

Marine Biological Laboratory at Woods Hole). With his private vessel he conducted dredging studies off the New England coast and made expeditions to Anticosti Is. to collect marine specimens and fossil cephalopods. He published some 50 papers on fossil cephalopods, describing many new genera and species (See *Malacol. Rev.* 6:38-40, 1973).

While studying mollusk collections in European museums (1872-73), he did special research on fossil planorbid shells and their supposed evolution at Steinheim (Germany) leading to a monograph (1880). He was a cofounder with E.D. Cope of the Neo-Lamarckian school of evolution and developed a theory of growth and development later called the Hyatt-Cope theory of acceleration and retardation. Hyatt also proposed an "old age theory" attempting to explain the life history of species. His last study — never completed — was on the geographical distribution and color patterns of land snails in Hawaii (Achatinellidae).

THE MARINE MOLLUSKS OF THE BAHAMA ISLANDS: IDENTIFICATION SYSTEMATICS, ZOOGEOGRAPHY, AND NATURAL HISTORY. Robert Robertson, Academy of Natural Sciences, Philadelphia, Pennsylvania.

This book is being prepared in collaboration with Jack N. Worsfold and Colin Redfern. About 1,300 species will be treated. The intended readership is serious amateur shell collectors, and marine malacologists and biologists. Currently, we are working on the introduction and archaeogastropods. We summarize here the most important background information in the introduction.

The Bahamas are limestone islands on slowly subsiding shallow banks stretching about 1000 km SE of S Florida, N of the West Indies. At their margins, the banks slope gently to depths of about 30 to 40 m, below which, surrounding all the banks, there is a nearly vertical "drop-off" to much deeper water. During each glacial advance in the Pleistocene, world sea level fell. This happened most recently only 20,000 to 15,000 years ago, when it fell somewhere between 85 and 130m (Milliman and Emery, 1968; CLIMAP Project Members, 1976; Emiliani, 1980). The Bahamian banks must have become towering plateaus surrounded by cliffs.

Presently, mean near-surface sea temperatures are 24° (winter) and 28° C (summer) (Fuglister, 1947). In Tongue of the Ocean (the deep-water embayment between Andros and New Providence) during each glacial advance temperatures have been estimated by Lynts et al. (1973) to have been 3° or 4° C lower than at present, perhaps enough to have eliminated some stenothermal species.

During each glacial advance, most of the non-rock-dwelling marine biota must have been exterminated. Habitats and organisms that we believe to have disappeared totally are: sand, turtle grass (*Thalassia*), mud, mangroves (*Rhizophora*, etc.), and most holothurians. Most of the now rich fauna in these habitats must have repopulated the Bahamas in the last 15,000 years. (The repopulation possibly happened much more quickly than this.) The source of the larvae would have been the West Indies, islands where the submarine geomorphology is different and whence currents flow. Bahamian habitats and organisms that may have per-

sisted despite the low sea levels are supratidal to subtidal rock surfaces, remnants of coral reefs, gorgonians, zoanthids, sponges, floating *Sargassum*, *Janthina*, plankton, nekton, and deep-sea taxa.

On average, 1.7 tropical storms and hurricanes pass through or seriously affect the Bahamas each year (Halkitis et al., 1982). The shallow water biota is temporarily devastated in their paths.

Seven Bahamian gastropods with direct development were known to D'Asaro (1970). Examples are *Fasciolaria tulipa* (Linnaeus, 1758) and *Turbinella angulata* (Lightfoot, 1786). There are no doubt more. (Non-neritacean archaeogastropods were believed by Strathmann (1979) all to be lecithotrophic, but this generalization may not be true.) It is puzzling how species with nonplanktonic larvae populated the Bahamas, but the Great Bahama Bank is separated from the Cuban "continental" shelf by the Old Bahama Channel, which at its narrowest is only about 10 km wide. Furthermore, some far more isolated tropical islands have nonplanktonic species in their faunas.

An example of a marine mollusk species apparently endemic to the Bahamas is *Vexillum (Pusia) chickcharneorum* Lyons and Kaicher (1978), but this, like the others, may turn out to occur also in the West Indies. A species possibly extinct in the Bahamas is *Cancellaria reticulata* (Linnaeus, 1767), occurring there in Pleistocene deposits (it persists outside the Bahamas).

One school of ecologic thought has it that tropical biotas, with their many species, have fairly stable populations. Our findings support the alternative view: because of extrinsic and probably also intrinsic factors, there is frequent decimation and resurgence of populations.

A PRELIMINARY BIOGEOGRAPHY OF THE BULIMULIDAE (PULMONATA: SIGMURETHRA) IN SONORA MEXICO. J.E. Hoffman. University of Arizona, Tucson.

Pulmonate snails in the deserts of the southwestern United States and northern Mexico usually display a patchy distribution wherein small populations are often totally isolated from one another. This generally results in the evolution of many species, often one or two per mountain range or patch of habitat. This has been shown to be the case for the genus *Rabdotus* in Baja California as well as *Sonorella* in Arizona and Sonora.

Preliminary research indicates, however, that this is not the case for *Rabdotus* in Sonora where only two species appear to inhabit hundreds of square kilometers of patchy habitat, with only a few related species which inhabit very limited ranges within or adjacent to the ranges of the two major species. This pattern, while unusual for desert land snails, is not unusual for *Rabdotus*; this pattern occurs often in this genus further east.

Of the two widespread species, *R. nigromontanus* seems to occur in and around Sonora's major river basins, and the almost continuous good habitat along these basins seems to provide a means for gene flow within most of the species' range. The other species, *R. baileyi*, inhabits lower, much more xeric habitats with no permanent rivers. Within its

range, *R. baileyi* inhabits isolated rock outcrops. A means by which gene flow might be maintained in this species is being sought.

In addition, a member of the genus *Orymaeus* in this family was found in the southern part of Sonora, a new record for this state.

INFLUENCE OF OPTIC TENTACULAR PRINCIPLE IN THE BIOSYNTHESIS OF STEROIDS IN THE OVOTESTIS OF CRYPTOZONA BELANGERI (DESHAYES) (PULMONATA; GASTROPODS). S. Rajasekaran, V. Srilamulu and T. Sridharan, Department of Zoology, Annamalai University, Annamalai Nagar, India.

Isoprenoid lipids, as components of hormones, are indispensable in the physiology of reproduction, since they regulate the functional differentiation of the reproductive organs during reproduction. Progesterone, testosterone and estrogen are groups of 21, 19, and 18 isoprenoid lipids which play an important role in regulating the reproductive activity in animals. The occurrence of the intermediary structure 17-b hydroxy testosterone in the pathway of conversion of estrogen from testosterone has also been studied, along with the progesterone, testosterone and estrogen in the gonad of the terrestrial pulmonate gastropod mollusc *Cryptozona belangeri* (Deshayes) using low frequency H'FT NMR Spectrometer.

The experimental snail is protandrous hermaphrodite where the male reproductive organs are activated first after the differentiation of the gonad towards the male phase (spermatogenesis) followed by the female phase (oogenesis). The spectrographic pictures showed that the male phase gonad has a higher level of testosterone, the estrogen level being low and while the female phase gonad exhibited a higher level of estrogen together with an increased level of 17-b hydroxy testosterone. The spectrographs of the optic tentaculised male phase snail analysed at an interval of 10 days up to 30 days showed a sharp fall in the titre of testosterone level, but recorded a characteristic increase in the level of estrogen. The 17-b hydroxy testosterone signalled an initial increase followed by a fall within 20 days after tenetaculectomy paving the way for the enhanced biosynthesis of estrogen.

In the present investigation, it is inferred that the steroid hormones are synthesised in the ovotestis of the snail and the hormones elaborated characterize the specific sex in the hermaphroditic snail, either to conform to male or female phase. The results of the optic-tentaculised snails illustrate the prevalence of relationship of optic tentacle with the gonad. Switching over from one phase to the other phase depends on the optic tentacular principle which plays a decisive role in modulating the biosynthesis of specific steroids, either androgens or estrogens, by gonad characterising the male or female phase of the snail.

RADULA DYNAMICS: ANALYSIS OF MOVEMENT PATTERNS AND SUBSTRATE INTERACTIONS. Carole S. Hickman, Department of Paleontology, University of California, Berkeley.

The morphological complexity of the molluscan radula makes the structure a rich source of characters for taxonomic

differentiation and analysis of phylogenetic relationships. The radula is also a source of "unconventional" characters that are derived not from static morphology but from analysis of radular function. Changes in spatial relationships of teeth, sequences of individual tooth-tooth interactions and tooth-substrate interactions, paths and rates of tooth movement, as well as patterns of tooth row movements and interactions are more variable than the static morphology of the extracted radula and its individual teeth.

Two techniques for defining dynamic characters are motion analysis of filmed feeding strokes and analysis of feeding tracks on artificial and natural surfaces.

Frame-by-frame analysis of a single feeding stroke of a duration of one second and filmed at 64 frames/second provides 64 static images of successive positions of tooth rows and individual teeth. Traces of the motion of rows and individual teeth relative to fixed points on the substrate yield patterns that can be described, illustrated, and quantified in the same ways that conventional morphology is treated. This method of analysis is restricted to animals that can be induced to protract and retract the radula on a transparent surface for filming. Feeding track analysis can be used alone or in conjunction with dynamic analysis. The traces of teeth on artificial and natural substrates have their own static morphology and also can be described, illustrated, and quantified in the same manner as conventional characters. If relationships can be established between individual incisions and the teeth that produced them and if the temporal sequence of incisions can be established, then several higher levels of pattern are available for use as characters. The four temporally and spatially parallel gouges of a patellacean limpet provide a striking contrast to sets of spatially parallel but temporally sequential gouges of a trochacean gastropod. When the traces are oriented relative to a morphological constant (the longitudinal axis of the radula) the difference is even more striking because the longitudinal axes of the gouge sets are 90 apart.

Traditional systematics avoids the use of functional and behavioral characters on the grounds that common function and behavior frequently are the result of convergence. However, if function is precisely defined and expressed in terms that are essentially morphological, it extends the definition of form and provides a basis for unmasking convergence in static morphology.

FUNCTIONAL MORPHOLOGY OF SOME CHITONID RADULAE (POLYPLACOPHORA: CHITONIDAE). Robert C. Bullock, Department of Zoology, University of Rhode Island, Kingston.

The radula of the polyplacophoran family Chitonidae consists of 17 highly modified teeth per row. There is much within row and within column integration of tooth function and the rows are difficult to discern due to their offset nature. Each centro-lateral of *Chiton* and *Acanthopleura* has a single cusp with a small pad on the distal lateral edge that articulates with the shaft of the major lateral when the ribbon is curled. The use of magnetite on the denticle cap of the major lateral is usually conserved and its presence on the back surface of



Hoffman, J E. 1986. "A Preliminary Biogeography of the Bulimulidae Pulmonata Sigmurethra in Sonora Mexico." *American malacological bulletin* 4, 113–114.

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