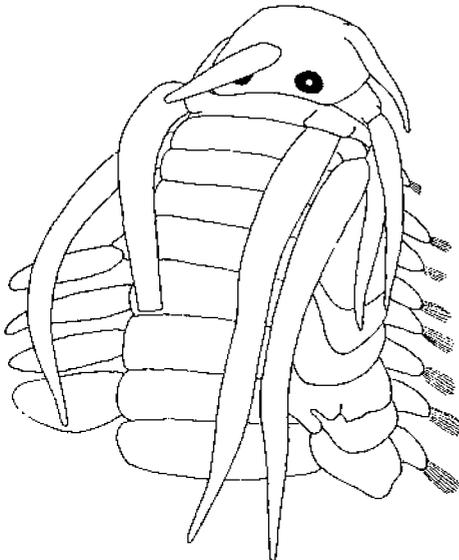


April, 1996

SCAMIT Newsletter

Vol. 14, No.12

NEXT MEETING:	<i>Eumida</i> and related genera
GUEST SPEAKER:	Danny Eibye-Jacobsen
DATE:	May 13 -14, 1996
TIME:	9:30am - 3:30pm
LOCATION:	Worm Lab, Natural History Museum of Los Angeles County 900 Exposition Blvd., Los Angeles, CA



Eumida longicornuta (from Eibye-Jacobsen 1991)

MAY 13 - 14 MEETING

The May meeting will be held over two days at the Worm Lab of the Natural History Museum and hosted by Dr. Danny Eibye-Jacobsen from the Zoological Museum, University of Copenhagen. The meeting will be a discussion of phyllodocid polychaetes, especially *Eumida* species. Members should bring any problem specimens for examination by Danny along with any questions on this group of polychaetes.

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SCAMIT Newsletter is not deemed to be a valid publication for formal taxonomic purposes.

MEETINGS, MEETINGS, MEETINGS

There are several important meetings that may be of interest to members that will be occurring in the next few months.

May 3 - 4 So. Calif. Academy of Sciences at Loyola Marymount University. One of the Friday symposia is on regional marine monitoring in the southern California Bight.

June 23 - 27 Western Society of Malacologists in San Diego at the Handlery Hotel and Country Club. Refer to March newsletter Vol.14(11) for details.

July 14 -18 The Crustacean Society Meeting and the 3rd International Large Branchiopod Symposium (held jointly) at the University of San Diego. Refer to Feb. newsletter Vol.14(10) for details.

August 5-9 9th International Echinoderm Conference, San Francisco. Seven Hills Conference Center, San Francisco State University. Contact Rich Mooi at the California Academy of Sciences @ (415) 750-7086 or rmooi@cas.calacademy.org for further information.

"SCAM IT" NEWSLETTER

The April 1st edition, Volume 14(13) seems to have been well received by the membership. Those of you who let your newsletter pile up before reading it or don't read it all the way thru missed out on a good chuckle last month. The newsletter staff is planning another edition for next year and will certainly welcome articles from other "twits" and "fools". Please submit articles as soon as Thalia (the Muse of Comedy - for the classically impaired) smites you with the whoopie cushion of inspiration. All submissions are welcome, but, with a year to prepare, we will attempt more subtlety in Volume 15(13).

ANOTHER INTRODUCED SPECIES

At the April meeting John Ljubenkov (MEC) informed members of an introduced species of anemone that has large stinging cells on its tentacles and lives on eelgrass. This anemone has been recently reported in Mission Bay by scientific divers. It is an apparently undescribed species in the genus *Bunodeopsis* which also has been taken in the Gulf of California according to John.

The City of San Diego has also recently seen another species of heart urchin *Nacospatangus depressus* in their trawls, which was previously unreported in local monitoring samples. This species was listed and illustrated in Charwat and Word 1975 as *Gonimaretia laevis*. They indicated it had been taken at 18m depths off San Clemente Island. It is more oval in shape than *Lovenia cordiformis*, but generally resembles that species although it lacks both long dorsal spines and an anterior ambulacrum. It is actually more closely related to *Spatangus californicus* and is in the family Spatangidae, not the Loveniidae. Both *Nacospatangus* and *Lovenia* were noted as occurring in the same trawl off Pt. Loma, so we should all critically examine our "Lovenia" to be sure they don't hide a few *Nacospatangus* as well.

According to Maluf (1988), the synonymy of *Gonimaretia laevis* with *Nacospatangus depressus* is provisional, and may be reversed once a definitive study of these animals is done. She lists it as having a depth range of 5-302m. The record from San Clemente Island represents the recorded northern range limit for the species, which ranges south to Isla Espiritu Santo.

BUBBLE SHELL NAMES

In Edition 2 of the SCAMIT Taxonomic Listing bubbleshells of the genus *Haminaea* were indicated as being in the family Atyidae. This placement is no longer accurate. For some time

a problem in nomenclature at the family level has been noticed by some workers. Dr. Myra Keen, in a letter to Jim McLean in the early 70's pointed out the problem, and suggested that the solution rested with the ICZN.

The problem was one of homonymy at the family level. In Mollusca there is a family Atyidae based on the type genus *Atys* de Montfort 1810. In Crustacea there is a family Atyidae based on the type genus *Atya* Leach, 1816. This later taxon was a replacement name for *Atys* Leach, 1815 [in Crustacea] non *Atys* de Montfort 1810 [in Mollusca]. In either case the family name derived from the generic name is the same, Atyidae. The family name was introduced in Crustacea by De Haan 1849, while it did not find usage in Mollusca until Thiele 1926. The next available family name is Haminaidae Pilsbry 1895. This name has been variously spelled as Haminaidae, Haminoeidae, and Haminaeidae based on the transliteration of the diphthong ae. There is currently before the ICZN a proposed use of the plenary powers for conservation of the name *Haminaea* Leach 1820, and for fixation of the correct spelling of the family name as Haminaeidae (Giannuzzi-Savelli & Gentry 1990). While the commission has not as yet formally acted, the evidence that the proposed approach is the correct one is persuasive (at least to your editor). Accordingly, the next edition of the Taxonomic Listing will replace the family Atyidae in mollusks with the family Haminaeidae [the generic change from *Haminoea* to *Haminaea* has already been made]. - Don Cadien

NEW LITERATURE

Volume 9 of the MMS Taxonomic Atlas, The Mollusca, Part 2, Gastropoda with sections by Jim McLean and Terry Gosliner is published and subscribers should be receiving it soon.

A Listing of Living Mollusca by Yoshihiro Goto and Guido T. Poppe has been recently published. It is in two parts and four volumes and includes

41,861 species. Its cost is \$US 185 plus postage for all four volumes. The weight of all 4 volumes together is almost 10 kg. Orders for this set may be sent to:

Mostra Mondiale Malacologia
Via Adriatica Nord, 240
63012 Cupra Marittima (AP - Italy)
tel: 39 (0) 735 777550
fax: 39 (0) 735 777232

Also, recently published by Y. Goto and P. Anseeuw is *The Living Pleurotomariidae*. This is a comprehensive synopsis of recent Pleurotomariidae which includes 24 species and 2 subspecies. It not only includes many text illustrations, color plates and distribution maps, but SEM images of radula as well. It costs \$US 210 and it is hardbound with a cloth cover and slipcase.

It may be ordered from:

Naturama
C.P. 28 - Succ.26
90146 Palermo Italy
e-mail: naturama@mbox.vol.it
fax: +(91) 6713568

Payment should be made with your order by international postal money order or with a VISA card (for a 5% charge) by fax not e-mail for obvious reasons.

Also from the same publisher. *Seashells of Eastern Arabia* by D. Bosch, P. Dance, R. Moolenbeek and G. Oliver. It is hardbound and includes more than 1000 species from Oman and the Arabian Gulf illustrated with color plates and SEM images. It costs \$US 80.

Shell-bearing Gastropods of the Arctic by A.N. Golikov is also available from Naturama. Its a softbound monograph with black and white plates only. It costs \$US 45.

The latest number of the Proceedings of the Biological Society of Washington contains a paper by member Dr. Mary Wicksten on the taxonomy of local *Neocrangon* species. It reports the results of her reexamination of the validity of *Neocrangon zaca*, and concludes it is a synonym of *N. resima*. This is another in the series of papers on shrimp and other decapods in preparation for the upcoming large scale revision of the decapods of California. Mary has recently indicated that the first installment of this is already accepted and in press at the California Academy of Sciences.

In the same issue the thalassinid genus *Calocarides* is reviewed (Kensley 1996), and our local *Acanthaxius spinulicaudus* transferred into it in the process. This is now properly known as *Calocarides spinulicauda* (Rathbun 1902).

MINUTES OF APRIL 22 MEETING

The meeting began with the guest speakers Don Cadien (CSDLAC) and John Ljubenkov (MEC) giving members some background information on the taxonomy, biology, and anatomy of cephalaspid mollusks. This general information was distributed thru handouts, which have been included in this newsletter.

Most cephalaspid mollusks are predatory animals. They have radula and gizzard plates that they use to catch, consume and process their prey. Species of the genus *Bulla* are mostly vegetarian, while most other cephalaspid groups are carnivorous. Generally, cephalaspids live on the bottom of the ocean and burrow into the sediments. Most have glands that secrete a mucous sheet on or within which they crawl, so that the fine particulate matter of the sediment does not clog up their respiratory system.

The shape of the gizzard plates gives the taxonomist an idea of what the animals are eating. Species with large robust plates generally consume animals with strong shelly protection.

Those with more gracile plates use them in crushing relatively fragile prey such as foraminifers, or use them only to hold the prey in position in the gut for gradual digestion.

Some have 3 equal or similar shaped plates while others have 2 equal or "paired" plates and 1 unequal or "unpaired" plate. The shape of the gizzard plates should allow the taxonomist to differentiate these animals to the generic level. While most of the gizzard plates of *Philine* are diamond shaped there seems to be some variation in the size and proportion among different species.

Before we broke for lunch Kelvin Barwick (CSDMWWD) showed members a videotape of cephalaspids from Pt. Loma. These included *Acteocina*, *Bullomorpha*, *Parvaplustrum*, *Volvulella*, *Philine sp. A* and *Philine californica*.

After lunch we examined specimens. First we examined *Philine auriformis*, the size of the animal making gizzard plate dissection a breeze. Megan Lilly (CSDMWWD) dissected the gizzard mass out with a ventral incision thru the foot using forceps and then cut the gizzard sheath with a small scalpel to separate the three plates. (Refer to the section on locating gizzard plates in the attached handouts.) We then compared these plates to *Philine sp. A*, which had 3 equal plates that were long and slender with a ventral rib that runs the entire length of the plates.

The *P. auriformis* plates were as illustrated by Gosliner (1995), flat laterally with a strengthening longitudinal rib, and prominently humped medially (the portion pointing into the lumen of the digestive tract) at midlength, although, not having a distinct rib. The lateral flat face was excavated near its center so the strengthening rib was almost free-standing near the middle of the plate.

We next compared shell specimens of *Cylichna diegensis*, *C. attonsa*, and *C. alba*. The specimens of *C. attonsa* came from Catalina Island, the Aleutian Islands, and Oregon. There

seemed to be quite a difference in opinion amongst members as to whether these shells were more straight sided or rounded at the shoulder and base. While we were unable to see much difference between the shells of *C. diegensis* and *C. attonsa*, the shell of *C. alba* was very different. It was thicker and had a closely adherent brown periostracum. The differences between *C. attonsa* and *C. diegensis* need to be further investigated by examination of the types.

We then looked at a very different cephalaspid shell, *Diniatys dentifera*, which had a small, but prominent tooth at the base of the columella. The specimens we examined were from Hawaii, but the species is also known from the eastern tropical Pacific. The small *Micraenigma oxystoma* Berry 1953 belongs in *Diniatys* (see Burn 1978) and Berry's species *oxystoma* may be a synonym of the nearly circumtropical *D. dentifera*. The holotype of *D. oxystoma* came from off the Coronados Islands just south of San Diego and, although not reported since, this species may occur in our samples.

The next specimens examined were *Acteocina inculca* from shallow water in outer Los Angeles Harbor. We dissected out the gizzard plates to see the two paired plates and the one unpaired, cordiform or heart-shaped plate, which is generally larger or equal in size to the paired plates. We also examined the suture of the whorls to see if these indeed belonged to *Acteocina* and not *Tornastra*, which is now distinguished by its deep groove or channel in the whorls (as well as by gizzard plate shape as in Marcus 1977). These specimens of *Acteocina* did not have a deep groove such as that expected in *Tornastra*. However, *Acteocina culcitella* does have this groove so it should be referred to *Tornastra culcitella*. Two other local species also appear to belong in *Tornastra*, *Acteocina infrequens*, and *Acteocina cerealis*.

We examined specimens from the mollusk collections of the Natural History Museum of Los Angeles County identified as all three of these species of *Tornastra*, but were only able to

clearly separate *T. infrequens* on conchological grounds. This predominantly southern species was differentiated from the others by presence of three spiral color bands on the shell. These faint purple-black bands were separated by slightly less than their width, and stood out prominently against the white base color of the shell.

Bullomorpha sp A, which is listed in the SCAMIT Taxonomic Listing Ed2 as family uncertain, has been further examined anatomically in efforts to place it within one of the existing families. This effort was not successful. The radula of *Bullomorpha* sp A was examined and found to have the formula 6-7.1.0.1.6-7. The lateral tooth was about twice the size of the largest marginal tooth, and there was no central tooth. All teeth lacked denticles, and had a robust base and a long hooked cusp. Gizzard plates were lacking in the animal. The only family known to occur in the eastern Pacific which lacks gizzard plates and has a radular formula like that of the examined animal is the Gastropteridae. *Bullomorpha* is clearly not a gastropterid so we must assume this animal requires a new family to contain it, and cannot be allocated to any of the existing families of cephalaspids.

Another change in local southern California cephalaspid taxonomy is *Meloscapander* sp. A which will now be called *Parvaplustrum* sp. B due to successful removal, mounting and examination of the radula (FINALLY!!!) of both *Parvaplustrum* sp. A and *Meloscapander* sp. A. In both species the radula is very small relative to the size of the animal, and has a formula of 1.0.1 with numerous rows of flattened leaf-like teeth closely packed in series. The bases of these teeth were very small, as shown for the generotype of *Parvaplustrum* by Marcus and Marcus 1969. This radular configuration is very unusual, and differs from that of *Meloscapander* (illustrated by Bouchet 1975 for *M. imperceptus*) which has differently shaped teeth, and a radular formula of 1.1.1. The two species are clearly congeneric based on their radulae, and appear properly placed in or near *Parvaplustrum*. In

both species gizzard plates are absent. Despite the similarity in shell to *Meloscaphander*, it's anatomy proves our species does not belong in that genus.

President Ron Velarde (CSDMWWD) brought three specimens of "Meloscaphander sp A" from a lot taken in about 500m from a submarine canyon off La Jolla. These were particularly fine and recently collected specimens with the typical glassy shell, but which showed pigmentation on the body corresponding to the pigmented liver area in *Parvaplustrum sp A*. This had not been seen in previous specimens, and may fade with longer storage. It did, however, make the two species (*Parvaplustrum sp A* and *sp B*) appear more similar.

The shells of the original lot of *Meloscaphander sp A* (taken at 630m off Orange County) were reexamined. They had lost their glassy transparency in the intervening decade, and were now translucent. Both John Ljubenkov (MEC) and Tony Phillips (Hyperion) recognized them as their "*Haminoea*" from deep-water, and may have additional records of the species in their data under that name. A new voucher sheet will be forthcoming providing description and illustration of the radula, and the key will be modified to reflect the pigmentation of the animal.

Lastly, we compared specimens of *Diaphana californica* and *D. brunnea*. In theory *D. brunnea* occurs in the boreal northeast Pacific, while *D. californica* is from the temperate and subtropical eastern Pacific. In examining specimens of *D. brunnea* from Alaska, no differences from *D. californica* could be seen in the shells. There may be consistent differences in the radula or gizzard plates of these animals, or other anatomical differences, but the shells appear to completely overlap in morphology. Gosliner (in the MMS Atlas) indicated that the separability of these two species should be reexamined, and we concur based on the specimens examined during the meeting. Specimens of *Diaphana minuta* examined from

the Beaufort Sea during the meeting seemed to differ clearly from both *D. brunnea* and *D. californica* on the basis of the rotundity of the body whorl. Lemche (1948) illustrated such a range of shell shapes for *D. minuta* that the differences we saw in the one lot examined may not hold up with examination of other material.

ONE LESS TAXONOMIC MESS

A SCAMIT voucher sheet from Vol. 4 #2,3 (1985) reviewed the status of *Owenia collaris* and compared it to *Owenia fusiformis*. Collar development is a primary diagnostic character. Unfortunately, the presence or absence of the collar has been sometimes erroneously reported in the literature. This voucher sheet suggests that variability of this character needs to be reviewed to better resolve the species concept. The decision at that time was to continue use of the locally applied name, *O. collaris*. The SCAMIT Taxonomic List contains only *O. collaris* partly as the result of this early voucher sheet and assumptions about the validity of *O. fusiformis*. In 1994 J. Dauvin and E. Thiebaut reviewed the *Owenia* mess and published a resolution in the Proceedings of the 4th International Polychaete Conference. They conclude that *Owenia lobopygidiata* and *O. fusiformis* are the only two diagnosable species of *Owenia* and suggest that all records of *Owenia collaris* are *Owenia fusiformis*. They further conclude that *O. fusiformis* is one of a few true cosmopolitan species of polychaetes. A draft of a new SCAMIT voucher sheet is being produced and will be distributed for comments to all those interested.

-Tom Parker

BRANCHING OUT FOR NEW SPECIES... OR SPLITTING HAIRS OVER SPLIT ANTENNAE

Good diagnostic characters are hard to find. Consistent differentiation of one species from another requires good diagnostic characters. As pointed out by Dauvin and Thiebaut, cosmopolitan polychaetes have been widely

reported but difficult to confirm. They conclude that poor descriptions and lack of keys have led to confusion and give examples where several species are listed under a single name (e.g. the names *Terebellides stroemi* and *Spio filicornis* have both contained several different species). Doubtless many other examples can be thought of by newsletter readers. Paraonids are traditionally differentiated on fairly slight differences in delicate structures. Branchial shape and number, neurosetal tip structure (Strelzov illustrates at least 17 setal shapes/tips), and even setal curvature changes within a fascicle have all been used to define genera and/or species. Not surprisingly the interpretation of these features is sometimes uneven. This is fertile territory for new taxa names! The paraonid *Allia ramosa* has been widely reported in local benthic programs and can be differentiated from other paraonids based on its neurosetal structure and branched antennae. It is one of the few paraonids world-wide that have branched antennae. No other paraonid has been locally reported with branched antennae. This species name has been reported from such widespread areas as Puget Sound, Japan, Cape Blanco, and (originally) the Gulf of Peter the Great. Depths range from 10 meters to at least 2400 meters. Is such a wide ranging habitat confirmed by a stable morphological condition? Four published illustrations can be consulted regarding the branched antennae.

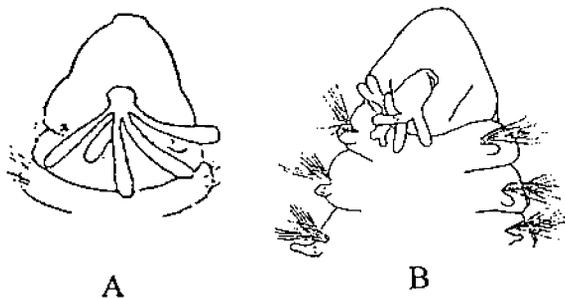
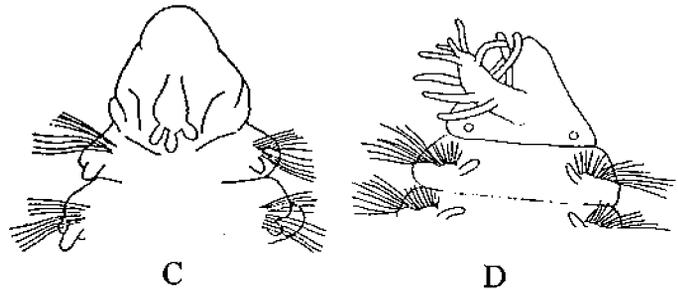


Figure 1 Antennae of *Allia ramosa* from A). Annenkova 1934; B). Strelzov 1973; C). Banse and Hobson 1968; and D). Hartman 1969.

Unfortunately, all four drawings show sharply different branched structures (Figure 1 A-D). Given the fine degree of structural discrimination relied upon in this family to define genera and species, the differences in these antennae are substantial enough to demonstrate a likely mix of species lumped under one name. None of the specimens reviewed from Palos Verdes resemble the original description depicted in illustration "A". They all are better matches for illustration "C".



Which antennae structure have you seen on your specimens? Have you ever seen the bifurcate branches illustrated in Strelzov? (Figure 1C). Has any re-examination of Hartman's specimen (Figure 1 D) been completed? If so, what species was it called. Bring some of your specimens or results of your re-examinations to the next SCAMIT polychaete meeting. We may have to just split the difference by issuing another provisional species voucher sheet for the local taxa.

-Tom Parker

Paraprionospio pinnata

In last month's newsletter there was mention of a table of diagnostic characters for *Paraprionospio* species, as described in the literature, prepared by Leslie Harris. We were unable to include this table with the newsletter due to an incompatible computer file format, but we now have it for this newsletter. Members should use this table to review and compare their own specimens of *Paraprionospio pinnata*. Perhaps this species is not cosmopolitan, as is commonly believed.

A RAPID TECHNIQUE FOR STAINING CIRRATULID POLYCHAETES

Local workers now use methyl green as the stain for species level identification of cirratulid polychaetes. Specimens of *Aphelochaeta* and *Monticellina* are abundant in many survey samples, with single benthic Van Veen grabs containing several hundred cirratulid specimens. These specimens require a great deal of time to handle and manipulate during staining, rinsing, destaining and identification. Problems with the current methods include slow stain uptake, long destaining process times, variable periods of staining and destaining, and messy liquid stain transfer procedures.

In Vol. 14, No. 6 of the SCAMIT Newsletter it was reported that formulation for methyl green stain varied between taxonomists, but that most people used 70% ETOH to dissolve the stain powder. The new modified technique reported here produces a much faster acting stain. The time necessary to process these specimens is greatly reduced. The new formula is:

3.0 grams methyl green powder
30 ml absolute ETOH
100 ml DI water
0.01gms KOH

This solution must be stirred to completely dissolve the powder.

New Staining materials:

Flat bottomed watch glass.
20-30 ml methyl green stain solution.
Gooch-style ceramic crucible (Coors 60151) with perforated bottom (5 cm tall).
Small disc of nitex screen cut to fit inside bottom of crucible.
Deep sided 300 ml pyrex dish for rinsing specimens in crucible.
70% ETOH for destaining.

New Staining Method

1. Set-up on stain resistant surface near sink

2. with bulk 70% ETOH supply.
2. Pour or eyedropper stain solution into watch glass.
3. Place nitex screen in bottom of crucible.
4. With forceps, place a large number (50-100) of specimens inside crucible on top of nitex screen.
5. Immerse perforated bottom of crucible into solution in watch glass.
6. Allow solution to completely cover specimens, add drops of additional stain over specimens if necessary.
7. Wait approximately 1-2 minutes while specimens soak in stain.
8. Remove crucible and specimens to deep sided dish about half full of 70% ETOH.
9. Gently raise and lower crucible within this dish to rinse out the excess stain. Drain and replace with fresh ETOH until most of excess stain is gone.
10. Remove specimens from nitex screen with forceps and place in dish for examination with microscope. With a large number of specimens, an additional step of destaining may be necessary while in the watch glass.

Aphelochaeta marioni specimens will stain in less than two minutes and reveal their characteristic barring pattern after 2-3 brief rinses; while *Aphelochaeta sp. C* stains with it's general non-barred pattern. There does not appear to be any great change in the reported stain patterns with this formulation. Advantages of this new method:

- ☞Rapid stain uptake by specimens greatly reduces identification time.
- ☞Use of crucible to stain and destain assures uniform treatment to all specimens.
- ☞Rapid destaining of specimens in crucible.
- ☞Removes stain handling from the microscope area.
- ☞Produces same stain patterns reported in other technique.

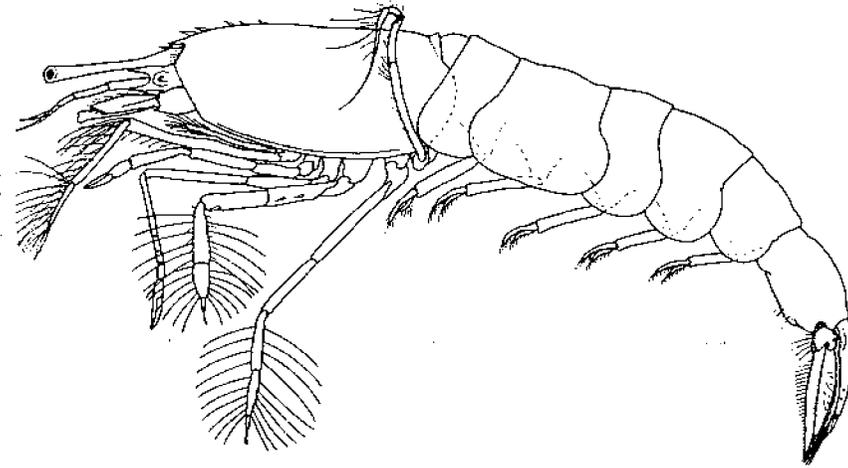
Please send any comments you may have about this technique to the newsletter editor.

-Tom Parker

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SCAMIT TREASURY SUMMARY, 1995-96

During the past fiscal year, April 1995 through March 1996, expenses were twice as great as income reflecting SCAMIT's increased activity in producing newsletters and publications. Costs for producing the newsletter (including printing, postage, and supplies) increased from \$2163.60 for last fiscal year to \$3399.61 due to the increased content of the newsletter. The second edition of the Taxonomic Listing was published (\$779.40) and SCAMIT Grant #96-1 was issued to Larry Lovell for a Nephytid publication (\$584.34). SCAMIT's primary source of income, \$1570.00, came from membership dues which covered half the costs for producing the newsletter. Grants and workshops will continue to be funded from the money collected for creating the Taxonomic Listing for SCCWRP during the 1994-95 fiscal year. The following is a summary of the expenses and income:

Expenses

Newsletter	\$3399.61
Publications (Taxonomic Listing, 2nd ed)	779.40
Grants	584.34
Miscellaneous	183.72
Total	\$5100.77

Income

Dues	\$1570.00
Interest	385.76
T-Shirts	0.00
Donations	10.00
Miscellaneous	510.25
Total	\$2476.01

Account balances (March 31, 1996)

Checking	\$ 999.49
Savings	17068.11
Total	\$18067.60

REVIEW OF THE CEPHALASPIDS OF CALIFORNIA
Don Cadien (CSDLAC) and John Ljubenkov (MEC)
SCAMIT Meeting 22 APRIL 1996

Mollusks of the Order Cephalaspidea (s.l.) are well represented in the waters of the Northeast Pacific. They are frequently encountered in environmental sampling, and nearly always identified to at least generic level by local taxonomists. There are, however, many problems associated with the taxonomy of the group which should be further resolved. This is especially true at this time, when two separate treatments of the group which embody differing authoritative views are being introduced into the literature (the sections on Opisthobranch Mollusks by Gosliner and Gastropod Mollusks by McLean in the Taxonomic Atlas of the Santa Maria Basin and Western Santa Barbara Channel).

This group of opisthobranchs is transitional in that some are externally shelled, and some virtually lack shells. They have been treated both by workers who deal exclusively with shelled mollusks, and those who deal primarily with shell-less mollusks. Shelled mollusks have a fossil record, and many groups were established on the basis of fossils, or on the basis of the shell without reference to the animal which created it. This is a very different approach from that of the general run of opisthobranch workers who usually base their taxonomy on soft anatomy rather than hard parts of the animals they study. In both "camps" the radula is considered an important source of characters for differentiating species and/or higher taxa, but in groups which have been established based on fossils, radular evidence is lacking for the types. Nomenclatural schisms have developed, particularly over genera such as *Acteocina* and *Sulcoretusa* where the generotype is either a fossil or described on shell characters alone.

Characterization and Phylogeny of the group

Until fairly recently the cephalaspids were easily identified by the synapomorphy of possession of a cephalic shield. Recent cladistic analyses have drawn this into question by demonstrating that some groups with cephalic shields belong to other groups. Groups traditionally considered within the confines of the cephalaspids have been excluded on the basis of such cladistic reassessments.

There have been several cladistic analyses of the group, the most complete and recent being that of Mikkelsen 1996. She was very thorough in laying the groundwork for her analysis, testing and discarding many traditionally used characters as inappropriate to the purpose (Mikkelsen 1993). As in the analysis of Gosliner 1981, which was not based on a full application of cladistic methods, characters of the nervous, digestive, and reproductive systems were viewed as of importance in establishing the phylogeny of the group.

In Mikkelsen's analysis the family Acteonidae is removed from the Opisthobranchia, and combined with a few disparate groups at the base of the Heterobranchia. She terms this stem group "unresolved", but there is little doubt that it is very primitive. Other groups traditionally grouped with the Acteonidae in the Acteonoidea were retained in the Opisthobranchia, but outside the Cephalaspidea in the analysis. Representatives of the Hydatinidae and Ringiculidae were joined into another unresolved primitive group the "Architectibranchia"

With the Acteonoidea thus fragmented and dispersed, only three superfamilies remain in the Cephalaspidea; the Bulloidea, the Philinoidea, and the Runcinoidea (which was not included in Mikkelsen's analysis). The first two were united by four synapomorphies in the analysis: flexed ciliated strips in the mantle cavity, three gizzard plates, a secondarily prepharyngeal nerve ring, and

the genital ganglion on the visceral nerve loop (Mikkelsen, 1996). The earlier "synapomorphic" character of possession of a cephalic shield is, based on Mikkelsen's analysis, now not even particular to Opisthobranchia, and within the opisthobranchs is found both in cephalaspids and sacoglossans.

Taxonomy of the group

The taxonomy of the group above the species level is presented in the attached appendix; taxa represented in the northeast Pacific are indicated with asterisks. There are still a number of unresolved problems in the higher classification of the cephalaspids, and the taxonomy as presented here is of necessity subject to immediate or future modification based on new evidence. That presented is derived from traditional sources, and includes several groups now excluded from the cephalaspids on the basis of cladistic analyses.

Californian cephalaspid fauna

Although cephalaspids were treated comprehensively as part of several general mollusk monographs (ie. Pilsbry 1895-96, Oldroyd 1927) they were first specifically addressed for the northeast Pacific by Steinberg (1963). Her treatment is little more than a list of the described species organized into family and higher categories, but it provides a convenient summary of the taxa, and a matrix on which to build. The current list of the California cephalaspids (Table ___) is smaller, with a number of species relegated to synonymy. There are also several undescribed taxa not included in Steinberg's list, some of which are familiar members of our soft-bottom fauna.

Biology of cephalaspids

Cephalaspids are predatory gastropods, living as hunters pursuing prey within the oxic surface layers of the bottom sediments. There are, of course, exceptions to this generalization. First among these are the bullids, which are herbivorous or omnivorous species (Rudman 1971b).

Regardless of diet, all members of the group are well adapted for movement on and through soft sediments. They bear a foot, generally broad, which is well supplied with mucous glands and has a ciliated surface for gliding locomotion. On soft sediments the mucous envelope secreted by the animal allows movement through sediments fine enough to clog respiratory surfaces, and fill the pallial cavity. This is prevented by secretion of a "sheath" within which the animal moves forward. This can be on the sediment surface, or below it. Much the same strategy and methods are used by other gastropod groups including the olivids, and the naticids.

The structure of the body also lends itself to rapid and effective burrowing in soft sediments. The shell is either reduced and internal, or external but covered by extensions of the mantle. This provides a smooth flexible surface over which the mucous envelope slides. Once again structure is homologous with the olivids and naticids, which also share the same life style.

Equipped by the above morphology cephalaspids can rapidly glide about in search of prey. Reported predatory strategy usually involves whole consumption of small prey items, but some members of the Acteonidae use a different strategy. These animals, including the local *Rictaxis punctocaelatus*, harvest exposed palps, cirri, or branchia of polychaete worms (Marcus 1972). This behavior, akin to siphon nipping by fishes, allows the prey to escape and regenerate the lost structures

TABLE 1

CALIFORNIAN CEPHALASPID MOLLUSKS

Superfamily Acteonacea		Superfamily Philinacea	
Family Acteonidae		Family Scaphandridae	
<i>Acteon traskii</i>	Stearns 1898	<i>Acteocina harpa</i>	(Dall 1871)
<i>Microglyphis brevicula</i>	(Dall 1902)	<i>Acteocina oldroydi</i>	Dall 1925
<i>Microglyphis estuarina</i>	(Dall 1908)	<i>Acteocina inculta</i>	(Gould 1855)
<i>Rictaxis painei</i>	Dall 1903	<i>Acteocina carinata</i>	(Carpenter 1857)
<i>Rictaxis punctocaelatus</i>	(Carpenter 1864)	<i>Acteocina intermedia</i>	Willett 1928
Family Hydatinidae		<i>Acteocina smirna</i>	Dall 1919
<i>Parvaplustrum sp A</i>	[SCAMIT 1995]	<i>Tornastra culcitella</i>	(Gould 1853)
Superfamily Diaphanacea		<i>Tornastra rolleri</i>	Ev. Marcus 1977
Family Diaphanidae		<i>Tornastra cerealis</i>	(Gould 1853)
<i>Diaphana californica</i>	Dall 1919	<i>Acteocina eximia</i>	(Baird 1863)
<i>Woodbridgea williamsi</i>	Berry 1953	<i>Acteocina planata</i>	Dall 1919
Superfamily Bullacea		<i>Tornastra infrequens</i>	C. B. Adams 1852
Family Bullidae		<i>Acteocina magdalenensis</i>	(Dall 1919)
<i>Bulla gouldiana</i>	Pilsbry 1895	<i>Meloscaplander sp A</i>	[SCAMIT 1995]
Family Haminaeidae		Family Cylichnidae	
<i>Atys castus</i>	Carpenter 1864	<i>Cylichna attonsa</i>	(Carpenter 1865)
<i>Atys nonscriptus</i>	(A. Adams 1850)	<i>Cylichna diegensis</i>	(Dall 1919)
<i>Diniatys oxystoma</i>	(Berry 1953)	Family Aglajidae	
<i>Micraenigma oxystoma</i>	Berry 1953	<i>Aglaja ocelligera</i>	(Bergh 1894)
<i>Haminaea vesicula</i>	Gould 1855	<i>Doridium adellae</i>	Dall 1894
<i>Haminaea virescens</i>	(Sowerby 1833)	<i>Chelidomura phocae</i>	Marcus 1961
<i>Haminoea olgae</i>	Dall 1919	<i>Melanochlamys diomedea</i>	(Bergh 1894)
Family Retusidae		<i>Aglaja nana</i>	Steinberg & Jones 1960
<i>Sulcoretusa montereyensis</i>	(A. G. Smith & Gordon 1948)	<i>Aglaja sp A</i>	[Cadien]
<i>Sulcoretusa xystrum</i>	(Dall 1919)	<i>Navanax inermis</i>	(J. G. Cooper 1863)
<i>Volvulella californica</i>	Dall 1919	<i>Doridium purpureum</i>	Bergh 1893
<i>Volvulella catharia</i>	Dall 1919	<i>Aglaja bakeri</i>	MacFarland 1924
<i>Volvulella cylindrica</i>	(Carpenter 1864)	Family Philinidae	
<i>Volvulella tenuissima</i>	Willett 1944	<i>Philine alba</i>	Mattox 1958
<i>Volvulella panamica</i>	Dall 1919	<i>Philine bakeri</i>	Abbott 1974 (non Dall 1919)
Superfamily Runcinacea		<i>Philine bakeri</i>	Behrens 1993 (non Dall 1919)
Family Runcinidae		<i>Philine auriformis</i>	Suter 1909
<i>Runcina macfarlandi</i>	Gostiner 1991	<i>Philine bakeri</i>	Dall 1919
<i>Runcinida sp A</i>	[Cadien]	<i>Philine californica</i>	Willett 1944
superfamily uncertain		<i>Philine polystrigma</i>	(Dall 1908)
family uncertain		<i>Broctonia polystrigma</i>	Dall 1908
<i>Bullomorpha sp A</i>	[Ljubenkov 1994]	<i>Woodbridgea polystrigma</i>	(Dall 1908)
		<i>Philine cf quadrata</i>	[MMS] (non Wood 1839)
		<i>Philine sp A</i>	[SCAMIT 1988]
		<i>Philine "no radula/gizzard"</i>	[Gostiner]
		<i>Philine "tubular"</i>	[Gostiner]
		Family Gastropteridae	
		<i>Gastropteron pacificum</i>	Bergh 1894

- thus providing a renewable food source. Other acteonids apparently take the entire animal. Hurst (1965), for instance, records finding the polychaete *Owenia fusiformis* in the gut of *Acteon tornatilis*.

More typical predatory behavior is shown by *Tornastra culcitella* and *Cylichna attonsa*, which are selective feeders on benthic foraminifers (Shonman and Nybakken 1978). Similar feeding behavior is exhibited by *Retusa chrysoma* (Burn and Bell 1974) and *Relichna murdochi* (Rudman 1971a). Burn and Bell (op. cit.) report *R. chrysoma* also selectively consumes a small gastropod, *Salinator fragilis*. Consumption of small gastropods is also reported for the local *Acteocina harpa* (Beeman and Williams 1980).

Other members of the Philinoidea are their own worst enemies. Members of the Aglajidae are specialized opisthobranch predators, feeding on nudibranchs, other cephalaspids, and in many cases other individuals of their own species. The behavior of these hunters is best known through studies of our local *Navanax inermis* (Paine 1963, 1965). Hunting in these animals is strongly based on chemosensitivity to chemical cues left in the mucous trails of their opisthobranch prey. Once a trail is crossed by a *Navanax*, it is turned onto and followed to its end, either in a meal or not, depending on which direction the predator adopts initially (to or away from the prey). If the prey is encountered it is attacked and swallowed whole by muscular contraction of the *Navanax* buccal bulb. No crushing or mastication of the prey occurs after swallowing, so that even very delicate shells of shelled prey are undamaged during passage through the *Navanax* digestive tract. Savvy shell collectors have long used this method of collection for the fragile shells of *Haminaea*, *Philine* and other cephalaspids. Not-so-savvy field collectors have found to their chagrin that a bucket full of opisthobranchs + one hungry *Navanax* = one contented *Navanax*, and nothing else.

Much more catholic tastes are exhibited by the introduced *Philine auriformis*. Food appears to be taken in proportion to availability in the environment, with food broadly defined. These hearty eaters have had guts filled with ophiuroid arm fragments, the crushed tests of the foraminifer *Rhabdamina*, other cephalaspids, *Pectinaria*, small *Parvilucina* and a variety of less identifiable fragments of benthic invertebrates. In their native New Zealand they are more specialized on strongly shelled small bivalves (Rudman 1970). Although predation by these animals has not been directly observed, it is assumed that capture is by snagging with the radula, followed by swallowing aided by the buccal pump. Once consumed the food is passed to the gizzard, where it is crushed by the action of the triad of robust gizzard plates and the muscular contractions of the gizzard. For those with sufficient interest in the subject, a wealth of information is available on feeding and digestion in cephalaspids (see for instance Rudman 1971a, b; 1972a, b, c, d).

All known members of the group are hermaphroditic, as are other opisthobranchs. Each animal contains both male and female reproductive organs, although these may not be simultaneously functional. Reproduction involves an exchange of sperm, internal fertilization, and deposition of fertilized eggs in an egg mass. Development is either direct, with larval stages passed within the egg and hatching as a metamorphosed juvenile; or indirect, with hatching of larvae from the egg. In the latter case the larval form may be short lived, metamorphosing rapidly into a benthic juvenile, or planktonic, with the larva (veliger) feeding for some period in the water column prior to metamorphosis.

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APPENDIX - WORLD GENERA OF CEPHALASPIDEA

Superfamily Acteonoidea

Family Acteonidae

- * Acteon Montfort 1810
 - Tomatella Lamarck 1812
 - Speo Risso 1826
 - Kanilla Sowerby 1838
 - Myosota Gray 1847
 - Alexandria Tomlin 1926 non Pfeiffer 1881
 - Tomlinula Strand 1932
- Crenilabrum Cossmann 1869
 - Lissacteon Monterosato 1890
- Inopinodon Bouchet 1975
- Iaponacteon Taki 1956
- Maacteon Rudman 1971
- * Microgyphis Dall 1902
- Mysouffa Ev. Marcus 1974
- Neactaeonina Thiele 1912
- Ovulacteon Dall 1889
- Pupa Roeding 1798
 - Solidula Fischer von Waldheim 1807
- * Rictaxis Dall 1871
 - Acteonoidea Gabb 1872
 - Pseudacteon Thiele 1925

Family Bullinidae

- Bullina Ferrussac 1822
 - Bullinula Swainson 1840
 - Perbullina Iredale 1929

Family Hydatridae

- Aplustrum Schumacher 1817
- Hydatina Schumacher 1817
- Micromelo Pilsbry 1894

Family undescribed

- * Parvaplustrum Powell 1951

Family Ringiculidae

- Ringicula Deshayes 1838

Superfamily Philinoidea

Family Scaphandriidae

- * Acteocina Gray 1847
 - Tomatina A. Adams 1850
 - Didontoglossa Annandale 1924
 - Neacteocina Kuroda and Habe 1952
- Cylichnum Dall 1908
- Mamillocychna
- Melioscaphander Schepman 1913
- Scaphander Montfort 1810
 - Bullaria Rafinesque 1815
 - Assula Schumacher 1817
- * Tomastra Ev. Marcus 1977

Family Cylichnidae

- * Cylichna Lovén 1846
 - Bullina Risso 1826 non Ferrussac 1822
 - Cylindrella Swainson 1840 non L. Pfeiffer 1840
 - Cyclina Gray 1857 non Deshayes 1850
 - Bullinella R. B. Newton 1891

Cylichnella Gabb 1873

Family Aglajidae

- * Aglaja Renier 1807
 - Doridium Meckel 1809
 - Acera Cuvier 1810
 - Bullidium Leue 1813
 - Lobaria Blainville 1825 non O. F. Müller 1776
 - Eidothea Risso 1826
 - Posterobranchaea Orbigny 1837
 - Posteobranchus Gray 1847
 - Posterobranchus Gray 1847
- Chelidonura A. Adams 1850
 - Hirundella Gray 1850
- * Melanochlamys Cheeseman 1881
- * Navanax Pilsbry 1895
 - Strategus Cooper 1862 non Hope 1837
 - Navarchus Cooper 1863 non Filippi & Verany 1857
- Odentogljaja Rudman 1978
- Philinopsis Pease 1860

Family Philinidae

- * Philine Ascanius 1772
 - Lobaria O. F. Müller 1776
 - Bullaea Lamarck 1801
 - ?Woodbridgea Berry 1953
- Philinorbis Habe 1950
- Pseudophilina Habe 1976
- Spiniphiline Gosliner 1988

Superfamily Philinoidea (cont.)

Family Gastropteridae

- Enotepteron Minichev 1967
- * Gastropteron Meckel (in Kosse) 1813
 - Sarcopterus Rafinesque 1814
 - Gastroptera Blainville 1825
- Sagaminopteron Tokjoka & Baba 1964

Superfamily Diaphanoidea

Family Diaphanidae

- Colobocephalus M. Sars 1870
 - Colpodaspis M. Sars 1870
 - * Diaphana Brown 1837
 - Roxania Turton 1834 [preocc]
 - Amphisphyrta Lovén 1846
 - Physema H. & A. Adams 1854
 - Newnesia Smith 1902
 - Anderssonia Smith 1902
 - Toledonia Dall 1902
 - Odostomiopsis Thiele 1903
 - Ohlinia Strebef 1905
 - Pisanula N. Odhner 1914
- Family Notodiaphanidae
- Notodiaphana Thiele 1917
 - Diaphanella Thiele 1912 non Clessin 1880

Superfamily Bulloidea

Family Bullidae

- * Bulla Linnaeus 1758
 - Bullus Montfort 1810
 - Bullaria Rafinesque 1815
 - Bullea Blainville 1825
 - Vesica Swainson 1840
 - Quibulla Iredale 1929

Family Bullactidae

- Bullacta Bergh 1901
 - Atyscaphander Annandale 1924

Family Haminoeidae

- Aliculastrum Pilsbry 1896
 - Alicula Ehrenberg 1831 non Eichwald 1830
- * Alys Montfort 1810
 - Naucum Schumacher 1817
- Austrocylichna Burn 1974
- Cylichmatys Kuroda & Habe 1952
- * Diniatys Iredale 1936
 - Micraenigma Berry 1953
- * Haminaea Turton & Kingston 1830
 - Haminea Gray 1847
 - Liloa Pilsbry 1921
- Limulatus Iredale 1936
- Micratys Habe 1952
- Mimatys Habe 1952
- Phanerophthalmus A. Adams 1850
 - Cryptophthalmus Ehrenberg 1821
 - Lathophthalmus Pruvot-Fol 1931
- Smaragdina A. Adams 1848
 - Linteria A. Adams 1850
 - Glauconeia Gray 1850
- Weinkauffia A. Adams 1858

Family Retusidae

- Pyrumculus Pilsbry 1894
 - Sao H. & A. Adams 12854 non Billberg 1820
- Retusa Brown 1827
 - Utriculus T. Brown 1844 non Schumacher 1817
 - Coleophysus P. Fischer 1883
- Relichna Rudman 1971
- * Sulcoretusa J. Q. Burch 1945 [=Cylichnina Monterosato 1884 fide Abbott 1974]
- * Vohvella Newton 1891
 - Vohvula A. Adams 1862 non Gistel 1848
 - Rhizorus auct. non Montfort 1810

Superfamily Runcinoidea

Family Ildicidae

- Ildica Bergh 1889
- Lapinura Marcus & Marcus 1970

Family Runcinidae

- Illia Burn 1963
- Metaruncina Baba 1967
- Pseudobilia Miller & Rudman 1968
- * Runcina Forbes 1851
 - Pelta Quatrefages 1844 non Berk 1837
 - Runnica Miller & Rudman 1968
- Runcinella Odhner 1924
- * Runcinida Burn 1963

ANATOMY OF NEW CEPHALASPIDEA

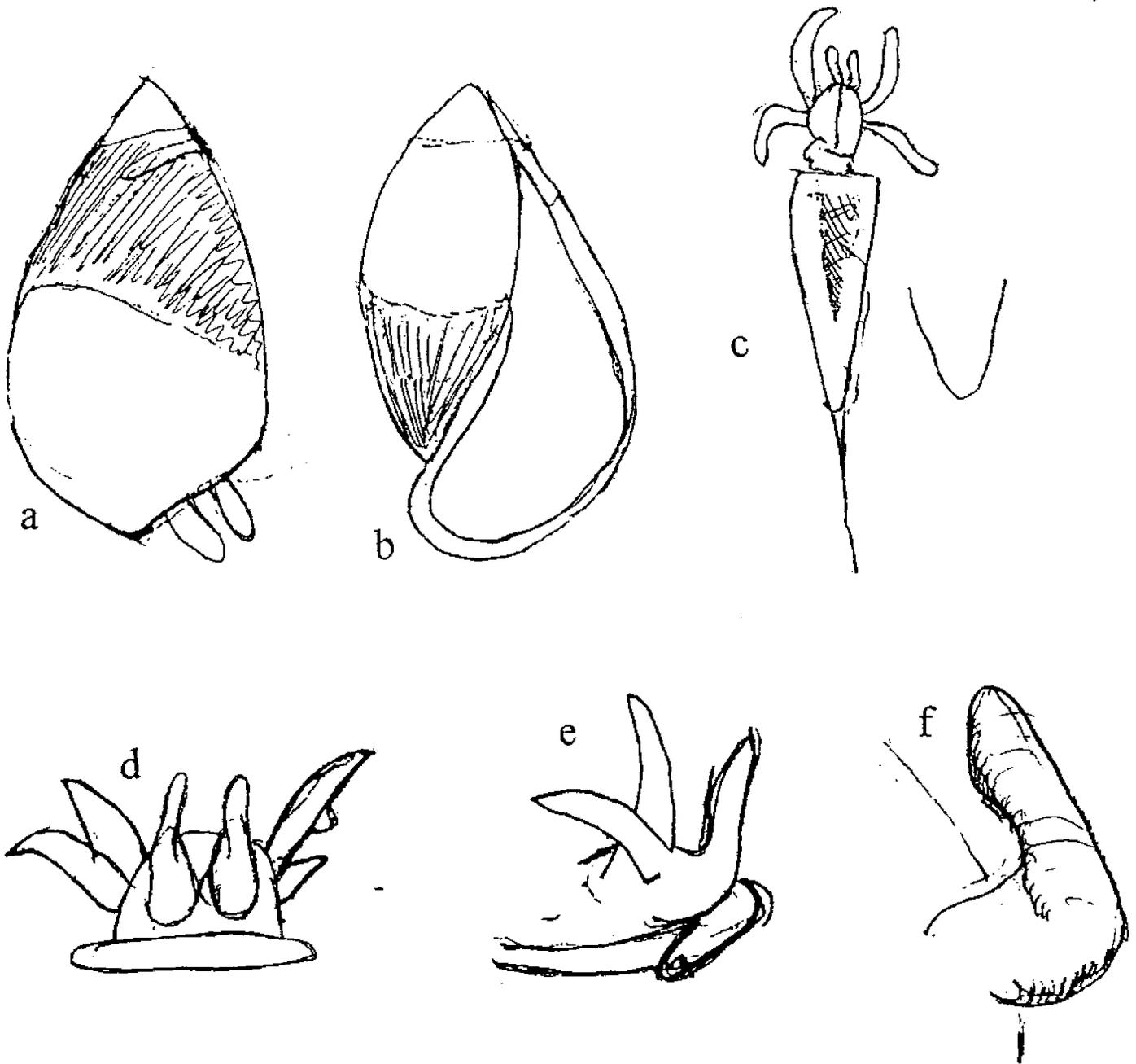
While most molluscan taxonomists ignore the soft bodies of their specimens, it is often the case that fleshy parts have many features which aid greatly in identification. These characters allow for the correct identification of damaged specimens with incomplete shells (often the case in screened material).

Paraplustrum sp. A

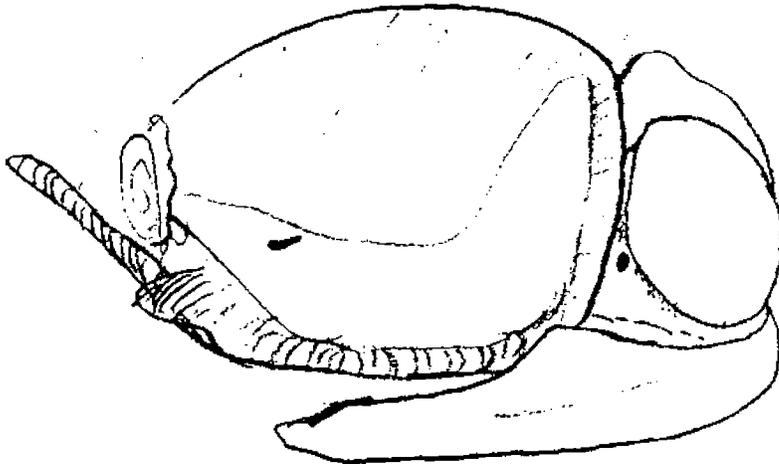
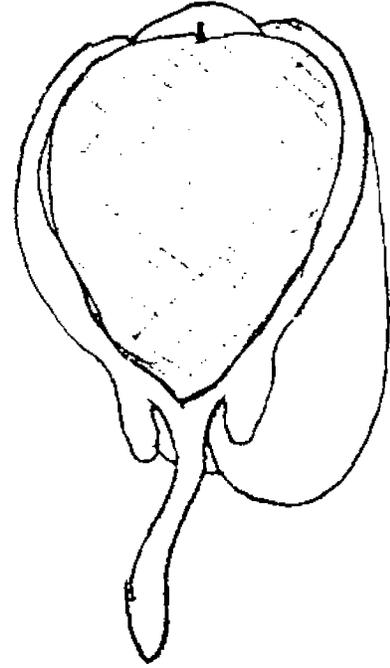
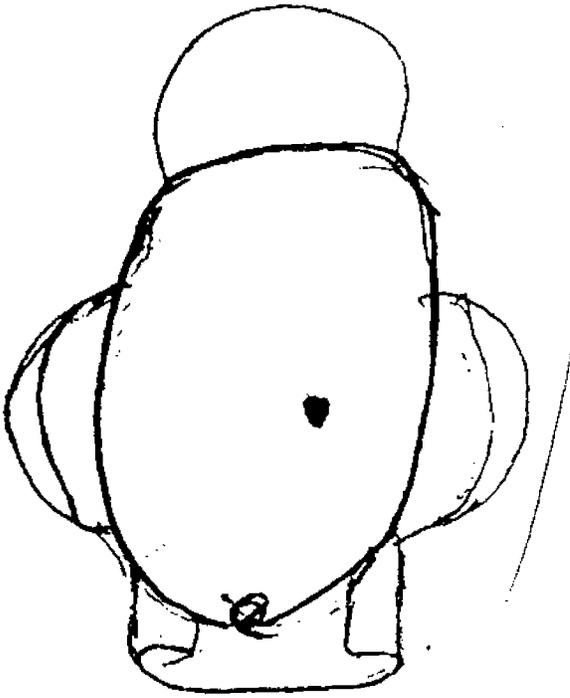
The **head** and its appendages are quite unique in comparison to other opisthobranchs. The center frontal portion of the head has a pair of **palps**(?) with swollen bases and digitiform distal ends. Posterolateral to each palp is a pair of **cephalic tentacles** whose bases are next to each other, and in one instance the bases were united.. The anterior foot margin is extended on both sides into **propodial lobes** (which may be hidden by contraction). I have been unable to find eyes, but it would not be surprising if they possessed them.. The **metapodium** or posterior end of the foot is extended into a long thread-like structure, also often hidden through contraction, but its exact position in life is unknown.

Bullomorpha sp. A

The **foot** is broadly cuneate and tapering posteriorly; it possesses two **parapodial lobes** which broadly flare out at the sides of the body. The **cephalic lobe** or disc is dorsally attached to the anterior end of the shell and usually protrudes even in contracted specimens. The **eyes** are positioned on the body just posterior to the base of the cephalic lobe and on either side of the mid-line of the dorsum. The **mantle** has a thickened edge anteriorly and dextralaterally (mainly following the lip of the shell. At the rear the mantle flares out into a **posterior mantle lobe**; of which the central portion is elongated into a **pseudo-metapodium** that coils into the involute spire. There is always a black, heavily **pigmented spot** on the mantle on the right side of the animal just forward of the posterior lobe. There is a **spermathecal groove** on the dorsal surface of the right-hand parapodial lobe.



Parvaplustrum sp. A, FIGURES a-f. [a] dorsum with liver dark; [b] ventrum with dark liver, note thickened lip of mantle; [c] underside of head and foot with long threadlike metapodium, note contracted metapodium; [d] frontal view of head; [e] side view of head with one palp and two cephalic tentacles; [f] palp, lateral view.



Bullomorpha sp. A, FIGURES 1-3: *Fig. 1:* Dorsal view with shell, pigmented spot showing through; *Fig. 2:* Ventral view; *Fig. 3:* View of right side of animal, no shell.

Cephalaspidea and gizzard plates

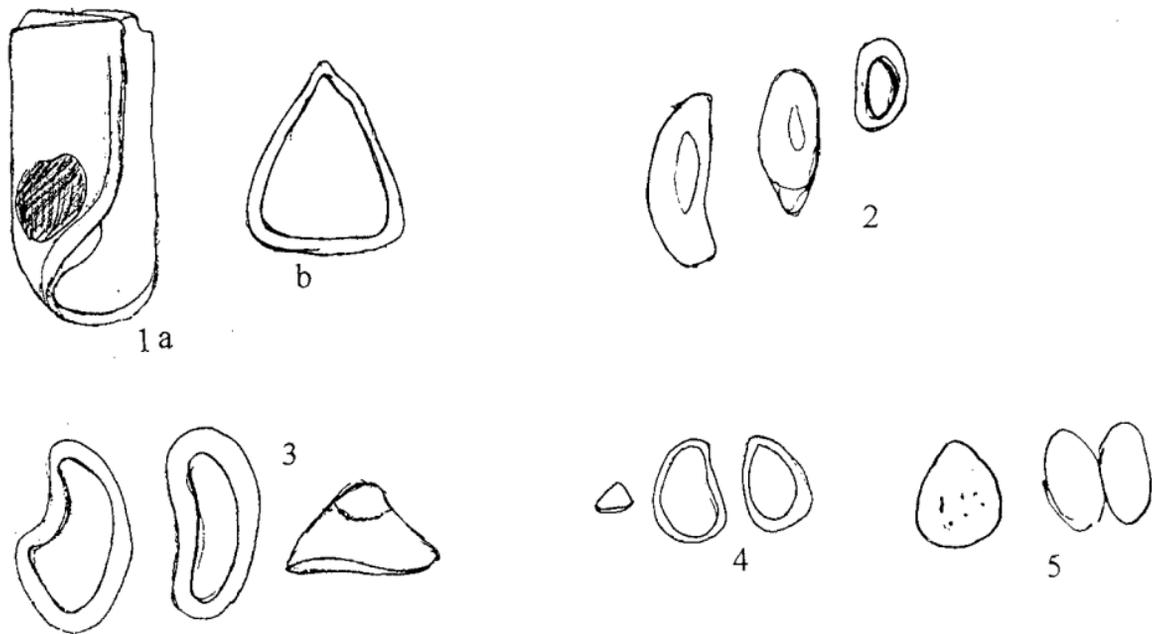
Many genera of Cephalaspideans possess gizzard plates and it is unfortunate that their exact relevance to taxonomy at higher levels will remain nebulous until more work is done. Somewhere along the length of the digestive tract, and posterior to the buccal bulb, the heavily reinforced sac which contains the gizzard plates can be found. The buccal bulb contains the radula, which is generally not that difficult to find and prepare for the microscope. Far easier to find, however, are the gizzard plates.

There are usually three plates composed of a tough, horny material that is dark and translucent. Each plate abuts the other two on its inner grinding face, while its back is embedded in the tough ligaments of the sac. The presence or absence of gizzard plates is most certainly of importance at the generic level i.e. all the species in a genus are alike in having or not having plates; usually their general shapes indicate a genus and the species are hard to differentiate except by very subtle variations. In genera such as *Cylichna* and *Philine* there are three equal (in size and shape) plates that are elongate, ovoidal, and flattened. In *Acteocina* and *Tornastra* (= *Acteocina*, in part) there are two equal paired plates and a third small plate of varied shape. In *Bulla* and *Haminaea* the three equal plates have their ends curled backward and their faces are adorned with a series of ridges for extra grinding efficiency. The shapes must reflect both the food item and the exact masticatory movements employed. Three equal, simple plates would seem to be the primitive condition with asymmetrical teeth (and masticatory patterns) arising later.

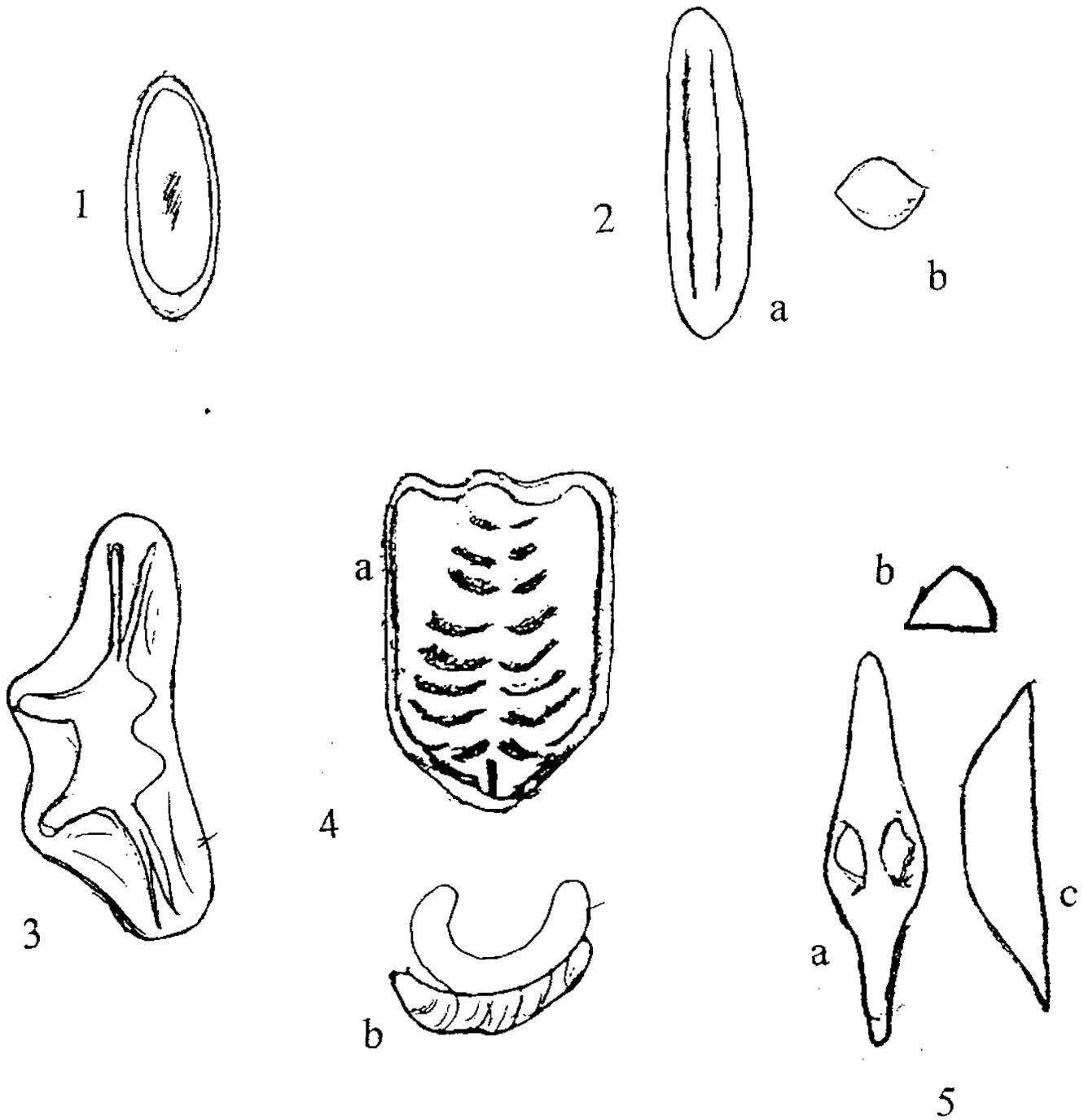
Locating gizzard plates

In benthic surveys, the most frequently encountered specimens are preserved rather than live animals, and therefore what follows refers to dead, contracted specimens. You will need a binocular microscope, very fine forceps and a small sharp scalpel.

Usually for the genera *Cylichna*, *Tornastra*, *Bulla*, *Haminaea*, etc., the gizzard sac is located just below the shell under the portion of the body whorl adjacent to the anterior part of the aperture. If this region of the shell is broken away, at least the uppermost gizzard plate will become apparent and the entire sac can be lifted out using only forceps and digging a little. With inspection it can be seen where the plates separate and a few careful scalpel cuts will cut the binding ligaments exposing the individual plates. The plates in *Bulla* and *Haminaea* are so large and obvious almost any cut through the animal is sufficient to expose them. In *Philine* spp. the sac is along the midline of the body and a simple incision through the center will cut through flesh and then encounter the sac which can be teased out with forceps.



FIGURES 1-5: Fig 1: *Acteocina inculta*, [a] dark area shows general location of gizzard plates; [b] unpaired gizzard plate; Fig. 2: *Tornastra cf. cerealis*, ala Marcus via MacLean, size 0.4-0.8 mm in length; Fig. 3: *Acteocina harpa*, size of longest plate about 0.6 mm; Fig. 4: *Tornastra cerealis/culcitella/eximia*, according to McLean, size unknown; Fig. 5: *Sulcoretusa xystrum*, size about 0.16 x 0.32 mm.



FIGURES 1-5. Fig. 1: *Cylichna diegensis*, size 0.9 x 0.4 mm, grinding face; Fig. 2: *Philine* sp. A, size 0.86 x 0.24 mm, [a] grinding face, [b] cross section; Fig. 3: *Bulla gouldiana*, size 5 mm in length, grinding face with central callous; Fig. 4: *Haminaea* spp. (generalized), size 1.8 x 1.3 mm, [a] grinding face with transverse ridges, [b] side view of plate with translucent, cartilaginous "backing plate"; Fig. 5: *Philine auriformis*, size 3.1 mm in length. [a] grinding face, [b] cross section, [c] side view.

PARAPRIONOSPIO

CHARACTER	AFRICANA Augener 1918	ALATA Moore 1923 (Pt. Pinos)	COORA Wilson 1990	LAMELLIBRANCHIA Hartman 1974
Prostomium shape	clearly pointed anterior	anterior blunt, slightly rounded	rounded anteriorly, spindle-shaped	rounded in front
No. of branchial pairs		3 pairs		3 pairs
Branchial lamellae		double row of pinnae on caudal face	basally bifoliate, then febelate	bifoliate, each lamellae penetrated by 3 vascular loops
Notopodial lobes		1st rudimentary; 2-5 then palette-shaped, with broad free ends covering the back; after 5 gradually reducing, by set. 24 only small, flattened lobe	elongate triangular lobes longest set. 1-4; then reducing in size but remaining dorsally acuminate; elongate subulate by set. 20, then cleftiform by set. 35	1-5 large, triangular, increasing in size thru set. 2-3 & then diminishing thru several segments until rounded lobes
1st branchiae with anterior basal lamellae		not mentioned	several, triangular, on anterior surfaces	not mentioned
Papillae on posterior margin of peristomial wings		not mentioned	yes, small	not mentioned
Filament at base of 3rd branchiae		not mentioned	no	no
Transverse dorsal crests		not mentioned	no	no
Lateral anal cirri		incomplete	yes, may be extremely fine	no
Neuropodial hooks begin; # of pairs of apical teeth		somite 20	set. 9; 2 prs., with internal striate hoods	set. 9; 2 prs; internal hood not mentioned or illustrated
Notopodial hooks begin; # of pairs of apical teeth		not mentioned; up to somite 50 with only capillaries	set. 38-41; 2 prs. shown in II; internal striate hoods	post postmedian parapodia; 2 prs; no mention of internal hood
Smooth, nonlimbate capillaries completely replace granulate limbate neurosetae by		not mentioned	appear at set. 9, replace smooth by set. 13	not mentioned
Smooth nonlimbate capillaries completely replace granulate limbate notosetae by		not mentioned	replaced by set. 24	not mentioned
Sabra setae begin		not mentioned	set. 9	present, but not specified
Ventral bilobed flap in set. 8		not mentioned	no	not mentioned
Interparapodial pouches		not mentioned	begin set. 8/9 to 13/14 (0.9 mm wide), up to 20/21 (1.8 mm wide)	present in larger worms, from set. 10-1 to 19-20, best developed at set. 16-18
Transverse dorsal ridges		not mentioned	set. 13-18; about 13-15 lighter colored, 2-3 per setiger	not mentioned
Dorsal glandular rings		not mentioned	not mentioned	not mentioned
Transparent cuticular areas on dorsum		not mentioned	no	not mentioned
Pigment spots on peristomium		not mentioned	can be present or absent	not mentioned
Ventral groove		not mentioned	not mentioned	not mentioned
Specimen size		head+53 seg. inc.: 29x1.6 mm	48 set. com.: 8x0.4mm 37 set. inc.: 19x1.6mm	141x2.0 mm for ___ set
Specimen locality		Pt. Pinos, CA	New South Wales; Tasmania	Mozambique Channel & northern Indian Ocean

PARAPRIONOSPIO

CHARACTER	PINNATA sensu Day	PINNATA sensu Fauvel 1932 (India)	PINNATA (Iranian Gulf) sensu Wesenberg-Lund 1949	PINNATA INAEQUIBRANCHIA Caulery 1914	PLUMOSA Treadwell 1931 (Chesapeake)
Prostomium shape		not mentioned	rounded in front		rounded anterior
No. of branchial pairs		3-4 pairs, most with 4	3 pairs		"should be 3" pairs
Branchial lamellae	bifoliate	pinnate, nearly flabelliform gills	pinnate with 2 rows of pinnules		two rows of filaments, development variable
Notopodial lobes		not mentioned	III: 1-4 large, lanceolate		flattened citrus-like lobe, largest on set. 1-3, then gradual decrease so they practically disappear by set. 8-10
1st branchiae with anterior basal lamellae		not mentioned	not mentioned		not mentioned
Papillae on posterior margin of peristomial wings		not mentioned	not mentioned		not mentioned
Filament at base of 3rd branchiae		yes, often very small	yes, #. shows 1 filament on left side & 2 on right side	yes	not mentioned
Transverse dorsal crests	set. 21-30	1 female w/ eggs had crests on 21st-25th	whitish crest, seg. 11-17, on some sexually mature worms		not mentioned
Lateral anal cirri		not mentioned, median only	not mentioned, only median		incomplete specimens
Neuropodial hooks begin; # of pairs of apical teeth		not mentioned	set. 9; teeth & internal hood not mentioned	4 pairs	set. 9; row of 3 smaller teeth above large subterminal tooth; double hood present
Notopodial hooks begin; # of pairs of apical teeth		not mentioned	not mentioned		posterior; resemble those of anterior neuropodia
Smooth, nonlimbate capillaries completely replace granulate limbate neurosetae by		not mentioned	not mentioned		not mentioned
Smooth nonlimbate capillaries completely replace granulate limbate notosetae by		not mentioned	not mentioned		not mentioned
Sabra setae begin		not mentioned	not mentioned		not mentioned
Ventral bilobed flap in set. 8		not mentioned	not mentioned		not mentioned
Interparapodial pouches	lacking	not mentioned	not mentioned		not mentioned
Transverse dorsal ridges		not mentioned	not mentioned		not mentioned
Dorsal glandular rings		not mentioned	not mentioned		not mentioned
Transparent cuticular areas on dorsum		not mentioned	not mentioned		not mentioned
Pigment spots on peristomium		not mentioned	not mentioned		not mentioned
Ventral groove		not mentioned	not mentioned		not mentioned
Specimen size		not mentioned	not mentioned		15x0.6mm incomplete
Specimen locality		India, Burma	Iranian Gulf		Chesapeake Bay

PARAPRIONOSPIO

CHARACTER	PINNATA sensu Wilson 1990 (LECTOTYPE)	PINNATA Foster 1968, 1971 (mixed)	PINNATA sensu Blake 1995 (MMS/ Wilson)	PINNATA sensu Maciolek (1985 mixed/Foster)
Prostomium shape	truncate to slightly rounded anteriorly	very narrow tapered cylinder to spindle-shaped	expanded slightly & rounded on anterior margin	spindle-shaped
No. of branchial pairs	3 pairs	3 pairs	3 pairs	3 pairs
Branchial lamellae	all bifoliate	pinnate (figs. of adult branchiae show bifoliate basally, foliate medially & distally)	bifoliate	large plate-like pinnules
Notopodial lobes	longest on set. 2-4; then becoming low rounded lobes to about set. 22, then lanceolate to at least 35	lanceolate on set. 1-5; post. to set. 5 increasingly rounded; then become long & thin until acuminate	longest on set. 2-4, triangular; reduced, low & rounded to about set. 20; then lanceolate to end	largest on set. 1-5, foliose; becoming smaller on subsequent setigers (no mention of later enlargement)
1st branchiae with anterior basal lamellae	no	not mentioned	not mentioned	not mentioned
Papillae on posterior margin of peristomial wings	no	not mentioned	no	not mentioned
Filament at base of 3rd branchiae	no	In some specimens	no, except on largest specimens	not mentioned
Transverse dorsal crests	no	not mentioned	sometimes set. 21-28	not mentioned
Lateral anal cliri	no	yes	yes	yes
Neuropodial hooks begin; # of pairs of apical teeth	set. 9; 3 pra., with internal striate hoods	set. 9; II. shows both 3 pra. & 4 pra.; internal striate hoods	set. 8; 3 pra.; with internal striate hoods	set. 9; 4 pra.; secondary hood present
Notopodial hooks begin; # of pairs of apical teeth	set. 33; 3 pra. in III.; internal striate hoods	posterior to set. 19; nr. pra. not given; internal striate hoods	set. 32-50, size-dependant	set. 20; 4 pra.; secondary hood present
Smooth, nonlimbate capillaries completely replace granulate limbate neurosetae by	transition set. 10-15	not mentioned	first appear set. 9	not mentioned
Smooth nonlimbate capillaries completely replace granulate limbate notosetae by	transition set. 10-15	not mentioned	not mentioned	not mentioned
Sabre setae begin	broken off on lectotype	set. 9	set. 9	set. 9
Ventral bilobed flap in set. 8	no	not mentioned	not mentioned	not mentioned
Interparapodial pouches	no	some specimens: pouches or thin membranes accompanying clear hyaline circles, start about set. 20	no, but set. 4-8 with enlarged swellings	no
Transverse dorsal ridges	not mentioned	not mentioned	not mentioned	not mentioned
Dorsal glandular rings	not mentioned	not mentioned	set. 12-16	not mentioned
Transparent cuticular areas on dorsum	semi-transparent patches dorsal cuticle set. 21-35	beginning about set. 20 on some specimens	set. 21-28	not mentioned
Pigment spots on peristomium	no	occasionally 2 diffuse areas	can be present or absent	not mentioned
Ventral groove	shallow depression on set. 1-20, then deep groove	not mentioned	shallow, deepening towards posterior	not mentioned
Specimen size	35 set. inc.: 16x2.0 mm, female lectotype	122 set.; up to 48 mm long	largest 120 set, 65x1.5 mm	not mentioned
Specimen locality	Lectotype - Chile	cosmopolitan	MMS material	cosmopolitan

PARAPRIONOSPIO

CHARACTER	TREADWELL (= plumose) Hartman 1951 (east coast)	TRIBRANCHIATA Berkeley 1927 (Nanoose Bay)
Prostomium shape	not mentioned	rounded anteriorly
No. of branchial pairs	4 pairs	3 pairs
Branchial lamellae	branchiae pinnately divided	about 80 transverse pinnae on posterior face, projecting on both sides
Notopodial lobes	not mentioned	1-5 largest, lanceolate; diminish & become more rounded until set. 22, when becomes lanceolate again
1st branchiae with anterior basal lamellae	not mentioned	not mentioned
Papillae on posterior margin of peristomial wings	not mentioned	not mentioned
Filament at base of 3rd branchiae	not mentioned	not mentioned
Transverse dorsal crests	not mentioned	not mentioned
Lateral anal cirri	not mentioned	no complete specimens
Neuropodial hooks begin; # of pairs of apical teeth	set. 9; uniseriate row of several smaller teeth; internal hood not mentioned	somite 10 (setiger 9); 3 secondary hooks; internal hood not mentioned
Notopodial hooks begin; # of pairs of apical teeth	"segments far back"; uniseriate row of several smaller teeth; internal hood not mentioned	posterior somites; # teeth & internal hood not mentioned
Smooth, nonlimbate capillaries completely replace granulate limbate neurosetae by	not mentioned	not mentioned
Smooth nonlimbate capillaries completely replace granulate limbate notosetae by	not mentioned	not mentioned
Sabre setae begin	set. 9	somite 10 (set. 9)
Ventral bilobed flap in set. 8	not mentioned	not mentioned
Interperapodial pouches	not mentioned	not mentioned
Transverse dorsal ridges	none	not mentioned
Dorsal glandular rings	not mentioned	not mentioned
Transparent cuticular areas on dorsum	not mentioned	not mentioned
Pigment spots on peristomium	not mentioned	yes
Ventral groove	not mentioned	not mentioned
Specimen size	15 to 30-40 mm	head+29 seg: 31 mm (type)
Specimen locality	Maryland, North Carolina, <i>Louisiana</i>	Nanoose Bay, B.C.

PARAPRIONOSPIO

CHARACTER	FORM A Yokoyama & Tamai 1981	FORM B Yokoyama & Tamai 1981*	FORM CI Yokoyama & Tamai 1981	FORM CII Yokoyama & Tamai 1981
Prostomium shape	bluntly pointed to round or truncate	round anterior end	round or bluntly pointed	round or bluntly pointed end
No. of branchial pairs	3 pairs	3 pairs	3 pairs	3 pairs
Branchial lamellae	all bifoliate, attached serially in 2 rows; w/ reticulated vascular tract within lamellae	bifoliate proximally; flabellate medially & distally; serial rows	bifoliate proximally, flabellate medially & distally	bifoliate proximally, flabellate medially & distally
Notopodial lobes	lanceolate, distally pointed; reduce in size, become rounded after set. 4; become acuminate in posterior	long, distally tapered; reduce in size, become low & rounded after set. 4; posteriorly subtriangular to lanceolate	long, foliaceous, distally pointed; after set. 4 gradually rounded; posterior to set. 10 increasingly elevated	lanceolate with tapered end; after set. 4 gradually reduced & rounded; posteriorly become blade-like
1st branchiae with anterior basal lamellae	no	no	yes - several, triangular	yes, 1-5
Papillae on posterior margin of peristomial wings	yes, small	no	yes	yes
Filament at base of 3rd branchiae	yes, length variable	yes	no, but occasionally very small protuberance	yes
Transverse dorsal crests	set. 21-38	no	no	no
Lateral anal cirri	yes	yes	yes	no
Neuropodial hooks begin; # of pairs of apical teeth	set. 9; 3 prs.; with internal striate hoods	set. 9; 3 prs; with striate internal hoods	set. 9; 3 prs., with internal striate hoods	first appear posterior to set. 9; 3 prs.; internal striate hoods
Notopodial hooks begin; # of pairs of apical teeth	usually set. 35 (posterior to set. 31-36); 3 prs; internal striate hoods	posterior to set. 36-42; 3 prs; with striate internal hoods	posterior to set. 24-54; 3 prs; internal striate hoods	posterior to set. 34-42; 3 prs; internal striate hoods
Smooth, nonlimbate capillaries completely replace granulate limbate neurosetae by	first appearance set. 10	first appear at set. 9	first appear at set. 9	first appear set. 9
Smooth nonlimbate capillaries completely replace granulate limbate notosetae by	posterior to middle body region	first appear at set. 9	posterior to set. 16	set. 9
Sabre setae begin	set. 9	set. 9	set. 9	set. 9
Ventral bilobed flap in set. 8	no	yes	no	no
Interpodial pouches	no	usually from set. 9 (8-10), variable, up to set. 42	on some specimens, usually begin set. 8(7-9), thru variable number of setigers	yes; first occurrence variable, from set. 4 to 15
Transverse dorsal ridges	not mentioned	not mentioned	not mentioned	not mentioned
Dorsal glandular rings	not mentioned	not mentioned	not mentioned	not mentioned
Transparent outcicular areas on dorsum	set. 21-36, with dorsal crests, with many concavities	set. 21-38	not found	set. 21-31
Pigment spots on peristomium	no	no	yes	yes
Ventral groove	not mentioned	not mentioned	not mentioned	not mentioned
Specimen size	114 set.: 81 mm	94 set.: 37 mm	120 set.: 70 mm long	98 set.: 65 mm long
Specimen locality	Japan	Japan	Japan	Japan