSA GRANOSISSIMA* (BIVALVIA: MYTILIDAE). Antonieto Tan Tiu,** University of Southern Mississippi, Hattiesburg, Mississippi.

Live specimens and freshly shucked shells of the Atlantic ribbed mussel, *Geukensia demissa granosissima*, transplanted to a continually submerged habitat (Winter 1985, Ocean Springs, Mississippi) showed an internal shell growth layer different from that of mussels of higher *Spartina alterniflora* Loiseleur-Deslongchamps salt marsh. The high salt marsh was alternately exposed to air and submerged in water (about 50% of total experimental period), while submerged habitat was continuously submerged in water. Shell lengths significantly decreased in emerged mussels (high marsh) and increased in submerged mussels (submerged habitat). Scanning electron microscopy observation of the internal shell microstructure inside and outside the pallial line of both anterior and posterior regions of initially collected (baseline) and caged mussels (live and freshly shucked shells) revealed that (1) Inside the pallial line, the nacreous layer was predominantly eroded in all mussels; a homogeneous-like microstructure composed of variously shaped and sized particles occurred in all mussels but submerged. (2) Outside the pallial line, growing and mature tablets with smooth surfaces were observed in both baseline and submerged mussels but not emerged mussels. Few emerged mussels had elevated borders of continuous ridges, beads or granules that surround partially or completely one or more tablets. These circumferential ridges may be due to shell dissolution rather than shell formation. In conclusion, distinct differences in internal shell microstructure occurs in mussels maintained between different habitat within a very small area. Submerged regions, at least in the winter season of the Mississippi Gulf Coast, may offer some buffering capacity to climatic variation and thus increase the ability of *G. d. demissa* to deposit shell material or deter shell dissolution.

**INTENSE PREDATION BY CRABS ON MANGROVE LITTORINIDS. David G. Reid,** Department of Invertebrate Zoology (Mollusks), National Museum of Natural History, Smithsonian Institution, Washington, D.C.

A taxonomic revision of the *"Littorina scabra"* group in the Indo-Pacific using characters of the shell and anatomy, has defined 17 species, which are placed in the genus *Littoraria*. Five of these species occurred at a study site on Magnetic Island, Queenland, where they were zoned at characteristic heights above the water level on *Avicennia* and *Rhizophora* trees.

From field observations and laboratory experiments, the major predators of post-larval snails were concluded to be grapsid crabs of the genus *Metopograpsus*, and the portunid *Thalamita crenata*. The grapsids were small, tree-climbing crabs with unspecialized chelae, capable of crushing small or thin-shelled snails. The portunid was a large species with dimorphic chelae, able to crush even the largest *Littoraria* species, but could only reach prey close to the water surface. From exclusion cage experiments in the field using *L. filosa*, it was estimated that crabs caused 79% of the mortality of snails in the size range 7 to 12 mm.

Repaired V-shaped breakages on the shell preserve a record of unsuccessful predation attempts by crabs during the life of a snail. Frequencies of repaired breakages in the *Littoraria* species were very high (means of 0.66 to 3.48 repairs per shell). From the known growth rates of the species, rates of injury were calculated, and found to be highest at small shell sizes ($< 5$ mm for most species). The size at which the rate of injury was highest corresponded to that at which snails just achieved immunity to the majority of *Metopograpsus*.

The *Littoraria* species zoned at lower levels on the mangrove trees had thicker shells, which can be explained as an adaptation to the increased severity of crushing predation nearer the water level.

**CONTRIBUTIONS OF ALPHEUS HYATT TO MALACOLOGY. Ralph W. Dexter,** Kent State University, Kent, Ohio.

Alpheus Hyatt (1838-1902) was trained by Louis Agassiz, and served as Honorary Curator of Fossil Cephalopods at the Museum of Comparative Zoology for life (1865-1902). He was also part-time Curator of Conchology (1863-67) and Curator of Paleontology (1867-70) at the Boston Society of Natural History, and Curator of Lower Invertebrates at the Peabody Academy of Science, Salem, Mass., before returning to the Boston Society of Natural History (1870) as Museum Custodian (i.e. Curator) for the remainder of his career. He founded the Teachers School of Science and the Annisquam Seaside Laboratory (which became the