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ABSTRACTS

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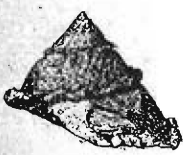

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PREFACE

This volume includes 369 abstracts of papers (lectures) and posters accepted for presentation at the 1998 World Congress of Malacology. Congress presentations fall into the following categories:

(1) Three symposia:

- Refining Molluscan Characters (Organizers: Timothy Collins, Gerhard Haszprunar, Diana Lipscomb, Winston F. Ponder).
- Interactions Between Mollusks and Humans (Organizers: Philippe Bouchet, George M. Davis, Eric Hochberg, Gerardo R. Vasta).
- Bridging Temporal Scales in Malacology: Uniting the Living and Dead (Organizers: Satoshi Chiba, Douglas Erwin, David G. Reid).

In this volume, these invited contributions are marked as "Character Symposium," "Human Symposium," and "Bridging Symposium," respectively.

(2) Contributed papers, arranged in thematic focus sessions, and

(3) Contributed posters (marked as "poster" in this volume).

All abstracts are arranged in alphabetical order by first author. For an index of all authors, see the back of the volume (pp. 370-376).

The presentation topics span the breadth of today's research fields and methods in the study of mollusks: from taxonomy to phylogenetic systematics exploring patterns and processes of evolution, from life histories to ecology and behavior, from morphological to molecular to digital photographic techniques, and from pure research to applied science to collection management. The phenomenal diversity (and often threatened status) of mollusks is illustrated by a number of formal biodiversity surveys as well as by the wide range of taxa featured – marine, land and freshwater; all major classes; Paleozoic to Recent. The international nature of this congress is well reflected by the 546 authors of this volume, representing 49 countries, and (in spite of the American venue) by the fact that nearly 70% of first authors are from non-U.S. institutions.

Abstracts, World Congress of Malacology, Washington, D. C., 1998
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The *Caecum pulchellum* Stimpson, 1851, problem

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Caecum pulchellum Stimpson, 1851 (Gastropoda: Caecidae), has the widest geographic range of other western Atlantic species of the genus. It occurs between 41°N and 34°S. And yet there seems to be no consensus as to what *C. pulchellum* really is, as it has been confused with *C. brasilicum* Folin, 1874, and/or *C. regulare* Carpenter, 1858. As happened with many other species described by Stimpson, the type of *C. pulchellum* was destroyed in the 1871 Chicago fire, thus it becomes necessary to create a neotype to stabilize the taxonomy of this species. According to the ICZN, the neotype should preferably be from, or from as near as possible, the type locality (in this case New Bedford, New England). Thus after examining the lot ANSP 315732 collected at Woods Hole, Massachusetts, with more than 100 shells, we considered it a good base for the selection of the neotype, due to the concordance of this material with Stimpson's original description and illustrations. [poster]

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The subgenus *Brochina* (*Caecum*, Caecidae, Mesogastropoda) from Brazil and some type species from the western Atlantic

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Conchological analysis reveals the existence of eight species belonging to the subgenus *Brochina* in Brazilian waters: *Caecum achironum, C. someri, C. circumvolutum, C. multicostatum and C. strigosum*, all of Folin, 1867; *C. antillarum* Carpenter, 1857; *C. marmoratum* Folin, 1870, and *C. lineicinctum* Folin, 1879, the latter for the first time assigned to Brazil. These eight species are discussed according to their synonyms. There are also illustrations (SEM) of types of the following species: *C. venosum* and *C. subvolutum*, both of Folin, 1867; *C. striatum* Folin, 1868; *C. vestitum, C. carmenensis*, and *C. veracruzianum*, all of Folin, 1870; *C. subornatum* and *C. limpidum*, both of Folin, 1874; *C. heladum* Olsson & Harbison, 1953; and *C. marmoratum* Folin, 1870 (= type of *C. butoti* De Jong & Coomans, 1988, as designated neotype following destruction of original type during SEM photographic procedure). [poster]

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The *Turbonilla* types deposited in the malacological collection of the Academy of Natural Sciences of Philadelphia

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Twenty-six types of the genus *Turbonilla* (Gastropoda: Pyramidellidae) deposited at the malacological collection of the Academy of Natural Sciences of Philadelphia are studied in a conchological basis and, for the first time, illustrated by scanning electron Micrographs: *T. abrupta, T. asperula, T. atypha, T. compsa, T. conradi, T. dalli, T. heilprini, T. hemphili, T. incisa, T. incisa constricta, T. inclinata, T. penistoni, T. pilsbryi, T. pupoides ischna, T. pyrrha, T. rushii, T. stimpsoni, T. swiftii,* and *T. unilirata*, all of Bush, 1899; *T. alfredi* Abbott, 1958; *T. dispar* and *T. uruguayensis*, both of Pilsbry, 1897; *T. haycocki* and *T. peilei*, both of Dall & Bartsch, 1911; *T. jaumei* Aguayo, 1934; *T. krebsii* (Mörch, 1875); *T. nivea* (Stimpson, 1851); and *T. stricta* Verrill, 1873. We refuse the synonymy between *T. abrupta* and *T. levis* (C. B. Adams, 1850) proposed by Jong & Coomans (1988), and the synonymies among *T. hemphilli, T. abrupta, T. heilprini, T. penistoni*, and *T. unilirata* proposed by Wise (1996). The varieties *T. pupoides ischna* and *T. incisa constricta* do not show enough characters to be considered valid taxa, so we propose them to be junior synonyms of *T. pupoides* Orbigny, 1840, and *T. incisa*, respectively. We also propose that *T. penistoni, T. inclinata*, and *T. swiftii* be considered as the same species, for which we suggest the maintenance of the name *T. penistoni*, and that *T. peilei* and *T. krebsii* be considered as senior synonyms of, respectively, *T. alfredi* and *T. jaumei*. [poster]

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Genetic confirmation of the presence of two species of *Crassostrea* (Bivalvia: Ostreidae) on the coast of Brazil

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Identification of oyster species living on rock and mangrove communities on the coast of Brazil has been a controversial matter. The two binomials *Crassostrea rhizophorae* (Guilding, 1828) and *C. brasiliana* (Lamarck, 1819) have been used indiscriminately. However, differences in growth rates and larval proportions between the two morphs of *Crassostrea* (intertidal and subtidal) indicate that the two might be distinct biological species. It is important, thus, to ascertain their specific status using characters that could verify whether the two putative species were interbreeding in the field. Molecular methods provide the ideal data set for this type of problem, because of their independence from the morphological characters that originated the dispute. In this paper we study, by allozyme electrophoresis, sympatric and allopatric populations of *C. cf. rhizophorae* and *C. cf. brasiliana*, to estimate their levels of gene variation and population structure, and to verify whether they are reproductively isolated. Four populations of *Crassostrea* from intertidal and subtidal regions along the southern Brazilian coast were studied. Genotype frequencies were used to estimate gene frequencies, heterozygosities, unbiased gene identities, and inbreeding indices. Twelve enzyme systems were analyzed and 15 loci resolved, of which 6 were diagnostic for each species even where they occurred in sympatry Genetic identity levels were high between populations of *C. rhizophorae* (0.990-0.999), but very low between those and *C. brasiliana* (0.276-0.297). This clearly demonstrates that they are reproductively isolated and belong, therefore, to different biological species. [poster]

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Larval development of the Brazilian oyster *Crassostrea brasiliana* (Lamarck, 1819)

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The Brazilian oyster *Crassostrea brasiliana* (Lamarck, 1819) (Bivalvia: Ostreidae) is a dominant estuarine benthic species of the Paraná littoral (southern Brazil) and an important economic fisheries resource. In this paper we describe its larval cycle, from fertilization to metamorphosis, in controlled conditions of temperature, food, and water quality. Growth rates and allometry of growth were calculated. The larval development is typical of bivalve species (blastula, gastrula, trochophore, D-veliger, umbo-veliger, pediveliger), with fast growing larvae, completing an entire cycle in 30 days, at 25°C and salinity of 28‰. Descriptions of significant morphological features and the growth pattern of early ontogenic stages permits the discrimination between larvae of closely related species, as is the case of *C. rhizophorae* (Guilding, 1828) and *C. brasiliana*, co-occuring oyster species on the Brazilian coast. The summary description of the morphology of larval shell of *C. brasiliana* presented should contribute to the identification of oyster larvae collected in plankton samples. [poster]

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Mollusks of Baikal-Lena Nature Reserve (northern Baikal)

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The authors studied a high-mountain lake near the mouth of Lena River, a small shallow bay of Pokoiniki Cape and the 20.5 km of open Baikal from Pokoiniki Cape up to Bolshoi Soloncovy Cape. 35 Baikal endemic species, including 32 gastropods and 3 bivalves, were found at depths from 1.5 to 137 m in open Baikal. The species diversity is higher (34 species) at depths to 40 m than within the zone 45-137 m (9 species). At a depth of 116 m the authors found *Pseudancylastrum frolichae* Sitn. *et al.* (Acroloxidae), early described from the regional thermal water outlet at depths of 360-420 m in Frolikha Bay (northeastern part of Baikal). The occurence of this species at depths that are not typical for all other species of Baikal Acroloxidae (23 species), dwelling in the zone from 3 to 36 m deep and beyond the vent, shows that *P. frolichae* is not a common inhabitant of the thermal water outlet region. 5 species (3 endemic and 2 Siberian) were encountered at the intersection (depth 0.9 m) separating open Baikal from the bay at Pokoiniki Cape. Only lymnaeids and bivalves inhabit the bay, which is 0.16 km² in area and 5 m deep, with sandy grounds with a lot of detritus. The high-mountain Lake Izumrudnoe is of karst origin. Its area is 0.04 km², depth not more than 2 m, and the ground is pebble-sandy with detritus. 3 Siberian species were found there.
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Mollusks, memory, and molecules: conserved principles of brain function

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Pavlovian conditioning of humans and other mammals fulfill defining criteria that are remarkably similar to those demonstrated for the visual-vestibular conditioning of the marine snail *Hermissenda*. This surprising conservation of behavioral associative learning from mollusk to human suggests conservation of underlying network, membrane, and molecular mechanisms responsible for memory storage. Our NINDS laboratory (LAS) has accumulated data that implicate molecular and biophysical mechanisms that are conserved in molluscan and mammalian species and thus could have relevance for human learning and memory. Cellular analyses of behavioral associative memory in the snail *Hermissenda* (Pavlovian/classical conditioning), the rabbit (classical conditioning), and the rat (spatial maze learning, olfactory discrimination) revealed a cascade of cellular and subcellular events during memory formation. These events include: elevation of intracellular calcium and diacylglycerol (DAG); translocation of PKC; PKC-mediated phosphorylation of the Ca^{2+} and GTP-binding protein, cp20 (calexcitin); inactivation of voltage-dependent K^+ channels; prolonged activation of the ryanodine receptor; learning-specific regulation of gene transcription; and rearrangement of synaptic terminal branches. Such conservation across species suggests that these associative memory mechanisms may provide targets of dysfunction in Alzheimer's disease. In fact, LAS scientists have revealed Alzheimer's-specific defects in K^+ channels, IP3-mediated release of calcium, and metabolism of the signaling protein, cp20 (calexcitin). Theoretical constructs based on conserved principles derived from brain-based memory networks have also been mathematically described. [Human Symposium]

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Molluscan biodiversity and conservation in the western Mediterranean

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The complex geological history of the western Mediterranean enhanced a remarkable diversification of terrestrial and freshwater mollusks. It has also caused the marine fauna to be a filtered admixture of boreal and tropical elements, with a small characteristic endemic component. Molluscan diversity study has immediate consequences for conservation in a region where unprecedented human-induced changes are occurring. Freshwater mollusks exhibit a pattern of restricted-range endemism, and increased demand for water supplies is leading most to extinction. Melanopsids, unionoids, and hydrobiids provide striking examples of endangered biodiversity. Large-scale sampling in the river Ebro has allowed evaluation of threatened populations. Conservation action has been started by setting small nature reserves and recovery plans for some species. Land snails comprise a large number of wild taxa with very small ranges. Geographical heterogeneity accounts for large diversities on continental areas, and isolation has yielded extreme diversification on islands. In contrast with vertebrates (and mollusks in other regions), but in accordance with plants, the insular molluscan faunas appear to have suffered no extinctions due to human colonization. However, current transformations on a landscape level threaten a large number of species. Marine mollusks are still insufficiently known, especially in deep-sea areas. Yet, it is clear that some species are threatened, either by overcollecting or through habitat destruction. The expansion of fisheries and pollution results in generalization of human influence and the need for documenting biodiversity and promoting its conservation.

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Phylogeny and biogeography of the loliginid squids based on morphology, allozymes, and DNA sequence data

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The cephalopod taxon Loliginidae is a species-rich group of tropical and temperate neritic squids, many of which are important fisheries objects and neurophysiological research organisms. Despite this, evolutionary relationships among these squids are poorly understood. To investigate loliginid phylogeny, three data sets were gathered: allozyme data for eight loliginid species (from the literature), DNA sequence data from two mitochondrial genes (16S and COI) for nineteen species, and morphological data for most described species. Maximum likelihood analyses were performed on a 16S + COI data set and on each molecular data set individually. Various combinations of the DNA, morphology and allozyme data were analyzed under three parsimony weighting schemes: equal weights, successive approximations, and "implicit weights" parsimony. Analyses that take character reliability into account in some way (*i. e.*, maximum likelihood, successive approximations, and implicit weights parsimony) result in very similar trees, in which three major loliginid clades are found: *Sepioteuthis* (occupying a basal position within Loliginidae), a clade consisting of all loliginids sampled from American waters, and a clade consisting of three east Atlantic species (*Loligo forbesi, L. vulgaris,* and *L. reynaudi*, and possibly two *Lolliguncula* species and *Alloteuthis*) and several Indo-West Pacific species. Cladogenesis within Loliginidae may be correlated with the widening of the Atlantic and the closure of Tethys, but additional analyses are required to reach more firm conclusions.

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Geographic and temporal body-size trends in Neogene corbulid bivalves of tropical America: a potential link to changes in productivity

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Speciation, extinction, and morphologic (especially body size) trends have been documented in several groups of marine invertebrates, including mollusks, in the Neogene of tropical America. Potential causes of these faunal trends include changes in productivity, glacial cooling, and predation intensity. Differential extinction of species in several genera and subgenera of corbulid bivalves has caused parallel, although not strictly coincident geographic and temporal trends in body size within this group. Taxa affected include groups endemic to tropical America (*Bothrocorbula* and *Hexacorbula*) and groups with wider geographic and geologic ranges (*Caryocorbula* and *Varicorbula*). Species with large body sizes (> 15 mm length) occur throughout the Neogene and persist to the present in the tropical eastern Pacific. Large-bodied species are present in the Caribbean and western Atlantic from at least the Early Miocene but are not living in this region today. Preliminary results of growth analyses of corbulid valves indicate that larger species grew more quickly than smaller species. Although geographic and temporal patterns of extinction are complex, the loss of large corbulids from the Caribbean and western Atlantic is best explained by a general decrease in nutrient upwelling and productivity in this region associated with oceanographic changes engendered by the emergence of the Central American isthmus.

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Beer bottles on the sea floor: trash, dens and research opportunities

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Den middens of octopuses have been used to determine their diet but middens have not been reported for the red octopus *Octopus rubescens* Berry, 1953, and its diet in the wild has been poorly studied. To determine its diet, *O. rubescens* were collected in beer bottle dens determined to be aged by their coating of barnacles. The octopuses were evicted from the bottles for measurement, and released. The shell contents of the bottles were then sieved, identified, and compared to those from bottles not containing octopuses. In addition, new brown beer bottles painted black were placed on the bottom for 60 days, and the contents of occupied bottles were compared to those from unoccupied bottles. The contents of the bottles were significantly different. We determined what the population of *O. rubescens* was in a limited area and what the octopuses were eating. Beer bottle trash on the sea floor bottom can be a major non-polluting den resource for *O. rubescens* and a valuable tool for aiding diet analysis where not otherwise possible.

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Anatomy of the Duplin Fauna: species diversity at the Pliocene thermal maximum in the Carolinas

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Molluscan species diversity from the thermal maximum (3.2-3.0 ma) in the Carolinas was developed from 8 papers and 3 collections. Early surveys from Hodge (1841) to Dall (1890-1903) included large taxa dominated by 56% bivalves. Subsequent studies increased bivalves 35% and gastropods 238%, averaging 16.6 new records/100 spp./faunule. The Locklin Natural Well collection (Florida Museum of Natural History, 362 spp.) provided an external test of census closure. Instead, this collection added 9 bivalves and 46 gastropods toward a total of 553 taxa. Therefore the Duplin fauna should exceed 650 taxa before leveling asymptotically. Rarefaction measures census completeness within a faunule if the samples were equitable. Filter-feeding bivalves were an order of magnitude more abundant than predatory gastropods. Doubling body volume approximated a change of niche, and 24 doublings separated *Skenea* (1 mm) from *Busycon* (20 cm = 6 million *Skenea* in biomass). The Timmonsville (SC) faunule provided quantitative data for the >12.7 and >6.3 mm fractions and presence-absence for smaller species. 28 liters of wet-screened sediment yielded 1.5 l coarse and 0.8 l fine shell concentrate. Coarse samples averaged 650 bivalves (30 spp.) and 37 gastropods (15 spp.). For larger bivalves, 3-liter samples achieved 90% commonality. Fine samples averaged 1,350 bivalves (50 spp.) and 100 gastropods (35 spp.). Coarse/fine bivalve rarefaction began leveling after 3,000 specimens, but gastropods continued climbing after 30 samples. Documentation of the Duplin fauna provides important information for evolutionary rates, Pliocene extinctions, and zoogeography. [poster]

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Sarmatian archaeogastropods of the Ukraine: current data on fauna

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The Sarmatian is very important for understanding the Miocene development of the European molluscan fauna. On the basis of collection materials and analysis of many publications devoted to the history of the Sarmatian malacofauna, the archaeogastropods of this basin are briefly reviewed. In the history of the Sarmatian basin and its fauna, three stages were precisely allocated: Early, Middle, and Late. Among the Early Sarmatian mollusks, are: *Acmaea incognita, A. laevigata, A. pseudolaevigata, Diodora graeca, Gibbula buchi, G. affinis, G. sarmates, G. picta, G. angulata, "Trochus" albomaculatus, "T." subbalatro, "T." podolicoformis, Calliostoma angulatosarmates, Theodoxus picta*, and others. The complexes of Middle Sarmatian archaeogastropods are considerably distinguished by structure and origin. The marine relicts have almost completely disappeared. Some species were preserved only in some separate areas. Numerous new endemic species have been noted (with new species estimated *ca.* 60%): *Acmaea angulata, A. sinzowi, "Trochus" podolicus, "T." rollandianus, "T." insperatus, "T." sulcatopodolicus, "T." marginatosinzowi, "T." bessarabicus, Calliostoma sarmates, Squamatisolariella squamosospinosa, S. mediana, S. sinzovi, Sinzowia striatotuberculata, Kishinewia bessarabica, Barbotella omaliussii, B. grossocostata*, and other acmaeids and trochids (*ca.* 70 species). A strong reduction of salinity in the Late Sarmatian basin resulted in a nearly complete die-off of this rich endemic malacofauna. There are only a few Late Sarmatian archaeogastropods which could be named *Theodoxus* spp. At the end of the Late Sarmatian, all mollusks of marine origin had disappeared.

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The subfossil continental snails of the "Los Canes" cave (Asturias, Spain)

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The "Los Canes" cave was excavated from 1985 to 1990 by Arias and Pérez (1992) who documented this Upper Palaeolithic to Neolithic human occupational site with three funerary Mesolithic structures. In this small cave (approximate dimensions 7 x 2 m), we found a high quantity of continental malacological remains. Twenty-seven snail species have been recognized, 24 land gastropods and 3 freshwater ones. The minimum number of individuals (MNI) estimated is 11,574. The species that show the higher numbers of specimens are, in this order, *Pomatias elegans*, *Cepaea nemoralis*, and *Cochlostoma* sp. *Cepaea nemoralis* is the only species that might have been used by humans as food and this is why we suggest its anthropic origin in the cave. The remaining accumulation of the other land snails in the site would be natural, as they might live in caves and so might be favored by the organic detritus present in the cave. The species assemblage found in the site is similar to the present gastropod fauna that lives in this region today. However, *Helix aspersa* does not appear in the cave. The biodiversity analysis of the molluscan species, as well as the number of individuals in each taxa, suggest milder climatic conditions in this region during the early Holocene to Mesolithic transition and in the Neolithic period. [poster]

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Some observations on the gonads of the hermaphroditic "heart-shell" *Trachycardium muricatum* (Bivalvia: Cardiidae)

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The state of Santa Catarina, located in the southern region of Brazil, is considered the largest producer of bivalve mollusks of the country. There, activities of cultivation of brown mussels (*Perna perna*) and Japanese oysters (*Crassostrea gigas*), as well as the sustainable handling of shellfish (*Anomalocardia brasiliana*) are being developed. *Trachycardium muricatum* occurs from North Carolina to Florida, Texas, West Indies, Suriname, Brazil, and as far as the San Marcos Gulf, in Argentina. Despite this broad distribution, little work has been done with this species, none related to the reproductive aspects. In this paper, we describe the histology of the reproductive acini of *T. muricatum*, and discuss the possibility of it being a simultaneous hermaphroditic species. The animals were collected in August 1997, at the Tapera beach region, located in the western region of Santa Catarina Island, southern Brazil (48°35'W, 27°45'S). The gonadal tissue is adjacent to the visceral mass. Acini are attached by conective tissue and are disposed around the intestinal channels, digestive gland, and muscles. Male acini lay beside the female ones, both with morphologically mature gametes, indicating a possible case of simultaneous hermaphroditism, according to literature. [Supported by CNPq, FNMA-MMA].

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A comparison of four new deep-sea species in a new aplacophoran genus (Neomeniomorpha: Simrothiellidae) with a biogeographic overview

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Species in a new aplacophoran genus (Neomeniomorpha; Simrothiellidae) have been identified from localities throughout the Atlantic at depths between 1,600 and 4,100 m. This genus is distinguished by the possession of captate spicules and small denticles flanking the lateral radular butress. The genus is placed in the family Simrothiellidae Salvini-Plawen, 1978, based on radula morphology, specifically, possession of distichous bars with many denticles at some point during ontogeny and paired anteroventral radular pockets. Morphologies of the radulae and spicules suggest that species from the southern Atlantic basins are more closely related to each other than either is to the northern Atlantic species.
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A comparison of four new deep-sea species in a new aplacophoran genus (Neomeniomorpha: Simrothiellidae) with a phylogenetic analysis, utilizing internal and external morphological characteristics, of the genera in the family Simrothiellidae

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There are presently 10 genera in the aplacophoran family Simrothiellidae, including a new deep-sea genus with four new species. This new genus is distinguished by the possession of captate spicules and denticles flanking the lateral radular buttress. The four new species were collected from distinct basins throughout the Atlantic Ocean. The southern Atlantic species are morphologically more similar to each other than either is to the northern Atlantic species. A phylogenetic analysis of the 10 genera of Simrothiellidae suggests that this family is not of monophyletic origin. This is the first phylogenetic analysis, based on morphology, for any aplacophoran taxa and elucidates systematic relationships within the subclass Neomeniomorpha.

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Reciprocal copulation prevents interchiral mating in hermaphroditic snails

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Bimodal shell shapes are associated with discrete mating types in simultaneously hermaphroditic pulmonates. Low-spired (flat or globular) species mate reciprocally facing each other. However, high-spired (tall) species mate non-reciprocally, a male-acting partner mounting the shell of a female-acting partner. Thus, for interchiral copulation, the dichotomous types of snails are required to achieve contrasting modifications of mating behavior. In flat/globular snails, either (but not both) partner has to reverse the entire body orientation so as to match the genitalia. However, tall snails could align their genitalia by moving the heads keeping nearly ordinary orientation. Therefore, interchiral mating would be more difficult in flat/globular snails, resulting stronger frequency-dependent selection against the chiral minority. Asami *et al.* (in press, *Am. Nat.* 151) have verified a prediction of this hypothesis that the chiral evolution rate is higher in tall groups. Although copulation failures between chirally opposite snails have been reported in reciprocally mating species, no proper test of relative mating success has been done with adequate replicates compared to intrachiral pairs of dextrals and of sinistrals. We demonstrated that genetically sinistral variants of reciprocally mating *Bradybaena similaris* can normally reproduce with sinistrals but not with ordinary dextrals. Copulation failure of interchiral pairs was significantly more frequent than in non-reciprocal mating of *Partula suturalis*.

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The importance of microstructure on shell strength in an intertidal snail, *Nucella lapillus*

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Shell strength varies considerably among conspecific intertidal gastropods and often represents a response to variation in predation pressure. Predation typically selects for stronger thicker shells. I examine whether differences in strength of thick- and thin-morphed shells of *Nucella lapillus* (Gastropoda: Muricidae) reflect differences in microstructure. In addition to increasing thickness, shells can be reinforced by altering the ratios of the microstructure layers which differ in strength. *N. lapillus* is a common intertidal predatory gastropod that exhibits considerable variation in shell strength and morphology among shores differentially exposed to predators. Snails were collected from 3 exposed and 3 protected shores between Kittery Point, Maine, and Nahant, Massachusetts. The force required to break each shell was measured by a crushing apparatus with an associated computer program that records the crushing strength. An image analysis system was used to measure the two miscrostructural layers on shell fragments. Preliminary results indicate that differences in the thickness of the inner shell layer (crossed-lamellar structure) may partially account for variation in strength.

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The shallow-water Rissoidae of the Azores

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Few works have been made on the marine malacofauna of the Azores and most of them have dealt with taxonomy and systematics. In this paper, the Rissoidae gastropod assemblages associated with heterogeneous algae settlements in a rocky shore of the northern coast of São Miguel Island, Azores, are described. Aspects of community structure (species composition, abundance, and zonation) were studied and multispecies analysis were conducted with both clustering and ordination techniques. A critical review about the distribution of the Rissoidae species by the islands of the Azorean archipelago is also made, based on bibliographic data as well as in the samples collected and sorted by the author.

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Ecological and zoogeographical comparative study of sand dunes in the Danube-Tisza Valley, Hungary, and Belgium-Holland

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Successional snail assemblages in two climatically different calcareous sand dune-lands were compared. Sampling was done at 46 sites in Belgium (Antenius 1956) and 20 sites in Holland (Bába), both with an oceanic (Atlantic) climate, and at 47 sites in the continental Danube-Tisza Valley. Altogether 6,987 individuals of 39 species were found in Belgium and Holland, and a total of 4,060 specimens belonging to 36 species in Hungary. The length of vegetation successional series was 5 and 3 in the two areas, respectively. For comparison, the following classifications were used: habitat types (Lozek, 1964; Falkner, 1990), nutritional types (Fromming, 1954; Kerney, *et al.*, 1983), and area-analytical classification (Ant, 1963; Bába, 1982). Statistical tests found the snail faunas homogeneous at the $p < 0.001$ level. Species number and abundance increased from east to west. Habitat types were present in similar proportions in the two areas, with steppe dwellers (St) and forest dwellers (HF) changing reciprocally. For nutritional types, the omnivore (O) and herbivore (H) groups changed in a complementary way. The climatic influence was reflected in the dominance of subatlantic faunal groups close to the ocean. Among continental elements, the East-Siberian and Holarctic classes were similarly dominant in both regions. The Atlanto-Mediterranean and Illyric-Moesian groups dominated at the seashore, while Holomediterranean and Tracian fauna elements in the continental area. [poster]

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Feeding selectivity of zebra mussels and its role in changing the Hudson River ecosystem

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Bivalve mollusks can have profound effects on the ecosystems in which they live. Zebra mussels (*Dreissena polymorpha*; Bivalvia: Dreissenidae) invaded North America in the 1980s and have severely lowered phytoplankton stocks and increased water clarity. Their invasion of the Hudson River in 1989 has dramatically changed the phytoplankton species composition and total abundance: dominant blue-greens have disappeared, diatoms now dominate, and phytoplankton standing stocks have declined profoundly, while turbidity has remained high. We examined the feeding rate and feeding selectivity of zebra mussels using standard techniques as well as flow cytometry. We have found that (1) zebra mussels prefer the formerly dominant blue-green species that has disappeared from the river, (2) zebra mussels feed selectively on blue-green algae and smaller greens, generally excluding large greens and diatoms, and (3) biodeposits (feces and pseudofeces) of inert particles (clay) and diatoms are easily resuspended. Our results indicate that the interaction of selective feeding by zebra mussels and the resuspension of biodeposits by tidal mixing may explain the differential decline in phytoplankton groups that has occurred in the Hudson River.

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Interpopulational variation in spermathecal morphology and amount of sperm stored in the simultaneously hermaphroditic land snail *Arianta arbustorum* (L.) (Gastropoda: Pulmonata)

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In a variety of invertebrate species with multiple mating and sperm storage, the morphological structure of the sperm storage organ (spermatheca) is important for the outcome of sperm competition. Simultaneously hermaphroditic pulmonates show a considerable interspecific variation in the structure of the spermatheca. We examined the morphological variation of the spermatheca (number of spermathecal tubules, tubule length) and the amount of sperm stored in the tubules in 115 individuals of the land snail *Arianta arbustorum* from six natural populations in the eastern Alps (Austria). The populations differed in density of potential mating partners (range: 0.9-39.8 individuals/m^2) and thus in the risk of sperm competition. The number of spermathecal tubules ranged from 2 to 9. However, the populations differed neither in the mean number of spermathecal tubules nor in the total length of the tubules. The number of tubules and tubule length were neither correlated with shell size nor with population density. Individuals from different populations did not differ in the amount of sperm stored (determined using a semi-quantitative method). Furthermore, the amount of sperm stored was not correlated with local population density. This indicates that the potential risk of sperm competition does not affect the complexity of the spermatheca in *A. arbustorum*. However, the possibility that individuals in high-density populations store sperm from more different mating partners than those in low-density populations should be examined.

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The early ontogenetic shell as tool to understand gastropod evolution

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Archaeogastropoda tort their body during embryogenesis and mechanically spiralize their embryonic primary shell before the onset of benthic life. Within the Mimospirina, the large smooth protoconch indicates a non-plankotrophic development as well. The Amphigastropoda (Bellerophontida), in contrast, could develop a planktotrophic larva that carried a bilaterally symmetrical shell, as did the adult. The ancestors of the three modern subclasses Neritimorpha, Heterostropha, and Caenogastropoda evolved planktotrophic larvae that secreted shell during their growth and carried out spiralization of the shell during or after metamorphosis to benthic life. Only during Devonian time, spiralization of the shell took hold of the larval and embryonic portions of the shell. The Neritimorpha preserved the non-spiralized embryonic shell while the coiling of the larval shell is very tight. Internal wall dissolution gave rise to the Neritoidea and their terrestrial relatives by Triassic time. The Euomphalomorpha with large cyrtoconic protoconch and similar shell structure have very large openly coiled protoconchs. Within the Heterostropha the Allogastropoda gave rise to species of *Cylindrobullina*-like shape from which Opisthobranchia as well as Pulmonata may have developed. In contrast to the Caenogastropoda the spiralization of the protoconch in Heterostropha was sinistral. In the Caenogastropoda the embryonic shell is well differentiated from the larval shell in regard to shape and ornament and there may have been several lineages leading from Peruneloidea-like Silurian and Devonian forms to several independent groups. [Bridging Symposium]

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Biodiversity of the western Palaearctic region as exemplified by continental Mollusca

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The CLECOM Working Group is preparing a fully digitalized checklist of the non-marine Mollusca (including synonymy) of the western Palaearctic region. The territory covered is Europe *s. l.*, including the western former Soviet Union to the Ural Mountains, Crimea, Caucasus, Turkey, and the Atlantic islands (Macaronesia). According to present knowledge ~3,600 non-marine molluscan (sub)species live here (16,000+ names are available). The estimated world fauna is 35,000 terrestrial and 5,000 freshwater species. Consequently, the western Palaearctic region harbors with respect to continental mollusks some 10% of the world fauna. This number is quite high: *e. g.*, from North America some 1,000 continental mollusks are reported, from Australia 1,600 (both areas are comparable in size). Diversity in the western Palaearctic is not randomly distributed, but concentrated to certain countries bordering the Mediterranean (Italy: 600 taxa, 300 endemic; Greece: 825 taxa, 625 endemic; Albania and former Yugoslavia: 975 taxa, 625 endemic; Turkey: 540 taxa, 300 endemic), the Atlantic islands (600 taxa, 450 endemic), and the Caucasus. Much of Russia, Scandinavia, and (north)eastern Europe have comparatively depauperate faunas. The highest species diversity for a given area is in the Atlantic islands: more than 600 (sub)species in 10,400 km^2. The Madeiran Archipelago is by far the richest of the Atlantic islands: 270 taxa in 800 km^2 (endemism 75%).

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Species boundaries within Lucinidae (Bivalvia): application of morphometric and molecular analyses

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Characters traditionally used in bivalve taxonomy are based on shell morphology. Species descriptions for some bivalves belonging to the family Lucinidae, based on shell characters, include high levels of morphological plasticity. Discriminant function analysis using shell characters, allozyme analysis, and mtDNA sequence analysis of lucinid clams from the Caribbean and Bermuda suggest that *Codakia* (= *Ctena*) *orbiculata* (Montagu) encompasses at least five biological species.

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Morphometrics and chromatophore arrangement of a new type of *Loligo* sp. hatchling from Patagonian coastal waters

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Two loliginid cephalopods are present in the coastal waters of northern Argentine Patagonia, *Loligo sanpaulensis* and *L. gahi*. A survey has been carried out since March 1996 in search for both species egg masses and hatchling paralarvae. One type of paralarva was obtained from egg masses periodically found over a period of more than 20 months, and depicted in a previous communication (CIAC '97). In March 1998, a new type of paralarva hatched from egg masses obtained in Golfo Nuevo (42°46'S, 65°02'W) after 5 days of incubation in an aquarium (temperature = 19°C). Average dimensions and chromatophore counts, characterized from a sample of 30 individuals, were: mantle length (ML) = 1.6 mm (s = 0.06); arm formula = 3.2=4.1; head length (HL) = 0.8 mm (s = 0.06); fin length (FL) = 0.4 mm (s = 0.03); ventral head chromatophores (VHCr) = 19 (s = 0.80, mode = 19), "cheek patches" including two red chromatophores; ventral mantle chromatophores (VMCr) = 38 (s = 3.9, mode = 38), yellow ones aligned in single vertical rows of 3 or 4 at both margins, red ones aligned in 6 or 7 horizontal rows (more or less regular) occupying the central part; dorsal head chromatophores (DHCr) = 7.3 (s = 0.95, mode = 8), all yellow, dorsal mantle chromatophores (DMCr) = 3.3 (s = 0.55, mode = 3) all yellow, and total chromatophores (TCr) = 68 (s = 3.51, mode = 68). Arms I, II, and III showed no chromatophores. At the same time and location of extraction of the egg masses, adult specimens of *L. gahi* were fished by jigging, suggesting that these paralarvae could belong to this species. [poster]

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Anatomy of the nervous system and gonad of *Tellina petitiana* Orbigny, 1846 (Bivalvia: Tellinidae)

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A detailed description of the morphology and histology of the cerebropleural ganglia, pedal ganglion, visceropallial ganglion, commissures, connectives, nerves, sensory tentacles, and gonad of *Tellina petitiana* is given. Observations about the "perivisceral" ganglion are added. The nervous system of this species is similar to that of *Macoma balthica*. Visceral and pallial ganglia are fused together forming a single visceropallial ganglion (in *M. balthica* the visceral ganglia are fused together and the pallials are not). In some individuals, between the cerebropleuro-visceropallial connectives and the umbo, a "perivisceral" ganglion, similar to that of Teredinidae and Pholadidae, was detected. The ganglia of *T. petitiana* are histologically similar to those of Pectinidae (peripheral ganglionic cortex; core of neuropile region). *T. petitiana* has two pairs of anterior pallial nerves (dorsal and ventral), in contrast to *M. balthica* (one dorsal pair). The 6 nerves which innervate each siphon show a definite pattern, located at the level of the internal longitudinal musculature and separated from each other by 8 muscular fascicles. Except in the siphonal region, the sensory tentacles (long and short) are distributed around the middle fold of the free mantle margin. Statoreceptors were not detected. The gonad of *T. petitiana* is of the "diffuse gland" type and is only evident during sexual maturity. The species is dioecius and sexing is not possible without histology. [poster]

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Morphometry of *Loligo gahi* and *L. sanpaulensis* from northern Patagonia, Argentina

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Two loliginid cephalopods are present on the northern coast of Argentine Patagonia, *Loligo sanpaulensis* and *L. gahi*. Previous studies described morphometric characters that allow discrimination between adults, but a lack of information on juvenile morphometry still remains. Moreover, with few exceptions, no emphasis was placed on variation of these characters with size. Since the species status of sympatric *Loligo* juveniles is unclear, additional studies are necessary. This work compares the morphometry of the two species over a wide size range, including measurements of mantle length (ML), weight (W), fin length (FL), fin width (FW), head length (HL), head width (HW), nucal cartilage length (NCL), funnel cartilage length (FCL), tentacle length (TL), arm length (AL), tooth number of the largest sucker ring of the tentacle carpus (RTN), ring diameter of the largest sucker of the tentacle carpus (CSRD), ring diameter of the marginal sucker beside the largest sucker of the tentacle carpus (MSRD), width of the free rachis at the terminus of the marginal ribs (AFR), width of the gladius rachis at the junction of the vane (RW), greatest width of the gladius vane (GW), and associated indices. Additionally, discussion is provided on comparison between the morphometric projections of individuals of both species to "paralarval size" and the actual morphometry of the two types of *Loligo* paralarvae found in the area.

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Altitudinal variation in size and composition of eggs in natural populations of the land snail *Arianta arbustorum*

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Egg size and egg provisioning are crucial for the survival of offspring in invertebrates without postlaying egg care. I examined the effects of elevation and size of the mother on egg size and on nitrogen and carbon concentrations of eggs in eight populations of the land snail *Arianta arbustorum* over an altitudinal gradient from 370-2,340 m in Switzerland. The dry weight of single eggs ranged from 1.48-2.79 mg and decreased with increasing altitude. Adult snail size also decreased with increasing elevation as did clutch size and reproductive investment of mothers. When differences in parental shell size have been taken into account, correlations between altitude and egg size, clutch size and reproductive investment disappeared. Thus, the altitudinal decrease in egg size, clutch size, and reproductive investment was mainly due to smaller snail sizes at higher elevations. The nitrogen concentration of eggs ranged from 3.4-4.5% and decreased with increasing elevation. The altitudinal variation in nitrogen concentration of eggs cannot be explained by differences in snail size. The carbon concentration of eggs (range 31.1-33.1%) showed no altitudinal variation. I also examined separately the nitrogen and carbon concentrations of the egg shell and egg fluid. The nitrogen concentration of the egg shell ranged from 0.7-1.8% and was lower than that of the egg fluid (5.1-5.8%). Similarly, the carbon concentration of the egg shell was lower (20.2-22.8%) than that of the egg fluid (35.8-40.2%).

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Sperm competition in the simultaneously hermaphroditic land snail *Arianta arbustorum*

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Intraspecific variation in the proportion of offspring sired by the second mate with a individual is an aspect of sperm competition that has received little attention in gastropods. I examined the effects of delay between copulations (range 9-380 days) and size of sperm donor on sperm precedence in double-mated individuals of the simultaneously hermaphroditic land snail *Arianta arbustorum*. Using shell color as a genetic marker, paternity was analysed in 132 broods produced by 35 snails that had mated with two partners of different genotype. Sperm precedence (P2) was influenced by the time between the two matings when the mating delay exceeded 70 days (one reproductive season). P2 averaged 0.34 in the first brood of snails that mated twice within 70 days indicating first mate sperm precedence. In contrast, P2 averaged 0.76 in broods of snails that remated in the following season, indicating a decreased viability of sperm from the first mate. The size of sperm-donating individuals had no effect on the fertilization success of their sperm in the first brood produced after the second copulation. Analysis of long-term sperm utilization in 23 snails that laid 3-9 batches over two years revealed striking differences among individuals. Five snails (21.7%) exhibited first mate sperm precedence throughout, eight snails (34.8%) showed second mate sperm precedence throughout, whereas 10 snails (43.5%) exhibited sperm mixing in successive batches. It is suggested that the individual variation in sperm precedence in *A. arbustorum* may partly be due to differences in the amount of sperm transferred.

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An electrophoretic examination of the transition zone between two subspecies of *Rabdotus alternatus* (Gastropoda: Pulmonata) from Val Verde County, Texas

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There are two currently recognized subspecies of the land snail *Rabdotus alternatus* (Orthalicidae) found in the Rio Grande Valley of Texas and Mexico. *R. a. alternatus* is characterized by a white shell with brown streaks and is found on the coastal plains and the lower Rio Grande Valley, northwest to southeastern Val Verde County. *R. a. hesperius* exhibits a predominantly white shell and is found from above Presidio downstream to Val Verde County where it is proposed that these two subspecies integrate in a broad transition zone. This study was undertaken to determine the validity of the proposed hybrid zone between these two subspecies. Both subspecies, as well as specimens from Val Verde County were subjected to allozyme analysis by cellulose acetate electrophoresis. Data from 10 scorable loci were analyzed using the BIOSYS-1 computer program. Results indicate that two of the 10 loci do in fact support the premise that the Val Verde population is intermediate when compared to the southeastern and northwestern populations (or subspecies).

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Long-term changes in soft-bottom molluscan assemblages in the north-central Adriatic Sea

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In the framework of the project PRISMA 2, one of the main purposes was to demonstrate changes in the structure of molluscan communities, particularly in the last 50 years. Current results were compared with Vatova's data from the 1930s: samples were collected using a 0.1 m^2 Van Veen grab along 13 transects perpendicular to the shore, in Summer 1996 and 1997. A total of 132 different species were recorded, 95 more than in Vatova's samples (77 bivalves, 54 gastropods, 1 solenogaster), 6 of which were found with a percentage of abundance in the pooled sample over 1%: *Corbula gibba, Chamelea gallina, Mysella bidentata, Nucula nitidosa, Hyala vitrea,* and *Cylichna cylindracea*. Communities are clearly separated, as stressed by multidimensional techniques. Below the Po River Delta a large littoral *Corbula* community is found, followed offshore by a more diversified community on "relict sands." Moving southward the bathymetrics are more closely spaced, determining a regular succession of communities: a *Chamelea* community is found between 6 and 10 m depth, followed by *Corbula* at 15-30 m and by a very impoverished zone characterized by *Corbula* and *Hyala*. Present molluscan density and diversity distributions are more strongly influenced by the Po River outflows: a general sediment instability is stressed by the high occurrence of *Corbula*, which substituted the *Turritella* community, and a narrower distribution of *Chamelea*.

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Biological control of aquatic pest snails

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Snail outbreaks in reservoirs obstruct filters and increase parasite frequencies. I examined the ability of the carp *Myllopharyngodon piceus* to serve as a biological control agent of pest snails. To determine satiation points in the laboratory, fish were offered increasing numbers of snails. Fish of 20-50 g consumed 267 ± 10.47 *Physella acuta*/day; fish of 30-100 g consumed 18.6 ± 6.7 g (*ca.* 124 snails) of *Melanoides tuberculata*/day in 19°C, and 16.7 ± 7.6 g (*ca.* 111 snails) in 25°C. To determine whether *M. piceus* can reach snails buried into sand, I used frozen-defrozen *M. tuberculata* in lab experiments in which each fish was offered 100 snails/day. When the snails were not buried, *M. piceus* consumed 63.08% ± 4.06, when buried 0.5 cm deep, 54.55% ± 3.81, and when buried 2 cm deep, 52.53% ± 3.81 (not significant differences). To determine predation efficiency in the field I first experimented in a concrete pond, where snails cannot shelter. In presence of fish, snail densities declined to 79.13% ± 7.25 their initial density; in fish absence, they increased to 181.23% ± 9.19. Next, I experimented in a boulders pond, where snails can shelter. In the presence of fish, snail densities declined to 34.42% ± 5.66 their initial density; in their absence to 79.88% ± 12.32. In conclusion, *M. piceus* can remove considerable quantities of snails, over a considerable period of time. It can reach snails buried in sand and can reduce snail populations, even when snails can shelter among boulders.

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Studies on distribution of medically important freshwater gastropod species collected from some parts of southeastern Anatolia

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Many freshwater gastropods have medical and veterinary importance due to their roles as intermediate hosts of trematodes. Among these gastropods, the most important is *Bulinus truncatus* (Pulmonata: Bulinidae). *B. truncatus* in an intermediate host of human blood fluke (*Schistosoma haematobium*) which causes schistosomiasis. According to WHO reports, schistosomiasis is widespread in some Middle Eastern countries. Because of the existence of schistosomiasis, some studies were reported on the distribution of *B. truncatus* on the borders with Iraq and Syria (Özcel & Şeşen). Our aim was to extend the study to some part of southeast Anatolia. In the present study, the distribution of medically important freshwater gastropods was investigated and a map of distributional sites in the region is given.

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The ultrastructure of the eyes of Heteropoda (Gastropoda)

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Adult Heteropoda are active, pelagic carnivores. They are highly modified for life in the open sea. The morphological adaptations include a reduction of the shell with an increase of body size, the development of a single swimming fin, and the development of large eyes on the base of the proboscis. Ultrastructural studies of the adult eyes indicate that the retina is a long ribbon. This ribbon is only a few receptor cells wide and many hundreds of receptor cells long. In the present paper, the eyes of different larval stages of *Carinaria lamarcki* and the eyes of adults of *Atlanta peroni* are examined. The results show that in young larvae of *C. lamarcki* the retina is hemispherical. The photoreceptive cells are exclusively of the ciliary type. In old larvae, however, the retina is an irregularly shaped body and is composed of two types of photoreceptive cells: light-sensitive ciliary cells and presumed light-sensitive rhabdomeric cells. As opposed to young larvae the ultrastructure of the photoreceptive cilia is altered in old larvae. In adults of *A. peroni* to types of presumed light-sensitive cells are found likewise. Ciliary sensory cells occur only in the posterior area of the retina. The membrane of the cilia is folded into numerous cylindrical bodies. These membranous bodies are arranged in three parallel rows.

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Preliminary report on the biostratigraphy of Tertiary holoplanktonic mollusks in Hungary

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Nearly 20 species, assigned to 8 genera (*Limacina, Creseis, Praehyalocylis, Ireneia, Styliola, Clio, Diacrolinia, Vaginella*) have so far been recognized from 33 Eocene, 21 Oligocene, and 42 Miocene localities in Hungary. A number of contributions to biostratigraphy have been achieved despite the fact that the taxonomic study is still in progress. It is of particular importance that the nannoplankton, plankton foraminiferal, and magnetostratigraphic zonations are available for most of the boreholes yielding pteropods, which offers an excellent opportunity for a multidisciplinary approach in correlations. In Hungary, the first planktonic gastropods - *Limacina, Creseis, Praehyalocylis* - appeared some 43 Ma ago, in the NN16 nannozone, the *Morozovella lehneri* planktonic foraminiferal zone, and the C20n magnetic zone. The appearance of the genus *Clio* in the NP-16 nannozone is particularly noteworthy. Oligocene marine sediments (NP22-25) also contain a rich fauna of pteropods. Among other things, the mass occurence of *Limacina* (NP22), the occurrence of *Ireneia tenuistriata* (NP24) which is an index fossil for the pteropod zone 16 in NW Europe, and *Vaginella tricuspidata* (NP24-25) which is an important species of a correlation of Late Oligocene deposits in Europe, are noteworthy. Of pteropods in Miocene marine sediments (NN4-5), *Clio pedemontana, C. fallauxi*, and *Diacrolinia aurita* (Early Badenian), and *Vaginella austriaca* (Early and Middle Badenaian), are of importance for further classification of the Middle Miocene. The species mentioned above exhibit the same time range not only in Hungary but in the Central Paratethys as well.

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An investigation of inter-operator variability in hand searching for terrestrial macromollusks

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In comparing results from different places or times, operators are presumed to work with similar acuity. However, inter-operator comparisons are rarely undertaken in ecology. This could be especially significant in remotely administered projects where teams of searchers are being paid. In a study of inter-operator variability, four operators with different experience simultaneously hand-searched for terrestrial snails (> 2 mm long) for 20 minutes at each of ten different sites on a single day in southern England. 8-50 living snails were found per operator per search. Operators varied significantly in the number of species found, but not the sizes of mollusks found and there was no difference in capture rates of male and female operators. The most experienced operator (A), who was most familiar with the sites, found significantly more snails than the others. Living numbers varied significantly between operators, especially when snail numbers were high. For living snails, omission of operator A had no significant effect on this variation; inter-operator variation in dead snail shell numbers, however, was significantly reduced. The implication is that in some comparative studies, operators should be trained up to similar levels of competence on site; in some cases, it might even be worth omitting the most successful operators to improve replicability. Obviously, this would not be appropriate where the intention was to maximize measures of species richness.

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Mangareva: splendor and decline of a Pacific island land snail fauna

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East of the Tuamotus, the last high islands of Polynesia are stretched over immense expanses of deep ocean, meaning high levels of biological endemism. The Gambiers are an isolated group of small, volcanic islands, 6 MY old. Their total land area does not exceed 26 km², of which Mangareva, that peaks at 440 m altitude, occupies 60%. The Bishop Museum Mangareva Expedition visited the island group in 1934 and made extensive mollusk collections, revealing an extraordinary diversification of at least 34 native species of land snails, with an 85% level of endemism. Although Mangareva has miraculously been spared the introductions of *Achatina* and *Euglandina*, this malacological microcosm is gone. Back in 1934, the Mangareva Expedition reported the islands to be almost totally deforested and ravaged by goats and fire. They have since been reforested with exotics (Caribbean pines, Casuarina, Albizia). An endemic species of *Philonesia* still occupies a minuscule remnant of native forest, but the rest of this unique land snail fauna, notably an endemic radiation of 3 genera and 24 species of Endodontidae, is extinct. With a population that has probably never exceeded 2000 inhabitants, without cash crop plantations, even without tourism industry, remote Mangareva has seen the total destruction of its endemic biota and their replacement by introduced aliens. [Human Symposium]

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Olfactory organs of midwater cephalopods: is there a smelly adaptation for life with less light?

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In the deep-sea, light is a precious and limited resource and yet known visual predators, including cephalopods, are well represented in the murky depths. Are cephalopods relying on visual acuity alone or are other sensory stimuli increasingly important as light diminishes with depth? Chemical stimuli are likely sources for both intra- and interspecific communication, possibly providing information regarding food sources, mates and predators. There are three identified loci of potential chemoreception, which are common to all coleoid cephalopods. Receptor sites on the lips around the mouth and sites on the arm suckers have been shown to receive "taste" stimuli, effective when the receptors are actually in contact with the stimulus. The third locus is the olfactory organ, which is paired and laterally located on the posterio-ventral surface of the head. This organ is thought to receive "smell" stimuli, or monitor chemical signals from a distance. In *Loligo opalescens*, olfactory organ stimulation from squid ink and its precursors elicit escape jetting, thus sensitivity to conspecific's ink in response to a threat is thought to be important in this schooling species. However, schooling responses in solitary midwater species do not make sense, and so I hypothesize that there is an alternative function for this prominent structure in midwater forms. Using behavioral experiments, comparative morphology and ultrastructure, this work focuses on better understanding olfactory organ structure and function in midwater coleoid cephalopods.

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Structural damage to the epithelium of *Bulinus africanus* after exposure to a plant molluscicide

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Adult *Bulinus africanus* (Gastropoda: Pulmonata: Bulinidae) were exposed to sublethal and lethal concentrations of a crude aqueous extract of *Agave attenuata* leaves for a 24-hour period. Sublethal toxic effects included locomotory retardation, swelling of the cephalopedal mass and hemorrhagic blistering in the subepidermis of the foot sole. Lethal concentrations resulted in cessation of locomotion, severe swelling of the cephalopedal mass, increased mucus secretion, and hemorrhage. Light microscopy showed that the molluscicide had induced gross structural damage to the foot epithelium, especially at lethal concentrations. TEM revealed cellular injuries such as a reduction and degradation of cilia and the breakdown of the connective tissue and blood sinuses causing an accumulation of hemolymph below the epidermal layer. This resulted in partial basal detachment and distortion of the adjacent epidermal cells. Other molluscicide-induced cellular changes included the accumulation of electron dense vesicles in the cells' apical regions, the discharge of glycogen, lateral compression of the nuclei, slight contraction of the nuclear envelope, mitochondrial swelling, and disruption of the cristae. Exposure to lethal concentrations caused the complete disintegration of the epidermal layer, apparently exacerbating the cellular damage observed at sublethal levels. These data suggest that the active ingredients of *A. attenuata* alter the metabolism and physiology of the snails' tissues, particularly affecting osmoregulation.

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Molecular phylogeny of European Arionidae (Gastropoda: Pulmonata)

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The Arionidae is a widely distributed family of terrestrial slugs. In Europe and northern Africa, the family is represented by four genera, *viz. Letourneuxia*, *Geomalacus*, *Ariunculus*, and *Arion*. Despite the fact that some European arionids are very abundant and sometimes become pests, the taxonomy and phylogeny of these slugs are still poorly known. Nevertheless arionids provide interesting model organisms for the study of breeding systems (selfing versus outcrossing) and sexual conflicts in simultaneous hermaphrodites. In this context we started a phylogenetic analysis of European arionids with the aim to assess: (1) the monophyly and relationships of the four or five currently recognized subgenera of *Arion*, (2) the position of *Arion intermedius*, *A. lusitanicus* and *Carinarion* spp., and (3) the degree of differentiation of a number of enigmatic or poorly known species such as *A. wiktori*, *A. franciscoloi*, *A. euthymaenus*, *A. atripunctatus*, *Geomalacus malagensis*, and *Ariunculus* sp. The phylogenetic analysis is based on DNA sequence variation in a 500 bp fragment of the 18S rRNA and the complete ITS1 gene. The preliminary results of this work are presented and discussed. [poster]

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The value of histological characters for anatomical investigations of nudibranchs: a study of the family Dendrodoridídae

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Classification of the Dendrodoridídae and its relationship to the similarly radula-less Phyllidiidiidae is open to debate. Previous phylogenetic analyses have shown opposing results and been limited by a lack of valid characters. Such analyses are only as good as the characters on which they are based. There is a need to expand our search for better characters by using less traditional methodologies. Histological investigation of opisthobranch mollusks for taxonomic purposes is not well established, however the information it provides is essential for analyzing relationships, not only within the "Porostomata" but also within the Nudibranchia. Histological investigations, using methacrylate resin procedures, of the nudibranch family Dendrodoridídae have revealed considerably more information than previous investigations based on direct dissections alone. In *Dendrodoris nigra* for example, several character sets have been refined, particularly those relating to organs with glandular tissue. Previously utilized characters, such as those relating to the phyloric gland, have been abandoned. Similarly, current histological investigations of *Doriopsilla* will no doubt provide further insight into relationships between this genus and *Dendrodoris* and their respective positions within the Nudibranchia.

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Bacteria in the reproductive system of a tropical marine gastropod

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A vestibular gland is associated with the reproductive system in several families of nudibranchs, *i. e.*, Aegiridae, Doridiidae, Dendrodorididae, Chromodorididae, and Flabellinidae, but such glands are not currently considered to be homologous. While studying the functional anatomy and ultrastructure of the nudibranch *Dendrodoris nigra*, a very unusual structure was observed in histological sections of the vestibular gland of healthy, adult animals. Further investigation of this gland by transmission electron microscopy revealed the presence of large numbers of densely packed, bacillus bacteria. We are certain that these bacteria are not external contaminants but symbionts that are actively reproducing and are stored within the nudibranch for a functional purpose. Although the function of both the vestibular gland and these bacteria is unclear our discovery that these bacteria are also embedded within egg masses suggests several hypotheses: (1) that these bacteria play a role in the breakdown of the egg mass mucus coating, (2) that these bacteria are passed to the next generation, and (3) that these bacteria may be functioning as a nutritional source for larvae. Further studies are underway to classify the bacteria, determine if other nudibranchs with vestibular glands also contain such bacteria, and to investigate the role of these bacteria. [poster]

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Morphometrical studies of shell and genital characters of Austrian species of *Stagnicola* (Gastropoda: Pulmonata: Lymnaeidae)

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The genus *Stagnicola* is represented in Austrian waters by several species that are conchologically hard to separate. This study aims to evaluate shell morphometrics by characters of the reproductive tract. A total of 151 specimens from four localities (two in Lower Austria, one each in Vienna and Salzburg) were collected. Height and width of the shell and of the aperture were measured. From the genital system, the following parameters were recorded: length of the penis sheath and the preputium, the number of ridges in the prostate gland, and shape of the bursa copulatrix duct. In most cases, shell morphometrics including Principal Component Analysis is of little use in separating the *Stagnicola* species. Three species, S. *fuscus*, *S. corvus*, and *S. occultus*, are characterized by their combination of preputium – penis sheath ratio, prostate gland ridges, and shape of the bursa duct. *S. turricula* (?) and *S. palustris* can only be separated statistically because their ranges of the preputium - penis sheath ratio overlap. The average ratio in *S. turricula* (?) is clearly shorter compared to the data in the literature. In this case, however, shell morphometrics served well in separating *S. turricula* (?) and *S. palustris*. The combination of genital characters in *Stagnicola* spp. is unusual. Whether this form arose by speciation or hybridization of *S. palustris* and *S. fuscus* will be tested by molecular methods. [poster]

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An unusual chiton from the southern Caribbean

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In recent years the authors have collected specimens of a small, undescribed southern Caribbean chiton that appears to be restricted to shallow-water algal turf formed principally by the red alga *Corallina officinalis* Linné. To date, the species has been found in Venezuelan waters on Isla de Margarita and at one site on the Peninsula de Paria. The chiton is light tan, often with light reddish brown markings at the exposed margins of the valves, approximately 8 mm long, very slender, with highly arched, smooth valves; slit formula: 9-1-12. The girdle is covered with minute, flattened, smooth scales. Numerous small, distally fluted, rod-like scales line the ventral girdle surface. A marginal fringe of paddle-like and broad, rectangular plates is evident. The radula is characterized by a non-cusped central tooth and a major lateral tooth with a 3-cusped denticle cap. Evidence suggests that this chiton is a member of the family Ischnochitonidae.

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Age structure of *Cochlodina laminata* (Gastropoda: Clausiliidae)

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The age structure at Muszkowice (beech forest, 200 m altitude) and at Buki nad Jeziorem Lutomskim (beech forest, 280 m altitude) was similar. The number of young snails increases from April to May. Simultaneously, the percentage of adults decreases. In June and July a small group of subadults appears; its number regularly decreases until it completely vanishes in September. The number of young snails decreases in June and July. By the end of summer and beginning of autumn the same thing happens as did in spring, that is, the percentage of young snails exceeds 50%. In both mentioned populations, for young snails (2-10 whorls), the percentage of each age group is similar. At the beginning of the vegetative season (April), there is a large group of young snails (4 -5 whorls) and a very small group of the remaining age groups. In May the number of snails with 5-6 whorls increases. In June and July the age distribution tends more toward the direction of snails with 7 whorls. By the end of the vegetative season, the spring situation repeats itself, with a large number of snails with 4-5 whorls. The age structure at Neissetal (a leafed forest lying on both banks of the river, 300 m altitude) seems to be only slightly different. The percentage of each age group of young snails at Buki Sudeckie area (beech forest, 600 m altitude) is as follows: The first young snails (4 whorls) appear in June. In July the population structure is similar to that from the spring reproductive season in lower-lying areas. The most interesting situation is at Mysliborski Ravine (sycamore forest, 400 m altitude). In spring and in autumn, the young snails (4 whorls) appear at different periods of time than at other locations, that is earlier in spring and later in autumn. [poster]

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New data on the radular tooth morphology of *Calma glaucoides* (Alder & Hancock, 1854)

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Calma glaucoides (Alder & Hancock, 1854) is an aeolid nudibranch inhabiting European (Atlantic and Mediterranean) western and southern coasts. Adults are currently found on spawns of teleost fishes (they feed on them) which deposit their eggs on the underside of boulders or empty shells. It has a very atypical uniseriate radula, with a row of very small teeth. Little is known about its formation or function, but it is believed that such a peculiar morphology is related with adult's feeding habits. Here we present a LM- and SEM-detailed study of radulae from individuals of different sizes. Small teeth measure about 1 μm and at high magnification it is possible to see some erosion on its outer border. It is thus presumed that the teeth are functional, regardless of their small size compared with those of other aeolidaceans. We have not seen in every radula examined, the typical carnivore (15 μm) teeth at the beginning of the radular ribbon as previously thought and drawn. We only find these teeth in some specimens, without any size correlation. These findings corroborate the idea that these teeth may only be used in the post-settlement phase, before juveniles can find fish spawns. Further studies with post-settled individuals will help to clear these assumptions. [poster]

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Solem's world model of land snail diversity: how much have we learned since 1984?

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While much work on land snail diversity since Solem's 1984 review has confirmed his ideas, there is some which requires significant modifications to be considered. New continental foci of sympatric and regional diversity provoke reconsideration of the particular contribution of high oceanic islands to global snail diversity, and challenge the claim that subtropical bush in New Zealand holds the highest level of sympatric diversity. There are also difficulties with Solem's category of "mosaic" diversity. Different areas with high levels of sympatric and regional diversity differ not only in taxonomic composition, as expected, but also in the size-ranges, the microhabitats, and the feeding habits of the species involved. Size-ranges differ dramatically, and a single model may not apply to all cases. Phylogenetic constraints seem to play a part, and even in the richest sites all possible niches may not be occupied. Progress has also been made in determining the time spans over which regional radiations have developed, and there are new clues to the influence of habitat and predators on diversity.

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Evolution of the Bivalvia: evidence from the 18S gene

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After over a century of study, the relationships among superfamilies and higher taxa of the Bivalvia remain contested. Molecular sequences provide a novel data set to help analyze these relationships. However, most molecular-based analyses have yielded anomalous results, including rejection of monophyly of the Bivalvia. The inclusion of over ninety taxa in the present study on the 18S gene, including several new sequences, has yielded phylogenies more closely in accord with the morphological evidence. In particular, data for higher taxa not represented in published data sets have greatly improved resolution and decreased long-branch attraction. Mollusca, Conchifera, Bivalvia, Heteroconchia, and Pteriomorphia all received support as monophyletic groupings, whereas most published studies (including my own) have not previously supported them. However, polyphyly is supported for some widely accepted taxa such as the order Myoida. The shell-less, sac-like *Xenoturbella bocki* is supported as a member of the Bivalvia, as suggested by Norén and Jondelius (1997) and Israelsson (1997).

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Extinction, speciation, and biogeography in Pliocene and Pleistocene bivalves of the northwestern Atlantic

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Analysis of 860 species of Plio-Pleistocene bivalves from Iceland to Texas clarifies the timing and magnitude of late Cenozoic extinction and speciation events. Presence-absence data were recorded by regions for nine Plio-Pleistocene time intervals as well as Recent or Miocene occurrences, based on taxonomic revisions of published and unpublished faunas. Taxon presence was interpolated if it was recorded from previous and subsequent time intervals. These data, compared to the reported taxon richness, suggested that up to 40% of the species existing in some intervals have not been reported. Data were analyzed for families, genera, and species, with 67 families and 222 genera. The rapid lower Pliocene increase in taxon richness is partly due to taphonomic bias. The timing of faunal turnovers is similar for genera and species, but the magnitude of change is much higher for species. Species richness and genus richness increased through the first four time intervals and then stabilized by 3.2 ma. High faunal turnovers occurred at 3.9 to 3.8 ma, 3.4 to 3.2 ma, and 1.7 to 1.6 ma. Family richness increased through the first three time intervals and then stabilized at 3.8 ma, with high first appearances at 3.9 to 3.8 ma and 1.7 to 1.6 ma. Warm- and cold-water taxa show different distribution and richness patterns through time.

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Invasions and extinctions: human-induced changes in global marine and estuarine molluscan communities

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Human activities in coastal zones of the world set into motion fundamental alterations in the diversity and abundance of marine molluscan communities more than 500 years ago. These alterations consisted of: (1) the vast reduction in abundance of many species and the complete obliteration of innumerable populations - and thus a probable reduction in the genetic diversity of many taxa, (2) the global deletion (extinction) of species, and (3) additions (invasions) of species. Evidence for the temporal and spatial scales of all three phenomena, however, is severely limited because diversity and abundance data are available for most marine ecosystems for only the past 50 years or less. Thus, we can presume that centuries or millennia of cryptic community metamorphoses have resulted in critical underestimations of the scale of historical alterations. Relative to extinctions, only a handful of species are known to be probably extinct, raising the dichotomous questions of whether there actually have been relatively few extinctions of marine mollusks in historical time, or whether our lack of knowledge of this phenomenon is due to the virtually complete absence of research in this field. In contrast, thousands of marine invertebrates (including more than 125 species of marine and brackish water mollusks) have been transported and inoculated successfully to new regions of the world. Ecological and economic impacts of molluscan invasions have been profound. [Human Symposium]

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Cladistic analysis of the Early Paleozoic bivalve radiation

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A total of 108 morphological characters have been coded for over 100 Cambrian to Devonian bivalve taxa for cladistic analyses. Current characterizations of morphology often reflect phylogenetic assumptions and may conceal similarities among species assigned to different higher taxa. Therefore, these analyses are based on a revised set of characters and character states. Preliminary results support some traditionally recognized higher taxa such as the Solemyoida, Anomalodesmata, Pterioida, and Tironuculidae, but others, particularly "actinodonts" and "modiomorphoids" may be polyphyletic or paraphyletic to several other taxa. Missing data, linked characters, and ordered characters remain problematic. Further revision of the character coding should help resolve some of these difficulties. [poster]

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Plicopurpura (Gastropoda: Muricidae): taxonomy, biology, and extraction of dyes

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Species belonging to the genus *Plicopurpura* Cossman, 1903, are distributed on both Pacific and Atlantic (Gulf of Mexico, Caribbean) coasts of Mexico. *P. pansa* and *P. columellaris* ocurr in the Pacific, whereas *P. patula* is found on the Atlantic coasts. *Plicopurpura* spp. are gregarious and live on intertidal rocks, preying voraciously on mussels, chitons, thaidids, neritids, and *Balanus*. They eat their prey by perforating 70% of the shells, as was shown by aquarium studies with *Nerita* spp. In Mexico, purple snail dyes were used in Pre-Columbian times, and at present, Mixtec and Zapotec cultures in the state of Oaxaca employ these dyes to stain various textiles. The quantity and quality of the dyes withdrawn from the snails depend on the manipulative hand. In Oaxaca, *Plicopurpura* spp. reproduce during May-June and the recruitment is during July to September. The ultrastructure of the shells varies between species and depends on the thickness of the composing layers. The taxonomy of the three species was based on a detailed study of the digestive tract, which showed great similarity between the twin species *P. pansa* and *P. patula*. Comparative anatomy with species of the genera of Muricidae and Thaididae showed that the genus *Plicopurpura* is akin to the Thaidinae. However, *Plicopurpura* spp. share radular characteristics with Muricinae spp., which might be more recently evolved traits. [poster]

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The shallow and deep-sea mollusks of Terra Nova Bay, Ross Sea, Antarctica

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The aim of this work is to improve the knowledge of the molluscan fauna collected from 25 to 1,000 m depth in more than 100 stations in Terra Nova Bay (Ross Sea), during Italian Antarctic Expeditions (Austral Summers 1987/88, 1989/90, 1993/94, 1995/96). Vertical and horizontal distribution, and diversity were analyzed and, for some particularly abundant species, such as *Adamussium colbecki* and *Yoldia eightsi*, the population structure was studied. At Terra Nova Bay, bivalves are not very abundant: 23 species were collected on the whole. In shallow waters, the gastropod fauna is represented by 22 species, among which *Neobuccinum eatoni*, *Philine alata*, and *Austrodoris kerguelenensis* are the most abundant, while among bivalves the commonest species are *Adamussium colbecki*, *Yoldia eightsi*, *Laternula elliptica*, and *Montacuta nimrodiana*. To identify faunistic assemblages, multivariate analyses were applied to stations grouped into 12 depth ranges. While shallow bathymetric ranges (25-150 m) are clearly defined, deeper clusters of stations are less characterized due to the high degree of euribathy of most of the species and of their scattered distribution. *Adamussium colbecki* is the dominant species in the upper 100 m, both on soft and hard bottoms, if the slope is suitable (density up to 40-60 individuals/m^2). On coarse sands this species is frequently accompanied by *Laternula elliptica* (density < 20 individuals/m^2). *Yoldia eightsi* characterizes areas with organic enrichment (density 70-80 individuals/m^2). [poster]

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A new species of phanerobranch dorid (Gastropoda: Nudibranchia: Polyceratidae) from the Cape Verde Archipelago (eastern Atlantic)

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A new species of *Tambja* Burn, 1962, is described from the Cape Verde Archipelago. The ground color is black-purple with a yellow edge on the notum and the foot, and only very few bands differing in length of the same color, on the notum, flanks, and tail. There is also a yellow coloration on the inner and outer sides of the rachis of the gills and on the upper edge of the oral tentacles. The radula is typical of the genus *Tambja*, with the inner lateral tooth having a conspicuous denticle on the inner edge of the primary cusp. The second inner lateral tooth also has a small cusp. The reproductive system has a prostate differentiated from the deferent duct, a rounded bursa copulatrix, and an elongate seminal receptacle, smaller than the bursa copulatrix. The external and internal features of this species are compared with those of the most similar Atlantic species. [poster]

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A new species of *Trapania* Pruvot-Fol, 1931 (Gastropoda: Nudibranchia), from the Natural Park "Bahia De Cadiz" (southwestern Iberian Peninsula), with remarks on Atlantic species of the genus

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A new species of *Trapania* Pruvot-Fol, 1931, is described from the southwestern Iberian Peninsula. The ground color of this species is translucid white with a conspicuous, but irregularly spread, black pigmentation. The black pigmentation can be arranged forming dark patches on the head, dorsum, flanks, and tail. This pigmentation is also present on the rhinopores and the gills and their lateral process and on the base of the oral tentacles and the foot corners. The radula is biseriate and has radular teeth with an outer, bigger and relatively long denticle, with the remaining much smaller. The labial cuticle has two areas composed by elongated rodlets. The reproductive system has the typical arrangement of this genus. The ampulla is pyriform and elongated, the bursa copulatrix is rounded, and the seminal receptacle is also elongated, but smaller than the bursa copulatrix. The external and internal features of the new species are compared with those of the Atlantic species. [poster]

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Re-examination of the phylogenetic relationships of the Notaspidea based upon the discovery of a new species of Notaspidea from the Canary Islands

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The phylogeny of Notaspidea was reviewed by Willan (1987). His hypotheses were not based on parsimony-based analysis. Since then, 3 new genera of notaspideans have been described. Recently, we have discovered a new species of pleurobranchid from the Canary Islands which possesses a mixture of plesiomorphic and apomorphic features not found in other taxa. To assess the systematic position of this species and its phylogenetic relationship to other members of the pleurobranchid clade, we have untaken a parsimony-based analysis of Notaspidea. The new species retains several plesiomorphic features not found in other taxa (posterior insertion of columellar muscle, uncleft anterior border of mantle, presence of penial gland). It has several apomorphies (tuberculate gill, external flaps surrounding genital aparture) shared with members of *Pleurobranchus*. The radula and jaws are typical of the genus. The features of this species are compared with those of the remaining Atlantic species. The most parsimonous placement of this new taxon is basal within *Pleurobranchus*. It represents the sister-group of the remaining members of the genus. The present phylogentic analysis not only supports placement of the present species in *Pleurobranchus*, but largely supports Willan's original hypothesis. However, monophyly of *Bathyberthella* and *Berthella* are not supported and require consideration of additional species and more detailed comparison with members of the monotypic genera *Polictenidia* and *Parabathyberthella*.

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Carbohydrate metabolism in the hepatopancreas of active and aestivating *Achatina fulica*

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Achatina fulica (Gastropoda: Pulmonata) undergoes aestivation at the onset of autumn, becoming active with the rainy season. The adaptive changes in carbohydrate metabolism are reported during aestivation. Healthy *Achatina* from same-age-group culture were acclimatized and induced to aestivate. 12 enzymes, *viz.*, phosphorylase, phosphofructokinase, aldolase, pyruvate kinase, IDH, SDH, G-6-P dehydrogenase, phosphenol pyruvate carboxykinase (PEPCK), LDH, glycogen synthetase, ALAT, and ASAT, were assayed from the digestive gland of males and females following standard methods. During active periods, enzymes of the EM pathway, TCA cycle, and other related enzymes showed similar activities. EMP enzymes increased during early aestivation in females. But later, aldolase and pyruvate kinase decreased while others continued increasing. TCA-cycle enzymes also exhibited augmentation for up to 30 days of aestivation, decreasing afterward. SDH exhibited three regular activity peaks. LDH and PEPCK activity patterns were similar to those of TCA-cycle enzymes. G-6-P dehydrogenase was not remarkably changed. Glycogen synthetase showed increased activity during early and late aestivation. In males, EMP enzymes showed similar activities to in females. TCA-cycle enzymes showed stable activity. LDH and PEPCK activity patterns were similar to in females but the peak activity period varied. No significant change was observed in glycogen synthetase activity, and G-6-PD showed similar trends to in females. These observations reveal that the digestive gland of *A. fulica* remains more active metabolically during aestivation in females than in males.

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Evolutionary morphology of the gastropod operculum: phylogenetic implications

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Gastropod opercula are classified into three morphogenetic varieties: (1) flexiclaudent spiral (mostly multispiral) opercula, which are secreted when the operculum is not in a closed position and fit by flexing into the whorl, (2) rigiclaudent spiral (usually paucispiral) opercula, and (3) rigiclaudent concentric opercula; these last two types grow in aperture-closed position and fit snugly into the whorl. This classification has proven to be highly significant at a systematic level: flexiclaudent opercula are dominant in archaeogastropods, and are considered to be the ancestral type; neritopsine opercula are always rigiclaudent; within Caenogastropoda, rigiclaudent spiral apercula are dominant and flexiclaudent opercula are found only in some basal cerithioidean families; concentric opercula predominate in higher neotaenioglossans and are exclusive in neogastropods. Except in one family, opercula in Heterostropha are rigiclaudent spiral. The ancestral flexiclaudent operculum emerged when, in early gastropods, trochospiral coiling allowed the periostracum to abandon its shell-secreting function at the zone of overlap between whorls; this periostracum was extruded from the shell; later, the opercular groove became independent from the periostracal groove and migrated toward the epipodium, where the opercular disc developed. Rigiclaudent opercula evolved several times from the flexiclaudent type and added widely apertured shells to those for which the operculum provided effective protection. Concentric opercula also evolved several times from rigiclaudent spiral opercula, thus broadening the spectrum of shells (*e. g.*, neogastropods) using opercula for protection. [Bridging Symposium]

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Intraspecific variation in the shell of *Corbula caribaea* Orbigny, 1842, and *C. cubaniana* Orbigny, 1853

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Corbulidae Lamarck, 1818, is represented on the Brazilian coast by one genus, *Corbula* Bruguière, 1797, distributed in three subgenera, totaling eight species. Samples of two species: *C. caribaea* Orbigny, 1842, and *C. cubaniana* Orbigny, 1853, collected on the coast of São Paulo and sent to the Malacology Laboratory of the Zoology Department of the IB-USP to be identified, showed variations in shell form which seem to be related to the animal's growth. While the two species' adult specimens present well-defined morphological characteristics that allow their identification, young forms present distinct characteristics from adults and are very similar among themselves. This fact makes it difficult to separate and identify the young forms of these species. According to Rios (1994), the shell of *C. caribaea* is characterized by valves with strong concentric lines, anterior side rounded, and posterior truncated, and the shell of *C. cubaniana* is subequivalve and characterized by valves with similar form and a nearly rectangular profile, a rostrum bordered by a keel. We developed a study of numerous animal's shells for the species, in different stages of growth, with special attention to the most used characteristics in systematic classification. We found significant differences not only in the shell size but also in the concentric lines, the relative position of the umbo and rostrum, and variations in the hinge. [Supported by a grant from Conselho Nacional de Pesquisas (CNPq) to MJEC].

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Accelerated evolution and hybridization in island land snails: evidence from mitochondrial DNA, allozymes, and fossil records

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Studies of island endemics have shown that phylogenetically close groups of organisms have undergone diverse radiations on isolated islands. They have provided insights into how drastic morphological and ecological diversification occurred within a lineage and how processes of microevolution and macroevolution can be integrated. Species of land snails of the genus *Mandarina* have undergone extensive radiation within the oceanic Bonin Islands in the western Pacific. Species of this genus have diversified into taxa occupying many habitats, *e. g.*, arboreal, semi-arboreal, and terrestrial, and show remarkable diversity in shell morphology. A phylogenetic relationship inferred from mitochondrial DNA (mtDNA) sequence variation showed that species with similar morphologies and life habits appeared repeatedly and independently in different lineages and islands at different times. Fossil specimens from the Pleistocene deposits showed that synchronous shifts in life habit occurred in many fossil lineages during only a few thousands years. The most plausible cause of the diversification in life habit is competitive interaction among species. Integrated studies of mtDNA, allozymes, and fossil records showed that interspecific hybridization has occurred in several species of *Mandarina*. However, these hybridization episodes did not reduce variations among populations but rather promoted diversification among the populations. Competitive and reproductive interactions among species have accelerated evolution of *Mandarina*. This reveals the importance of interactions among taxa as a cause of macroevolutionary change. [Bridging Symposium]

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Anatomy of the digestive system, heart, kidneys, and pericardial cavity and glands of *Tellina petitiana* Orbigny, 1846 (Bivalvia: Tellinidae)

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A detailed description of the morphology and histology of the lips, mouth, esophagus, stomach, crystalline style, style sac, digestive gland, intestine, anus, heart, kidneys, pericardial cavity, and pericardial glands of *Tellina petitiana* is given. Labial palps are included as part of the labial palps-lips complex. Observations on hemolymph are added. The digestive system, the pericardial cavity, the heart, the pericardial glands, and the kidneys are similar to those of other Tellinidae. The labial palps, radially folded and contiguous to the gill, are similar to those of *Macoma balthica*. The stomach of *T. petitiana* is similar to that of *T. tenuis*. The crystalline style (cylindrical, semitransparent, gelatinous, and straight) agrees with those described for the genus *Tellina*. Hemocytes were observed in the hemolymph, and spherical lymphocytes were frequent in pericardial glands and gonad; granular eosinophilic amoebocytes were abundant in the gonad and in the periphery of the ascending intestine. [poster]

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Coiling at small sizes: a functional view of larval evolution of Recent and fossil heterobranch gastropods

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A number of structural features present in marine larval invertebrates has been interpreted as adaptations to living in an environment where viscous forces dominate over inertial forces (Low Reynolds Numbers). Structures such as long cylindrical arms, flaps, and spines increase the drag of the larval body. Studies performed on echinoid larvae demonstrate that drag: (1) reduces their settling velocity (contributing to buoyancy) and, (2) increases their efficiency on passing water through their body (contributing to respiration and/or feeding). To what extent has this functional scenario constrained the evolution of coiling in gastropod larvae? In this study, ellipsoids of revolution simulating larval shell morphologies and modeling at Low Reynolds Numbers demonstrate that: (1) drag is an important force that is opposed to larval translation; (2) larval shell architecture increases drag; and (3) differences between drag forces exerted by axisymmetrical and not-axisymmetrical flows in large trochospiral larval shells are similar to those observed in small planispiral larval shells. In other words, if the optimization of shell drag is critical during larval evolution, then it is expected to produce small planispiral (oblate) and large trochospiral (prolate) larval shells. A review of Recent and fossil heterobranchs and caenogastropods shows that larval morphologies correlate with the predicted results. Nevertheless, intermediate larval morphologies have also evolved, suggesting an evolutionary scenario involving phylogenetic, developmental, and functional constraints. [Bridging Symposium]

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The eastern Pacific species of *Sphenia* (Bivalvia: Myidae)

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There are four eastern Pacific Ocean species of the genus *Sphenia*: (1) *S. fragilis* (H. Adams & A. Adams, 1854), occurs in a variety of nestling situations from the intertidal zone to shallow water, from Santa Barbara County, California, to Guayas Province, Ecuador, and has as synonyms *S. fragilis* Carpenter, 1857, *S. pacificensis* de Folin, 1867, and *S. trunculus* Dall, 1916. It is probably morphologically indistinguishable from the western Atlantic *S. antillensis* Dall & Stimpson, 1901. (2) *Sphenia* A, a new species, is restricted to soft bottoms in the Golfo de California. (3) *S. hatcheri* Pilsbry, 1899, occurs from Buenos Aires Province, Argentina, through the Estrecho de Magallanes, as far north as Isla Chiloé, Chile; *S. subequalis* Dall, 1908, is a synonym. It probably occurs in relatively soft substrata. (4) *S. luticola* (Valenciennes, 1846), occurs offshore in rock cavities from Jefferson County, Washington, to San Diego County, California, and has as synonyms *S. pholadidea* Dall, 1916, *Cuspidaria nana* Oldroyd, 1918, and *S. globula* Dall, 1919. *S. bilirata* Gabb, 1861, appears to have been based on Recent specimens of *Hiatella arctica* (Linné, 1758). *S. ovoidea* Carpenter, 1864, is based on a juvenile *Mya*, most probably *M. arenaria* Linné, 1758.

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At the event horizon during speciation in the hydrobiid genus *Caldicochlea* from Dalhousie Springs in arid South Australia

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There is a stage during differentiation of interacting populations that determines whether they collapse into a single species or continue on evolutionarily separate trajectories toward completed speciation. We have discovered a case in hydrobiid snails in arid South Australia to add to the few known examples of taxa which are near this event horizon. The genus *Caldicochlea* is endemic to the *ca.* 80 Dalhousie Springs which occupy *ca.* 70 km^2 in the north of the state. Two major taxa (or groups of taxa) in the genus are distinguished electrophoretically, principally on the basis of leucine aminopeptidase phenotype. *C. harrisi* is found in almost all springs but *C. globosa* is restricted to the northeast where it is widely sympatric with its congener. In most springs containing both species, there is little if any hybridization. In two springs, however, the species apparently hybridize freely. Moreover, rare Lap heterozygotes in the southern springs suggest that *C. globosa* immigrants can successfully interbreed with resident *C. harrisi*. Possible explanations of the patterns of reproductive isolation in *Caldicochlea* include: (1) isolation occurs only after secondary contact, occurring independently in different springs; (2) hybridizing populations are relicts from colonization before the evolution of isolation; (3) isolation may break down independently in multiple populations, possibly in response to extreme environmental conditions or local disappearance of a niche; or (4) breakdown may have occurred once within *C. globosa* distribution and undergone a limited sporadic spread.

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New anatomical data on Camaenidae of Papua New Guinea

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The Camaenidae is a helicoid family defined by the absence of a dart sac and associated glands on the female genitalia. The are no characters unique to the family. Within the Camaenidae a large diversity and a large degree of apparently intraspecific shell polymorphisms is observed. However little is known about camaenid taxonomy and relationships. It is for example possible that the Camaenidae is not monophyletic. In this context we started a systematic study of selected camaenids of Papua New Guinea and adjacent islands. Here we present some preliminary observations on Camaenidae samples in the collection of the RBINS collected during the period 1976-1991. The alcohol samples were determined, dissected, and compared with literature data. The present observations include the very first anatomical data on *Forcartia buehleri*, a species described on shell features only. In addition we found that *Rhynchotrochus* sp. produces spermatophores, a fact hitherto unknown in Camaenidae. Finally, we provide further observations on the viviparous nature of *Megalacron novaegeorgensis* and *M. klaarwateri* in which we found 3-4 well-developed young individuals in several adult specimens. [poster]

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Morphology and development of *Nitidiscala tincta* (Gastropoda: Epitoniidae)

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The anatomy of *Nitidiscala tincta* agrees with the few previous descriptions of epitoniid anatomy. *N. tincta* feeds by biting off pieces of intertidal anemones using an elongate proboscis, jaw, and a radula with numerous serriform teeth. Like other epitoniids, this species is an aphallic, protandrous hermaphrodite, that produces spermatozeugmata during the male phase. Females lay clusters of 75 µm eggs inside sand-covered capsules that are connected together by a mucus thread. The first two cleavages are equal and produce a small polar lobe. Epibolic gastrulation results in a trochophore stage with distinct embryonic kidneys. At hatching, the larvae are 125 µm in length, with dextral, hydrophobic shells and pigmented mantle organ. Embryologically this species has characteristics of both caenogastropod and heterobranch development. Our morphological and developmental findings will be used to evaluate relationships within the Ptenoglossa.

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Refining models of character evolution in gastropod phylogenetics: molecular, paleontological, and morphological data

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Paleontological, molecular, and morphological data are all relevant to understanding the evolutionary radiation of the Gastropoda. These contrasting approaches can be used as independent checks on one another and to refine ideas about the processes being investigated. In particular, refined knowledge of the pattern and process of molecular evolution has been shown to improve phylogenetic estimates from molecular data. Difficulties arise, however, because certain molecular processes such as changing transition-transversion ratios and saturation can result in erroneous conclusions about the rates and relative frequencies of various nucleotide substitutions. This is especially true when studying higher-level phylogenies, and can be further complicated by methods of character-state reconstruction that may themselves be systematically biased by underestimating the number and type of changes. In this study we have taken advantage of the outstanding fossil record of the gastropods to calibrate rates of molecular evolution for the 18S rRNA gene. We have focused especially on the relatively recent and paleontologically well-documented fossil record of the Caenogastropoda. This divergence minimizes distortions in analyzing patterns of character evolution using parsimony. A tree topology derived for the Caenogastropoda from both morphological and molecular characters was used for analyzing patterns of character evolution, and rates were calibrated from a conservative reading of the fossil record. This model of character evolution was then used for phylogenetic analyses to investigate the timing and pattern of evolution within the Gastropoda. [Supported by NSF DEB-9318231 & 9509324]. [Character Symposium]

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Molecular phylogeny and evolution of brooding systems of Sphaeriidae

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The Sphaeriidae is a family of freshwater heterodont bivalves with a worldwide distribution. Its members are a prominent component of the benthic invertebrate community. Four major genera are recognized: *Sphaerium, Musculium, Pisidium,* and *Eupera.* Historical relationships among the species have not been clearly elucidated, and the phylogenetic problem is compounded due to taxonomic complexity and the use of multiple nomenclatural systems. DNA sequence data from the small subunit mitochondrial ribosomal 16S gene were obtained from 23 taxa representing four continents. A phylogeny that is consistent with the elaboration of parental care was constructed with this data using parsimony criteria. The basal taxon, *Eupera*, is a simultaneous brooder with simple brooding physiology. *Pisidium*, the next derived clade, is also a simultaneous brooder, but has a more complex brooding architecture. In the next derived clade, the diploid taxon *S. cornium* is sister to a clade containing all other *Sphaerium* and *Musculium* taxa. These taxa have a complex brooding physiology, including sequential brooding. The *Sphaerium/ Musculium* clade consists of three nested clades, a *Musculium* clade with components from North America, South America, and Europe, a *Sphaerinova* clade with Australian and New Zealand members, and the most derived clade consisting of polyploid North American taxa of the genus *Sphaerium.*

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Collections of Recent and fossil Mollusca at the Department of Invertebrates, American Museum of Natural History (AMNH)

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The AMNH collection of Recent mollusks comprises 323,000 lots (3 million specimens) and was largely founded in 1874 with the acquisition of the lifetime collection of Dr. John C. Jay. Regional strengths include the tropical Pacific and western Atlantic Oceans. Taxonomically, the families Conidae, Cypraeidae, and Epitoniidae are exceptionally well-represented. The type collection includes 1,791 primary types (9,338 specimens) with extensive material from the AMNH Congo and *Vema* Expeditions as well as the Jay, Haines, Nowell-Usticke, and Whitney South Seas Collections. The fossil collection comprises 4 million specimens (mostly mollusks) and was founded upon the purchase of the James Hall collection in 1875. Regionally, North America is well-represented as are Europe and South America. Taxonomically, the collection is rich in Paleozoic and Mesozoic bivalves, gastropods, and ammonites. The type collection includes 2,509 primary types including material from the Hall, Whitfield, Greene and McConathy, and Columbia University Collections. The invertebrates department currently staffs 5 full-time and 3 curators emeriti including one Recent mollusk curator who studies marine heterobranch gastropods and bivalves and one fossil curator with research interests in fossil cephalopods. In addition, a collections manager studies Recent freshwater bivalves and two scientific assistants are responsible for the fossil and non-molluscan invertebrates, respectively. Access to the collection for studying invertebrates, obtaining type catalogs, depositing vouchers, or applying for collections study grants may be achieved by contacting collections staff. [poster]

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Analysis of color pattern morph frequencies in Neogene neritid gastropods from the Dominican Republic

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Color patterns, although rarely preserved in the fossil record, provide a chart of physiological activity that is under a combination of intrinsic and extrinsic control. Accordingly, changes in pattern frequencies in populations may reflect changes in gene frequency, changes in the environment, or both. From large samples of the neritid gastropods *Smaragdia viridimaris* and *Neritina figulopicta* from the Neogene of the northern Dominican republic, we classify intricate color patterns into 7 distinctive types and analyze changes in morph frequencies in a tightly controlled stratigraphic, geographic, and paleobathymetric framework. Our analyses indicate an environmental control on the overall distribution of both species. Based on independent estimates of paleodepths, all samples containing *Smaragdia* and *Neritina* represent depths of > 50 m, and population sizes decline with increasing paleodepth. Living species of *Smaragdia* occur obligately on seagrasses, especially in the genus *Halophila*, which tolerates low light and turbid conditions and has been reported as deep as 85 m in very clear water. Living species of *Neritina* are restricted to shallower depths. Within the two fossil species, changes in color morph frequencies follow separate spatial and temporal patterns. We document distributions that are geographically distinct and coherent within individual stratigraphic sections as well as distributions reflecting a predominance of paleoenvironmental control and change up section. Differences between the two species support a conclusion that there is no single pattern of response intrinsic to neritids. [poster]

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Notes on *Mitrella lunata* (Say, 1826) (Gastropoda: Columbellidae)

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Mitrella lunata is reported along the eastern American coast from Nova Scotia Province, Canada, to Santa Catarina State, Brazil. This species has a long list of probably unjustified synonyms. We have examined lots from various collections ranging from New York State, U. S. A., to São Paulo State, Brazil, and found four species identified as *M. lunata*. One species had records from Florida, U. S. A., to São Paulo State, Brazil, and could be identfied as *M. pusilla* (Sowerby, 1832). Another species (*Mitrella* sp. 1) ranged from Bahamas, northern Caribbean, to Espirito Santo State, Brazil. Yet another species (*Mitrella* sp. 2) has only one record in Florida. And the last one (*Mitrella* sp. 3) has records ranging from New York State to South Carolina, U. S. A. *Mitrella* sp. 1 is still under investigation, we still have to examine the types of *M. duclosiana* (Orbigny, 1842). The two most probable candidates to be true *M. lunata* are species 2 and 3, due to the type locality indicated by Say (1826: 213; "southern states"). Species 3 could also be *M. dissimilis* (Stimpson, 1851) and/or *M. gouldiana* (Stimpson, 1851). But the situation is further complicated because the type of *M. lunata* is probably lost, as well as the types of Stimpson lost in the Chicago fire. To stabilize the taxonomy of this group neotypes will probably have to be created. [poster]

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Speciation in the Madeiran endemic landsnail genus *Heterostoma* through the mechanism of genital variation

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The Madeiran endemic landsnail genus *Heterostoma* (Pulmonata: Helicidae) consists of two species that differ most significantly in genital anatomy; the euphallic taxon produces a full set of male and female genitalia while the hemiphallic taxon lacks a flagellum and epiphallus. Where the taxa are sympatric there are also differences in shell morphology, microhabitat, local demography, and microdistribution. Using evidence from RAPD analysis, field and laboratory studies of habitat associations and multivariate analysis of shell morphology from modern and fossil samples a model of sympatric speciation is proposed that functionally links genital variation and ecological divergence. [poster]

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Identified neurons and cellular homologies in mollusks

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The nervous systems of adult gastropod mollusks have long been known to possess cells which can be recognized as distinct individuals. Such cells can be identified within every member of a species by virtue of the size, position and colour of their somata, and their axonal morphology, synaptic connectivity, transmitter phenotype, and membrane characterisitics. Some of these identifiable cells appear to be conserved across gastropod orders and even subclasses (*e. g.*, opisthobranchs and pulmonates), and more recent evidence also suggests that certain identified cells may be recognized in both gastropod and bivalve larvae. Efforts are also being made to compare individual larval neurones in mollusks with those in related phyla, such as the annelids. These studies of cellular homologies offer intermediate levels of analysis for bridging the gap between work on molecular evolution and more classic studies of comparative morphology. Evolutionary changes in the anatomy and/or physiology of identifiable cells might also explain evolutionary changes in the behaviors which they mediate. Examples of such cellular homologies and problems encountered in their recognition will be discussed. [Character Symposium]

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North American freshwater mussels: distribution, biology, and conservation

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Knowing species distribution is essential to conservation or management. One objective of the National Strategy on Conservation of Freshwater Mussels was to prepare an atlas of North American species. An organizational meeting was held in October 1997 to discuss preparation of *North American Freshwater Mussels: Distribution, Biology and Conservation*. This will be based on the *Atlas of North American Freshwater Fishes* (Lee, *et al.*, 1980, North Carolina State Museum of Natural History). The meeting goals were to: (1) compile lists of regional coordinators, compilers, and included species, (2) develop a draft format for maps and a database of sources, (3) develop a budget, (4) target funding sources, and (5) develop a timetable. Authorship will be the regional coordinators with species compilers credited on individual account pages as in the fish atlas. Each species account will include: color photograph, common/scientific name (including author/date), original citation, type locality, systematics, key characters, distribution, habitat, biology, and conservation status. Appendices will include state references, synonyms, and fish host(s). The layout will be similar to the fish atlas but will include a two-page format for most species. One goal is to compile the data in GIS-usable format. Software will be distributed to compilers to document sources of distributional data. Exact locality data are desired (citing museum numbers) but published maps and other sources will be used if well documented. [poster]

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New data about the invading freshwater mussel *Limnoperna fortunei* (Dunker, 1857) (Mytilidae) in the neotropical region

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The invasion of the Southeast Asian freshwater mussel *Limnoperna fortunei* (Dunker, 1857) was first reported in the Americas at Río de la Plata, Argentina, in 1991. Still earlier, it had invaded the Hong Kong area in the late 1960s and Japan in the 1970s. In this contribution, the distribution of this species in the neotropical region is analyzed. Its importance in causing impact in the human environment (biofouling) and natural environment (affecting the taxocenosis of autochthonous mollusks favoring the settlement of other macroinvertebrate fauna not common in the environment) is emphasized. Samplings and collections in the Río de la Plata coast were made during low tides. In the Paraná River flood plain, a dredge was used. Periphytic populations were sampled by hand. In the mouth of Paraguay River, macrofouling samplers were used. In 1993, this bivalve entered the Plata Basin (nowadays this is the only neotropical environment invaded by this species) through the Río de la Plata. The last capture (10/21/96) was made in Cerrito Island where the Paraguay River joins the Paraná River (27°20'S, 58°43'W), its northernmost distribution. Since the introduction of this species in 1991, it has invaded 1,100 km through the Plata Basin. These facts show its permanent expansion and adaptation to different environments of the basin and call the attention to the impact that this species will cause on the environment.

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The reproductive cycle of *Limnoperna fortunei* (Dunker, 1857) (Bivalvia: Mytilidae) from a neotropical temperate locality

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Limnoperna fortunei is a dioecious freshwater mytilid native to Asia. The reproductive biology of this invasive species is analyzed for the first time in its neotropical habitat. About 35 specimens were processed monthly with usual histological techniques in sections 5-7 µm thick. The size of microscopic sex differentiation varies throughout the year. From June to October, the sexes differentiate at 5-6 mm shell length, and from March through May, at 7-10 mm. When mature, male follicles occupy a larger volume in the mantle than those of mature females. Females present a period of follicular expansion against connective tissue - of 28-40% - between April and July, alone with the first stage of vitellogenesis. Adult males show mature sperm through the whole year. Mature oocytes measure 70-100 µm. The main spawning occurs during February-March. Partial spawning may be observed in April-May. After the main spawning, follicles undergo a clear retraction. In males, the follicular occupation of the mantle decreases from 65% to 45%. In females, retraction is from 40% to 25% with lysis of non-evacuated oocytes. Oocyte proliferation is seen in April-June, with a large proportion of oocytes smaller than 40 µm. Immature oocytes are recorded all the year round. As seen microscopically, more than one event of maturity-spawning is recognized in females larger than 10 mm in shell length.

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Paleopathological phenomena on the shells of Upper Oligocene (Egerian) scaphopods (Wind Brickyard, Eger, Hungary)

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The profile of Wind Brickyard (Eger, Hungary) is the stratotype of the Egerian stage which represents a transition between the Upper Oligocene and Lower Miocene. Five marine facies can be distinguished in the section. These contain molluscan fossils abundantly. The presence and position of naticid borings, signs of crab predation, and external fracture repair on the shells of scaphopods collected from four different layers of the exposure have been examined. The four layers are: glauconitic sandstone, molluscan clay, silty finegrained sandstone, and limonitic sandstone. The number of scaphopod species found in the above-mentioned layers are as follows: 1, 9, 4, 4. The number of individuals decrease toward the limonitic sandstone. Three types of naticid borings have been observed in the collected material (successful, unsuccessful, unfinished). The rate of successful borings are the highest in every layer and these can be found in the middle part of the shells. The percentage of bored specimens increases with the increasing grain-size of the sediment. The same situation can also be observed in the case of fracture repairs. *Fustiaria taurogracilis* (Sacco) is the most preferred species for the naticids, while fracture repairs are most abundant on the shells of *Dentalium fissura* Lamarck and *F. taurogracilis*.

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Gastropod foraging behavior: video lessons from a tropical system and a temperate system

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We examined foraging behavior in the tropical non-homing limpet *Cellana grata* and the temperate winkle *Littorina littorea*. Using time-lapse video equipment, we recorded the movement patterns of a *C. grata* population on a wall *in situ* for two weeks. Movement was tightly matched with the rise and fall of the tide. Limpet speed was greatest when the rate of change of tide height was at a maximum. Activity patterns became less clear as the tides became irregular. Our technique enabled a vast amount of data to be collected over a short period of time. Laboratory examination of foraging behavior of littoral snails typically uses uniform and unnatural substrata. In reality, substrata will be covered with gastropod mucus trails of varying ages and these trails act as an adhesive for planktonic and benthic microalgae. We therefore videoed trail-following behavior in *L. littorea* when presented with conspecific trails containing *Amphora coffeaeformis*, *Tetraselmis suecica*, or no microalgae. Degree of trail following, speed of tracker snail, and feeding rate were all greater on *Amphora*-coated trails than on the control or *Tetraselmis*-coated trails. Tortuosity of trail was not affected by trail type, but was less if the tracker snail was the same animal as the marker snail. The results are discussed in terms of the functional significance of different foraging behaviors and the utility of video techniques in foraging experiments.

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Coevolution of Asian snails and human trematodes: ongoing evolution and emerging diseases

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The Tropical Medical Research Center, Institute of Parasitic Diseases, Shanghai, China (funded by U. S. National Institutes of Health), was founded in 1996 to study the following throughout southern China: (1) genetic diversity of three helminthic diseases (schistosomiasis, paragonimiasis, hookworms); (2) to uncover emerging helminthic diseases through studies of genetic diversity; (3) to assess impact of genetic diversity on vaccine and drug research; (4) to assess impact of the Three Gorges Dam on emerging diseases. Schistosomes and *Paragonimus* are snail-borne parasites and have coevolved with various snail lineages. Asian schistosomes infecting man have coevolved with 2 subfamilies of Pomatiopsidae (rissooidean/freshwater-amphibious) starting with introduction from the Indian Plate into northern Burma and Yunnan, China, in the early Miocene, and with subsequent evolution down evolving river systems of southeastern Asia and China. The greatest species diversity has been in China along the Yangtze River basin. Our current research has shown that clades based on anatomical data are confirmed with molecular genetics involving allozymes and mitochondrial gene sequences (Cytb, COI). Current molecular data have shown that Pomatiopsidae is phylogenetically distinct from Hydrobiidae. We have resolved taxonomic problems involving *Oncomelania* in China. Triculines transmit both schistosomes and *Paragonimus*. They transmit two distinct species complexes of schistosomes: (1) the *sinensium* complex has candidates for spawning a potential emerging disease; and (2) the *japonicum* complex infects man. The genetic relationships of triculines to pomatiopsines is discussed. [Human Symposium]

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Phylogeny and biogeography of *Euplica* (Neogastropoda: Columbellidae)

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The columbellid taxon *Euplica* is a primarily modern Indo-Pacific group that includes about 12 extant and one extinct species. The taxon is not well-known, and is often confused with other columbellids, particularly members of the genus *Pyrene*. Species in this group have three basic protoconch morphologies, differing principally in nuclear-whorl size, number of whorls, and sculpturing. One basic type is associated with nonplanktic development, and two with planktic development. A preliminary cladistic phylogeny of *Euplica*, generated using conchological and radular characters, is combined with geographic range information to investigate three issues: (1) the monophyly and relationships of *Euplica*; (2) the evolution of planktic and nonplanktic developmental modes in the group; and (3) the relationship between differences in larval shell morphology and geographic range.

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Anatomy of *Prunum guttatum* (Dillwyn, 1817)

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This work is a contribution toward making more anatomical information available so that eventually a cladistic analysis of this family may be done. Only female specimens were available for this work. Several characteristics were found in the pallial-visceral mass: (1) a modified osphradial lamella that fuses with the columellar muscle and conducts the osphradial nerve toward the head-foot mass; (2) a septum situated between the ctenidium and the anal septum, running parallel to the latter; (3) anteriorly placed heart; (4) sub-median connection between the ctenidial vein and auricle; (5) kidney well-developed and solid. And in the foregut: (1) the proboscis retractor muscle pair, fused medially, the resulting muscular bundle runs along the esophagus, into the proboscis, fusing with the interior ventral wall, running toward the anterior end where it detaches from the proboscis wall, originating the radular muscles; (2) the duct of Leiblein opens posterior and very close to the buccal pouch sphincter; (3) the buccal pouch is muscular sac, seven major groups of muscles attach to it: one anteriorly and six posteriorly; (4) five of the posterior muscle groups will cross the wall of the buccal pouch and attach in distinct ways to the sub-radular membrane and/or to odontophoral cartilage and actuate the radula; (5) the radular nucleus is a very thin strip at the posterior end of the sub-radular membrane. [poster]

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Land snail diversity of a square kilometer of rainforest in southwestern Cameroon

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Systematic sampling of a single square-kilometer patch of acidic, undisturbed, fairly uniform Cameroonian rainforest during two different rainy seasons yielded 97 species of land snails, belonging to at least 12 families, with the carnivorous Streptaxidae comprising 34% of the fauna. Up to 45 species were collected within sites of 20 x 20 m during a single visit and up to 51 when visited in both seasons. This might be the world's highest sympatric land snail diversity reported to date. Overall snail abundance was rather low, and many species were rare. A substantial difference was observed in overall snail abundance between the two sampling periods. About 27% of the species were uniquely found in one of the two sampling periods. At least 27% of the species appeared to be largely or completely arboreal, and 19% were found to live both on the ground and in the vegetation; 46% of the species were confined to the ground, and for 7% insufficient information was available. Major adult shell dimensions (height or diameter) range between *ca.* 1 and 165 mm, but shells of 74% of the species are smaller than 10 mm. The shell height:diameter ratio distribution differs from those previously reported for other faunas by relatively many "globose" (H:D = 0.8-1.2) and very tall (H:D = 2.8-4.4) shells. The distribution of neither shell size nor shell shape differed between ground-dwelling and (partly) arboreal species. [poster]

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Population structure and gene flow in the planktonic developing periwinkle, *Littorina striata*: a tale of a snail living in Macaronesia

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Allozymes were used to investigate the genetic structure of 41 populations of the planktonic developing periwinkle *Littorina striata*, troughout its entire geographic range (Azores, Madeira, Canary Islands, Cape Verde Islands). Although only very limited amounts of population diferentiation were detected, there were indications of a macrogeographic patterning of variation at 5 allozyme loci, such that at least the populations from the Cape Verdes appeared different from those of the other archipelagos: (1) There were 8 unique alleles in the Cape Verde archipelago and 2 in the Azores (none elsewhere), (2) the mean number of alleles per locus was highest in the Cape Verde Islands, (3) the number of loci, revealing between-archipelago heterogeneity, was highest for comparisons involving the Cape Verde Islands, and (4) both a correspondence analysis and UPGMA clustering separated the Cape Verde archipelago from the other archipelagos. Despite these data reminiscent of an isolation-by-distance model, there was no significant correlation between geographic and genetic distances. It is hypothesized that the current macrogeographic genetic structuring in *L. striata* is the result of the recent history of the species, as *L. striata* is suposed to have colonized Macaronesia from the Cape Verde archipelago countercurrent-wise during the Tertiary.

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Severe storm causes morphological transition in the aperture height of wave-exposed *Littorina striata* (Mollusca: Prosobranchia)

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Aperture size has been shown to vary with wave exposure in many gastropods. Generally specimens from wave-exposed shores tend to have a larger aperture size compared to wave sheltered specimens, enabeling them to develop a larger foot, providing for a better holdfast onto the substratum. Likewise the aperture height of the Macaronesian periwinkle *Littorina striata*, shows a relationship with wave exposure. On Ilheu de Villa Franca, a drowned volcanic crater situated in the Azores, wave-exposed and wave-sheltered populations differ, in for example aperture height, such that wave-exposed specimens have a larger aperture height compared to wave-sheltered specimens. Moreover specimens change their aperture accordingly when transplanted from a sheltered to a wave-exposed shore. In December 1996, a severe storm hit the Azores, producing extreme waves. Comparison of wave-exposed and wave-sheltered populations of *L. striata*, collected at Ilheu de Villa Franca, before and after this storm, revealed: (1) a difference in aperture height between wave-exposed and wave-sheltered populations, regardless of possible storm effects, (2) a significant increase of aperture height, at the wave-exposed population after the storm, and (3) no morphological differences between wave-sheltered populations, before and after the storm. These results reinforce the hypothesis of a wave action-aperture height relation in *L. striata*, giving a functional explanation for the observed aperture size variation. [poster]

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ITS1 sequence variation in *Ovatella myosotis* Draparnaud, 1801 (Mollusca: Basommatophora)

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Ovatella myosotis is a marine, planktonic-developing pulmonate living in the high littoral zone. The species has a vast distribution and has been introduced in many areas throughout the world. Yet, in Belgium the species is relatively rare and is confined to a few populations that occur in brackish water habitats. These populations are small and quite isolated from larger populations in adjacent countries. To assess whether this isolation and limited population sizes have provoked a loss of genetic variation and/or resulted in an increased degree of differentiation compared to neighboring populations, we looked at DNA-sequence variation in a number of nuclear (parts of 18S rRNA, complete ITS1) and mitochondrial genes (parts of 16S rRNA, cytochrome b, cytochrome oxidase subunit I). Hitherto only 18S rRNA and ITS1 gave consistent and clear PCR amplifications. Hence in a first analysis we concentrated on the ITS1 gene and sequenced it in 7 populations from Belgium, the Netherlands, France, Great Britain, and the Azores. The preliminary results of this work will be presented. [poster]

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Zoogeographic relationships of the fossil and Recent molluscan faunas of a Caribbean oceanic reef complex (San Andres Island, Colombia)

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Late Tertiary lagoon and reef deposits and Pleistocene rocks at San Andres Island (SW Caribbean) contain abundant molluscan fossils. The island is surrounded by a reef complex with a variety of shallow-water environments. Based on previous works and collections of both fossil and Recent material, checklists of Miocene, Pleistocene, and Recent species were arranged to be compared with those available for other Caribbean localities. The results show that the molluscan fauna of this oceanic reef complex has always been composed of a low number of characteristic Caribbean elements. Most species of the Miocene of San Andres are represented in late Tertiary formations of the Greater Antilles, whereas a lesser amount is characteristic of the pre-Isthmian deposits of Central America. Only few occur in Miocene deposits of northern and western South America. The majority of the elements found in Pleistocene rocks are represented either in the Pleistocene of Bahamas, Cuba or Grand Cayman, corresponding entirely to widely distributed species of the recent tropical western Atlantic fauna. The Recent molluscan fauna is also almost exclusively composed of wide-ranging species having planktotrophic development. We conclude that the relatively remote, oceanic condition of this reef complex hindered the arrival of many forms with lecitotrophic larvae, being this the main reason for the relatively low number of shallow-water species of mollusks ocurring there since Late Tertiary times. [poster]

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The USR model of life history evolution in freshwater mollusks

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Reproductive effort is a power function of adult weight in freshwater mollusks. In *Pisidium*, in over 39 observations (13 populations, 7 species), the average weight of all offspring produced in a year was estimated to be $A = 0.23B^{1.07}$, where B is the average weight of the parent, both variables expressed in micrograms of carbon. A similar relationship was found in 25 observations taken from unionid, pulmonate, and prosobranch populations ($A = 0.92B^{0.84}$). Here I introduce the USR model of life history evolution in freshwater mollusks, inspired by the "CSR" model for plant strategies of Grime. Populations displaying the reproductive efforts predicted from their adult sizes are designated U-populations, undifferentiated with respect to resource allocation. R-populations display an order of magnitude greater reproductive effort than expected, and S-populations an order of magnitude less. R-populations are predicted to show rapid growth and reproduction, semelparity, and adaptation to rich but unpredictable environments. S-populations show slow growth, long life span, and adaptation to poor but stable environments. I illustrate the USR model by application to Jokinen's large data set on the distribution of freshwater snails in New York and New England.

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Purification and characterization of three glycosil hydrolases from a freshwater mollusk, *Pomacea flagellata*

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Three glycosyl hydrolases were purified from viscera of a freshwater mollusk, *Pomacea flagellata*, by ammonium sulfate precipitation, low pressure DEAE-Sepharose chromatography, and anion exchange HPLC. In this study we describe the purification and properties of *P. flagellata* enzymes with glycosyl hydrolase activity, including physicochemical characteristics of the enzymes (amino acid analysis, molecular weight, isoelectric focusing, and effect of pH on temperature on glycosyl hydrolase activity), substrate specificities, effects of various compounds and metal ions, and secondary structure content of these enzymes.

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Chromosome and electrophoretic study of the freshwater snail *Pomacea* from Veracruz, Mexico

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The genus *Pomacea* is an organism appropiate as a model for investigation, principally within the genetic field. In this work, karyotypic and electrophoretic comparisons were made to continue the organism characterization of the genus *Pomacea* originating in the state of Veracruz, and thus to determine its interspecific and intraspecific diversification. The polymorphism registered in individuals originating in different regions did not show significant differences, at least not in reference to the cytogenetic and electrophoretic studies made between *Pomacea flagellata* and *P. patula catemacensis*, the latter being a species exclusive to the region of Lake Catemaco the State of Veracruz. However, variations are present within the different regions of collection; Lake Alvarado, Tlacotalpan, and Misantla River, in the magnitude of the band pattern both in the localization of the isoelectrofocus (IFE) point and molecular weight, which presents a band characterized principally in the region of Lake Catemaco perhaps as an endemic population. In this way, this technique is determining, on the one hand, the differentiation between the variations of the analyzed populations, and on the other, determination of the source and diversity of clones.

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Aspects of population dynamics, growth, secondary production, and role in soil-formation of the terrestrial snail *Xeropicta derbentina* (Krynicki, 1836) (Gastropoda: Pulmonata) in Crimea

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The terrestrial mollusk, *Xeropicta derbentina*, is a dominant species in the snail fauna of the steppe and ruderal vegetation of Crimea. Samples of this species were taken every month from 1995-1997 in forested regions of Crimea (Colchuhino, Pribrezhnoe, and Simferopol); 16 ring samples (diameter 35.7 cm) were determined each month (May-November). All specimens of *X. derbentina* found within the ring were recorded and their density was converted to specimens/m^2. The maximum shell diameter of each snail from each sample was measured. After measurement the animals were replaced where they were originally found. Mollusks were recorded in size classes of 3 mm intervals. The relationship between weight of the snail (W) and maximum shell diameter (D) were: for live weight (W_l) - $\log W_l = 2.902 \pm 0.228D$; for dry-air weight ($W_d$) - $\log W_d = 2.141 \pm 0.226$ D. *X. derbentina* lives one year. Its egg-laying period is in autumn. Hatching of young snails takes place in April-June. During the summer, snails are growing and attain maximum biomass in August-September. In another part of the same area, the biomass of *X. derbentina* ranges from 20-621 g/m^2, with the mean of all samples 1,172 ± 64 g/m^2 (172 tons/ km^2). The dry-air weight of excrement was 2.48-5.62% of live weight of the mollusks per day; with the variation related to the type of forage and age of the snail. During summer, this ranges from 28-1,180 g/m^2. Thus *X. derbentina* is one of the basic producers of the humid part of the soil in the xerophitium biocenosis of Crimea. [poster]

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Late Badenian (Middle Miocene) reef-associated molluscan fauna from Diósd (Hungary, Central Paratethys)

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Reef-associated molluscan faunas are hardly known from the Central Paratethys. Recently a rich fauna was collected from Upper Badenian Leitha Limestone exposed near Diósd, south of Budapest. The molluscan fauna of the small patch reef comprises 60+ species. 500 bivalve specimens represent *ca.* 30 species. Dominant genera are *Lithophaga, Chlamys*, and *Barbatia*. Other common taxa include *Ctena, Hiatella*, arcids, modiolids, cardiids, and venerids. Bivalves of epibenthic habit predominate but infaunal elements are also present in a surprisingly large number. About 43% of the specimens belong to byssally attached epifauna. The other two common life habits are burrowing and boring infauna. Cementing and free-living epifauna are less important. Regarding feeding strategy, only suspension-feeding bivalves were found. With respect to bottom preference, 44% of the specimens require hard substrate whereas the proportion of soft-bottom dwellers is also very high. 400 gastropod specimens belong to 30+ species. The most dominant group is the cerithids. Other common genera include *Diodora, Gibbula, Rissoina, Alvania*, and *Cerithiopsis*. The dominant life habit is epibenthic: 96% belong to vagile epifauna. Regarding feeding habits, more than 60% of the specimens are herbivorous and *ca.* 20% are carnivorous. Suspension feeders, ectoparasites, and scavengers form small groups. The relatively high ratio of burrowing bivalves indicates that the reef was not continuous spatially, and there were some soft-bottom areas developed between the coral colonies. The high number of herbivorous gastropods indicates the presence of submarine flora in the living assemblage.

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Bacterial contributions to cephalopod survival and development: insights from the mariculture of *Euprymna scolopes*

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The bioluminescent mutualism formed by the luminous prokaryote, *Vibrio fischeri*, and the sepiolid squid, *Euprymna scolopes*, serves as a simple system for defining contributions non-pathogenic bacteria make to the survival and development of animals they colonize and for identifying bacterial genes essential for symbiosis. To assess the role of *V. fischeri* in survival and development of *E. scolopes*, we established an experimental mariculture system that permitted the animal to be cultured to adulthood in the presence or absence of *V. fischeri*. Growth, behavior, and survival of the aposymbiotic animals was similar to that of the *V. fischeri*-colonized animals. We characterized the symbiont-independent development of the light organ system and found that colonization by *V. fischeri* had no obvious effect on development of the accessory tissues of the light organ system but had a distinct effect on other tissues of the light organ. To identify bacterial genes essential for the symbiosis and those involved in symbiont-dependent morphological changes, we are using a reverse-genetics approach with emphasis on proteins whose production is dependent on the inter- and intra-cellular signals, autoinducer and cAMP. *V. fischeri* mutants defective in the genes for these proteins are being constructed and characterized and will be examined in colonization assays with hatchling *E. scolopes* to assess the role of these genes and their protein products in the initiation and maintenance of the association. [Human Symposium]

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Do freshwater snails actively behave or passively respond?

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A criterion for active behavior is that an organism shows homeostatic independence from environmental factors and does not only act as an inert and passively responding object. To test this assertion in a malacological context, freshwater snails, particularly species of medical importance, were investigated in relation to their local dispersal, surfacing capability, habitat dimensionality, and responses to dynamic environmental parameters such as water flow. In static circumstances, snails move across surfaces in an apparently random manner, reminiscent of physical phenomena such as diffusion. Nevertheless, there are degrees of aggregation which suggest higher orders of behavior. Also, snails respond to air/water interfaces in ways which are only partially determined by environmental circumstances and are predicated on decision choices such as surface/not surface/sink. The response to habitat dimensionality suggests that snails respond to submerged surfaces but not edges, in ways reminiscent of osmosis; again, however, aggregation phenomena can operate. In dynamic situations, including sexual encounters, environmental responses involve large elements of behavior, sometimes making responses difficult to predict. Conversely, predictable responses can be obtained; for example, the hydrodynamic aspects of shell shape mean that drag coefficients can be measured. In general, freshwater snails seem to adapt their responses to their environment by modulating relatively passive responses. After 600 million years of evolution, it is not surprising that they have a capacity to behave but what determines their instantaneous choice between active behavior and passive response is another question.

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Intraspecific morphometric variation of *Cylindrus obtusus* (Draparnaud, 1805) as a result of isolation processes

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Cylindrus obtusus (Draparnaud, 1805) serves as a good example of intraspecific differentiation processes by ecological barriers and geographical isolation. As a member of the subfamily Ariantinae (Gastropoda: Helicidae) with a high spiral shell, *C. obtusus* commonly occurs in a wide range in the eastern Alps at the top regions at altitudes not less than 1,400 m. The species consists of many disjunct populations which must be seen as genetically isolated reproductive units. Its present distribution is believed to be a relict of the last Pleistocene. Morphometric research on samples of shells from various sites disclose high morphometric variability of populations on one hand and remarkable differences between populations on the other. It can be easily shown that different accumulations of special characters occurred. They are equivalent with geographical variation and disclose some special patterns of subsequent separation of populations. Morphometric investigations in addition may resolve whether some subspecies in the literature are valid. Morphometric studies correspond with the results of anatomical research by other authors. Comparisons between shell measurements and the length and width of the head-foot in living specimens from special sites show that shell variability corresponds to morphometric variability of the soft-body. Correlation coefficients between measurements of the shell and soft-body disclose strict relations and morphological interdependencies between the external skeleton and muscular construction.

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Genetic confirmation of limpet sibling species and a test of possible character displacement

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We have found allozyme evidence confirming the existence of a sibling species pair, *Lottia digitalis* (Rathke, 1833) and *L. austrodigitalis* (Murphy, 1978). Despite the fact that it was described two decades ago, *L. austrodigitalis* has not been generally recognized as a valid species, probably due to a lack of perceived morphological distinction by specialists. The diagnosis of *L. austrodigitalis* was based on mostly allozyme frequency differences at two enzyme-coding loci, together with geographic differences. *L. digitalis* was claimed to extend south only to Monterey Peninsula, California, whereas *L. austrodigitalis* ranged north only to Monterey Peninsula. The evidence for their sympatry at Monterey Peninsula suggests an intriguing possibility that these species might be undergoing character displacement where their geographic range overlaps. For example, one species might be found more frequently in high "rock" habitats and the other more often in lower "barnacle" habitats. We employed starch gel electrophoresis to compare multiple enzyme systems, sampling limpets from southern and northern California locations and also from both "rock" and "barnacle" habitats at each location. We found new evidence from multiple loci strongly supporting the existence of the two species as originally described, with only *L. digitalis* at the northern site and only *L. austrodigitalis* at the southern site. Ongoing studies are designed to test whether character displacement might be occurring where the two species overlap at Monterey Peninsula.

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Socio-cultural and traditional medical value of the giant African land snail *Archachatina marginata* in southern Nigeria

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Archachatina marginata (Gastropoda: Pulmonata: Achatinidae) is an edible land snail species, traditionally consumed in southern Nigeria. The cherished meat is utilized in various ways: fried, boiled, oven-dried, or smoke-dried for various purposes other than human consumption. This study investigated the market availability, demand for medicinal and festival values of *A. marginata* in Nigeria where it plays a very significant role in the culture and tradition of the people. In the traditional medicine the by-products of *A. marginata* are as significant as its edible part. The shell, fluid, as well as the whole snail are important ingredients for preparing concoctions for healing various ailments, such as dysentery and convulsions in children. The shell serves as a decorative vase in various homes, shrines, hotels, recreational and relaxation centers, and as an abrasive in various kitchen utensils. During festivals in southern Nigeria. *A. marginata,* being one of the largest of snails, is used whole; the meaty part, particularly the foot, is used in ritual sacrifices to traditional gods. Taboos exist against direct consumption of snail meat as a protein source in some areas as *A. marginata* is often dedicated to traditional gods.

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Exploratory phylogenetics within three land-snail families of Madagascar

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For Madagascan vicariance biogeography and phylogeny-based conservation, four land snail groups have been predicted as most readily informative: Acavidae, *Boucardicus* (Cyclophoridae), Charopidae, and Streptaxidae. Acavids have been evaluated previously. Phylogenetic analyses, using appropriate outgroups, were performed on 17 *Boucardicus* (31 characters, 120 states), nine charopids (21 characters, 53 states), and 15 streptaxids (19 characters, 68 states). The *Boucardicus* cladogram was marginally robust; it supported monophyly of the genus, and it implied evolutionary trends toward larger, more color-patterned, more globose shells hatched from larger eggs; toward a dorsally and more weakly papillate penis with a large, external gland; and toward a broad-based, tightly convoluted fertilization pouch-seminal receptacle complex with an internal, muscular funnel. Neither the charopid nor the streptaxid cladogram provided robust resolution among species. Thus acavids (112 species known) remain the most accessible of Madagascar's major land-snail groups for phylogenetics, mainly because of existing frozen-tissue collections, which have a limited shelf life. *Boucardicus* (194 species known) is clearly the second most accessible.

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Structure of the excretory system of Hawaiian nerites

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Nerites (Gastropoda: Neritoidea) are present in freshwater, brackish, and marine environments, which vary in salinity and exposure to dehydration. In this study I examine the structure of the excretory system of Hawaiian nerites, which indicates possible processes that enable these gastropods to survive in a wide range of environments in the Hawaiian Islands. As is true of other nerites studied to date, the main excretory mechanism of Hawaiian nerites is through filtration of the blood by podocytes. Podocytes are filtration cells in the auricular epicardium. Filtration of the blood between podocytes produces an ultrafiltrate, which collects in the pericardial cavity. No podocytes are present on the surface of the ventricle of Hawaiian nerites. The reno-pericardial canal conveys the urine to the kidney, the epithelium of which is composed mainly of acidophilic cells in marine nerites. In brackish and freshwater species, basophilic cells are present in addition to the acidophilic cells present in marine nerites. It is proposed that the basophilic kidney cells allows non-marine nerites to osmoregulate and produce a hyperosmotic urine at low salinities. A bladder is present, and empties into the mantle cavity near the gill by way of a ureter.

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Description of a new species of *Halgerda* from the Indo-Pacific with a preliminary phylogenetic analysis

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A new species of *Halgerda* (Gastropoda: Nudibranchia: Halgerdidae) is described based on several specimens all having morphological similarities with *H. elegans* Bergh, 1905. This new species is known from Okinawa, Papua New Guinea, and Indonesia. Comparison is made with the original description and newly collected material of *H. elegans* and with other described *Halgerda* species. The coloration, and reproductive and radular morphology of this new species differ significantly from *H. elegans* and other previously described *Halgerda* species. The presence of some anatomical consistencies and similar color patterns between *H. elegans* and the new species suggests that the two species may be more closely related to each other than to some other members of the genus. A preliminary phylogenetic analysis establish the relationship between the species. [poster]

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Observations on the life history of *Sphaerium (Nucleocyclas) nucleus* (S. Studer, 1820) (Eulamellibranchiata: Sphaerioidea)

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Until recently *Sphaerium nucleus* has been considered as an ecological form of the common euryoecious *S. corneum* without taxonomic significance. Anatomical and conchological examinations of Korniushin, however, revealed that this form represents a self-standing, well-characterized species. This view is supported by bionomic specialities of *S. nucleus*. With animals from the Bavarian Danube valley, the author started in 1990 breeding experiments in semi-natural pond aquaria (exposed to natural variation of light and temperature). General results: (1) growth is very slow with two annual interruptions, and does not cease during the whole life; (2) individuals reach an age of more than five years; (3) parturition normally starts during the second year and lasts until death; (4) reproduction rate is very low, the offspring of one individual only being 5-8 juveniles per annum; (5) birth occurs during all months between March and December with two peaks in early summer and middle autumn; (6) the length of the newborn juveniles is 1.8-2.1 mm and thus markedly below that of *S. corneum*, in which the birth size is normally more than 3.0 mm. Data obtained in captivity could be corroborated by field observations. From the thorough studies of Thiel (1924-1930) the life history of *S. corneum* is well known: the life span is normally less than one year, and the reproduction rate much higher than in *S. nucleus*. Compared to *S. corneum*, the stenoecious *S. nucleus* may thus be characterized as a K-strategist.

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Incompatibility of morphologically and allozymatically based systematics within the genus *Bythinella* (Hydrobiidae)

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Systematics is mostly based on morphology and it must be thus, since molecular data are always fragmentary. In some cases, however, morphology alone is insufficient or even misleading for a taxonomist to base upon. Such is the case with *Bythinella,* a minute European hydrobiid spring snail. All of its morphological characters are highly varied among species and populations, while differences between the distinguished "morphospecies" are slight. In this study, 45 morphological characters were measured or counted for 30 males and 49 for 30 females from each of 20 central European populations representing 8 presumed morphospecies. For the same populations, 9 loci were assayed by means of cellulose-acetate allozyme electrophoresis. Morphological differences between the presumed morphospecies were slightly marked. Molecular interpopulational differences were of the level from typically intraspecific to rather interspecific. Three populations were different from all the others morphologically as well as molecularly. Intraspecific molecular differentiation within *B. austriaca* surpassed differences between this species and both *B. cylindrica* and *B. zyvionteki*, although morphologically and biologically the three species seem distinct. On the other hand, 4 populations were molecularly apparently distinct from one another and from all of the other 16 populations, but their morphological distinctness was marked very slightly.

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Contrasting modes of larval development across the Isthmus of Panama

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Biogeographic patterns of marine organisms are related to either historical or ecological factors. Either way, dispersal capabilities have a large impact on rates of speciation, extinction, and species longevity. One way to assess this is to compare patterns in developmental modes among closely related taxa across different environments. The Caribbean and eastern Pacific differ greatly. The latter is more seasonal and productive, and these differences have existed for several million years. Likewise, reproductive propagules (eggs, larvae) of echinoderms, corals, and bryozoans are smaller or exclusively planktonic in the eastern Pacific than in the Caribbean. This is probably due to greater seasonality and productivity of the eastern Pacific, versus the more stable, less productive Caribbean. Protoconch morphology was used to infer developmental patterns for 73 Early Miocene to Recent species of columbellid gastropods of the *Strombina*-group. Planktotrophy predominated in both oceans during the Miocene, then shifted to mostly direct development in the Caribbean while eastern Pacific species remained mostly planktotrophic. Recent *Conus, Oliva*, and *Olivella* suggest similar trends. Thus mollusks exhibit the same differences between these two oceans as other phyla. Virtually all studies of evolutionary trends in modes of development are for Atlantic and Mediterranean species. Our data from the eastern Pacific indicates that the widely reported tendency to evolve from planktotrophic to direct development may reflect changing environmental conditions in the Atlantic rather than an inevitable evolutionary trend. [Bridging Symposium]

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Endemics in an ancient western North American lake (Upper Klamath Lake, Oregon): lake or stream origin?

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Ancient lakes have been touted either as reservoirs from which more recent stream faunas are derived (Russel-Hunter, 1978) or independent centers of endemism which may show little relation even to tributary stream drainage (Boss, 1978; Davis, 1979; Taylor, 1988). Late Cenozoic western North America had a plethora of large pluvial lakes with large endemic molluscan faunas. The best remaining example is the hypertrophic Upper Klamath Lake, Oregon, remnant of a system dating to the Miocene. Survey of 300 UKL drainage sites yielded > 70 mollusk species: > 25 are narrow endemics, of which some 16 are undescribed. Very few taxa are endemic to the lake only; most occur in springs in limited portions of surrounding and tributary drainages. Most "lake" endemics are confined to small areas influenced by underwater springs. Endemics are mostly prosobranchs (*"Fluminicola," Pyrgulopsis, "Lyogyrus"*) and pulmonates (*Vorticifex, Carinifex*) derived from ancient but precinctive western North American stocks, thus corroborating partially the pattern reported by Boss & Taylor. However, these genera are found mostly in springs and streams, not lakes. Thus, there are lakes and there are lakes; but stream origin and diversity are more important, as suggested by Davis and Taylor.

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The hydrobiid subfamily Amnicolinae in the northwestern United States

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Epigean and subterranean freshwater amnicolinids (Gastropoda: Hydrobiidae) are well deployed in the eastern U. S. and Europe but virtually unreported from the western U. S., with only one taxon described, *"Lyogyrus" greggi* (Pilsbry, 1935). Northwestern states' and northern California 1988-1998 collecting proved them relatively widespread, if uncommon (present at 170 of 2,500 sites). Amnicolinids are largely absent from areas north of the Wisconsinan glacial border and the Great Basin. Apparent absences elsewhere may be due to undercollecting or historic factors. *Amnicola s. s.* occurs in a few kettle lakes, a habitat like that of some eastern taxa. Other western forms differ substantially in anatomy, habitat, or (typically) both. Currently known are: (1) a form resembling some eastern U. S. *Lyogyrus* in habitat (ponds and lakes) but substantially different anatomically; (2) *"Lyogyrus" greggi* and congeners, restricted to cold springs; (3) nearly pigmentless cold limnocrene taxa associated with pluvial lake basins; (4) a coastal lineage found in cold, muddy seeps, and small springs. Northwestern forms generally are restricted to very cold oligotrophic habitats; most are photophobic. Roughly half of the sites also have other precinctive hydrobiids. Northwestern subterranean forms have yet to be found. Taxonomic and habitat differentiation from eastern forms implies relatively long separation and separate evolution, both also true of other western hydrobiids and pleurocerids.

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Did the ancestors of higher gastropods (Neritimorpha, Caenogastropoda, and Heterostropha) have an uncoiled shell?

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An uncoiled protoconch was recently found in several, long-lived groups of Paleozoic gastropods (Cyrtoneritimorpha, Perunelomorpha, and Euomphalomorpha). The Ordovician-Permian Cyrtoneritimorpha with uncoiled, fish-hook-like protoconchs probably gave rise during the Paleozoic (?Silurian) to the modern Neritimorpha with a strongly convolute protoconch. A strong peak in mortality during the early shell ontogeny of Ordovician-Devonian members of the Perunelomorpha suggests the existence of a planktotrophic larval shell. The oldest undoubted members of subclasses Caenogastropoda and Heterostropha, which also had a planktotrophic larval shell, are known from the Early Carboniferous. The perunelomorph gastropods may thus represent their ancestral group. The Euomphalomorpha forms an independent gastropod group, known only from the Paleozoic, which may be related to the Neritimorpha (Bandel & Frýda, 1998). The uncoiling of the protoconch found in the above-mentioned groups may represent a very old shell feature. In contrast to these groups, the latter feature is not known among the members of the subclasses Archaeogastropoda and Amphigastropoda. The above data suggests that the higher gastropods (Caenogastropoda, Heterostropha, and Neritimorpha) as well as the extinct Euomphalomorpha may have evolved from a common ancestor with an uncoiled shell, and thus not from the Archaeogastropoda and/or Amphigastropoda in contrast to many recent phylogenetic schemes. [poster]

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Higher classification of the Paleozoic gastropods inferred from their early shell ontogeny

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A study of Silurian and Devonian gastropods of the Prague Basin (Czech Republic), focused on their protoconch morphology, has revealed the presence of five natural gastropod groups: Amphigastropoda, Archaeogastropoda, Neritimorpha, Euomphalomorpha, and Perunelomorpha. The morphology of the early shell of *Bellerophon* and related genera (Amphigastropoda) demonstrates that these mollusks do not belong to the subclass Archaeogastropoda and form a long-lived (Cambrian through Triassic) independent molluscan group. The most common gastropod group, the Archaeogastropoda, also contains extinct groups such as the Murchisonoidea, Cirroidea, and Stylogastropoda. The discovery of archaeogastropod-type protoconchs in some Early Devonian gastropods indicates that the subclass Archaeogastropoda has had the same early ontogenetic pattern for at least 400 Ma (Devonian to Recent) and represents a very old, independent gastropod group. Two groups can be recognized among gastropods belonging to the subclass Neritimorpha. The first group (Cycloneritimorpha) is characterized by a strongly convolute protoconch and may be traced from the Recent back at least to the Triassic. The Ordovician-Permian "platyceratids" with openly coiled, fish-hook-like protoconchs form the second group (Cyrtoneritimorpha). An uncoiled protoconch was also found in two independent gastropod groups, the subclass Euomphalomorpha and the order Perunelomorpha. The last order is based on the Ordovician-Devonian superfamily Peruneloidea. [poster]

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Evolution and biostratigraphic ranges of the Quaternary molluscan fauna in central Europe

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An intensive Quaternary investigation was evolving all over Europe at about the turn of the century. The calcareous shells of the bivalves and gastropods are well-fossilized and in most Quaternary sediments they occur in large masses. During the last hundred years, a considerable amount of valuable molluscan material was collected from the Quaternary sediments in Hungary (central Europe). The first data on the molluscam fauna of the Pleistocene sediments come from the last third of the 19th century, but the real beginning of malacological investigations is dated only from the beginning of the 20th century. The aim of the present work is the stratigraphical evaluation of Quaternary malacological data in the Carpathian Basin and the biostratigraphic division of central European Quaternary formations on the basis of the molluscan fauna. We believe that the best way of showing these results is in the joint presentation of the work by three coauthors. Thus, the Pleistocene malacostratigraphical division (Krolopp), the stratigraphical problems of the Upper-Pleistocene loess and soil formations (Sümegi), and the elaboration of the Holocene malacostratigraphy (Fűköh) are presented. Based on the three pieces of work, a coherent view can be obtained on the Quaternary malacostratigraphical investigations of the past 40 years in the Carpathian Basin. [poster]

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Description of a new species belonging to the genus *Glossodoris* (Doridoidea: Chromodorididae) from Pacific Ocean waters of Panama

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In June 1996 and February 1997, two specimens of an unknown Chromodorididae species belonging to the genus *Glossodoris* were collected under rocks at the intertidal zone of Coiba Island and on an oyster at Jicarita Island (7 m depth), respectively. In this paper, a description of the external and internal anatomy of these specimens is given and compared with other *Glossodoris* of a similar coloration pattern. [poster]

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Faunistic data about the opisthobranch gastropods from Coiba National Park (Panama)

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Few records on opisthobranch mollusks exist from the Pacific Panamian coasts. During some expeditions around some islands belonging to the National Park of Coiba (Panama), included in the Project Inventory of the fauna and flora from the National Park of Coiba, and supported by Agencia Española de Cooperación Internacional, several intertidal and infralittoral sites were examined and more than 150 opisthobranch specimens, belonging to more than 30 species, were collected. Faunistic data about the opisthobranchs found during the expeditions are indicated. [poster]

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Data on a species of *Neomenia* (Mollusca: Solenogastres) from Livingston Island (South Shetland, Antarctica)

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The project BENTART '95 (ANT94-1161/E; ANT95-1011) includes the study of solenogaster mollusks collected on Livingston Island (South Shetland, Antarctica) during the Spanish Antarctic expeditions targeting the study of Antarctic benthos. Only one specimen was collected off Miers Bluff to the south of Livingston Island (62°44'17"S; 60°28'11"W) at a depth of 80 m, from a bottom of fine mud and sand using a box-corer type dredge. Only the anterior part of this specimen was able to be reconstructed and studied, as the posterior part presented substantial histological deterioration. The specimen belongs to the order Neomeniamorpha since it has thick, acicular spicules and striated scales. It does not have ventral foregut glandular organs and has folds for breathing. It is classified within the family Neomeniidae because of its relatively thick cuticle with epithelium papillae, its thick, acicular spicules and elongated scales with striations. It does not have a radula nor does it have ventral foregut glandular organs. It has a pedal groove with several folds. It is located within the genus *Neomenia* Tullberg, 1875, since it complies with the primary characteristics of this genus. This presentation describes the anterior part of this specimen, which presents marked differences from the six Antarctic and Sub-Antarctic species currently known to belong to the genus *Neomenia*. However, the lack of knowledge on its important posterior organization makes it impossible to conclude with the nomination of a new species. [poster]

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The presence of a new species of *Dorymenia* (Solenogastres: Cavibelonia) on Livingston Island (South Shetland, Antartica)

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Preliminary data are presented on a new species of *Dorymenia*, collected on Livingston Island (South Shetland, Antarctica) during the Spanish Antarctic Expeditions targeting the study of Antarctic benthos within the project BENTART '95 (ANT94-1161/E; ANT95-1011). Only one specimen was collected to the south of Livingston Island at station A-19 (62°43'43"S; 60°31'27"W) with a Agassiz type trawl on muddy bottoms at a depth of 235 m. This species is located within the order Cavibelonia because of its hollow acicular spicules arranged in several layers within a thick cuticle having epidermic papillae. It belongs to the family Proneomeniidae due to its polistich/polyserial radula, ventral foregut glandular organs type C, and the presence of individual seminal receptacles on each side of its body. The traits that allow it to be included within the genus *Dorymenia* are well-defined: a buccal opening at the end of the atrium buccal space, a midgut having lateral bags and the presence of copulatory spicules and a dorsoterminal sense organ. Considering the radular structure and the shape of the teeth, which have a long base and a caudally arched tip, it is related to *Dorymenia* discovery (Nierstrasz, 1908), *D. antarctica* (Thiele, 1913), *D. hoffmani* (Salvini-Plawen, 1978), *D. usarpi* (Salvini-Plawen, 1978), although in these species the radular teeth are larger. Other traits that distinguish it from the four species mentioned above are also discussed. [poster]

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Report on the distribution of the genus *Dorymenia* (Solenogastres: Cavibelonia) on the South Shetland Islands, Antarctica

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During the Spanish Antarctic Expeditions for the study of Antarctic benthos carried out within the projects BENTART '94 (ANT93-0996; ANT95-1011) and BENTART '95 (ANT94-1161/E; ANT95-1011) a small collection of solenogaster mollusks was compiled and is currently being studied. Although the solenogastres are one of the lesser known classes of mollusks, 44% of the species described come from Antarctic waters, since on a number of oceanographic expeditions carried out in Antarctic waters during this century a substantial number of specimens was collected. They have all been compiled and examined in the monographic work "Antarktische und subantarktische Solenogastres" (Salvini-Plawen, 1978). The genus *Dorymenia* is one of the most diverse of its class. 20 species are known to date, 13 of which belong to the Antarctic or Sub-Antarctic domain, and 6 in particular were found in the waters off the South Shetland Islands. During the BENTART expeditions, 13 specimens of solenogasters were collected, 12 of which were classified as 3 new species of the genus *Dorymenia*. This presentation reports on the distribution of the 9 species, currently known to belong to the genus *Dorymenia* from the South Shetland Islands, which represent 40% of the species known to be of this genus. A table is also provided explaining the differences between these species in addition to diagrams of the characteristic cuts of their posterior parts. [poster]

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Growth, mortality, and influence of abiotic factors on reproduction and recruitment of the fan shell *Pinna carnea* (Pinnidae: Bivalvia) from the Colombian Caribbean

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A *Pinna carnea* population was studied to obtain basic information on the biology of this pinnid species, which has been identified has a potential candidate for aquaculture. Growth, mortality recruitment, and reproduction as well as the abiotic factors controlling the reproductive cycle were studied. *P. carnea* is a synchronous monoecious (simultaneous hermaphroditic) species exhibiting a continuous spawning cycle throughout the year with a period of high reproductive activity between July and January. Growth parameters according to the von Bertalanffy growth model, obtained from tagging-recapture data, were K = 0.679/year and asymptotic shell height H_∞ = 152.5 mm. Total mortality, estimated from the length-converted catch curve was Z = 2.822/year. Recruitment was in accordance with the continuous reproductive cycle, a continuous presence of postlarvae during the study period with two maxima, one in June and the second in November-December. The relationship between reproduction cycle and abiotic factors is discussed. Significant correlations where observed for the following annual cycles: spawning/temperature, shell free dry weight/salinity and recruits/temperature. [poster]

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Micro-pulmonates in tropical rainforest litter: a new bio-jewel

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In contrast with insect diversity, mollusks in tropical forests are not known to be remarkably diverse, with beta-diversity usually standing well below 20 species. Indeed, the lack of calcium in the soils of the Congo-Zaire or Amazon basins gives reasons for not expecting a rich and diverse malacofauna. However, recent studies in French Guyana making extensive use of sieving techniques disclose a novel radiation of micro-pulmonates in the forest litter. Collecting effort concentrated on twenty 2 x 1 m quadrats within a 1 km^2 plot of the Nouragues Biological Reserve. The study area comprises habitats ranging from the lower slopes of a granitic inselberg to dense forests on lateritic soils. The samples, totalling 280 liters or 102 kg, were sieved through 3, 2, 1 and 0.5 mm. Alpha-diversity of up to 20 species per quadrat was documented, with a beta-diversity of 34 species for the study area, of which 23 may represent undescribed species. The molluscan fauna consists mainly of minute and rare species. A majority of species is smaller than 5 mm, and there are species never collected on sieves above 0.5 mm. Eleven species (32% of the total) are represented by fewer than 5 specimens. This newly revealed dimension of tropical molluscan faunas suggests that their real diversity may have been underestimated worldwide.

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Ingestion and assimilation of ^{14}C-labeled algae by juvenile rainbow mussels (*Villosa iris* Lea, 1829)

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Little to no information exists on the nutritional requirements, ingestion rates, and particle-size preferences of unionids. Concern over declining populations of unionids has led to a national strategy for the conservation of unionids which includes propagation of threatened species for stock enhancement to native streams. Understanding the feeding ecology of the juvenile life stage is critical to the success of these programs. Thus, we determined the ingestion and assimilation efficiency of algae (carbon) by juvenile *Villosa iris*. Five replicate cultures containing 200 juveniles were fed approximately 3.4 mg dry weight of ^{14}C-labeled *Neochloris oleoabundans* (Chantanachat & Bold, 1962). Juveniles ingested *ca.* 30% (0.27 ± 0.21 mg) of the available carbon in 2 hours. Of the total carbon ingested, 62% was defecated (0.09 ± 0.07 mg), 4% excreted as waste (0.02 ± 0.03 mg), 7% respired (0.04 ± 0.03 mg), and 27% incorporated into tissues (0.12 ± 0.09 mg). Consequently, mussels assimilated (incorporation + respiration) 34% of the ingested carbon. Thus, at relatively high cell concentrations, *N. oleoabundans* has nutritional value as a food for propagating juvenile mussels.

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Blockade of the electrically- and L-arginine-induced, nerve-mediated relaxation of the bulbus cordis branchialis of *Sepia officinalis* Linné by a selective inhibitor of nitric oxide (NO) stimulated guanylylcyclase and NOS-inhibitors

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Pharmacological studies on the regulation of the autonomously contractile bulbus cordis branchialis (BCB) of the cuttlefish *Sepia officinalis* L. reveal a possible participation of inhibitory nitrergic mechanisms which are probably not induced by acetylcholine (Gebauer & Schipp, *Zool. Anal. Complex Sy.*, in press). In the present study, electrical stimulation and pharmacological experiments were carried out on isometrically stretched, ring-shaped preparations of the BCB including its innervating visceral nerve and cardiac ganglion. The BCB innervation was demonstrated by DiI tracing and silver staining according to Bodian's method. Electrical stimulations (undelayed, 300 ms, 5V) on the visceral nerve induced negative tonatropic and negative inotropic responses of the BCB which were significantly reversed by ODQ (2×10^{-6} M), a selective inhibitor of NO stimulated guanylylcyclase. After application of the NO-precursor L-arginine (10^{-5} M – 5×10^{-5} M), comparable effects were recorded. These were also reversed by ODQ (2×10^{-6} M) and, on top of that, significantly blocked by the NOS-inhibitors carboxy-PTIO potassium and L-SMTC in a concentration of 5×10^{-6} M. In contrast to that, L-arginine induced no effects on denervated preparations of the BCB. On the basis of the results presented here the possibility that NO could be produced in peripheral nerves innervating the BCB of the cuttlefish has to be considered. Further studies using antibodies against nNOS will clarify this assumption. [Supported by grants of the Deutsche Forschungsgemeinschaft (Schi 99/7-4)].

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Biogeography of the Haliotidae (Gastropoda: Vetigastropoda)

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The Haliotidae are a family of gastropods with a worldwide distribution in tropical and temperate waters. Distributional data from approximately 4,000 lots of the 55 species were collected to address the question of the origin of the family. Three scenarios have been proposed in the literature: (1) Pacific Rim, (2) Indo-Pacific, and (3) Tethys. Area cladograms with an underlying vicariance assumption were constructed. Three alternative roots corresponding to the three proposed origins of the family were used, and tree length was employed as the discriminating factor. Comparison with a preliminary parsimony analysis of the taxa is made.

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DNA data as elementary hypotheses: how to avoid impossible character state reconstructions

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The use of DNA sequence data has transformed systematic biology, including malacology. Despite a wealth of data having been acquired, the debate on the proper utilization of the data is unsettled. One of the most basic questions of how observation should be represented in a data matrix is here addressed with a special focus on the homology concept. DNA sequence alignment is discussed and the commonalities between morphological as well as molecular data is highlighted. As alignment is an observational process, gaps must be coded as additional character state and not as missing data. The treatment of questionable aligned regions is explored through multiple coding strategies. Elision, case sensitive, missing data, and polymorphic coding all violate homology either through the test of conjunction or by contradiction with the original observations. Only character exclusion and contraction result in character state reconstructions in agreement with homology. Furthermore it is proposed to use additional character states to include highly divergent sequences. Some examples from ongoing work in the Haliotidae illustrate the effects of the various coding strategies.

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On bivalve phylogeny

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After several studies attempting to solve bivalve phylogeny using independent sets of characters (shell characters, soft anatomical characters, and 18S rDNA sequence data), little consensus has been reached about either the monophyletic status or the internal relationships of the second most diverse class of extant mollusks. Here, we explore bivalve relationships using a compilation of morphological (shell and soft-anatomy) and molecular (18S rDNA, 28S rDNA, and cytochrome oxydase I) data for all bivalve orders and other molluscan classes (molecular data not available for Solenogastres and Monoplacophora). Phylogenetic analyses and data exploration through sensitivity analyses are done using direct character optimization (Wheeler, 1996).

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Transspecific introgression in *Albinaria* (Gastropoda: Pulmonata)

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In central Greece, the genus *Isabellaria* is distributed with several species, characterized, *e. g.*, by the structure of their clausilial apparatus [CA] (G-type). In the eastern Peloponnese, several couples of strikingly similar, vicariant species occur, with the G-type and the N- (Normal) type of clausilial apparatus, respectively. Two alternative hypotheses have been proposed to explain this pattern. (1) The G-type species in the Peloponnese are classified with *Isabellaria*, and the N-type species with *Albinaria*; their similarity is explained by intergeneric introgression and local adaptation. (2) The species couples in the Peloponnese are sister species; a strong selection pressure (predation) triggers the repetitive, parallel development of the locally superior G-type, which has not yet replaced the N-type populations completely. DNA analyses strongly support the phylogenetic relationships implied by hypothesis 2. The distributional pattern of the various forms, and the fact that occasional hybridization is common among *Albinaria* species, enables a third hypothesis, without frequent repetitive parallelism, explaining also why the phenomenon is geographically localized: the genetic background of the G-type CA, originated in central Greece and is passed from one species to another in the Peloponnese: transspecific introgression.

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Wrestling with homology: evolution of vivipary in tropical freshwater gastropods (Cerithioidea: Thiaridae *s. l.*)

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Vivipary has been treated as one of the key innovations accompanying the colonization of freshwater. Phylogenetic analyses of morphological data, including sperm ultrastructure and some molecular data (conducted in cooperation with Winston Ponder, John Healy, and Charles Lydeard) have revealed that within the superfamily Cerithioidea several independent colonization events occurred. Freshwater cerithioideans include families such as Thiaridae *sensu lato*, Melanopsidae, Pleuroceridae, and Pachychilidae that have not been properly revised in a modern phylogenetic context and the boundaries of these family groups continue to be confused in the literature. Analyses of the freshwater and brackish-water cerithioideans also revealed that the Thiaridae *s. l.* are polyphyletic. In addition to the Melanopsidae and Pleuroceridae, the Thiaridae *sensu lato* should be separated into at least three evolutionary lineages representing the Thiaridae *sensu stricto* (with *e. g., Thiara* and *Melanoides*), Paludomidae (with *e. g., Paludomus* and *Cleopatra*), and Melanatriidae (with *e. g., Potadoma, Brotia,* and possibly *Pachychilus*). Only some of these lineages within the Thiaridae *s. l.* are viviparous. However, amongst these viviparous taxa two distinct brooding strategies can be found correlated with unique anatomical structures. The reproductive modes of a number of taxa are discussed, including those from East African and Sulawesi lakes as well as from Southeast Asia and Australia. It is concluded that vivipary, although of great importance for speciation in some cases, is not the ultimate factor for thiarid radiation in freshwater.

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Caecum debile Verrill & Bush, 1900, as a synonym of *C. multicostatum* Folin, 1867 (Gastropoda: Caecidae)

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Despite the number of species concentrated in tropical waters, the family Caecidae Gray, 1850, has been poorly studied. Conchological analyses by SEM and studies with observation of type-series lead us to new discoveries. The study of the type-series of *Caecum multicostatum* Folin, 1867, stored at Muséum National d'Histoire Naturelle, and the holotype of *C. debile* Verrill & Bush, 1900, stored at Peabody Museum of Natural History, clarifies our doubts about the taxonomic situation of both species. Even with the eroded state of *C. debile* shell surface, it was possible to characterize a sculptural pattern composed of low longitudinal ridges exactly as in *C. multicostatum*. In this way, *C. debile* with type locality assigned to Bermuda is now a synonym of *C. multicostatum*. The subgeneric position of *C. debile*, originally in *Costulata* (*Elephantulum* Carpenter, 1857), must be corrected to *Brochina* Gray, 1857, due to septum and mucro characters. [poster]

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Parasites of *Octopus vulgaris* (Cuvier) from the southern Caribbean

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A total of 42 *Octopus vulgaris* from La Guaira, in the Venezuelan Caribbean, have been examined for parasites. As a result several species of dicyemids (Mesozoa) have been identified as well as the presence of a coccidian protozoan (*Aggregata* sp.). The kidneys of all *O. vulgaris* examined showed the presence of several species of dicyemids, at least two of which seem to be new species. One of the dicyemid species is very closely related to the Gulf of Mexico *Dicyema bilobum-apalachiensis* complex and probably belongs to it. The two other species are different from all others thus far described from the coast of Florida and the Gulf of Mexico, on the basis of calote shape, size of adult stages, and larval morphology. The largest species found measures (nematogen stage) 260-442 μm, and has 17-18 somatic cells. The rhombogen stage measures 230-343 μm and has the same number of somatic cells. The other species present in both nematogen and rombogen stages has a short and ovoid shape, and is smaller than all the other species described in the nearest locations (68-134 μm). Coccidian protozoans (*Aggregata* sp.) were found parasiting the digestive tract of *O. vulgaris*. This represents the first report in the western Atlantic for such parasite in that particular host, the nearest report being the Azores Islands.

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Toxic deception: mimicry complexes of nudibranchs and polyclad flatworms

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Recent studies of organisms inhabiting tropical reefs in the Indian and Pacific Oceans have brought to light numerous unpalatable organisms that have remarkably similar, elaborate color patterns. These represent some of the first documented cases of Batesian and Mullerian mimicry involving phylogenetically distantly related groups of marine organisms. Mimicry circles have been described for complexes of nudibranch species, but have not been well-documented for complexes involving nudibranchs and flatworms. Numerous examples of different mimetic complexes involving nudibranchs and flatworms are presented. Some members of these complexes represent intermediate conditions between Batesian and Mullerian mimicry, as there is differential unpalatability, depending on the predators involved. Mimetic complexes occur commonly in tropical reef ecosystems and represent a common adaptive strategy of nudibranchs and flatworms in these ecosystems. [poster]

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Some thoughts on genetic differentiation, gene flow, and habitat-specific selection in marine snails (*Littorina saxatilis*)

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Littorina tenebrosa Montagu is a small fragile-shelled periwinkle which lives on permanently submerged algae in coastal lagoons and non-tidal brackish pools. This snail is a member of the rough periwinkle group, *L. saxatilis* Olivi, *L. arcana* Hannaford Ellis, *L. compressa* Jeffreys, and *L. neglecta* Bean, but its exact systematic status is in doubt. Eight samples of *L. tenebrosa* and *L. saxatilis* from Ireland and Britain, including pairs of each from two locations in Ireland, were screened for genetic variation at 12 polymorphic enzyme loci using starch gel electrophoresis. UPGMA analysis showed that *L. saxatilis* and *L. tenebrosa* populations clustered as a monophyletic group, but within this group there was further separation, partly by habitat. Genetic distances were high (mean D = 0.20) between allopatric populations of *L. saxatilis* and *L. tenebrosa*, but between parapatric populations of the different species genetic differentiation was of the same order of magnitude as for allopatric populations. This indicates that there is a barrier to gene flow between the two forms and that *L. saxatilis* and *L. tenebrosa* can be regarded as separate taxa. These results are discussed in the light of additional data on shell morphometrics and DNA polymorphisms (SSCPs).

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The role of Melanopsidae (Mollusca: Gastropoda: Pectinibranchia) in the European epidemiological situation

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According to a recent taxonomic revision of European/Asian Melanopsidae (Starobogatov, *et al.*, 1992), Ukrainian waterbodies yield *Fagotia dneprensis* Star., Alex. & Lev., 1992; *F. danubialis* Bgt., 1884; *F. berlani* Bgt., 1884 [all usually as *F. esperi* (Férussac, 1823)], *Microcolpia potamoctebia* (Bgt., 1870); *M. canaliculata* Bgt., 1884; *M. ucrainica* Star., Alex. & Lev., 1992 [all as *F. acicularis* (Férussac, 1823)]. According to our data, all Ukrainian Melanopsidae play important roles in epidemiology of trematodosis of freshwater fishes and in the transmission of sanguinicolosis of water birds. All species of *Fagotia* and *Microcolpia* act as intermediate hosts for larval stages of parasites. *F. dneprensis* (from river Dnestr) had parthenites and cercariae of *Sanguinicola* sp.; the extent of infection (EI) = 33.3%. *F. danubialis* (from rivers Styr and Goryn) had parthenites and cercariae of *Cercaria pulsans* Zdun, *C. myzura* Pagenst., and *S. inermis* Plehn.; EI = 12.3%. *F. berlani* (from river Dnestr) had cercariae of *C. pulsans, C. curta* Zdun, and *Sanguinicola* sp.; EI =17.2%. *M. potamoctebia* (from rivers Styr and Goryn) had parthenites and cercariae of *C. pulsans, Sanguinicola* sp., and *Notocotylus attenuatus* (Rud.); EI = 32.1%. *M. canaliculata* (from rivers Dnestr and South Bug) had parthenites of *C. curta, C. subulo* Pagenst., *C. alia* Zdun, *S. inermis*, and *N. attenuatus*; EI = 15.5%. *M. ucrainica* (from river Dnestr) had parthenites and cercariae of *C. pulsans, Sanguinicola* sp., and *N. attenuatus*; EI = 54.5%. [poster]

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Use of museum specimens in molecular phylogenetic analyses of freshwater mussels (Unionidae)

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Molecular phylogenetic analyses of the Unionidae (and other mollusks) have relied on the availability of recently collected specimens as a source of nucleic acids. This bias toward relatively fresh tissue neglects a potential source of DNA: the numerous museum specimens accumulated over the last more than 150 years. Dried tissue, as residue of adductor muscle or mantle adhering to the shell, harbors DNA, but these molecules are of unknown quantity and quality. To date, I have applied various PCR techniques to amplify DNA from museum specimens. I will present the progress of my on-going research and discuss its possible future uses.

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From RAPDs to microsatellites: genetic structure of populations of the rough periwinkle, *Littorina saxatilis*

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Variation is the raw material of evolution, and the conversion of polymorphism into species level differences is a phenomenon both fascinating and important. The intertidal gastropod *Littorina saxatilis* is an important species in the study of gastropod variation: it exhibits a wide range of forms often referred to as 'ecotypes.' Here we show that RAPDs can be used to differentiate between some of these on a strictly local basis. Much more importantly, we show that RAPDs band-derived clones have led to the discovery of a microsatellite which appears to show different mutation properties in two ecotypes - and this is not a local phenomenon. This result has implications for the study both of polymorphic species and of microsatellites.

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A checklist of the terrestrial mollusks in the Bosawas Biosphere Reserve, Atlantic region, Nicaragua

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Bosawas is a vast forested area that extends from the north-central Altiplano (highlands) to the Caribbean lowlands. Bosawas was declared a Biosphere Reserve by "Man and the Biosphere" of UNESCO on 26 February 1998. As in many other neotropical reserves, knowledge of the malacological fauna of Bosawas is limited. Since 1996, the Malacology Center and the German Cooperation Agency GTZ-MARENA (Nicaraguan Ministry of the Environment and Natural Resources) have developed a research program focusing on the Biosphere Reserve. The main objective of this program is to elaborate a faunistic inventory of terrestrial mollusks in the Bosawas Reserve. This paper shows the results of the faunistic inventory of this region. The biological material studied comes from the collections made *in situ* between 1996 and 1998. Collections were made at: (1) Cerro Saslaya National Park-SA 13°45'30"N, 85°01'W; (2) Río Waspuk-WA 14°22'N, 84°37'W; (3) Cerro Las Latas-LA 14°03'N, 84°31W; (4) Peñas Blancas-PB 13°17'N, 85°38'W; (5) Kilambé Park-MK 13°34'N, 85°42'W; (6) Cerro Musún-CM 14°33'N, 85°07'W; and (7) Caves Tunawalan-CT 14°32'N, 85°07'W. A total of 94 species of terrestrial and aquatic gastropods are listed, distributed in 46 genera and 22 families. The families with higher species diversity were Spiraxidae (20%), Subulinidae (9%), Systrophidae, Heliocarionidae, and Bulimulidae (7% each), Helicinidae, Poteriidae, and Vallonidae (5% each). The remaining families showed species diversities lower than 5%. This is the first taxonomic study on the terrestrial malacological fauna from Bosawas. [poster]

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A phylogenetic analysis of the Patellogastropoda based on morphological and molecular data sets

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The relationships among taxa and character transformation series within the Patellogastropoda have not been previously examined in a rigorous phylogenetic context. We scored 83 morphological characters based on gross anatomy, microstructure, ultrastructure, and histology in 18 ingroup taxa. Ingroup OTUs represent a range of "taxonomic" levels dependent on our confidence of OTU monophyly. Some OTUs represent species while others are at the "family" level. Four outgroup taxa were used based on recent phylogenetic hypotheses in the Gastropoda. Analyses with and without outgroups comprise hypotheses based on morphology only. We then used the most parsimonious trees from the morphological data as starting trees and optimized these against the less complete molecular data set to determine the best fit between morphology and molecules. The best supported phylogenetic hypothesis shows two major clades, with one branch leading to the Patellina and Nacellina and the other to the Acmaeoidea. The deep-sea taxon *Bathyacmaea*, whose anatomy has never before been described is placed as a basal Acmaeoidea; mosaically sharing apomorphies with *Patellina* and *Nacella* and others with the Acmaeoidea. A major finding of the character analysis is that although patellogastropod muscle and radular systems appear plesiomorphic, cartilage morphology and the association of cartilage and radula have undergone major modifications likely related to the change from flexoglossate to stereoglossate feeding.

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The effect of isolation on the life-history traits of *Pseudosuccinea columella* (Pulmonata: Lymnaeidae)

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A population of *Pseudosuccinea columella* was grown under laboratory conditions and life tables were determined for snails raised individually (G-1) and in pairs (G-2). Individuals of G-1 were significantly larger in shell size than those of G-2 after the seventh week. Both groups had the same life span (24 weeks) but the survival curves were different, G-2 exhibiting higher survival probabilities at the beginning of the experiment and lower values after the eleventh week, whereas G-1 showed a step-like curve during its entire life range. Statistically significant differences were found for the number of eggs per individual from week 5 to 9, with G-1 snails exhibiting the highest values. Both curves displayed the same shape though, with a reproductive peak on the fifth week. The number of viable eggs per individual also manifested similar changes, but statistical differences were found on weeks three and four, the highest values being exhibited by the G-2 snails. The intrinsic and finite rates of increase were found to be very high in both groups, with greater values for snails belonging to G-1; this was accompanied by a greater net reproduction rate in this group and a similar value of the mean reproduction time compared to G-2. A possible chemical inhibition of the reproduction between individuals of this species is proposed as the cause of the differences.

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Paralarval octopods of the Florida Current

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A study was conducted regarding some taxonomic and ecological aspects of the paralarval octopods found in the waters off Ft. Pierce, Florida, between Februry 1987 and July 1990. Nine external features were analyzed: mantle length (ML), relative length of arms (arm formula), number of suckers per arm, relative size of suckers (suckers formula), chromatophore pattern on arms, ventral head, dorsal head, ventral mantle, dorsal mantle, and funnel. Also, the relative abundance of the species present was determined and associated with seasonal occurrence, depth, distance offshore, as well as day and night occurrence. Nine different species of octopus were found in the samples. The most common species was *Octopus vulgaris* followed by *O. burryi* and *O. defilippi*. This last apparently presented two different morphs (named type A and type B) which could correspond to different species since they differed in the arm formula and in the arm chromatophore pattern. Two unidentified groups were also found, tentatively assigned to *Scaergus unicirrus* (Unidentified A) and *Octopus joubini* (Unidentified B) because of similarities with those species. The seasonal distribution of the most abundant species seemed to be associated with variations of the weather, since the relative abundance was higher in the warmest months of the year. Most of the animals appeared more frequently in the region between 18 and 22 miles offshore and the middle zone of the water column. Also, except for *O. burryi*, a greater abundance was found at night than during the day.

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Solar orientation and visual capabilities of *Nerita picea* (Gastropoda: Neritidae) during Summer 1997 at Sandy Beach, Oahu, Hawaii

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The objective of this study was to asses the existence of solar and visual orientation of the intertidal prosobranch *Nerita picea* (Recluz, 1841) which are abundant mollusks on the rocky shorelines of Oahu, Hawaii. Individual snails were tested on a Plexiglas disk at Sandy Beach and sunlight (with and without ultraviolet light) and artificial black and white visual cues were tested as exogenic factors that may act on *N. picea* to provide orientation information. Orientation was monitored as a magnetic compass was placed above the anterior end of each snail and bearing in regards to 0°N was recorded. Results showed that *N. picea* had a preferred north and southwesterly during morning hours away from position of the sun thus these snails are photonegative. Snails crawled faster in the absence of ultraviolet light and in darkness. *N. picea* demonstrated skototaxis when given a choice of white and black boards. Among the behavioral adaptations developed by intertidal invertebrates, including gastropods, many orientation mechanisms are light-compass reactions due to spatial and temporal variation of the sun. It seem *N. picea* uses sunlight as a primary compass information over time in combination with perception of stimuli by eyes and/or extra-optic structures, altogether with the well-known adaptations of tidal rhythmic activity patterns and non-random distribution on the shore. [poster]

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Radiation of crenobiontic gastropods on an ancient continental island: the *Hemistomia*-clade in New Caledonia (Caenogastropoda: Hydrobiidae)

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A vast radiation of hydrobiid snails comprising 54 named species of which 50 are new, all endemic to New Caledonia, a continental island in the southwestern Pacific known for its unique flora and fauna, is described. The majority of the species belong to the genus *Hemistomia*. The remaining species are attributed to four new genera. The radiation as a whole is characterized by the formation of the digestive gland, the stomach, and the subdivision of the pallial oviduct. Whether a denticle situated behind the outer lip is a synapomorphy of the whole group cannot be stated with certainty. The genera are distinguished mainly by features of the genital system. The majority of the species occur in very restricted areas. 26 species were found in a single locality and only 6 species in ten or more places. The hydrobiid diversity of west coast drainages is much higher than that of river systems draining to the east, which is probably due to the differing precipitation regimes and geological conditions. Many of the taxa are highly threatened due to human activities like deforestation, agriculture, surface mining, or uncontrolled fires. The conservation of the unique New Caledonian radiation of crenobiontic gastropods requires a transformation of land management practices on privately-owned sites, and a more global reappraisal of the impact of fire and deforestation on water resources.

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Preliminary results of molecular phylogenetic studies on pteriomorph Bivalvia

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Bivalvia present particularly nasty problems to students of their phylogeny. Morphologists are stunned by the numerous cases of parallel evolution in various organ systems such as shell shape, hinge dentition, mantle siphons, gills, and stomach differentiation. High hopes are, therefore, put into the molecular approach. Previous molecular phylogenetic studies using the 18S rDNA gene produced diphyletic Bivalvia, separated by Polyplacophora and/or Gastropoda. The objective of this study is to investigate phylogenetic relationships between the major groups of the subclass Pteriomorphia, the Arcoidea, Limoidea, Mytiloidea, Ostreoidea, Pectinoidea, Pinnoidea, and Pteroidea, based on sequence divergence of 18S rDNA and a partial sequence of the mitochondrial cytochrome oxidase subunit I (COI) gene. As outgroups serve representatives of the bivalve subclasses Eulamellibranchia (*e. g.*, Lucinoidea) and Protobranchia as well as Scaphopoda. The data are analysed with parsimony and distance methods, maximum likelihood and spectral analysis with separate and combined data. Preliminary results obtained from 7 individuals of pteriomorph Bivalvia show that both 18S rDNA and COI sequences do not support bivalve monophyly. While 18S rDNA indicates separate origins of Eulamellibranchia and Pteriomorphia, the COI sequences support their monophyly. A single species of the Limoidea, however, clusters with a gastropod outgroup. Within the Pteriomorphia, the basal position of Mytiloidea in the 18S rDNA tree is in agreement with morphological results. The preliminary COI trees have a pectinid as basal branch.

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Using Recent bivalves to resolve evolutionary problems: possibilities and pitfalls

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Recent bivalves appear to have a far greater diversity, in both taxonomic and ecological terms, than they have ever had before and the class has an excellent fossil record, arguably the best of any invertebrate group. These two facts should combine to make them one of the most promising candidates for truly palaeobiological work. The study of modern bivalves equip paleomalacologists with the ability to interpret the life-habits and functional morphologies of extinct taxa and the application of molecular techniques will allow the construction of phylogenies which can be tested by reference to the fossil record. Furthermore, there is the potential for using living bivalves to test evolutionary hypotheses by constructing experiments which in some way modify environmental conditions or the functional parameters of live specimens. I shall outline some of these approaches and demonstrate the requirement for more work which straddles the two disciplines of palaeontology and zoology. The use of modern bivalves to understand the evolutionary history of the class relies heavily on uniformitarian principles, but how far can we push such a notion? [Bridging Symposium]

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What is a good character? The example of gastropod cephalic tentacles

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Cephalic tentacles of gastropod mollusks fulfill nearly all requirements of a "good" systematic character. (1) They are present in nearly all gastropods; only few heterobranch taxa (*e. g.*, *Omalogyra*, bullomorph and certain sacoglossan and nudibranch opisthobranchs, Trimusculidae) show reduction or loss. Other taxa exhibit to a greater or lesser extent specializations concerning sperm transfer, prey capture, or presence of neuroendocrine centers. (2) Differences occur from the level of subclasses (Patello- versus Orthogastropoda) to infrafamiliar level (*e. g.*, within the Rissooidea). (3) Because various gastropod groups have independently colonized freshwater or terrestrial habitats, analogies (homoplasies) based on ecological constraints are easily recognized. (4) Last but not least, the comparative study of gastropod cephalic and further (pallial or epipodial) tentacles clearly shows the modular epigenetic organization of animal morphology. Differences of gastropod cephalic tentacles may concern several subsets of characters so that various independent methods of investigation should be applied. The external shape includes tapered, papillate, or triangular forms with various positions of the eye or modifications for additional functions (*e. g.*, as a copulatory organ). Extension is caused by muscular hydrostates or by an hydraulic system. The specific equipment with various chemo- and mechanoreceptors has high phylogenetic significance. Finally, there are various types of innervation which interact with other cerebral neural elements. Examples of these variations and their significance for gastropod phylogeny are given. [Character Symposium]

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Polyadenylation of land snail mitochondrial tRNA transcripts as a general phenomenon unrelated to RNA editing

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Complete sequencing of mitochondrial DNA of the land snail *Albinaria coerulea* revealed the presence of tRNA genes lacking their 3' ends. In all cases, the 5' ends of these tRNAs are composed of T residues to the extent of the missing 3' end. Thus, we have initially proposed that truncated 3' ends were completed with A residues probably by a mechanism resembling polyadenylation. Data from other mollusks and Metazoa revealed the presence of A residues at the 3' end of such tRNAs and an RNA-editing mechanism has been proposed to act after cleavage, on truncated 3' ends of tRNAs. Our data, obtained using the RACE method on immature tRNAs that are either incomplete or complete, revealed that in all cases the cDNA clones contained a poly(A) tail. Moreover we found polyadenylated clones that contained C residues at the position of the characteristic CCA sequence of mature tRNAs, as well as some clones that contained deletions of 20-71 nucleotides. These data suggest that polyadenylation is a general mechanism acting indiscriminately on any mitochondrial RNA free 3' end. The most parsimonious explanation for mitochondrial polyadenylation is that it is of prokaryotic origin. In evolutionary terms, fixation of this mechanism in metazoan mitochondria seems to be connected with the need for smaller mtDNA molecules. Therefore, we can propose a pathway for metazoan mitochondrial tRNA maturation.

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Phylogeny of the Limacoidea *s. l.* (Gastropoda: Stylommatophora)

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There is hardly any agreement about the relationships among the families of the Limacoidea *sensu lato* (Gastropoda: Stylommatophora) in modern classifications. Therefore, 37 characters of the genitalia, nervous system, muscle system, lung, digestive system, external morphology, and shell have been used for a cladistic analysis of the families of the Limacoidea *s. l.* The Sagdidae and the Helicoidea are included in the analysis as outgroups. The Helicoidea including the oxygnath Sphincterochilidae and Cepoliidae proved to be the sister-group of the Limacoidea *s. l.* According to the strict consensus tree of 27 most-parsimonious cladograms found with the program PAUP, the main groups of the Limacoidea *s. l.* are related as follows: (Staffordiidae, ((Dyakiidae, Gastrodontoidea) (Parmacelloidea, ((Zonitidae, Helicarionoidea), Limacoidea)))). The Gastrodontoidea includes most of the groups of the polyphyletic Zonitidae *sensu auct.* The Parmacelloidea includes slug families, which are characterized by a horse-shoe-shaped groove on the mantle. The fusion of the terminal, glandular section and the basal section of the stimulator is a synapomorphy of the Zonitidae, the Helicarionoidea and the Limacoidea *s. s.* A synapomorphy of the Zonitidae and the Helicarionoidea are retractor muscles on the terminal section of the stimulator. Autapomorphies of the Limacoidea *s. s.* are the reduction of the epiphallus and the spermatophore and the course of the vas deferens inside of the penial tunica.

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Density, size, and age of the commercial unionid *Megalonaias nervosa* (Rafinesque, 1820) in 277 miles of the Mississippi River, Reaches (pools) 9-19, Lansing-Fort Madison, Iowa, July-September 1997

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The Shell Exporters of America (SEA) sponsored an extensive commercial unionid survey from Mississippi River Mile 663.0-386.0, Reaches 9-12, 14-16, and 19, with an emphasis on *Megalonaias nervosa*. Sites were identified by clammers, malacologists, and a Resource Inventory. We used modified 0.25 m^2 Surber samplers. 1-2 major sites were sampled in most Reaches. 252 randomly timed dives started near shorelines; mean CPUE was 1.19 *M. nervosa*/min. If productive, we did quadrats (N = 692) in transects across the unionid bed. Over 20,400 unionids were processed from 944 dive sites. Mean density of living *M. nervosa*/Reach ranged 2.7-7.6/m^2. Over 4,800 living *M. nervosa* were measured and aged after scrubbing with steel brushes to remove *Dreissena polymorpha* debris. Few *M. nervosa* were fresh-dead from *D. polymorpha*. Weak age classes of young *M. nervosa* in 1986 were not real as evidenced by large numbers of 10-13 year-old age classes; these strong age classes may represent response to the 1982-1986 Mississippi unionid die-off. Nearly all age classes were well represented from ages 5-early 20's, especially 5-7 year age classes in some areas. Age does not equal size. Growth varies, and generally increases further south. In most Reaches, 2.4-10.8% (mean 7.8%) of a bed is of commercial height (101.6 mm, 9-38 years). The highest percentage of legal unionids were in Sylvan Slough Sanctuary, Illinois (18.5%), indicating little illegal harvest.

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External aging of unionids revisited: height versus age of 4,800 *Megalonaias nervosa* (Rafinesque, 1820), Mississippi River Reaches 9-19, Lansing-Fort Madison, Iowa, July-September, 1997

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Shell Exporters of America (SEA) sponsored the most extensive commercial unionid mollusk survey ever done using modified 0.25 m^2 Surber samplers, from Mississippi River Mile 663.0-386.0, Lansing-Fort Madison, Iowa, Reaches 9-12, 14-16, 19, with emphasis on *Megalonais nervosa*. Over 20,400 unionids were processed during 252 random (timed) and 692 quadrat samples (944 dives). Over 4,800 living *M. nervosa* were scrubbed with steel brushes to remove *Dreissena polymorpha* debris, measured, and aged. Few *M. nervosa* were fresh-dead from *D. polymorpha*. Mean density/Reach was 2.7-7.6/m^2. Mean height/age class/Reach, and mean age/height class/Reach were analyzed. Age does not equal size. Large 10-13 year-old age classes likely represent response to the mid-1980's mussel die-off, or else indicate a peak period of reproduction. Number/size class for *M. nervosa* showed bell curves, but every Reach had shift to the left with the number/age class, usually with peaks around 10-13 years of age. Reach 14, and to a lesser extent Reach 19, had bimodal age distributions. In most Reaches, 2.4-10.8% (mean 7.8%) of a commercial bed is the legal height of 101.6 mm (age range 9-38 years). The youngest *M. nervosa* was 2 years (10 mm height); 3.18% were less than 50 mm height (2-7 years). The most legal unionids (18.5%) were in Sylvan Slough Sanctuary, Moline, Illinois, indicating little illegal harvest. Growth generally increases further south; 130 6-year-olds had the largest height range, 65 mm; 118 21-year-olds varied 37 mm. [poster]

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Distribution and population structure of the Japanese turban shell, *Turbo cornutus*, at Awa-shima Island in the Sea of Japan

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The Japanese turban shell, *Turbo cornutus*, occurs predominantly in shallow sublittoral rocky areas, and forms an important local fishery in Japan. Awa-shima Island is small in size, but its long and narrow shape with a rather high sea level offers considerable environmental differences between southeastern and northwestern sides of the island, particularly during the winter months under the prevailing wind. Two main study stations were established at both sides and an area covering 2 x 50 m was searched at each sampling. Yearly change in population structure was analyzed using the size frequency distribution of samples obtained at 6 m deep in June from 1993 to 1997. Intensive samplings were made at the depths of 2, 6, 10, and 14 m in June 1996 for the survey of vertical distribution pattern, and at 6 m deep at 8 stations around the islands in June 1997 for the horizontal distribution. Yearly changes in population structure and distributional pattern with depth differed between the wave-exposed and rather calm survey areas. Various sites around the island also showed the difference. However, it was inferred that the turban shell can occupy a variety of habitats as a whole, and that irregularity of recruitment, represented by the dominant year-class possibly born in 1993, greatly affects the later abundance and distribution of this species.

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Effects of interspecific hybridization on the genetic variation of land snails: evidence from mitochondrial DNA sequences

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In the present study, genetic variations derived from interspecific hybridization were detected by examination of mitochondrial DNA (mtDNA) encoding 16S ribosomal RNA (16S rRNA) of land snails of the genus *Euhadra* (Bradybaenidae). I focused on *E. peliomphala*, which is restricted to the south Kantou district of Japan, and several related species of *Euhadra*. Distinct intraspecific variations in 16S rRNA sequences were found in *E. peliomphala*. Sequence divergences between several individuals of this species exceeded more than 10%. Haplotypes possessed by populations from two areas were closely related to those of *E. eoa*, which is sympatric with *E. peliomphala* in other areas. This implies that the *E. eoa*-like haplotypes in *E. peliomphala* were introduced from *E. eoa* through hybridization between these species. The hybridization events have occurred more than two times, and *E. eoa* has become extinct in one area, but its haplotypes remain in the populations of *E. periomphala* of this area. Distinct intraspecific genetic disparity among populations of *E. peliomphala* are not necessarily produced by isolation. The disparity may be produced by a breakdown of reproductive isolation in local populations. [poster]

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Relationships of the buccinid genera inferred from partial mitochondrial gene sequences: a preliminary report

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The Buccinidae is one of the most prosperous families among the Caenogastropoda. It ranges from the poles to the equator, inhabiting a wide variety of marine environments, and has conspicuous fossil records extending back to the mid-Cretaceous. However, the phylogenetic relationships among this family remain ambiguous at the suprageneric level due to a paucity of synapomorphies. To address this problem preliminarily, mainly to elucidate the intergeneric relationships within buccinines, I determined sequences of a partial mitochondrial 16S rRNA gene for 12 buccinines, 2 nassariines, 2 fasciolariines, 2 muricids, and 2 neotaenioglossans, and performed molecular phylogenetic analyses. At the intergeneric level in the Buccininae, the resultant neighbor-joining tree offered two monophyletic groups, (*Buccinum* + *Neptunea*) and (*Engina* + *Cantharus*), with relatively high bootstrap probabilities. The topology confirmed the polyphyly of the Buccininae; however, the bootstrap probabilities for early splitting within the family were too low to regard this as a definitive result. [poster]

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Taxonomy and comparative anatomy of two species of the brackish water limpet, *Septaria*

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In 1816, Lamarck described *Navicella tessellata* and *N. lineata*, two species of brackish water limpets from India. He was unaware that Férussac (1807) had already given the neritid limpets the generic name of *Septaria*. Subsequent authors have considered that the two species are synonymous and although the species has been known by both names, *S. lineata* has been used more often. The type specimens in the Muséum d'Histoire Naturelle, Genève, confirm that Lamarck's two types are the same species and that the holotype labelled *N. lineata* is the narrow or compressed variation, as is one of the syntypes of *N. tessellata*. Nevertheless, the so-called *S. lineata* of Vanuatu and Fiji differs from the Asian *S. lineata* in shell and operculum shape and in reproductive anatomy, indicating that two species do exist, even though both species show similar variation in shell color and shell width. Examination of 47 type specimens of *Septaria* showed that the South Pacific species conformed to the two syntypes of *N. livida* Reeve, 1856, held in The Natural History Museum, London. This newly designated species, *S. livida*, is significantly wider than *S. lineata*, and its spermatophores are short (8 mm long) compared with those of *S. lineata* (20 mm long). The narrow fragile-shelled varieties of both species live on plant material in quiet backwaters, while the robust wide forms live on stones in swift tidal waters. Intermediate forms and egg cases of *S. livida* are found on bamboo and tree branches.

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Comparative caenogastropod sperm ultrastructure: characters and analyses

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Caenogastropods produce the most diverse range of sperm morphologies to be seen within the Mollusca. In several taxa the fertile spermatozoa (euspermatozoa) are accompanied by one or more types of infertile spermatozoa (paraspermatozoa), and, as both of these cell types are structurally complex, it is possible to recognize several discreet sperm characters for cladistic analysis. Sperm morphology is very informative in assessing basal caenogastropod relationships, but of limited usefulness in 'higher' groups such as the Neogastropoda where uniformity, especially in eusperm features, appears to be widespread. In basal caenogastropods, eusperm midpiece characters such as the number, shape, internal structure, and orientation of periaxonemal mitochondria are shown to correlate well with family- and superfamily-level taxa based on traditional anatomical features. Eusperm nuclei provide few characters for analyses, while features of the acrosome, even though very useful for diagnosing taxa, sometimes show high levels of homoplasy depending on how characters are scored (*e. g.*, shape of the acrosomal vesicle). For paraspermatozoa, the shape and orientation of the nucleus prove to be good characters for distinguishing groups of basal caenogastropods, but of no use in most neotaenioglossate and neogastropods which generally produce apyrene cells. Parasperm features of greater value across the entire Caenogastropoda include the number and orientation of axonemes, the size, shape and disposition of dense vesicles, and the distribution of mitochondria. Cladistic analyses run on various data sets of sperm and anatomical characters (parasperm, eusperm, combined sperm features, sperm + anatomical/shell features) are contrasted.

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Aspects of the population dynamics of two populations of *Musculium lacustre* (O. F. Müller, 1774) (Bivalvia: Eulamellibranchiata: Sphaeriidae)

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Like other organisms feeding on suspension, the population dynamics of sphaeriids depend directly on the maximum primary-production of the habitat. As an adaptation to different habitats, sphaeriids show high plasticity in population dynamics and reproductive strategy. Although the Sphaeriidae display great intra- and interspecific variation in the characteristics of their life-history, there are some parameters available for comparison: number of larvae, number of breeds, organic carbonate content in adults and larvae, and the interaction of these parameters. Thus, we investigated the ecology of a sympatric [co-occuring with *Pisidium casertanum* (Poli, 1791)] and an allopatric population of *Musculium lacustre* by comparing the organic carbonate using the "wet-oxidation" method for quantification (Russell-Hunter, *et al.*, 1968). Our results clearly show that: (1) Both populations can be divided into two subpopulations. All subpopulations are iteroparous and produce up to three larval generations each year. (2) Reproductive effort is directly linked with energy-balance of the adults. A lack of necessary resources will cause suboptimal conditions and hence cause a lower reproductive effort. Thus in the populations we investigated, the population dynamics follow a typical "bottom-up" regulation. (3) The energy-impact of the larvae was up to a maximum of 30% of the whole organic carbonate of the organism. Our study has shown that beside the high variability in the life-history characteristics of sphaeriids there are some reoccurring components. [poster]

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Common names for mollusks

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Conservation of molluscan biodiversity is impossible without support of the general public, but to create a public awareness to mollusks, lay people must be able to talk about them. As scientific nomenclature is too cumbersome for the broad public, we malacologists must coin common names. Names for genera are the most important, in creating awareness to molluscan biodiversity among the broad public - but they are also the most difficult to coin; names for species and for higher taxa come more easily. Attractive names may be achieved by malacologists cooperating with linguists to create a list of common names that, if accepted by a language academy, becomes authorized. I present my experience in coining common names for mollusks. My working guidelines are: (1) Target population: high-school pupils, naturalists, mass media. (2) Target taxa: only mollusks encountered by devoted naturalists. (3) Name-coining: coin names primarily for mollusks encountered in the field, not in books; avoid transliteration of scientific names; avoid using 'snail' or 'bivalve,' except for groups that are difficult to recognise as such; avoid names that honor persons; name only endemics by their region; distinguish introduced from native mollusks. We have so far coined 350 common names of gastropods (marine, freshwater and terrestrial), and 100 names of bivalves (marine and freshwater). Which mollusks are the helter-skelters? twisters? jetters? sea-cutes? ivory-towers? sea-hovers? [Human Symposium]

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Recent versus fossil *Melanopsis*: systematics, distribution and hybridization

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To what extent does the highly variable freshwater mollusk *Melanopsis* fit into clearly-distinguishable species? To what extent does it hybridize? To what extent does it evolve rapidly? A conchiometric study of *Melanopsis* in the Jordan Valley reveals three well-defined species: snails with smooth shells (*buccinoidea*) in springs; with straight ribs that extend almost the entire height of the ultimate whorl (*costata*) in the Jordan River, Lake Kinneret and (recently dried) Lake Hula; and with tubercle-ribs that usually extend about half the height of the ultimate whorl (*saulcyi*), in swamp peripheries. Hybrids are found in zones of sympatry, at low frequencies and over distances of no more than a few hundred meters. These abrupt conchiometric transitions from one species to another via very narrow hybrid zones suggest very strong isolating selective forces. Within these species, geographic variation in shell proportions, rib morphology, and notch proportions (small, stout shells correlate with a stormy habitat) suggest several subspecies. We are currently comparing these Recent *Melanopsis* with 750,000 year-old fossils, also from the Jordan Valley. Assigning the fossil material to well-defined species is more difficult than among Recents. There may be some evidence for hybridization. Some species in these fossil strata seem ancestral to Recents, others are completely different. These preliminary results suggest very rapid evolutionary rates within *Melanopsis*.

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Malacological "muthi": the use of mollusks in the traditional medicine trade in KwaZulu-Natal

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This paper is based on a snap-shot survey of invertebrate usage in the informal "muthi" (traditional medicine) market in Durban. This was conducted to establish the spectrum of taxa used, the sources of supply, the scale of utilization, and the conservation implications. Mollusks feature prominently in the faunal component of this "muthi" trade, perhaps more so than any other invertebrate phylum. The bulk of material is of marine origin, some collected dead, some alive. Not all is collected within the limits of the province. Harvesting is largely unregulated, but is probably of limited conservation concern since levels of utilization are low and stock turnover in the market is slow. However, one species of littoral chiton which is collected alive needs to be flagged as being of potential concern. Medical use of animal products centers on their inherent magico-medicinal properties, which may in turn stem from symbolism or certain behavioral characteristics of the animal concerned, or simply its Zulu name. The precise use of any one animal product, however, will vary from practitioner to practitioner and from time to time, since much depends upon the spiritual advice received on a given occasion. Marine mollusks also feature prominently in the regalia of traditional healers, particularly of izangoma (diviners), and in their divination materials. This is linked to spiritual communication with their "water ancestors."

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Protoconch microsculpture of fifteen land snails from northwestern Spain

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In this work we have studied the importance of protoconch microsculpture for distinguishing species of land snails, mainly when we only dispose of empty shells, pieces of shells or fossils, where it is not possible to use typical characteristics such as those of the genital system, body morphology, radula, or jaws. Several authors have studied this feature in gastropods: Robertson (1971), Thiriot-Quevreux (1972), Rodríguez Babío (1978), Giusti (1976), Castillejo, *et al.* (1978), Gittenberger (1977), Bank & Gittenberger (1985), Riballo (1990), etc. We have studied 15 land snail species from the northwest of Spain: Valloniidae: *Vallonia pulchella* (O. F. Müller, 1774), *V. costata* (O. F. Müller, 1774); Endodontidae: *Toltecia pusilla* (Lowe, 1831), *Punctum pygmaeum* (Draparnaud, 1801), *Discus rotundatus* (O. F. Müller, 1774); Hygromiidae: *Oestophora barbula* (Rossmässler, 1838), *O. silvae* (Ortiz de Zárate, 1962), *O. lusitanica* (Pfeiffer, 1841), *Oestophorella buvinieri* (Michaud, 1841), *Xerosecta cespitum* (Draparnaud, 1801), *Xerotrichia conspurcata* (Draparnaud, 1801), *Helicella itala* (Linné, 1758), *Pyrenaearia cantabrica* (Hidalgo, 1873), *Microxeromagna armillata* (Lowe, 1852), *Cernuella virgata* (da Costa, 1778). For each species a comment about the microsculpture and a discussion about the most significant diferences in microsculpture of similar species are added. The study of the specimens was made using an electron microscope. [poster]

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The gastropod larval shell as a model for integrative analysis of structure

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Larval shells have been used to infer life history and nutritional modes in ecological, paleoecological, and macroevolutionary studies. The larval shell encodes considerably more information. A program of research focusing on the total information content of larval shell morphology is based on the study of living veliger larvae from the Hawaiian plankton. Using a comparative and integrative approach, I explore the interplay of features that are (1) purely constructional and emerge from specific biomineralization processes and growth rules, (2) ecological, (3) phylogenetically shared as innovations in specific clades, and (4) adaptive in terms of close-fit to engineering paradigms for performance advantage. Some of the most surprising results emerge from experimental studies of veligers in culture in the absence and presence of predators. Repeated patterns of larval shell breakage and subsequent repair, documented with SEM, shed light not only on the nature of predation attempts but also on antipredator adaptations in shell construction. Use of the paradigm method provides equally powerful evidence of a set of features of larval shell microsculpture that serve to retard breakage at particularly vulnerable points on the larval shell. Finally, there are microarchitectural features that suggest fundamentally different mechanism of mineralization in larval and adult shells and a reorganization of shell formation at metamorphosis.

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Spermatozoon morphology of some Acmaeoidea (Patellogastropoda)

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Spermatozoon morphology of Acmaeoidea was studied by transmission electron microscopy to provide characters of potential cladistic utility. Spermatozoa of 22 species were examined including representatives of Acmaeidae (1 genus, 2 species) and Lottiidae (6 genera, 20 species). All species produced ect-aquasperm. The mid-piece of all sperm consisted of a ring of 4 spherical mitochondria surrounding the orthogonally arranged centrioles. Most lottiids had an elongated (about 1 μm long) cytoplasmic collar surrounding the anterior tail section. The nuclei of all but *Nipponacmaea schrenkii* were cylindrical, rounded anteriorly, but not intruding into the subacrosomal space (nucleus length:breadth ratio ranged from 1:1 to 3:1 in Lottiidae to >3.5:1 in Acmaeidae). The nucleus of *N. schrenkii* was also cylindrical in shape, but it narrowed anteriorly and intruded into the subacrosomal space. The sperm acrosome of all species was conical and invaginated posteriorly. All had a posterior acrosomal lobe. Despite fundamental acrosomal similarities, 7 morphological forms of acrosome could be distinguished: *Acmaea* spp. and *Patelloida* spp.; *Lottia limatula* and *L. gigantia*; remaining *Lottia* spp. and *Discurria* sp.; *Tectura* spp.; *Collisella* sp.; *Nipponacmaea* sp.; *Macclintokia* sp. The possibility that acrosomal similarities might reflect phylogeny will be addressed by considering individual sperm characters in the context of a more inclusive phyogenetic analysis.

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Evolutionary relationships and morphological character state transitions in unionoid bivalves (Bivalvia: Unionoida): a molecular systematic perspective

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The lack of robust phylogenetic hypotheses for the higher taxa within the Unionoida has impeded evaluations of character state evolution within the group. Therefore, the evolutionary relationships and morphological character state transitions within the Unionoida are being assessed using comparisons of cytochrome C oxidase subunit I (COI) DNA sequences. Parsimony and neighbor-joining analyses of the COI sequences, followed by mapping of the morphological character states onto the best tree topologies, are being used to evaluate hypotheses of evolutionary relationships and character state evolution. Hypotheses to be tested include the following: (1) the monophyly of the Muteloidea, Unionoidea, Hyriidae, Mutelidae, Mycetopodidae, and Unionidae, (2) the ancestral nature of glochidial larvae and tetragenous larval brooding, and (3) the conchological similarities between *Castalia* and *Neotrigonia* are due to convergence.

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An inferred phylogeny of North American pleurocerid snails (Caenogastropoda: Cerithioidea) based on molecular and morphological data

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The North American pleurocerids are a diverse assemblage of snails that constitute nearly 44% of North America's freshwater, gill-breathing snail fauna. They are found in abundance in the rivers and streams of the southeastern United States. To reconstruct the phylogenetic relationships of the family, I used both molecular and morphological data. For the molecular data, I examined DNA sequence variation of the mitochondrial 16S rDNA gene from representative species of each North American extant pleurocerid genus, and for the morphological data I examined radula variation from individuals of this same group of representative species. My objective was to assess the phylogenetic relationships within and among these genera using separate and combined data matrices.

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Physiological impacts of zebra mussels on unionid mussels: direct or indirect effects?

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We examined the physiological state and biochemical composition of unionid mussels (*Amblema plicata*) from a natural population in Lake Pepin, Mississippi River, Minnesota, that were infested by zebra mussels (*Dreissena polymorpha*). Results were compared to non-infested *Amblema* collected from the same site. Physiological state was assessed by measuring metabolic rates, oxygen:nitrogen ratios, and clearance rates. Biochemical composition was indicated by assays of carbohydrate, protein, and lipid. Zebra mussel infestation of *Amblema* resulted in greater ammonia excretion rates and lower clearance rates, compared to non-infested specimens. Carbohydrate and protein contents were lower in infested *Amblema* than in non-infested mussels, resulting in a significantly lower total caloric content. Our study shows that infestation by zebra mussels had a greater negative impact on the health of unionid mussels in Lake Pepin than did the presence of zebra mussels in the system. This suggests that direct attachment of zebra mussels to unionids was more important than local decreases in food availability due to zebra mussel filtering activities. [poster]

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Hosts and host attracting behaviors of five upper Mississippi River mussels

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Of 297 freshwater mussel species living in North America, 213 are either endangered, threatened, or of special concern. The identification of fish hosts is listed as an urgent research objective in the National Strategy for Freshwater Mussel Conservation. Suitable hosts were determined by artificially infesting various fishes and amphibians with glochidia from one of five mussel species. A fish was considered a suitable host when larval metamorphosis to the juvenile stage was observed. Observations of host attracting behavior were made in the laboratory and under natural conditions. *Cumberlandia monodonta* released branched, white conglutinates held together in a clear, gelatinous matrix. Hosts have not been identified. Brooding female *Tritogonia verrucosa* displayed a crenulate mantle, and released thin yellow conglutinates. Three-fold shell growth was observed on juveniles collected from yellow bullheads. *Cyclonaias tuberculata* displayed a slightly inflated mantle and released glochidia individually or together in a 1 x 3 cm conglutinate. Glochidial transformation was observed on four ictalurids. Brooding *Venustaconcha ellipsiformis* displayed a small, light-sensitive, mantle flap with an eyespot. Glochidial transformation was observed in two cottids, four darters, and brook stickleback. *Ligumia recta* displayed a large, elaborate mantle and released 1 cm lanceolate, white conglutinates. Largemouth bass, bluegill, and walleye were suitable hosts for this species. Species-specific molecular markers are being developed for use in the identification of excysted juvenile mussels collected from naturally infested fish. [poster]

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Implication of spatial and seasonal variation of food availability on the life history pattern and diet of the limpet *Cellana grata* in Hong Kong

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The relationship between food availability and life history pattern of *Cellana grata* was investigated on two moderately exposed shores, Shek O and Heng Fa Chuen in Hong Kong. A distinct seasonal pattern of food availability was recorded at Shek O; during the hot and wet summer no visible growth of biofilm formed in the high- and mid-shore where limpets foraged, but during the cool and dry winter conspicuous growth of diatom films formed in the mid-shore. Conversely, at Heng Fa Chuen, a different pattern was observed; the encrusting alga *Pseudulvella applanata* grew throughout the year in the mid-shore and food abundance (measured as chlorophyll a concentration) was higher at Heng Fa Chuen than Shek O. Limpet populations at both sites were composed of two distinct cohorts, however limpets grew faster and achieved a larger size at Heng Fa Chuen than Shek O. Examination of diets revealed that limpets at Shek O fed mainly on cyanobacteria but had a mixed diet of cyanobacteria and diatoms during winter; limpets at Heng Fa Chuen exhibited a constant diet of cyanobacteria and encrusting algae throughout the year. Variation in food availability, therefore, had a great implication on the life history pattern and diet of *C. grata*.

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Molecular phylogeny of octopod cephalopods

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Due to the difficulties of finding discriminant morphological characters, numerous octopod taxa are still controversial. Complementary approaches are needed to clarify octopod systematics. The aim of the present work is to test for octopods two mitochondrial portions which have proven to be adequate to solve decapod classification problems: the 3' end of the 16S rDNA (500 bp) and the third subunit of the cytochrome oxidase gene (700 bp). Their different evolutionary patterns allow the study of several classification levels. The results analyze relationships among Octopodinae, and especially whithin the large genus *Octopus* (60% of the Octopoda species), among which is the cosmopolitain *O. vulgaris* from various geographical areas (Europe, South Africa, South America, Asia). The utility of the molecular markers used is discussed. Several results confirm morphological analyses, but others are more surprising. The preliminary phylogenetic results show paraphyly of the genus *Octopus* and highlight the necessity of reconsidering the traditional classification using both complementary approaches: molecular and morphological analyses. Molecular methods help to identify discriminant morphological characters at various hierarchical levels.

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The economics of shell thickness in two terrestrial snails

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I measured shell thickness in *Trichia hispida* (Pulmonata: Hygromidae) and *Monacha cantiana* (Helicellidae) by embedding whole shells and sectioning down their coiling axes. Shells were collected throughout the year and varied widely in size. As snails grow, shell thickness increases roughly isometrically with linear dimensions. Not only are the new whorls formed with a greater thickness, but the early whorls are thickened. Consequently the outer surface of the whole spire is remarkably constant in thickness, which makes sense adaptively (a chain's strength is that of its weakest link), but seems difficult to achieve physiologically. The pattern of change is very different in adjacent parts of each whorl's cross-section. Whatever the snail's age, its outer whorl is fairly uniform in shell thickness; but those parts that become internal when subsequent whorls are added are first thickened from the outside, then thinned from the inside. I developed a numerical model to calculate how much shell material is required at each growth stage, and how much can be obtained by thinning the internalized part of earlier whorls, and by not thickening it subsequently in line with other parts. The model also calculates to what extent changes in shell shape use less or more shell material. Snails require calcium carbonate for their eggs, and the model estimates the thinning required to produce a particular mass of eggs.

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Snail shell shape: optimizing whorl overlap to minimize required shell material

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Snail shells are conventionally modelled as logarithmic helicospirals with circular generating curves. If the generating curve overlaps its position one revolution earlier, the aperture is crescent-shaped. New shell need be secreted only around the outer arc, because the preceding whorl forms the inner wall. Heath (1985) realized that an optimal degree of overlap exists that minimizes the ratio of shell material to volume enclosed; land snails showed less overlap than his predicted optimum. Heath's analysis was inappropriate in three respects. (1) He minimized perimeter/area of the whorl cross-section (not equivalent to minimizing surface-area/volume ratio). (2) He compared shells differing in volume, but these ratios decrease with size. It is better to compare at equal volumes (equivalent to minimizing shell-mass/volume if shell thickness increases isometrically with volume$^{1/3}$). (3) He compared shells differing in the taper of their interior. It is more meaningful to keep taper constant (equivalent to comparing shells with equal aperture areas at a particular volume). My reanalysis predicts more realistic looking overlaps. Results are robust to whether or not the shell is planispiral, and to whether a shell's larger whorls are thicker than inner ones. But real shells have non-circular apertures, different thicknesses of shell are secreted around the whole aperture, and shell material is redistributed as whorls become internalized. More complex models are needed but should still incorporate the optimization criteria developed here. [poster]

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Fossil potamidids and batillariids (Caenogastropoda: Mollusca) from the Middle Miocene Kukinaga Group in Tanegashima Island, Japan

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Four potamidid and two batillariid species were found in the Middle Miocene Kukinaga Group in Tanegashima Island, South Kyushu, Japan. Of these, two batillariid species are new species to be described. Potamidids and batillariids from the Kukinaga Group are composed of three elements: (1) last appearance of the species commonly found in the Late Early to Early Middle Miocene, (2) species confined in occurrence to the Middle Miocene, and (3) living species. The occurrence of *Vicarya japonica* Yabe & Hatai from the Kukinaga Group marks the last appearance in Japanese Neogene, and *Telescopium telescopium* (Linné) marks the first appearance in Neogene of Indo-Pacific region. In contrast, the Kukinaga Group yields no species of *Terebralia, Cerithidea s. s.*, and *Batillaria (Tateiwaia)*. The Kukinaga Fauna flourished during Middle Miocene time along the Pacific coast of southwestern Japan under the strong influence of a paleo-Kuroshio warm current. The period corresponds to a remarkable marine climatic warming event correlated with Neogene Climatic Optimum 2. [poster]

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Xenoturbella bocki: the most primitive bilaterian animal or a protobranch bivalve? The killing of a phylum

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The enigmatic *Xenoturbella bocki* is one of the most strange free-living animal. It is merely an up to 3 cm long ciliated sac with mouth but without anus or any organs except for a "statocyst" with motile flagellated "statoliths." It is marine and has only been found off Sweden and in the North Sea. *X. bocki* was originally described as a platyhelminth. Later, different authors have argued that it is neotenous enteropneust or holothurian, or representing one of the earliest offshot from the metazoans (thus the unique represent of the most plesiomorphic phylum of the bilaterian animals). However, the oogenesis (as well as nucleotide sequence data obtained by Mikael Norén and Ulf Jondelius) indicates a possible relationship with protobranch bivalves. I will report a study of the embryology of *X. bocki* that clearly indicate a protobranch relationship.

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Symmetry of losses of primary characters in the phylogenesis of mollusks and the value of apomorphies by losses

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Based on the hypothesis about monophyly of Mollusca and all class-group taxa, nearly all possible variants of phylogenetic relations between molluscan classes can be found in the literature. Most phylogenetic schemes are based on a bifurcation between Aculifera and Conchifera that occurred in the very early evolution of mollusks. Losses of primary and most distinct molluscan apomorphies (shell, foot, serial musculature, and tetraneural nervous system) occur in the two most progressive groups (Caudofoveata and Coleoidea) of both phylogenetic branches. Despite differences in causes and mechanisms of losses, their final results are essentially the same. The losses of primary functions and organs in Mollusca is a regular and wide-spred process. In contrast to parallel appearance of new structures, their parallel losses cannot be defined unequivocally. The use of losses in cladistic reconstructions together with apomorphies by appearance of new structures leads to paradoxical and hardly applicable results. Therefore, the schemes based on least number of losses are preferable in reconstructing molluscan phylogeny.

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Phylogeny and evolution of color pattern in chromodorid nudibranchs

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The chromodorid nudibranchs are a diverse, brightly colored group of more than 600 species found primarily in tropical and subtropical waters. Although there has been recent interest in this taxon, due to their striking color patterns, much of their taxonomy remains in a rudimentary state. This project focuses on five relatively small genera within the family Chromodorididae: *Thorunna, Pectenodoris, Digidentis, Durvilledoris,* and *Ardeadoris*. There are currently 23 described species in these genera, as well as six or more undescribed species. Anatomy of all of the taxa included in these groups are examined. Monophyly for each of these genera has been hypothesized, but never tested. Phylogenetic analyses of the members of these genera and other taxa in the family are used to ascertain the evolutionary relationships among species and to test for monophyly. The resulting hypothesis of phylogeny is used to address questions regarding biogeography and evolution of color pattern in these nudibranchs.

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On the trail of snail molecular markers linked to schistosome resistance: *Biomphalaria glabrata*, the tale so far

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Schistosomiasis is a serious public health problem in 74 countries throughout the developing world. Freshwater snails of the genus *Biomphalaria* are an essential component of the schistosome life-cycle. Irrigation schemes often intensify infection and allow the disease to spread, prompting costly and labor intensive control programs. Effective control depends upon limiting the parasite's access to compatible snails. The relationship between snail and parasite is an intricate one. Some species of schistosome are wholly dependent upon finding a particular species of snail in which to continue their development, and in turn susceptibility to the parasite varies both within and between species of snail. The existence of snails which are naturally resistant to the parasite provides us with an opportunity to investigate the genetic basis of resistance/susceptibility. Using a variety of novel approaches, which utilize snails differing in their genetic susceptibility to parasite infection, we have begun to identify regions of the snail genome involved in schistosome resistance. [poster]

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Ontogenetic age determination in Jurassic *Gryphaea*: solution to a classic problem in heterochrony

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Few fossil mollusks have figured more prominently in evolutionary studies than the coiled Jurassic oyster, *Gryphaea*. Some 75 years ago, Trueman (1922) reported several phylogenetic trends in *Gryphaea* populations from the British Lias, two of which remain controversial and poorly understood: changes in left valve coiling and overall size increase. More recent analyses of evolutionary patterns in this lineage identified the main procedural problem to be improper standardization when comparing ancestors and descendants. Standardization at common or even maximum size is not a good basis for comparison in a lineage characterized by strong allometry and phyletic size increase. Standardization by ontogenetic age is much more desirable but seldom possible in fossils. Fortunately, sectioning of the left valves of thousands of specimens revealed prominent growth increments which, based on comparison with modern bivalves and coincident major cycles in oxygen isotope composition, are interpreted to be annual features. Counting and measuring these yearly increments permits age and growth rate determinations for populations throughout the series: *G. arcuata* to *G. mccullochi* to *G. gigantea*. Growth curves suggest that accelerated growth in descendants relative to ancestors is responsible for phyletic size increase, not a hypermorphic extension of time to maturity. The familiar decrease in coiling in the upper part of the sequence, accompanied by size increase and juvenilization of form, thus represents a true case of neoteny.

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Allozyme, RAPD, and phally polymorphism in *Zonitoides nitidus* and *Z. excavatus* (Gastropoda: Pulmonata)

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All pulmonates are hermaphroditic. Some species show phally polymorphism, *i. e.*, the total (aphallic) or partial (hemiphallic) reduction of the male genital organs. Normal hermaphroditic individuals (euphallics) can act as male, female, or may sometimes reproduce uniparentally, whereas aphallics/hemiphallics are not capable of donating sperm and thus can only act as female and/or reproduce uniparentally. Natural populations of *Zonitoides nitidus* and *Z. excavatus* have low proportions of euphallics (*Z. nitidus* < 20%; *Z. excavatus* < 10%) while the majority are hemiphallics. Therefore, it is expected that biparental inbreeding and/or uniparental reproduction must be high. An allozyme study of several populations of both species suggested that the two species mainly reproduce uniparentally, with few polymorphic enzyme loci in *Z. nitidus* and none in *Z. excavatus*. A parallel RAPD analysis confirmed the lower genetic variability of *Z. excavatus*. Because of their uniparental reproduction, it seems that *Z. excavatus* consists of a few (1 with allozymes, < 5 with allozymes and RAPD data combined) homozygous multilocus genotypes (strains) whereas more strains can be found in *Z. nitidus* (8 with allozymes, >15 with allozymes and RAPD data combined). Populations differed significantly in strain composition and there was no relationship between phally type and genotype. The functional significance of phally polymorphism in these species remains to be investigated.

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Formation of marginal radular teeth in Conoidea (Neogastropoda) and the evolution of the hypodermic envenomation mechanism

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The outstanding feature of the Conoidea is the feeding mechanism of killing prey by stabbing with marginal teeth and injecting venom. Radular morphology is extremely variable within the superfamily. Four main types are recognized: (1) the clavid type - 5 teeth in a radular row and large comb-like laterals; (2) the pseudomelatomid/duplicariid type - 2-3 teeth in a row, solid curved and pointed marginals; (3) the turrid type - 2-3 teeth in a row and wishbone marginals, and (4) hypodermic type - 2 hollow enrolled marginals, subradular membrane absent. Marginal teeth, similar, or even indistinguishable from those of the fourth type, are recorded in groups normally possessing the first (*Imaclava)* and the third types (*Pilsbryspira, Toxiclionella, Ptychobela*), suggesting that hypodermic teeth have evolved repeatedly. Aside from hypodermic teeth, the most unusual are the wishbone teeth (family Turridae), which comprise robust major and smaller secondary limbs but with many variations. SEM studies of teeth maturation have shown that wishbone teeth are formed initially as a flat plate, with subsequent thickening of the edges and folding of the tooth lengthwise. Hypodermic teeth form in a similar way and thus could be derived from wishbone teeth, but without pronounced thickening of the edges of the initial plate. Teeth of the first, third, and fourth radular types can all be used individually at the proboscis tip for envenomation of prey. The evolution of wishbone teeth may be explained in mechanical terms, providing the stiffness necessary for penetration of prey. As wishbone and hypodermic teeth are formed in a similar way, it is not surprising that the latter appear repeatedly in conoidean evolution. [Character Symposium]

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Anatomy and biology of a living fossil, *Globularia fluctuata* (Sowerby) (Gastropoda: Ampullospiridae): implications for naticid predation history

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Specimens of *Globularia fluctuata* (Sowerby), the sole living species of the Mesozoic-Cenozoic family Ampullospiridae, from a lower tidal flat in the Philippines, is an herbivorous snail and shows an anatomical relationship with the freshwater Ampullariidae and the marine *Campanile symbolicum*. This species was previously regarded as a typical carnivorous, shell-drilling, predatory naticid gastropod. Jurassic and Early Cretaceous naticid-like snails now can be interpreted as herbivores and not shell-drillers, thereby strengthening the evidence for a Mid-Cretaceous naticid-drilling origin and effectively eliminating the mystery from the lack of naticid drillholes prior to the late Early Cretaceous. Removal of the Ampullospiridae from the Naticidae suggests that predatory naticids were uncommon and very localized during most of the Late Cretaceous but became gradually more common and widespread in shallow marine environments from the end of the Cretaceous during the Early Cenozoic. This pattern of naticid diversification from the Mid-Cretaceous onward coincides well with that of naticid predation evidence previously documented, suggesting that the apparently anomalous fossil record of naticid drillholes may realistically demonstrate increasing naticid predation activity though geologic time. [Bridging Symposium]

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Lasting impressions: what micromollusks tell us about benthic marine communities

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Micromollusks, microscopic shells less than 10 mm in greatest dimension, are useful indices of benthic marine community structure because they exhibit a variety of trophic and spatial habits, they persist in sediments over time, and they occur in numbers which permit statistical analysis. More than 20 years of study of micromollusks from four wastewater outfall sites at depths of 30-70 m, deep dredging sites at 800 m, shallow waters at 10 m, and bays and harbors at 10-30 m off Oahu, Hawaii, shows that distinctive assemblages of micromollusks are consistently associated with different depth regimes, distribution of assemblages is patchy, and that although assemblages and stations are stable over time, communities are disrupted by storms, and can and do reflect conditions of water quality.

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Neogene Cypraeidae (Gastropoda) of the northern Dominican Republic

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Nine species referred to five genera of the gastropod family Cypraeidae are reported from the early Miocene to Pliocene of the Cibao Valley, northern Dominican Republic. These species are represented by about 400 specimens in the National Museum of Basel, Switzerland; the Paleontological Research Institute, Ithaca, New York; and elsewhere. Five species are now extinct. Of the Recent species, *Luria cinerea* occurs in Florida, the Caribbean, and south to Brazil; *Erosaria spurca* in the eastern and western Atlantic and the Mediterranean; and *Macrocypraea cervus* in Florida and the Bahamas. Four species were described from the Dominican Republic but none is considered endemic to the island. *M. henekeni* and/or congeners appear in the fossil record of the east and west coasts of North and South America; *M. cervus* and *L. patrespatriae* also have congeners in the eastern Pacific. *Muracypraea henekeni* appears related to Pliocene and Recent cowries from South Africa and the Red Sea, and now-extinct species in Pakistan/India and the Indo-Malaysian archipelago. *E. spurca* and *M. henekeni* dominate the fossil assemblages. Stratigraphic occurrence is associated with environmental factors: specimens of *M. henekeni* occur in what were sandy sea-grass flats, the habitat of its descendant, *M. mus*, in the Caribbean; most specimens of *Zoila spurcoides* and *E. spurca* are associated with coral rubble.

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Population dynamics of the mytilids *Musculista senhousia* and *Limnoperna fortunei kikuchii*, with special reference to larval recruitment

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The purpose of the present study is to examine the dynamics of benthic populations of two mytilids *Musculista senhousia* and *Limnoperna fortunei kikuchii* in relation to fluctuations of their supplied planktonic larvae and new settlers in a brackish semi-closed Lake Hamana along the Pacific coast of middle Japan. These two mytilids are dominant among the intertidal macrobenthos in the lake. *L. fortunei kikuchii* has been found in Japan since the 1970s. Sampling was carried out for two years from July 1991 to August 1993, once a week for the planktonic larvae and new settlers and once a month for benthic populations of the two mytilids. The planktonic larvae and new settlers of the two mytilids in the samples were identified based on those reared artificially in the laboratory. The planktonic larvae and new settlers of the two mytilids were found throughout a year, and were very abundant for the period from June to December. Recruits with shell lengths of more than 1.0 mm were found from August to October. Based on cohort analyses of new settlers to benthic populations of the two mytilids and on experimental studies on influences of water temperature on larval development of the two mytilids, it was made clear that success and/or failure of larval recruitment depended on occurrence of water temperature comfortable for rapid larval development of the mytilids.

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The content of chemical elements in the shells of certain bivalve mollusks

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While investigating the poral apparatus of certain groups of Bivalvia, we found it necessary to study the chemical composition of their shells and mantles, in particular the epithelial projections of the latter. Under investigation was the chemical composition of shells of 12 freshwater and marine Bivalvia species: *Colletopterum piscinale falcatum, C. ponderosum rumanica, Anodonta zellensis michelli, A. cygnea, Unio rostratus, U. conus borysthenicus, U. tumidus falcatulus, Solen vagina, Moerella tenuis, Ostrea edulis, Polititapes aurea,* and *Flexopecten ponticus*. It was established that it comprised 10 chemical elements: C, O, Al, Si, Cl, Ca, Cu, K, S, and P. Their percent-weight proportions are different in each species due to different quantitative and qualitative characteristics of their respective water bodies.

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Recovery of the molluscan epibenthic fauna after a severe salinity decline at a Caribbean turtle grass community

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Las Luisas Bay is a semi-enclosed shallow area at Morrocoy National Park, on the central western coast of Venezuela, with salinity ranging from 34-40‰ throughout the year. It is characterized by an extensive *Thalassia testudinum* bed with around 10 gastropod and 5 bivalve epibenthic species, with the dominant species the herbivores *Modulus modulus* (17-21 ind/m²) and the green sea urchin *Lytechinus variegatus* (19-28 ind/m²). During the last quarter of 1996, heavy rains altered the salinity at Morrocoy National Park, reaching values as low as 18‰ at Las Luisas Bay. Those values were maintained for at least four weeks, causing a mass mortality of the marine fauna. The density of molluscan species descended to near zero. When normal salinity was recovered, *Thalassia* blades were first colonized by a gastropod of the genus *Bittium*, at a density ranging between 6-30 ind/blade (486-2,366 ind/m²) within the first two weeks. After 13 weeks, *Pinctada radiata* (37-60 ind/m²) dominated the community with *M. modulus* (56-89 ind/m², 18 weeks), with these two species substituting each other in their relative importance regarding density within the first six months. The whole community recovered its normal composition after six months. Although severe mortality of *T. testudinum* was observed, the rapid colonization and succession of molluscan herbivore species contributed with low epiphytic algae on the blades that assisted in recovery of the sea grass. [poster]

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New aspects of opisthobranch phylogeny (Gastropoda, Opisthobranchia): comparative histological and ultrastructural studies of the nidamental glands and egg masses

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Opisthobranchs have a complex hermaphroditic reproductive system. The nidamental glands are glandular, sac-like enlargements of the oviduct. They consist of structurally and functionally different parts (albumen, capsule and mucus glands), which are responsible for the formation of the egg masses. Although the reproductive system has been subject to phylogenetic studies for a long time, the nidamental glands have always been neglected. Up to now their structure and especially ultrastructure has not been studied in detail comparatively within the major opisthobranch taxa. The nidamental glands and egg masses of Cephalaspidea, Sacoglossa, Anaspidea, Pleurobranchomorpha, and Nudibranchia have been investigated using histological and electron-microscopical techniques. The homologies of the different parts of the glands within these taxa are discussed. Moreover the structure of the egg masses is presented and the functions of the different parts of the nidamental glands in the building of the egg masses is discussed. Under the light of the new findings a possible scenario of the evolution of the nidamental gland system in the Opisthobranchia is proposed.

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Snail spears and scimitars: a character analysis of *Conus* radular teeth

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The harpoon-like radular teeth of *Conus*, the structural basis of the conotoxin delivery system used by the members of the largest genus of marine snails to overcome and paralyze prey, can provide additional characters of use in differentiating species. They can thus enhance the base of taxonomic information, presently limited almost entirely to shell characters. Comparative morphological and morphometric analysis of radular teeth has (1) improved species-level systematic knowledge by expanding the set of informative taxonomic characters, (2) advanced understanding of functional morphology of radular teeth in injecting the potent venoms into prey, and (3) added characters that will help generate the first objective phylogenetic hypotheses for this major evolutionary radiation of marine animals. We describe character states and a system for coding them, and we estimate the range of variation in characters within and among individuals and species of generalist and specialist predator species and in putatively primitive species. Finally, we test the effectiveness of radular tooth characters in distinuishing similar species, with particular emphasis on molluscivorous species of *Conus*. [Character Symposium]

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Affinities of sphaeriid clams (Bivalvia: Sphaeriidae) from different continents as suggested by anatomical characters

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The freshwater bivalve family Sphaeriidae in its traditional sense includes about 200 species and is characterized by cosmopolitan distribution. Despite many descriptive publications, affinities of the taxa from remote countries are poorly known. The aim of this study is to apply anatomical chracters earlier studied by the author in the Eurasian taxa to species from the other continents. Some similarities in these characters probably indicate synapomorphies and suggest affinities between geographically distant taxa. The North American species *Sphaerium simile* (Say) and *S. striatinum* (Lamarck) are similar to European *S. rivicola* in their partially visible ligament, very strong siphonal retractors, numerous brood pouches with a few embryos in each, and a nephridium with visible lateral loop. North American *S. rhomboideum* (Say) is similar to European *S. nucleus* (Studer) in its broad dorsal lobe of the nephridium. Several species of *Sphaerium s. l.* from India (*S. indicum* Deshayes), Africa [*S. incomitatum* (Kuiper)], and South America (*S. forbesi* Philippi) as well as Australian and New Zealand *Sphaerinova* species have diagnostic nephridium characters of *Musculium* (small excretory sac without valve and long funnel) and should be placed in the latter genus. Evidently reduced siphonal retractors might indicate their close affinity or parallel evolution. Australian *Pisidium carum* Cotton and *P. etheridgei* Smith are similar in their gills and mantle musculature to African *P. langleyanum* Melville & Ponsonby and *P. viridarium* Kuiper respectively. Similarity between South African *P. ovampicum* Ancey and Holarctic *P. milium* Held (both have very short pedal slit and strongly concentrated mantle muscles) is also remarkable.

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Control of intermediate host snails for parasitic diseases: a threat to biodiversity in African freshwaters?

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For several decades, control of parasitic diseases in man or domestic animals has included control of the intermediate host. This has been attempted through a number of different methods, such as molluscicides, environmental manipulations, and biological control. Because snail control has often been done unspecifically causing death of non-target animals like other snails, fish, or insects, such activities have been looked upon with great concern among conservationists and laypeople. In a world with ever-growing awareness of the importance of protecting biodiversity, snail control activities must be questioned, and medical malacologists must take conservation issues seriously and find new ways of controlling snail-borne diseases so that associated faunas are not harmed. Snail control is not always harmful. In artificial habitats like dams and irrigation schemes we often find environments with poor biodiversity. But in natural habitats such as the big lakes of Africa, with endemic snail faunas, snail control activities could be catastrophic. Healthy aquatic ecosystems, with high diversity, are needed to supply the people of Africa with good quality water. Medical malacologists can play a part in safeguarding the future richness of the living snail fauna. The status of the African local faunas, including biodiversity, is given. Threats to the indigenous faunas by invasive snail species are discussed. Together with an analysis of threatened habitat types, recommendations are given for how medical malacologists can contribute to conservation.

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Ecomorphic variation on a macroevolutionary scale

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Ecomorphic variation, or distinct intraspecific shape differences associated with a particular environment, has been documented in many intertidal snails. Littorines have proven to be the model system for studying ecomorphic variation. Much if not all of this work has focused on determining whether this variation is purely epigenetic or has a population genetic component. This microevolutionary perspective is potentially limiting, and we focus on ecomorphic variation at the species level and above as a complimentary and new, macroevolutionary way to understand patterns and processes which generate variation. We compare intraspecific and interspecific shell shape variation in three closely related *Littorina* species with the same "ecomorph" categories. Relative Warp Analysis (RWA) is used to summarize the shape variation (independent of size) in our samples, which are grouped by species and ecomorph. RWA also shows whether or not this variation is local or global and thus allows us to determine where in ontogeny shape change is occurring. Shape is also compared to size using multivariate allometry. Our RWA shows distinct clustering according to ecomorph but not according to species. This suggests that the developmental flexibility leading to ecomorph variation is not species-specific but instead inherited from a common ancestor of all three species. Multivariate allometry shows that shape is significantly correlated with size. We suggest that allometry is an important factor in explaining ecomorphic variation. [poster]

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The relevance of environmental control of *Bulinus truncatus* (Gastropoda: Planorbidae) in the schistosomiasis elimination program in Morocco: a case study

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As a result of a schistosomiasis control program run by the Ministry of Public Health in Morocco, schistosomiasis prevalence and transmission is presently at such low levels that elimination of the disease seems a realistic goal. It is considered important that control efforts are multifaceted as no single method will be successful in controlling transmission. Control of the intermediate host, *Bulinus truncatus*, is an important element to reduce transmission as much as possible. Focal application of niclosamide has been done extensively in the past, but the cost of chemical and its possible harm to the environment led to re-consideration of this control measure and environmental control based on habitat modification is now gaining importance. Various methods were evaluated in a modern irrigation system and in a traditional system, *i. e.*, Tessaout Amont (central Morocco) and Akka oasis (southern Morocco), respectively. In the modern system, creating a permanent dark environment by covering snail breeding sites (siphon boxes = inverted weirs) led to significant reduction of snail abundance and reproduction. Draining and removing substrate from these siphon boxes also reduced snail densities, but re-colonization was fast. In the traditional irrigation system in oasis, removal of vegetation scheduled and implemented by villagers in snail habitat led to reduction in *Bulinus truncatus* densities. Preliminary results show that ecological methods are cheaper and more sustainable than chemical measures.

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Tuberculate micro-ornament on the embryonic shells of Triassic ceratites and the monophyly of the Ammonitida

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Embryonic shells of the ceratites *Trachyceras* (*Trachyceras*) *aon* (Münster) and *T.* (*Brotheotrachyceras*) *larva* (Klipstein) from the Carnian (Upper Triassic) of Italy display a tuberculate micro-ornament. The tubercles cover the exposed portions of the embryonic shell and terminate at the primary constriction. The tubercles are randomly distributed and are approximately 3 μm in diameter. This micro-ornament is similar to that on the embryonic shells of Phylloceratina, Ammonitina, Ancyloceratina, and Lytoceratina. The presence of this micro-ornament in all five suborders lends support for the monophyly of the Ammonitida (*sensu* Hewitt, 1996), which is also supported by the presence of a U-type sutural development (Schindewolf, 1954). However, to strengthen this conclusion it is important to (1) sample species of other Ceratitina, and (2) document the kind of micro-ornament on the embryonic shells of Prolecanitina. Characters of the tuberculate micro-ornament itself, *e. g.*, size of the tubercles, distribution of tubercles on the shell surface, may prove useful in resolving relationships within the Ammonitida.

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The effects of forest practices on freshwater molluscan habitat: a case study from the Torpy River watershed in east-central British Columbia, Canada

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The impacts of forestry and other anthropogenic activity on freshwater mollusks is not well understood. Our approach has been to examine molluscan diversity in a watershed that has a 40-year history of forestry activity. Specifically we examined the ecology of the sphaeriid clam, *Pisidium casertanum,* in the Torpy River watershed in east-central British Columbia. This watershed is mountainous with an alluvial substrate of clay, sand, and gravel. Streams are mainly first order, either spring-fed or the result of snow-melt and ground-water inputs. The forest cover is primarily coniferous. Forestry related activities, such as the installation of culverts to allow access roads to cross streams, have affected stream hydraulics and resulted in the accumulation of fine organic-rich sediments which host populations of *P. casertanum*. A survey of 75 streams along 47 km of the watershed adjacent to the river revealed some strong associations among clam density in these newly created habitats and certain environmental variables. Clam density was significantly correlated to water temperature ($r = 0.457$, $p = 0.016$) and organic content of the sediment ($r = 0.379$, $p = 0.050$) but not to dissolved oxygen, conductivity, or pH. Further research this summer will examine the relationship between upstream forest practices (*i. e.*, clearcuts, riparian conditions) and the downstream sampling sites. Ultimately we hope to examine these and other anthropogenic impacts on the ecology of freshwater mollusks throughout northern British Columbia.

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Chromosome numbers in the North American Sphaeriidae (Bivalvia: Veneroida)

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Chromosomes of freshwater sphaeriid clams are being studied to assess the evolutionary significance of polyploidization within the family. High chromosome numbers of two North American sphaeriid species, *Sphaerium striatinum* (Lamarck) [with *ca.* 150 chromosomes in mitosis] and *Pisidium dubium* (Say) [with *ca.* 292 chromosomes in mitosis], were obtained from gonadal tissue using the acetic-orcein squash method. These results are consistent with recent studies of several species of North American and European sphaeriids by other workers. Interestingly, the chromosome numbers obtained to date in the Sphaeriidae are all very large (more than 150 mitotic chromosomes) except for the European *S. corneum* (2n = 36). The large numbers of chromosomes in this family are far above the normal range within the Bivalvia, and the numbers are obviously polyploid. Therefore, polyploidy may be widespread in the family and probably has played a major role in evolution of the Sphaeriidae. Observations on spermatogenetic chromosome spreads to date has failed to show meiosis. Further studies are necessary to determine if the sperm observed in both species are haploid or diploid (*i. e.*, are produced by meiosis, or by chromosomal non-reduction). [poster]

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Ammonia and urea excretion by the aquatic gastropod *Elimia taitiana* (Prosobranchia) during starvation

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Ammonia and urea excretion typically result from protein metabolism. For gastropods, ammonia is the most common excretory by-product, although excretion of urea also has been reported for some species. Starvation in at least one species of snail has been linked to an excretory shift from primarily ammonia to urea. The purpose of the present study was to determine the primary form of nitrogen excretion for the aquatic prosobranch *Elimia taitiana* under starved and fed conditions. Snails were grouped into two treatments (snails fed on lettuce diet and starved snails; n = 24) and were monitored in aerated containers over a 20-day period. Ammonia and urea levels released into surrounding water were measured every fourth day. All snails excreted detectable levels of ammonia, and there was no difference in ammonia excretion between treatments. However, ammonia levels increased during the 20-d period, indicating perhaps that all snails underwent some level of starvation. Measurable levels of urea were also produced, but these did not vary between treatments and, unlike ammonia, were constant over the study period. Increased ammonia excretion by *E. taitiana* may be a typical response to starvation for this snail; however, detected levels of urea may not be a result of protein metabolism. [poster]

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Distribution of wood-boring bivalves in the Mamanguape River estuary, Paraíba, Brazil

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The occurence of wood-boring bivalves of the families Teredinidae and Pholadidae is reported for the first time for Paraíba state, northeastern Brazil. This study was conducted at four stations in the Mamanguape River estuary (6°45'S, 35°5'W), according to a salinity gradient. The animals were collected in mangrove tree trunks and in artificial collectors, between February 1997 and February 1998. Five teredinid species were found: two Teredininae Rafinesque, 1815 (*Neoteredo reynei* and *Teredo bartschi*) and three Bankiinae Turner, 1966 (*Nausitora fusticula*, *Bankia fimbriatula,* and *Bankia* sp.). *B. fimbriatula* and *N. fusticula* were found at all stations and were the most abundant species, in that order. Their populations increase with young specimens after the rainy season, suggesting that their reproductive cycle is synchronized with the salinity variation. *Bankia* sp., *N. reynei,* and *T. bartschi* occurred along the entire salinity gradient. *N. reynei* was the least abundant species. The pholad *Martesia striata* occurred at all stations in trunks or collectors. Two free-living polychaete species were found in teredinid burrows: *Eurithoe complanata* - a natural predator of teredinids - and *Nereis lamellosa*. The identification of mollusks was according to Turner (1966; 1971). [poster]

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Mitochondrial DNA evolution in the Greek species of the pulmonate genus *Helix*

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We sequenced 700 base pairs of the cytochrome oxidase I (COI) gene of mitochondrial DNA in 10 species of *Helix* from the mainland and islands of Greece. We found extremely large divergences. DNA sequences between species were on the average 20.3% different, a value that in other organisms is typical of different genera. Populations of the same species differed as much as 14.8%, with the introduced *H. aspersa* being the most variable. Such high divergences may result from the existence of sibling species, but, this does not seem to be the case in *H. aspersa*, because a previous isozyme study by Lazaridou-Dimitriadou *et al.* failed to detect similar genetic discontinuities. For the same reason, it does not seem to be the result of the subdivided nature of land snail populations. High mitochondrial DNA differences in morphologically similar populations seem to be a feature of land snails; they have also been detected for different regions of the molecule by Thomaz *et al.* in *Cepaea* and by Douris *et al.* in *Albinaria*. Phylogenetic analysis of the *Helix* sequences reveals that (a) *H. figulina* from northern Greece and the Aegean islands probably belongs to a different species, (b) *H. pomatia rodopensis* is more closely related to *H. philippinensis* and *H. scerscernenda* than to *H. pomatia* from France, and (c) *H. aperta* is the sister-species of *H. aspersa*.

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Molluscicidal activity of extracts from *Lycopersicon esculentum* leaves on *Biomphalaria glabrata* (Mollusca: Planorbidae)

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Aqueous and alcoholic extracts were obtained from crushed dried leaves of tomato plant (*Lycopersicon esculentum* c. v. Cereja). By using methanolic extraction and alkaline precipitation, a product named "crude steroidal glycoalkaloid" (GEb) was obtained. The presence of tomatidine was characterized in this product. In laboratory evaluation, the aqueous and alcoholic extracts and GEb showed molluscicidal activity against *Biomphalaria glabrata*. GEb presented high molluscicidal activivity (LC_{50} =8.01 and LC_{90} = 13.17 ppm), similar to that of tomatine. Aqueous and alcoholic extracts were active against *Schistosoma mansoni* miracidia. These extracts and GEb were active against schistosomal cercaria. None of the compounds tested affected *B. glabrata* egg masses. The levels of activity shown by the various extracts and GEb, pointed to GEb as the only candidate to be considered for further tests toward field trials as a molluscicidal agent.

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An evaluation of the role of different hierarchical levels in the resolution of gastropod phylogeny

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Much discussion has focused on the utility of character subsets in phylogenetic reconstruction. One of the central issues of this debate is the value of morphological versus molecular characters. Within molecular characters there is a secondary but related debate concerning the appropriateness of certain genes in being informative relative to the depth of the divergence. Within morphological characters this debate is just as rigorous, but without much empirical justification. Here we evaluate the role of morphological character suites in the resolution of gastropod phylogeny. Our analysis uses as a baseline the Ponder & Lindberg data set consisting of 117 characters and 40 gastropod taxa. Five outgroup taxa were included, representing four conchiferan groups and Polyplacophora. We begin by examining the nature of morphological data at different hierarchical levels (*e. g.*, ultrastructure, gross anatomy, histological) and at the level of different anatomical systems (*e. g.*, digestive, nervous system) which encompass different hierarchical levels. Our methodology is to exclude certain data sets (*e. g.*, all histological or digestive system characters) and determine loss or gain in the optimization of characters and trees. Using parsimony as the optimality criterion, exclusion of gross anatomy, histological, or ultrastructural characters had no significant effects on the final topologies. Identical results were also found when we removed the more integrated (structurally and functionally) anatomical system data. There is no necessary panacea in any data set.

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Zoogeographic relations of Magellanic Mollusca

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408 Magellanic molluscan species are known: 10 species of Aplacophora, 253 species of Gastropoda, 7 species of Scaphopoda, and 138 species of Bivalvia. Polyplacophora and Cephalopoda are not included. Molluscan species collected with an epibenthic sledge in the Beagle Channel served as the basis for this zoogeographic study. In total, 118 species were identified from this collection, 43 species were new records for the Magellanic mainland and 35 species for the entire Magellan region. 10 of these species were reported from the high Antarctic. The species list was completed by literature data on the distribution of mollusks from the Southern Ocean and from the Peruvian and Patagonian regions. Species similarities with the northern regions were 13% with the Peruvian and 7% with the Patagonian region. Species similarities to Antarctic regions decreased from the Magellanic mainland toward the Falkland Islands (37% similarity) and from South Georgia (12%) to Antarctica (4%). The Gastropoda show high similarities to the Falkland Islands (42%) and South Georgia (11%) and only 1% similiarity with the Antarctic continent, whereas the Bivalvia are more similiar to the high Antarctic fauna, *e. g.*, to the South Shetland Islands 14% and to the Ross Sea 10%.

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Some new data on prosobranch gastropods from Neoeuxinian deposits of Lake Yalpug

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The Neoeuxinian Lake-Sea came into existence about 18,000-20,000 years ago after the end of the Wurm glaciation. The Neoeuxinian fauna should be considered as an ancient predecessor of the modern Black Sea's inhabitants. The salinity of this water-body was approximately 5-7%, and the animals were adapted to brackish waters. The main goal of our investigation was learning the composition of gastropods from Neoeuxinian deposits of recent Lake Yalpug, which is situated in the south of the Odessa region (Ukraine). All of our materials were collected near the village Kotlowina on the western shore of Lake Yalpug in 1987. In all, 21 species of freshwater pectinibranch (= Prosobranchia part.) gastropods were found in our samples: Neritidae: *Theodoxus fluviatilis* (L.), *T. pallasii* (Lindholm), *T. euxinus* (Clessin), *T. sarmaticus* (Lindholm); Viviparidae: *Viviparus viviparus* (L.), *V. ater* (Cristophori & Jan); Valvatidae: *Borysthenia naticina* (Menke), *B. menkeana* (Jelski), *B. alligans* (Lindholm), *Cincinna (Atropidina) pulchella* (Studer); Melanopsidae: *Fagotia dneprensis* Starobogatov, Alexenko & Levina, *F. danubialis* Bgt., *F. berlani* Bgt., *Microcolpia ukrainica* Starobogatov, Alexenko & Levina, *M. canaliculata* Bgt.; Pyrgulidae: *Turricaspia lincta* (Milaschewitch), *T. grigorievi* Alexenko & Starobogatov; Lithoglyphidae: *Lithoglyphus naticoides* (Pfeiffer), *L. pyramidatus* (Mollendorff), *L. apertus* (Kuster); Bithyniidae: *Opisthorchophorus hispanicus* (Servain) (= *Bithynia inflata* auct.). [poster]

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Sperm depletion in the hermaphroditic land snail *Arianta arbustorum*

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Sperm number is an important feature in sperm competition. We examined how long individuals of *Arianta arbustorum* (Pulmonata: Helicidae) need to recover from sperm depletion after a successful copulation (Locher & Baur, in prep.). The results of a mating experiment showed that a pause of at least 8 days between two copulations is required to replenish the sperm reserves. Theory predicts that in simultaneous hermaphrodites the resources allocated to either sexual function may negatively affect the other function. However, oviposition between two copulations did not affect the number of sperm transferred in the second copulation, irrespective of the intermating interval. These findings contribute to a better understanding of sperm competition and sex allocation in simultaneous hermaphrodites.

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Feeding mode mediates success of invasive whelk

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The recent expansion of Kellet's whelk, *Kelletia kelletii* (Forbes, 1852), from Point Conception to Monterey Bay, California, introduced a novel feeding mode to the guild of invertebrate predators preying on trochid snails in Monterey Bay. Sea stars, the primary native predators of trochids in Monterey Bay, feed using an eversible stomach; *Kelletia* feed with a prehensile proboscis. I used two sea stars (*Astrometis sertulifera, Pisaster giganteus*) and *Kelletia* from southern California as predators and two trochid congeners as prey, to (1) compare predator consumption rates; and (2) assess prey anti-predatory defenses. Prey were either *Tegula eiseni* (southern California) or *T. brunnea* (Monterey Bay). Single predators had a constant density (n = 6) of a single prey species for 70 days. Prey species were switched after 35 days. *Astrometis* ate both *Tegula* spp. at equal rates. *Pisaster* and *Kelletia* ate significantly more *T. brunnea* than *T. eiseni*. Escape frequency and consumption time were greater for *T. eiseni*, supporting previous suggestions that *T. eiseni* is better defended than its congeners. Among predators, *Kelletia* ate a significantly higher proportion of *T. brunnea* than either *Pisaster* or *Astrometis*. While deep withdrawal by *T. brunnea* was a partially effective defense against sea stars, it was ineffective against the novel feeding mode of *Kelletia*. Successful establishment of *Kelletia* in non-native habitats may be expedited by its novel feeding mode.

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Growth measurements of *Norrisia norrisi* (Sowerby, 1838) in a kelp forest at Santa Catalina Island, California

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Growth rates for Norris' top snail *Norrisia norrisi* (Sowerby, 1838) in kelp forests have not been studied previously. Field measurements of individual snails at Pumpernickel Reef, Santa Catalina Island, California, were recorded over a 10-month period beginning in June 1992. I measured growth along the greatest dimension of the shell *in situ* using calipers precise to 1 mm. Individual snail sizes were scratched into the periostracum of the shell with a scriber and lasted up to 5 months. It is not known when *Norrisia* reproduce but recruits (4 mm) displaying larval shell morphology were observed during early summer only. As expected, small snails (< 30 mm) increased at a significantly greater rate (1.8 mm/month) than larger snails (30 mm, 1 mm/month). Using conservative but realistic growth rates, I propose snails 17 mm are 1 year (young of the year), snails 18-29 mm are 1-2 year, and snails 30 mm are 2 years old. Snails 42 mm were uncommon in the kelp forest and did not measurably increase from month to month. [poster]

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Anatomy and histology of the alimentary tract of *Oxychilus (Drouetia) atlanticus* (Morelet & Drouët, 1857) (Pulmonata: Zonitidae)

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Oxychilus (Drouetia) atlanticus, endemic to São Miguel, Azores, has been successfully subjected to laboratory predatory experiments on *Lymnaea truncatula*, thus showing that this species is carnivorous in addition to its vegetable diet (Cunha, 1991). According to Lopes *et al.* (1995), the omnivorous tendency of this species was also observed in the field. The present study is aimed to reveal the anatomy and histology of the alimentary tract of *O. atlanticus*, as part of an ongoing study on its digestive system. Such a study is important to provide a sound basis for subsequent histochemical studies indispensable for understanding this system mode of functioning. Light-microscopic observations on the alimentary tract of *O. atlanticus* demonstrated that according to the cell types and the morphology of its internal folds, it is divisible into six morphologically distinct regions: buccal mass, esophagus, crop, stomach, intestine, and rectum. There is some evidence for the functional division of *O. atlanticus'* gut: the esophagus appears to be specialized for the movement of food particles; the crop, wide and thin-walled, serves as storage organ; the stomach is very simple, with the most conspicuous characteristic the presence of two major typhlosoles responsible for food selection; the intestine shows four distinct histological regions, probably related to different moments of the digestive process. The alimentary tract ends in the rectum, responsible for the fecal formation, to which the rectal gland seems to contribute. [Partially funded by Praxis/2/2.1/BIA/169/94].

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Genetic differentiation within and between species of the genus *Phenacolimax* in the Azores (Pulmonata: Vitrinidae)

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A recent taxonomic revision of the genus *Phenacolimax s. l.* in the Azores by Mordan and Martins (in prep) recognizes six endemic species based on the shell form and sculpture, external body characters and pigmentation, and anatomy. These species belong to two genera, a new genus (possibly in the Vitrininae) and *Phenacolimax (Insulivitrina).* The latter group comprises five species distributed on all islands of the Azores, with the exception of Graciosa, *viz. P. angulosa* and *P. pelagica* (Santa Maria), *P. laxata* (São Miguel), *P. brumalis* (São Miguel, São Jorge, Pico, and Terceira) and *P. finitima* (Flores and Corvo). To support this taxonomic arrangement, we started an electrophoretic comparison of protein variation in the different taxa. Here we focus on *P. laxata, P. brumalis,* and *P. finitima*. Using native polyacrylamide gel electrophoresis (PAGE) and isoelectric focusing (IEF) of allozymes we aimed to (1) test the degree of genetic isolation between the three taxa, (2) assess their degree of intraspecific differentiation, and (3) evaluate to what extent morphological and electrophoretic data are congruent. The electrophoretic data apparently confirm the morphological distinctions among these three species. Moreover, the intraspecific differentiation between the populations of *P. laxata* on São Miguel seems to follow the geological age of the island. The populations of *P. brumalis* show two separate clusters, on São Miguel and on the remaining islands. [Supported by Research Grant Praxis/2/2.1/BIA/169/94].

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Evolutionary patterns and phylogenetic content of the mitochondrial 16S rRNA gene of select mollusks

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DNA sequence data offer a wealth of information for resolving evolutionary questions and estimating phylogenetic relationships. Molecular systematic studies have been instrumental not only in reconstructing geneological histories, but in revealing patterns of DNA sequence change over time. Conversely, our increased understanding of nucleotide substitution patterns increases our ability to conduct phylogenetic analyses appropriately. Ribosomal RNAs (rRNAs) are perhaps the most commonly employed genes for inferring relationships among organisms. Here I present an analysis of the complete mitochondrial 16S rRNA gene among a select group of mollusks. I present hypotheses on the secondary structure of the 16S rRNA gene among the mollusks and suggest how secondary structure may provide useful phylogenetic information. In addition, I explore the phylogenetic utility of the gene for inferring relationships within mollusks. [Character Symposium]

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Water resources development and schistosomiasis in Africa

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Schistosomiasis can be expected to remain an important public health problem owing to the continuing increase in the human population and the ensuing demands on energy and food which will result in an increased construction of hydroelectric dams and large irrigation schemes. Furthermore, there will be an increase in the number of smaller dam constructions to create the necessary reservoirs for either drinking water supply or small scale irrigation. There are numerous examples that such projects result in increased schistosome transmission. Creation of dams often results in ecological changes conducive for intermediate host snails, not only in the retention lake but possibly also in the river downstream from the dam. Many dams may serve both for the supply of water for irrigation and for hydroelectricity generation. Irrigation schemes also constitute important areas for transmission. Due to variation in topography and size of the area, the crop's water requirements, and financial input, a great variety of irrigation systems exists in Africa and all systems may have specific problems related to establishment of schistosome intermediate hosts and subsequent establishment of schistosome transmission. Through a number of case studies, ecological aspects of schistosome transmission are discussed in such water development schemes and possibilities for manipulations of the schemes for control of the intermediate hosts are reviewed. [Human Symposium]

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Comparative feeding ecology of four species of predatory gastropods on Brazilian intertidal rocky shores

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The muricids *Stramonita haemastoma* and *Morula nodulosa*, the fasciolariid *Leucozonia nassa*, and the buccinid *Pisania auritula* coexist on Brazilian intertidal rocky shores, constituting a guild that exploits sessile or slow mobile prey. Diets of the four species were quantitatively analyzed and compared with prey abundance at three different sites. Predator distribution was also studied. Schoeners overlap indices for diet and habitat usage showed that there was strong resource partitioning among these gastropods in the intertidal zone. *S. haemastoma* and *M. nodulosa* mainly exploit the lower and upper midlittoral zones respectively, while *L. nassa* and *P. auritula* preferentially exploited the sublittoral fringe. Diet analysis indicated a marked niche overlap between the first pair of species, although they fed in distinct habitats and ate prey of different sizes. The four species exhibited a broad diet. *S. haemastoma* consumed mainly bivalves, *M. nodulosa* exploited small barnacles and bivalves, whereas *L. nassa* and *P. auritula* ingested preferentially large barnacles and polychaetes. The muricids showed low prey selectivity exploiting the majority of prey according to their availability in the environment. Habitat partitioning is as important as food partitioning in structuring this gastropod guild. Diet flexibility is an adaptive strategy under conditions of recruitment site uncertainty for predators and prey, associated with long-distance larval dispersal cycles. [poster]

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Additions to our knowledge of the opisthobranch mollusks of Ria Formosa, a coastal lagoon in southern Portugal

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New data are reported on the opisthobranch mollusks of Ria Formosa coastal lagoon (Algarve, southern Portugal), as a result of collecting field work that took place between 1996 and 1997 within the project "Study and contribution to the general understanding of the gastropod mollusks of Ria Formosa." The more important works dealing with opisthobranch mollusks of Portuguese coastal waters are Paulino de Oliveira (1895, *Opisthobranches du Portugal de la collection de M. Paulino d'Oliveira, O Instituto,* 42: 574-592), Nobre (1931, *Moluscos marinhos de Portugal 1, Inst. Zool. Univ. do Porto,* 466 pp.; 1932-1936, *Moluscos marinhos de Portugal* 2, 378 pp.; 1938-1940, *Fauna malacologica de Portugal I. Moluscos marinhos e das águas salobras. Porto,* 806 pp.), Hidalgo (1917, *Trab. Mus. Nac. C. Nat., ser. zool.* (30): 1-744), Cervera *et al.* (1988, *Iberus* suppl. 1: 1-83), and García-Gómez *et al.* (1991, *Boll. Malacol.* 27(5-9): 125-138). The authors mention a total of 23 species, of which 13 are first references for Ria Formosa; of these 6 are new additions to the Algarve and Portuguese fauna. A biogeographical discussion of these new findings is added. [poster]

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Comparing early ontogeny shells of phylogenetically related Jurassic and Recent bivalves: a step toward taxonomic and paleoenvironmental interpretations

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Larval shells of fossil bivalves could be of multiple use for paleoenvironmental and paleobiogeographic interpretations (Jablonski & Lutz, 1983, *Biol. Rev.* 58: 21-89, for an overview). However, this requires a comprehensive basis for taxonomical identification and much better knowledge of the correlation of prodissoconch sizes and planktotrophy. Here I present a comparison of excellently preserved middle Jurassic pteriomorphs with phylogenetically related recent taxa. Preliminary results already demonstrate that: (1) pteriomorphs are more easily identified by general shell outline than heterodonts, (2) advanced P II shell stages reflect the general proportions and shape of the adult, (3) shapes of larval shells are conservative within higher taxa, (4) the P II and nepioconch sculptures are taxon specific, (5) P I sizes of Jurassic non-heterodonts hint toward planktotrophy, (6) there exist significant size differences of the P II of middle Jurassic and late Jurassic oxytomids that may reflect either phylogenetic size increase or differences in ambient temperature, (7) quantitative characters such as length and height of the two prodissoconchs reflect species differences, and (8) covariances are often below 6% implying reasonably small sample sizes for statistical tests of differences of means between two populations. The results so far suggest that larval shells provide sufficient characters for taxon identification down to species level. In addition, they contain valuable new information on ontogenetic development and character evolution.

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Upper Oligocene to Lower Miocene pectinid bivalves of central Iran

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Due to their abundance and rapid speciation, pectinids are regarded as a useful biostratigraphic and paleobiogeographic tool in shallow marine environments from Oligocene to Recent times. Biozonations are worked out for, *e. g.*, the central Paratethys, the western Mediterranean and northern Europe. Knowledge of eastern Mediterranean/western Indo-Pacific pectinids, however, is still very poor, particularly for the Oligocene/ Lower Miocene interval. Within an Austrian/German paleo(bio)geographic research project at the Oligo/Miocene boundary in the eastern Mediterranean/western Indo-Pacific also the Qom Formation in central Iran is under study. Four sections were investigated in which pectinids are common and often accumulated in distinct layers of vertically changing taxonomic composition. The oldest parts of the Qom Formation are characterized by an *Amussiopecten placenta* assemblage partially with abundant *Pecten tietzei* and a diverse assemblage of aquipectinids. Similar pectinid types can be traced to stratigraphically comparable sequences of the Mesohellenic trough and northern Italy. The Aquitanian part of the Qom stratotype section contains characteristic monospecific lags of a medium-sized, inaequilateral morphotype of *Amussiopecten burdigalensis*. This form also occurs in Greece and Italy. In the Zefreh section near Esfahan, stratigraphically similar or slightly younger, a pectinid lag is present composed exclusively of *Chlamys rotundata*, a typical Aquitanian pectinid from southern France. At the Qom section, the Burdigalian top contains characteristic central Paratethyan to Mediterranean Lower Miocene pectinid types, particularly *C. holgeri*, a widespread Burdigalian index fossil.

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Study on the experimental susceptibility of two *Cernuella* species (Mollusca: Stylommatophora) to *Dicrocoelium dendriticum* (Digenea)

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The small liver fluke *Dicrocoelium dendriticum* (Rudolphi, 1819) is the parasite responsible for sheep and cattle dicrocoeliosis in various parts of the world. Several species of land mollusks and ants are its first and second intermediate hosts, respectively. The experimental susceptibility of two species of *Cernuella* (Stylommatophora) to *D. dendriticum* was studied to understand the natural infection data and dicroceliosis epidemiology. Two batches of 150 *C. (C.) virgata* (Da Costa, 1778) and 70 *C. (Microxeromagna) vestita* (Rambur,1868) specimens were tested with doses of 60 and 20 *D. dendriticum* eggs per mollusk, respectively. These mollusks were maintained under laboratory conditions (22.2°C ± 0.18 SE; 42.4% ± 0.30 relative humidity) and killed periodically. [The following results concerning *C. (C.) virgata* are marked by one asterisk (*); those of *C. (M.) vestita* by two (**).] *D. dendriticum* hatched eggs were observed in the feces eliminated by 34.6%* and 35.7%** of the mollusks. The parasite was detected using the stereomicroscope in 36%* and 24.8%** of the snails. The first observation of *D. dendriticum* (daughter sporocysts with undifferentiated germinal masses) in the mollusks was on day 61* post-infection (p. i.) and 62** p. i. Sporocysts with developed cercariae were observed in *C. (C.) virgata* from day 135 p. i. until the end of the experiment (167 p. i.), while only inmature cercariae were detected in *C. (M.) vestita* until day 132 p. i. [Supported by CICYT Ref. AGF92-0588]. [poster]

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Some freshwater mollusks from Iran

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Freshwater snail faunas of most parts of the world are almost covered, but an Iran-wide snail survey has not completely been done. For this reason, a country-wide snail search has been undertaken through a 7-year grant supported financially by the Tehran University of Medical Sciences, and technically in part by the British Museum and Danish Bilharziasis Laboratory. Prosobranchs: *Bellamya bengalensis* (Lamarck, 1822); *Bithynia (Alocinma) ejecta* (Mousson, 1822) Annandale, 1920; *B. (A.) sistanica* Annandale, 1920; *B. badiella* Annandale, 1920; *B. (B.) tentaculata* (Linné, 1758); *Falsipyrgula sieversi* (Boettger, 1881); *Frauenfeldia elbursensis* Starmuehlner, 1957; *Gangetia uzielliana* (Issel, 1886); *Hydrobia ventrosa* (Montagu, 1803); *Melanoides tuberculata* Annandale, 1919; *Melanopsis costata* (Oliver) Brot, 1879; *M. doriae* Issel, 1865; *M. nodosa* Férussac, Mousson, 1874; *M. praemorsa* (Linné, 1758); *Neritina mesopotamica* Martens, 1879; *Pseudamnicola ?brevicula* (Martens, 1874); *Theodoxus (T.) doriae* Issel, 1866; *T. (Neritraea) euphraticus* (Mousson, 1874); *Thiara scabra* (Müller, 1774); *Valvata cristata* (Müller, 1774); *V. piscinalis* (Müller, 1774). Pulmonata: *Anisus leucostoma* (Linné, 1758); *A. vortex* (Linné, 1758); *Bulinus truncatus* (Audouin, 1827); *Gyraulus* spp. Agassiz in Charpentier, 1837(32); *Indoplanorbis exustus* (Deshayes, 1834); *L. gedrosiana* Annandale, 1919; *L. palustris* (Müller, 1774); *L. pereger* (Müller, 1774); *L. rufescens* Gray, 1822; *L. stagnalis* (Linné, 1758); *L. truncatula* (Müller, 1774); *Physa acuta* Draparnaud, 1801; *Planorbis carinatus* Müller, 1774; *P. intermixtus* Mousson, 1874; *P. planorbis* (Linné, 1758).

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Hyriidae (Unionoida) glochidia: a review of the discoveries and descriptions of unknown or little-known larvae

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The glochidia of South American Hyriidae (Unionoida) were first described and illustrated by Lea in 1869. It was only 52 years later that Ortmann (1921), followed by Bonetto (1954) and others, described the larvae of various species. However, many larvae are still unknown. The sequence of larval discoveries and a list of their measurements are given. The two different types of glochidia are illustrated and described as: (1) fish-parasitizing glochidia with the presence of a tooth in each valve, and (2) glochidia that do not parasitize fish with valves devoid of teeth or spinules. The parasitizing glochidia, in turn, are divided into two types on the basis of morphological differences: (1) glochidia with the presence of a larval filament and S-shaped teeth, ending in two or three pointed cusps, without additional spinulae (Diplodontini and Prisodontini), and (2) glochidia with no larval filament and with smooth, strongly pointed, aculeus-shaped teeth, without terminal cusps or spinules (Castaliini). Some of the larvae illustrated were photographed with a scanning electron microscope and some were drawn using a biological microscope with camera lucida. The technique for larval cleaning and slide preparation follows Mansur & Campos-Velho (1990). The measurements and illustrations of unknown or little-known larvae are added [Supported by CNPq]. [poster]

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Variations in the diversity and morphology of bivalve mollusks along the Uruguay River

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The Uruguay River is one of the most important rivers in the Prata basin system, South America, not only due to its great extension, but also because of the large number of molluscan species living in it. Collections performed over several years along parts of the upper, middle and lower Uruguay River and in several of its tributaries, as well as the examinations of various scientific collections, have permitted a listing of species and the comparison and identification of morphotypes along each stretch of the river. Illustrations and data about the environmental preferences and areas of occurrence of each species are also presented. [Supported by CNPq]. [poster]

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Molluscan biodiversity threatened in the Mercosul Region: environmental degradation, dissemination of mollusks that transmit parasitic disease, and uncontrolled expansion of exotic mollusks

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The countries belonging to MERCOSUL (Argentina, Brazil, Paraguay, and Uruguay) are involved in a project of integration/development of a vast territory and face various environmental problems affecting biodiversity of the endemic molluscan fauna in its various terrestrial, freshwater, and marine environments. The malacologists of this region met at the Malacology Symposium of Mercosul in Florianópolis, Brazil, to share information about the problems and at the WCM to find urgent solutions. Extinct species and those threatened by extinction are listed. The basic problems are: (1) extinction of terrestrial species, especially of Megalobulimidae due to environmental degradation especially in areas of the Atlantic forest; 2) extirpation of Thiaridae (freshwater) from the upper course of the Paraná River due to construction of dams. Populations of 5 distinct phenotypes are being kept alive in MACN aquaria while awaiting resources and measures needed for their integration in a natural environment with no harm to the diversified pool of species; (3) chemical contamination of the estuarine waters of Rio Prata and of various rivers of the Atlantic basin, with a reduction of the diversity of freshwater bivalves (naiads); (4) uncontrolled dispersion of Asiatic mollusks introduced into the Prata River basin, with serious damage to the native fauna by suffocation and competition; (5) dissemination of mollusks that transmit parasitic diseases of sanitary importance which are gradually advancing toward southern Brazil and northern Argentina; (6) predatory hunting and fishing of marine mollusks in Argentina, Uruguay, and northeastern Brazil, with the risk of extermination of various species. [poster]

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Allozyme differentiation and diagnosis of the short-finned squid species of the genus *Illex* (Cephalopoda: Ommastrephidae)

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The genus *Illex* is distributed throughout the Atlantic as a complex of three main taxa, *I. argentinus* (Castellanos, 1960), *I. illecebrosus* (Lesueur, 1821), and *I. coindetii* (Vérany, 1837). Taxonomic identification based on morphological characters is carried out when individuals are completely mature, however, diagnostic characters may still overlap. Allozyme polymorphisms have proved to be effective for detection of genetic differences at inter- and intraspecific levels. Of a total of 29 enzymes assayed by horizontal starch gel electrophoresis, 33 presumptive enzyme-coding loci were studied in 224 individuals from allopatric populations: two samples of *I. argentinus*, one of *I. illecebrosus*, two of *I. coindetii*, and one of *Todaropsis eblanae* for comparison. The *SOD** locus showed three fixed alleles for each *Illex* taxon. Moreover, *IDHP1** locus showed different alleles at high frequency (> 0.95) in each taxon, whereas *ALPDH** locus showed one characteristic allele in *I. coindetii* and a different one for *I. argentinus* and *I. illecebrosus*. Low levels of genetic variability were found (unbiased expected heterozygosity ranged from 0.01 to 0.03). No significant differences in allele frequencies were detected between populations within both *I. argentinus* and *I. coindetii*. Genetic identities among *Illex* taxa were around I = 0.9. The presence of completely and partially diagnostic loci among taxa, together with the low levels of allozyme variability, strongly suggest that *Illex* taxa may be considered as different biological species rather than as subspecies.

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The Pedipedinae: a convenient assemblage? and a revision of the relationships within the Ellobiidae

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The Pedipedinae Fischer & Crosse, 1880, originally monotypic, included the ellobiid snails which lack inner whorl shell resorption. Consideration of radular characters lead to the inclusion in the subfamily of *Marinula* and *Plecotrema* (= *Laemodonta*) by Odhner (1925, *Arch. Zool.* 17A: 1-15, pls. 1-2) and *Pseudomelampus* and *Leuconopsis* by Thiele (1931, *Handb. syst. Weicht.* 1: 377-778). Morton (1955), based on anatomical characters, added *Rangitotoa* (= *Microtralia*). Also on the basis of the anatomy, Martins (1996a, *Origin Evol. Rad. Moll.* 24: 285-294) removed *Laemodonta* from the Pedipedinae and (1996b, *Malacologia* 37(2): 163-332) added the new genus *Creedonia* which, like *Pedipes*, lacks inner whorl shell resorption. Martins (1996a) pointed to the heterogeneity of the subfamily and recently (in press, *Proc. 3rd Int. Conf. Mar. Biol. S. China Sea, Univ. Hong Kong*), on the basis of the anatomy of the terminal region of the pallial gonoducts, revived Cassidulinae, removing from the Pedipedinae the genera *Creedonia* and *Leuconopsis*. The present study reviews the anatomy of *Microtralia* and concludes that, on the basis of features of the distal pallial gonoducts and internal morphology of the penis, this genus belongs in the Cassidulinae. Also, a detailed analysis of these anatomical features in various species of the remaining Pedipedinae genera, *viz., Pedipes, Marinula, Pseudomelampus,* and *Sarnia*, is conducted and the relationships within the Ellobiidae are reassessed. [Partially funded by the Project Praxis/2/2.1/BIA/169/94].

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Studies on the anatomy of *Bankia fimbriatula* Moll & Roch, 1931 (Mollusca: Bivalvia: Teredinidae)

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Bankia fimbriatula Moll & Roch, 1931, is a highly specialized bivalve adapted for boring into wood. The species was collected alive at the mangrove region of Ubatuba (45°15'W, 23°30'S), State of São Paulo, Brazil. Living specimens were maintained in aquaria at room temperature (21°C) at the laboratory of the Departamento de Zoologia da Universidade de São Paulo. The species tolerates salinity variations from 0 to 33 in the natural environment. Ciliary currents of feeding and other functional adaptations were observed in living specimens. Studies of the anatomical features were made on living as well on relaxed and preserved specimens. *B. fimbriatula* belongs to Group VI of the Teredinidae (Turner, 1966). The species of the genus *Bankia* present pallets greatly elongated and blades composed of numerous cone-like elements on a central stalk; the siphons are fairly long and separated. The siphons belong to Type B of Yonge (1957). The inhalant and the exhalant siphons present cilial activity at the tentacles, as Lopes (1991) described for the first time in *Nausitora fusticula*. The posterior ctenidia are homorhabdic (Ridewood, 1903) and are classified as Type G of Atkins (1937). The stomach belongs to Type V as defined by Purchon (1960). A comparison is made between *B. fimbriatula* and other teredinids already known. [Bolsista de Produtividade de Pesquisa do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) Proc. No. 300490/94-1 (W. Narchi)]. [poster]

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A new genus of Patelliformes (Gastropoda) and some systematic questions on Paleozoic limpets

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The anterior part of a cap-like shell can be differentiated from the posterior part usually by apex position. This is true in the case of docoglossate gastropod morphology. However, if the horseshoe-shaped muscle scar could be observed, the anterior margin should be identified by the opened part of the muscle scar, the most reliable feature. Therefore, in spite of traditional opinion, the apex of Archinacellidae, as well as Metoptomatidae, should be regarded as posteriorly shifted. If so, the Metoptomatidae basically differ from docoglossate gastropods and should be considered closely related to archinacellid gastropods and thus is moved to the order Archinacelliformes Knight and Yochelson, 1958. A new genus is proposed for the Late Paleozoic limpets possessing a subcentral apex and a horse-shoe-shaped muscle scar opened toward the anterior. The new genus is referred to the family Damilinidae Horny, 1961, order Patelliformes. The genus *Floripatella* Yochelson, 1988, previously referred to Archinacellidae is moved to the family Damilinidae. Two new species from the Carboniferous rocks of the Moscow Basin and five previously known species (*Lepetopsis parrishi* Gurley, 1884, *L. patella* Yochelson, 1960, *L. beedei* Yochelson, 1960, *L.* sp. 1 Yochelson, 1960; and *L.* sp. 2 Yochelson, 1960) from the Late Paleozoic of the North America are moved to the new genus. Apparently the Metoptomatidae were extinct at Lower/ Middle Carboniferous boundary. [poster]

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Comparative anatomy establishes correlativity in distributional direction and phylogenetic progression in the Achatinidae

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A continuing program of dissecting the soft anatomies of the giant African land snails (Achatinidae) has greatly strengthened the hypothesis that the earliest forms originated in the Lower Guinea of Cameroon and Gabon. Phylogenetically close to these plesiomorphic forms, the family broke into two major trunks. The anatomically more conservative trunk formed three branches: (1) a strong western branch that moved through the Upper Guinea and the small islands of the Guinea Sea; (2) an evolutionarily vigorous branch of small, hardy forms that proded the Sahara all along the north and penetrated deeply into Central Africa; and (3) a direct eastern thrust into the Horn of Africa, and a strong side branch to the Cape. The second major trunk from the Lower Guinea, with its distinctive morphology, also formed three branches: (1) a weak branch that moved straight south through Angola and Namibia into western South Africa; (2) a strong southeastern branch that fanned out into the Congo Basin to form a rich group of very similar appearing species; and (3) a direct eastern branch that moved into the Lake country, with a weak side branch to the Horn of Africa and a stronger one going to southern Africa. The intermixing third branches of the two major trunks passed through similar environments to produce conchologically similar appearing species from anatomically distinct stocks.

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Radular myoglobin variation among the subgenera of *Littorina* (Gastropoda: Prosobranchia)

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The radular muscles of several littorinids are known to contain myoglobin (Mb). Mb can be a useful taxonomic marker as resolved by native polyacrylamide gel electrophoresis (PAGE) and isoelectric focusing (IEF). Here we extend a previous study concerning Mb variation in some littorinid species, by comparing the Mb variation among the four currently recognized subgenera of the genus *Littorina*. Our results suggest that: (1) the Mb patterns of the subgenera *Liralittorina* (*Littorina striata*) and *Planilittorina* (*L. keenae*) represent a plesiomorphic condition because they are very similar (if not identical) to those of *Nodilittorina*/*Littoraria*, while (2) the subgenus *Littorina* (represented by *L. scutulata*, *L. plena*, and *L. littorea*) has Mb profiles which are indistinguishable from those of *Neritrema* (represented by *L. saxatilis* and *L. compressa)*. Yet, within *Neritrema* it seems that some species or species groups (*e. g.*, *L. arcana*, *L. obtusata*, *L. fabalis*) developed particular Mb profiles which may indicate special ecological adaptations or which may point to the highly derived position of these species. Hence littorinid Mb variation seems to be consistent with the current phylogeny of the group.

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Some aspects of reproductive strategy of the land snail *Eobania vermiculata* (Müller) in the Crimea

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The terrestrial mollusk *Eobania vermiculata* (Gastropoda: Pulmonata: Helicidae) is of Mediterranean origin. In the Crimea it had been introduced in the second part of 19th century by chance. Now this species is living in the Crimea everywhere. We study the reproduction, dynamics of age structure, and population dynamics of *E. vermiculata* in their natural habitats in 4 regions of the Crimea (Sebastopol, Pribrezhnoe, Simferopol, and Alushta) from April 1996 to January 1998. In Greece, *E. vermiculata* has one reproductive period per year (October). It aestivates from July to September and hibernates from December to February (Lazaridou-Dimitriadou & Kattoulas, 1991, *Canad. J. Zool.* 69: 881-891). The Crimean climate is more inclement than that in Greece. Here hibernation in *E. vermiculata* lasts from mid-November to March, and aestivation from July to August. There are two periods of reproduction, in autumn and spring. Observation of marked adults in the field yielded the following statistics: 85% of the adults laid eggs in the period from mid-September to the end of October, and 15% in April. Newly hatched snails appeared in October-November and May. Thus *E. vermiculata* has a population reproduction reserve in the extreme condition of existence. This peculiarity helps it to recover its population density after the very cold winter. [poster]

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Karyotypes of certain freshwater mollusks of the fauna of Ukraine

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Over the last years, cytogenetic methods have been used more and more widely in solving various problems of systematics, closer definitions of the status of organisms, and discovery of phylogenetic relations among groups of animals. Karyological investigations in malacology combined with conchological, anatomical, and biochemical methods, make it possible to study various systematic groups of mollusks. Karyotypes serve as parameters that help solve a number of problems in biology of reproduction and evolution of chromosomes. Organizational peculiarities of chromosomes are directly connected with formation of reproductive isolation as well as differences in fertility and viability. Our investigation dealt with karyotypes of representatives of *Lymnaea* (Gastropoda: Pulmonata) and *Unio* (Bivalvia: Unionidae). We established the diploid number of chromosomes (2n), their morphology, their chromosome formulae, and the basic number (NF). The results of the research are as follows: *L. stagnalis*: 2n = 6m + 10sm + 20t = 36; NF = 52. *L. auricularia*: 2n = 22m + 4sm + 2st + 6t = 34; NF = 62. *L. ovata*: 2n = 14m + 20sm = 34; NF = 68. *L. patula*: 2n = 22m + 12sm = 34; NF = 68. *U. pictorum*: 2n = 26m + 8sm + 4st = 38; NF = 76. *U. conus borysthenicus*: 2n = 22m + 14sm-st + 2t = 38; NF = 74. Arm ratios were determined by the method of Levan *et al.* (1964).

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Structural alterations of the larval radula induced by ^{60}Co gamma radiation in *Biomphalaria glabrata* (Say, 1818)

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Biomphalaria glabrata (Gastropoda: Planorbidae) is one of the principal vectors of schistosomiasis, an endemic disease affecting about 200 million people in approximately 70 countries. In view of its medical and sanitary relevance, studies on biology of this species are of great value. In this work, *B. glabrata* larvae submitted to ^{60}Co gamma radiation were analyzed to elucidate some aspects of the hatching mechanism. Since there are few data in the literature on this subject, the purpose was to achieve a better understanding of the mollusk's biology that might help in the control of the species in reservoirs. Larvae in the early veliger stage were submitted to gamma radiation doses of 20, 25, and 30 Gy (311 Gy/hour) in a ^{60}Co irradiator Panoramic type, from Yoshizawa Kiloc Company - LTD, at IPEN (Nuclear Energy Research Institute). Larvae analyzed 8 days after irradiation did not hatch, although apparently looking normal [unhatching rate = 1.8 (control) 73.6 (20 Gy) and 84.4% (30 Gy)]. Radulae were observed under scanning electronic microscopy (Zeiss- DMS 940). When compared to the control group, structural alterations were observed in the lateral, marginal, and central denticules. This may be one indication that inhibition of hatching in larvae submitted to 20, 25, and 30 Gy of radiation is the result of structural alterations in the larval radula. [Supported by CAPES; FAPESP].

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El Niño impact on the production of commercially important mollusks in Independencia Bay, Peru

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This study analyzes the changes in molluscan production in Independencia Bay based on species composition from landings and surveys in normal and El Niño years. Independencia Bay is one of the most productive invertebrate fishing area in the world, located 250 km south of Lima. 15 of a total of 30 species exploited commercially along the Peruvian coast inhabit Independencia Bay. The most important mollusks are *Argopecten purpuratus, Aulacomya ater, Thais chocolata, Gari solida, Octopus* sp., *Concholepas concholepas,* and *Fissurella* sp. 25% to 85% of the total landings in the Peruvian coast are landed in this bay. The species composition in the landings show a different pattern during El Niño years than in normal years. Almost 75% of the total landings during El Niño years correspond to *Argopecten purpuratus* followed by *Aulacomya ater* (18%). Contrary to this, normal years show an alternating dominance between both species. *Argopecten purpuratus* only contributes 11%, and *Aulacomya ater* and *Semele solida* 68% and 16% respectively. The El Niño phenomenon is positively affecting growth, recruitment, and mortality in the case of *A. purpuratus, Thais chocolata*, and *Octopus* sp., and negatively in the case of *Aulacomya ater*, in which population increases strongly during very cold years (La Niña years). The main environmental factors causing changes in production and the need to model the bay during different environmental states are discussed to optimize the use of mollusks in the Independencia Bay. [Human Symposium]

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Ecological, biological, and morpho-functional aspects of *Lissarca rubrofusca* Smith, 1877 (Bivalvia: Philobryidae), from Admiralty Bay, King George Island, Antarctica

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The epibyssate *Lissarca rubrofusca* is endemic to Antarctic/Subantarctic waters where it lives at 0-30 m. During the XV and XVI Brazilian Antarctic Expeditions (austral summers 1996-1997, 1997-1998), it was found attached to the phaeophycean *Desmarestia* sp. at 5-7 m, at Napier Rock, Admiralty Bay (62°05'S, 58°23.5'W), Antarctica. The algae densely covered by *Lissarca* was collected by scuba and maintained in circulating seawater (*ca.* 0°C) at the Brazilian Station "Comandante Ferraz," Antarctica. Living specimens were observed in aquaria and under stereomicroscopes to record behavior and functional morphology. Populations included specimens with shell lengths < 1-5.2 mm, the largest (3.5-5.2 mm) sexually mature, not rarely brooding in the pallial cavity two large rounded masses of yolky eggs. Juveniles were not found in the pallial cavity. The filibranchiate demibranchs are of different height and length, the posterior thirds remaining free from the visceral mass, highly mobile, and sensitive. Equally active is the foot which permits the animal to creep about once free from the byssal attachment. All ciliary currents on the foot, visceral mass, ctenidia, lips, labial palps, and mantle are very active and predominantly reject the bulk of particles entering the pallial cavity. Such efficient cleansing mechanisms suggest adaptation to waters rich in suspended matter. [Supported by research award CNPq/PROANTAR (Conselho Nacional de Desenvolvimento Científico e Tecnológico/ Programa Antártico Brasileiro); Bolsista de Produtividade em Pesquisa do CNPq. Processo 300660/92-8 (RN) (Domeschi)]. [poster]

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Tales of slime trails and forgotten snails: the systematics and biogeography of the freshwater snail species-complex *Elimia curvicostata* in the southeastern United States (Gastropoda: Prosobranchia: Pleuroceridae)

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Elimia (= *Goniobasis*) *curvicostata* is composed of 1-9 synonymized species based on prior studies (Goodrich, 1942; Clench & Turner, 1956; Chambers, 1990). The distribution of this complex encompasses the Gulf Coastal river drainages of Florida, Georgia, and Alabama. 109 locality sites were surveyed in 6 Gulf Coastal river systems. Four southern Atlantic Coastal rivers were surveyed for comparative material. This investigation utilized shell morphology and mtDNA to differentiate between the taxa. Univariate (ANOVA) and multivariate (CDA) statistical analyses detected significant morphological differences between the populations examined. None of the wild populations resembled the type specimens (*Melania curvicostata* Reeve, 1861). However, snails found within the Apalachicola River system appeared most similar to types of *M. densicostata* Reeve, 1861. Genetic analysis revealed that 4 of the taxa within the complex were genetically distinct. These taxa are endemic to a single river drainage except for *E. densicostata* which is also found within the lower Choctawhatchee River system. Three of these taxa were previously overlooked. This study concludes that *E. doolyensis* and *E. induta* of the Flint River should be synonymized under *E. densicostata,* not *E. curvicostata.*

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Bivalve biodiversity in the Florida Keys

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Despite a century of shell collecting and the recent years of increased biodiversity awareness, the marine malacofauna of the Florida Keys has never been comprehensively assessed. Encompassing 10,000 km^2 of marine habitat, the region includes hypersaline ponds, mangrove islands, seagrass meadows, sand bars, deep sand plains, and the only living coral reef in the continental U. S. (newly protected by the Florida Keys National Marine Sanctuary). Influences on the fauna include the Gulf Stream flowing northward from the Caribbean, nutrient-heavy waters from the Everglades moving southward across Florida Bay, as well as millions of vacationing tourists per year. This survey, compiled from original collections, museum and literature records, comprises *ca.* 1,300 species (*ca.* 900 gastropods, 300 bivalves, 100 others), surpassing the only other published list (Lyons & Quinn, 1995; 630 spp.) by 106%. This part of the ongoing assessment examines the Bivalvia. Half of the recognized bivalve families (70% of superfamilies) are represented in the Keys. Analyses by habitat show roughly equal proportions of infauna and epifauna, with the latter including important coral reef borers and cementers. Within-Keys distributions include one-third ranging the full length of the island chain, one-third so far recorded from only one zone (Upper, Middle, Lower, Tortugas), and one-third overlapping two or more zones. Species ranges show *ca.* 50% of Keys bivalves considered "wide ranging" both north and south, but 85% of the remainder decidedly tropical in distribution. Historical records indicate little species turnover, although habitat shifts from natural to artificial substrata are evident.

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File clams and flame scallops in the western Atlantic (Bivalvia: Limidae)

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The western Atlantic representatives of *Lima* and *Ctenoides* are revised. Studies of live-collected material from the Florida Keys, supplemented by museum collections and literature data, identified anatomical characters to corroborate genus- and species-level taxa formerly based on shells. *Lima* (file clams) includes *L. caribaea* Orbigny (Bermuda, Carolinas-Brazil), and *L. marioni* Fischer (deep-water Atlantic, including off Brazil). The former is *L. lima* of authors (in part), distinguished from eastern Atlantic *L. lima* Linné, Indo-Pacific *L. sowerbyi* Deshayes, and eastern Pacific *L. tetrica* Gould, by relative numbers of radial shell ribs. *Ctenoides* (flame scallops) includes two shallow-water species, *C. scabra* (Born) (Carolinas-Venezuela) and *C. floridana* (Olsson & Harbison) (Carolinas-Venezuela), and two deep-water species, *C. planulata* (Dall, 1886) (Florida, Barbados) and one new species. *C. floridana* (= *tenera* Sowerby, non Turton), previously considered a variety of *C. scabra*, is a sympatric congener based on consistent characters in shell and anatomy. The new species, from southern Florida to Caribbean South America, is distinguished by roundly ovate valves, flattened ribs with minute prickles and narrow interspaces. As presently understood from western Atlantic species, the genera are characterized by features (apomorphies?) of shell and anatomy: *Lima*, with ungaping, inequilateral valves, strong ribs with large erect scales, non-persistent periostracum, short (whitish) pallial tentacles, truncated visceral mass; and *Ctenoides*, with gaping, equilateral shells, scaly ribs divaricating centrally, brownish periostracum, long colorful (red-orange) pallial tentacles, expanded visceral mass with intestinal loop. [poster]

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The genus *Cumanotus*: aeolid nudibranchs with deviance, but how deviant?

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The genus *Cumanotus* consists of three species of soft-bottom-dwelling aeolid nudibranchs. They have short, wide bodies and long cerata used in swimming. The only species in which the reproductive system is known, *C. beaumonti* (Eliot, 1906) has bizarre sexual habits. A simultaneous hermaphrodite like other nudibranchs, the female region of *C. beaumonti* features a pair of prominent studded claspers which grasp the partner's long snaky penis. Other, less dramatic features also differentiate this genus. It has been treated as a monogeneric subfamily or given family status depending on the importance attached to the position of its anus. The recent discovery of a fourth species in the northeastern Pacific and a reexamination of the other poorly described Pacific species extends our knowledge of this little known genus.

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Biochemical content of the embryos and intracapsular liquid of *Voluta musica* (Caenogastropoda: Volutidae) during early development

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South American volutids are very homogeneous regarding their reproductive strategies; they generally spawn egg capsules with few eggs, the embryos feed on substances contained in the intracapsular fluid and hatch as crawling juveniles. *Voluta musica* inhabits between 1 and 2 m depth on soft bottoms at Isla Caribe, eastern coast of Venezuela. The spawn consists of a single egg capsule containing 1-5 eggs measuring around 330 µm in diamenter embedded in a dense, mucus liquid. At hatching, the crawling juveniles measure around 7 mm in shell length and the intracapsular fluid is completely liquified. The protein and sugar content of the embryos and the intracapsular fluid were determined by standard techniques to determine the amount of food available for the embryo during early development as well as the balance of these substances between the first stages and hatching. Egg capsules of *V. musica* have a volume varying between 500 and 1,500 µl. At the first stage (uncleaved egg stage), the total protein content of the intracapsular fluid varies between 30 and 90 mg, of which only 400 µg remain at hatching in scarcely 20 µl of liquid. Each hatchling contains around 8 mg of protein. The most important ingestion stage is the intracapsular veliger stage, characterized by a very large velum, a small foot, and a small non-calcified shell. The total sugar content of the intracapsular fluid at the first stage varies between 3,000 and 5,000 µg. At hatching, each juvenile contains around 1,400 µg of sugar. The results indicate that the intracapsular fluid contains enough protein and sugar to account for these totals in the hatchlings.

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Molecular systematics of the unionid bivalve genera *Fusconaia* and *Quincuncina*: enigmatic, unnatural taxa

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North American freshwater unionid bivalves are a diverse group with 51 genera and nearly 300 species. Unionids exhibit an array of conchological anatomical, life history, and reproductive characteristics that figured prominently in previously proposed classification schemes. A tremendous amount of attention has been focused on unionids recently because they are considered the most endangered group of organisms in North America, with over 70% of the species considered either extinct, endangered, threatened, or of special concern. Unfortunately, one factor confounding conservation efforts is the assumption that currently recognized genera and species actually reflect monophyletic groups. For example, one might assume that the genus *Fusconaia* is monophyletic and therefore implement similar conservation strategies for all members of the genus. Here I present a molecular phylogeny based on mitochondrial DNA sequence data of representative North American unionids with an emphasis on species of the genera *Fusconaia* and *Quincuncina* and demonstrate their polyphyly. Until a robust phylogeny is available for all unionids, we urge caution in treating species and genera as monophyletic.

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Gastropod mollusks from the southeastern Brazilian continental shelf: a biogeographical approach

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Classical biogeographical studies have emphasized the composition of biotas from discrete geographical areas. Determination of boundaries of biotic provinces has been a traditional concern of this descriptive approach. Since pioneer works about the biogeographic distribution of marine mollusks, many authors have pointed out the Rio de Janeiro region (24°S) as the southern limit of the distribution of the western Atlantic tropical fauna. Based on a taxonomic survey of gastropod mollusks from the continental shelf off Campos Basin region, Brazil (21°20'-23°40'S), the patterns of distribution of species occurring simultaneously in this area and in Tropical and/or Patagonian Provinces are examined. About 43% of the species with tropical affinities present in the area extend their range south of Rio de Janeiro. On the other hand, 63% of the gastropods with Patagonian affinities have the Rio de Janeiro area as their northern limit of distribution. Considering the number of shared species, the studied region shows a strong affinity with the tropical fauna, while the contribution of cryophilic species is small. Nevertheless, if we weight the contributions of tropical and patagonian faunas, based on the species described in each area, these contributions to the local fauna are almost equal (1:1.1). This situation is probably derived from larval transport of Patagonian species by the South Atlantic Central Water (15-18°C) during the upwelling events described for the region. [poster]

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The digestive system of *Neoteredo reynei* (Bartsch, 1920) (Bivalvia: Teredinidae)

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The anatomy of *Neoteredo reynei* was studied by Turner (1966) and Rancurel (1971), but detailed anatomy of the digestive system is unknown. The anatomy of the stomach, midgut, anal canal, and digestive diverticula are described, using preserved and living specimens, by histological and scanning-electron-microscope preparations. The specimens were collected in mangroves (45°15'W, 23°30'S) in São Paulo State, Brazil. According to Turner (1966), the stomach of *N. reynei* is of globular type 2. Considering the works of Purchon, it can be classified as type V, that presents in the anterior region, inside the limits of the shell, the right caecum, the style sac, the spiraled dorsal hood, the left pouch associated with the slender and ramified left caecum, the major and minor typhlosoles, the folds R, R1, and R2, and the sorting areas SA3, SA6, SA7, and SA8. In this region also occur the normal and specialized digestive diverticula, that open into both caeca and into the left pouch. Outside the limits of the shell is the well-developed appendix. A complex structure herein designated as the semi-spiral conical projection, formed by the SA3, SA11, and R2, partially embraces the proximal end of the appendix. The midgut describes a loop over the style sac, and the anal canal is broad, long, and always full of feces. [Grants from Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP) - Proc. No. 96/09988-1 (D. Moraes)]. [poster]

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Molluscan diversity in the soft-bottoms of the Bay of Baiona (NW Spain)

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The Bay of Baiona is situated in the mouth of the Ria de Vigo (Galicia), in the northwestern Atlantic coast of Spain. During the course of a study of its benthic communities carried out in December 1995, 88 species of mollusks were found (3 Polyplacophora, 46 Gastropoda, 1 Scaphoda, 38 Bivalvia) for a total of 9,832 specimens. According to Thorson (1957, *Geol. Soc. Amer.* 67(1): 461-534), the following communities were identified: (1) *Venus fasciata – Branchiostoma lanceolatum*, in the mouth of the bay, characterized by the high density of the small bivalve *Goodallia triangularis*, and the presence of *Clausinella fasciata* and *Arcopagia crassa*; (2) a transition zone of medium sands between the coarse sands of *Amphioxus* and the fine sands of *Venus gallina*, with *Caecum imperforatum* and *Digitaria digitaria*; (3) *Venus gallina – Echinocardium cordatum*, occupying the fine sands of the center and margins of the bay, with *Fabulina fabula* and *Mysella bidentata* as dominant species; and (4) *Syndosmya alba*, in the muddy bottoms around the harbor of Baiona, with *Thyasira flexuosa* and *Loripes lacteus* the dominant mollusks. The distribution pattern of the sediments and the molluscan communities follow the same one occurring in the galician rias, but at a smaller spatial scale. [poster]

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The pyramidellids (Mollusca: Gastropoda: Pyramidellidae) and their hosts: a revision

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The pyramidellids are a group of small gastropods well-known by their ectoparasitic habits on various groups of marine invertebrates (mollusks, polychaetes, sipunculids, hydroids, etc.). They lack jaws and radula, and feeding is based upon sucking the corporal fluids of their hosts by a specialized acrembolic proboscis. The last is formed by an elongation of the gut, which comprises the oral tube, buccal cavity, and esophagus, with a sucker, stylet, and muscles for pumping the blood and protraction-retraction of the proboscis. In the 1940s observations on feeding and anatomical studies on the proboscis were made, and new records of various hosts were reported, establishing the nature of this ectoparasitism. The idea of a specific host-parasite relationship was early suspected, but it has now been documented that some species have a range of probable hosts. Besides, recently some species were found in mollusks of commercial interest, *e. g.*, tridacnid bivalves. However, for the large majority of known species, no hosts are known. In this communication, we present a list of the known hosts for different species of pyramidellids complemented by our own records. The samples were taken with a quantitative grab, and a total 71 specimens belonging to 11 species of pyramidellids were collected. We list probable host species found in the same samples as the pyramidellids. [poster]

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The *cribraria* conundrum: untangling a species complex in the Cypraeidae (Mollusca: Gastropoda)

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The species boundaries are blurred between several apparently closely related taxa in the *Cribrarula cribraria* species complex (Cypraeidae). The number of species is controversial, with authors disputing the status of taxa at the specific- or subspecific-level. The purpose of this ongoing study is to try to define species boundaries in this complex using three sets of characters: conchological, anatomical, and molecular. This presentation will focus on the biogeography of the taxa, and the results obtained thus far from conchological studies. The nominal species, *C. cribraria* (Linné, 1758), is widespread and variable, ranging from eastern Africa to the central Pacific. A number of geographical forms have been recognized as subspecies, but they might also be recognized as 'good' species. Thus shell characters alone cannot be used to define species in this complex. Other recognized species in the complex have smaller geographical ranges, and usually less variation than *C. cribraria*. I currently recognize at least seven groups of shells in this complex. More than 300 specimens of the apparently Hawaiian endemic species, *C. gaskoini* (Reeve, 1846) were studied. The most noticeable conchological feature is a bimodal distribution in shell size, which suggests sexual dimorphism. Other workers have found that in cowries, females usually have larger and more inflated shells than males. I have confirmed this in the few specimens dissected, but further work is needed to support this hypothesis.

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Digital photography in malacology: the flatbed scanner as a great research tool

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Digital photography has played a growing role in our daily lives, especially due to the growth of the Internet, new technologies, and dropping computer prices. This tool has an untapped potential for scientific research and teaching, as well as numerous other areas. Here, I will (1) compare the advantages and shortcomings of digital and conventional photography; (2) provide an overview of the different image inputting devices; and (3) discuss some of the uses of digital imaging in malacology. Digital images can easily be edited, printed, sent via email, posted on the Internet, and archived into databases. The flatbed scanner is one of the best tools for digitizing images; its most obvious uses are to digitize photographs and to convert printed texts into editable files. Another use that is not yet popular is to scan small 3D objects, such as shells. I will also describe a simple method to produce good quality images directly from shells, bypassing film-based photography. Although digital cameras are also a useful tool, they are currently still expensive; scanners offer better value and quality for your money. Taxonomists could also benefit immensely from museums that prepare image databases of the type specimens in their holdings into CDs or websites. Flatbed scanners or digital cameras could help in this endeavor at reasonable costs and a fast pace. [poster]

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Anatomical study of the digestive tract of some lucinid bivalves inhabiting various environments

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The digestive tract of the Lucinoidea has been described as simplified by Allen (1958) well before the discovery of sulfur-oxidizing bacterial symbionts in their gill cells. Stable carbon isotope ratios for *Lucinoma aequizonata* (Cary, *et al.*, 1989) demonstrate a nutrition provided by the bacteria up to 75%. However, the digestive tract of this species has not been described. The present work focused on the macro- and microscopic anatomy of the digestive tract of four species: (1) *Lucinoma aequizonata* living in reducing mud at 500 m depth, (2) *Codakia orbicularis* and *Linga pensylvanica* living in or near shallow water seagrass beds, and (3) *Lucina pectinata* living in reducing mud of mangrove swamps. In all cases the palps are reduced but the digestive tract of *L. aequizonata* appears to be the most simplified with a small stomach and a short gut going straight from stomach to heart, whereas in *L. pectinata* the proximal part of the gut makes loops and is distinct from the midgut. In *C. orbicularis* and *L. pensylvanica*, the gut has an intermediate length and no typical loops in its proximal part. A structural study of the digestive diverticula will provide more information about the intracellular digestion in each species. However, these preliminary results allow us to postulate that *L. aequizonata* is less dependent on filter-feeding for nutrition than the tropical species. [poster]

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Schistosomiasis intermediate hosts in eastern Mexico: a new survey of the aquatic malacofauna

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Species of *Biomphalaria* (Gastropoda: Planorbidae) known to be susceptible to *Schistosoma mansoni* (intestinal schistosomiasis) have been reported from several parts of Mexico but little is known of their wider distribution within the country. Although the disease does not occur in Mexico, the presence of susceptible *Biomphalaria* in the country has assumed significance with the recognition that *S. mansoni* could be introduced via migrants from endemic countries en route to the United States. A freshwater snail survey was therefore carried out in July 1997 in northeastern Mexico, the presumed route of these migrants, specifically to look for *Biomphalaria* and to provide baseline malacological data to help assess the likelihood of schistosomiasis becoming established. The species of *Biomphalaria* collected in the area and its rich freshwater molluscan community are discussed.

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Mollusks associated with Mayan ruins on the Yucatan Peninsula, Mexico

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The Mayan ruins in the state of Yucatan are a habitat for a variety of land and freshwater mollusks. Since the middle of last century, several workers have contributed to a gradually improving knowledge of the non-marine mollusks of the area (Morelet, 1949; Phillips, 1846; Pilsbry, 1891; Bequeart & Clench, 1933, 1936, 1938). Since Harry (1950), however, the non-marine malacofauna of Yucatan has received little attention compared to the marine species. A revision of this non-marine malacofauna has been undertaken, using both classical information based on shell morphology on the one hand and scanning electron microscopy, anatomical features, and radulae on the other. Field work was done in some of the "cenotes" (freshwater-filled sinkholes) typical of this karstic area, grottos in which the ceiling has partly collapsed, and ruins. Mollusks were also collected from shady areas. Families and genera reported in this survey are: Mesodontidae (*Praticolella* and *Polygyra*); Annulariidae (*Choanopoma*); Subulinidae (*Allopeas* and *Subulina*); Spiraxidae (*Streptostyla* and *Euglandina*); Hydrobiidae (*Pyrgophorus* and *Littoridinops*); Bulimulidae (*Bulimulus* and *Drymaeus*); Urocoptidae (*Macroceramus*); Succineidae (*Succinea*); and Planorbidae (*Biomphalaria*). These studies have not only resolved some long-standing taxonomic problems, but have updated distributional data and provided information on the conservation status of the non-marine Yucatan mollusks. [poster]

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On the labial palps of *Tagelus plebeius* (Lightfoot, 1786) (Mollusca: Bivalvia)

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The palps of *Tagelus plebeius* are of great size and are capable of considerable contraction and extension. On the apposed faces there are fine folds, separated by deep grooves. It will be observed that these folds do not cover the entire face of the palp. On its margins, below the folds, there is a narrow plain tract and above the folds occurs a very large triangular area where the anteroventral margin of the inner demibranch is fused to the inner palp lamella. The narrow plain tract on the ventral part of the external labial palps is more developed and embraces the distal part of the internal labial palp. In this way it forms a closed area along the entire extension of the palp, except at the distal region. This structure was not observed in any other bivalve already known. The outer faces of the palp are not smooth as in other bivalves already known (Thiele, 1886). There is a great number of digitiform papillae distributed as follows: 30 in a line near the marginal edge of the labial palps and various papillae irregularly distributed all around the outer face of the palp. Probably these papillae are sensitive and protect the palps from being injured by sand grains of the substratum. [Bolsista de Produtividade de Pesquisa do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) Proc. No. 300490/94-1]. [poster]

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On the inhalant siphonal membrane of *Tivela ventricosa* (Gray, 1838) (Bivalvia: Veneridae)

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Kellogg (1915) stated that in the aperture of the inhalant siphon there is a small siphonal membrane in some species of Veneridae, but there is no waste canal on the mantle. According to Haas (1929, 1940), there is a siphonal membrane at the base of the siphons in many groups of bivalves. Yonge (1949) stated that in some species of Tellinoidea the inhalant siphonal membrane is associated with a covered waste canal and directs the inhalant current ventrally in the mantle cavity. In *Tivela ventricosa* there are two associated siphonal folds that form a ventral canal similar to that in the Tellinoidea. The difference is that the siphonal folds in *T. ventricosa* are united at the apex of the inhalant siphon, contrary to what occurs in the Tellinoidea, in which they united at the basal region of the inhalant aperture. This is the first record of this structure in the Veneridae. These folds may be elevated and bent toward each other until they almost meet at the summit of the inhalant siphonal opening. They thus enclose a canal similar to what Kellogg (1915) described for the Tellinoidea as waste canal. The siphonal membrane probably is an adaptation to deal with the great quantity of sediment in the water were the animal lives, aiding in the removal of waste matter. [Bolsista de Produtividade de Pesquisa do Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) Proc. No. 300490/94-1 (W. Narchi)]. [poster]

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On the labial palps of *Sanguinolaria sanguinolenta* (Gmelin, 1791) (Mollusca: Bivalvia)

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Thiele (1886) studied the labial palps of many species of Bivalvia, but not the genus *Sanguinolaria*. Pohlo (1972) studied *S. nuttalli* from California. The palps of *S. sanguinolenta* are well developed, and present large folds separated by deep grooves on the apposed faces. The outer faces of the palps have a inconspicuous ridge, starting at the anterior region and ending at the posterior region, running along their ventral region. The inner faces of the labial palps present large folds. The inner labial palp has many arborescent papillae at the outer side, varying in number, much developed at the free edge of the labial palp. The trunk of the arborescent papillae of *S. sanguinolenta* is not solid, being merely a thin sheet of palp tissue. At the extreme tips of the papillae there is epithelium made up of very much elongated ciliated cells and groups of large gland cells. The terminal end of the inner labial palp forms a pouch, where the tips of the outer labial palp search for shelter. These features were not observed in any species of bivalve already known. The projection of the outer labial palp into the inner one, and the presence of a developed pouch at the terminal end of the inner labial palp probably submits the particles in the rejection current to the resorting currents. [Bolsista de Produtividade de Pesquisa do Conselho Nacional de Desenvolvimento Científicoe Tecnológico (CNPq) Proc. No. 300490/94-1 (W. Narchi); Bolsista de Mestrado da Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) (M. Moriya)]. [poster]

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Conservation and commerce: the management of freshwater mussel resources in the United States

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The United States is blessed with the world's greatest diversity of nearly 300 species of freshwater mussels (Unionoida), providing numerous ecological, scientific, and economic benefits to the nation. However, as a result of intense economic development in the 19th and 20th centuries, this fauna was subjected to habitat destruction, water pollution, and benign neglect that resulted in the loss of populations and species. Presently, about 35 mussel species are presumed extinct, 62 species are federally protected as endangered or threatened, and numerous other species are candidates for protection. Propagation of these endangered species is underway to expedite their recovery. In contrast to this sizable group of rare species, a small assemblage of ubiquitous species occurring in large rivers and reservoirs within the Mississippi River drainage support a multi-million dollar commercial shell industry. Most shells are shipped to the Far East to provide beads for a thriving cultured pearl industry; however, exports in this decade peaked in 1995 and face an uncertain future. Harvest and management regulations are being unified in the Mississippi River in 1998 to conserve mussel resources from overexploitation, to resolve law enforcement problems among states, and to consider the exotic zebra mussel (*Dreissena polymorpha*), which now infests most commercially exploited unionid populations. In the next decade, adequate attention to resource management will decide the fate of this world-class mussel fauna. [Human Symposium]

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Evolution of specificity between sepiolid squids and their luminous symbionts

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Mutualistic associations between bacteria and their eukaryotic hosts have a variety of mechanisms which provide the specificity for symbiont recognition and colonization. Although most symbiotic bacteria are capable of infecting their particular host partner, very few are able to switch partners. The sepiolid squid-bioluminescent bacteria symbiosis is one such system where closely related bacterial strains are capable of infecting similar host species. Different symbiotic strains have the same infection and colonization behavior as do native strains, but when placed in direct competition with one another, the native strain is always dominant. Experimental results indicate that this specificity for native strains of symbionts over non-native strains in the light organs is established within the first 48 hours post-infection. This can be demonstrated by a variety of colonization experiments, where aposymbiotic juveniles are first inoculated with non-native strains, and then later given native strains to test specificity. Along with these competition experiments, immunocytochemistry using genetic markers in the symbionts have provided evidence for spatial differentiation between native and non-native strains. Both techniques have allowed the measurement of both temporal and spatial differentiation between competing symbiont strains, and provide additional clues to the evolution of specificity in this symbiosis.

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Ontogenies of fossil gastropods

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It is well known that Recent gastropods can have planktonic veliger larvae that either feed on plankton (planktotrophic) or live on their own yolk supply (lecithotrophic). Snails can also hatch without a planktonic larva (direct development). Normally each of these different strategies causes a particular protoconch morphology (early ontogenetic shell), so that the protoconchs of well-preserved gastropods can reflect the type of ontogeny. Gastropods with preserved protoconchs are rare in the Paleozoic and Lower Mesozoic. It was possible to obtain such well-preserved gastropods and to interprete them regarding their ontogeny. Different ontogenies in two fossil caenogastropod families are demonstrated by measuring their protoconchs. The Paleozoic Pseudozygopleuridae include species with planktotrophic larval development as well as species with non-planktotrophic ontogeny. This is similar to most Recent families of caenogastropods. However, all species of the Mesozoic Zygopleuridae with known protoconchs are planktotrophic. Planktotrophy is dominant in warm equatorial seas and becomes more and more seldom toward the poles. Therefore, gastropods are potential climate or palaeogeographical indicators. Regarding systematics, it should be taken into account that planktotrophic and non-planktotrophic species may occur within the same genus. Dimensions of planktotrophic protoconchs normally display a low intraspecific variability. Thus, closely related species with very similar adult shells can be separated by measuring their protoconchs.

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New or confirmed host identifications for eleven freshwater mussels

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New or confirmed (*) host identifications were performed for 11 freshwater mussels (Bivalvia: Unionoidea). Fish species were infested with glochidia and monitored during laboratory experiments. Two methods were used: (1) feeding conglutinates to fish, and (2) placing fish in aerated buckets of water containing glochidia in suspension. Aquaria contents were sampled and examined for unmetamorphosed glochidia and metamorphosed juveniles under polarized light. Johnny darter, largemouth bass, bluegill, and white shiner were hosts for *Elliptio fischeriana*. Bluegill and shield darter were hosts for *Fusconaia masoni*. Silver shiner and creek chub were hosts for *F. flava*. Striped shiner, streamline chub, smallmouth bass*, largemouth bass*, green sunfish, bluebreast darter, greenside darter, rainbow darter, and yellow perch were hosts for *Villosa iris iris*. Bluntnose minnow, striped shiner, smallmouth bass*, largemouth bass*, bluegill*, and longear sunfish were hosts for *Lampsilis radiata luteola*. Green sunfish and western banded killifish were hosts for *L. cardium*. Longnose gar, largemouth bass, yellow perch, longear sunfish, bluegill, slenderhead darter, and logperch were hosts for *Megalonaias nervosa*. Largemouth bass and bluegill were hosts for *Anodontoides ferussacianus*. Largemouth bass, banded sculpin, and central stoneroller were hosts for *Actinonaias ligamentina carinata*. Blackside darter, striped shiner, central stoneroller, and logperch were hosts for the federally endangered *Pleurobema clava*. Banded darter, bluebreast darter, brown trout, and banded sculpin were hosts for the federally endangered *Epioblasma torulosa rangiana*. [poster]

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Molecular phylogeography of the marine clam *Lasaea*

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The marine clam genus *Lasaea* (Galeommatoidea) is a cosmopolitan component of rocky intertidal crevice faunas and is predominantly composed of highly polyploid clonal lineages lacking pelagic larval development. The breeding system and phylogeography of representative global populations have been characterized using nuclear (allozymes, karyology, flow cell cytometry and single-copy gene sequences) and mtDNA genetic markers. Polyploid clonal lineages showed marked deviation from expected random mating patterns (within and among loci), frequent fixed heterozygosity, and multiple unbalanced loci, indicating probable allopolyploid origins. Spatial analysis of mtDNA and allozyme markers revealed strong geographic structure and yielded no cosmopolitan clonal lineages. Australian diploid sexual species formed sister taxa to a minority of the clonal lineages, but pronounced mitochondrial genetic divergence levels, and developmental differences, precluded their identification as convincing parental species to any of the studied clones. A majority of asexual lineages may have originated in areas where no sexual congeners are presently known. The observed nuclear and mtDNA genetic structure suggests that *Lasaea* clonal diversity is enriched by local mutational derivatives and that asexual lineages in this genus may have exceptional antiquity and polyphyletic origins from presumably extinct parental species. [Character Symposium]

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Biomphalaria tenagophila (Mollusca: Planorbidae) infected with *Schistosoma mansoni* submitted to desiccation

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The crossing of melanic and albino individuals of *Biomphalaria tenagophila* (Orbigny, 1835) was performed, resulting in the melanic F_1 generation and, by self-fertilization, the melanic F_2 generation. The purpose of the work was to study the resistance to desiccation of the *B. tenagophila* generations F_1 and F_2. Snails were buried for 7, 14, 21, and 28 days. Variability in survival rate of F_1 and F_2 generations was small. The longer the desiccation period, the higher the mortality rate. Snails that survive desiccation show mucus or soil aggregated in the shell aperture, which avoided the excessive loss of humidity of the animals' tissues protecting them from desiccation. Snails that died during desiccation showed neither mucus nor soil blocking the shell aperture. Usually, the snails unburied themselves during the period when the soil was soft and humid. Mortality was higher among the snails that stayed buried throughout the desiccation period. Snails from F_2 were more sensitive to desiccation than those from F_1. The greatest weight loss occured after 21 and 28 days of desiccation, in the same groups where the mortality rate was higher. The mortality rate of desiccated snails seems to depend on the weight lost during desiccation. [Supported by FAPESP].

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Malacological survey of Oban Hills National Park, southeastern Nigeria

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Oban Hills National Park is one of Nigeria's last great rainforests, covering a few thousand square kilometers. It has remained densely forested for millions of years. Because the forest has been undisturbed, it has an amazing number of species, some of which are yet to be fully described. A preliminary malacological survey was carried out for the first time to determine the molluscan fauna using an equal-size grid of 10 km^2. Sampling was carried out during the dry and rainy seasons from over 200 sites by sieving and handpicking. The land snails were dominated by members of the Streptaxidae, Urocyclidae, Subulinidae, and Achatinidae. Other families of land mollusks include the Aillyidae, Enidae, Succineidae, Hellicidae, and Veronicellidae. Most of the species were not readily identifiable. Some have a wide range of distribution extending to the western part of Nigeria. However, the vast majority of the species are new records for the area with very limited ranges of distribution. Presently the Oban Hills area is facing a serious threat from land speculators, logging companies, forest fires, and introduction of exotic species of trees. This may bring about habitat change which may gradually reduce the diversity of the molluscan fauna. [poster]

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Phylogenetic relationships of the Aplacophora and the Polyplacophora (Mollusca): a molecular analysis using the nuclear coding gene elongation factor-1 alpha

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Aplacophora are shell-less vermiform mollusks in which the external cuticle is covered by numerous aragonitic spicules. Polyplacophora are characterized by a spicule-embedded mantle girdle around the flattened, elongate body. Two competing hypotheses regarding the relationships of these two molluscan groups have been presented. In one, the Aplacophora and Polyplacophora form the monophyletic Aculifera; in the other, they form a basal paraphyletic grade of mollusks. We are using molecular sequence data from a highly conserved nuclear coding gene, elongation factor-1 alpha, to examine the monophyly of the Aculifera and the position of the Aplacophora and the Polyplacophora within the Mollusca. The results will help to resolve the phylogenetic relationships of these groups and will have important implications for the evolution of the molluscan body plan.
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Diversity, distribution, and phylogeny of the chemosynthetic bivalve *Calyptogena s. l.* in the northwestern Pacific

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Since the submersible Shinkai 2000 discovered a large colony of living *Calyptogena soyoae* (Bivalvia: Vesicomyidae) in 1984, more than ten species of the same genus have subsequently been discovered by the same submersible as well as Shinkai 6500 and Nautile from cold seeps and hydrothermal vents in the northwestern Pacific. Through intensive surveys on reducing environments around Japan, it became clear that each species is generally confined to a specific locality with a limited bathymetric range with only a few exceptions. This situation does not coincide with the distribution patterns of other chemosynthetic animals, such as vestimentiferans and *Bathymodiolus* bivalves that exhibits wide-spread distribution in chemosynthetic communities. Phylogeny of these *Calyptogena* species in the northwestern Pacific have been analyzed using nucleotide sequences of mitochondrial DNA. This resulted in recognizing a sibling species within the *C. soyoae* complex and in clarifying molecular phylogenetic relationships among members of the genus *Calyptogena s. l.* in the northwestern Pacific. [poster]

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The effect of toxicants on oogenesis of bivalve mollusks

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The paper is concerned with the study of toxic influence of 'Round-up' (herbicide produced by Monsanto, U. S. A.) on freshwater bivalve mollusks of the family Unionidae. An experiment was performed during spawning of *Unio rostratus* and during preparation for spawning by *Colletopterum piscinale*. By means of a tentative toxicological test it was established that Round-up was a moderately toxic substance for the mollusks investigated. The influence of the toxicant on the mollusks' gonads was studied by laboratory experiments with LC_{25} and LC_{75}. With LC_{25}, it was established histologically that non-specific defence reactions developed in the interacinar tissue of the gonads. In addition, 50% of the acini had both their interacinal tissue and walls affected. In the acini with destructured tunics, one-third of the oocytes and oogonia were in a state of degeneration. With LC_{75}, the walls of all acini and interacinar connective tissue were affected. This ranged from vacuolization to necrotization which resulted in injury to the generative zone in the first place, and also to injury of oogonia and ripening oocytes. Therefore, the damage done to the gonads of *Colletopterum* in preparation for spawning was greater than that to spawning Unionidae.

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Influence of vegetation types on the distribution of terrestrial gastropods: a synecological study

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The view that vegetation affects the distribution of terrestrial gastropods has been advanced from various angles and conclusions (Beyer & Saari, 1977; Bishop, 1977; André, 1982; Bába & Podani, 1992; Štamol, 1995; Bába & Bagi, 1997). Some authors attach great importance to the influence of vegetation, in some cases going so far as to define vegetation/gastropod communities; others consider that gastropod distribution is determined by other factors. Our starting assumption is that all species prefer some habitats over others, so that different habitats can be seen as rich or poor depending on conditions that they offer to the specific demands of the species in question. In the present study, we collected 498 soil samples (each from a 0.5 m^2 area) from three vegetation types (woodland, grassland, riverbank; 166 samples each). The samples were wet-sieved and gastropods collected with the aid of a magnifying glass. A total of 17,902 specimens of 47 species were detected. Community structure was investigated first through an ordination technique using Correspondence Analysis (CANOCO; Ter Braak, 1988, 1990) and subsequently with a divisive hierarchical classification technique (TWINSPAN) (Hill, 1979). The results indicate that grassland sites are characterized by a species group comprising *Cochlicopa lubrica*, *Nesovitrea hammonis*, and *Zonitoides excavatus*. In contrast, a group comprising *Columella aspera*, *Oxychilus alliarius*, *Acanthinula aculeata*, and *Punctum pygmaeum* characterizes woodland sites. *Vitrea contracta*, *Discus rotundatus*, and *Aegopinella nitidula* form a group of companion species of the woodland group. [poster]

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Genome changes and endemism in Baikalian gastropods

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Karyotype investigations of the endemic gastropods are carried out at Baikal to answer two questions. Does the penetration of initial species to Baikal result in change of chromosome number? The answer is negative for three groups of Baikalian gastropods: 7 species of the genus *Choanomphalus* (5 Baikalian endemic species, 1 Hovsgolian endemic) have n = 18; like all investigated worldwide valvatids, Baikalian species have 2n = 20; *Radix auricularia*, being found in the open littoral of Baikal, does not differ from other representatives of this holarctic species in chromosome number (n = 18). The second question: did the adaptive radiation of animals in Baikal require substantial changes in the genome? As suggested by the example of baicaliids, valvatids, and planorbids, inhabiting different biotopes, one can see that the adaptive radiations had occurred without substantial numerical rearrangements of the chromosomes. However, one cannot deny the role of significant genome rearrangements in the speciation of new endemic species - the relatives coexist in the same biotopes, but have different chromosome numbers and polyploidy. [Partly supported by the RFBR-Baikal, grant 97-04-96237, RFBR, grant 98-04-49279, and MESSC-Japan "An integrative study on biodiversity conservation under global change and bioinventory management system" (E. Wada)]. [poster]

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Phylogeny of the Umboniinae (Vetigastropoda: Trochidae)

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The gastropods of the Umboniinae in the Indo-western Pacific Province are an ecologically and evolutionarily interesting group of the Gastropoda, because of their infaunal mode of life on sandy bottom as filter feeders and also their distinct color and color pattern polymorphism of shells. They may provide evolutionary biology of Mollusca with excellent material for following the process in evolution at morphologic and molecular levels, because they contain both extinct species having a good Neogene and Quaternary fossil records and also extant species. Using sequence data of the fragments of mitochondrial 12S ribosomal RNA (*ca.* 900 b. p.) and CO II (419 b. p.) genes, I have reconstructed a molecular phylogeny for all living 13 species of the genus *Umbonium* (8 species of the subgenus *Umbonium* and 5 species of the subgenus *Suchium*), 2 species of *Monilea*, 2 species of *Ethalia*, a species of *Zethalia,* and a species of *Conotalopia*, using closely related species of the Solariellinae as outgroups. Monophyly of the genus *Umbonium*, the subgenus *Umbonium,* and the subgenus *Suchium* is supported with high bootstrap values. Molecular and fossil data suggest that the Umboniini and the Monileini diverged in the Paleogene and that the *Umbonium s. s.*-*Umbonium (Suchium)* divergence occurred in the early Miocene. [poster]

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Phenotypically plastic food preference in gastropods with plastic feeding morphologies

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Snails in the genus *Lacuna* have phenotypically plastic radular tooth morphologies. Pointed cusped teeth are formed when snails feed on macroalgae, and blunt cusped teeth are produced when snails feed on microalgal epiphytes (primarily diatoms) on the surface of eelgrass. We tested whether the food preference in two species, *L. vincta* and *L. variegata*, was correlated with current diet, current feeding tooth morphology, the morphology of teeth newly formed, or was affected by diet history. We found that *L. vincta* preferred whatever food they were currently feeding on, independent of their tooth morphology or the morphology of the newest teeth produced. The strength of their preference was affected by feeding history; preference increased with increasing time spent feeding on a given food. Food preference in *L. variegata* was also independent of feeding morphology, and epiphytes were generally preferred independent of current food type. However, as with *L. vincta*, feeding history affected the strength of the food preference.

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Species diversity of micro-snails in Thailand

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Species diversity of micro-snails (maximum shell dimension less than 5 mm) in 26 limestone areas in Thailand was compared with elevation, herbaceous vegetation, cave length, cave moisture, stalactite and stalagmite types. The data were collected from January 1997 to February 1998. Our total collections comprised 103 species, of which 37 (36%) were described, and 66 (64%) undescribed. From a total of 2,080 individual snails, 53 species were Vertiginidae, 18 were Diplommatinidae, 8 were Streptaxidae, and 5 were Subulinidae. There was a significant positive correlation between species diversity of snails and elevation, herbaceous vegetation. Cave-dweller species prefer both short- and long-distance caves with high moisture content. Some species were collected at 10 km length at 60% moisture content. Vertiginids prefer stalactite habitats while subulinids and cyclophorids prefer stalagmite. One species of *Diplommatina* was also collected from stalagmite habitats. [Supported by a grant from The Thailand Research Fund (TRF : RSA/15/1994)].

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Sphaeriids and corbiculids represent separate radiations into freshwater environments

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Nine families of bivalved mollusks have undergone successful radiations in freshwater habitats, including three heterodont taxa: the Sphaeriidae, Corbiculidae, and Dreissenidae. The phylogenetic relationships of these heterodont taxa are controversial, however, most workers place the first two families in the Corbiculoidea and assume they represent a monophyletic grouping. We have tested competing phylogenetic hypotheses for the Corbiculoidea by constructing a representative molecular phylogeny based on domains D1-D3 (1.3 kb) of the nuclear large subunit 28S rDNA. This gene fragment was sequenced for 21 heterodont bivalves and for two oyster outgroup taxa. Our results are consistent with the hypothesis that all three families of freshwater heterodonts represent independent colonization events by marine ancestors. The corbiculid taxa form a clade with venerid and mactrid outgroups, however, we were not able to identify a putative marine outgroup for the sphaeriids.

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Systematics and phylogeny of the genus *Trophon* Montfort, 1810 (Gastropoda: Muricidae), from Patagonia and Antarctica

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The systematics and phylogeny of the species included under the genus *Trophon* from Patagonia and Antarctica were studied. The following questions were addressed: (1) How many valid species belonging to this genus are found in Patagonia and Antarctica? (2) What are their geographic ranges? (3) What are the valid genera belonging to the subfamily Trophoninae that are represented in the study area? (4) Is the subfamily Trophoninae a monophyletic group? What are its sister groups? Approximately 1,000 specimens from the collections of the museums of La Plata, Buenos Aires, and USNM were studied. Radular, anatomical, and shell characters were used to redefine each species. Preliminary results of this analysis yielded 33 valid species that have been previously described and five new species. The program PAUP was used to perform a cladistic phylogenetic analysis based on radular, shell, and anatomical characters. These analyses produced a group of phylogenetic hypotheses that could be unified as a strict consensus tree. This tree suggested that the Patagonian species group and the Antarctic species group heretofore considered to be in the same genus, are probably polyphyletic. The Patagonian group showed closed relationships among its representatives probably due to evolution in isolation since the Tertiary period. The species belonging to the Antarctic group are less known and further studies will probably show that this group includes representatives of different clades.

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Ingestion and assimilation of ^{14}C labeled algae by the freshwater mussel, *Villosa iris* (Lea, 1829) at three cell concentrations

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While some information exists on particle selection, filtration rates, and gut contents of unionids, no published information currently exists on the efficiency of unionid assimilation. In this study, assimilation efficiencies (AE) and carbon budgets were established for *Villosa iris* using radiolabelled cultures of *Neochloris oleoabundans* at three cell concentrations. At 1 x 10^5 cells/ml (3.4 mg dry weight/l), 37% of the ingested carbon was defecated, 8% excreted as waste, 15% respired, and 40% incorporated into tissues. Assimilation efficiency at this cell concentration was 55%. At 1 x 10^4 cells/ml (0.34 mg dry weight/l), 50% of the ingested carbon was defecated, 4% excreted as waste, 5% respired, and 41% incorporated into tissues. Assimilation efficiency at this cell concentration was 46%. At 1 x 10^3 cells/ml (0.03 mg dry weight/l), 41% of the ingested carbon was defecated, 6% excreted as waste, 4% respired, and 49% incorporated into tissues. Interestingly, assimilation efficiencies for *V. iris* were independent of cell concentration. Regardless of these similarities, assimilation efficiencies indicate that *N. oleoabundans* is readily assimilated (*ca.* 50% AE) by the freshwater mussel, *V. iris*. In addition, total assimilation was maximized at 1 x 10^5 cells/ml (3.4 mg dry weight/l) which indicates that *V. iris* has the largest amount of energy available for growth, reproduction, and maintenance of condition in captivity at this cell concentration.

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Some aspects of the reproduction of two South American species of *Olivancillaria* (Caenogastropoda: Olividae)

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The spawn and some reproductive patterns of *Olivancillaria urceus* and *O. deshayesiana* are described. Both species occur in Mar del Plata, Argentina, in shallow water sandy bottoms (4-10 m depth). A remarkable specificity in choosing the substrate to spawn was observed, always on the shells of living *Buccinanops moniliferum* (Nassaridae). In *O. urceus*, the egg capsule is ovoid, attached by a small base; it is thin, translucid, and has an unrigid wall, containing a single egg. The uncleaved egg is yellow and ovoid, measuring 920 x 1085 µm in diameter. The embryo develops a small bilobed velum which is completely reabsorbed before hatching as a crawling juvenile. *O. deshayesiana* egg capsules are rigid, hemispherical in shape, with a flat base and a very clear and distinguishable hatching plug. A single egg per capsule measuring 865 µm develops and hatching takes place as a crawling juvenile. The eggs of *Olivancillaria* are the largest recorded in the family and among the biggest in the caenogastropods.

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Canonical correspondence analysis of the interactions between the freshwater snails of Hanabanilla Lake, Cuba, and some environmental variables

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The relationship of the freshwater snail's abundance with the abiotic environment was investigated in Hanabanilla Lake, located in the central region of Cuba, using a Canonical Correspondence Analysis. The data utilized in this field study were gathered from samplings made between 1986 and 1992. It includes the relative abundance of 14 species as well as the values of 10 abiotic factors: salinity, total hardness, temperature, pH, depth, distance offshore, calcium, chlorides, nitrates, nitrites, and ammonium. The most important interactions found were the positive influence of calcium concentrations on the two species of *Biomphalaria*, whereas this parameter exert a negative effect on *Corbicula fluminea*. High values of pH are preferred by most of the pulmonates and by *Pyrgophorus coronatus* as well, however *Helisoma duryi, Eupera cubensis,* and *Pseudosuccinea columella* tolerate lower values of this variable. Pulmonate snails were found to prefer higher values of temperature than prosobranchs. The most frequent snails (*Tarebia granifera*, *Melanoides tuberculata,* and *Pomacea paludosa*) were spread all over the sampling area so they are considered more tolerant to the abiotic environment than the rest of the species present. The possible causes for the interactions observed are discussed.

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Continental molluscan fauna of the Nicaraguan Pacific slope: a preliminary list with the example of a remarkable taxon

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A preliminary species list is offered for the northern side of the Nicaraguan Pacific slope, and one species [*Thysanophora crinita* (Fulton, 1916)] is dealt with in greater detail, providing a preview of what may be expected from the final results. The species list for the study area comprises a total of 66 species (56 terrestrial, 10 freshwater), belonging to 44 genera and 25 families. One terrestrial species represents a new taxon recently described by one of the authors. Six other species may be new to science. *T. crinita* is described in detail: Shell depressed, opaque. Profile with slight keel in upper left side of body whorl. Color brown. Sculptured with numerous oblique and sinuous axial lines. Periostracal hairs also brown. Specimens often encrusted with dirt. Suture deep. Apex flat. Whorls 4. Shell umbilicate. Aperture D-shaped. Diameter: 3.61 mm. Height: 1.86 mm. Penis well-developed; epiphalus slightly marked; no flagellum. Vagina as wide as penis and a little less than half the length. Prostate thin and long. Spermatic duct of medium-short size. Bursa copulatrix pear-shaped and small-sized. To date, the species has been described and cited only from Colombia. [poster]

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An analysis of allozyme variation in populations of the land snail *Euglandina* (Gastropoda: Pulmonata) from Texas and northern Mexico

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This study was undertaken to determine levels of allozyme variation in populations of the carnivorous land snail *Euglandina* from Texas and northern Mexico. Specimens examined during this study included a population of *E. texasiana* (Pfeiffer) from the Rio Grande Valley of Texas, two disjunct populations of *E. singleyana* (Binney) from the Edwards plateau region of Texas, and a population from northern Mexico. Tissue samples were examined by use of cellulose acetate electrophoresis. Variation was analyzed by the use of the BIOSIS-1 computer program. Results are indicative of considerable genetic variation both among and between populations.

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The present knowledge of the taxonomy of the genus *Turbonilla* Risso, 1826 (Gastropoda: Pyramidellidae), from the Brazilian coast

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Knowledge of the taxonomy of the genus *Turbonilla* from the Brazilian coast is improving late in relation to other regions of the planet, such as the European and African coasts, and contains erroneous reports, misidentifications of species, and non-actualized statements, which makes necessary a substantial conchological revision as a basis for future works on anatomy and phylogeny. There are 16 species listed from the Brazilian coast: *T. abrupta**, *T. americana*, *T. atypha**, *T. coomansi**, *T. dispar**, *T. dubia**, *T. fasciata**, *T. haycocki**, *T. iheringi**, *T. interrupta*, *T. nivea*, *T. portoricensis*, *T. puncturata**, *T. rushii**, *T. turris**, and *T. uruguayensis**. After examining the type series of almost all of the species listed above, we confirmed the occurrence of the species marked with an asterisk (*), with the following remarks: *T. dubia* is, in fact, *Finella dubia*; *T. puncturata* is junior synonym of *T. pyrrha*; *T. nivea* and *T. americana* were not found in the Brazilian malacological collections studied; the types of *T. interrupta* and *T. portoricensis* were not found and these species cannot be accurately determined. Besides that, we first report 12 other species to the Brazilian coast: *T. arnoldoi*, *T. deboeri*, *T. krebsii*, *T. peilei*, *T. penistoni*, *T. pupoides*, *T. rhabdota*, *T. stimpsoni*, *T. westermanni*, *T.* cf. *rathbuni*, *T.* cf. *paralaminata*, and *T.* cf. *portoricana*, and around 10 taxa without identification. [poster]

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Modulation of metamorphosis by catecholamines in the opisthobranch gastropod *Phestilla sibogae*

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Larvae of *Phestilla sibogae* (Nudibranchia: Tergipedidae) are induced to metamorphose by a factor from their adult prey, the coral *Porites compressa*. Increases in levels of endogenous catecholamines occur 6-9 days post-fertilization, when larvae become competent for metamorphosis. In the present study 6-9 day larvae were treated with the catecholamine precursor L-DOPA (0.01 mM for 0.5 hours), then assayed for metamorphosis in response to coral inducer and for catecholamine content by HPLC. L-DOPA treatment caused 20- to 50-fold increases in dopamine with proportionally greater increases in younger larvae, so that L-DOPA-treated larvae of all ages contained similar levels of dopamine. A much smaller (about 2-fold) increase in norepinephrine occurred in all larvae. Six-day larvae failed to metamorphose in response to coral inducer with or without L-DOPA treatment. Such treatment significantly enhanced frequency of metamorphosis of older larvae, particularly at low concentrations of inducer. Anatomical specificity of catecholamine enhancement was examined by aldehyde-induced histofluorescence at 9 days. L-DOPA treatment increased the brightness of cells also labeled in MBL controls, and revealed additional cells. However, all labeled cells were consistent with the locations of cells showing tyrosine hydroxylase-like immunoreactivity. Catecholamines are likely to be important neurochemical regulators of metamorphosis in *P. sibogae*, but that rising levels of catecholamines around the time of competence are insufficient alone to account for the increased sensitivity to inducer in older larvae. [poster]

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Invading gastropods: a benefit or a nuisance for public health?

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Invading mollusks have received special attention for many years because they often have a catastrophic ecological impact on local biodiversity. Considering their significance on public health, invading mollusks may have either negative or positive influence. The negative influence can be illustrated by two major parasitic diseases transmitted by freshwater gastropods, *e. g.*, blood and liver flukes for which recent studies carried out in the New World, have brought new and sometimes conflicting insights on the consequences of snail introductions. It is well established that the parasites responsible for these diseases, were introduced repeatedly into the neotropical area through African slave trade and cattle import during the 1500-1800 period. It was formerly thought that the parasites had encountered there suitable snail intermediate hosts. However, recent genetic studies have revealed a non-local origin of some of these hosts. Conversely, freshwater snail invasions may be beneficial to public health. For example, some thiarid species are good competitors of the pulmonate hosts of blood and liver flukes and several biological control programs have demonstrated their usefulness in the Caribbean area. However, the relationships between invading mollusks and public health are more complex as some of these "beneficial" species are also suspected to play the role of intermediate hosts for several animal or human parasitoses such as the lung fluke (*Paragonimus westermanii*), intestinal fluke (*Centrocestus formosanus*), or meningitis (*Angiostrongylus cantonensis*). [Human Symposium]

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Stirpulina ramosa: a living fossil and the Cretaceous history of clavagellid pelecypods

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Over the past decade, Cretaceous clavagellids have received considerable study and all known species have a shell in which the left juvenile valve is cemented to the rest of the crypt and the right juvenile valve is free within the crypt; this is regarded as the primitive condition in clavagellids. Four genera having these features are recognized in Upper Cretaceous rocks: *Clavagella, Stirpulina, Parastirpulina,* and *Ascaulocardium*. The derived condition, having both juvenile valves cemented into the crypt, is represented by such younger genera as *Humphreyia* and *Brechites*. The living species *Stirpulina ramosa* (Dunker) seems to be a rare taxon occurring in the western Pacific from Tokyo Bay to somewhere near Okinawa in waters up to 80 fms deep. Its geographic and depth ranges are poorly known and poorly documented by museum specimens. *S. ramosa* has the primitive characteristic features of the Cretaceous genera *Parastirpulina, Ascaulocardium*, and Cretaceous species of *Stirpulina*, including the free right juvenile valve, anterior tubes that do not form a sieve plate, and complex overgrowths of the free right valve. Thus, *S. ramosa* is regarded as a living fossil that retains primitive clavagellid features.

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Is ovoviviparity rightly advertized?

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In oviparous snails, a considerable proportion of pre-adult mortality involves eggs. The incubation period varies from 7 days to 6 weeks. Various selection pressures which could favor ovoviviparity were suggested in the literature, *e. g.,* irregular onset of wet period or the advantage of earlier production of progeny which is consequently favored in competition for food. Each egg retention inside the parental organism should be of advantage in terms of increased reproductive success. Hence ovoviviparity should be selected for even at the earliest stages of its evolution. It is easily obtainable, since it requires practically no structural changes and should thus be common among land snails. Ovoviviparous forms should be expected to occur mainly in habitats which are unpredictable and unstable with respect to humidity and food resources. Although about half of land pulmonate families include ovoviviparous species, the latter hardly comprise 5% of all species. In unpredictable and/or unstable habitats there are practically no ovoviviparous species; most live in habitats of constant, predictable humidity supply. Adults of ovoviviparous species have developing embryos in their uteri throughout the vegetation season or throughout the year. As a rule, there are 2-4 embryos at a time, which is few. Incubation of numerous eggs in the parental organism, especially in small snails, is impossible. The increase in reproductive success ensured by ovoviviparity probably in most cases cannot compensate for the decreased fertility, since the reproductive period cannot always be extended.

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More than just a mouth: gastropod mouth structures and gastropod phylogeny

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The comparative morphology of gastropod mouth-parts has not been critically examined previously. This study uses scanning electron microscope examination of critical point dried material. External structures around the mouth of gastropods include various labia and their modifications, denticles, cilial bands, glandular areas, etc. These structures are shown to be phylogenetically informative with complex, but different, morphology in patellogastropods, vetigastropods, and neritopsines. In contrast, simple mouth-parts are found in most caenogastropods and lower heterobranchs where an introvert is not developed. There is a considerable similarity in the mouth-parts of these groups to those seen in juvenile members of the "archaeogastropod" clades, perhaps providing additional evidence of the paedomorphic origin of the apogastropods. [Character Symposium]

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Taxonomy, ecology, geographic distribution, and conservation of terrestrial mollusks in Crimea

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Crimea is a peninsula in southeastern Europe, with an area of 26,000 km^2. There are three geographical zones: north steppe, and the mountains on the southeastern and southern coasts with Mediterranean climate. On the basis of literature and more than 5,400 samples collected from more than 1,700 sites (1984-1998), there are 89 species of terrestrial mollusks in Crimea. 17 of these are endemic to the peninsula: *Bilania boettgeri* (Cles.) (Daudebariidae); *Brephulopsis bidens* (Kryn.), *Peristoma rupestre* (Kryn.), *P. merduenianum* (Kryn.), *Thoanteus gibber* (Kryn.), *Ramusculus subulatus* (Rossm.) (Buliminidae); *Chondrina rhodia taurica* (Cles.) (Chondrinidae); *Mentissa canalifera* (Rossm.), *M. gracilicosta* (Rossm.), *M. velutina* Baird (Clausiliidae); *Oxychilus diaphanellus* (Kryn.), *O. cobelti* (Lind.), *O. deilus* Bourg. (Zonitidae); *Helicopsis retowskii* (Cles.), *H. paulessei* (Linh.), *H. filimargo* (Kryn.) (Hygromiidae); and *Krynickillus melanocephalus* (Kalenicezenko) (Agriolimacidae). Degrees of similarity and difference have been established among faunas from 21 natural climatic regions of Crimea. The roles of 9 species in the transformation of vegetation were determined. The planned Red Book of Crimea includes 22 species of terrestrial snails: Pectinibranchia: Pomatidae (1); Pulmonata: Daudebariidae (1), Vitrinidae (1), Vallonidae (2), Orculidae (1), Vertiginidae (2), Buliminidae (3), Clausiliidae (1), Zonitidae (2), Helicidae (1), Hygromiidae (1), Succineidae (2), Milacidae (1), Agriolimacidae (2), and Limacidae (1). Land mollusks are very important in biodiversity conservation of the invertebrate terrestrial fauna (except Insecta) in Crimea.

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A cladistic analysis of cuttlebone morphology (Sepiidae: Cephalopoda)

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The cuttlefish (Sepiidae) are among the most diverse modern cephalopods, with over 60 species occurring along the Eastern Hemisphere from shallow water to depths of 600 m. Traditionally, species are distinguished by the morphology of their tentacular clubs and the morphology of their broad, internal shell (the cuttlebone, used for buoyancy control as in *Nautilus* and *Spirula*). Khromov's (1987) taxonomy of the group relied on only a few explicitly defined cuttlebone characters. We elaborate on this work, defining several characters that capture interspecific variation in cuttlebone morphology, including features of the inner and outer cones, dorsal shield, and phragmocone. This character matrix allows us to conduct a cladistic analysis of cuttlebones from a wide geographic range. Preliminary analyses were based on 86 characters (non-continuous binary and multistate, all unordered and equally weighted) from 81 specimens in 21 species of *Sepia* Linné, 1758, and one of *Sepiella* Gray, 1849. Data were analyzed with PAUP ver. 3.1.1. Deep-water species appear closely related, although this may be due to convergence as some cuttlebone characters correlate with habitat depth. The addition of soft-part anatomy may better estimate phylogeny, but tentacular morphology is known to be depth-related in other cephalopods. We recommend that depth-related convergence should be considered when evaluating phylogenetic hypotheses of modern and fossil cephalopods with shells for buoyancy control.

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Zoogeography of the small freshwater mussels (Sphaeriidae) on the Scandinavian peninsula

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The Scandinavian peninsula comprises >773,800 km^2, ranging north-south 1,800 km. Within this area, 23 sphaeriids occur. 7 (30%) [*Pisidium casertanum*, *P. hibernicum*, *P. lilljeborgii*, *P. milium*, *P. nitidum*, *P. obtusale*, and *P. subtruncatum*] are distributed peninsula-wide. 8 (35%) have an eastern distribution: *P. amnicum*, *P. henslowanum*, *P. moitessierianum*, *P. pseudosphaerium*, and *Musculium lacustre* and, less pronounced, *P. pulchellum* and *Sphaerium corneum* (possibly also *S. nucleus*). *P. moitessierianum*, *P. pseudosphaerium*, and *M. lacustre* have northern limits in the *limes norrlandicus* zone, an important biogeographical transition area between Boreal and southern Scandinavian regions. *P. amnicum*, *P. henslowanum*, *P. pulchellum*, and *S. corneum* extend into northwestern Sweden. *P. supinum* and *P. tenuilineatum* are rare southern species, not reaching *limes norrlandicus*. 3 (13%): *P. hinzi*, *P. waldeni*, and *S. nitidum*, occurring in the northern peninsula, especially the mountain ridge, are post-glacial immigrants from the northeast. *P. conventus* shows affinities to this group, but extends southward. *P. personatum* is south-southwestern; it is absent in northeastern Sweden with its northernmost localities in coastal Norway. The isolated southern Swedish occurrences of *P. subtilestriatum* form the westernmost outposts of this eastern species, spreading westward through southern Finland. If the distribution limits of incompletely distributed species are plotted, many coincide in *limes norrlandicus* zone, the Scandinavian mountain ridge, and the transition between woodlands and the mountain ridge in interior northern Sweden. These form the most important distribution barriers for sphaeriids. [poster]

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Ultrastructure of ovotestis of active and aestivating *Achatina fulica*

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The functional state of the ovotestis in *Achatina fulica* (Gastropoda: Pulmonata: Achatinidae) is controversial with contrasting claims of protandry or protogyny. The present work is an attempt to unravel the actual functional state of the organ using TEM. The tissues were fixed in a paraformaldehyde-glutaraldehyde combination, then processed for study following standard procedures. The ovotestis of *A. fulica* consists of a number of follicles, closely apposed to each other. The interfollicular spaces are occupied by connective tissue. In active *A. fulica*, each follicle contains a single ovum plus spermatogenic cells in various stages of spermatogenesis. The ovum is large, oval with excentric nucleus, and is surrounded by a thin membrane. Fat droplets are also observed in the ovum. The spermatids are being assembled around a large nutritive cell comparable to the mammalian Sertoli cell. This cell contains many secretory vesicles and stacks of Golgi bodies. Bundles of mature sperm have also been observed. In an aestivating snail, the features of the follicle are more or less similar to that of an active snail. However, the ovum is smaller, the number of spermatids is diminished, and the nutritive cell is not observed. The present study reveals that the ovotestis of *A. fulica* produces both sperm and ovum simultaneously within a single follicle. The presence of a nutritive cell is also significant.

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Alteration of aggregation behavior of hemocytes of *Bellamya bengalensis* exposed to methylparathion

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Bellamya bengalensis (Gastropoda: Viviparidae) is a potent aquacrop of India propagated infreshwater habitat and exposed to the risk of contamination by methylparathion, anorganophosphorus pesticide. Physiological defence of *Bellamya* is conceived to be dependent on the activity of hemocytes. Information on surface characteristics of hemocytes was required to recommend appropriate environmental protection for *Bellamya*. Hemocyte aggregation as an immunoresponse was screened under the given challenge of sublethal concentrations of methylparathion *in vivo* and *in vitro*. Hemocytes were isolated, quantified aseptically, and checked for viability during routine assays of aggregation. Spreading hemocytes exhibited 27, 48, 58, and 72% of aggregation against 1, 2, 3, and 4 ppm/48 hour of *in vivo* exposure of methylparathion, respectively. Round hemocytes showed feeble reactions up to 3 ppm following a sharp increase up to 29% at 4 ppm. Aggregations *in vitro* were recorded against identical concentrations of methylparathion exposure for 1 hour. Maximum aggregations of 89% and 30% were recorded against 4 ppm in spreading and round hemocytes, respectively, *in vitro*. This study indicates that alteration of hemocyte surface characteristics induced by methylparathion may lead to formation of cell clumps in circulating hemolymph involving both cell types. A dose-dependent relationship and higher tendency of aggregation of the spreading type would pose an overall physiological threat to *Bellamya* in a contaminated habitat. [poster]

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The origins of the antitropical distribution of the patellid limpets: evidence from morphological and molecular phylogenetic analyses

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The Patellidae consist of about 37 living species, classified in 4 genera: *Patella s. s.*, *Cutellastra*, *Cymbula*, and *Helcion*. This new phylogenetic classification is based upon a recent phylogenetic analysis of morphological characters (shell microstructure, pallial complex, radula, and sperm). A molecular analysis of mitochondrial DNA sequences (with members of Lottiidae and Nacellidae as outgroups) largely confirms these principal clades and provides improved phylogenetic resolution, but calls into question the monophyly of the Patellidae. The geographical distribution of the limpet family Patellidae is essentially antitropical, with 18 species in southern Africa, 10 in the northeastern Atlantic, and only 11 species elsewhere (although 4 of these do occur in the tropics). The traditional explanation for this is a recent, perhaps Early Pliocene, migration from southern Africa northward. Our analyses show that this is true for only one of the species (*Cymbula safiana*) in the northeastern Atlantic. The remaining European patellids form a single rather uniform clade (*Patella s. s.*), and are distant from all other members of the family. From the limited fossil record and estimated rates of molecular divergence, *Patella s. s.* appears to have originated at least as early as the Upper Cretaceous, and its northern distribution may have been achieved at the same time. The geographical origin of the family remains unclear, but a Mesozoic radiation in southern Gondwana is possible.

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Evidence for possible outcrossing in the terrestrial slug *Arion intermedius* (Pulmonata: Arionidae)

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Some arionid slugs have mixed breeding systems comprising selfing and outcrossing, while others are strict outcrossers. In *Arion intermedius*, however, the only indication of possible outcrossing is a recent finding of spermatophores in Iberian specimens. Although this observation suggests that mating may have occurred, it is inconclusive with respect to outcrossing. Indeed, all other previous data indicate that *A. intermedius* is a strict selfer. For example, allozyme studies have hitherto failed to detect heterozygotes. In this context, we screened three enzyme loci (LDH, IDH - polymorphic in other populations - and HBDH) in 176 specimens of *A. intermedius* from an abandoned mining area southeast of Görlitz (Germany). In this population, LDH and IDH were monomorphic, but HBDH showed diallelic variation, not only producing homozygotes of both types, but also the first reported occurence of heterozygotes. This observation, together with the presence of two spermatophores in the same population, suggests outcrossing. However, the frequencies of observed genotypes differ significantly from Hardy-Weinberg equilibrium, indicating a predominantly selfing population. These results will be discussed with respect to alternative interpretations, geographic differences in breeding systems and the likelihood of detecting outcrossing in species with low degrees of polymorphism.

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Contributions of morphological, molecular, and fossil data toward an understanding of scaphopod phylogeny

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The Scaphopoda has long been considered the most "minor" of the molluscan classes; its modest diversity, superficial homogeneity of form, and most recent stratigraphic appearance have largely marginalized the clade from exigent malacological issues such as speciation, morphological disparity, and early evolution of the phylum. Yet the Scaphopoda present a singular opportunity for study of molluscan evolution; they constitute a monophyletic class small enough for broad and deep phylogenetic analysis, with a fossil record ideal for comprehensive incorporation of extinct taxa and examination of diversification throughout history. Recent studies nevertheless reflect the refinement of a stable taxonomy despite notably little phylogenetic resolution, while hypotheses of conchiferan relationships are remarkably disparate. Concurrent work on morphological and molecular character development and review of fossil data provide a complementary approach for discerning supported patterns in scaphopod evolution. Improved resolution exposes new quandaries: maximum parsimony analysis of 34 morphological characters from 12 terminals shows the family Gadilinidae paraphyletic; maximum likelihood analysis of COI mtDNA sequences from 11 terminals shows paraphyly of the family Dentaliidae and the genus *Antalis*. Fossil data in tandem with cladistic analyses allow age estimates and congruence tests of divergence patterns, but also reveals taxonomic effects. For example, the Dentaliidae represents a relict super-taxon from which genera have been successively removed and subsequently elevated hierarchically; achieving taxonomy that reflects phylogeny will considerably undermine current systems.

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Life-history differences in three populations of *Bithynia tentaculata* (L.) (Gastropoda: Prosobranchia)

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Long-term studies of individual invertebrates under natural conditions are sparse. In this study females of the gonochoristic snail *Bithynia tentaculata* were kept caged in the field. It is an iteroparous prosobranch common in European inland waters. Each female inhabited an individual cage. The three populations studied lived in a lowland stream, a permanent pond and a small artificial pond in Hanover, Lower Saxonia, Germany. The populations differed in several key life-history features. Differences were found in shell size at maturity, percentage of reproducing adult females, mean shell size of reproducing females, number of eggs per reproducing female and percentage of eggs hatching. The mean number of hatchlings per adult female was 139 in the stream, 157 in the pond, and 92 in the artificial pond. The onset of the spawning season and its mean length were the same for all populations. The females exhibited marked individual differences in the measured parameters. Especially egg number, mean number of eggs per spawn mass, hatching rate, number of spawn masses, and length of spawning season differed. Surprisingly, shell size of females did not correlate with egg number. These findings suggest that different life-history strategies can exist between and within populations of the same species even in close spatial proximity. [poster]

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Toward a new phylogeny of the higher Caenogastropoda

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Based upon paleontological evidence it can be clearly shown that Ficidae have a much longer evolutionary history than tun shells and thus the former cannot represent an offshoot of the latter, which has been the most commonly proposed hypothesis in corresponding modern literature. This hypothesis argued mainly with the taenioglossate radula in the however highly evolved *Ficus*. Examination of Late Cretaceous gastropod radiations suggest strongly that taenioglossate *Ficus* and *Thalassocyon* have their origin in the same group of caenogastropods as, *e. g.*, rachiglossate *Melongena* and *Turbinella*. In particular *Ficus* and *Melongena* show some striking morphological similarities such as the nervous system, the alimentary tract, the shape of the head-neck region, or the shape of egg capsules. While the radula of *Melongena* is typically buccinid, that of *Turbinella* could have evolved directly from a ficid radula type. Postulation of very close relationship between certain taenioglossate and rachiglossate taxa provocates a series of consequences to be considered with regard to the systematics of higher Caenogastropoda. Consequently the morphological concept has been tested with a molecular model based upon 16S and 18S DNA sequences. In this analysis we included the ranellid *Cymatium* and the truncatelloid *Rissoa*. It will be demonstrated that the morphological concept is more or less consistent with the molecular data.

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Ecological aspects of *Aplysia brasiliana* (Rang) (Mollusca: Opistobranchia) on a rocky platform at Las Salinas, Venezuela

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To determine some ecological aspects of *Aplysia brasiliana* (Rang) between December 1996 and December 1997, a rocky platform of 240 by 50 meters at Las Salinas (central coast), Venezuela, was surveyed. Daily activity was monitored in two transects of 50 m^2 each during 24 hours. The two transects were observed every 2 hours and the species and number of individuals feeding, moving, or resting were registered. To determine the abundance of the species in the platform, surveys were made in December 1996, March, July, September, and December 1997, with transects of 10 and 20 m in length and quadrats of 0.04, 0.2, and 1.0 m^2. *A. brasiliana* has been observed throughout the year in the rocky platform. During the day they were among or under the rocks. In the afternoon (after 18:00 hours) and at night, they presented the maximum daily activity, swimming, or crawling in the pool of the platform. *A. brasiliana* presented an aggregated distribution with a mean abundance of 1.71 organisms/m^2 in March. In this month, a reproductive congregation occurred. The individuals were found copulating at the base of algal clumps on the platform and the egg masses were attached to the algae. Additionally between October and January, the study population migrated from one extreme of the platform to the other where food (macroalgae) was more abundant. [poster]

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Alien invasions: the effects of the Global Economy on snail introductions

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With the expanding Global Economy, increasing trade volume and international trade agreements facilitating commodity movements worldwide, the risks of "alien" introductions are increasing. Of over 3500 molluscan interceptions from almost 100 countries by USDA APHIS PPQ inspectors over the last five years on commodities entering the United States, more than 360 gastropod taxa, belonging to 175 genera in 69 families, have been identified. Although expected on agricultural and horticultural products, "hitch-hikers" also are found in and on shipping containers, military hardware, aquarium supplies, etc., as well as being deliberately introduced. Many of these mollusks belong to a lengthening list of tramp or traveller species, and the number of introduced species in each country is increasing inexorably despite efforts to slow their invasions. Many countries lack or have minimal quarantine restrictions, or where inspection agencies exist, they may be ineffective and/or underfunded. Local agriculture is negatively affected, native species adversely impacted, and the establishment of a non-indigenous species creates a reservoir for its further spread when that country exports its own products abroad. These alien species are a potential threat to agriculture, indigenous species, and native habitats, and may be human and livestock disease vectors. As we lack specific ecological information for these taxa, there is an urgent need for pooling of such data from concerned scientists and governments worlwide. [Human Symposium]

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Life tables of eight Cuban populations of the genus *Biomphalaria* (Pulmonata: Planorbiidae) under laboratory conditions

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The growth, reproduction, and survival of eight Cuban populations of the freshwater genus *Biomphalaria* were studied under laboratory conditions. The group from Jardin Botanico was the one with the largest shell size (13.8 mm), showing a life span of 18 weeks, whereas individuals from Guatao lasted 29 weeks but reached 10.7 mm shell size. Both Santa Rita and Arroyo Arenas populations exhibited a life span of 11 weeks and reached shell sizes of 8.3 and 8.9 mm respectively, being the ones with the shortest life span and the lowest shell growth. The greatest values of net reproduction rate were exhibited by the group from Guatao (Ro = 898.53) and the lowest by Arroyo Arenas (Ro = 350.26). The Villa Vazquez population displayed the highest mean generation time (T = 10.90), however its values of both the intrinsic (r = 0.88) and finite (λ = 2.42) rates of increase were the lowest, the highest values corresponding to the Zanja Ferrer population (λ = 6.51 and r = 1.87). The life expectancy at hatching had its greater expression in Hanabanilla (e_o = 36.03) as well as the hatching rate (Hx = 0.98 reached during the sixth week). The possible influences of the differences observed between these populations on the taxonomic status of the genus are discussed.

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Molecular systematics of the "superconglutinate" producing mussels of the genus *Lampsilis* (Bivalvia: Unionidae)

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Several lineages of freshwater unionoidean mussels have evolved different strategies, which are thought to increase the likelihood of infecting a suitable fish host with their parasitic larvae. These strategies include mantle margins which resemble fishes or invertebrates. Yet another strategy is the production of superconglutinate lures which consist of the entire larval contents of all water tubes are packaged together in a mucus matrix. These superconglutinate lures are extruded from the mantle cavity and via the excurrent siphon and contained in a translucent mucus tube and mimic a small minnow-like fish when acted upon by water currents. The presence of superconglutinate lures has been documented in three nominal species of mussels (*Lampsilis altilis, L. perovalis, L. subangulata*) and a fourth species (*L. australis*) is suspected based on its similar gill morphology. One question of evolutionary significance is whether the aforementioned species constitute a monophyletic group, in other words did the superconglutinate reproductive strategy evolve once in the ancestor of these taxa, or did it evolve multiple times? A phylogenetic analysis of representative lampsiline taxa based upon the DNA sequences of a portion of two mitochondrial genes provides a test of the monophyly of these mussels as well as hypotheses concerning the evolution of this reproductive strategy, *i. e.*, from which ancestral condition did the superconglutinate lure evolve?

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Some news on truncatelloidean gastropods endemic to Lake Baikal

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Data on embryology, the embryonic shell, and spermatozoan ultrastructure are presented for the first time for truncatelloidean gastropods (Hydrobiidae: Benedictiinae; Baicaliidae) of Lake Baikal. Embryology at 6°C lasts about 6 months in baicaliid species, even longer (8-11 months) in *Benedictia*. Two types of protoconch can be distinguished in baicaliids according to sculpture: (1) with distinct striae or lirae, or (2) with malleate depressions. Some baicaliids exhibit an increased number of whorls at hatching (up to 2.7). A small protoconch (1.5 whorls) with striae seems to be the plesiomorphic condition (considering Hydrobiidae for outgroup comparison). Benedictiinae are the largest known hydrobiids; this is also true regarding the protoconch. Species of *Kobeltocochlea* hatch with a conch of 0.5 cm shell length and 2 whorls. The sculptural pattern differs between *Kobeltocochlea* and *Benedictia*. Protoconch morphology of *Benedictia* resembles that of the Lithoglyphinae, especially the North American genus *Fluminicola*. Investigations on mature euspermatozoa reveal that *Benedictia* shows the same pattern as *Hydrobia* - a massive, relatively short nucleus, and a spatula-like acrosome. The investigated species of Baicaliidae have a different type of spermatozoon characterized by a tubular nucleus. Spermatozoan patterns resemble those described in the literature for *Rissoa* and differ significantly from those of hydrobiids to which baicaliids are often attributed. [Supported by the Deutsche Forschungsgemeinschaft]. [poster]

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Molecular analysis of planorbid snails of medical importance: identification, phylogeny, and disease transmission

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Parasitic diseases associated with freshwater snails pose a significant threat to the health of millions of people living in the tropical and subtropical world. In Africa, schistosomiasis remains a major public health problem and large scale water development programs are all too often associated with dramatic increases in the prevalence of the disease. Molecular approaches are increasingly being used to complement traditional methods of snail identification, to understand relationships between taxa, to study population genetics and to explore genetic interactions between snails and parasites. This paper will consider the progress and potential of some of these approaches in relation to species of *Bulinus* and *Biomphalaria*. Valuable molecular markers for the discrimination of *Bulinus* species in Africa and Madagascar have been identified using PCR-based techniques such as restriction fragment length polymorphism (RFLPs) of the internal transcribed spacer region of ribosomal RNA genes and random amplified polymorphic DNA (RAPDs), in addition to mitochondrial and genomic DNA sequencing. Molecular phylogenies provide further insights into the relationships of *Bulinus* species and of *Biomphalaria* species from the New and Old World. A search for genomic regions in *Biomphalaria glabrata* linked to or involved in resistance to *Schistosoma mansoni* has been initiated using a RAPD approach in conjunction with progeny pooling methods. The development of molecular markers into simple dot-blot or specific PCR-based assays may have a direct and practical application for the identification and monitoring of resistant snails in natural populations. [Human Symposium]

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Species level diversity of Jamaican snails: the highest in the world

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Ten person-hours of collecting at a 4 hectare, karstic, partially disturbed site near Auchtembeddie, Jamaica, yielded 70 species of land snails and 3 species of slugs, totalling 73 species of terrestrial mollusks. Of these, 63 species are native to Jamaica, 6 are introduced, and 4 are of uncertain status. Of the 63 native species, 58 are endemic to Jamaica. Highest diversities previously reported for terrestrial mollusks are 60 species in the Waipipi Reserve, New Zealand (57 native species and 3 introduced), and 52 native species at Manombo, Madagascar. Only 15 (21%) of the Jamaican species sampled reach maturity at under 5 mm; in contrast to 84% in New Zealand and 63% in Madagascar. The Jamaican terrestrial molluscan fauna totals 550 species. Of these, 514 are native, and at least 18 are introduced. Among the native species, 505 are endemic. Taking area into account, the native diversity of Jamaica is comparable to that of the most diverse known island faunas, Lord Howe Island, Rapa, and Oahu. Unlike these islands, the Jamaican fauna has suffered little extinction. This may be because native species of carnivorous snails occur in Jamaica, which make the fauna resistant to introduced predators, because more of the native vegetation of Jamaica is intact, and because sympatric diversity is much higher than on these islands, meaning that species have larger average ranges.

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Spatial and temporal patterns of morphological evolution in stromboidean gastropods

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While morphological diversity metrics are being used increasingly in paleobiological studies, very little quantitative data exist on the spatial distribution of morphology in modern marine ecosystems. Gastropods provide an excellent system in which (1) present day spatial trends in morphological diversity can be quantified, and (2) the evolution of these spatial patterns can be studied directly using the fossil record. Data for stromboidean gastropods suggest that present day interspecific spatial trends in body size and morphology have resulted mainly from differential extinctions, and evolutionary radiations have played a secondary role. Thus in this case, patterns of morphological evolution cannot be correctly inferred simply from a phylogeny of the living members of the clade; it is essential to unite the living and the dead. [Bridging Symposium]

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Distribution and abundance of the malacofauna of ground leaf litter in a tropical rain forest in southern Veracruz, Mexico

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In 1991, Naranjo-García started the first study of the molluscan fauna of the ground leaf litter at Estación de Biología Los Tuxtlas, southern Veracruz, Mexico. She found about 51 taxa from this type of habitat. Subsequent studies have focused on the distribution and abundance of these mollusks. Litter samples were collected monthly from November 1996 to October 1997 at three sites, one in old secondary forest and two, named "Hectare" and "Vigia 4," in the tropical rain forest proper. During the study period, 34 species belonging to 13 families were recovered from the ground leaf litter. The most common species at all sites were: *Systrophia* A, *Thysanophora plagioptycha*, *Miradiscops* A, *Pseudosubulina berendti*, and *Pseudosubulina* B. Species found only at particular sites were: *Omphalina* sp. (Vigia 4), *Xenodiscula* sp. (Hectare), and *Strobilops* A (Secondary forest). More living snails were found during the rainy season (August-November) than in the dry season. The Shannon-Wiener and Sorensen diversity indices were similar for each site. [poster]

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Taxonomic revision and biological notes of the genus *Tomigerus* Spix, 1827 (Bulimuloidea: Odontostominae)

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The present work is based mainly on material deposited in the malacological collections of Museu de Malacologia (MZUSP) and Museu Nacional (MNRJ), besides material given on loan by several museums. *Tomigerus* Spix, 1827, and its known subgenera and species are characterized including synonymies and geographical distributions. The shell (above all, lamellae and the pleats of the aperture, that seem to present a specific code for extrusion and intrusion of the cephalopedal mass) and soft parts were studied. Important taxonomic characters were evaluated and illustrated. Studies were carried out to determine the oviparity and viviparity of *T. (Tomigerus)* Spix, 1827, and *T. (Biotocus)* Salgado & Leme, 1990, respectively. This study resulted in modernization of the characterizations of the subgenera *Tomigerus s. s.*, *Digerus* Haas, 1939, and *Biotocus* Salgado & Leme, 1990, and of their species: *T. (T.) clausus* Spix, 1827, *T. (T.) matthewsi* Salgado & Leme, 1991, *T. (T.) corrugatus* Ihering, 1905, *T. (T.) rochai* Ihering, 1905, *T. (T.) laevis* Ihering, 1905, *T. (T.) pilsbryi* Baker, 1914, *T. (T.) esamianus* Salgado & Coelho, 1990, *T. (D.) gibberulus* (Burrow, 1815), *T. (B.) cumingi* Pfeiffer, 1849, *T. (B.) venezuelensis* Pfeiffer, 1856, *T. (B.) ubajerensis* Leme, 1980, and *T. (B.) turbinatus* (Pfeiffer, 1845).

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On new species of Neomeniamorpha (Mollusca: Solenogastres)

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Fifteen currently named species (size 15 mm - 20 cm) of the order Neomeniamorpha (class Solenogastres) belong to four genera within the families Hemimeniidae (*Archaeomenia, Hemimenia*) and Neomeniidae (*Neomenia, Heathimenia*). Besides a mantle cover with characteristic spicules and an originally polyserial radula (mostly reduced), they are particularly characterized by a highly elaborated accessory genital system. Whether *Imeroherpia*, which has a different mantle cover (and is thus currently placed within the order Sterrofustia) and a tetraserial (divided biserial) radula, yet has an accessory genital apparatus almost identical to the Neomeniamorpha, actually belongs to that order remains to be settled (see other contribution to this congress). Seven new species are under description. They come from off Galicia (Spain), off the Azores, the South Shetland Islands, and off New Zealand. It is interesting to note that two samples each included two species of the same genus. A comparative analysis of the organization of all these representatives is presented and a systematic revision of the order Neomeniamorpha will be set forth.

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Toward a new system of Solenogastres (Mollusca)?

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The Solenogastres (formerly Aplacophora-Neomeniomorpha) constitute a systematically difficult group. In 1978, on the occasion of a monograph on Antarctic and Subantarctic Solenogastres including 50% of the then-known representatives, a new system was introduced. It distinguishes the four orders Pholidoskepia, Neomeniamorpha, Sterrofustia, and Cavibelonia according to the elaboration of the mantle cover. Among them, the Cavibelonia with hollow, needle-shaped spicules, was defined with some reservation (as possibly being polyphyletic) due to certain inconsistencies. New findings support the interpretation that present Cavibelonia are not monophyletic, referring, *e. g.*, to Pholidoskepia-Dondersiidae + Amboherpia with hollow needles or to Cavibelonia-Simrothiellidae + Helicoradomenia with solid needles. There appears to be no doubt that Solenogastres with scales (instead of solid or hollow needles) and subepithelial ventral foregut glands (so-called 'type A') represent the conservative stock (Pholidoskepia). But the present Phyllomeniidae (Sterrofustia), Pararrhopaliidae (Cavibelonia) and possibly also Rhopalomeniidae (Cavibelonia) might be classified together, with another group formed by Heteroherpiidae (Sterrofustia) and Syngenoherpiidae (Cavibelonia). On the other hand, Neomeniamorpha (with Imeroherpiidae?), Amphimeniidae (Cavibelonia) and possibly also Simrothiellidae might represent separate lines. However, our current knowledge on the important characters (mantle cover, radula, foregut glands, genital apparatus) within a total of 190 known (of an estimated 500) species is far too weak for a thorough systematic revision of Solenogastres into more comprehensive natural groups.

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The genera *Burnupia* Walker, 1912, and *Laevapex* Walker, 1903, in Brazil (Gastropoda: Basommatophora: Laevapecidae)

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Neotropical "ancylids" have been commonly attributed to *Gundlachia sensu latum* (*Gundlachia*, *Hebetancylus*, *Anisancylus* and *Uncancylus*). Recent studies including revision of literature data and scientific collections showed that beside these typical genera, *Laevapex* and *Burnupia* are also present. *Laevapex* was considered restricted to North America until Santos (1989) described *Laevapex vazii* from southeastern Brazil; new data increase its distribution to Central America, and northeastern and southern Brazil. *Burnupia* was considered restricted to Africa, until Santos (1990) cited its occurrence in southeastern Brazil; now it is known to at least southern Brazil and Uruguay. Comparative anatomical studies are being carried out to determine taxonomic positions preliminary to understanding and discussing systematic and zoogeographical relationships. On the other hand, careful revision is necessary of all nominal species previously identified as *Gundlachia* to detect misidentifications. [poster]

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The muscular system of neotropical Laevapecidae as an aid to systematics of Ancylidae (Gastropoda: Pulmonata: Basommatophora)

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To contribute to the understanding of relationships of neotropical ancylids, detailed studies of adductor muscles are presented, based on *Gundlachia radiata* (Guilding, 1828), *G ticaga* (Marcus & Marcus, 1962), *Hebetancylus moricandi* (Orbigny, 1837), *Uncancylus concentricus* (Orbigny, 1835), *Anisancylus obliquus* (Broderip & Sowerby, 1832), *A. dutrae* (Santos, 1994), *Laevapex* sp., *Burnupia* sp., and *Ferrissia* sp. Two groups were observed. (1) including *G radiata*, *G ticaga*, *H. moricandi*, *Laevapex*, and *Ferrissia*, with three adductor muscle scars of approximately same size and shape (rounded, oval or elliptical); an elongated adhesive area, formed by insertion of two muscular fascicles: a longitudinal, that originates at the head region and runs back over the buccal bulb, and a transverse one that originates at the inner side of right muscle and runs to right over the first fascicle; the right aductor muscle formed by two clearly separeted fascicles: an anterior that originates at the foot, next to the tentacular region and runs obliquely above and back to coalesce with the posterior one. (2) including *A. obliquus*, *A. dutrae*, *U. concentricus*, and *Burnupia*, with the right adductor muscle scar bigger and distinct from the other two; a V-shaped adhesive area formed only by longitudinal muscular fascicles; the right adductor muscle formed by a continuous muscular fascicle. These characters, besides others from conchological, radular, and genital systems, allow us to consider "neotropical ancylids" as non-Ancylidae, and to revalidate the Laevapecidae Hannibal, 1914. [poster]

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Anatomy of *Sasamocochlis sasamorii* and its phylogenetic implications

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Sasamocochlis sasamorii has been regarded as the largest species in the "Cerithiopsidae" (Gastropoda: Ptenoglossa: Triphoroidea). Living material of this species had never been collected before it was discovered in 1992/1996 off southern Hokkaido, northern Japan. The anatomy of this species with serial sections and SEM was carried out for the first time. The basic plan of this species is typical caenogastropod-type in structure of pallial, renal, and circulatory systems and configuration of alimentary and reproductive systems. Some phylogenetically important character states are found in reproductive, alimentary, and nervous systems: (1) pallial vas deferens with ventrally open prostate, (2) absence of penis, (3) pallial oviduct with almost closed capsule gland and partly open slit, (4) receptaculum seminis with oriented sperm, (5) gametolytic gland including dissolved sperm mass, (6) bursa copulatrix with unoriented sperm, (7) buccal musculature similar to basic littorinoid-truncatelloidean type lacking odontophoral retractors, (8) oral tube not specialized for long acrembolic proboscis, (9) septate esophageal glands well-developed along mid-esophagus, and (10) concentrated configuration of circumesophageal part with unusual fusion of connectives. The results of this study and a review of previous literature indicate that the current "Triphoroidea" and "Ptenoglossa" are probably polyphyletic. [poster]

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The bivalve genus *Limatula* (Limidae) twenty years after C. A. Fleming: systematics and composition of the Atlantic species

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Limatula is widely distributed, with a fossil record extending back to the Triassic-Jurassic. It ranges intertidally to abyssally, mostly on soft bottoms, with 5 subgenera: *Limatula s. s.*, *Stabilima* Iredale, 1939, *Limatuletta* Fleming, 1978, *Antarctolima* Habe, 1977, and *Squamilima* Fleming, 1978 (= objective synonym of *Antarctolima*). Sir Charles Fleming (1978) reviewed *Limatula,* listing 100+ fossil and Recent species. This review of southwestern Pacific species has not been followed by other comprehensive regional monographs. *Limatula* species are characterized by: shell small to medium (2 to 40 mm), elongately oval to pyriform, subequilateral; auricules small, subequal, with auricular sinuses; margins rarely gaping; fine radial riblets; "median structure" (radial riblet stronger than remaining ornamentation); hinge edentate. A complete revision of Limidae genera using old and new (shell structure, anatomy) characters is needed to clarify ranking and relationships of the many taxa. Based on type and other museum material, 21 Atlantic species (6 new) are recognized. 12 live on the continental shelf, 8 inhabit bathyal depths, and one is abyssal. The group of *L. subauriculata* Montagu, 1808, has the largest number of species (12) and comprises shelf species and two bathyal. The group of *L. subovata* Jeffreys, 1876 (4 spp.), is strictly bathyal. One southwestern Atlantic species (*Antarctolima*) has affinities to Antarctic species. 4 species cannot be allocated to previously established groups and represent different lineages. Both sides of the Atlantic have similar species numbers; 5 species have large distributions on both sides.

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The adoral sense organ in Nuculoida (Protobranchia, Bivalvia): fine structure of a recovered character

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The Protobranchia are the most primitive group of the recent Bivalvia. This taxon shares a number of pleisiomorphic characters. Salvini-Plawen & Steiner (1996, In: J. D. Taylor, ed., *Orig. Evol. Rad. Moll.*, University Press, Oxford, pp. 29-51) suggested the adoral sense organ to be a useful synapomorphic character. This resulted in a monophyletic origin of the Protobranchia in their analysis. To confirm this suggestion these authors requested detailed investigations of the structure and homology of the adoral sense organs. The adoral sense organ is known from few species investigated in a period from 1899-1939. Later on this subject was mentioned neither in works dealing with bivalves nor with invertebrate sensory structures. The best known protobranch example *Nucula nucleus* was investigated by EM and compared to other species. The organ is a paired ridge of a specialized epithelium positioned laterally at the base of the labial palps near the mouth. In this presentation the organ is characterized as a pseudostratified epithelial thickening bearing a cuticule of microvillar type and a basal matrix with a lamellar construction. There are 3 types of bipolar primary receptor cells bearing about two subcuticular cilia and 2 types of supporting cells and basal cells. [Character Symposium]

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New evidence for segmentation in Aplacophora

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Transverse rows of spicules were inadequately described in a single aplacophoran larva more that 100 years ago by Pruvot, and although never substantiated, this description has formed the basis for equivocal evolutionary conjecture about segmentation in the Mollusca. A recently collected postlarval neomenioid aplacophoran with six transverse rows of dorsal spicules verifies dorsal ectodermal segmentation during the ontogeny of Aplacophora. The seven bare spaces between the dorsal spicule rows and between them and the posterior and anterior terminal groups of spicules may be homologous to polyplacophoran shell fields. Ventrally the postlarva bears three paired longitudinal, unsegmented rows of spicules which find homology with the rows of sclerites in the Cambrian halkieriids and wixaxiids. Segmentation is here defined as longitudinal repetition of body structures expressing the homeobox gene engrailed, homologs of which have been identified in 5 molluscan classes including the Polyplacophora; the Aplacophora and Monoplacophora were not examined (Wray, *et al.*, 1995). The dorsal ectodermal segmentation of Aplacophora during ontogeny suggests a segmented, aculiferan molluscan ancestor. It is probable that this segmentation is embryologically determined by macromere D, which in the Annelida and Mollusca gives rise to both ectoderm and mesoderm and, in the Annelida, to segmentation.

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Relationships between Siliquariidae (Mollusca: Caenogastropoda) and sponges

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Sponges were considered by Pearse as "living hotels" because they host an impressive amount of vagile fauna in their canals. Most lodgers are vagile, while sessile invertebrates are rarer. Among gastropods, the family Siliquariidae Anton, 1838, is formed by obligate commensal species of sponges. Siliquariids are morphologically convergent with other uncoiled gastropods, but strongly differ in biology and ecology. Their peculiarity is the presence of a longitudinal slit in the shell, that seems to be an adaptation to the life within sponges. The slit in fact could be used for conveying the mollusk's water outflow into the sponge aquiferous system. Several sponges from the Mediterranean Sea, New Zealand, Philippines, and New Caledonia, in which siliquariids were found, have been analyzed to verify this hypothesis. The topological relationship between the siliquariids and their host sponges have been investigated on castings obtained from the injection of a resin into the sponge aquiferous system and on X-ray pictures of the sponges. The slit shape seems to be related to the structure of the aquiferous system of the sponge and not to the molluscan developmental bauplan, whereas its status (functional/not-functional) depends on its position inside the sponge. At present this association seems not to be species-specific, but a strong affinity certainly exists with some sponge families belonging to the order Astroporida and with the family Halicondriidae Vosmaer, 1887.

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To speciate or not to speciate?

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Exposed limestone in Peninsular Malaysia is limited to a scatter of small hills, often separated by hundreds of kilometres of acidic soils. As a result, many land snail genera (*e. g., Opisthostoma* and *Diplommatina*) have speciated dramatically, with each hill possessing endemic species. Other rock-dwelling snails, however, have hardly radiated at all. Using DNA-sequence data for the first Internal Transcribed Spacer (ITS-1), we have constructed phylogeographies to determine whether the speciating and non-speciating groups are equally old, and what colonization/vicariance patterns are apparent. In addition, we emphasise the uniqueness of these biotas, which are severly threatened by surrounding agriculture and exploitation.

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Reliability of morphologic reductive characters in the phylogenetic reconstruction of cardiid bivalves as tested with molecular systematics

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Morphological characters have been used to study the systematics and evolution of the bivalve family Cardiidae. Many of these characters include states of reduction and/or loss. Several putative clades, most notably the Tridacninae (giant clams), the Fraginae, and subclades of Fraginae, have been defined by several reductive characters. It has been argued that (1) reductive characters are more homoplasious than other characters, and (2) secondary losses of structures may be miscontrued as primitive absences. The best method of determining the phylogenetic reliability of morphologic reductive characters is through the use of the independent approach of molecular systematics. An approximately 600 nucleotide fragment of the D2 domain of the 28S gene is used to construct a phylogenetic hypothesis for the Cardiidae. Multiple species from each of the generally recognized cardiid "subfamilies" are included, with species of the noneucardiid *Nemocardium* used as outgroups. The major cardiid subclades found in the morphological analysis are also found in the molecular analysis, but the relative positions of the subclades to each other differs between the two analyses. Therefore it is concluded that (1) morphologic reductive characters are reliable for cardiid phylogenetic reconstruction, and that (2) the D2 domain of the 28S gene is more reliable for resolving relationships within cardiid subclades (divergence times < 40 m.a.) than between them (divergence times > 40 m.a.).

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The phylogenetic position of *Doridoxa* (Gastropoda: Nudibranchia): a histological account

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The monophyletic order Nudibranchia is divided into two major clades, Ctenidiacea (Bathydoridoidea + Doridoidea) and Actenidiacea (Wägele, 1997, *Verhandl. Deutsch. Zool. Gesel.* 90(1):184). The enigmatic, doridiform genus *Doridoxa* was placed into the former due to synapomorphic possession of a caecum (Wägele, 1989, *Zeit. zool. Syst. Evol.* 27: 273-281). The absence of primary gills and lateral position of the anus, however, are unusual for Ctenidiacea and might suggest close relationship to the Actenidiacea. A specimen of *Doridoxa ingolfiana* Bergh, 1899, was serially sectioned and examined histologically. Major organ systems were reconstructed. Differences from Bergh's original description are the more elongated shape and the notum being anteriorly fused with the oral veil. The digestive gland has a holohepatic outline, but consists of numerous branches entering the stomach by three separate openings. The caecum of *Doridoxa* mentioned by Bergh (1899, *Nudibranchiate Gastropoder den Danske Ingolf-Expedition, Kjöbenhavn* 2(3):1-46, pls. 1-5) is shown to be an intestinal appendage. It is not homologous with the transformed right digestive gland of Ctenidiacea, therefore, no synapomorphy of *Doridoxa* + Ctenidiacea remains. Instead, the reduction of primary gills, the possession of compact jaws, and the fused cerebropleural ganglia of *Doridoxa* are regarded as synapomorphies shared with Actenidiacea as characterized by Wägele (1997). *Doridoxa* retains a blood gland, lost in all other Actenidiacea (see Wägele, 1989, 1997), and is, therefore, assumed to be their first offshoot. [poster]

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Red Listing for mollusks: a review of the data needs and the value as a tool for conservation

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The total of molluscan extinctions outnumber all vertebrate extinctions since 1600. Many of these occur as the result of the human interaction with the environment. In recognition of this, Red Data books and Red Lists were produced to draw attention to species of concern. These lists provide the non-specialist, especially those agencies responsible for conservation, with access to information so that they cannot say "we did not know that there was a problem." The 1996 Red list of Globally Threatened animals contained information on nearly 2000 species of molluscs. Of these, 45% were considered to be "High Risk," with a further 25% as Data Deficient. These molluscs were the first to be evaluated under the new criteria adopted in 1994, a process undertaken by over 125 scientists on a worldwide basis. This paper describes the problems which were highlighted in the use of the new criteria and the recent progress toward refining their use. Examples are given to show the types of data required to evaluate the Threatened status for Red Listing. The goals for the next two years are to: (1) attempt a more complete evaluation of geographical regions; (2) achieve better taxonomic coverage; and (3) encourage the involvement of more molluscan workers in the process of evaluation. The role of these lists in obtaining action for species conservation is also discussed.

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Implications for land snail faunas of the conversion of eastern African rainforest to commercial plantation

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We sampled mollusks in Kakamega Forest, western Kenya, to investigate the implications of conversion of indigenous rainforest to commercial forestry plantation. Using plot-based, standardized sampling consisting of fixed-time direct searching and fixed-volume litter sieving, we estimated diversity, abundance, and distribution of land snails in mixed indigenous rainforest and in monoculture plantations of three tree species. Replicate plots were sampled in two plantations each of the exotic (non-African) trees *Bischofia javanica* and *Pinus* spp., and the central African *Maesopsis eminii*, a natural component of the rainforest at Kakamega. The diversity and abundance of snails varied among the different sites. Diversity (species/plot and diversity index) and abundance (specimens/plot) were lowest in the *Pinus* plantation and highest in the indigenous forest. Snails were more abundant in *Maesopsis* than in *Bischofia*, but mean species/plot and total species number did not differ significantly. Generally, species abundance was more uniform in indigenous forest than in plantations which were characterized by a relatively small number of more dominant species. Several species were confined to the indigenous rainforest and may be unable to colonize new plantations. Only 2% of East Africa's land area is forest, but 70% of the region's land snails are forest-dependent, many having small geographical ranges. Forest is being depleted and 10% of the forest estate in Kenya has been converted to commercial plantations. The results of the study are considered in the light of these observations.

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Historical change in *Littorina obtusata* (L.) shell morphology in Maine (United States): from 3900 B. P. to 1997

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It is well known that the shell morphology of *Littorina obtusata* in the western Atlantic shows strong variation over space and time. We extend studies of this variation by comparing (1) sub-fossil and modern populations of *L. obtusata* in mid-coastal Maine, and (2) populations of *L. obtusata* in eastern Maine between 1984 and 1997. The sub-fossil populations from two archaeological sites, Nevin (39-3600 years B.P.) and the Basin (3800-2000 years B.P.), are tall and extremely thin-shelled compared to modern populations found at these sites. The morphology of *L. obtusata* and the abundance of a crab predator [*Carcinus meanas* (L.)] has fluctuated in recent years at sites in eastern Maine. Understanding the relationship between *L. obtusata* and *Carcinus* during the last 13 years in eastern Maine helps us interpret the unusual sub-fossil form of *L. obtusata* found in Maine shell middens.

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Autecological studies of *Vertigo angustior* Jeffreys and *V. geyeri* Lindholm in Wales, U. K.

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Vertigo angustior and *V. geyeri* are both classified in the British Red Data Books as RDB1, Endangered. Both species are also considered vulnerable throughout Europe and appear on Annex 2 of the EC Species and Habitats Directive. Threats of further decline in existing populations are due to habitat loss, especially drainage of wetlands. Monthly samples are being taken from two sites in Wales to gain valuable information about population dynamics. Fieldwork is concentrating on Whiteford Burrows NNR, Glamorgan (*V. angustior*) and Waun Eurad SSSI, Anglesey (*V. geyeri*). This monthly sampling will yield information about longevity of individuals and the age structure of the populations being studied. This monitoring is scheduled to continue until the end of 1999. Efforts are being made to determine the life cycles of both these species, particularly regarding reproductive biology. By using microdissection techniques, information can be gathered about fecundity. Future work is to include captive breeding experiments and further fieldwork to identify microhabitat requirements. The aim of this project is to provide recommendations for a practical monitoring strategy. This will be used to enable conservation agencies to fulfill their monitoring requirements under the UK Biodiversity Action Plan and EC Habitats and Species Directive. [poster]

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Quantitative analysis of morphology to determine developmental discontinuities in cephalopod life cycles

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Controversy over the validity of describing newly-hatched cephalopods as "larvae" prompted the introduction of the term "paralarva" to distinguish the planktonic, post-hatching phase of life of octopod and teuthoid cephalopods from older conspecifics. We examine the applicability of the concept of a "paralarva" to describe the post-hatching phase of life in an oceanic squid species. We use a novel analysis of discontinuities in developmental growth trajectories. Ten measurements of *Ctenopteryx sicula* external morphology were recorded and plotted against increasing dorsal mantle length (DML) to produce an ontogenetic growth trajectory. Discontinuities in growth trajectories were quantified via a piecewise regression analysis using a regression model that accounted for an unknown breakpoint. As required by the definition of a paralarva, differences in daytime and nighttime vertical distributions were used as an indicator of ontogenetic change in ecological niche. Morphological and ecological evidence shows that the concept of a paralarva, as it is presently defined, is valid for *C. sicula*. [poster]

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Epioblasma triquetra (Rafinesque) (Bivalvia: Unionidae) host fish revisited using PCR/RFLP analyses

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Experimental laboratory infections have shown that glochidia from the snuffbox mussel, *Epioblasma triquetra* (Rafinesque), can complete larval development on logperch, *Percina caprodes* (Rafinesque) hosts. However, little is known about the host-fish associations of this species in natural populations. Specimens of *P. caprodes*, and horneyhead chub, *Nocomis bigattatus* (Kirtland), collected from the upper Clinton River, Oakland County, Michigan, in 1993 had several glochidial infections assumed to be either *E. triquetra* or *Elliptio dilatata* (Rafinesque). These identifications were based on glochidial morphology. DNA was extracted from glochidial encystments and the ITS-1 region of nuclear rDNA was amplified and typed using a polymerase chain reaction/restriction fragment length polymorphism approach. Future development of these techniques can be used to quantify glochidial infections of target unionid species on field-collected fish.

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Morphological study of caenogastropod superfamilies as base for a phylogenetic revaluation

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The gastropod order Caenogastropoda comprises more than half of all molluscan species, includes species adapted to almost all environments and habits, and presents a great disparity of forms. In general, the order comprises the following superfamilies and suborders: Cerithioidea, Campaniloidea, Littorinoidea, Hydrobioidea, Xenophoroidea, Crepiduloidea, Hipponicoidea, Ctenoglossa, Stromboidea, Cypraeoidea, Naticoidea, Tonnoidea, Muricoidea, Cancellarioidea and Conoidea. Some authors also include the architaenioglossan families within caenogastropods. One to several representative species of each family of the above-mentioned taxa, as well as several archaeogastropods, heterobranchs, and taxa of other classes (outgroups) were selected for detailed, holistic morphological study. While each caenogastropod superfamily is studied, a phylogenetic analysis of its representatives is realized, with the objective (1) to test its monophyly, and (2) to search for its ground plan. To date, about half of the selected species have been analyzed, and phylogenetic trees of some superfamilies have been obtained. The morphological studies, the obtained trees, and the conclusions extracted from them are exposed to the scientific community. At the point when a phylogeny of each caenogastropod superfamily will be obtained, all data will be reunited with the intention of obtaining a phylogeny of the whole order. [poster]

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Reproduction in corbiculid clams in North America

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The Asiatic Clam, a (or perhaps several) species of *Corbicula*, has(have) been introduced into North America from Asia, often causing serious problems in industrial and domestic water supply systems. *Corbicula* also may be a threat to the survival of some native bivalves, as some anecdotal accounts suggest. Prior studies have not adequately accounted for the mode of reproduction of *Corbicula*, yet preliminary studies from our laboratory have shown that at least three widely separated North American populations of *Corbicula* are triploid, a condition that basically rules out sexual reproduction. The significance of parthenogenesis in the evolution and phylogeny of bivalved mollusks has been little studied. Studies are underway to determine (1) if diploid *Corbicula* have also been introduced into North America; (2) the true identity of our North American species of *Corbicula*, using comparative shell morphology and softpart anatomy; (3) the chromosome cycle in both diploid and triploid *Corbicula*; (4) how triploid *Corbicula* reproduce, including the function of sperm in a parthenogenetically reproducing animal; (5) what type of cell activity produces the presumably triploid sperm; and (6) the cause of the bi-flagellate sperm in triploid *Corbicula*. [poster]

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Shell variations and ecology of the Baikalian endemic gastropods

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More than 150 species of the gastropods are known in Baikal, 112 of which are endemic. Some endemics are distinguished by shell color. Littoral species have green-grey or brown shells, sublittoral species are light-brown, those living at a depths more than 80-100 m have light-yellow or transparent-pink shells. There are other shell adaptations to different sediments and depths: species living on stones in shallow depths (with wave currents) have large-aperture shells, or sculpture, or their shells have shouldered whorls. Shells of species inhabiting sand at the same depths are oval, smooth, or spherical. The spherical form may be attained at the cost of periostracal cilia on the lirae or broad last whorl. Shell form and sculpture of sublittoral populations (without wave currents) are very different and are connected to mode of live and, perhaps, to history of these species. Giant *Benedictia* species inhabit depths of 80-200 m. There are dwarfs among endemic gastropods living at very deep depths (< 300-1,380 m).
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Abnormal shells and frequency of chromosomal aberrations in the embryonic cells of *Benedictia baicalensis*, a Baikalain endemic mollusk

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It was early shown that frequency of chromosomal aberration in male cells of the testis of the Baikalian endemic gastropod *Benedictia baicalensis* (Gerstfeldt, 1859) collected from the area affected by waste waters of the Baikalsk Pulp and Paper Mill (BPPM) was 7 times greater (average over investigating years) than that in other regions of the Lake (Ostrovskaya, *et al.*, 1983). The occurrence of abnormal shells of this species in different regions of Baikal was investigated. Deformed shells have a longitudinal keel, distorted aperture, or abnormal growth of whorls. Mollusks with abnormal shells were not found in the littoral zone of areas without human settlement on the coast. We found "monsters" near the mouth of the River Tyya (1%), in the Bolshie Koty (1.7%) and predominantly (4.1%) in the area affected by waste waters of the BPPM. An experiment was carried out with the aim to account for chromosomal aberrations in cells of embryos obtained from *B. baicalensis* collected in Bolshie Koty Bay and in the area of pollution by BPPM. The gastropods collected were cultivated under the same, near-natural conditions. The frequency of chromosomal aberrations in the second group of embryos was significantly higher than in the first. We conclude that there is mutagenic activity of the pollutants, which shows itself at different ontogenetic stages.

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Communities the bivalves of the Chivyrkuisky Gulf of Lake Baikal

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Bivalves of the Chivyrkuisky Gulf, Lake Baikal, include 16 species or 52% of the common bivalves of Baikal. We studied: *Sphaerium baicalense, S. dybowskii, S. westerlundi, Pisidium baicalense, P. amnicum, Lacustrina dilatata, Henslowiana czerskii, H. semenkevitschi, Euglesa granum, E. minuta, E. korotnevi,* and *Conventus raddei*. The most preferred depths were 3.5-21 m. The bivalves form 7 communities, discussed according to increase in biomass. Community *C. raddei* is found in an external portion of the gulf, the most deep-water station including bivalves. Community *E. minuta* is found at the mouth of a depression on sand with silt. Community *E. granum* is found on open slopes of a hollow in internal portions of bays on black silt. This species is more stable against the influence of near-bottom currents and can consume larger suspended particles. Community *P. amnicum* is found near shore, under weak wave influences, on sandy bottoms with silt. Community *H. semenkevitchi* is associated with very fine, strongly silty sand. Community *S. baicalense* is found in external portions of the bays of the western coast and in deep waters of an internal portion. Community *S. dybowskii* is formed at sites with maximum flows of seston and finer particles of silty sand. The greatest average biomass and numbers were possessed by communities *S. baicalense* and *S. dybowskii* (1.88-2.14 g/m^2 and 283-192 individuals/m^2); the least were *C. raddei* and *E. minuta* (0.03-0.04 g/m^2 and 41-22 individuals/m^2). [poster]

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Not another little black snail

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The world has changed. 25 years ago, species were described mainly on gross morphological and shell characters and by what malacologists "felt" was different; nobody apart from other malacologists took any notice. Today many new species are based on cladistic studies and protein or DNA characters; the existence of these new species is acquired and used by environmental managers, conservation activists, threatened-species legislators, and many other non-malacologists. This paper signals the need for a malacological interpretation stage between the scientific description of species and the non-systematic end-users of those descriptions. Using the example of a revision of the hydrobiid genus *Beddomeia* in Tasmania, which added more than 30 new species to the faunal list, some of the problems of the end-users are detailed. Suggestions are then advanced of possible ways in which an informed malacological interpretation of these descriptions may be made. These include assessments of the needs of the end-users and the kinds of information needs in each case. Those responsible for identification of field samples need clear character descriptions, species differentiation, and keys. The environmental managers need assessment of genetic aggregation and legislators need criteria on which to base funding priorities and public awareness campaigns. All of these should be provided by malacologists.

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The scaphopod dataset: a new character and other data revisited

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There is plenty of room for refining scaphopod characters for phylogenetic studies. Only about 30% of the 600-odd species are studied for their radula and just about 15% for their anatomy. Attempts in filling these large gaps should yield an improved inventory of character states and character combinations. This contribution focuses on three character sets, each presenting a different way of refining our understanding of phylogenetic issues. First, as a new character, variation in scaphopod shell microstructure is presented with an evaluation of its systematic significance. Second, the set of radula characters concerning the rhachis and lateral teeth is redefined and recoded presenting alternative hypotheses on homology. Third, recent and systematically disjunct findings of a single pair of dorsoventral muscles in the Dentaliida (otherwise two pairs) force us to reconsider the likelihood of homoplastic evolution in some characters, ordered vs. unordered characters and possible or plausible ancestral states. Finally, phylogenetic reconstructions with different assumptions (character types, homology decisions, differential weighting) are compared. The monophyly of the two orders Dentaliida and Gadilida is well supported. It is hardly surprising that branching patterns for some families vary with the underlying assumptions. [Character Symposium]

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Lower Cretaceous bivalves and gastropods from the Agua Salada Formation, Lampazos Sequence, Sonora, Mexico

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An outcrop of Late Aptian time has been sampled for bivalves and gastropods in the Lampazos Sequence, which is situated in east-central Sonora, Mexico. The fossils have been collected near the small village Tepache from upper black shale beds of the Agua Salada Formation. In this area, the Agua Salada Formation transitionally overlies the older El Aliso Formation. It has developed in the lower part thick chert beds, which are rich in ammonites, while the upper part mainly consists of medium-gray to dark-black shale beds, which differ in resistance to erosion. The black shale is intercalated with light carbonate banks. An open shelf environment is supposed for the Agua Salada Formation. The massive black shale in the lower Upper Agua Salada Formation is partly rich in fossils. In this state of research, at least four different gastropod species can be recognized, which mainly belong to the Mesogastropod subclass. In addition, six different bivalve species have been observed. The shallow marine bivalve and gastropod paleofauna show similarities to the Lower Cretaceous of northeastern Texas, Arizona, and California.

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Spine formation in bivalve mollusks

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A number of varied hypotheses have, in the past, been put forward as to the function of pronounced shell ornament, such as spines, in bivalved mollusks. There appears, however, to be scant observations of the mechanisms of formation of such spines in highly ornamented taxa, such as the families Spondylidae and Chamidae. Personal observations on preserved material have shown that the spines are formed from differentiated areas of the outer secretory marginal fold of the mantle, here termed 'corpora spinosa.' In the Spondylidae, these extensions of tissue are constructed from a complex array of muscle fibers surrounding a central lumen or hemocoel. This hemocoel can be traced as an extension of the circumpallial artery and the suggestion is that the integrity of the corpora necessarily required to produce prominent spines is provided through turgidity by blood pressure from the circumpallial artery. The shape of the corpora is closely associated with a network of various sets of muscle fibers. During growth, the morphology of the corpora directly accounts for the shape of the resultant spines. The evidence presented shows that the circumpallial artery, in pectinoid bivalves at least, may influence the sculpture of the shell surface, and its morphology may even contribute to the formation of the marked radial ribs that are so characteristic of many pectinoid taxa.

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On the morphology and taxonomy of *Aylacostoma tenuilabris* (Reeve, 1860) (Gastropoda: Thiaridae) from Brazil

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Thiaridae includes species distributed throughout the tropical regions of the world. Among them are the Asiatic *Melanoides tuberculata* (Müller, 1774) and *Thiara granifera* (Lamarck, 1822) used in biological control programs as competitors of the snails intermediate hosts of *Schistosoma mansoni* Sambon, 1907. Based chiefly on shell characters, the taxonomy of Neotropical thiarids is very confused. As *Aylacostoma tenuilabris* (Reeve, 1860) is among the oldest specific names described to Brazil, morphological sudies were carried out on specimens collected by the authors at its type locality, Rio Tocantins, State of Goiás. Studies on shell, radula, and macro- and micoanatomy of the male and female reproductive systems were undertaken, resulting in the following diagnostic characters of this species: spiral lines at the base of the body whorl along the shell aperture; ovary with few branches, and saccular prostatic gland. [poster]

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A preliminary review of allozyme variation in the land snail *Holospira pedroana* (Gastropoda: Pulmonata) from central Mexico

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There are currently two recognized subspecies of the land snail *Holospira pedroana* (Urocoptidae) from the Cerro San Pedro region of San Luis Potosi in central Mexico. These two subspecies date from an earlier time period (1926 and 1953 respectively) when studies of land snails were based upon poorly known distributions and small morphological differences served as the basis for describing new species and subspecies. *H. p. pedroana* and *H. p. laevissima* are known to occur sympatrically and exhibit only minor differences in shell morphology. This study was undertaken to determine if this population of land snails does in fact represent two subspecies or just a single species which exhibits a wide range of morphological variation. Results based upon starch and polyacrylamide gel electrophoresis reveal a lack of enzymatic variation among the two morphological types. Comparison of additional populations of *Holospira* from both Texas and Mexico are reviewed.

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On inapplicable characters in molluscan systematics

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Analysis of molluscan phylogenetic relationships presents unique problems to systematists. Large scale trends of reduction and loss across the Gastropoda, as well as in many clades within the Gastropoda, reflect modifications to small size or unique life modes. Consequently, systematists are often confronted with the problem of coding inapplicable characters; coding the various expressions of a feature when it is absent in some taxa. Traditionally, inapplicable characters have been denoted with question marks. However, it is well documented that the analysis of question marks can result in persistent arbitrary resolutions and that the optimization of inapplicables as missing can support suboptimal topologies. This has contributed to the view that such analytical problems should be circumvented through character recoding. Several coding schemes have been suggested as appropriate alternatives. Most commonly, traditional coding has been discarded in favor of composite (multistate) coding, and absence coding (replacing question marks with absence states). However, analysis of a hypothetical data matrix reveals that coding absence in a multistate character renders absence informative in determining the phylogenetic placement of taxa characterized by "absence" relative to other taxa. The influence of these coding methods was explored on a data set for cocculinid gastropods. Choice of coding method significantly affected the phylogenetic placement of several pivotal basal taxa. This example highlights the fact that character coding carries important implications for phylogeny, taxonomy and character evolution. [Character Symposium]

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Miocene Pupilloidea (Gastropoda: Pulmonata) from Belchatów (Central Poland) against a background of paleobotanical data and their biostratigraphical significance

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Fossil snails may approximately display the conditions under which shell-bearing deposits were laid down. Ecological requirements of living pupilloid snails, particularly of the groups extinct nowadays in Europe and found in Belchatów (*Gastrocopta, Strobilops*, and *Negulus*), as well as paleobotanical data, have been used as a basis for inferring the habitat which existed in central Poland over a dozen million years ago. Pupilloid snails from three horizons (Bel-C, Bel-B and Bel-A) of the Belchatów profile display a relatively long period correlated with the biozones MN4-MN9, in which the malacofauna was undergoing changes. The lowermost seam with fauna (Bel-C) contains only a few species of *Gastrocopta, Strobilops*, and *Vertigo*. The composition of the flora with a prevalence of *Rhus* and *Engelhardtia* indicates a warm humid subtropical or even paratropical climate in the Lower Miocene. The middle seam (Bel-B) contains the most diversified fauna with particularly numerous species of *Gastrocopta* and *Strobilops*, as well as *Negulus, Acanthinula, Vallonia,* and *Argna*. The main vegetative complex is represented by Taxodiaceae-Cupressaceae forests with an admixture of *Nyssa* and *Alnus*, whereas the facies of drier habitats are more differentiated and represent more types of forests with a prevalence of *Pinus*. The upper seam (Bel-A) includes pupilloid species unknown from the older horizons (*e. g., Vertigo oecsensis*). The floristic composition is characterized by a small admixture of Tertiary elements, but their presence determines the flora as being still of Neogene age.

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Euomphaloidean survivor, extreme trochoidean, or something else? A new discoidal gastropod from the Tethyan Jurassic

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Traditionally, Mesozoic discoidal gastropods are classified within Euomphaloidea but as a result of some recent investigations, also concerning shell structure, Euomphaloidea has been regarded as becoming extinct in the Late Palaeozoic or perhaps the Triassic. Most of the Mesozoic discoidal gastropods have been proposed as accomodated in various superfamilies which are not closely related to each other (*e. g.*, Architectonicoidea, Trochoidea). During revision of a Sinemurian fauna, collected from condensed, red, nodular, ammonitic limestone beds (typical "Ammonitico Rosso") of Tethyan origin, a shelly discoidal gastropod was found. Amongst the cooccurring fossils, thousands of ammonites, some trochid and eucycloidean gastropods, originally having aragonitic shells, occurred exclusively as steinkerns. The crinoid ossicles preserved their original calcitic material, and the discoidal gastropod seemed to have done this as well. This find provides an occasion to again think about the phylogeny and classification of a morphologically related group, providing characteristic components of (especially the Tethyan) Triassic and Jurassic faunas. Some thoughts will be offered in answer to the questions: do they belong to extinct group(s) or are they related to taxa which have living members?

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Departures from HWE and gene flow in the spring snail *Bythinella*

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Bythinella are minute hydrobiids inhabiting springs and subterranean waters. Population genetic structure of the genus was studied in 20 central European populations. Eight enzyme systems represented by 9 loci (6 of them polymorphic) were analyzed using cellulose acetate electrophoresis. HWE, F-statistics, theta, and Nm were calculated using GENEPOP and FSTAT. In most of the populations, significant departures from HWE were found, mostly caused by heterozygote deficiency. There was no correlation between f for different loci, and between f and population size score. This suggests that the observed departures from HWE were due not to inbreeding but to other factors, like the negative selective value of heterozygotes in juveniles or differential selection in time-scale leading to the Wahlund effect. Compared with the literature, theta was higher than usually recorded in freshwater gastropods. In several cases Nm pairwise estimates were inconsistent with biological reality and support neither the isolation by distance model nor infinite island one. The main factors responsible for the observed pattern of interpopulation differentiation were probably local differential selection, genetic sampling process at establishing a new population, genetic drift, and mutations. Despite the short time scale, the observed heterozygote deficiencies in particular loci may indicate a relatively high mutation rate in these loci, with mutations leading to the loss of enzyme activity in a locus.

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Effect of ^{60}Co gamma radiation on *Biomphalaria tenagophila* (Orbigny, 1835)

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Biomphalaria tenagophila, a freshwater snail (Planorbidae), is a vector of schistosomiasis. Ionizing radiation may induce some alterations on the development of the snails such as mortality, growth, fecundity, and fertility. Mature *B. tenagophila* was irradiated with ^{60}Co at doses 50, 70, 90, and 110 Gy. Those snails were mantained in self-fertilization and cross-fertilization conditions. The goal of this project was to verify that the radiation affects the snails in self-fertilization and cross-fertilization conditions at the same level. The following parameters were analyzed to compare the results: mortality, growth, fertility, and fecundity. The mortality in the cross-fertilization group was higher than in the self-fertilization group. The LD_{50} was 70 Gy in the self-fertilization group and 90 Gy in the cross-fertilization group. The fecundity (egg masses/day) and fertility (hatching) were higher in the self-fertilization group. These results showed that the self-fertilization group was more resistant than the cross-fertilization group when submitted to the same radiation doses. [Supported by FAPESP].

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Bivalves with concrete overcoats: *Granicorium* and *Samarangia*

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Two rare and unusual venerid bivalves, *Granicorium indutum* (Hedley) and *Samarangia quadrangularis* (Adams & Reeve) from the Indo-Pacific, encrust their shells with a thick, hard layer of sand which may be thicker than the smooth and glossy true shell. In *Granicorium*, the sand layer is constructed at the shell margin on the outside of the periostracum and comprises sand grains bound by an aragonitic cement, very similar in form to marine inorganic cements such as that of beachrock. The sand grains are held initially in thick mucus secreted by the mobile middle and inner mantle folds. This mucus contains an abundant bacterial flora as well as small growing crystals of calcium carbonate. Our hypothesis is that the biofilm enhances crystal growth allowing rapid cementation of the sediment grains held by the mucus. Crystal growth of the cement proceeds forming a rigid "concrete overcoat," which may continue to harden throughout the life of the animal. The function of the sand layer is untested but protection against predators and/or endobionts is the strongest possibility. *Samarangia* has a similar sand layer but formed into a pseudosculpture of radial ribs and blunt spines. Diverse calcified and arenaceous extra-periostracal structures have been described from several bivalve families but thick, cemented sand encrustations have so far been found only in *Granicorium* and *Samarangia*. Although these two genera have been placed in two different subfamilies of Veneridae, shared characters suggest a close relationship.

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Checklist of *Pomacea* (Gastropoda: Pilidae) recorded to South America with morphological remarks on some species

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Pilids are amphibious freshwater snails distributed throughout the tropical regions in the world. Besides *Pomacea* Perry, 1810, three genera, *Asolene* Orbigny, 1837, *Felipponea* Dall, 1919, and *Marisa* Gray, 1824, occur in Brazil. The genus *Pomacea* includes the largest neotropical freshwater snails and ranges from northern to southern Brazil. In spite of abundance and wide distribution, the taxonomy of the group, based chiefly on highly variable shell characters, is still confused with more than fifty specific names recorded to Brazil. Studies on the shell, radula, pallial complex, macro- and microanatomy of male and female reproductive systems aiming toward taxonomic revision of this genus have been done by the author based on specimens collected at type localities. A checklist of nominal species of *Pomacea* originally described to Brazil as well as morphological data of *P. canaliculata* (Lamarck, 1801), *P. lineata* (Spix, 1827), *P. glauca* (Linné), *P. sordida* (Swainson, 1823), and *P. scalaris* (Orbigny, 1835) are given. [poster]

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Heterobranch relationships from a 16S rRNA viewpoint

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The phylogenetic relationships of some heterobranch taxa are analyzed using data from the mitochondrial large subunit (16S) rRNA gene. Despite the common notion that this is too variable to provide any information at this "high taxonomic level," several clades have substantial bootstrap proportions. Although it is necessary to exclude some of the more variable regions as these vary to much in length to be confidently aligned, the remaining (less variable, more conserved) regions seem to contain variation for 16S data to be useful in this context. We specifically aim to explore relationships among "opisthobranch" taxa and lower heterobranchs such as relationships between nudibranch subtaxa and the position and relationships of pyramidellids. The sequences were analyzed using both parsimony and distance methods, and different methods gave a consistent result concerning clades with substantial bootstrap support. Additionally, an inferred exclusion of a part of a highly conserved helix appears to be an apomorphy for Euthyneura. Some results are a support for the division of nudibranchs into two taxa (Anthobranchia and Cladobranchia), that pyramidellids are euthyneurans, and that *Acteon* is sister group to a clade comprising remaining "opisthobranchs" and pulmonates in the study, rather than being included among "opisthobranchs." [poster]

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The role of mollusks in influencing stability and species diversity of freshwater ecosystems subjected to nutrient and pesticide loading

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There is evidence that eutrophication of shallow freshwater bodies is followed by the rapid demise of submersed macrophytes and a reduction in the species diversity of the invertebrate and fish communities. However, as the effects of concomitant pesticide loading is often ignored, it is therefore necessary to consider the effects of these two major perturbations separately to unravel the underlying causative mechanisms. To achieve this, a series of experiments using cylindrical plastic enclosures were set up in drainage channels in Sussex, U. K., to elucidate the effects of nutrient loading, a reduction in snail numbers, and an increase in snail predator densities. The results may be summarized as follows: (1) nutrient loading resulted in the dominance of phytoplankton, epiphyton, zooplankton, or floating plants; (2) reduced snail densities caused increased periphyton densities and a decline in phytoplankton and submersed macrophyte biomass; (3) increased snail predator densities caused a decline in zooplankton densities, changes in phytoplankton composition - snail densities declined initially, but were not significantly different from the controls by the end of the experiment. The mechanisms responsible for these effects will be considered and their relevance to conservation and the control of the snail hosts of schistosomiasis discussed.

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Polyphyletic origin of the agglutinating habit in cerithioid gastropods

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In gastropods, agglutination is restricted to a small number of living and fossil taxa, such as Xenophoridae. The habit was independently evolved in several clades through the Phanerozoic. Three other extant families are known to contain agglutinating taxa: Modulidae, Scaliolidae, and Turritellidae (all Cerithioidea: Caenogastropoda). The Modulidae contains two genera: *Modulus* and the sand-agglutinating *Psammodulus*. The latter diminutive (< 4 mm), extinct taxon is widespread and sometimes abundant in the Mio-Pliocene of the Caribbean. Continuing research shows the Scaliolidae to comprise a larger and morphologically more varied clade than previously thought, also including primitive non-agglutinating taxa. These were centered on western Europe in the Early-Mid Eocene, undergoing two principal radiations in the Late Eocene-Early Oligocene and post-Miocene respectively. Until recently, agglutination in turritellids was known only from *Springvaleia*, of the Caribbean Mio-Pliocene, which attached densely-packed large clasts throughout its ontogeny. Recently an unnamed clade of silt clast-agglutinating turritellids has been discovered occurring in the Miocene-Recent of Central America, with an unexpected species recorded living off of Venezuela. In this group agglutination is restricted to the early teleoconch whorls. Plausibly, the agglutinating habit may be interpreted as providing tactile or visual camouflage from predators. We might ask whether the above cerithioid families have anatomical or behavioral adaptations which may have facilitated its acquisition. [poster]

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Fossil and living *Turbo* (Vetigastropoda: Turbinidae) from Japan and adjacent regions

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As the result of systematic survey of the living and fossil species of the genus *Turbo* from Japan and adjacent regions, we recognized 15 species distributed among 5 subgenera including 7 fossil species distributed among 3 subgenera. Fossil taxa were obtained from two different stratigraphic levels in the Neogene of Japan and Formosa, *i. e.*, four species of *Turbo (Marmarostoma)* are found in the Lower Middle Miocene (*ca.* 16 Ma) and each one species of *Turbo (Marmarostoma), Turbo (Lunatica),* and *Turbo (Batillus)* in the uppermost Miocene (*ca.* 6-5 Ma). Living taxa of *Turbo (Turbo), Turbo (Marmarostoma), Turbo (Lunatica),* and *Turbo (Batillus)* first appeared in the Upper Pliocene (*ca.* 2 Ma) of Japan and Formosa. *Turbo* species are essentially warm-water elements for the Japanese molluscan fauna and these fossil occurrences indicate that a warm ocean current (the Kuroshio Current) strongly flowed along the Pacific coast of Japan, at the time of the Early Middle Miocene, the Late Miocene to Early Pliocene, and the Late Pliocene. In this paper we also discuss the phylogenetic relationships among fossil and living species of the genus *Turbo* on the basis of the fossil records and morphological comparison. [poster]

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Studies of daily vertical movement of *Nautilus pompilius* by Sr/Ca ratios

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Strontium contents in the biogenic calcium of *Nautilus* shells were examined to determine whether they record daily vertical migrations. Previous studies have used magnesium and strontium contents in the biogenic calcium carbonate of several organisms, *e. g.*, corals, foraminiferans, and ostracods, to estimate past seawater temperature. Specimens of *N. pompilius* used in this study were collected in the Phillipines and specimens cultured under constant water temperature were also used. The strontium/calcium ratios in the *Nautilus* shells were measured every 5 μm on each septum with an Electron Probe Micro Analyzer. The Sr/Ca ratios in the shells were highly variable. There were many peaks in the Sr/Ca ratios within each septum. The captured specimens showed clear fluctuations in the values of Sr/Ca ratios, but the cultured specimens did not. This implies that the fluctuations in Sr/Ca ratios correspond to changes in water temperature induced by vertical movements of *Nautilus*. This suggests that the variation in seawater temperature and the daily vertical movement of *Nautilus* are recorded in the shells. [poster]

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Sperm competition or use of allosperm in the freshwater hermaphrodite snail *Biomphalaria glabrata* (Say, 1818)?

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The pulmonate gastropod *Biomphalaria glabrata* (Say, 1818), an intermediate host of *Schistosoma mansoni*, is a simultaneous hermaphrodite. Female-acting albino *B. glabrata* paired with homozygous pigmented conspecifics immediately switch from using allosperm to autosperm. When paired with both albino and pigmented conspecifics, the albino female actors are reported to use the pigmented allosperm, regardless of the order of pairing. It has been suggested elsewhere that sperm competition might be responsible for this excess, particularly as pigmented sperm are longer than albino sperm. An alternative hypothesis could be that preferential use of allosperm, *i. e.,* donated sperm (pigmented or albino), rather than sperm competition between the albino and pigmented sperm is a selecting factor. To test this hypothesis, female-acting homozygous albino *B. glabrata* were initially paired with homozygous pigmented, and then paired with homozygous albino, conspecifics. Instead of producing only heterozygous embryos, which would be expected if sperm competition was favoring pigmented sperm, the twice-mated albinos produced similar numbers of albino and heterozygous offspring. This suggests that allosperm from both the albino and pigmented partners was being used rather than just pigmented allosperm. We infer from these results that preferential use of allosperm as opposed to sperm competition is probably the mode of sperm selection.

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Preliminary results on distribution of some opisthobranchs at Laing Island (Madang Province, Papua New-Guinea)

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During July and August 1996, we collected and examined more than 190 specimens of opisthobranchs belonging to more than 24 species in Laing Island (north of Papua New-Guinea). The study zone is located in Hansa Bay (Madang Province) on the northern coast of Papua New Guinea. Laing Island is a low coral formation (850 m long, 150 m wide), and is the only emerged portion of a reef string aligned along a north-south axis in Hansa Bay. Here we present the preliminary distribution of the species found at the island with descriptions of external morphologies and sampling substrates. [poster]

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Gastropod phylogeny inferred from mitochondrial genomic structure

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Metazoan mitochondrial DNA (mtDNA) is a closed-circular molecule encoding for 37 genes. Although mitochondrial gene arrangements are generally conserved in eucoelomate animals, gastropod mtDNAs show unusual variability in the gene orders. Euthyneuran gastropods have very similar mtDNA genome, but their gene arrangements are radically different from those of a vetigastropod, *Nordotis*. Such a high level of variability of mtDNA gene arrangements provides an excellent molecular marker for reconstructing gastropod phylogeny, because identical gene arrangements would likely be shared only as a result of common ancestry. Unfortunately, available data on gastropod mtDNA genome is restricted to some limited members of taxa and much more data on various gastropods is needed. We have performed a systematic examination of gastropod mtDNA genomic structure and surveyed a wide range of higher taxa including Patellogastropoda, Vetigastropoda, Neritomorpha, Cocculiniformia, Architaenioglossa, Cerithioidea, Campaniloidea, some "higher Neotaenioglossa," Neogastopoda, Ptenoglossa, Heterostropha (Valvatoidea, Omalogyroidea, and Pyramidelloidea), Opisthobranchia, and Pulmonata. Based on a cladistic analysis of mtDNA gene arrangements, we could reconstruct a gastropod phylogeny which is largely consistent with current morphological data. Molecular evolution of gastropod mtDNA genome and its systematic significance will be discussed. [Character Symposium]

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Annual larval variability and growth under culture conditions of five bivalve species from the Colombian Caribbean (*Pinna carnea, Pinctada imbricata, Pteria colymbus, Argopecten nucleus,* and *Nodipecten nodosus*)

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Annual larval variability and growth of bivalve species from the Colombian Caribbean were studied to evaluate their potential for aquaculture purposes. Between March 1994 and September 1997, mean monthly abundances of larvae/m^3 and postlarvae/spat-collector were estimated. Abundance was compared with temperature and salinity cycles (Spearman correlation). Temperature and salinity exhibit opposite trends. Between May and July, temperature increases (38°C) while salinity decreases; in September/ November temperature starts decreasing again (36°C). In many cases the recruitment of the five species studied was related to temperature and salinity cycle as high abundance was observed during periods of high temperature. The Spearman correlation matrix gave highest values for: *Pinna carnea*, larvae/temperature = -0.364; *Pinctada imbricata*, larvae/ salinity = 0.397; *Pteria colymbus*, larvae/temperature = -0.379; *Nodipecten nodosus*, postlarvae/temperature = -0.463. Growth of juveniles in suspended systems was estimated with the ELEFAN method using length-frequency data and with the Simplex Algorithm applied to the von Bertalanffy growth model and age-length data (estimating the absolute age of the cohort with data from the spat collectors). The following growth results were obtained: *Nodipecten nodosus*, ELEFAN: L_∞ = 135 mm, K = 1.2/year, C = 0.6, SIMPLEX: L_∞ = 135 mm, K = 0.858/year, t_0 = 0.220/ year; *Pteria colymbus*, ELEFAN: L_∞ = 95 mm, K = 0.9/year, C = 0.7, SIMPLEX: L_∞ = 95 mm, K = 0.868/year, t_0 = 0.371/year. [poster]

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Pleistocene climatic effects on the evolution of Galapagos land snails

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Palynological data shows that the late Pleistocene climate of the Galapagos Islands was drier than today; the last dry period ended 10,000 years ago. The Galapagos flora was greatly affected. The unusual distribution patterns of the genus *Naesiotus* (Pulmonata: Orthalicidae) may also be attributed to climatic effects: the south-central islands are richer than expected in species and closely related species clusters, the northern islands, poorer. The diminutive land snail species exhibit a distribution closer to the expectation; the difference may be attributed to their greater dispersal capacities. Hitherto undescribed patterns of variation and distribution in Galapagos finches are consistent with these assumptions. Traditional explanations such as the geological age of the islands, their distance from the continent, area, elevation, and ecological diversity correlated with area, isolation, and position in the archipelago, on the other hand, appear as improbable alternatives.

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Radular loss in the evolution of dorid nudibranchs: a phylogenetic hypothesis of the Porostomata

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Porostomata is a controversial group created to unite Dendrodoridídae and Phyllidiidae, the two families of radula-less dorid nudibranchs. Several authors, based on the distinct gill morphology of phyllidiids, questioned the monophyly of the Porostomata. Different origins for phyllidiids have been suggested, all of them implying that radula has been lost twice independently in dorid evolution. The present paper attempts to test whether the Porostomata is a monophyletic group, using an array of characters and taxa. The external morphology and anatomy of the type species of all the genera involved and additional representatives have been carefully examined, using in many cases the critical-point technique for scanning electron microscopy. A database was generated, including 31 taxa of porostomids, and other 5 cryptobranch and phanerobranch genera for comparative proposes. Fifty-two informative characters were considered, polarized with *Bathydoris* as the outgroup. A single consensus tree was produced. It shows that Porostomata is a monophyletic group, supported by several apomorphies. An unnamed species from South Africa, provisionally assigned to *Doriopsilla,* is the sister group of the rest of the taxa involved, and therefore is regarded as a distinct new genus. *Dendrodoris, Doriopsilla*, and phyllidiids are three independent monophyletic clades. There is little resolution within phyllidiids. With this scenario a new classification should be proposed for these taxa. The families Dendrodoridídae and Phyllidiidae are regarded as synonyms, with Phyllidiidae being the older valid name.

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Environmental technology for management of fluvial ecosystems containing threatened large mussels

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Rivers form a multifacial ecosystem with great species diversity. River constructions have caused disparition of fluvial ecosystems in the natural state in Finland. Many extensive projects have been realized to restore treated river sections. This must be realized quickly, because populations of freshwater pearl mussels *Margaritifera margaritifera* (L.) and *Unio crassus* (Philipsson) have been strongly reduced or eliminated. The generally accessible information on river restoration is held by rare expert-sides. However, restoration wrongly realized can cause irreparable damage to endangered species. Another problem is caused by conflicts of interest between the needs of leisure and ecology. Rivers will be restored using the so-called "soft restoration technique," a Finnish invention. Rivers will be protected against shortage of water due to utilization and regulation by using embankments. Populations of endangered pearl mussel species will be revived by re-establishment and by cultivating local brown trout populations. Reproduction of the pearl mussels will be assisted by assuring that larval fixation to brown trout (hosts) are solid, and by installing fish in adequate emplacements in the river. Also, diversity of the river bottom will be recreated using boulders and cobbles, removing silt, and adding gravel beds for spawning. Trees shielding the river will be cared for. Conflicts of interest between ecology and leisure will be diminished by guiding fishing and trekking to sites where they do the least harm to the environment. In implanting fishes, the choice of species and number of populations will be the best possible.

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Speciation through space and time: phylogeny of a clausiliid genus in the Aegean area based on ITS sequences (rDNA)

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Albinaria (Gastropoda: Clausiliidae) is an extremely speciose genus occuring in the Aegean area. On nearly all islands in the Aegean Sea, one or more *Albinaria* species are present. Although species are conchologically distinguishable, we cannot use these morphological characters to reconstruct phylogeny. It is unknown whether the distribution of the genus took place before or after the rise of sea level with the subsequent formation of the islands. To investigate the historical relationships within the genus we analyzed over 40 species. Their ITS1 and ITS2 of rDNA were sequenced and aligned. The sequences were rather variable and large regions could not be aligned unambigiously. We used both spacers combined and seperately and corrected for a TS/TV bias. The resulting tree will be shown and we will look for correlations with paleogeographic data and morphological traits.

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Genetic characterization of peripheral isolated populations of *Isognomostoma isognomostoma* in Belgium (Pulmonata: Hygromiidae)

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Isognomostoma isognomostoma is a hermaphroditic land snail whose distribution is confined to the mountainous regions of central Europe. The species also occurs in Belgium in a small, isolated, peripheral area, where it was recorded for the first time in 1970. Peripheral and isolated populations (PIPs) are of particular interest in evolutionary and conservation biology. Because PIPs are often strongly affected by genetic drift and inbreeding, and may be subject to increased selection pressures near the edges of a species range. Therefore, PIPs may be prone to 'genetic revolutions' leading to speciation. However, genetic drift and inbreeding will usually result in genetic erosion, so that PIPs may be vulnerable and threathened to extinction. Hence in view of their importance as possible source for generating biodiversity, it is necessary to identify and protect PIPs with an independent evolutionary potential. This has been emphasized more generally by the IUCN and the 'Convention on Biological Diversity,' which both recognize the need to protect intraspecific genetic variation. Using morphometric and allozyme data we aimed at determining whether and to what degree the Belgian *I. isognomostoma* population is differentiated from the populations elsewhere in Europe and thus may represent an 'Evolutionarily Significant Unit' (ESU). Similarly, these data allow an assessment of the genetic impoverishment that may have occurred in Belgian *I. isognomostoma*. [poster]

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Genetic divergence between populations of *Leptaxis azorica* in the Azores and the implications for conservation (Pulmonata: Hygromiidae)

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Leptaxis azorica is an Azorean representative of the subfamily Leptaxinae, endemic for the Macaronesian archipelagos (Azores, Madeira, Cape Verde, and Canarian Islands). This endangered, hermaphroditic land snail was described as different subspecies from the islands Santa Maria (*L. a. minor*) and São Miguel (*L. a. azorica*), which are separated by a distance of approximately 50 km. The nominal subspecies, however, was also described from the island of Flores, more then 500 km away, with no populations described from the islands in between. To clarify the relationships between these populations, we conducted a population genetic analysis based on allozyme electrophoresis and morphometeric data of the shell and the genital tract. Our results suggest that *L. azorica* is in fact a complex of different species or may consist of four supposedly "Evolutionarily Significant Units" (ESUs), and the differentiation between the two subspecies is so large that they are probably to be considered as separate species. Within *L. a. azorica*, there is not only a clear distinction between the populations from the islands of Flores and São Miguel, but also between the populations from east and west. This is consistent with the geological history of São Miguel. When aiming at protecting a maximum amount of genetic variation, these ESUs should be considered as units for conservation. Yet, futher work based on mtDNA markers is needed to confirm the ESU status of the populations studied here. [poster]

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Molecular approaches to the study of "dermo" (*Perkinsus marinus*) disease in the eastern oyster *Crassostrea virginica*

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Despite improvement in growing techniques for marine mollusks, there is a need to address problems related to disease diagnosis, prevention, and remediation, and those associated with shellfish as vectors of disease. Mass mortalities due to protistan infections such as "dermo" (*Perkinsus marinus*) have caused critical population reductions and impaired oyster production. *In vitro* culture of *P. marinus* has enabled application of molecular technologies to the detection, identification, and enumeration of this parasite. We developed a PCR-based assay for *P. marinus* selecting an intergenic, non-transcribed spacer between the 5S and small subunit rRNA genes as the target sequence. The assay is species-specific and can detect a single *P. marinus* trophozoite in 30 mg of oyster tissue. We have also applied molecular approaches to *P. marinus* virulence factors. The antimicrobial activity of oyster phagocytes is dependent on the oxidative burst and lysozomal degradation of the engulfed particle. Phagocytosis of *P. marinus*, however, fails to produce measurable chemiluminescence in hemocytes. We examined factors that regulate the transcriptional expression of two superoxide dismutase genes, providing evidence that iron starvation and exposure to host serum can induce the predominant iron-dependent superoxide dismutase. The differential expression of a unique actin gene was also characterized, against the backdrop of the protein phosphatase 1 gene, which is constitutively expressed. These studies will contribute to understanding *P. marinus* intracellular survival mechanisms and the factors regulating life cycle transformations. [Supported by DOC/NOAA grants NA46RG0091, NA57FL0041, and NA90AA-D-SG063]. [Human Symposium]

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Unusual incirrate octopods from the South Shetland Islands, Antarctica

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Among the many octopods collected during an Antarctic trawling survey were several species that are not members of the common Antarctic subfamily Pareledoninae. All are either poorly known or new to science, so we describe their morphology and anatomy. Thirty-nine specimens of a *Benthoctopus* species are similar to *B. levis* (Hoyle), but differ from it in arm length, web depth, and details of the hectocotylus. A single *Graneledone antarctica* Voss is unusual because it is the largest reported specimen (104 mm dorsal mantle length, DML) and the first mature female. The 9 *Thaumeledone cf. brevis* (Hoyle) were collected across a great range of depths. They include mature males and females and allow us to redescribe the species and to discuss variability within it. Six *Bentheledone* from a single deep (3,213 m) sample may be *B. albida* (Berry), until now known only from the holotype. They are characterized by a small calamus and tiny anterior salivary glands. A very small (23 mm DML) mature female of a fragile dark purple species without an ink sac has suckers in a single series and proportionally huge salivary glands. We consider it to be a new genus and species in the subfamily Bentheledoninae.

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Give us time: integrating the study of living mollusks with history

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Research on living mollusks has often proceeded independently of that on fossils. This is neither necessary nor desirable. With their excellent fossil record, mollusks provide unparalleled opportunities to add the dimension of time to the study of systematics, biogeography, and adaptation. I give examples of studies on muricid, buccinid, and pseudolivid gastropods in which knowledge of the living species alone would have led to serious misinterpretations of biogeography, evolution, and adaptation. I discuss patterns of diversification, adaptation, and geographical restriction that could not have been inferred without fossils. Conversely, I cite molecular and anatomical result for muricids that significantly inform and enrich conclusions founded on fossils. [Bridging Symposium]

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Sepia-collagen provides a useful substratum for the long-term cultivation of embryonic systemic hearts of the cephalopod *Sepia officinalis* L.

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To cultivate embryonic *Sepia* hearts, tissue culture procedures for vertebrate cells were adopted to conform to the marine environment. The main modifications employed were: (1) adjusting the osmolarity of the medium to 1000 mOsm/kg, (2) using an ionic environment similar to that of the *Sepia* hemolymph, (3) lowering the incubation temperature to 20°C, and (4) using *Sepia*-collagen as substratum. The medium consisted of 78 ml Dulbeccos MEM, 20 ml FCS, 1 ml Antibiotic-Mix (100x), and 1 ml L-Glutamine (100x). The medium contained 460 mM NaCl, 10 mM KCl, 10 mM $CaCl_2$, 50 mM $MgCl_2$, and 20 mM HEPES. The pH was adjusted to 7.4. *Sepia* collagen was isolated from the mantle muscle according to Kimura *et al.* (*J. Biol. Chem.* 256, 24: 13230-13234; 1981). The collagen substratum was prepared according to Elsdale & Bard (*J. Cell Biol.* 54: 626-637; 1972). TEM analysis of the collagen substratum revealed a three dimensional network of collagen fibrils which showed a banding pattern of 67+2 nm. Embryonic *Sepia* hearts cultured on this substratum survived for 60-70 days. Rhythmical contractions were observed throughout. SEM analysis showed that prolific outgrowing fibroblast-like cells from the explants margins attach to the collagen-fibrils. The proliferation of these cells lead to a continuous spreading of the explants and muscle cells, round cells and spindle shaped cells could be observed. TEM analysis revealed mitosis and cell differentiation processes for several weeks. [Supported by the Deutsche Forschungsgemeinschaft Schi 99/7-2; Schi 99/7-4].

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Prey swimming behavior affects feeding selectivity in hatchling squid

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We analyzed the factors affecting selective feeding of laboratory-reared *Loligo opalescens* hatchlings on copepods. The encounter rate with prey, number of attack attempts, and successful captures were estimated. The importance of prey size and swimming patterns in determining attack rate and the importance of escape behavior in determining capture rate were examined. Adult *Acartia* copepods are relatively small (0.8-1.2 mm), white, and their swimming pattern is characterized by a burst of speed resembling jumping. Due to this, the encounter rate with hatchlings is increased, resulting in more attacks. But, with their jumping escape response, they are able to move out of the hatchlings' field of vision and avoid capture. Pontellid copepods (*Anomalocera ornata, Labidocera*, and *Pontella*) are larger, darker, and have a different swimming pattern. They quickly swim forward within the hatchlings' field of vision, enabling more attacks and captures. The size, visibility, and escape response of these copepods may favor their capture by hatchlings. Even though the encounter was higher on *Acartia*, the capture rate was much lower. Successful capture increased with age and experience. Our preliminary results indicate that copepod swimming patterns may play an important role in the feeding selectivity of hatchling squid. [Funded by grant RR04226-09 from National Institute of Health, National Center for Research Resources and the Marine Medicine budget of the Marine Biomedical Institute; E. Vidal currently supported by fellowship from Brazilian National Research Council (CAPES)].

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Laboratory study of reproduction in *Ostrea corteziensis*

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A laboratory study was carried out in Panama Bay, Panama, in 1997, to assess the relationship of morphometry and reproduction in *Ostrea corteziensis* to seasonal changes in temperature and phytoplankton densities. One of two large aquaria was maintained at 20°C (high phytoplankton densities), and the other was maintained at 28°C (low phytoplankton densities) (these temperatures were those observed in the field in Panama during the dry and wet seasons, respectively). Water temperature was maintained with a recirculating bath. Temperature of the water was measured with a salinity-temperature probe meter (YSI). Phytoplankton densities were recorded by direct count using a compound light microscope and a hemocytometer. The laboratory study showed that *O. cortesiensis* did not increase significantly in total weight, shell height, and shell length by 30 days in dry and wet season conditions. However, a significant spawning and fertilization process was observed in animals at 20°C and high phytoplankton densities, compared to those mantained at 28°C and low phytoplankton densities.

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Biological investigations of the genus *Graneledone* from abyssal and bathyal depths of the North Pacific Ocean

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Increasing our understanding of the diversity and distribution of benthic octopuses in the deep sea requires that we gain more information about the animals' biology and collect detailed morphological data to allow us to better distinguish cryptic taxa. Members of the octopodid genus *Graneledone* occur at abyssal and bathyal depths in many of the world's oceans. Members of the genus share conspicuously warty skin on the dorsal mantle, few gill lamellae, and a limited number of suckers that usually occupy a single row; they lack the ink sac and crop. The skin and sucker characters allow individuals of *Graneledone* to be identified to genus in videotapes filmed by submersibles. These observations increase our knowledge of the animals, their appearance *in situ*, and their reproductive biology. This study compares 46 specimens from between 1,100 and 2,450 m depth in the northeastern Pacific Ocean. Specimens from abyssal depths, referred here to *Graneledone pacifica* Voss & Pearcy, 1990, can be distinguished from those at bathyal depths by subtle differences in the numbers of suckers on each arm, of gill lamellae, and of tubercles on the dorsal mantle. The differences may reflect ecophenotypic variation, if a single species occurs over this 1,300-m depth range or, arguably more likely, these differences may signify the existence of a cryptic species isolated by depth.

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Design elements of the molluscan mantle cavity

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The molluscan mantle cavity houses the principle sites of metabolic exchange between the animal and its environment. The multiple functions of the mantle cavity result from the coordination of a suite of design elements: an incurrent window, an incurrent chamber, the pump, the exchange surface, an excurrent chamber, and an excurrent window. The incurrent and excurrent windows are usually specific regions of the shell and mantle that control the shape and size of the incurrent and excurrent streams. These may include quite subtle or obvious elaborations including siphons, tremata, slits, or other openings of the shell and underlying mantle. The shapes of the incurrent and excurrent chambers are defined by the overlying mantle and shell, the gill or gills, and the underlying surface of the animal's head and anterior visceral mass (often called the "floor" of the mantle cavity). Cilia beating on the surface of the gill and the interior mantle surface, as well as muscular contractions of the mantle, work singly or in concert to provide the pump. The vascularized gill is usually the primary exchange surface. Other organs within the mantle cavity include the anus, the openings of the urogenital ducts, sensory structures, mucus glands, and the nerves and blood vessels associated with these organs. The diversity of designs of modern molluscan mantle cavities reflect compromises between restraints and possibilities of design and function.

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Toward a molecular phylogeny for the pulmonate land snails

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The evolutionary relationships between pulmonate land snails of the order Stylommatophora remain unresolved. The present subordinal classification was defined on the basis of the anatomy of the excretory system, with the identification of four primary divisions, the Orthurethra, the Sigmurethra, the Heterurethra and the Mesurethra. Only the Orthurethra remains universally recognized. The evolutionary relationships between stylommatophoran families and the relationship of the Orthurethra as a whole to other pulmonate families are unknown. We have employed a molecular phylogenetic approach to investigate the evolutionary relationships between the pulmonate land snails. An approximately 1400 base pair fragment of the ribosomal RNA gene cluster, spanning the 5.8S, ITS-2, and 5' end of the large subunit (28S) gene, has been examined. Phylogenetic analyses based on this fragment have revealed that the Orthurethra appear to be a good taxonomic group, with taxa of all orthurethran families sequenced to date clustering in a single monophyletic group. In addition, the analyses reveal a possible sister-group relationship of the Clausiliidae with the Orthurethra. The molecular data is consistent with stylommatophoran taxonomic classification at the family level. Nevertheless, the relationships between superfamilial/subordinal groups are not well resolved lending support to the idea that the stylommatophoran radiation was explosive. The phylogenetic analyses also do not appear to be consistent with the idea that the Orthurethra are the primitive stem group from which the other Stylommatophora evolved.

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First results on the phylogeny of the Nudibranchia (Gastropoda, Opisthobranchia)

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The monophyly of the Nudibranchia and its major taxa is seldom challenged, but until now only few groups have been discussed in the light of Hennigian systematics. A thorough re-evaluation of more than 100 characters, partly drawn from literature, but mainly resulting from our own anatomical and especially histological investigations was performed. After assessment of character polarity, using other opisthobranch taxa as outgroups, relationships within the Nudibranchia and their autapomorphies are discussed. The following taxa are apparently monophyletic: Nudibranchia, Ctenidiacea, and Actenidiacea. Within the Ctenidiacea the monophyly of the Bathydoridoidea and Doridodoidea is affirmed. Within the Actenidiacea, the Aeolidoidea and the Dendronotoidea are monophyletic, although the Dotidae do not fit into the dendronotoid system and their relationship has yet to be clarified. The Arminoidea are paraphyletic. The sister-taxon of the Nudibranchia is the Pleurobranchomorpha.

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Anatomical disparity over time as inferred from modern gastropods: contrasting paleontological and neontological patterns

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Paleontological data suggest that many taxa displayed high rates of morphologic change early in their evolution, followed by low rates. Among taxa analyzed, only gastropods are diverse in the modern world. Gastropods also apparently retain many clades that diverged early phases in clade evolution. Paleobiological studies suggest that rates of evolution decreased especially markedly among differences associated with different soft anatomies. A prediction of paleobiological studies is that estimated rates of change among soft-anatomy characters should be greatest at the base of the tree. The fossil record plus estimated phylogenies explicitly predict when particular character combinations existed: *e. g.*, earliest gastropods appear in latest Cambrian and the apparent precursors to extant vetigastropods/allogastropods apparently diverged in Early Ordovician, so morphologies linking vetigastropods and allogastropods are necessarily posited to have evolved over a short period of time. I tested this using two published estimates of phylogeny (Haszprunar, 1988; Ponder & Lindberg, 1997). Statistical analyses suggest that rates of change (measured by patristic dissimilarity) for soft-anatomy were significantly greater during Early Paleozoic than afterwards. The results are robust to choice of phylogeny, character data, or assumptions about character evolution. Sampling biases probably worked against this: many Paleozoic gastropod clades likely lack extant members, depriving the analyses of additional unique and early-derived morphotypes, and estimated divergence dates within many basally derived clades likely are too recent. Therefore, predictions made by paleobiological analyses appear to be supported by neontological data. [Bridging Symposium]

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Development of the musculature in the limpet *Patella*: a study by confocal laser scanning and electron microscopy

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Whole mount technique using fluorescent-labeled phalloidin for actin staining and confocal laser scanning microscopy as well as SEM and TEM were applied to investigate the ontogeny of the muscular systems in the limpets *Patella vulgata* L. and *P. caerulea* L. (Gastropoda: Patellidae). Whereas earlier studies described one or two larval shell muscles, the pretorsional trochophore-like larva shows no less than four different muscle systems, namely the asymmetrical main larval retractor, an accessory larval retractor (both obliquely striated) with distinct insertion area, further a circular prototroch/velar system, and a plexus-like pedal muscle system (both smooth). Only posttorsional larvae are able to retract into the shell and to close the aperture with the operculum. Shortly after torsion the two (smooth) adult shell muscles originate independently in lateral positions, starting with two fine muscle fibers which insert at the operculum and laterally at the shell. During late larval development the main larval retractor decreases in volume, the accessory larval retractor becomes reduced, and the velar muscle system disappears. In contrast, the paired adult shell muscles and the pedal muscle plexus increase in volume, and new mantle and tentacular muscles arise. Because the adult shell muscles are entirely independent from the various larval muscular systems, several current hypotheses on the ontogeny and phylogeny of the early gastropod muscle system have to be reconsidered. [poster]

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Embryonic development of *Biomphalaria straminea* (Dunker, 1848) (Mollusca: Planorbidae)

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Biomphalaria straminea is an intermediate host of schistosomiasis. Cell lineages in mollusks have been studied since the end of last century. Spiral cleavage is characteristic of mollusks except for the cephalopods. By observing the type of cleavage, it is possible to know the fate of an individual cell of the embryo. *B. straminea* egg masses were obtained from Mocambeiro, Minas Gerais State, and reared under laboratory conditions for many years. The first two cleavages are meridional, however the third cleavage is equatorial, giving rise to the first quartette of micromeres and macromeres. Viewed from the animal pole of the egg, the four upper cells are anti-clockwise in relation to the macromeres; this is known as sinistral reversal spiral cleavage, and the same is observed in *B. glabrata* and *B. tenagophila*. SEM preparations of the first cleavages, blastula, gastrula, early trochophore, trochophore, early veliger, and veliger stages were studied.

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Why are freshwater mussels so big? Size, function, and phylogeny

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Large size is not a prerequisite for bivalves living in freshwater or marine environments. Yet, North American unionoids are significantly larger (mean length = 9.7 cm) than other North American bivalves, whether marine (mean = 4.4 cm) or freshwater (mean < 1 cm). Their size is the result of two adaptations not found together in any other bivalve group in North America: brooding of larvae; and a parasitic life cycle. Minimum larval size is dictated by the functional ability to attach to host tissue. High fecundity is dictated by the need to compensate for high larval mortality associated with a parasitic existence. Larval size, great fecundity, and the space required to brood these larvae, all lead to a large adult size. Species may greatly reduce the number of larvae necessary to complete the life cycle by modifying their morphology to attract specific types of hosts. Mantle flaps and conglutinates are such modifications. In these mussels, adult size depends not on the number of larvae, but on the size of the lure. Unionoids probably developed parasitic larvae from free-living, brooded larvae that fortuitously attached to "proto-hosts." Comparisons with fossil taxa indicate that the earliest mussels were already quite large (mean = 6 cm). This suggests that parasitism may be an ancient feature of this group.

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Miocene Western Amazonia as a center of molluscan radiation

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In the Miocene, between *ca.* 20 and 8 mya, the Amazon did not exist and Western Amazonia was covered by a huge lake system that was episodically reached by marine incursions from the Caribbean. In this system, Lake Pebas, a diverse endemic fauna of mollusks and ostracods developed. Deposits from this period are nowadays found in outcrops along rivers in Western Amazonia, and yield the well-reserved remains of the evolution of these biota. The paleoecological developments within Lake Pebas are dealt with. Attention is drawn particularly to the evolution of cochliopine hydrobiids and pachydontine corbulids. Furthermore, the identification of possible descendants and their actual distribution gives insight in the importance of Miocene Lake Pebas for the modern (non-marine) neotropical malacofaunas.

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Gender choice and gender conflict in *Physa*

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Complementing albino isofemale lines were used to determine the effect of previous reproductive history on gender choice in the simultaneous hermaphroditic snail, *Physa heterostropha*. The snails seemed to have no mechanism to increase their likelihood of mating as females. Virgin snails were more likely to initiate copulation as males than snails that had previously mated, a preference that did not diminish even after they had switched to self-fertilization. Virgin snails paired with virgin partners tended to display more rejective mating behaviors than those paired with previously mated snails, suggesting substantial gender conflict in this system. Data also suggested that gender conflict (between snails competing for the same gender role) may be stronger than sexual conflict (between snails in opposing gender roles) in some circumstances. However, we found no evidence that gender conflict ultimately lowered mating success.

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Density and recruitment of an intertidal chiton within a coralline algae mat

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Chitons within the genus *Nuttallina* are abundant along the central coast of California; *N. californica, N. fluxa,* and an undescribed species, *Nuttallina* sp. A. Density, size ranges, and species composition of *Nuttallina* within a *Corallina vancouveriensis* algal mat were determined at Stillwater Cove, Carmel Bay, California in August, 1997. Mean density of *Nuttallina* spp. within the coralline algae mat was 55.19 (SD = 9.95, n = 35) per 100 cm^2. Mean size, measured as width of valve iv, for *Nuttallina* sp. A was 3.7 mm (SD = 1.5, n = 1748), for *N. californica* was 3.5 mm (SD = 1.3, n = 117), and for *N. fluxa* was 5.9 mm (SD = 1.0, n = 67). *Nuttallina* sp. A accounted for 90.5% of all chitons within the algal mat, whereas *N. californica* accounted for 6%, and *N. fluxa* accounted for 3.5%. Approximately 5.5% of chitons were new recruits. Because of the great density of *Nuttallina* spp. within coralline algae mats, and the propensity for many mollusks, including chitons, to settle in response to the presence of coralline algae, laboratory experiments were conducted to determine the effect of substrate type and the presence of adult mucus on settlement of *Nuttallina* larvae. Laboratory settlement experiments indicated a greater number of *Nuttallina* sp. A settled on coralline algae with and without adult mucus and encrusting coralline algae with mucus than other treatments. Thus, coralline algae may provide necessary habitat for recruitment and propagation of *Nuttallina* sp. A.

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Defining species and assessing species-level relationships in the morphostatic snail genus *Hydrobia* (Hydrobiidae: Gastropoda)

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Why is there so much confusion about species identifications for the caenogastropod genus *Hydrobia*? This is not trivial, as this marine to brackish genus is of considerable ecological importance and is one of the most intensely studied molluscan genera in the world. The systematic confusion is traceable to the late 1970s when species were described using shell, radula, penis, and operculum. With the recent acceptance of cladistic methodologies, one sees a return to detailed comparative anatomy. However, *Hydrobia* belongs to a morphostatic species radiation in allopatry with little niche differentiation and correspondingly low anatomical differentiation. The fewer anatomical differences for nesting taxa by unique derived character-states, the more the need for molecular data. Multidimensional phylogenetically-based systematic studies are underway that emphasize defining species, assessing species-level relationships and taxonomy of *Hydrobia*, combining anatomical and genetic studies of 85 populations involving 25 nominal species, to: (1) Integrate detailed anatomical data, allozyme populational genetic data, and mitochondrial gene sequencing data to define species from topotypical localities. (2) Establish a phylogenetic hypothesis of species relationships, by calibrating genetic distances with anatomical distance coefficients to quantitatively assess differences among taxa. (3) Establish a collections/ bioinformatics center for *Hydrobia*. This work will provide a solid phylogenetic framework and reference base for future work on Hydrobiidae with its 1,000+ species, to serve the international community of scientists using *Hydrobia* for diverse studies.

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Littorinid phylogeny on the basis of 18S and 28S ribosomal RNA sequences

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In the past, littorinid phylogeny was mainly studied using morphological and anatomical data. Recently, also molecular sequence data were introduced as an independent data source (Reid, 1996, *Systematics and Evolution of Littorina*, The Ray Society). In this context, a preliminary study of the applicability of 18S rRNA to trace *Littorina* relationships showed that the molecule is not only suited to resolve ancient divergences, but may also be informative about more recent radiations (1-10 MYA) (Winnepenninckx, *et al.*, in press, *J. Mol. Evol.*). The present contribution pursues this issue by using complete 18S rRNA and partial (800 bp) 28S rRNA sequence data to assess: (1) the phylogenetic relationships within the *L. saxatilis s. l.* complex and the subgenus *Neritrema* in general, (2) the position of *L. striata*, and (3) the basal radiation pattern within the Littorinidae. These sequence data were analyzed in a historical biogeographical context. The suitability of both molecules for assessing littorinid relationships was evaluated and compared to other molecular markers previously used in littorinid phylogeny (12S rRNA, 16S rRNA, and cytochrome b). [poster]

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Morphological, allozyme, and RAPD survey of the sinistral *Busycon* of North America

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In his 1958 monograph of North American *Busycon*, Hollister recognized four extant sinistral species: *B. perversum* (Linné, 1758) (range: Campeche Bay, Mexico) and his (then newly described) *B. sinistrum* (range: Cape Hatteras, Florida Keys, and Yucatan, Mexico), *B. aspinosum* (range: Sarasota, Florida), and *B. pulleyi* (range: Texas, north Mexico, and Louisiana). Here we report the results of a survey of seven populations [Atlantic (2), Gulf Florida (3), Texas (1), and Yucatan, Mexico (1)], as well as a *B. carica* control population. Divergence was high among populations, as might be expected from animals with internal fertilization, an essentially sessile egg case, and direct development. There is some evidence of a barrier to dispersal between the two Atlantic populations and the five populations of the Gulf of Mexico. Divergence among Gulf populations seems attributable to isolation by distance. Our data suggest that all living North American populations of sinistral *Busycon* be relegated to the oldest available nomen, *B. perversum*. The elongate spines and tumid ridge(s) typically well-developed in Yucatan populations may be induced by intense, localized stone crab predation.

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Phylogeny of the Nudibranchia (Gastropoda: Opisthobranchia) based on 18S rDNA and 16S mtDNA

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18S rDNA (small subunit ribosomal DNA) and 16S mtDNA sequence data were obtained from taxa representing the major living orders and families of the Nudibranchia. So far as is known, this is the greatest amount of molecular data for Nudibranchia worldwide. As outgroups, representatives of the Cephalaspidea, Anaspidea, Gymnomorpha, Pulmonata, Bivalvia, and Polyplacophora sequenced by the author or taken from Genbank were used. Phylogenetic utility and information content of the 18S rDNA and 16S mtDNA sequences for Nudibranchia and Opisthobranchia in general are discussed by a detailed *a priori* analysis of the information content of the data and phylogenetic reconstructions with distance and parsimony approaches. The molecular data has been compared with morphological data and the similarities and discrepancies found are shown.

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Feeding behavior of the green-lipped mussel, *Perna viridis*, during spring and neap tidal cycles

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Food availability for green mussels (*Perna viridis*; Bivalvia: Mytilidae) was different during spring and neap tides. During spring tidal cycles, the content of total particulate matter increases with an increase of the content of particulate inorganic matter, because this increase was due to the tidal disturbance at high tidal height. The fluctuations of the contents of total particulate matter, particulate inorganic matter, and particulate organic matter are relatively smaller during neap tidal cycles. Whether during spring or neap tidal cycles, clearance rates of the mussels decrease exponentially with the increase of total particulate matter and increase linearly with the increase of organic matter. It is obvious that clearance rates are higher when the tidal height is lower and lower when the tidal height is higher, particularly during the spring tidal cycles. Organic content is responsible for the variation of clearance rates coupled to the tidal height. Meanwhile, organic content was the key factor to influence mussel filtration rates, organic ingestion rates, absorption rates, and absorption efficiencies, and the feeding rates generally increase linearly with the increase of organic content. Clearance rates, absorption rates, and absorption efficiencies are higher in spring tidal cycles than that in neap tidal cycles except that there was no difference between the organic ingestion rates. The mussels usually received constant energy whether in spring tides or neap tides. [poster]

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Isolating mtDNA from fresh or fixed molluscan specimens

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Fast and efficient methods for isolating mtDNA from fresh or fixed molluscan specimens with different conditions have been developed. The standard method involves isolation and purification of a large amount of mtDNA to a moderate purity from regular samples, even those containing jelly, mucus, or lipids; the second method extracts mtDNA from a small quantity of sample, such as from one trochophore; and the third method obtains mtDNA from formalin- or alcohol-fixed specimens.

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Mollusks in CITES

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More than 26 species of freshwater pearl mussels and all species in the family Achatinellidae were listed in the Appendix I of CITES. All *Paryphanta*, Tridacnidae, and *Strombus gigas* were also listed in the Appendix II of CITES. The characters, distribution, type locality, synonymy, and color pictures of the mollusks in CITES are described. [poster]

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Reproductive anatomical differentiation in some Cuban populations of the genus *Biomphalaria* (Pulmonata: Planorbidae)

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An anatomical study was conducted on 15 Cuban populations of the genus *Biomphalaria* to determine the degree of differentiation within this confused taxon. Six variables of the reproductive system were measured on a minimum of 30 individuals for each population: length of the cephalic portion (Ce), length of the caudal portion (Ca), length (Lps) and width (Aps) of the penial sheath, as well as length (Lpp) and width (App) of the preputium. Four ratios were calculated from the above mentioned measures: Ca/Ce, Lps/Lpp, Lps/Aps, and Lpp/App. Qualitative differences were found between populations, mainly concerning the prostate gland and the penial complex. A cluster analysis revealed the presence of two easily distinguished groups. The first comprised only 4 populations in which anatomical characters very much resembled those described for *B. havanensis*. The second group was formed by the remaining 11 populations. This large group was in its majority represented by *B. peregrina* (9 populations); there was also one population with characteristics conforming to those described for *B. orbignyi* (Socorro), and another which is probably a new record for science (Guato). This last population strongly differs from the rest in the Ca/Ce ratio, a very conserved feature for this genus; it is also different in several qualitative characters. The implications of the results for the taxonomic status of the genus in Cuba are discussed.

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Applications of the *Biomphalaria glabrata* embryonic (Bge) molluscan cell line to the study of human blood fluke-snail associations

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In biomedical research, cell lines have provided an invaluable tool for investigating animal and human disease processes. Recently, we have utilized a cell line derived from *Biomphalaria glabrata* embryos (Bge cell line) to investigate various aspects of snail immunobiology and host-parasite relationships. Applications of the Bge cell line include the following: (1) Cloning of genes expressed in snail blood cells (hemocytes): Because of functional, and presumably ontological, similarities between Bge cells and hemocytes, and in many cases, a lack of sufficient hemocyte material for molecular studies, Bge cells have been used to clone hemocyte-like genes for subsequent study. Using this approach, a hemocyte ß-integrin cell adhesion receptor homologue has been cloned and sequenced. (2) *In vitro* cultivation of early larval stages of diverse trematode species: Studies have shown that larvae co-cultivated with Bge cells as feeders, undergo advanced growth and development. (3) Finally, Bge cells are being used in the development of a prototype molluscan genetic transformation system in which foreign genes of interest can be stably introduced and expressed in Bge cells. Research activities in this area include the identification of homologous promoter systems and construction of vectors with reporter or selectable markers for use in Bge cell transfection experiments.
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Testing *Helisoma duryi* as a biocontrol agent against schistosome vector snails in Egypt

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Under simulated natural conditions, the existence of *Helisoma duryi* and *Biomphalaria alexandrina* (Pulmonata: Planorbidae) in mixed culture, led to a significant reduction of the population density of the latter snail, more pronounced with the increase of *Helisoma* snails in the culture (*e. g.,* 1B:3H). *H. duryi,* furthermore, adversely affected the reproductive index, as well as brought about significant reduction in the growth rate of *B. alexandrina,* regardless of the ratio between the two species. The infection rate of *B. alexandrina* with *Schistosoma mansoni,* in the experimental ditches was significantly reduced with the presence of *H. duryi* at all ratios studied (1:1, 1:3, 1:5) particularly as the proportions of *H. duryi* increased. A reduction in the infection rate of *B. alexandrina,* ranging between 58.6% and 81.9%, was attained at the ratio IB:5H. On introducing *H. duryi* into a newly reclaimed area in North Sinai, it succeeded in establishing itself in 50% of the natural water courses, where schistosome vector snails lived, and started to build up a rich population 7 months after introduction. Meanwhile, the population density and infestation rate of both schistosome snail species *(B. alexandrina* and *Bulimus truncatus)* in such canals showed significant reduction directly correlated with the relative number of *H. duryi* snails present.

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Development of the protobranch bivalve *Acila castrensis* and speculation on the relation of the pericalymma larva to molluscan evolution

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Protobranchs are among the oldest bivalves in the fossil record and possess a unique developmental form, the pericalymma, which may represent an ancestral or derived feature of the Bivalvia. Discussion has been limited by a lack of thorough information within the group, especially at the ultrastructural level. We present a comprehensive description of development in a member of the Nuculidae, *Acila castrensis*. This wide-ranging and abundant species lives in near-shore sediments of the eastern Pacific and a diagnosis of its larval form will also be of use in coastal plankton research. Organisms were collected near San Juan Island, Washington, and embryos reared at the University of Washington's Friday Harbor Laboratories. Using light and electron microscopy, development is described from whole mounts and sections. Cleavage follows a typical bivalve pattern and, by day 3, formation of the ciliated test, or calymma, has begun along with production of an internal shell. A previously unknown and distinct larval sense organ is also described. Development proceeds in the plankton and is complete by 8 days at which time the test is shed and the shelled juvenile takes up a benthic existence. Inferences of developmental mode from shell characteristics in other bivalves do not hold true for this and presumably all protobranchs. Diversity in pericalymma form is compared among protobranchs and similarities are drawn to other molluscan developmental forms.

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Can pearl mussels (*Margaritifera margaritifera*) relocate to avoid inhospitable conditions?

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Pearl mussels (*Margaritifera margaritifera*) are considered to be sedentary bivalves, with ability to burrow but limited propensity to move through the substratum. The question of whether they can relocate to avoid unsuitable environmental conditions was tested in experiments conducted in the Varzuga River basin, northwestern Russia. This watershed includes tributaries that are devoid of mussels because of high levels of organic solutes. In September 1996, 300 adult pearl mussels were collected from the main channel, marked, randomly assigned to three equal groups, and translocated to three sites: main channel upstream of an organic-loaded tributary (control), main channel within the outflow of a tributary and 1 m from the clear mainstream water, and within the tributary 50 m upstream of confluence. All mussels were placed into comparable, stable habitats and protected from high current velocities by boulders immediately upstream. After 1 year, 87 mussels were recovered alive from the main channel at or near the original translocation site. A total of 72 living mussels were found at the boundary waters site, and all specimens had migrated 1-2.5 m upstream into main channel water. No live mussels were found in the tributary. Results showed conclusively that high organic water was unsuitable, and pearl mussels moved against rapid flows (1.5 m/s) to avoid the inhospitable conditions.

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Extremes in longevity of the freshwater pearl mussel (*Margaritifera margaritifera*): a model system for long life

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The freshwater pearl mussel (*Margaritifera margaritifera*) is one of the longest lived animals, attaining ages in excess of 150 years in polar climates. Because of its long life, the species may be useful for studying genetic and physiological mechanisms contributing to longevity. An ongoing study is comparing six southern populations in Spain, with maximum recorded ages of 28-40 years, to three Arctic populations in northwestern Russia, with maximum ages of 116-155 years. Within Arctic populations, 20% of mussels live more than 90 years in rivers that are pristine. Possible evolutionary significance of northern longevity is an adaptation to severe cold and unstable environments in high gradient rivers. During winter, mussels have a near-famine existence during the Polar Night, and experience some shell damage from ice formation and flows. In summer, periodic droughts result in exposure and desiccation. In response to adversity, pearl mussels have acquired effective mechanisms for shell reparation and tissue healing and regeneration. Northern populations have low metabolic rates, reducing energy expenditure for growth under normal as well as extreme conditions. However, this species is capable of increasing metabolic rate up to 130 times for tissue regeneration and self-healing. The physiological adaptations to sustain longevity may provide useful clues to impedence of the aging process.

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Fossil and extant Baicaliidae: a case of convergence?

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To study the evolutionary history of the Baikalian endemic gastropod family Baicaliidae, nucleotide sequences of Folmer's mtCOI gene fragment for 29 species (of 40 so far described) have been obtained. Based on these data, phylogenetic relationships among species have been inferred and the time of species radiation has been estimated. An unexpectedly low degree of sequence polymorphism has been found (< 8% dissimilarity), predominately synonymous. Despite the fossil record of Baicaliidae in a region of the Baikal rift zone since the Oligocene, according to the DNA sequence data obtained, the latest common ancestor of baicaliids is dated to only 1.5-2.0 MYR if the known estimate for molluscan mtDNA synonymous substitution rate is used. This date coincides well with the beginning of the first Pliocene climate cooling (1.6-2.0 MYR) which could cause the mass extinction of the ancient malacofauna. Therefore, morphological similarity between fossil and modern Baicaliidae may be a case of convergence. We suppose it is most reasonably explained by the principle of homologous rows in hereditary variability first revealed by the Russian geneticist Nikolai Vavilov in 1920. He postulated that the spectra of mutations in genetically related taxa are similar. We suppose this principle is applicable to the related extinct and extant taxa as well. [poster]

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Molluscan distribution patterns in Northern Safaga Bay (Red Sea, Egypt)

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The shallow marine subtropical Northern Bay of Safaga is composed of a complex pattern of sedimentary facies closely associated with coral reefs and other hard substrata. In sediments, more than 600 molluscan taxa were recognized. The most common taxon, *Rissoina cerithiiformis*, represented more than 5% of the total molluscan content in the samples. The main part of the fauna consists of micromollusks, including both small adults and juveniles. Individual numbers, numbers of taxa, and diversity indices are very high in samples from sand between coral patches, reef slopes, and seagrass, and distinctly lower in the mangrove, muddy sand, and mud. Among bivalves, epifaunal (byssate and cemented) suspension feeders dominate on reef slopes, infaunal suspension feeders in muds, and infaunal chemosymbionts in muddy sand and seagrass. Sands between coral patches and the mangrove are dominated by both infaunal suspension- and deposit feeders. The various hard substrata are characterized by diagnostic molluscan associations: reef flats are dominated by *Dendropoma maxima*, scleractinian carpets by *Pedum spondyloideum*, *Tridacna maxima*, and *Coralliophila neritoidea*, *Sarcophyton* carpets by Chamoidea and *Cerithium rüppelli*, rocky intertidal flats by *Modiolus auriculatus*, Chamoidea, *Morula granulata*, and *Nerita albicilla*. More detailed studies on bivalve distributions suggest gradual shifts in faunal composition rather than distinct groups. The taxonomic shifts are accompanied by continuous variations in bivalve density and percentage of living individuals as well as by a change of coral associations and potential bivalve habitats.

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