

## New Monogenetic Trematodes from Hawaiian Fishes, II<sup>1</sup>

SATYU YAMAGUTI

IN THIS SECOND REPORT are described seven new species of monogenetic trematodes belonging to six new genera, two of which represent each a new subfamily. One of these two species seems to occur rather uncommonly on the Hawaiian flying fishes; so far I have managed to collect only four specimens after a long search. Although the host of this worm is a pelagic fish, its parasite fauna seems rather endemic in character, inasmuch as the monogenetic and digenetic trematodes found on or in the Hawaiian flying fishes are quite different from those occurring in the allied host species in the neighboring waters. This fact strongly suggests that the distribution of the Hawaiian flying fishes is not very extensive.

All the other new genera of Monogenea to be reported by me from Hawaii will be described in a monograph upon Hawaiian monogenetic trematodes, so that the present report is the last of the series for new Hawaiian monogenetic genera to be described in short articles.

Thanks are due to all the institutions and persons concerned in my survey of Hawaiian trematodes, including the National Science Foundation, the University of Hawaii, my assistant, Mr. Shunya Kamegai, and my wife, Ikuko Yamaguti.

The new species described herein are assigned to the following families and subfamilies:

### I. Capsalidae Baird, 1853

#### Benedeniinae Johnston, 1931

1. *Pseudallobenedenia apharei* n. g., n. sp.
2. *Pseudallobenedenia opakapaka* n. sp.
3. *Lagenivaginopseudobenedenia etelis* n. g., n. sp.

### II. Discocotylidae Price, 1936

#### Opisthogyninae Unnithan, 1962

4. *Metopisthogyne sphyraenae* n. g., n. sp.

### III. Pterinotrematidae Bychowsky and Nagibina, 1959

5. *Pseudopteriotrema albulae* n. g., n. sp.

### IV. Axinidae Unnithan, 1957

#### Sibitreminae n. subfam.

6. *Sibitrema poonui* n. g., n. sp.

#### Cypselurobranchitreminae n. subfam.

7. *Cypselurobranchitrema spilonopteri* n. g., n. sp.

### 1. *Pseudallobenedenia apharei* n. gen., n. sp. Fig. 1

HABITAT: Gills of *Aphareus rutilans*; Hawaii.

HOLOTYPE: U. S. Nat. Mus. Helm. Coll., S. Y. No. 45.

DESCRIPTION (based on 21 whole mounts): Body approximately fusiform, 2.6–5.3 mm long, with maximum width of 0.7–1.9 mm at about testicular level. Posterior extremity of body proper attenuated to a flap covering opisthohaptor dorsally. Opisthohaptor discoid, usually projecting a little beyond posterior end of body proper, 0.43–0.8 mm longitudinally except for scalloped marginal membrane 20–80 $\mu$  wide, with a central pit 0.1–0.15 mm in diameter; on the concave ventral surface there are three pairs of anchors, but no definite septa or ridges, although several symmetrical radiating excretory vessels are seen bifurcating or not at their submarginal ends; anterior anchor 28–37 $\mu$  long from tip to posterior end, situated posterolateral to central pit; two posterior anchors close together near posterolateral edge of opisthohaptor; longer J-shaped medial one slender, 18–33 $\mu$  long; shorter lateral one hook-shaped, with bifid root, 14–21 $\mu$  long. Prohaptors elliptical, saucer-shaped, 0.54–1.0  $\times$  0.24–0.48 mm, connected dorsally by medianly incised frontal plate which never projects forward beyond the prohaptors. Mouth opening ventrally at level of posterior end of prohaptors, with one pair or two of eyespots dorsally. Pharynx muscular, incised anteriorly into five lobes, more or less

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ABBREVIATIONS USED IN FIGURES					
AB	atrial bulb	GI	genito-intestinal canal	PH	prohaptor
AG	apical gland	GO	Goto's organ	PM	pars muscularis
AP	accessory piece	GP	genital pore	PR	prostatic reservoir
AS	axial sclerite	HC	head cone	RS	receptaculum seminis
BC	bulbus cirri	I	intestine	S	sucker
BE	bulbus ejaculatorius	IB	intestinal branch	SG	shell gland
C	cirrus	ID	intestinal diverticle	T	testis
CA	caudal appendage	LL	larval lappet	TG	terminal genitalia
CL	clamp	M	mouth	U	uterus
CP	cirrus pouch	O	ovary	V	vagina
CS	crown of spines	OC	eyespot	VD	vas deferens
CV	clamp valve	OH	opisthohaptor	VGD	vaginal duct
DE	ductus ejaculatorius	OS	oral sucker	VP	vaginal pore
E	egg	P	pharynx	VR	vitelline reservoir
ES	esophagus	PC	prostatic cell	VT	vitelline gland
GA	genital atrium	PD	prostatic duct	VTD	vitelline duct

constricted laterally near broadly rounded posterior end,  $0.22-0.52 \times 0.24-0.65$  mm. Esophagus short; each intestinal limb giving off more or less dendritic outer branches, of which the anterior pair extends into the frontal plate, almost meeting in the median line; posterior-most pair sends out several outer branches reaching lateral edges of body and a few shorter inner branches probably anastomosing each other; no anastomosis between two main intestinal limbs posteriorly.

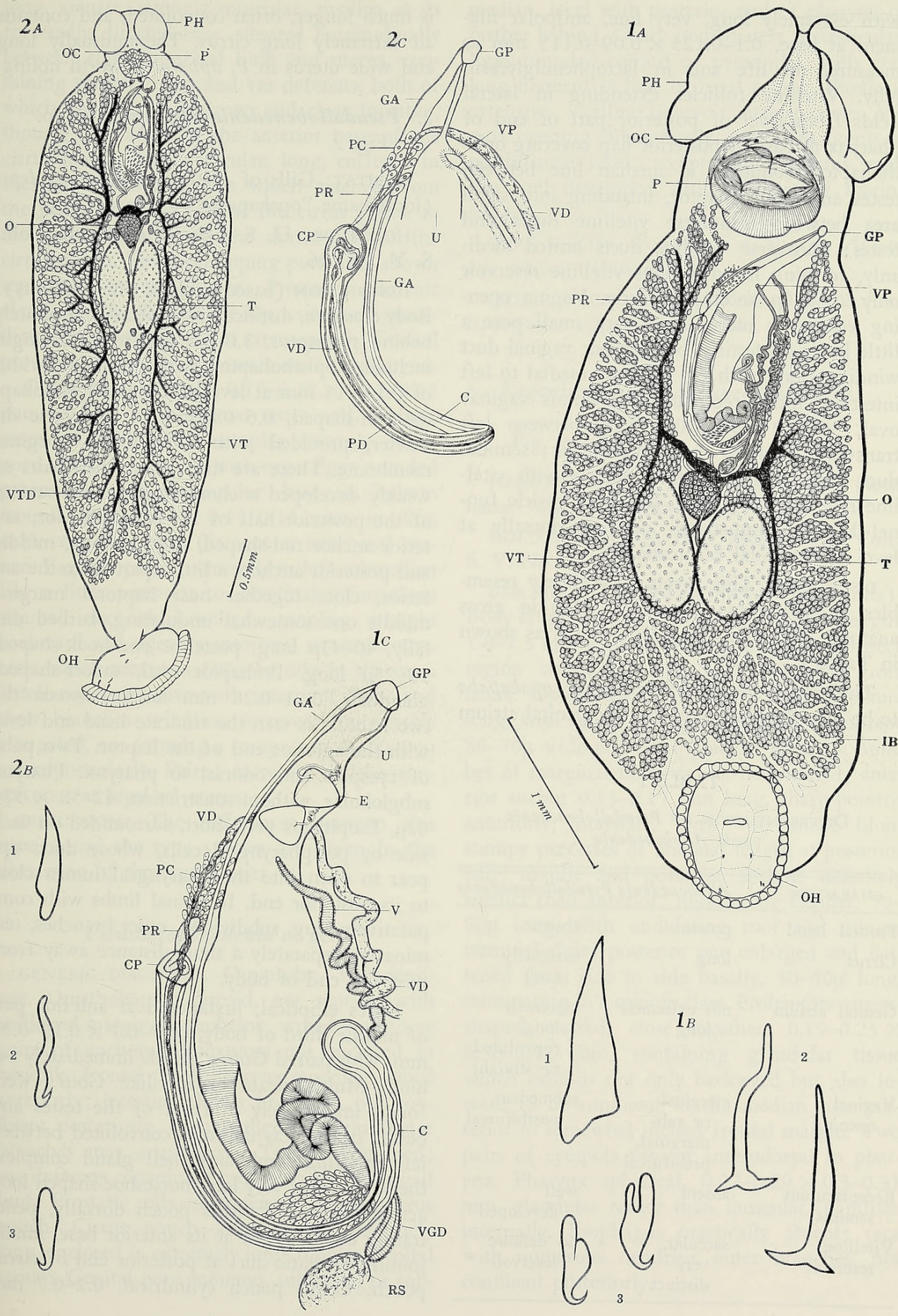
Testes oval to elliptical,  $0.28-0.8 \times 0.18-0.5$  mm, directly juxtaposed, largely in posterior part of middle third of body, with paired multinucleate Goto's glands immediately behind. Vas deferens running forward along left margin of ovary, convoluted just medial to left intestinal limb, then crossing uterus dorsally and coming to right side of median line, where it enters the cirrus pouch along with the prostatic reservoir and finally unites with the prostatic duct to lead into extremely long (2-3 mm or more) spicular cirrus. Prostatic cells massed around distal portion of vas deferens and prostatic reservoir which is elliptical, 0.1 mm long by 0.05 mm wide in the type and lies longitudinally alongside the vas deferens. Cirrus pouch somewhat muscular, small (exact length not determinable), containing winding vas deferens

and more or less convoluted prostatic duct; both ducts joining together to form cirrus which is enclosed throughout its length in the thin-walled, tubular, genital atrium, and may or may not project out of the genital pore. The genital atrium is continued from the wall of the cirrus pouch with the same diameter as the latter, but tapers into a very long, narrow tubule which runs backward and then curves toward the left in front of the transverse vitelline duct; it turns back on itself here to follow the same course as its proximal portion, and after passing beside the cirrus pouch proceeds straight obliquely forward to open ventrosublaterally at the level of the posterior end of the pharynx on the left side.

Ovary subglobular,  $0.08-0.28 \times 0.1-0.25$  mm, situated medianly between anterior ends of testes. Germiduct arising from anterior end of ovary, joining duct from vitelline reservoir and leading into ootype which passes into a long, winding, muscular uterine duct. Uterus proper forming diverticle-like expansion when distended with eggs; distal portion of uterus proper running obliquely forward along with genital atrium, opening together with latter by a common pore. Shell gland cells developed around ootype. Eggs mostly rounded conical, but rounded triangular in flattened condition,

FIG. 1. *Pseudallobenedenia aphaei* n. g., n. sp. 1A, Holotype, ventral view; 1B, haptoral anchors of paratype; 1C, terminal genitalia of paratype, ventral view.  
FIG. 2. *Pseudallobenedenia opakapaka* n. sp. 2A, Holotype, ventral view; 2B, haptoral anchors; 2C, terminal genitalia, ventral view.







with extremely long, very fine, antipolar filament at base,  $0.1-0.125 \times 0.09-0.115$  mm as measured in life and in lactophenolglycerin jelly. Vitelline follicles extending in lateral fields from level of posterior part or end of pharynx to base of posterior flap covering opisthohaptor, confluent in median line between testes and opisthohaptor, intruding into small area between transverse vitelline ducts and testes; transverse vitelline ducts united medially, forming inconspicuous vitelline reservoir only  $20-110\mu$  anteroposteriorly. Vagina opening ventral to uterus by a very small pore a little behind intestinal bifurcation; vaginal duct winding along with vas deferens medial to left intestinal limb; receptaculum seminis vaginae oval,  $50-150 \times 30-110\mu$ , lying between left transverse vitelline duct and ootype; seminal duct connecting seminal receptacle with vitelline reservoir very short. Excretory vesicle funnel-shaped, symmetrical, opening dorsally at level of intestinal bifurcation.

DISCUSSION: This genus very closely resembles *Allobenedenia* Yamaguti, 1963 in gross anatomy, but differs in minor details as shown in Table 1.

The present species differs from *P. opakapaka* to be described below in that the genital atrium

is much longer, often convoluted, and contains an extremely long cirrus. The unusually long and wide uterus in *P. aphareis* is worth noting.

## 2. *Pseudallobenedenia opakapaka* n. sp.

Fig. 2

HABITAT: Gills of *Pristipomoides microlepis* (local name "opakapaka"); Hawaii.

HOLOTYPE: U. S. Nat. Mus. Helm. Coll., S. Y. No. 46.

DESCRIPTION (based on three whole mounts): Body elongate, distinctly constricted immediately behind prohaptor,  $3.0-5.5$  mm in total length including opisthohaptor, with maximum width of  $0.1-0.15$  mm at level of testes. Opisthohaptor bell-shaped,  $0.6-0.8$  mm in transverse diameter, provided with a scalloped marginal membrane. There are three submedian pairs of weakly developed anchors on the inner surface of the posterior half of the opisthohaptor; anterior anchor rod-shaped,  $40-50\mu$  long, middle and posterior anchors a little apart from the anterior, close together near haptoral margin; middle one somewhat undulating, barbed distally,  $40-43\mu$  long; posterior one hook-shaped,  $18-25\mu$  long. Prohaptor oval, saucer-shaped, glandular,  $0.21-0.28$  mm long; between the two haptors is seen the truncate head end level with the anterior end of the haptor. Two pairs of eyespots anterodorsal to pharynx. Pharynx subglobular, without constriction,  $42-58 \times 52-62\mu$ . Esophagus very short, surrounded on each side by postpharyngeal cells, whose ducts appear to open into the pharyngeal lumen close to its posterior end. Intestinal limbs with comparatively long, subdivided, outer branches, terminating separately a short distance away from posterior end of body.

Testes elliptical, juxtaposed at anterior part of middle third of body,  $0.37-0.7 \times 0.17-0.28$  mm, with paired Goto's glands immediately behind. Multinucleate organs like Goto's were found immediately in front of the testes and beside ovary. Vas deferens convoluted between left intestinal limb and shell gland complex, then forming a very long horseshoe-shaped loop across uterus and cirrus pouch dorsally, penetrating cirrus pouch at its anterior base, finally joining prostatic duct at posterior end of cirrus pouch. Cirrus pouch cylindrical,  $0.2-0.7$  mm

TABLE 1  
DIFFERENTIATION OF *Pseudallobenedenia*  
FROM *Allobenedenia*

CHARACTER	<i>Allobenedenia</i>	<i>Pseudallobenedenia</i>
Frontal hood	present	absent
Cirrus	long	extremely long
Genital atrium	not extremely long	extremely long, convoluted or straight
Vaginal opening	marginal or sub-marginal, prebifurcal	submedian, postbifurcal
Receptaculum seminis	absent	well developed
Vitelline reservoir	saccular, very distinct	no definite reservoir



long, arcuate, strongly muscular, swollen at its forwardly directed base, situated longitudinally between right intestinal limb and uterus, containing prostatic duct and vas deferens, both of which are straight, narrow, and close together, though convoluted at the anterior base of the cirrus pouch. Cirrus spicular, long, enclosed in sheathlike genital atrium which extends from the posterior distal end of the cirrus pouch to the genital pore along the dorsal side of the cirrus pouch. This overlapping portion is shown separately in the figure. Prostatic reservoir elongate,  $80\text{--}90 \times 100\text{--}130\mu$ , situated immediately in front of base of cirrus pouch. Genital pore common, just posterosinistral to pharynx.

Ovary subglobular,  $0.17\text{--}0.27 \times 0.17\text{--}0.22$  mm, situated between two testes and vitelline reservoir. Shell gland complex strongly developed. Uterus distended with eggs. Eggs rounded pyramidal, with triangular base in balsam mounts,  $0.12\text{--}0.14 \times 0.12\text{--}0.15$  mm in life, with very fine, long filament at one basal corner. Vagina opening ventrally in left submedian line a little posterior to intestinal bifurcation; vaginal duct thick-walled, running straight backward and opening into oval seminal receptacle which measures  $100\mu$  by  $80\mu$  in the type. Vitellaria coextensive with intestinal limbs and their branches; vitelline reservoir transversely elongated, not forming a compact mass,  $60\text{--}90\mu$  anteroposteriorly. Paired excretory vesicles conspicuous at level of uterus.

DISCUSSION: The differences between this species and the type species are given in the discussion of the type species.

### *Pseudallobenedenia* n. gen.

GENERIC DIAGNOSIS: Capsalidae, Benedeniinae. Opisthaptor discoid, not septate, with scalloped marginal membrane, armed with three pairs of anchors. Prohaptors not enclosed in hoodlike frontal plate. Pharynx muscular, lobed anteriorly; intestinal limbs branched, not confluent posteriorly, though their posterior inner branches may anastomose. Testes juxtaposed; vas deferens convoluted medial to left intestinal limb. Prostatic cells and reservoir outside cirrus pouch. Cirrus pouch long; cirrus extremely long, enclosed in extremely long, tubular, genital atrium. Genital pore common, sublateral or sub-

median, level with posterior end of pharynx or farther behind. Ovary immediately pretesticular. Eggs rounded conical or pyramidal, with very long filament at base or basal corner. Vitellaria extensive; vitelline reservoir inconspicuous. Vagina opening submedianly ventral to uterus at postbifurcal level; receptaculum seminis vaginae well developed. Gill parasites of marine teleosts.

TYPE SPECIES: *P. apharei* n. sp., on *Aphareus rutilans*; Hawaii.

OTHER SPECIES: *P. opakapaka* n. sp., on *Pristipomoides microlepis*; Hawaii.

### 3. *Lagenivaginopseudobenedenia etelis*

n. g., n. sp.

Fig. 3

HABITAT: Gills of *Etelis carbunculus* (local name "onaga"); Hawaii.

HOLOTYPE: U. S. Nat. Mus. Helm. Coll., S. Y. No. 47.

DESCRIPTION (based on three whole mounts): Body elliptical, flat, 2.9–4.3 mm in total length, 1.8–2.3 mm wide in midregion; head and neck region contracted and well separated from trunk. Opisthaptor elliptical, 0.53–0.75 mm long, with finely scalloped marginal membrane  $30\text{--}70\mu$  wide and three pairs of anchors; number of marginal hooklets not determined; anterior anchor 0.13–0.17 mm long, sharp-pointed anteriorly, nonalate, with two small blunt stumpy processes of unequal length at posterior end; middle and posterior anchors definitely smaller than anterior; middle one slender,  $50\text{--}80\mu$  long, with undulating root and minute terminal claw; posterior one enlarged and flattened from side to side basally,  $30\text{--}40\mu$  long, terminating in a minute claw. Prohaptors saucer-shaped, paired, close together,  $0.19\text{--}0.23 \times 0.36\text{--}0.42$  mm, containing glandular tissue which extends not only backward but also inward to be confluent in the median line posterior to somewhat incised frontal margin. Two pairs of eyespots present anterodorsal to pharynx. Pharynx spherical,  $0.27\text{--}0.29 \times 0.3\text{--}0.31$  mm, glandular rather than muscular, papillate internally. Esophagus practically absent; ceca with numerous dendritic outer branches, not confluent posteriorly.



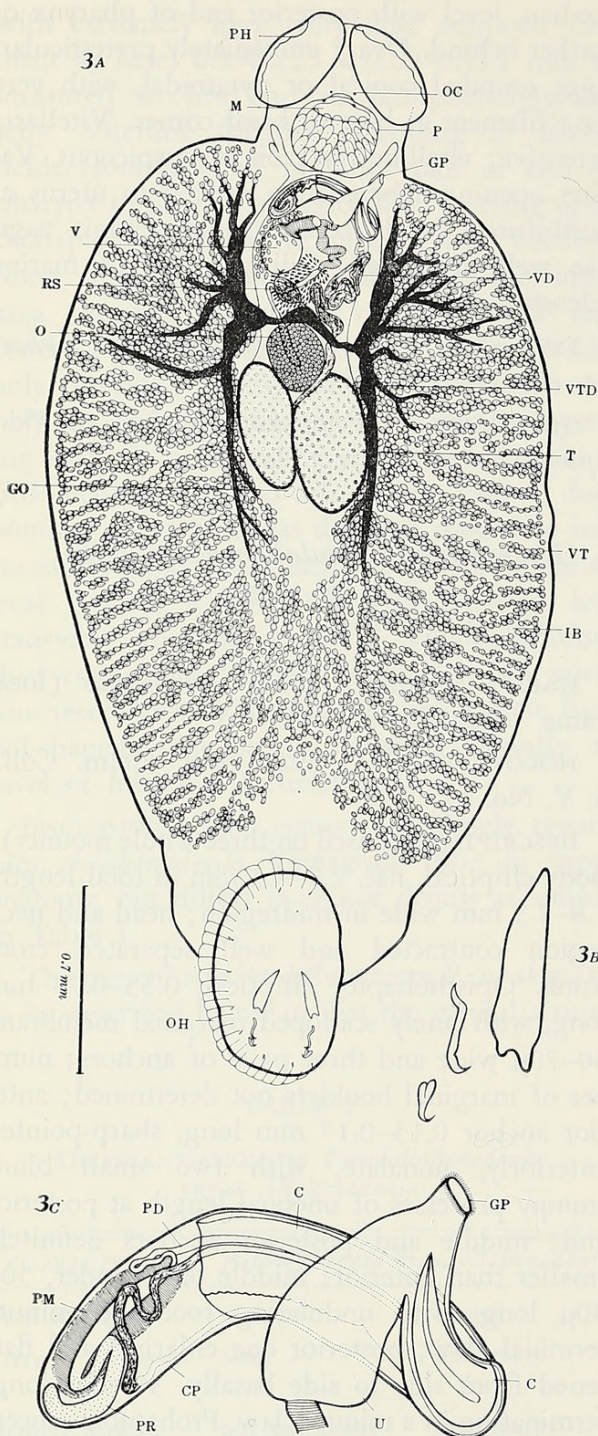


FIG. 3. *Lagenivaginopseudobenedenia etelis* n. g., n. sp. 3A, Holotype, ventral view; 3B, haptoral anchors of holotype; 3C, terminal genitalia of holotype, ventral view.

Testes elliptical,  $0.31-0.5 \times 0.2-0.34$  mm, juxtaposed contiguously at anterior part of middle third of body. Rudimentary Goto's organ present. Vas deferens convoluted immediately anterosinistral to vitelline reservoir, then winding along posterior wall of cirrus pouch, which

it penetrates from the dorsal side; after entering the cirrus pouch it pursues a short winding course, then a long straight course alongside the distal portion of the prostatic duct, with which it finally unites to form the ejaculatory duct. Cirrus pouch subcylindrical, thin-walled,  $0.25-0.4 \times 0.08-0.1$  mm, curved transversely behind pharynx, containing at its base a small, tubular, prostatic reservoir and cylindrical pars muscularis of prostatic duct which is  $0.1-0.13$  mm long and provided with a thick coat ( $30-60\mu$  wide) of fine circular muscle fibers. Prostatic cells distributed around base of cirrus pouch. Cirrus elongate conical, pointed,  $0.42 \times 0.06$  mm in the type; it may or may not project out of the genital pore. Common genital pore posterosinistral to pharynx, a little ( $0.1$  mm in the type) away from nearly right angle formed by neck and trunk.

Ovary subglobular to oval,  $0.15-0.3 \times 0.09-0.22$  mm, situated medianly, with its posterior end intercalated between two testes. Ootype spherical,  $0.15-0.2$  mm in diameter, provided with epithelial lining; uterus proper well separated from ootype,  $0.2$  mm wide in the type, opening into common genital pore by a funnel-shaped passage. No eggs observed. Vitellaria consisting of small follicles, coextensive with intestine, wide apart anteriorly, but confluent posteriorly; paired longitudinal collecting ducts distended with yolk cells; transverse duct may be narrower, up to  $70\mu$  wide in the larger paratype, not forming a definite reservoir. Vagina lageniform,  $0.17$  mm wide in the type, muscular at its narrow neck, situated between uterus and right intestinal limb, opening almost midventrally behind cirrus pouch. Seminal receptacle oval,  $0.1 \times 0.055$  mm in the type, between vagina and vitelline reservoir. Excretory system not made out.

DISCUSSION: This genus, characterized by the head and neck being marked off from the trunk and by the peculiar structure and position of the vagina, bears a certain resemblance to *Pseudobenedenia* Johnston, 1931, especially in the prostatic vesicle being enclosed in the cirrus pouch, but it seems justified to separate the genus in question from *Pseudobenedenia* on the basis of the above mentioned features. The compound generic name refers to the lageniform vagina and close relationship to *Pseudobenedenia*.



*Lagenivaginopseudobenedenia* n. g.

GENERIC DIAGNOSIS: Capsalidae, Benedeninae. Prohaptors consisting of paired glandular saucers placed close together. Opisthohaptor discoid, aseptate, with scalloped marginal membrane, armed with three pairs of anchors. Eyespots present. Head and neck region much narrower than trunk and well marked off from it. Pharynx spherical, without constriction, rather glandular, papillate internally. Intestinal limbs with dendritic outer branches, not confluent posteriorly. Testes juxtaposed, entire. Vas deferens strongly convoluted in front of left transverse vitelline duct, passing transversely behind cirrus pouch and penetrating it near its base. Cirrus pouch cylindrical, extending transversely behind pharynx, containing small prostatic reservoir and well developed pars muscularis of prostatic duct at its base. Cirrus elongate conical, pointed, projecting into thin-walled genital atrium. Common genital pore ventrosubmedian, well apart from body margin. Ovary entire, not separated from testes by vitellaria. Vitellaria co-extensive with intestine; no definite vitelline reservoir. Vagina lageniform, between uterus and right intestinal limb, opening almost mid-ventrally behind cirrus pouch; seminal receptacle well developed. Gill parasites of marine teleosts.

TYPE SPECIES: *L. etelis* n. sp., on *Etelis carbunculus*; Hawaii.

4. *Metopisthogyne sphyraenae* n. gen., n. sp.  
Fig. 4

HABITAT: Gills of *Sphyraena helleri* (local name "kawalea"); Hawaii.

HOLOTYPE: U. S. Nat. Mus. Helm. Coll., S. Y. No. 48.

DESCRIPTION (based on five whole mounts): Body 4.4–8.9 mm long, slender, gradually widened toward opisthohaptor which is 0.8–2.0 mm long by 0.6–1.0 mm wide at base and bears four pairs of short-stalked clamps and a short, trapezoidal, median, caudal lappet provided with three pairs of hooks. Clamp skeleton 0.24–0.3 mm in transverse diameter, consisting of a very stout median spring, a pair of inner basal sclerites, two pairs of arcuate lateral sclerites and a pair of accessory sclerites; one prong

of median spring with three or four minute holes, enlarged at apex in form of a triangle; other prong with anchor-shaped apex, may be bulbously swollen near its base. Of the caudal hooks the larger outermost is 41–46 $\mu$  long from tip of root to height of curve of blade, and has a curved guard a little shorter than root; the smallest middle is 16–18 $\mu$  long and has a comparatively long root and a short curved blade; the innermost is somewhat similar in shape to the outermost and 25–28 $\mu$  long. Head rounded in front, 0.16–0.32 mm wide, with ventral mouth aperture and a pair of groups of gland ducts at apex; paired oral suckers aseptate, muscular, 70–93  $\times$  58–72 $\mu$ , close together, followed by ovoid nonmuscular pharynx 51–70 $\mu$  long by 48–58 $\mu$  wide; esophagus 1.0–2.0 mm long, simple, wide, bifurcating just in front of vaginal pore; intestinal limbs with short side branches, terminating separately, one at base of opisthohaptor and the other a little more posteriorly.

Testes small, ovoid, 93–162 in total number, extending in interintestinal field from anterior part of middle third of body to anterior half of caudal third, mostly preovarian, partly para- and postovarian. Vas deferens strongly winding in median field between testes and vagina; in the region between the vagina and the pars muscularis there are numerous prostate cells, though the pars prostatica is not distinctly differentiated. Pars muscularis representing ejaculatory duct, 0.35–0.45 mm long by 40–60 $\mu$  wide, provided with strong transverse or spiral muscle fibers, followed by muscular cirrus 0.18–0.26 mm long which is bulbously swollen near its distal end and projects into the nonmuscular genital atrium in the type. Genital atrium opening on left margin of body at a distance of 0.55–0.8 mm from head end.

Ovary tubular, long, folded back on itself just medial to left intestinal limb, 0.3–0.4 mm long lineally as a whole, arising about one-third of body length from posterior extremity. Germiduct giving rise to genito-intestinal duct before joining vitelline reservoir. This duct opens into the left intestinal limb a little anterior to the distal end of the ovary. Uterus midventral, containing only one fusiform egg in the type. Eggs 0.17–0.18 mm long, with rigid bipolar filaments 0.15–0.21 mm long. Vitellaria largely



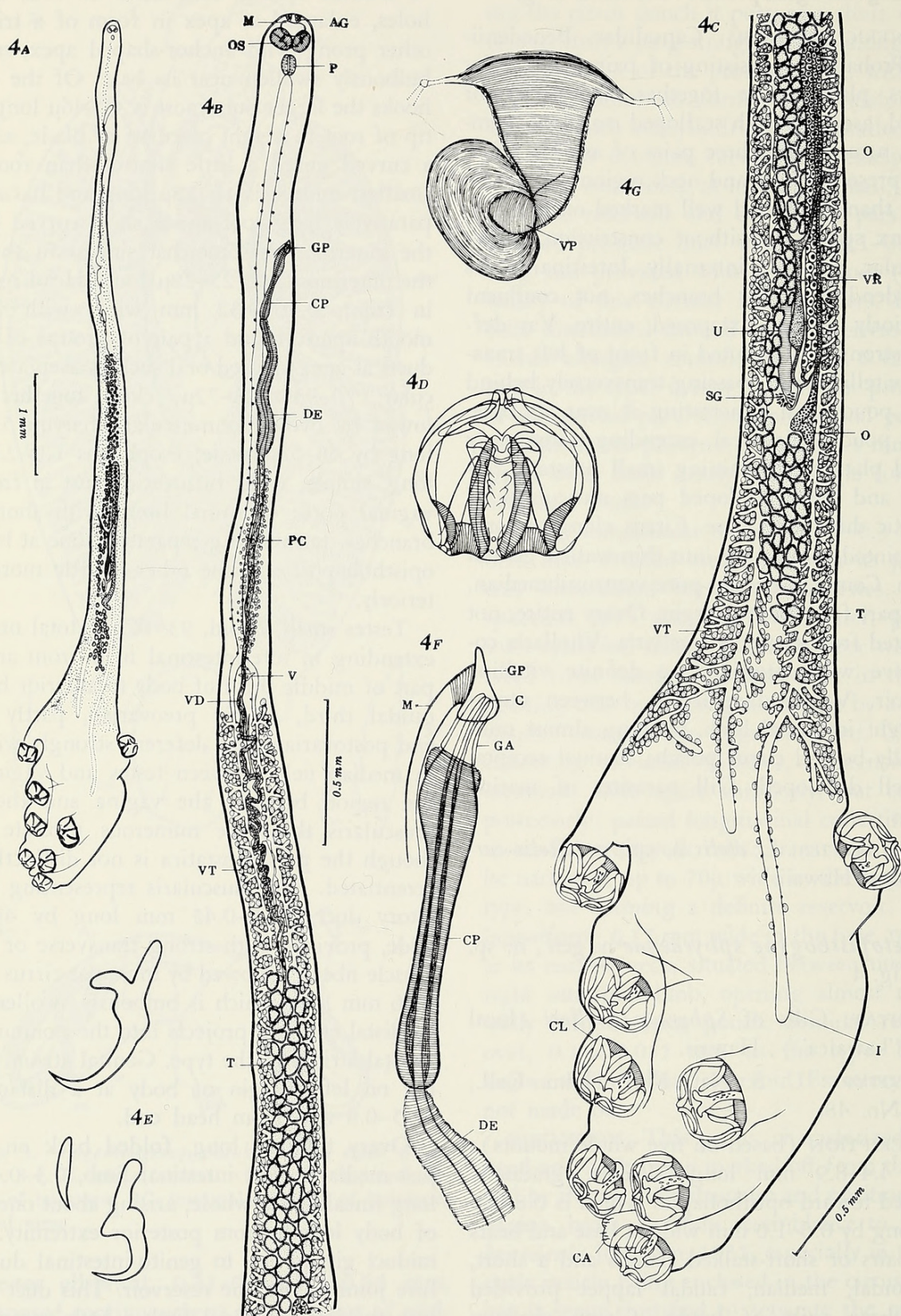


FIG. 4. *Metopishogyne sphyraenae* n. g., n. sp. 4A, Holotype, ventral view; 4B and 4C, enlarged anterior and posterior regions of holotype, ventral view; 4D, clamp of paratype; 4E, anchors on caudal appendage of paratype; 4F, terminal genitalia of holotype, ventral view; 4G, vagina of paratype, ventral view.



coextensive with intestine, commencing a little behind vaginal pore and terminating at base of opisthohaptor; vitelline reservoir Y-shaped, in ovarian zone. Vagina funnel-shaped, strongly muscular, sending out a short narrow duct on each side of its anterior end. This duct appears to be connected with the anterior end of the longitudinal vitelline duct of its own side, although no distinct connecting duct is seen. Vaginal pore middorsal, postbifurcal, provided with a conspicuous bulb of fine lamellar muscle fibers, situated at a distance of 1.2–2.25 mm from head end.

DISCUSSION: This genus differs markedly from *Opisthogyne* Unnithan, 1962, in the distribution of the testes. In *Opisthogyne* the testes are limited to the preovarian region, whereas in the present genus they are much more numerous and more extensive. The V-shaped ridges characteristic of *Opisthogyne* and *Gemmacaputia* Tripathi, 1959, are absent in the posterior part of the body in the present genus.

#### *Metopisthogyne* n. gen.

GENERIC DIAGNOSIS: Discocotylidae, Opisthogyninae. Body symmetrical, elongate, without V-shaped ridges posteriorly. Four pairs of similar clamps of *Gastrocotyle* type. Terminal lappet with three pairs of hooks. Esophagus long; intestine with side branches, terminating separately. Testes numerous, mainly preovarian, partly para- and postovarian. Ductus ejaculatorius strongly muscular. Cirrus muscular, unarmed. Genital pore ventromarginal. Ovary tubular, folded back on itself in posterior half of body; eggs fusiform, with filament at each pole. Vitellaria coextensive with intestine. Vaginal pore middorsal, immediately postbifurcal. Gill parasites of marine teleosts.

TYPE SPECIES: *M. sphyraenae* n. sp., on *Sphyraena helleri*; Hawaii.

#### 5. *Pseudopteriotrema albulae* n. g., n. sp. Fig. 5

HABITAT: Gills of *Albula vulpes*; Hawaii.

HOLOTYPE: U. S. Nat. Mus. Helm. Coll., S. Y. No. 49.

DESCRIPTION (based on 26 whole mounts): Body slender, cylindrical, 1.75–2.4 mm in

length exclusive of haptor clamps, up to 4.5 mm in length including clamps, 0.12–0.26 mm wide in ovariotesticular region. Opisthohaptor fan-shaped, asymmetrical, on posterior extension of body proper, with nine pedunculate clamps. As numbered from the right end of the opisthohaptor of the type the first to the ninth clamp gave the following measurements, presenting different features respectively:

(1) First clamp 0.18 mm long, divided into a caudal appendage bearing a pair of large sub-apical anchors 37–48 $\mu$  long and two more, very small, apical hooklets 9–15 $\mu$  long, and a shorter clamp than others. This clamp consists of two opposing valves fringed on each side with about a dozen curved spines and supported by comparatively short stout sclerites.

(2) Second clamp arising from common trunk with first, 0.25 mm long, consisting of a slender stalk about 0.2 mm long, and provided on each side with membranous fringe supported by a row of about a dozen acicular spines and a single axial sclerite; apical clamp valve single, fringed with over a dozen curved spines.

(3) Third clamp about 0.4 mm long from its basal two-valved sucker to tip of double terminal clamp valve; its stalk supported by two unequal axial sclerites, one of which articulates with the sclerite of the second clamp at the base, while the other slender one articulates with the stronger axial sclerite of the fourth clamp; axial clamp valves pressed against each other.

(4) Fourth clamp 0.38 mm long, similar in structure to the third, with double apical clamp valve, bearing at base a two-valved sucker on the right and a larval lappet on the left. This lappet is a plump rod-shaped lobe 25–40 $\mu$  long by 15–22 $\mu$  wide and bears two pairs of very small larval anchors 12–17 $\mu$  long.

(5) Fifth clamp 0.47 mm long from its basal sucker to apex which consists of two similar valves.

(6) Sixth clamp 0.25 mm long, with double apical valve similar in structure to that of third.

(7) Seventh clamp 0.23 mm long; terminal clamp valves symmetrical.

(8) Eighth clamp about 0.18 mm long, with two separate apical valves and a common stalk supported by two parallel axial sclerites, of



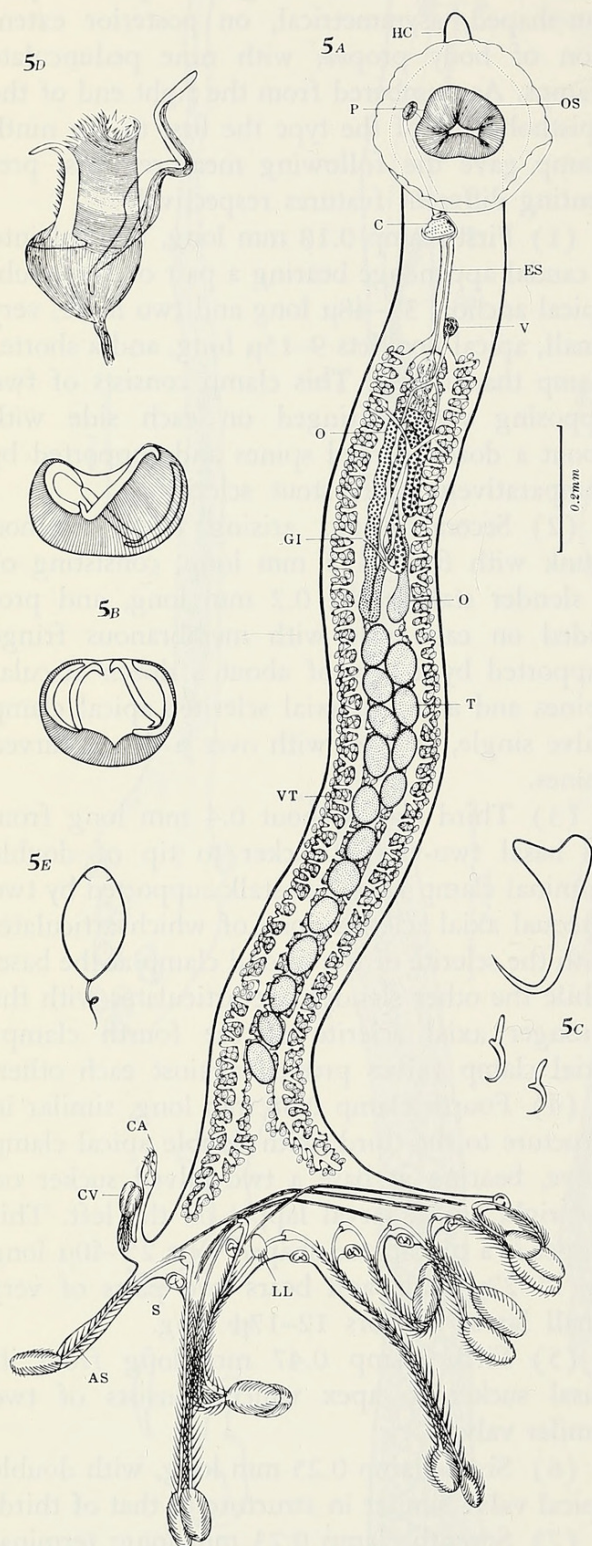


FIG. 5. *Pseudopterinothrema alubulae* n. g., n. sp. 5A, Holotype, ventral view; 5B, two-valved sucker; 5C, anchors on caudal appendage of holotype; 5D, cirrus and its accessory sclerites of paratype, dorsal view; 5E, egg.

which the right one articulates with the left axial sclerite of the seventh clamp and the left one articulates with the extreme left ninth sclerite.

(9) Ninth clamp about 0.12 mm long and fringed on each side with a row of spines like other clamp stalks, but bears one apical clamp valve, although it has a two-valved sucker on the left side of its base.

The above mentioned two-valved suckers, 23–40 $\mu$  wide and seven in all, are arranged in a transverse row at the base of the clamps. Each sucker has a sclerotized frame consisting of four sclerites and appears  $\infty$ -shaped in profile.

Prohaptor circular, 0.2–0.47 mm in diameter, membranous, with somewhat crenulated margin and a simple middorsal cone 40–70 $\mu$  long and 40–70 $\mu$  wide at base. Oral sucker 0.11–0.21 mm in diameter, opening at bottom of prohaptor; prepharynx present; pharynx always lateral to oral sucker, cylindrical, 40–60  $\times$  20–30 $\mu$ ; esophagus very narrow, 0.3–0.65 mm long. Ceca with short branches, terminating separately at base of opisthohaptor.

Testes rounded, up to 25 in number (mostly 16), arranged in a zigzag longitudinal row, occupying greater part of postovarian interintestinal field. Vas deferens may be strongly swollen in preovarian interintestinal field. Cirrus plug-shaped, muscular, covered inside with spinules, 50–90  $\times$  27–50 $\mu$ , with two unequal sclerotized filaments at base; anterior filament 50–120 $\mu$  long, usually widened distally, posterior hook-shaped, 35–60 $\mu$  long, both often appressed against cirrus. Genital pore ventromedian, 0.06–0.22 mm posterior to pharynx.

Ovary turned back on itself five times, forming N-shaped loop posteriorly and double loop anteriorly, situated in anterior part of middle third of body. The germiduct running forward gives off the genito-intestinal duct near its origin and soon unites with the descending vitelline stem. Uterus largely ventromedian; eggs elliptical, 110–130  $\times$  50–75 $\mu$ , with long, very fine filament at antipolar pole. Vitellaria coextensive with intestinal limbs; vitelline reservoir Y-shaped, with long, sometimes short, stem, and rather short arms, coinciding with ovary. Vagina well cuticularized, with wide mid-



dorsal opening 0.1–0.35 mm posterior to genital pore, usually anterior to anterior end of vitellaria, but sometimes much posterior to this level. Vaginal duct inverted Y-shaped, each branch opening into arm of vitelline reservoir of its own side.

DISCUSSION: This genus bears a superficial resemblance to *Pterinotrema* Caballero, Bravo-Hollis, and Grocott, 1954, but differs from it fundamentally in the structure of the clamps and the terminal genitalia, and in possessing a typical oral sucker and a pharynx. I prefer to separate it as representing a new genus, for which the name *Pseudopteriotrema* is suggested, with the following diagnosis.

*Pseudopteriotrema* n. g.

GENERIC DIAGNOSIS: Pterinotrematidae. Body small, cylindrical. Prohaptor circular, with a dorsal conical papilla. Opisthohaptor with nine long-stalked clamps, one of which, to the extreme right in the type, bears an armed caudal appendage. Each clamp, except for two extreme right ones, with two axial sclerites fringed with spines on its stalk, and two terminal clamp valves which are also fringed with spinelets. A transverse row of six small, two-valved suckers present at base of third to seventh clamp stalks, extreme left one to left of base of ninth sclerite. At base of fourth clamp is a rod-shaped lobe bearing two pairs of very small larval hooklets. Oral sucker and pharynx present. Intestinal limbs with short outer branches, terminating separately at base of opisthohaptor. A number of rounded testes in a zigzag longitudinal row in posterior interintestinal field. Copulatory organ consisting of plug-shaped, muscular, spined cirrus and two accessory sclerites. Genital pore ventromedian, immediately behind prohaptor. Ovary tubular, looped, pretesticular. Vagina sclerotized, opening middorsally near intestinal bifurcation; vaginal duct inverted Y-shaped, each branch connected with arm of vitelline reservoir of its own side. Eggs elliptical, filamented at antiopecular pole. Vitellaria coextensive with intestine. Gill parasites of marine teleosts.

TYPE SPECIES: *P. albulae* n. sp., on *Albula vulpes*; Hawaii.

6. *Sibitrema poonui* n. g., n. sp.

Fig. 6

HABITAT: Gills of *Parathunnus sibi* (local name "poonui"); Hawaii.

HOLOTYPE: U. S. Nat. Mus. Helm. Coll., S. Y. No. 50.

DESCRIPTION (based on a single gravid specimen): Body 19.2 mm in total length, distinctly divided into three regions: body proper, haptor stalk, and haptor region. Body proper slender, lanceolate, tapered anteriorly, with a pair of compact eyespots, constricted behind, 11.7 mm long, 1.4 mm wide in posterior part where the ovary is situated; haptor stalk fusiform,  $4.3 \times 0.45$  mm, containing intestine and vitelline gland alone, attenuated posteriorly and then gradually enlarged to pass into haptor region which is spatulate, produced posteriorly into a conical terminal appendage. This appendage is 0.2 mm long, 0.2 mm wide at the base, and bears on the ventral surface of its apex two pairs of larval hooklets of different size; outer pair  $46\mu$  long, inner pair  $21\mu$  long, both with a very prominent guard and a well curved blade. On the left border of the haptor region is a single longitudinal row (about 3 mm long) of 48 clamps  $50\text{--}90\mu$  in transverse diameter. Clamp skeleton consisting of a pair of inner basal processes, two pairs of lateral arms, a pair of accessory pieces meeting in median line, and a stout median spring, one end of which is anchor-shaped, while the other end is surmounted by a Y-shaped apical piece. Mouth cavity wide, opening ventroterminally, with oval paired suckers ( $46 \times 23\mu$ ) laterally and a globular, weakly muscular, median pharynx at its bottom; esophagus simple, 1.45 mm long, contracted at beginning, but soon enlarged to width of 0.15 mm, bifurcating immediately behind genital pore. Intestinal limbs with numerous short inner and longer outer branches; right limb terminating at base of terminal appendage, left one 0.5 mm farther in front.

Testes rounded, 75 in total number, pre-, para-, and postovarian; preovarian testes in two parallel submedian rows of 15 or 16 each; paraovarian testes 18 or 19, in two longitudinal rows immediately outside ovarian loop; behind the ovary there are only several testes in the median field. Vas deferens median, dorsal to uterus;



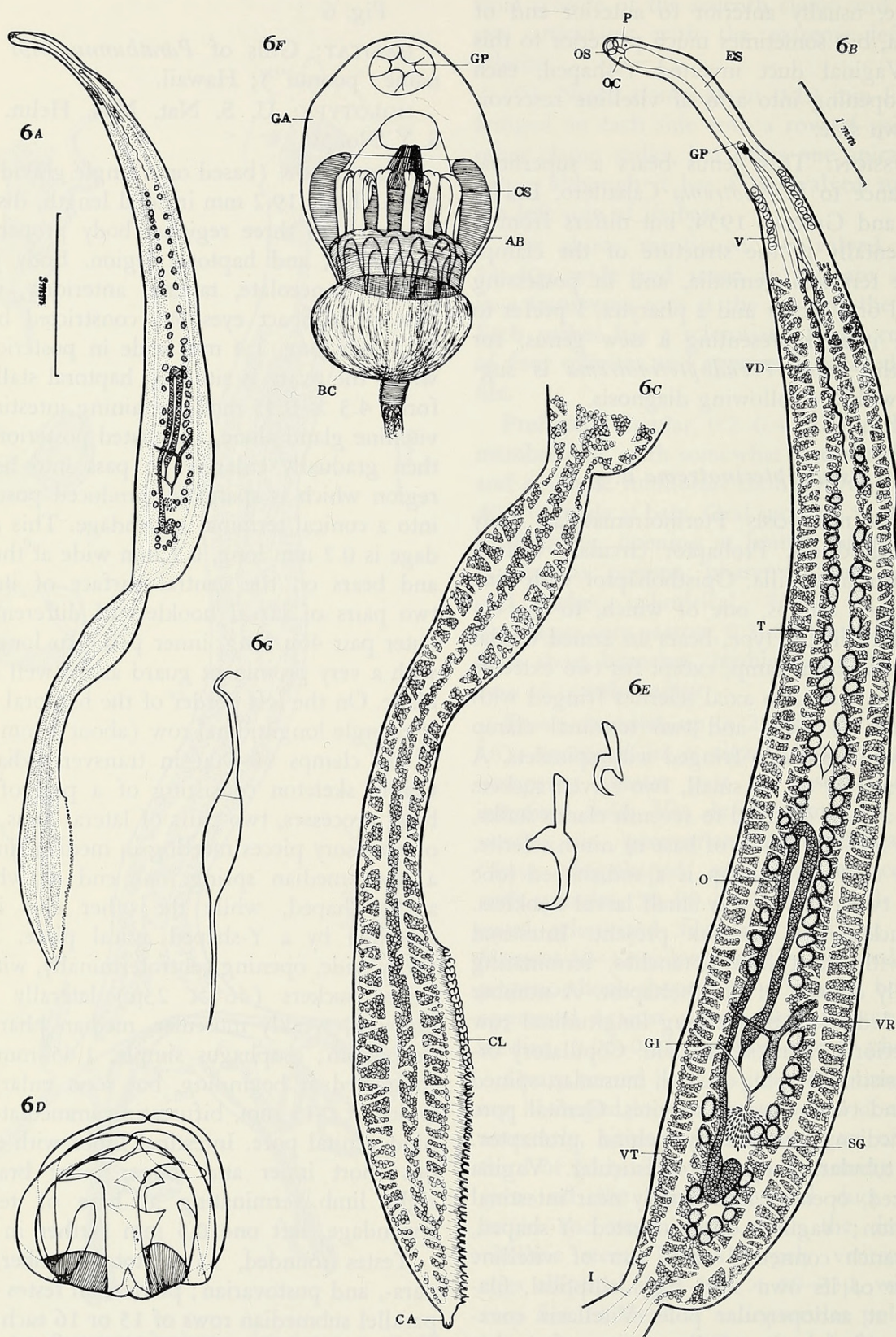


FIG. 6. *Sibitrema poonui* n. g., n. sp. 6A, Holotype, ventral view; 6B and 6C, enlarged anterior and posterior regions of holotype, ventral view; 6D, clamp; 6E, anchors on caudal appendage of holotype; 6F, terminal genitalia of paratype, dorsal view; 6G, egg.



bulbus cirri weakly muscular, 70 $\mu$  in diameter, situated just ventral to intestinal bifurcation. Cirrus consisting of several sharp-pointed spines which are 35 $\mu$  long and bundled together immediately in front of atrial crown of 12 spines; these spines are 51–56 $\mu$  in length including base which forms a ring of 12 backwardly directed prongs; the shaft of each spine is straight, but the apex is curved inward and bifid at the tip. This crown of spines is enclosed in a very thick-walled atrial bulb of radial muscle fibers, which in turn is enclosed in a membranous genital atrium. Genital pore midventral, at anterior end of genital atrium, 1.45 mm from head end.

Ovary tubular, bent back on itself on right side of median line, 3.15 mm long as a whole, swollen (0.3 mm wide) at postequatorial proximal end in form of a recurved mass and at distal end in form of a club, from the posterior end of which the germiduct arises. Genito-intestinal canal arising from near middle of germiduct, running obliquely forward across proximal portion of ovary ventrally to empty into right intestinal limb. Vitelline follicles small, coextensive with intestinal branches, commencing a little behind vaginae; vitelline reservoir Y-shaped, to left of distal end of ovary, connected with germiduct by a narrow descending median stem 0.15 mm long. Uterus straight, midventral, containing a few eggs; eggs fusiform, 0.23–0.25  $\times$  0.07–0.09 mm, with filament 40–60 $\mu$  long at each pole. Vaginae symmetrical, about 0.5 mm long, divided into a series of several (8–14) areolae, situated laterally about halfway between genital pore and anterior end of vitellaria.

DISCUSSION: This genus closely resembles *Alloposeudaxine* Yamaguti, 1943, in internal anatomy, but differs markedly in general body shape and, what is more important, in the structure of the clamp. On the basis of the latter difference I prefer to propose the new subfamily Sibitrematinae for its reception, with the following diagnosis.

#### *Sibitrematinae* n. subf.

SUBFAMILY DIAGNOSIS: Axinidae. Body divided into three distinct regions. Opisthohaptor asymmetrical, without prehaptoral larval

anchors. Clamp skeleton consisting of two pairs of lateral sclerites, one pair of basal inner sclerites, an arcuate median spring, and a pair of accessory sclerites. A terminal lappet bearing larval hooklets present. Testes numerous, pre-, para-, and postovarian. Ovary inverted U-shaped. Vaginae double, symmetrical.

#### *Sibitrema* n. g.

GENERIC DIAGNOSIS: Axinidae, Sibitrematinae. Body long, divided into three distinct regions: body proper, haptoral stalk, and opisthohaptor with a row of numerous clamps unilaterally and a terminal lappet bearing two pairs of anchors. Paired oral suckers poorly developed. Esophagus bifurcating near genital pore. Intestinal limbs with numerous side branches, terminating blindly near base of terminal lappet. Testes numerous, pre-, para-, and postovarian. Genital atrium membranous, immediately prebifurcal, enclosing atrial bulb of radial muscle fibers at bottom, latter in turn provided inside with a crown of spines, beyond which the bundled cirrus spines project forward. Ovary tubular, bent back on itself in middle third of body. Genito-intestinal canal crossing proximal portion of ovary. Eggs with filament at each pole. Vitellaria coextensive with intestinal branches; vitelline reservoir Y-shaped, in ovarian region. Vaginae divided into a series of several areolae, situated about halfway between genital pore and anterior end of vitellaria. Gill parasites of marine teleosts.

TYPE SPECIES: *S. poonui* n. sp., on *Parathunnus sibi*; Hawaii.

#### 7. *Cypselurobranchitrema spilonotopteri* n. g., n. sp.

Fig. 7

HABITAT: Gills of *Cypselurus spilonotopterus*; Hawaii.

HOLOTYPE: U. S. Nat. Mus. Helm. Coll., S. Y. No. 51.

DESCRIPTION (based on four whole mounts): Body 7–10 mm in total length, enlarged laterally up to 2.3–3.5 mm wide in midregion; anterior third abruptly tapered toward head end which is 0.2–0.4 mm wide at the level of the oral suckers; posterior third occupied by large



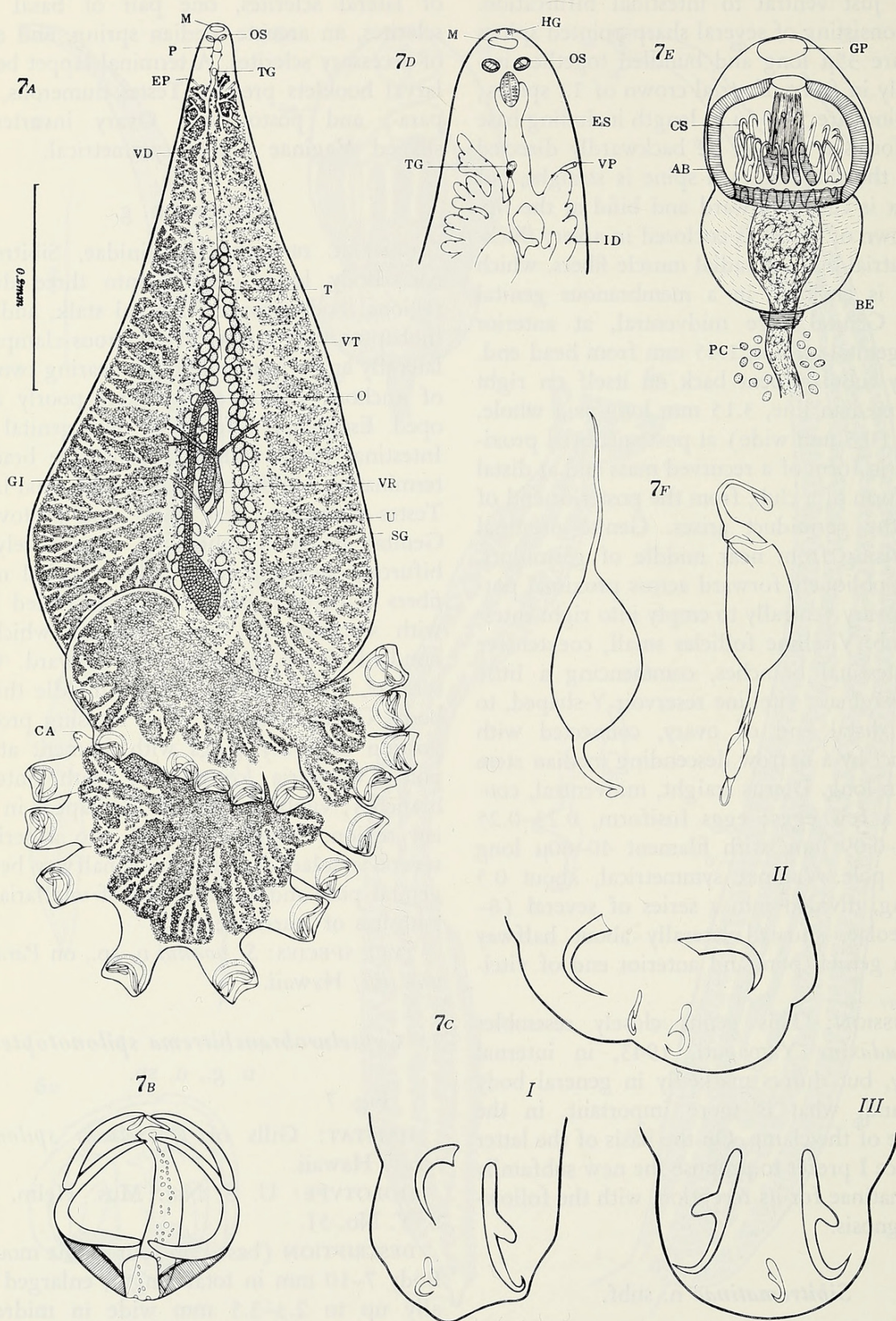


FIG. 7. *Cypselurobranchitrema spilonotopteri* n. g., n. sp. 7A, Holotype, ventral view; 7B, clamp; 7C, anchors on caudal appendage of holotype (I) and two paratypes (II and III); 7D, anterior extremity of paratype, ventral view; 7E, terminal genitalia of paratype, ventral view; 7F, mature eggs from paratype.



cotylophore which is 2.4–4.2 mm long by 2.8–3.8 mm wide and extends on the ventral side from behind the posterior end of the ovary to a considerable distance back of the posterior end of the body proper. In the type this cotylophore begins in the midventral region at the level of the junction of the middle with the posterior third of the entire body with a smooth semicircular fold 1.2 mm wide which is followed by a twisted, fan-shaped body fold fringed with a semicircular row of 18 or 19 long-stalked clamps. For convenience of reference the clamps are numbered from in front backwards; the first clamp next to the semicircular fold is the smallest (about 0.2 mm in diameter), rather short-stalked, the 12th may be slightly out of the row of other clamps, the 14th to 16th are the largest (up to 0.45 mm in diameter), with longer stalks, and the last 18th (19th in one paratype) attached to the right posterior end of the body proper is provided on the proximal anterior margin of its stalk with a blunt-conical or subcylindrical caudal appendage 0.15–0.16 mm long. This caudal appendage is armed in the type with a small guarded apical hook 35 $\mu$  long and two dissimilar subapical hooks, one of which is 77 $\mu$  long and guarded like the apical hook, but the other is simple, falcate and 37 $\mu$  long lineally. In the paratypes either the guarded subapical or the falcate hook is absent (see Fig. 7C), so that the armature of this appendage is variable. Clamp skeleton 0.18–0.46 mm in diameter, consisting of an arcuate, perforated, median spring, and two pairs of curved lateral arms articulating with each other, of which the smaller pair articulates at the distal end with a small  $\lambda$ -shaped accessory sclerite.

Head end rounded; mouth aperture wide, subterminal; oral suckers paired, muscular, septate, 53–81  $\times$  65–93 $\mu$ ; pharynx oval, weakly muscular, 116  $\times$  98 $\mu$  in the type. Esophagus simple, 0.5–0.7 mm long, bifurcating a little behind genital pore. It is not certain whether the intestinal limbs are confluent posteriorly or not; there are wide anterolaterally directed diverticles on each side anteriorly (Fig. 7D), the remaining greater part with few short inner, and numerous longer, subdivided, outer branches accompanied by vitellaria and pigment

cells; posterior outer branches extending into basal portion of clamp stalks.

Testes rounded, about 50 in total number, arranged in two zigzag longitudinal rows, one on each side of median line; anterior ones pre-ovarian, posterior ones para-ovarian, some between ovarian limbs. Vas deferens straight or gently undulating in median field, surrounded at its distal end by prostate cells; no pars prostatica differentiated. A distinct globular bulb of very fine muscle fibers is developed around the somewhat swollen distal end of the ejaculatory duct. Cirrus represented by a cylindrical group of very fine acicular spines, enclosed basally in a crown of 18 hooks, which in turn is enclosed in the atrial bulb with thick walls of radial muscle fibers. The hooks are fused near the base, and their simple attenuated points are curved inwards. This thick-walled atrial bulb is 51–80 $\mu$  in outside diameter, and enclosed entirely in the genital atrium with a membranous wall. Genital pore midventral, immediately in front of the above mentioned thick-walled atrial bulb, 0.5–0.7 mm from head end.

Ovary inverted U-shaped, 2.35 mm long by 0.4 mm wide as a whole in the type, enlarged at proximal end to an elongate compact mass, situated to right of median line in middle third of body. Genito-intestinal duct arising from germiduct just before the latter unites with the stem of the vitelline reservoir. Ootype postero-sinistral to this genital junction. Uterus proper alongside vas deferens, opening into genital atrium ventral to male duct. Mature eggs elongate oval, 0.25–0.26  $\times$  0.11–0.15 mm, with a rigid filament at each pole; anterior filament 0.19–0.26 mm long, posterior filament 0.12–0.2 mm long, slightly enlarged at tip. Genito-intestinal duct running straight obliquely forward and emptying into right intestinal limb, with distinct accompanying cells. Vaginae indistinct in the type, but present on each side in form of a ventrosubmarginal longitudinal row of several rudimentary areolae just behind level of symmetrical excretory pores in one of the paratypes. Vitelline reservoir Y-shaped, with short arms. Excretory pores symmetrical, dorsal, submarginal at about level of genital pore or a little posterior to it.





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