PHYLUM PLATYHELMINTHES

Class Turbellaria

The Platyhelminthes comprise three classes of which two, the Trematoda (flukes) and Cestoda (tapeworms), are parasitic and although well represented in the Woods Hole region are not treated in this manual. Of the mostly free living class Turbellaria, a few species of the orders Tricladida and Polycladida are well known to investigators at the MBL, but there are a great many small forms belonging to the orders Aceola, Rhabdocoela, and Alloeocoela which are not well known, and which merit much further investigation. The work of Dr. Louise Bush in preparing the preliminary key, check list, and illustrations of these smaller forms is gratefully acknowledged.

METHODS OF COLLECTING AND HANDLING TURBELLARIANS

by Dr. Louise Bush

Turbellarians may be collected in several ways. Many of the larger forms will come to the top of the water or crawl to the surface of mud or debris which has been allowed to stand in containers in the laboratory for several hours or days. This is the time honored method and works well for large marine species and for many fresh water forms, but the smaller marine species do not survive crowding or standing in containers with other plants and animals for more than a few hours; to obtain these, materials must be examined as soon after collection as possible. Stones, algae, debris, and especially hydroids and other materials from pile scrapings should be washed or stirred up thoroughly in sea water and the water poured off and examined under a dissecting binocular. Turbellaria may be found in such washings swimming about, moving beneath the surface film, or crawling about on the bottom or sides of the container. Hand sorting of debris under a dissecting microscope may also be resorted to, but does not seem to be more effective than washing and is much more time consuming.

Examination of the animals should first be made as they swim or crawl about. A familiar species may often be recognized by color, shape, and type of movement, but for exact determination, careful study of compressed specimens, of permanent mounts, and often of serial sections is necessary. The general student may make a tentative determination and learn something of the structure of these animals by mounting them on a slide so that they are slightly flattened by the coverslip. This may be accomplished by judicious control of the amount of water on the slide or by ringing the coverslip with vaseline and compressing the material while observing it under the microscope.

The following key uses characters which may be easily seen, and should enable the student to identify some of the commoner species found at Woods Hole, but in cases where examination of permanent mounts or sections is mandatory for specific identification the key will lead only to some of the higher categories. Figure references are to Plate 4.

PRELIMINARY KEY TO COMMON TURBELLARIANS

by Dr. Louise Bush

1. Large: over 5 mm in length. Body flattened and leaflike and usually showing the pattern produced by the ramifications of the gut (other color patterns may also be present):
   . . . . . Order TRICLADIDA, see annotated list on page 32.
   . . . . . .Order POLYCLADIDA, see keys to species on page 36.
1. Small: under 5 mm and often from 1-2 mm in length. Body shape varies from oval and flattened to cylindrical to almost globular or egg shaped 2

2. Without a clearly defined gut; food lies in center of body more or less irregularly surrounded by parenchyma cells. Statocyst present but eyes absent . . . . . Order ACOELA 3

2. With a true gut which can be distinguished by its clearly defined outer wall. Eyes may be lacking or one or two pairs present. Statocysts only occasionally present . . . . . Orders RHABDOCOELA and ALLOEOCOELA 7

3. Posterior end of body with indentation in which are found 1-5 small tail-like appendages (fig. 1a, b, c). Color reddish-orange to orange . . . . . Polychoerus caudatus

3. No tail-like appendage present 4

4. Yellowish area at anterior end of body with dark reddish-purple to black pigment scattered in the middle of body. Under higher magnification this pigment is seen to be in violet to purple individual cells (fig.2) . . . . . Aphanostoma diversicolor

4. Color otherwise 5

5. Penis doubled and appearing as two distinct structures side by side at the very posterior end of body (fig. 3). There may be more than one species of this genus in our area but at least one has elongated hairs or spines over the surface of the body and a yellow color from pigmented cells in the parenchyma . . . . . Childia groenlandica

5. Penis single and this, with accessory structures, may be seen in posterior third of the body 6

6. Color orange to dark orange or reddish-brown, the pigment occurring in irregularly shaped little nodules over the surface of the body. Found creeping on the surface of mud below low tide (fig. 4) . . . . . Anaperus gardineri

6. Color pale tan to transparent. Sperm masses and eggs easily seen scattered at posterior end of body: several species of small acoels, mostly belonging to the family . . . . . Proporidae

7. Asexual reproduction evident as transverse partitions formed or partly formed at intervals along the rather transparent body (fig. 5). Sexual reproduction rare. Eyes lacking . . . . . Microstomum davenporti

7. Sexual reproduction only; no transverse divisions 8

8. Statocyst present. Body elongated with a squarish posterior end containing adhesive papillae, the whole being used for attachment (fig. 6). See check list for comment on this form . . . . . Monocelis sp.

8. Statocyst absent 9

9. Body chalky white, with or without pigmented areas. Form "chunky", almost circular in cross section 10

9. Body more or less transparent or otherwise colored but not chalky white. Form usually somewhat flattened or more or less elongated 11

10. One pair of eyes with a network of black pigment between and around them so that the animal appears to have a distinct black spot on the anterior end. Pharynx just behind eyes. Penis without cuticular stylet at posterior end of body (fig. 7) . . . . . Plagiostomum sp.
10. Two pairs of eyes. A ciliated groove extends across body just behind the eyes. Pharynx in posterior half of body (fig. 8) . . . . . Monoophorum sp.
10. One pair of eyes without associated black pigment. Ciliated groove lacking . . . . . young of Plagiostomum sp. or other alloeocoels

11. Proboscis at anterior end of body, protruded through a pore at the apex in catching prey. Pharynx is separate and located near the middle of the body 12
11. Tongue-like process lying in front of the eyes in the cavity with the pharynx, may be protruded through the subapical mouth (fig. 9) . . . . . Woodsholia lilliei
11. No protrusible proboscis or tongue-like process present 13

12. A straight penis stylet appearing like a conspicuous needle at posterior end of body (fig. 10) . . . . . Gyratris sp.
12. Penis stylet otherwise; may be curved or coiled . . . . . other species of the KALYPTORHYNCHIA

13. Pharynx simple, that is, not conspicuously muscular. Mouth appears as a more or less oval opening just back of eyes. Penis stylet curved, needle-like, at posterior end of body. Adhesive papillae on rounded posterior end of body (fig. 11) . . . . . Macrostomum sp.
13. Pharynx doliiform, that is, appears as a bulbous muscular organ just posterior to the eyes (fig. 12) . . . . . one of the species of DALYELLIOIDA
13. Pharynx rosulate, that is, round and closing as if by a purse string. Mostly fresh water species . . . . . various species of the TYPHLOPLANOIDA

ANNOTATED LIST OF ACOELA, RHABDOCOELA, and ALLOEOCOELA

by Dr. Louise Bush

Order Acoela

Anaperus gardineri Graff, 1911. This species has been taken since 1953 for use in the Invertebrate Zoology Course from mud brought in from below low tide mark in Great Harbor. Many of these worms come to the surface after the mud has stood for two or three days in the laboratory. They do not seem to be present in the Eel Pond.

Aphanostoma diversicolor Oersted, 1845. This species occurs on both sides of the North Atlantic, and is common at Woods Hole on algae. It is easily recognized by its coloration and by the more pointed ends of the body as compared to other common acoels.

Childia groenlandica (Levinsen, 1879). Hyman (1959) considers the Childia spinosa described by Graff (1911) from Woods Hole to be a synonym of the widespread C. groenlandica.

Polychoerus caudatus Mark, 1892. Formerly common in the Woods Hole region and regularly taken both in dredgings and on Ulva from pilings and rocks. Recently

it has not been reported. Its use in embryological studies is described in Costello et al. (1957).

Order Rhabdocoela

Suborder Opisthandropora

Macrostomum spp. Species of this genus in the Woods Hole fauna are probably most easily recognized by the characteristic curved penis stylet and the simple pharynx located at the anterior end of the gut close behind the eyes. Specimens common on Fucus at Nobska Point have adhesive papillae at the caudal end and conspicuous hairlike setae scattered among their cilia.

Microstomum davenporti Graff, 1911. These animals have a characteristic appearance and are easily recognized, since they are one of the few marine flatworms (the only ones seen at Woods Hole) which regularly reproduce by transverse fission. The cylindrical transparent body with the gut as a straight tube inside shows clearly the development of transverse walls and new pharynges as division proceeds. When handled, those individuals in which division is nearly completed usually break in two, so that one often gets only very short specimens on a slide.

Suborder Lecithophora

Section Dalyellioida: Members of the family Dalyelliidae itself are mostly fresh water forms, but the section includes a number of marine genera and species, many of which are in the family Umagillidae and are endocommensal with marine invertebrates, especially echinoderms. The group is poorly known at Woods Hole.

Section Kalyptorhynchia: Includes Gyratrix sp., characterized by having a proboscis in a separate pocket opening anteriorly (fig. 10), and easily seen in the living animal.

Section Typhloplanoida: This group probably includes Woodsholia lilliei Graff, 1911, of which a few specimens are believed to have been taken in 1963. These have a tongue-like process, difficult to see, in the pharynx. The penis sheath is characteristic, and best seen in whole-mounts.

Order Alloeocoela

Suborder Cumulata: Species of this group seen at Woods Hole are thick and more or less cylindrical in body form, chalky white in color, sometimes with black or brown spots, stripes, bands, or reticulations.

Monoophorum sp. Common on Ulva; resembles a chalky white lump until disturbed, when it swims slowly away as a short cylindrical animal with two pairs of eyes and a stumpy tail.

Plagiostomum sp. Longer than Monoophorum, and with only one pair of eyes, which are so surrounded with black pigment that the head appears to have a single large dorsal spot.

Suborder Seriata

Monocelis sp. In 1911, Graff described from the Eel Pond a monocelid which he placed in a new genus, Myrmeciplana, distinguished from Monocelis by having sensory hairs born on sensory papillae on the rostral end of the body; his species was reported as being eyeless. Animals collected from the Eel Pond in 1963 resemble Myrmeciplana, but have a pair of eyes in most cases, and also have the anterior

Plate 4

TURBELLARIA (except for polyclads)

Figures 1b, 1c, and 15 are redrawn from Verrill (1892); rest redrawn from sources as cited or from life by Dr. Louise Bush. Scale bars on all figures equal 1 mm.

Figure 1. Polychoerus caudatus, with one "tail", after Graff.

1b and 1c. Rear of Polychoerus caudatus with 5 and 3 "tails", after Verrill.

2. Aphanostoma diversicolor, after Graff.

3. Childia groenlandica, from life. Actual size under one mm long.

4. Anaperus gardineri, from life.

5. Microstomum davenporti, from life.

6. Monocelis sp., from life.

7. Plagiostomum sp., from life.

8. Monoophorum sp., from life.

9. Woodsholia lilliei (?), from life.

10. Gyratrix sp., with proboscis shown extended at right, from life.

11. Macrostomum sp., from life.

12. Unidentified dalyellioid, from life.

13. Bdelloura sp., probably candida, from life.

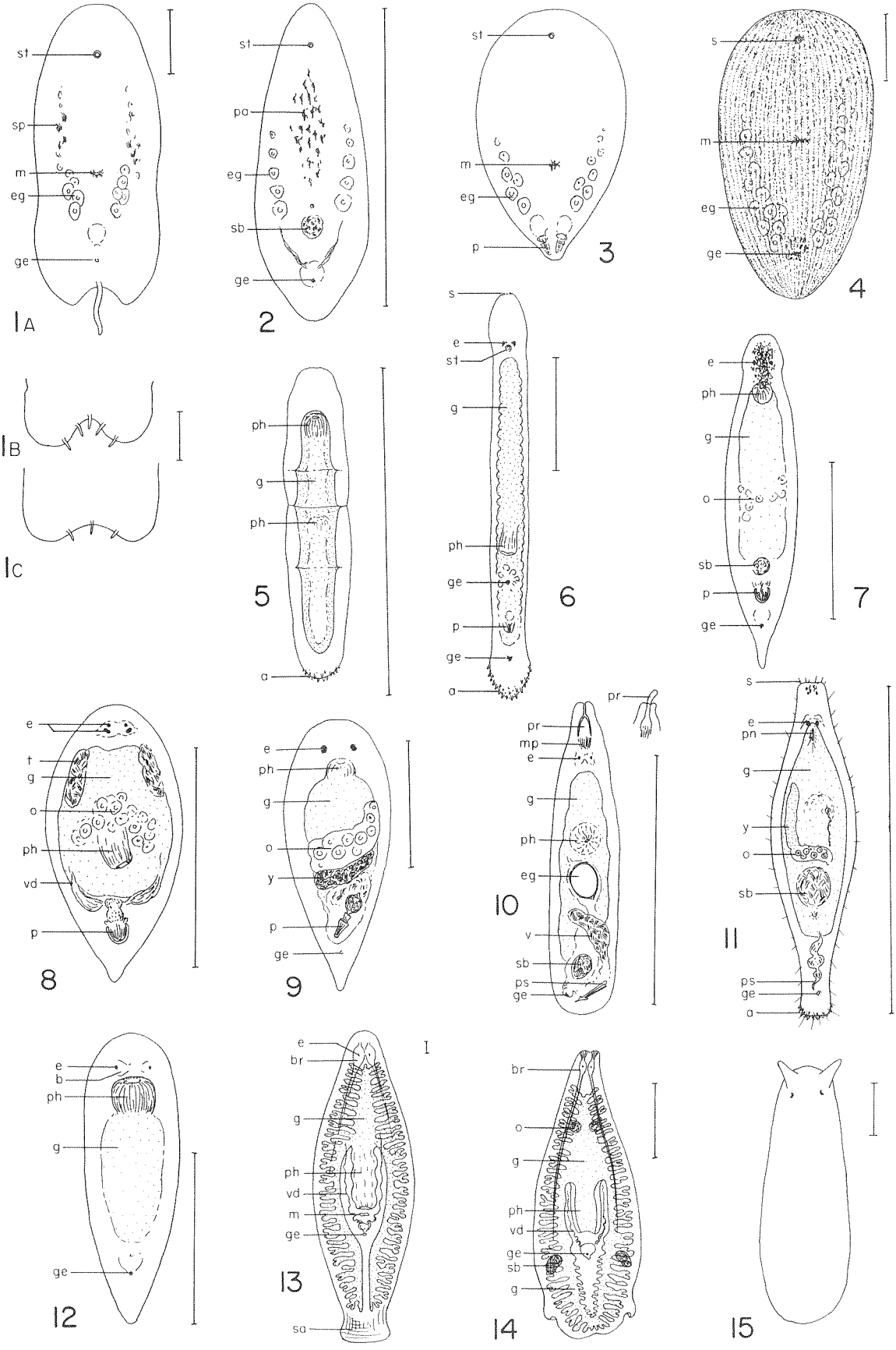
14. Syncoelidium pellucidum, from life, showing the diagnostic fusion of the hinder branches of the triclad gut.

15. Procerodes wheatlandi, reconstructed outline from figures in Verrill.

Abbreviations:

a - adhesive papillae
br - brain
e - eyes
eg - egg
ge - genital pore
m - mouth
mp - muscles of proboscis
o - ovary
p - penis
ph - pharynx
pr - proboscis
ps - penis stylet
pu - purple cells
s- sensory hairs
sb - seminal bursa
sp - sperm
st - statocyst
su - sucker
v - seminal vesicle
vd - vas deference
y - yolk gland

Plate 4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sensory hairs set in a thin area of epidermis and not on papillae. The worms from the Eel Pond should be good class material: they are large (up to 4 mm long), can be reared in the laboratory, and regenerate readily. When kept in Syracuse dishes and fed small bits of annelid worms, they laid eggs which developed in about one week into small worms, like the adults except for undeveloped reproductive structures.

Order Tricladida

Although marine triclads are in general uncommon, Woods Hole has several species. Bdelloura spp. (fig. 13) and Syncoelidium (fig. 14) are very easily found as commensals on the gill-books and around the leg bases of Limulus. The following annotated list may aid in the identification of the more common local triclads (figure references are to Plate 4):

Bdelloura candida (Girard, 1850). Abundant on Limulus; the name is usually applied to any Bdelloura collected, although another species is also present. B. candida reaches a length of 15 mm, and has 60-100 testicular sacs on each side of body.

Bdelloura propinqua Wheeler, 1894. This is described by William Morton Wheeler in his paper on Syncoelidium. B. propinqua reaches a length of 8 mm, and has about 170 testicular sacs on each side.

Syncoelidium pellucidum Wheeler, 1894. Also found on Limulus but much less numerous than Bdelloura spp. Length 3 mm with about 15 testicular sacs on each side. The distinguishing feature of Syncoelidium is the fusion of the two posterior branches of the gut, and the lack of a distinct posterior sucker.

Procerodes wheatlandi (Girard, 1850) is considered by Hyman (1944) "to be at best a geographic variant of P. littoralis" (Strøm, 1768) which extends from Newfoundland to Scandinavia. P. littoralis in turn may or may not be conspecific with Procerodes (Gunda) ulvae, which tolerates low and variable salinities and is well known as an experimental animal in European studies of osmoregulation. It is reported to be a small (5 mm long) dark animal with a pair of anterolateral tentacles and 2 eyes (fig. 15).

Order Polycladida

Several species of polyclads are common at Woods Hole, and others occur less frequently. The key that follows is restricted to the commoner forms plus a couple that were easily included; consult the annotated list for forms that do not "key out" readily. Polyclads are in some cases very difficult to identify alive, and well cleared whole mounts or even sagittal sections are needed for serious work. In the key, only superficially visible chacteristics are employed; while this facilitates an approximation to an identification, anyone doing experimental work on polyclads should be sure to fix material for determination by a qualified systematist before publication.

For fixation, Hyman recommends hot seawater saturated with mercuric chloride, followed by thorough washing, dehydration in alcohol, and clearing in oil of wintergreen. (For details consult Bull. Amer. Mus. Nat. Hist., 100: 269 et seq.)

KEY TO SOME OF THE POLYCLADS OF WOODS HOLE

(Figure references on polyclads are to Plate 5)

1. Tentacles absent 7
1. Tentacles present (either "marginal" at front edge, or arising dorsally near the brain) 2

2. Tentacles formed by upfolded anterior margin; thin undulated margin; tentacles brownish on pale flesh colored ground; body 10-12 mm long (fig. 1) . . . . . Prostheceraeus maculosus
2. Tentacles dorsal, in region of brain (not always obvious when one looks directly down on living animal (figs. 2-4) 3

3. Marginal eyes present on edge of body in addition to more centrally placed eyes 4
3. Marginal eyes absent (but others may be present) 5

4. Body somewhat elongated, with distinct pattern of white or yellowish and brown cross-bars . . . . . Stylochus zebra
4. Body broadly elliptical, of various shades of cream, yellow, gray, or brown (figs. 3, 4) . . . . . Stylochus ellipticus

5. Body oval, tentacles do not contain scattered eyes 6
5. Body elongated, widened anteriorly, pointed posteriorly; 6-8 mm long; tentacles contain scattered eyes (fig. 2); body yellowish to pellucid with brownish spots . . . . . Gnesioceros floridana

6. Generally found in mantle cavity of Busycon; color white . . . . . Hoploplana inquilina
6. Occasionally drifts in on Sargassum weed; color pattern of white reticulation on a brown ground . . . . . Hoploplana grubei

7. Body yellowish to gray-brown; 8-12 mm long; slender, resembling a fresh-water planarian; eyes near brain, typically 4-5 on each side in a lengthwise row, and 2 set closely together a little to rear of each row (fig. 5) . . . . . Euplana gracilis
7. Eyes in 4 conspicuous clusters in area of brain (fig. 6); to be expected only north of the Cape . . . . . Notoplana atomata

ANNOTATED LIST OF POLYCLADS OF THE WOODS HOLE REGION

Acerotisa baiae Hyman, 1940. Taken (Goodchild) at Lagoon Pond bridge (Hyman, 1952). The genus Acerotisa lacks tentacles and has 2 eye clusters. A. baiae is small (3 mm), translucent whitish. Not in key.

Acerotisa notulata (Bosc, 1801). A minute species that might occasionally drift into Woods Hole on Sargassum (Hyman, 1952). Not in key.

Coronadena mutabilis (Verrill, 1873). A rare southern form; status at Woods Hole uncertain. C. mutabilis lacks tentacles and has marginal eyes around anterior half of body; gray to yellowish brown; 18 by 5 mm. Not in key.

Euplana gracilis (Girard, 1850). Reported abundant in Eel Pond and among masses of sponges and hydroids on pilings.

Eurylepta maculosa, see Prostheceraeus maculosus.

Gnesioceros floridana (Pearse, 1938). A southern species, but recorded from eel grass in Woods Hole and Quissett Harbors, also on sandy bottoms at 8-10 meters (Hyman, 1939, 1940). There has been confusion about the name; it was once wrongly referred to Imogine oculifera, and in Hyman's good description (1939) it is called Gnesioceros verrilli.

Gnesioceros sargassicola (Mertens, 1833). Has been taken from Sargassum in Vineyard Sound (Hyman, 1939). Color pellucid with brownish spots; shape characteristic of genus, widened anteriorly, tapering to a pointed posterior end.

Gnesiceros verrilli, see G. floridana.

Hoploplana grubei (Graff, 1892). Has been collected (Hadley) from Sargassum in Vineyard Sound (Hyman, 1939).

Hoploplana inquilina (Wheeler, 1894). Described by William Morton Wheeler as Planocera inquilina, under which name its embryology was described by Surface in a well known study. Occurs locally in the mantle cavity of Busycon canaliculatum

but further south has been reported from Thais and Urosalpinx (Hyman, 1944).

Imogine oculifera, see Gnesioceros floridana.

"Leptoplana", used by E. B. Wilson (1894) in an often cited cell lineage study, is not a Woods Hole flatworm, but an unidentified species from Puget Sound, whose actual genus cannot be determined.

Leptoplana variabilis, see Notoplana atomata.

Notoplana atomata (O. F. Müller, 1776). Hyman (1939) calls this the commonest polyclad of the North Atlantic shores, from northern Massachusetts to Scandinavia, but there is doubt that it extends south into inshore waters of Woods Hole. It has been reported from Nantucket.

Planocera elliptica, see Stylochus ellipticus.

Planocera inquilina, see Hoploplana ellipticus.

Planocera nebulosa; considered by Hyman (1944) a synonym of Stylochus ellipticus. P. nebulosa was used in the Invertebrate Zoology Course Keys during the 1940's to refer to a greenish polyclad without marginal eyes, apparently following the usage in Pratt's Manual (p. 188). Verrill (1892, p. 472) points out that "P. nebulosa" has eyes that are difficult to see in the deeply colored living animals. It is probably a color variant of S. ellipticus.

Prosthecereaus maculosus (Verrill, 1892). Reported "in some abundance" on pilings of Lagoon Pond bridge (Hyman, 1952). This has been known as Eurylepta maculosa up until 1952, when an anatomical restudy by Hyman necessitated its transfer to Prosthecereaus.

Stylochus ellipticus (Girard, 1850). Under stones in shallow water and in tide pools. Feeds on oysters and barnacles (Hyman, 1940).

Stylochus zebra (Verrill, 1882). Easily recognized by color pattern. Usually collected from shells of Busycon occupied by the large hermit crab Pagurus pollicarus, but also found free living on rocks and pilings.

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Meixner, J., 1938. Turbellaria, in Die Tierwelt der Nord- und Ostsee . Leipzig part IV: 1-146. (Mostly on biology and ecology of the turbellaria but includes

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Plate 5

VARIOUS UNSEGMENTED WORMS

Polycladida (figs. 1-6), Nemertea (figs. 7-12), Sipunculoidea (figs. 13, 14), Nematomorpha (figs. 15-18). Figs. 11, 12, 15 by Mrs. Emily Reid; figs. 13, 14, 16-18 by Bruce Shearer. Scales various.

Fig. 1. Prostheceraeus maculosus, outline to show marginal tentacles; note cerebral and tentacular eyes.

2. Gnesioceros floridana, simplified after Hyman (1939) to show body outline, cerebral and tentacular eyes.

3. Stylochus ellipticus, simplified, showing tentacles and eyes.

4. Stylochus ellipticus, viewed from side to show dorsal tentacles, and marginal, tentacular, and cerebral eyes.

5. Euplana gracilis, from life, showing pattern of cerebral and "tentacular" eyes. Note that actual tentacles are absent.

6. Notoplana atomata, outline of body and pattern of eyes, simplified after Hyman (1939).

7. Lineus bicolor (Heteronemertea), head in dorsal view, from life, showing left cephalic slit and eyes.

8. Amphiporus ochraceus (Hoplonemertea), proboscis stylets as seen in a worm flattened on a slide; central stylet on pear shaped basis and accessory stylets in 2 lateral pouches. Drawn from a photo taken by Dr. W. E. McCaul.

9. Zygonemertes virescens, head of older animal with many eyes, stylet with truncated basis. After Coe.

10. Amphiporus cruentatus, head and stylet. After Coe.

11. Malacobdella grossa. After Verrill.

12. Cerebratulus lacteus (Heteronemertea), whole animal with head in ventral view, showing mouth, left cephalic slit, proboscis pore anteriorly, and caudal cirrus. After Verrill.

13. Golfingia gouldi, from life; one with extended introvert showing tentacles, other with introvert withdrawn; about half natural size.

14. Phascolion strombi, with extended introvert; much enlarged (scale bar equals one mm).

15. Nectonema agilis, impression of the worm as seen swimming. About natural size.

16. Nectonema agilis, anterior end of living specimen much contracted after shedding eggs. Note 2 rows of natatory bristles.

17. Nectonema agilis, anterior end of relaxed, living specimen, prior to shedding of eggs.

18. Nectonema agilis, posterior end of the above specimen.

Plate 5