A Commensal Sea Cucumber

Although echinoderms may serve as hosts to commensals and parasites (1), no parasitic or commensal echinoderms have been reported to date. On 12 September 1968 the R.V. *Velero* made a net haul between 500 and 1050 fathoms, 19.5 miles southeast of Head Light on San Clemente Island off the coast of southern California. In this haul was an angler fish, *Gigantactis macronema* Regan, that had four small, cylindrical, gray organisms attached to one side of its body. Whole mounts were made of three of these, and the fourth was serially sectioned. Whole mounts were stained with Mayer's paracarmine, but sections were stained with Mallory's triple. Lengths and maximum widths in millimeters of the three whole mounts are—1.75 by 7.14; 2.52 by 5.71; and 2.24 by 5.18. The anatomy is unquestionably holothurian.

The cucumbers were firmly attached to the fish host, but there appeared to be no invasion of host tissue. These few small individuals probably did not interfere with the host's movement. The cucumbers would benefit by being transported about, increasing their range and providing new feeding areas. They appear to be commensals.

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2. Supported by NSF grant GB-6962.

19 March 1969

Gnathostomulida: Is There a Fossil Record?

Current investigation (1) on the new phylum Gnathostomulida injects a new choice into the paleontological controversy surrounding conodonts. Most specialists (2) have favored association of conodonts with fish or primitive vertebrates. Affinity with worms has been proposed (3) but questioned (4), and similarity to the copulatory apparatus of some Turbellaria has been suggested (5). Comparison has been made with molluscan radular teeth (6) and I had supposed conodonts to be proventricular teeth of trilobites on the basis of similar chemical analyses published for conodonts and phacopid exoskeleton. Hass (7) suggested that they might be internal supports for tissues located in regions of stress, either external or internal, but did not guess affinity of the group.

Microconodonts (8) from Baltic Cretaceous chert, characterized by conodont-like form and much smaller size, have been considered to be worm jaws (9).

Conodont structure restricts the choice of groups for potential association. Fibrous conodonts (Neurodontiformes) found crushed and frayed, but not broken, were probably endoskeletal in muscular tissue as Hass (7) suggested. Laminated conodonts (Conodontiformes), with layers of close packed fibrous crystals perpendicular to laminar interfaces and arranged cone-in-cone, must have been apically accretionary. Thus these also are endoskeletal, probably deposited between dermal membrane and conodont in rigid oral papillae. Occasional finds of broken conodont teeth, repaired by apical overgrowth, support this interpretation. Organisms bearing exoskeletal deposits or ecdysial elements (Trilobites, Crustacea and other arthropods, annelid worms) may be ruled out. Nor could conodonts be close to Onychophora or Tardigrada for the jaws of the former and the claws of both are formed by internal periodic deposition of new layers under a wearing outer surface. Tardigrad stylets are possibly of intramuscular origin. The association of slender and often abruptly curved teeth, long multidentate rami, with plates, found in Conodontophoridia, Gastropoda, Amphineura, and Gnathostomulida suggests similarity of function. Riedl (1) reports preferential feeding of gnathostomulids on fungi and blue-green algae. Gastropods with conodont-shaped radular teeth and chitons are generally algal feeders. Hence it is suggested that conodonts were the cores of endosclerotized circumoral papillae, used to tear up and ingest fungal hyphae and algal mats, by probably benthonic "worms." Scalelike objects of conodont-like composition, found in association with conodonts (10) in the Ordovician, often with parallel rows of nodular bosses (unpublished), from the Silurian, may be interpreted as basal plates comparable to those of the gnathostomulids. Small spheroidal bodies of similar material may be statocysts similar to those of the gnathostomulidan foregut.

On the basis of size, microconodonts are probably fossil Gnathostomulida closely related to the living fauna. Conodonts belonged to larger organisms which are probably best considered as the class Conodontophorida within the phylum Gnathostomulida, filling in part, the niche constellation of benthonic browsing organisms now occupied by chitons and snails.

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10 February 1969

Riedl's description (1) suggests that members of the new phylum Gnathostomulida are survivors of the group represented by the conodonts (2–4), minute toothlike fossils known from the Late Cambrian or Early Ordovician at least to the Late Triassic (very roughly, from 5 to 2×10^8 years ago). Some of the similarities are striking. Riedl states that "The mouth . . . is hardened by thin cuticularized basal plates, sometimes with a 'jugum' in the upper lip, mostly with a 'basal plate' in the lower lip area. The latter always bear lamellae, teeth, or a distinct tiny comb in its center. . . . a pair of lateral jaws in the mouth cavity . . . vary from simple pincer and forceps types to complicated lamellar snap-jaws with three pairs of comblike rows bearing up to 60 teeth," a fair description of conodont morphology. The jaws and basal plates shown in his Fig. 3 compare favorably with figures of individual toothed plates of conodonts (2), of assemblages of such plates (3), and of basal plates (4). Furthermore, gnathostomulids are reported to prefer fine sediment and to be very tolerant, if not fond, of relatively anaerobic conditions; it is well known that conodonts are common in black silty shale deposited under anaerobic conditions, where other fossils or evidences of life are rare.

The chief distinctions between gnathostomulid jaws and conodonts seem to be size and composition. Gnathostomulid jaws are measured in tens of microns and are "cuticularized," but conodonts are measured in hundreds of microns or millimeters and are chiefly calcium phosphate (and hence preservable). One might suggest that conodonts are the hard parts of a group (order, class?) or groups of the phylum Gnathostomulida that developed phosphatic jaw parts and were hence enabled to grow somewhat larger but that became extinct during the Mesozoic, whereas the groups without such hard parts survived to the present (*5*).

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5. I thank A. L. McAlester and K. M. Waage for comments and discussion.

13 February 1969

Without wishing to detract from the scientific merit of the article on the phylum Gnathostomulida by Riedl (*1*), I must object to his disregard of basic points of zoological nomenclature; part of this blame should be shared by critics and editors in permitting these errors. The International Code of Zoological Nomenclature (*2*) is not to be ignored even though there has never been any method to force compliance except its worldwide acceptance by systematists.

The International Code is clear in its requirements for specific and generic names. One may argue that the specific name "*jenneri* Riedl" is published, but only by giving a most liberal interpretation to the rules. That species is not clearly described and is certainly not distinguished from other species in spite of some of the details given about it. The author has not designated a holotype, nor has he indicated a repository for his material, or even a precise locality where he obtained the specimens.

The four new generic names are possibly diagnosed because there are a few remarks that may differentiate them from other genera. However, no type species are designated for these four genera, and each generic name will remain meaningless until a species is described. The first person to describe a species and refer it to one of these genera will automatically fix that species as type and will thereby establish the characters of the genus. It may be that these characters will not be what the original author intended, and confusion will result. The names of "new species" given in his Figs. 2 and 3 are invalid.

In systematics one must avoid premature citations of new names (*3*). Otherwise, errors creep into the literature and persist until the work is repeated, and the errors are removed. I do not believe that it is asking too much for anyone who uses biological names, and especially when he proposes new names, to follow universally established procedures.

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6 February 1969

Without doubt there are similarities between conodonts and the cuticularized parts in the foreguts of gnathostomulids, as expressed by Durden (*1*), Rodgers (*2*), and in several other letters I have received referring to my article (*3*). Although I have considered this relationship since my findings in the Red Sea (*4*), I hesitated to publish a statement as long as most of the information was still in the field of paleontologists. Therefore, I particularly appreciate their interest and effort. Today, rapidly increasing neontological facts strengthen our hypothesis.

Although we have no evidence of calcium phosphate in gnathostomulids jaws, neither do we have (calcified) conodont records since the Mesozoic, and, although lamellar structure in gnathostomulids is not yet clear, their jaws are much thinner than one lamella of the conodont jaws used for structural studies.

Size differences between the two groups lose importance since gnathostomulids have been found with jaws 30 to 40 μ long (*5*) similar to the jaws of Cretaceaous microconodonts, 80 μ long (*6*), which were questioned because they were thought to be too small. Some "uncommon" scolecodonts which are perhaps related to the gnathostomulids have a lower size range of nearly 25 μ (*7*). Bearers of macroconodonts must have reached 1 foot in length and consequently were digging types (that is, endopsammon), whereas gnathostomulids live interstitially (mesopsammon). Yet, almost every invertebrate phylum has developed mesopsammal dwarf types, with size reduced to hundredths of the original, many of which show neotenic characters as do the gnathostomulids. Furthermore, the gnathostomulid jaws, under pressure, fall into parts almost in the same positions as conodont assemblages are found (*8*). Thus, the probability of a relationship increases.

I am now studying growth and ultrastructure in collaboration with W. E. Sterrer. Chemical and x-ray analyses, as suggested by S. P. Ellison (University of Texas, Austin), J. W. Huddle (U.S. Geological Survey, Washington, D.C.), and J. Jansonius (Imperial Oil, Alberta), are in preparation.

I agree with Yochelson (*9*) that *nomina nuda* should be avoided. Since *Science* is not the place to describe new species in detail, and as *Science* also hesitates to accept secondhand information already published, the original descriptions are prepared and will appear in a more specialized journal this year. To avoid confusion between my brief in *Science* and these descriptions, I mentioned this in reference 15 of my article.

My prediction in this article (*3*, Fig. 1), that gnathostomulids would outnumber the last new phylum, the Pogonophora, is already fulfilled. Due to Sterrer's additional findings on Atlantic coasts (North Carolina, Florida, and Panama), 80 species (*10*) are known to us, and a grouping into two orders and several families is considered; these facts together improve our ability to make valuable definitions, that is, systematic predictions.

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24 March 1969