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Stricto and Its Repartition into
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On the Functional Morphology of a New Fauna of Monogenoidea on Fishes from Trivandrum and Environs. Part IV. Microcotylidae Sensu Stricto and Its Repartition into Subsidiary Taxa

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ABSTRACT: A restricted concept of the family Microcotylidae (Monogenoidea) is discussed. Microcotylinae s.s. has typical forms with a long tail-like haptor: *Bradyhaptorinae* subfam. n., with an exceptionally short haptor but with a steep size-gradient in its clamps; *Caenomicrocotylinae* subfam. n., all genera with a metahaptor; and *Bychowskicotylinae* subfam. n., for *Bychowskicotyla mormyri* (Lorenz) comb. n., in which the later-formed larger clamps show an incipient asymmetrical modification. Five new microcotylid species are described from fishes of southern India: *Atriostellata otolithis* gen. et sp. n. on *Otolithes argenteus* Cuv.; *Diplostamenides umbrinae* gen. et sp. n. on *Umbrina russellii* Cuv.; *Polynemicola bulbouaginata* gen. et sp. n. on *Polynemus indicus* Day; *Polynemicola tristis* sp. n. on *Elcuthronemu heptadactylus* (Cuv.); and *Meta-microcotyla manaarensis* sp. n. on *Mugil troscheli* Blkr. New genera and subgenera are allocated, in *Microcotylinae*: *Microcotyle* with type species *Microcotyle* (*Microcotyle*) *donavini* v. Ben. & H. (17 other spp.); *Scintillovulva* subgen. n. type species *Microcotyle* (*Scintillovulva*) *labrae* (v.B. & H.) comb. n. (one other sp.); *Atriostellata* gen. n. has *Atriostellata* subgen. n. with type species *Atriostellata* (*Atriostellata*) *otolithis* gen. et sp. n. and two other spp.; *Biplacunella* subgen. n. for *Atriostellata* (*Biplacunella*) *australis* (Murray) comb. n.; *Diplostamenides* gen. n. has *Diplostamenides* subgen. n. with type species *Diplostamenides* (*Diplostamenides*) *umbrinae* gen. et sp. n. and six other spp.; *Vulvostella* subgen. n. type species *Diplostamenides* (*Vulvostella*) *pamae* (Tripathi) comb. n. and one other sp.; *Bivulvostella* subgen. n. for *Diplostamenides* (*Bivulvostella*) *canthari* (v.B. & H.) comb. n.; *Solostamenides* gen. n. with type species *Solostamenides* *mugilis* (Vogt) and six other spp.; *Prosomicrocotyla* Yamag., 1958; *Mantarella* gen. n. with type species *Mantarella* *heteracantha* (Manter) comb. n. and four other spp.; *Nudimasculus* gen. n. has *Nudimasculus* subgen. n. with type species *Nudimasculus* (*Nudimasculus*) *spari* (Yamag.) comb. n. and three other spp.; *Bistellavulva* subgen. n. type species *Nudimasculus* (*Bistellavulva*) *tai* (Yamag.) comb. n. and two other spp.; *Bivaginuda* subgen. n. type species *Nudimasculus* (*Bivaginuda*) *sillaginae* (Woolcock) comb. n. and one other sp.; *Micracotyloides* Fujii, 1944; *Polynemicola* gen. n. has *Polynemicola* subgen. n. with type species *Polynemicola* (*Polynemicola*) *bulbouaginata* sp. n. and three other spp.; *Ishiella* subgen. n. for *Polynemicola* (*Ishiella*) *ichimidae* (Ishii & Sawada) comb. n.; *Metamicrocotyla* Yamaguti, 1953 (five spp.).

Bradyhaptorinae, with *Bradyhaptorus* gen. n. type species *Bradyhaptorus* *trachini* (Par. & Per.) comb. n. and *Bradyhaptorus* *draconis* (Briot) comb. n.; *Gammacallum* gen. n. monotypic with *Gammacallum* *macrourum* (MacCallum & MacCallum) comb. n.; *Diplasiocotyle* Sanders, 1944, monotypic with *Diplasiocotyle* *johnstoni* Sand., 1944.

Caenomicrocotylinae, with *Caenomicrocotyle* gen. n. has *Caenomi-*

crocotyle subgen. n. with type species *Caenomicrocotyle* (*Caenomicrocotyle*) *fusiformis* (Goto) comb. n. (eight other spp.); *Notaster* subgen. n. monotypic with *Caenomicrocotyle* (*Notaster*) *australiensis* (MacCallum, 1921) comb. n.; *Dinotaster* gen. n. monotypic with *Dinotaster centrodoni* (Brown) comb. n.; *Diurix* gen. n. monotypic with *Diurix leiognathi* (Tripathi) comb. n.; and *Paradiurix* gen. n. monotypic with *Paradiurix acanthogobii* (Yamag.) comb. n. Tabular summaries are added of these supra-specific categories (comprising 83 spp. of *Microcotyle* sensu lato) and for the specific characters of *Metamicrocotyla* Yamag., 1953.

INTRODUCTION

Several authors have attempted to subdivide the unwieldy genus *Microcotyle* v. Ben. & Hesse, 1863. During the last 16 years ten species have been removed to newly erected genera which are now outside the family Microcotylidae *sensu stricto* (Table 1), but there remain over 90 species usually referred to *Microcotyle* sensu lato; 15 or more of these are too inadequately described for their precise relationships to be determined. Restudy of a few of the older species, including the type species from Miss N.G. Sproston's collection, and a detailed study of new species from fishes of Southern India (Unnithan, 1957), together with a reassessment of the published figures and descriptions of the majority of known species, have led to the recognition of four subfamilies. Recognition of these subfamilies was based on the growth potentials of the haptor in three of them (analogous to the basis for the subfamilies in Heteromicrocotylidae (Yamaguti, 1963; Unnithan, in press) and on the incipient modification of the basic microcotylid clamps in the fourth subfamily, which may be transitional to Heteromicrocotylidae. The genera within these subfamilies are characterized by the type of male terminalia and the general distribution (or absence) of armature. Subgenera are based on the type of vaginal pores (single or paired), and presence or absence of armature on the vulva or adjacent suckers.

Specific characters fall into 10 or possibly more categories: 1) shape of clamps; 2) angles of the dorsal jaw-rami, also relative thickness of the clamp sclerites, including degree of cuticularization of ligament from dorsal arm of median spring, forming the so-called appendix of Goto; 3) shape of true appendix on dorsal arm if present; 4) nature of the oral pouches, and their rims; 5) size of pharynx relative to oral pouches; 6) presence of head organs or sticky gland-cells in groups on preoral lip; 7) presence or absence of diverticula along esophagus; 8) entry of crura into haptoral zone and their unequal development terminally; 9) route of the proximal vaginal ducts, direct, branched and *via* vitelline canals, etc.; 10) shape and number of spines associated with male terminalia; and 11) number of testes.

The number of clamps, except within rather wide limits, or less in association with a worm species of definite length, is of doubtful value; clamps are continually formed, at characteristic rates, in all Microcotyloidea. The number may have specific significance if, for example, the smaller of two similar species has more clamps than the

TABLE 1.—Summary of supra-specific taxa of *Microcotylidae* s.s.

Genus	Armature		Subgenus	Vaginal pores		Species
	atrium	penis		no.	armature	
Microcotylinae sensu stricto.....(65)						
1. <i>Microcotyle</i> v. B. & H.	++	—	(<i>Microcotyle</i>) (<i>Scintillocutua</i>)	1	—	18
2. <i>Atriostellia</i> nov.	+	—	(<i>Atriostellia</i>) (<i>Biplacurella</i>)	1	—	2
3. <i>Diplostamenides</i> nov.	+	+	(<i>Diplostamenides</i>) (<i>Vulvostella</i>) (<i>Bibubostella</i>)	1	—	3
4. <i>Solestamenides</i> nov.	—	+	2	+	1
5. <i>Prosmicrocotyla</i> Yamag.	(+)	—	1	—	7
6. <i>Manterella</i> nov.	(++)	—	2	+	2
7. <i>Nudimasculus</i> nov.	—	—	(2)	—	10
8. <i>Microcotylodes</i> Fujii	—	(+)	1	—	5
			(<i>Nudimasculus</i>) (<i>Bistellaputiva</i>) (<i>Bivaginuda</i>)	1	—	2
			1	(+)	4
			2	(+)	3
			(lat.) 1	—	2
				—	9
				—	1

TABLE 1.—(continued)

Genus	Armature		penis	Subgenus	Vaginal pores		Species
	atrium	stratum			no.	armature	
9. <i>Polynemicola</i> nov.	—	—	cirrus	(<i>Polynemicola</i>) (<i>Ishiella</i>)	1 2	+ +	3 1 4
10. <i>Metamicrocotyla</i> Yamag.	+	—	0	.....	0	—	5 —
Bradyhaptorinae nov. (4)							
11. <i>Bradyhaptorus</i> nov.	—	—	+	1	—	2
12. <i>Gammacallum</i> nov.	—	—	+	1	—	1
13. <i>Diplasocotyle</i> Sanders	+	—	—	1	(—) (—)	1
Caenomicrocotylinae nov. (13)							
14. <i>Caenomicrocotyle</i> nov.	++	—	—	(<i>Caenomicrocotyle</i>) (<i>Notaster</i>)	1	+ —	9
15. <i>Dinotaster</i> nov.	—	—	—	1	(+) (+)	1
16. <i>Dixia</i> nov.	+	—	—	1	—	1
17. <i>Paradiutix</i> nov.	(+)	—	—	1	—	1
Bychowskicotylinae nov. (1)							
18. <i>Bychowskicotyla</i> nov.	+	—	—	1	—	1
				(14)			(83)

larger. If the replication rate is constant for a species, the larger will have potentially fewer clamps.

There is a secondary replication stimulus in some species, namely, the lateral dichotomy of the formative zone in both lateral replication-axes, whereby double or even triple rows of clamps may be formed in the middle and/or anterior region of the euhaptor (later-formed clamps) (Unnithan, in press). This has been found in at least four unrelated species of Microcotylinae s.s.: *Microcotyle* (*Microcotyle*) *pomatomi* Goto, 1900, on *Pomatomus saltatrix* from the USA Atlantic; *Diplostamenides* (*D.*) *priacanthi* (Meserve) comb. n. on *Priacanthus* sp. from Galapagos; *Nudimasculus* (*N.*) *pogoniae* (MacCallum) comb. n., on *Pogonias chromis*, a sciaenid from USA Atlantic; and in *Microcotyloides incisa* (Linton) Fujii, 1944, on *Lutianus griseus* from Florida waters. Similar multiple rows have been found in the anterior region of the haptor in *Chauhanea madrasensis Ramalingam*, and in *Gotocotyla* spp. (both Gastrocotylidae).

Diagnosis of the family Microcotylidae Taschenberg, 1879 *sensu stricto nov.*: Microcotyloidea characterized by potentially unlimited replication of microcotylid-type of clamps, modified or not; clamps not markedly altered in shape or function (thus excluding the opened sucker-clamp types) and with no evidence for superimposed inhibition on either of the axes of replication; superimposed stimulus may be present causing an anterior-posterior dichotomy of the formative zone in both clamp-rows, resulting in a bilaterally symmetrical meta-haptor (Unnithan, in press). Euhaptor typically long and tail like, with many similar microcotylid clamps on either side, their number increasing anteriorly throughout life. Ovary often double arched, distal limb always descends. Type genus *Microcotyle* van Beneden & Hesse, 1863. Four subfamilies.

1) **MICROCOTYLINAE** Monticelli, 1892, s.s. emend. n.—Microcotylidae with regular anterior replication of both lateral clamp-rows, the whole haptor being a euhaptor, usually not embracing body proper. Length of clamp rows subequal, shorter at least 80% as long as the longer. Usually slight regular gradation of size of clamps towards middle of rows, but largest not more than double first-formed primary clamps. Type genus *Microcotyle* v. Ben. & Hesse, 1863: nine other genera (Table 1).

2) **Bradyhaptorinae** subfam. n.—Microcotylidae in which replication stimulus is less than typical, but compensated by very steep gradation in clamp size: seldom as many as 20 clamps, usually fewer than 12 on each side, with largest more than double (3-17 times) size of first primary clamp; clamps not significantly modified in shape. Type genus: *Bradyhaptorus* gen. n.: two other genera (Table 1).

3) **Caenomicrocotylinae** subfam. n.—Microcotylidae with symmetrical bilateral meta-haptor: an anterior haptor wing, separate from the body and free to be bent posteriorly in line with the euhaptor, forming a "fishtail" on which body proper may pivot in feeding postures, but meta-haptor usually in line with body-axis ventrally.

Formative zone at junction of euhaptor and metahaptor; new clamps, detected by abruptly smaller size or malformation, thus found near middle of rows opposite to end of body proper; new clamps forming centrifugally: on posterior side of formative zone for euhaptor, and anteriorly contributing to metahaptor. Type genus: *Caenomicrocotyla* gen. n.: one other genus (Table 1).

4) *Bychowskicotylinae* subfam. n.—Microcotylidae in which clamps show an incipient modification and lateral (abaxial-adaxial) asymmetry. Type genus; *Bychowskicotyla* gen. n.; monotypic with *B. mormyri* (Lorenz, 1878) comb. n.

Short provisional generic and subgeneric diagnoses will be given after the five new species, all members of the Microcotylinae, have been described and defined.

This newly contrived scheme for the microcotylids is admittedly highly provisional, dependent on re-examination of more of the older species and knowledge of their range of variation; it is intended to facilitate reference to the formerly unwieldy assemblage of species of *Microcotyle sensu lato*. The collection and treatment of specimens were as described by Unnithan (1957). All measurements not otherwise designated are in millimeters.

Acknowledgments.—The author is grateful to Miss N. G. Sproston for the many weeks of evening discussions at Mandapam Camp in 1956, during which the anlage of the present scheme of classification was laid down; Dr. Y. R. Tripathi for the manuscript of his paper on this family (1956), then in press; Dr. N. K. Panikkar, then Director of the Central Marine Fisheries Research Institute, Mandapam Camp, South India, for providing excellent laboratory facilities; and Dr. C. C. John for permission to work in the Marine Biological Laboratory of the University of Kerala, in Trivandrum.

Atriostella otolithis gen. et sp. n.

(Figs. 1-5)

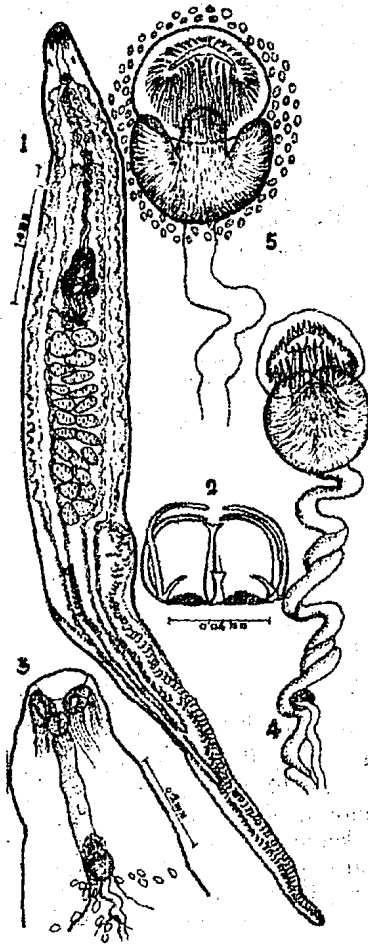
Host and locality.—*Otolithes argenteus* Cuvier (= *O. argenteus* of Day), Trivandrum, India.

Location on host.—Gills.

Type specimens.—Holotype will be deposited in the Zoological Survey of India. Paratypes in author's collections.

Description (based on 60 specimens).—Body proper elongated, anterior half tapering gradually to bluntly rounded (not expanded) anterior end; haptor region tapering, slender tail-like, slightly less than half total length; total length, 7.2-8.1, maximum width, 0.750-0.921 across almost parallel-sided gonad zone (Fig. 1). Clamp rows subsessile, on subventral short frills; left row usually slightly longer (101/85 clamps in the holotype), shorter row never less than 80% of longer (84% in the holotype). (All microcotylids found on Sciaenidae in India exhibit similar slight discrepancy between the lengths of clamp rows.) Clamps (24 x 40 μ -40 x 56 μ) typically microcotylid, barely twice as wide as long and with squarish jaws but not strictly angled distally (Fig. 2). Smallest clamps at either end, gradually increasing to less

than double the size of primary clamps near the middle of row; those on longer side appreciably larger than bilateral mates, particularly near middle of rows. Median spring of clamps typical, slightly furrowed, with long ventral arm tapering before its bifurcate expansion distally: fork slender and points sharp, dorsal arm barely half as long and broadly truncated with ligament very lightly cuticularized, as usual, in two converging parts. Mouth subterminal, slit-like (Fig. 3), with



Figs. 1-5.—*Atristella otolithis* gen. et sp. n., 1. complete worm, ventral view; 2. clamp, dorsal view; 3. anterior region, dorsal view; 4. vagina and male terminalia with retracted unarmed cirrus and armed male genital pore; 5. male terminalia with the cirrus partly protruded

thick muscular anterior lip and without conspicuous gland-cells. Oral pouches ($60 \times 40 \mu$ - $64 \times 44 \mu$) septate, anterior loculus much narrower; strong muscle bundles from each end of ellipsoidal pouches extend back through lateral fields to body wall in or behind esophageal zone. Pharynx ovoid ($45 \times 40 \mu$ - $50 \times 48 \mu$) with intrinsic gland-cells in walls. Esophagus rather short and lacking diverticula, crural bifurcation just behind genital atrium (0.49 from anterior end in holotype), simple external and shorter internal diverticula of crura begin immediately behind intestinal bifurcation and continue to end of body proper, always accompanied by spheroidal rosettes of vitelline follicles (average diam 40μ); no intestinal side-branches or extensions into haptor (to equal lengths near mid-haptoral level), but occasional vitelline follicles bordering their fields. Testicular zone occupies posterior 40% of body; number of testes varies slightly, suggesting addition of few during growth. Testes 20-22, in two roughly alternating longitudinal rows of ovoid follicles ($75 \times 105 \mu$ - $195 \times 240 \mu$), variable in shape, larger usually showing signs of spermatogenesis. *Vas deferens* traceable from anterior margin of testicular area as a wavy duct, dilating immediately in front of ovary into moderately large ovoid vesicula seminalis, continuing to vaginal zone, then becoming thicker-walled with gland cells (*pars prostatica*); all ducts between the ovarian and vaginal zones convoluted (this region is highly contractile and extensible). Distally *pars prostatica* passes into *ductus ejaculatorius*, immediately opening into a large trilobed muscular penis; retracted penis roughly spheroidal ($56 \times 58 \mu$) (Figs. 4, 5); expanded penis unarmed. *Atrium masculinum* with circular muscular rim, at least three times as wide posteriorly as anteriorly, embedded with about 40 slightly curved spines in single row, directed towards crescentic male pore; ventral spines about 28μ long, with slightly hooked tips, grading laterally to straighter spines 20μ long; spines completing corona anterodorsally appear much shorter in optical perspective; actually about 12μ long and relatively broader than lateral spines. (Mass of spheroidal cells surrounding atrium not densely chromophilic, perhaps partly hydraulic in function, aiding in protrusion of penis-bulb, which lacks conspicuous extrinsic muscles.) Vaginal pore median, dorsal, unarmed, transverse, unspecialized funnel-like vulva about 0.98 behind anterior end and surrounded by radial muscles and halo of gland cells; its diameter similar to that of atrial pore of similar-sized worms, so that when the spines of the latter are applied to vulval region, the partly protruded penis could be easily accommodated. Vaginal duct with no permanent *receptaculum seminis*, leading directly to fertilization chamber beyond ootype. Ovary double arched occupying middle fifth of body proper, proximal spheroidal lobe about 90μ in diameter on right side; first ascending limb straight, then sharply recurved for a short distance; ascending on left as a broad limb equal to distal descending limb on right, where it overlaps proximal limb and contracts to oviduct, passing obliquely back to ootype surrounded by dense Mehlis' gland-cells. Transverse vitelline ducts confluent below lower

arch of ovary, forming median vitelline duct which dilates to form vitelline ampulla; latter uniting posteriorly with ootype duct at entrance of fertilization chamber (spheroidal and $40\ \mu$ wide). Fertilization chamber also shows origin of: 1) vitellointestinal canal, leading as usual to right crus; 2) a wide short ($60\ \mu$) duct extending obliquely backwards and filled with vitelline cells and globules, and 3) from its distal end another similar short duct on left dilating into vesicle $24\ \mu$ wide, also filled with vitelline material. This terminal vesicle is capped by a large nucleated cell, around which a cluster of gland cells are disposed. This complex of ducts on the opposite side to the vitellointestinal canal and ending in an ampulla with gland-cells, is considered to be the *blind homologue of Laurer's Canal in Digenea*: a similar structure which actually perforated the dorsal wall was described in *Dicotyle vellavoli* (Unnithan, 1961). The third exit from the fertilization chamber continues through the ootype and Mehlis' gland region (which comprises whole complex of ducts just described) to emerge anteriorly as the uterus, which runs forward and opens just anterior to the *atrium masculinum*. Interuterine eggs not observed.

Generic diagnosis of *Atrioistella* gen. n.: Microcotylinae with a practically symmetrical haptor as tapered continuation of the body, with unmodified microcotylid clamps: if of unequal numbers, shorter row never less than 80% of the longer. Atrium armed with erect, usually long spines of dissimilar lengths; muscular penis lobed or not and entirely unarmed. Type species: *Atrioistella otolithis* sp. n. Subgenus (*Atrioistella*) subgen. n. with single middorsal unarmed vaginal pore; *Atrioistella* (*Atrioistella*) *otolithis* sp. n. on *Otolithes argenteus* Cuv.; other spp.: *A. (A.) sciaenae* (Goto) comb. n. on *Nibeia schlegeli* (Bleeker); and *A. (A.) angelichthystownsendi* (MacCallum, 1916) comb. n. on *Angelichthystownsendi* Nichols & Mowbray, from USA Atlantic. Also (*Biplacumella*) subgen. n.: *Atrioistella* with a ventral cuticular post-atrial body plaque and a much wider dorsal plaque behind the two unarmed vulvae. Monotypic, with *A. (Biplacumella) australis* (Murray, 1931) comb. n. on *Sparus australis*.

Comparison.—*Atrioistella otolithis* is unlike most Microcotylinae in having an atrial corona of erect slender spines and a strongly muscular unarmed penis. In this respect it closely resembles *Atrioistella (A.) sciaenae* (Goto, 1894) (redescribed fully by Yamaguti [1958: 80-81]). The main differences between *A. sciaenae* (Goto) and *A. otolithis* lie in the septate oral pouches and the less accentuated difference in the double row of atrial spines of the latter.

A. (A.) angelichthystownsendi (MacCallum, 1916) comb. n. appears to be closely related in respect of the long hair-like spines clustered around the *atrium masculinum* and uterine pore, its round oral suckers are septate; the clamp-rows are apparently equal and its host is a chaetodontid, but there is a single unarmed middorsal vagina.

A. (Biplacumella) australis (Murray, 1931) comb. n. is probably congeneric; the *atrium masculinum* is a muscular pad bearing two

rather long, erect sharp spines, with a group of four short spines just lateral and posterior to them. The small muscular penis is shown retracted (within or against?) opposite the large dilation of the *vesicula seminalis*, connected to the atrial cavity by a duct, and from its distal end there is apparently the attachment of an oval plaque, a cuticularized area of the ventral body wall. A similar but wider plaque occurs on the dorsal side just below the zone of the paired and unarmed vaginal pores. These cuticularized areas may serve as exoskeleton for the attachment of muscles ancillary to the genital terminalia. Ducts from the paired vulvae form a short 'V'-confluence to the longer median vaginal duct, which again bifurcates immediately in front of the transverse vitelline ducts which it joins, and these are again confluent (forming a small diamond-shaped circulus) just anterior to the ovarian field, to form the median vitello-vaginal duct. The ovary is in the form of a single arch. The oral pouches, about three times the area of the pharynx, are biloculate, the outer triangular lobulus being only a third the size of the posterior-median loculus. The preoral lip has three eversible gland-pits, and the broadly oval egg has two long filaments. These characters, apart from the two kinds of erect spines of the atrium, all serve to distinguish this form subgenerically from the typical *Atrio stella* spp. on sciaenid hosts.

Diplostamenides umbrinae gen. et sp. n.

(Figs. 6-9)

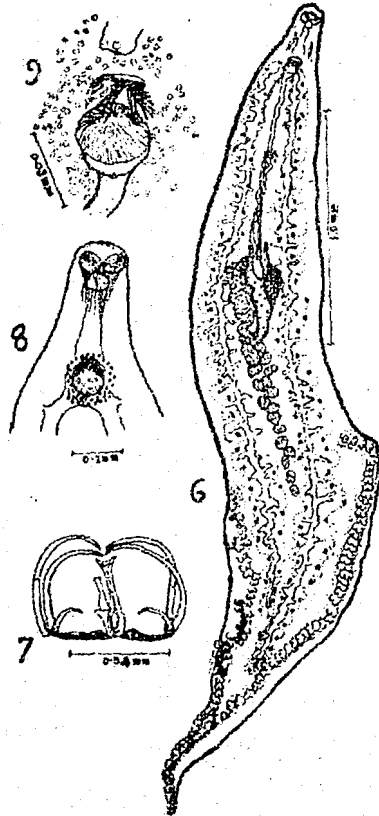
Host and locality.—*Umbrina russellii* Cuv., Trivandrum, India.

Location on host.—Gills.

Type specimens.—Holotype will be deposited in the Zoological Survey of India. Paratype in author's collections.

Description (based on two specimens).—Total length 3.67, 4.2; maximum width in testicular zone 0.75, 0.85 (Fig. 6). Haptor region rather wide, embracing posterior tapered end of body and including slightly branched ends of crura, right one not reaching half way, left at least half way, to the haptor; left clamp-frill longer (1.73, 1.85) than right (1.35, 1.49). Number of clamps on either side unequal, about 50-63 but folding near apex prevents precise counts. Clamps (Fig. 7) typical, sclerites not unusually stout or angled, but dorsal jaw-rami slightly longer and jointed about mid-length; median spring rather thick and deeply furrowed, ventral arm bluntly bifurcated; dorsal arm about a third as long, with a cuticularized ligament without a groove, which is blunt distally in most clamps. Hinge-line and lips of clamp capsule thickened with fibrous tissue, but without striae across ventral wall. Clamps on left row, $21 \times 42 \mu$ to $29 \times 63 \mu$, slightly shorter and proportionally wider than those in right row, $42 \times 50 \mu$, to $42 \times 63 \mu$. Mouth wide, subterminal, almost circular; preoral gland cells not conspicuous: mouth leading across oblique aseptate and ovoid oral pouches which are slightly larger than spheroidal pharynx (36 - 40μ diameter), placed immediately behind oblique and contiguous oral pouches. Esophagus wide, lacking diverticula and bifurcating into

crura immediately behind male terminalia (Fig. 8), whence lateral branches and vitellaria commence on either side. Testes in 18 irregular follicles 60-75 μ wide, first six or eight in two rows, rest in single file to base of haptor. *Vasa effrentia* confluent anteriorly in sac-like *vesicula seminalis*, from which *vas deferens* extends parallel to the vaginal canal to base of spheroidal muscular penis; head of penis armed with nine stout curved spines in semicircle anteriorly only; spines graded from 4 μ long anterodorsally to 12 μ laterally, posteroventrally are intrinsic radial muscles but no spines embedded therein; extrinsic muscles not conspicuous, but a wide halo of putative hydraulic cells may provide turgescence within the *ductus ejaculatorius* for protrusion of the penis. *Atrium masculinum* slightly in front of intestinal bifurcation armed with erect corona of 36 slender, slightly



Figs. 6-9.—*Diplostamenides umbrina* gen. et sp. n. 6. complete worm, ventral view; 7. clamp, dorsal view; 8. anterior region, ventral view; 9. male terminalia showing armature of penis and *atrium masculinum*, ventral view.

curved, forward-pointing spines with blunt outwardly curving tips; spines of graded lengths, posterior pair $42\ \mu$ long sloping like an open arch, bilateral numbers radiate from atrial lip, becoming much shorter ($21\ \mu$ or less) around anterodorsal sector of the corona (Fig. 9). There thus appear to be three arches of spines, the outer smallest, the middle long and slender and the inner stout (the latter actually belonging to the head of the penis, as described above). This is the interpretation for the disposition of spines described for *Microcotylis pancerii* Sonsino, 1891, which is probably congeneric. Ovary inverted 'J'-shaped, with distal complex of ducts typical, and the vitelointestinal canal branching from the base of the ootype to the right crus. Vaginal pore with simple unarmed vulva encircled by gland cells situated midway between top of ovary and genital atrium: long narrow vaginal duct empties into median vitelline duct at or near its confluence with lateral collecting ducts. Eggs not observed.

Generic diagnosis of *Diplostamenides* gen. n.: Microcotylinae with atrium masculinum armed with corona of graded spines and relatively few, usually much stouter, spines on head of penis. Type species: *Diplostamenides umbrinae* gen. et sp. n. Of the 10 species, six are on Sciaenidae, three on Sparidae and one on Priacanthidae. Three subgenera may be recognized, one of which is *Diplostamenides* subgen. n., with a single bare vaginal pore. Type species *D. (D.) umbrinae* sp. n.

Comparison.—*D. (D.) madrasi* (Tripathi, 1959) comb. n. on *Pseudosciaena diacanthus*, from Bay of Bengal, has the atrial corona of rather slender spines posteriorly, apparently on the penis, a double pair of laterals and three median different stout spines; one crus extends unbranched deep into the haptor, which has over 60 clamps on each side in worms 2.0mm long; the oral pouches are aseptate and not much bigger than the pharynx. The vagina is assumed to be unarmed since it could not be seen: the same doubtful assumption applies to *D. (D.) pancerii* (Sons.) and *D. (D.) priacanthi* (Meserve, 1938) comb. n., on *Priacanthus* sp. from the Galapagos Islands; more than 200 clamps on the haptor occur in multiple rows; atrial spines in a corona broken posteriorly are $24\text{--}28\ \mu$ long, larger towards the emergent penis head with four strong spines up to $32\ \mu$ long with bulbous bases. Oral pouches septate and nearly double the size of the pharynx; 11 testes in single file; single unarmed vagina. *D. (D.) pancerii* (Sonsino, 1891) comb. nov. on *Sciaena umbra* from the Mediterranean; its clamps are larger than in most species, $120\ \mu$ wide, and about 100 each side; testes very numerous; atrium with an outer corona of about 80 and an inner of 50 smaller spines, and apparently the 30 posterior spines are associated with the penis. *D. (D.) salpae* (Par. & Per., 1890) comb. n., on *Box salpa* from the Mediterranean; atrium with a radial corona of hooked spines $28\ \mu$ long broken posteriorly where the emergent penis head carries 12 longer spines with incurved bases; the single vaginal pore is unarmed. *D. (D.) eriensis* (Bangham & Hunter, 1936) comb. nov. on *Aplodinotus grunniens* from Lake Erie, N. America; very

closely resembling a young version of *D. (D.) spinicirrus* (MacCallum, 1918) comb. n., on the same host (though Bangham & Hunter, 1936, were satisfied with the distinction): in the latter the vagina is a very large median sac with a narrow neck to a small unarmed vulva medially, a vaginal duct leads to the median vitelline duct; 40-50 testes, apparently increasing with age; atrial corona of 70-80 slender hooks $40\ \mu$ long, the transverse oval broken posteriorly, admitting the muscular penis head with its erect turret of thorn-like hooks (14-18, $36\ \mu$ long); worms about 5mm long have over 90 clamps each side, up to $80\ \mu$ wide; the rows are subequal, the type specimen showing a numerical ratio of 81%.

Subgenus *Vulvostella* subgen. n., including species of the genus *Diplostamenides* with a spiny corona around the middorsal vaginal pore: type species *D. (Vulvostella) pamae* (Tripathi, 1936) comb. n., on the fresh-water sciaenid *Pama pama*, from Chilka Lake and Hooghly River, Bay of Bengal; with a circle of recurved spines on the vulva, and around the atrium long slender spines ($38\ \mu$) while penis head has a ring of 15-20 stouter spines ($15\ \mu$ long); clamp-rows subequal (numerically 82.5% to 84.5%), each about $40\ \mu$ wide, in strong fibrous capsules with 6-7 striae across sectors of ventral valve; in worms 2mm long the longer side had 34, in 5-mm worms 64 clamps; 8-11 testes; egg with cuplike anopercular appendix on short stalk, a peculiarity shared by another microcotylinean from a sciaenid (*M. heteracantha*). Second species: *D. (V.) sargi* (Par. & Per., 1890) comb. n., on *Sargus* spp. from the Mediterranean: vagina with circle of minute spinules; atrial corona of 22 erect spines (graded to $42\ \mu$ long), incomplete posteriorly, admitting penis with its stouter spine-circle (each $14\ \mu$ long). Clamps exceptional in Microcotylinae since in the proximal half of the rows of 60-70 pairs, the clamps are three times the size of the smallest primaries, the range is $28\ \mu$ to $78\ \mu$ wide; oral pouches aseptate, with minutely papillate rims; egg with two polar filaments, the shorter with an anchor-like end.

Bivulvostella subgen. n., members of the genus *Diplostamenides* in which there are paired vulvae with a star of short spines. Monotypic with *D. (Bivulvostella) canthari* (van Ben. & Hesse, 1863) comb. n., on *Cantharus lineatus* from *E. Atlantic* and Mediterranean, the type species; atrial spines in a corona of 20-30 arrow-pointed spines and behind them, presumably on the penis, are two small groups of eight shorter spines; in 4-mm worms 90-100 clamps on each side; 17 testes; egg with a long opercular filament and short stouter anopercular filament.

Polynemicola bulbovaginata gen. et sp. n.

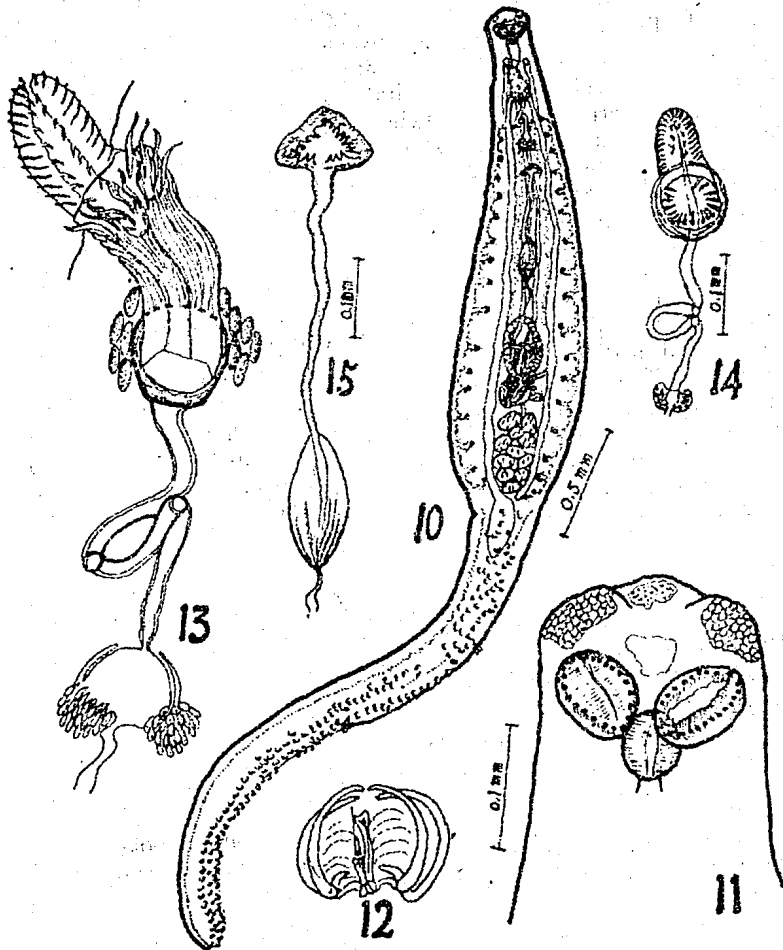
(Figs. 10-15)

Host and locality.—*Polynemus indicus* Day, Trivandrum, India.

Location on host.—Gills.

Type specimens.—Holotype will be deposited in the Zoological Survey of India. Paratypes in author's collections.

Description (based on 50 specimens).—Specimens remarkably uniform, total length 5.025-5.04, haptor accounting for more than half (54%); body proper 2.325-2.335 long; maximum width (0.58-0.59 in midgonad zone tapering gradually to half this width in anterior third, and to a quarter the maximum width in esophageal zone behind slightly expanded broadly triangular head (Fig. 10). Haptor region a



Figs. 10-15.—*Polynemicola bulbovaginata* gen. et sp. n. 10. complete worm, dorsal view; 11. anterior region, dorsal view; 12. clamp, ventral view; 13. male terminalia showing the ejaculatory bulb, cirrus and associated structures, ventral view; 14. partly retracted cirrus with a portion of the ejaculatory duct; 15. vaginal complex showing the vaginal bulb, armature of the vagina, etc., dorsal view

delicate submarginal frill of similar, numerous, and rather small pedunculate clamps on a nearly cylindrical, and only slightly tapering, extension of body, but marked off from it at its abruptly narrowed origin, where width is only 0.32-0.39, thence tapering gradually to bluntly pointed end, from which protohaptor is lost. Lateral angles of the head contain prominent and dense clusters of sticky gland-cells, with slightly protrusible mouth-cone between them. Mouth subventral, 30-32 μ wide, leading to obliquely placed ovoid (60 x 75 μ to 60 x 80 μ), aseptate oral pouches with moniliform rim and thick walls. Pharynx subspherical (60-62 μ wide) slightly overlapping oral pouches dorsally (Fig. 11). Esophagus short, simple bifurcating to form intestinal crura within or just behind zone of genital atrium. Crura with moderately developed, external lateral branches but practically none internally; hind end of right crus bends inward at end of testicular field, while left crus, no longer branching, dilates into elongated bulb, as long as the width of origin of haptor, and encroaches into median field here. Haptor, a euhaptor having equally developed similar clamp rows, with about 125-130 clamps on each side and slight gradation in size towards middle of rows. Clamps unmodified microcotylid and nearly square, or not more than 25% wider than long, with an average width of about 50 μ (Fig. 12); jaws not conspicuously angled distally; median spring with typical median furrow but only slightly bifurcated distally, dorsal arm only half as long as ventral, ligament slightly cuticularized, appearing as a pointed bipartite appendix; ventral wall of capsule slightly thickened by 5-6 'V'-shaped striae of delicate fibrous tissue on each side of median spring. Conspicuous glands at base of frills, marking origin of vessel and muscle fibers to each clamp. Testicular zone packed with subequal, variously shaped, 10-12 follicles (105-135 μ wide) in two irregular rows, occupying intercrural field in an area 480-485 μ x 180-182 μ in posterior fifth of body proper. *Vasa efferentia* uniting at limit of testes zone to form *tes deferens*. *Vesicula seminalis* (Figs. 13, 14) a double-walled sac, wider than long, into which open surrounding prostate gland-cells: anteriorly, it gives rise to *ductus ejaculatorius*, a narrow tube with an oval loop at midlength, thence opening directly into base of elaborate cirrus-sac near genital atrium.

(Exceptionally in Microcotylinae, there is an eversible cirrus in *Polynemicola*; it is a long, cylindrical, highly muscular structure, bearing lateral ranks of short, sharp spines; basally a wider muscular bulb bears four circles of much longer, slightly sigmoid spines, hooked at the tips, probably functioning as grapnel hooks for the vulval region of the partner. A cluster of large hydraulic cells (transparent, ovoid and chromophobic) surrounds the base of the cirrus and covers the anterior part of the bulb in repose; on eversion, the hydraulic cells appear as lateral clusters. The thick bulb is propelled forwards and the thinner-walled cirrus-head is everted, doubtless by turgescence, provided by the hydraulic cells, opening into the lumen with the *ductus ejaculatorius* carrying the sperm and prostatic secretions from the *vesicula seminalis*. The loop in the *ductus* is constant and clear thickenings of

its lumen are seen at its beginning and end, suggesting that this is a vulvular device for sperm rationing: the volume within the loop is equivalent to one emission.)

Atrium masculinum unarmed, 90-96 μ in diameter. Vaginal pore triangular, middorsal, about as far behind male pore as latter is behind anterior end (Fig. 15), diameter precisely that of cirrus bulb; triangular lip a tumid vulva, and in repose the inner margins carry about 20 broad-based, sharp, triangular spines directed inwardly. Vaginal canal cuticularized and folded distally; passing backwards about 350 μ when expanding into spindle-shaped bulb, 180-185 x 75-80 μ with ribbed or folded fibrous wall, constricted posteriorly to a very narrow, wavy vaginal canal which runs directly to ootype and fertilization chamber. A terminal variable dilatation is probably a functional *receptaculum seminis vaginae*; the conspicuous bulb may be regarded as a true *receptaculum seminis*, and may, by virtue of its muscular wall, act as a suction pump. Ovary a single long arch above zone of its proximal, irregularly rounded lobe, which lies mostly on right side: in some worms, this appears as a closely coiled 'S', occupying a field 75 x 90 μ , its ascending arm crossing to left, forming long arch so that the wide descending arm contracts to form oviduct dextrally just above proximal lobe. Oviduct guarded by sphincter at each end, representing ovjector chamber with thick muscular walls, leads to the pyriform ootype surrounded by Mehlis'-gland cells, obliquely between ovarian and testicular fields. Ootype region receives vitelline duct or reservoir formed by confluence of symmetrical short transverse ducts within arch of ovary; here, the vitellointestinal canal is given off to right crus; uterus entirely ascending, pursuing median course into genital atrium just anterior to male pore; uterine eggs about 250 μ long, with anterior filament 125-150 μ long, posterior filament about 25% this length. Vitelline follicles co-extensive with branches of crura in external fields, but not confluent posteriorly, nor do they enter haptor.

Polynemicola tritestis sp. n.

(Figs. 16-20)

Host and locality.—*Eleuthronema heptadactylum* (Cuvier), Trivandrum, India.

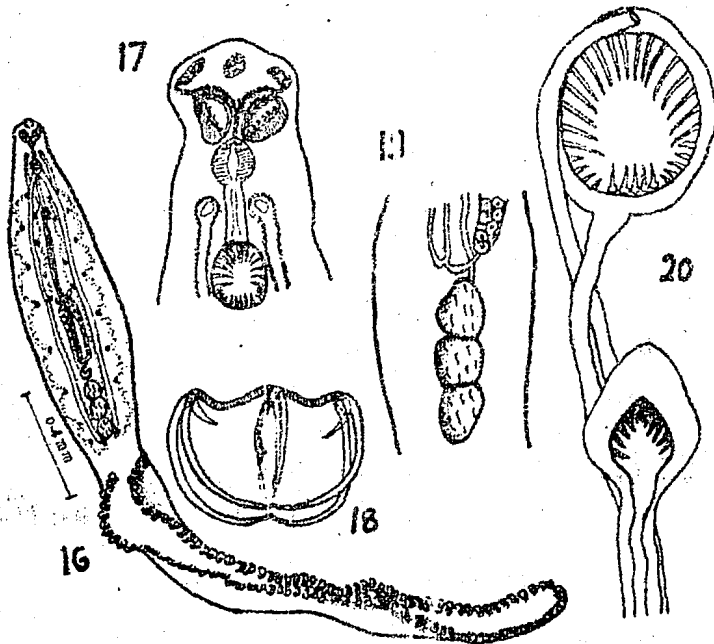
Location on host.—Gills.

Type specimens.—Holotype will be deposited in the Zoological Survey of India. Paratype in author's collections.

Description (based on two specimens).—Total length 2.75, 2.92, maximum width 0.68, 0.78 mm (Fig. 16). Haptor slightly more than half total length. Body proper less tapering than that of *P. bulbovagina*; length of body proper about four times maximum width; row of three spherical testes much shorter in proportion: here, less than length of ovarian zone. Head slightly expanded, rounded angles filled with sticky gland-cells, and another cluster on slightly protuberant upper lip with a band of similar gland-cells along inner edges of oral pouch.

apparently in dorsal wall of buccal cavity and joined to head groups by ducts between external ends (Fig. 17). Oral pouches with thick fibrous walls and moniliform glands on rims; pharynx ovate, close behind oral pouches and receiving a duct from glands above the pouches; esophagus simple, bifurcating into intestinal crura in zone of genital atrium.

Crura, with only few lateral diverticula and practically devoid of medial diverticula, extend to level of last testis, ending blindly without dilating or entering haptoral region; haptor 1.52×0.15 and 1.75×0.19 slightly constricted from body and nearly parallel-sided with a rounded tip, lacking an anchor-bearing protohaptor. Clamp rows similar with 75-78 almost sessile clamps, on rather wide membranous frills arising within margin of haptor on ventral side. Middle clamps slightly longer than those nearer the ends—smallest ($25 \times 34 \mu$) is at posterior end; near middle, average clamp is $29 \times 37 \mu$. Clamp pattern typically microcotylid (Fig. 18), jaws relatively much more delicate than in *P. bulbovaginata*, capsule thinner and without fibrous striae across ventral wall; terminal bifurcations of median spring barely discernible, ligament of dorsal arm of spring only lightly cuticularized though entire spring has median furrow. Testes 3, large and spherical ($630-635 \mu \times$



Figs. 16-20.—*Polynemicola tritestis* sp. n. 16. complete worm, dorsal view; 17. anterior region, ventral view; 18. clamp, dorsal view; 19. region of the testis and ovary; 20. vagina and male terminalia with the uterus, dorsal view

504-508 μ), constitutes the most obvious specific feature (Fig. 19). *Vas deferens* nearly straight, apparently without intercalary *vesicula seminalis* of the type species. Cirrus pouch retracted in both specimens near genital atrium, which therefore shows concentrated spines radiating inward: those posteriorly, in lateral groups (Fig. 20), represent lateral spines of cirrus proper, posterior group of five stiff spines with bulbous bases and anterior arc of 21 slender spines associated with basal bulb of the now inverted cirrus, represent the grapnel spines for vulva of partner: so the rather wide rim of atrium proper is actually unarmed in *P. tritestis* also. Uterus arches over right side and opens in front of atrium masculinum in a simple median pore. Vagina situated (Fig. 20) as in type species *P. bulbovaginata*, but triangular vulva has much wider tumid border. Vaginal pore shaped like a Norman arch, its muscular inner edge bearing 12 sharp, triangular, inwardly-directed spines 8-9 μ long (none on posterior side of triangle). Pore 21 μ long, but whole vulval field nearly twice this and corresponding in diameter to erect basal spines of cirrus of a similar-sized partner, outer diameter of the oval atrium 50 μ . Distal triangular part of vagina cuticularized, then becoming muscular-walled for short distance and tapering into thin-walled vaginal canal, in marked contrast to abrupt bulbous *receptaculum seminis* in corresponding region of type species; vagina continues posteriorly, directly to fertilization chamber in the middle of ootype. Ovary a very elongated arch, its field 195 μ long immediately in front of testes; descending limb containing ova up to 17 μ in diameter, abruptly constricted to form double sphinctered thick-walled ovjector, leading horizontally to the Mehlis'-gland region of ootype. In this region uterus and vitellointestinal canal arise, and vitelline duct enters: transverse vitelline ducts confluent near anterior end of ovarian field. Vitelline follicles relatively large (20-25 μ) spheroidal resettes, comparatively sparsely scattered between lateral branches of crura from intestinal bifurcation to end of testicular zone. A single uterine filamented egg (100 μ long) observed.

Generic diagnosis of *Polynemicola* gen. n.: Microcotylinae with haptor nearly as long as, and distinct from, body proper, bearing numerous, similar, unmodified microcotylid clamps in equal rows; only slightly graded in size towards middle of rows. Male terminalia an eversible spiny cirrus, atrium unarmed, usually with a muscular sphincter-like rim; *receptaculum seminis* often well developed near distal end of vagina. Type species: *Polynemicola bulbovaginata* gen. et sp. n. : two subgenera.

Polynemicola subgen. n.: includes species of genus *Polynemicola*; with a single vagina middorsally, with triangular tumid vulva and spines on its inner rim; long vaginal canal cuticularized distally and may have an abrupt bulbous *receptaculum seminis* before narrowing to thin-walled canal, leading direct to ootype region. Parasites of Polynemidae. Includes type species *P. (P.) bulbovaginata* and *P. (P.) tritestis* sp. n.; probably also *P. (P.) polynemi* (MacCallum, 1917) comb. n., originally on *Polynemus auratus* from Batavia; and accord-

ing to Tripathi (1956) found on *E. tetradactylum* (Day) and *P. indicus* Day, from Chilka Lake and estuaries of Hooghly and Matla Rivers (Bay of Bengal).

Ishiella subgen. n.: includes species of *Polynemicola* with two lateral (dorsal) vaginae, vulvae connected by transverse duct and each with a circlet of spines; long, median vaginal canal leads to ellipsoidal *receptaculum seminis*: monotypic with *P. (Ishiella) ichimidai* (Ishii & Sawada, 1938) comb. n., on *Pagrosomus major*; its worms 3-3.6 mm long are 40-48 pairs of clamps on distinct euhaptor; 35-40 testes, and said to have a superficial resemblance to *Gotocotyla acanthophallus* (Gastrocotylidae).

Comparison.—These two species of the subgenus *Polynemicola* from polynemid hosts are unusual among Microcotylidae in having a clearly eversible cirrus, with lateral spines and a bulbous base bearing long hooks, while the *atrium masculinum* itself is not armed. The development of hydraulic cells in the type species is of remarkable interest in view of their ancillary action in everting the cirrus and providing turgescence for the cirrus and its bulbous base with grapnel spines. The basal spines of the cirrus are disposed so as to correspond in span with the turgid lip of the vulva of a similar-sized partner. The triangular vaginal pore is characteristic of the genus but the spines within it are variable: the unique bulbous *receptaculum seminis* is visible only in the type species. The second species, much smaller, on another host-species, has only three large testes compared with the dozen or so in a cluster in *P. bulbovaginata*: another specific character of the latter is the bulbous extension of the left cirrus into the haptor-base, whereas in *P. tritestis* the simple-ended crura are equal and end with the testicular zone.

Tripathi (1956) gives a very brief report on finding what he identified as *Microcotyle polynemi* MacCallum 1917, on the gills of *Polynemus indicus* Day, and *Eleuthronema tetradactylum* (Day), caught from Chilka Lake and the estuaries of the Hooghly and Matla Rivers in the NW region of the Bay of Bengal. The type material was from *Polynemus auratus* in Indonesian waters (Batavia), but the original description is not available for reference. However, Tripathi's material may possibly be congeneric, if not conspecific, with *P. bulbovaginata* sp. n. His worms were from 4.9 to 6.6 long, and the haptor 1.5 to 2.8 long (less than half of total length, but relatively long), but the testes in his worms were smaller (83 μ diam) and far more numerous (38-50 follicles). He mentions long spines associated with a 'cirrus,' without describing the male terminalia or vagina. In spite of the rather large size of Tripathi's worms he found only 62-70 pairs of clamps on the haptor ("62-60" is a misprint, pers. comm.). A re-examination of his material and a comparison with the Indonesian species is desirable to determine whether these represent one, two or three species, and if one of them is conspecific with *P. bulbovaginata* sp. n. from Trivandrum coastal fishes.

Metamicrocotyla manaarensis sp. n.

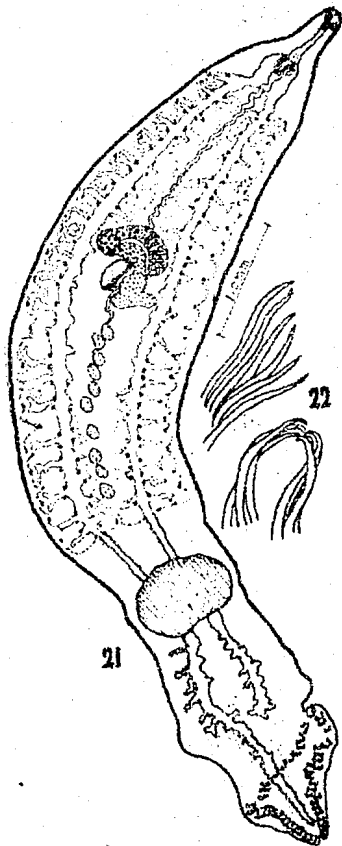
(Figs. 21-22)

Host and locality.—*Mugil troschelii* Bleeker, (including *M. posecilus* Day) Mandapam, India.

Location on host.—Gills.

Type specimens.—Holotype will be deposited in the Zoological Survey of India. Paratypes in author's collections.

Description (based on three specimens).—Body extremely muscular, practically parallel-sided, with protrusible neck region which may be abruptly narrowed in extension; usually widest in ovarian zone near end of anterior third. Testicular zone tapers to thick haptoral peduncle devoid of vitellaria but containing branching ends of crura, one of which ends in front of haptor, while the other (perhaps always left



Figs. 21-22.—*Metamicrocotyla manaarensis* sp. n. 21. complete worm, dorsal view; 22. anterior and posterior group of genital spines

one) extends nearly to its tip and continues to branch. Haptor a broad triangular expansion, slightly constricted from thicker peduncle, and bearing ventral frills along margin for subequal rows of nearly sessile clamps, longer row on left (27/25). Protohaptor indicated by slight notch between ends of narrowed haptor frills terminally (Fig. 21). An exceedingly contractile species, particularly in the region behind testes, though contractility is strong throughout body. Fixed specimens 8.25-8.97 long with maximum width of 1.47-1.56; in life at least 12 long, and correspondingly narrower, with parallel sides tapering in anterior quarter and posterior third. Most remarkable and unique feature is muscular sucker in first third of peduncle, most obvious when peduncle is contracted, appearing as a transverse-oval, raised area of densely packed longitudinal muscle fibers surrounded by delicate fibrous sheath, and in living state by pale halo, accentuated by the relative capacity of the sucker itself. Outline of sucker not easily visible in extended living animals, but dense striae of muscles remain and merge partly into those of wall of peduncle in front and behind it, and area itself becomes more transparent than rest of the worm; when a wave of contraction passes down body-axis the dark oval sucker instantly appears to reform. This striking feature is remarkable to unaided eye in living worms, and since it is not mentioned by Yamaguti for his two related species, nor by Hargis (1956) for the third species from *Mugil cephalus* (from Texas and Florida waters), I conclude that it is a specialized development in *Metamicrocotyla manaarensis* sp. n. In my material it is 567 x 945 μ to 580 x 954 μ (Fig. 21). No diverticula on crura in region of sucker, though they are present posterior to it, particularly on outside of (left) longer crus, but branches reduced as crus enters haptor, suppressed in last half of haptor. Oral pouches aseptate, ellipsoidal, obliquely placed immediately behind transverse subterminal mouth: 68 x 84 μ -63 x 105 μ . Pharynx less than half this size (nearly two-thirds of oral pouches in *Celebes* spp.): 43 x 32 μ . Prepharynx absent, esophagus (about 0.77 long) with irregular outlines, but no diverticula, bifurcates after a dilated region into two immediately ramifying crura, just behind zone of genital atrium. Testes 10, tandem. Ovary double-arched, and associated ducts similar to those in other species of the genus. Vagina not observed. *Atrium masculinum* superficially similar to that of *M. bora*, but shows differences in detail of same order as those separating the four other species: anterior paired group 6-7 spines, 80-100 μ long, slightly signoid and with points directed forward and inward; middle and posterior groups, each of three bowed spines with hooked tips mutually opposed and only 48-56 μ long (Fig. 22).

Vitelline follicles (29-31 μ in diam) (co-extensive with external branches of crura only in anterior two-thirds of worm, just behind testicular field where lateral branching ends in front of peduncle, but not present where branching is resumed beyond region of sucker.

Comparison.—*M. manaarensis* sp. n. is nearest to the type species *M. bora* Yamaguti, 1953, but apart from the presence of the con-

spicuous peduncular sucker, differs in fewer testes, half the number of atrial spines in the two posterior groups, and in the relatively smaller pharynx compared with the oral pouches. The tabular comparison shows closeness of the relation of the three stout and the two filiform species, from widely separated regions of the world.

THE SYSTEMATIC PARTITION OF THE SUBFAMILIES
OF MICROCOTYLIDAE S.S.

In the most recent attempt to subdivide the species of *Microcotyle sensu lato*, Tripathi (1956) created four new subgenera based on the armature of the genital terminalia, and removed some species showing graded clamp-size to *Diplasiocotyle* Sandars (irrespective of the clamps being relatively restricted in number, or the nature of the haptor, or the genital terminalia). Furthermore, the name cirrus was used throughout with reference to the male terminalia in *Microcotyle*, which denoted protrusible penis as well as eversible cirrus and also the atrium masculinum, either or both being armed in his subgenus (*Microcotyle*) while the vagina (-ae) is bare. In *Bispina* both male and female pores have associated spines "Cirrus and vagina (-ae) armed"; in (*Vaginispina*) "cirrus unarmed, vagina (-ae) armed"; and (*Aspina*) with "cirrus and vagina (-ae) unarmed." The species are listed under each subgenus in alphabetical order, but no types were designated for the subgenera. These subgeneric names are therefore not available, according to Article 13b of the International Code of Zoological Nomenclature. Nor was this grouping systematically satisfactory because of ambiguity in both the criteria (penis and atrium, and one or two vaginal pores). The present scheme attempts to eliminate ambiguities as far as possible in accordance with the published data. The rationale for the four subfamilies and their definition appears in the Introduction above; their 18 genera follow.

MICROCOTYLINAE Monticelli 1892, *emend.*, *sensu stricto*.—*Microcotyle* v. Beneden & Hesse, 1863, *sensu stricto*.—Microcotylinae with the genital atrium and preatrial bulb covered with similar low conical prickles sometimes absent in median area (path of unarmed end of protrusible ductus ejaculatorius), usually similar prickles in two shallow lateral pockets in posterior wall of atrium. Haptor of similar clamp frills containing unbranched extension of one or both crura, but not embracing lower parts of the testicular zone.

Microcotyle subgen. n., with type species *Microcotyle (Microcotyle donavini* v. Beneden & Hesse, 1863, on *Labrus bergylta*, in which there is a single middorsal unarmed vaginal pore. Other spp.: (also on Labridae) *M. (M.) hiatalae* Goto, 1900, on *Tautoga onities*; *M. (M.) furcata* Linton, 1940, from same host; *M. (M.) erythrimi* v. Beneden & Hesse, 1863, on *Pagellus erythrinus* and *P. acarne*, also *Box boops*; *M. (M.) elegans* Goto, 1894, on *Scombrops cheilodipteroides*; *M. (M.) centropristis* MacCallum, 1915, on *Centropristes striatus*; *M. (M.) helotes* Sandars, 1944, on *Helotes sexlineatus*; *M. (M.) lichiae* Ariola, 1899, on *Lichia amia*; *M. (M.) aigoi* Ishii &

Sawada, 1938, on *Siganus fuscescens*; *M. (M.) toba* Ishii & Sawada, 1938, on *Siganus fuscescens*; *M. (M.) parasillaginae* Sandars, 1944, on sp. of Australian Sillaginidae; *M. (M.) caudata* Goto, 1894, on *Sebastes* spp.; *M. (M.) sebastis* Goto, 1894, on *Sebastodes schlegeli* [probably including two forms, that of Yamaguti (1934) and of Bychowsky (1957), Fig. 244, differing in some specific criteria from that of Goto (1894) and of Bonham & Guberlet (1937)]; *M. (M.) victoriae* Woolcock, 1936, on scorpaenid *Helicolenus percoides*; *M. (M.) pomatomi* Goto, 1900, on *Pomatomus saltatrix*; and from embiotocid, *Ditrema temmincki*, *M. (M.) tanago* Yamag., 1940, and *M. (M.) ditrematis* Yamag., 1940; and on chaetodontid *Holacanthus ciliaris*, *M. (M.) angelichthys* (MacCallum, 1916) comb. n.

Scintillovulva subgen. n. *Microcotyle* s.s. in which the single middorsal vaginal pore is surrounded by a halo of prickles, and the type species also has papillae on the vulva: *Microcotyle (Scintillovulva) labracis* (v. Ben. & Hesse, 1863) comb. n., on *Labrax lupus*; and *M. (Scintillovulva) archosargi* (MacCallum, 1913) comb. n., on sparid *Archosargus probatocephalus* Walb.

2) *Atriostellata* gen. n. (defined above)—*Atrium masculinum* with erect spines; muscular penis bare; vagina bare, single, middorsal: *Atriostellata (Atriostellata) otolithis* sp. n.; *A. (Atriostellata) sciaenae* (Goto) comb. n., and *A. (Atriostellata) angelichthystownsendi* (MacCallum, 1916) comb. n.; *Biplacunella* subgen. n., in which there are two vulvae on the dorsal side, and there is a broad cuticularized plate apparently supporting the terminal genitalia on ventral and dorsal surfaces: Monotypic with *Atriostellata (Biplacunella) australis* (Murray).

3) *Diplostamenides* gen. n. (defined above) — *Microcotylinae*, *atrium masculinum* armed with corona of graded spines, different spines on the penis-head (appearing as two whorls of stamens). *Diplostamenides* subgen. n. with single bare vaginal pore middorsally: *Diplostamenides (Diplostamenides) umbrinae* sp. n. (type species) and six other spp. (see above). *Vulvostella* subgen. n. with single vaginal pore bearing corona of spinules: type species *Diplostamenides (Vulvostella) paniae* (Tripathi, 1956) comb. n. and one other sp., *Bivulvostella* subgen. n. with two armed vulvae, monotypic with *D. (Bivulvostella) canthari* (v. Ben. & Hesse) comb. n.

4) *Solostamenides* gen. n.—*Microcotylinae* with penis-head alone armed with spines, atrial rim muscular, single middorsal vaginal pore unarmed; type species: *Solostamenides mugilis* (Vogt, 1879) comb. nov., on *Mugil cephalus*; *S. pseudomugilis* (Hargis, 1956) comb. n., on *Mugil cephalus* (considered identical with *Microcotyle mugilis* of Par. & Per., 1890, and with *M. macracantha* Alexander, 1954); *S. mouwoi* (Ishii & Sawada, 1938) comb. n. on *Siganus* sp. and *Epinephelus* sp., with only four spines on penis-head; *S. suzuki* (Ishii & Sawada, 1938) comb. n., on *Lateolabrax japonicus*, with 20 spines on penis-head; and doubtfully, *S. chrysophryi* (v. Ben. & Hesse, 1863) comb. n., which is said to have a penis corona of 50 thorn-like hooks like those

on rostellum of taenioid cestodes, and are up to 100 μ long (this species may be closer to *Atrio Stella* gen. n.); on *Chrysophrys* (= *Sparus*) *aurata*.

5) *Prosomicrocotyla* Yamaguti, 1958.—Microcotylinae with preatrial bulb (characteristic of *Microcotyle* s.s.), a muscular cup armed internally with ring of broad-based spines (appears eversible immediately in front of end of unarmed tip of *ductus ejaculatorius*); lateral haptoral frills entirely lateral to body proper and not on tail-like extension as in other Microcotylidae; primary clamps separated by terminal notch, in larval life occupied by anchor-bearing protohaptor (see Bychowsky, 1957: Figs. 120, 209-213); a single bare middorsal vaginal pore; type species: *Prosomicrocotyla gotoi* (Yamaguti, 1934) Yamaguti, 1958; other species *P. chiri* (Goto, 1895) Yamaguti, 1958, both on *Hexagrammos otakii*.

6) *Manterella* gen. n.—Microcotylinae with penis unarmed and small, atrium masculinum most complex in family: at least two posterior-lateral deep pockets, which may be subdivided, and usually antero-lateral pockets, armed with specialized spines, usually of different kinds; single middorsal vulva unarmed, but lacks median vaginal duct, lateral vaginal ducts opening into transverse vitelline ducts near ovarian zone, confluent at vaginal pore immediately behind vulva. Four or five species are on sciaenid hosts; type species: *Manterella heteracantha* (Manter, 1938) comb. n. on *Cynoscion regalis* (Bl. & Schneider) and *Erioscion nebulosus* (Cuv.) with four kinds of spines, and four other spp.: *Manterella pseudoneteracantha* (Hargis, 1956) comb. n., on *Cynoscion nothus* (Holbrook), with three kinds of atrial spines; *M. longicauda* (Goto, 1900) comb. n., on *Cynoscion regalis*, with two kinds of atrial spines in loculi; *M. sciaenicola* (Murray, 1933) comb. n., on *Sciaena antarctica*, with two extremely long lateral pockets lined with apparently one kind of spine; egg with anopercular filament only, as in genotype and second sp.; and (doubtfully) *M. pentapodi* (Sandars, 1944) comb. n., on lethrinid *Pentapodus milii*, with lateral unarmed atrial pockets of considerable length while cavity of atrium has prickles and two posterior groups of small spinules; eggs have two polar filaments.

7) *Nudimasculus* gen. n.—Microcotylinae with atrium and muscular, bulbous penis devoid of armature, preatrial bulb absent. *Nudimasculus* subgen. n. includes species with single unarmed middorsal vagina without lateral suckers; type species *Nudimasculus (Nudimasculus) spari* (Yamaguti, 1937) comb. n., on *Sparus longispinis* (T. & S.), in this and second species, goblet-like vagina immediately bifurcates into lateral canals which eventually join transverse vitelline ducts; *N. (N.) virgatarum* (Tubangui, 1931) comb. n., on *Lutjanus virgatus*, with haptor of two peculiarities: clamps in multiple rows in middle and anterior region, and each clamp has both jaw-rami kinked at distal angle as in dorsal jaw of *Microcotyle donavini* and others. *N. (N.) pogoniae* (MacCallum, 1913), on the sciaenid *Pogonias chromis*, clamps in multiple rows, egg with single polar filament. A doubtful

member, since the vaginal condition is unknown, is *N. (N.) gerres* (Sandars, 1944) comb. n., on *Gerres ovatus*.

Bistellavula subgen. n., with two groups of spinules around, or just lateral to the middorsal vagina, usually with paired vulvae: type species *Nudimasculus (Bistellavulva) tai* (Yamaguti, 1938) comb. n., on *Pagrosomus unicolor* (Q. & G.), with muscular transverse vulva leading to median vaginal canal opening eventually into transverse vitelline ducts near confluence, but with a superficial vulval canal leading to two circular suckers, each with a corona of 10 spinules (10 μ long)—a condition similar to that of second species except that lateral spines are in semilunar clusters of about 50, not in circles: in *N. (Bistellavulva) tai* dorsal jaw-rami of clamps kinked at distal angles, a dagger-like cuticularization of ligament on median spring dorsally. *N. (Bistellavulva) pagrosomi* (Murray, 1931) comb. n., on *Pagrosomus auratus*; *N. (Bistellavulva) alcedinis* (Par. & Per., 1890) on *Smaris alcedo* and *Moena vulgaris*, in which lateral vulvae have muscular borders with shelf of spines, and may represent blind dorsal suckers either side of median vulva.

Bivaginuda subgen. n.—*Nudimasculus* species with two lateral vaginal pores on dorsal side, each with sphincter devoid of armature: type species *Nudimasculus (Bivaginuda) sillaginae* (Woolcock, 1936) comb. n., on *Sillaginoides punctatus*: second species *N. (B.) baumi* (Sprehn, 1929) comb. n., on *Cantharus* and other fishes in the Berlin Aquarium.

8) *Microcotyloides* Fujii, 1944.—Microcotylinae with neither atrium nor penis armed with spines, but with complex penis-bulb and three cuticularized rods associated with and opening into base of prostatic glands and their reservoirs: vagina single but unique in family by position on margin of one side in zone of penis-bulb and complex, which is slightly shifted to opposite side of median field. Monotypic with *Microcotyloides incisa* (Linton, 1910) Fujii, 1944, on *Lutianus griseus*.

9) *Polynemicola* gen. n. (defined above).—Microcotylinae exceptionally, with an eversible spiny cirrus. *Polynemicola* subgen. n., species with single median vagina armed with spines; type species: *Polynemicola (Polynemicola) bulbovaginata* sp. n. on *Polynemus indicus* Day, and two other species on Polynemidae (see above). *Ishiella* subgen. n. four species with two dorso-lateral vaginae armed with corona of small spines, their transverse connective leading to a long median vaginal canal with an ellipsoidal *receptaculum seminis*. Monotypic, with *Polynemicola (Ishiella) ichimidae* (Ishii & Sawada, 1938) comb. n., on sparid *Pagrosomus major*.

10) *Metamicrocotyla* Yamaguti, 1953.—Microcotylinae with neither cirrus, penis, nor vagina, but atrium masculinum has three paired groups of specialized spines in lateral ranks. Parasites of Mugilidae. Type species *Metamicrocotyla bora* Yamaguti, 1953, and four other species (Table 2).

Bradyhaptorinae subfam. n.—Microcotylidae with haptor un-

TABLE 2.—Specific differences in the genus *Metanicrocotyla* Yamaguti, 1953

Criterion	<i>M. bora</i> Yamag. '53 <i>Mugil</i> Macassar	<i>M. cephalus</i> Azim '39 <i>Mugil</i> Egypt	<i>M. manarensis</i> sp. nov. <i>Mugil</i> <i>trochelli</i> S. India	<i>M. macracantha</i> (Alexander '54) <i>Mugil</i> <i>cephalus</i> C. of Mexico	<i>M. filiformis</i> Yamag. '53 <i>Mugil</i> <i>cephalus</i> Macassar
Locality					
Body:					
Tot. length	10.5-13	9 mm	8.25-9 (10+)	10.2-14.5	12.0 mm
Max. width	1.23-1.26	.....	1.47-1.56	0.8-1.0	0.36 mm
Width %	9.7%-11.7%	11%	(17.4-17.8%)	6.9-7.9%	3.0%
Haptor:					
Length	.....	1.0 mm	1.2-1.3 mm	1.3 mm	1.3 mm
% body	.....	11%	c. 15% (c. 13%)	10.9%	10.8%
No. clamps	27/27	17/17	23/27	58 to 77	48/53
Spring:	triangular	.....	"Y"	dagger	"Y"
appendix	notched	.....	.....	.....	.....
Oral pouches:	72-81 μ x	.....	68 x 84 μ x	bilocular	unilocular
length x width	45-60 μ	.....	63 x 105 μ	55-64 μ diam	60 x 45 μ
Pharynx	33-45 μ	.....	32 x 43 μ	49-58 μ diam	33 x 30 μ
Area phx/	.....	.....	.....	.....	.....
O. pouch %	62.5%	.....	22.5%	72.5%	36.7%
Testes no.	12 +	100	10	34-77	70
Atrial hooks:	.....	(15)	.....	.....	.....
No.; length					
ant. group	5-6:	2:-	6-7: 80-100 μ	4-6: 49-52 μ	4: 50 μ
mid. group	6-7: 65 μ	.....	3: 48-56 μ	3-6: 43-49 μ	4: 40 μ
post. group	6-7: 70 μ	6-7:-	3: 48-56 μ	3-7: 33-47 μ	4: 40 μ
(all paired)	.....	7-6:-	.....	.....	.....
Remarks:	L. crus unbranched to near haptor tip	2 ant. hooked at tip	Long L. crus branched. Prehaptor sucker as wide as stem and 1/2 length of haptor	More atrial hooks but groups irregular. Crural ends unbranched. No vitellaria in haptor	Fewer, but regular groups of atrial hooks. Some vitellaria in the haptor

usually short with usually not more than 10 clamps in similar rows, clamps show unusually steep size gradation (largest more than thrice smallest primary clamp); three genera.

11) *Bradyhaptorus* gen. n.—Bradyhaptorinae with short haptor narrower than body and free from vitellaria or crural intrusion. Clamps of unmodified microcotylid in type, in rather strong fibrous capsules, in graded sizes towards middle of short rows, largest thrice the smallest (first primaries); genital atrium and penis unarmed; single middorsal vaginal pore unarmed. Type species *Bradyhaptorus trachini* (Par. & Per. 1889) comb. n., on *Trachinus radiatus*; in worms 9-11 mm long, are 8-10 pairs of clamps 42-126 μ wide; haptor less than 20% of total length; oral pouches aseptate with denticulate rims, and reniform cavity; egg with bipolar filaments of unequal length. Other species: *B. draconis* (Briot, 1904) comb. n., on *Trachinus draco*, with 7-11 pairs of clamps and haptor 20% or more of total length; 17 testes.

12) *Gamacallum* gen. n.—Bradyhaptorinae with haptor short and wide (rhombic), with up to 25 pairs of clamps (unmodified microcotylid), increasing up to eightfold in size; atrium unarmed but penis may have four spines; single vaginal pore unarmed. Monotypic with *Gamacallum macrorum* (Mac. & Mac., 1913) comb. n. on *Roccus lineatus*; ratio of first primary clamp width (40 μ) to middle and anterior clamps is 1 : 8 and 2 : 3, respectively; oral pouches non-septate 120 x 160 μ ; testes about 100; eggs with shorter filament anchored at tip; (generic name to commemorate G. A. MacCallum's pioneer contributions to knowledge of N. A. Monogenea).

13) *Diplasiocotyle* Sandars, 1944.—Bradyhaptorinae with haptor about one-third of total length and into which vitellaria penetrate more than halfway, but with seven pairs of pedunculated clamps of steeply graded sizes; circle of 15 spines said to occur on genital atrium with lateral crescents of nine and seven spines, and a pair of dorsal suckers associated with unarmed vagina. Monotypic with *Diplasiocotyle johnstoni* Sandars, 1944, on *Agonostomus forsteri* (Val.)—Mugilidae: the ratios of the widths of the first primary clamps to the 2nd, 4th and 7th are 1 : 4.0 : 6.0 : 7.0 : 6.85 respectively, but ratios of effective areas respectively are 1 : 17 : 36 : 50 : 49; median spring has tendon cuticularized into an oblong appendix, otherwise clamps are unmodified microcotylid; oral pouches aseptate, 137 x 109 μ , with denticulate rims; 22 testes; egg with anopercular polar filament slightly longer than egg and hooked at end.

Caenomicrocotylinae subfam. n.—Microcotylidae with bilaterally symmetrical metahaptor: four genera.

14) *Caenomicrocotyle* gen. n.—Caenomicrocotylinae with genital atrium usually an inverted heart-shaped sac covered with prickles and surrounded by halo of radial muscles, similar to condition in *Microcotyle* s.s., penis being represented by end of *ductus ejaculatorius* without specialized armature: two subgenera.

Caenomicrocotyle subgen. n. including species with a single bare vaginal middorsal pore; type species: *Caenomicrocotyle* (*Caenomi-*

crocotyle fusiformis (Goto, 1894) comb. n., on *Pholis* (= *Centronotus*) *robulosus* from Japan ('gimpo'), and on *P. gunellus* (L.) from British seas: broad triangular haptor into which left crus extends more than halfway to tip, together with few external branches and surrounding vitellaria; near level of end of intestinal branch is the formative zone for new clamps, usually marked by one or two abruptly smaller clamps deep in the lateral frills, these extend anteriorly as metahaptor embracing sides of body proper at least halfway up testicular zone in worms 2.8 mm long, in British material, but in Japanese nearly to top of testicular zone in worms 2.0 mm long, largest (British) worms had 35 pairs of clamps of unmodified microcotylid type (49-57 μ wide); typical preatrial bulb present covered with prickles about 7 μ long as in atrium proper; oral pouches septate, testes 14-16 in Japanese and only six, but larger, in British worms; pharynx distinctly larger than oral suckers; internal branches lacking on intestinal crura; long vaginal canal from unarmed vulva joins confluent vitelline ducts halfway to ovarian zone. Other species: *C. (C.) gimpo* (Yamag., 1958) comb. n. on *Enedrias nebulosus* (T. & S.) ('gimpo' as for host of type species): left crus extends deep into haptor with lateral branches and vitellaria, metahaptor about half or less of haptoral field extends as lateral lobes to midtesticular level; again three head-glandpits, but preatrial bulb larger and atrium has anterior wide and posterior less wide chamber both with scattered prickles and extensive radial muscles, prostatic ducts open directly into posterior bowl-like chamber with unarmed end of *ductus ejaculatorius*; worm 2.5 mm long had 64 pairs of clamps but one only 1.3 mm had 32 pairs; median spring with simple dorsal appendix; 15-20 testes.

C. (C.) cepolae (Yamaguti, 1937) comb. n., on *Cepola schlegeli* (Blkr.). Euhaptor and metahaptor with nearly parallel sides, latter extending ventrally over last third of testicular zone but free from body as typical antero-ventral metahaptoral wing, originating (according to two smaller clamps in Yamaguti, 1937, xix, Fig. 32) opposite to ends of equal crura: worms 2.3-3.3 mm long have 19-24 clamps on each side; 15-20 testes in three irregular rows; oral pouches aseptate but minutely dentated and slightly smaller than pharynx; preatrial bulb with fewer prickles than lateral regions of heart-shaped atrium; unarmed vulva leads to long vaginal canal at confluence with vitelline ducts halfway to ovary.

C. (C.) branchiostegi (Yamaguti, 1937, xvii) comb. n., on *Branchiostegus japonicus*: worms 2.75-3.75 mm long with 41-48 clamps on each side, about half of which belong to the metahaptoral wing originating opposite ends of equal crura; oral pouches septate, larger than pharynx; 20-24 testes; conspicuous lateral lobes in *atrium masculinum* with few prickles, radial muscles strong, especially from preatrial bulb, muscular penis unarmed; vagina as in *C. cepolae*.

C. (C.) cuicides (MacCallum & MacCallum, 1913) comb. n., on *Roccus lineatus*: metahaptoral wing about one-third of total haptor,

88 clamps on each side; 32 testes; atrium inverted heart-shaped and covered with prickles.

C. (C.) stenotomi (Goto, 1900) comb. n., on *Stenotomus chrysois*, from U.S.A. Atlantic: metahaptoral wing free from body (whole haptor about third of worm length), with 40-48 clamps in worms 2.5-3.0 mm long (smaller than usual 45 μ wide), haptoral stem distinct containing end of longer crus: 12 testes in two rows; oral pouches aseptate about three times larger than pharynx; wide triangular atrium with dense prickles 4-5 μ high, opposite to bifurcation of intestine; vagina typical canal meeting vitelline ducts halfway to ovary.

C. (C.) sebastisci (Yamag., 1958) comb. n., on *Sebastiscus*, *Sebastodes*, *Sebastichthys* and *Epinephelus* spp.: wedge-shaped haptor has a metahaptoral wing originating opposite to end of longer branching crus: worms 1.7 and 4.4 mm long had 11 and 31 clamps, respectively, on each side graded in size towards later-formed clamps at middle (up to 80 μ , where small newly-formed clamps occur); septate oral pouches slightly smaller than pharynx; slightly diverticulate esophagus; atrium prickly except over preatrial bulb; unarmed vagina typical.

C. (C.) poronoti (MacCallum, 1915) comb. n., on stromateid *Poronotus triacanthus*; metahaptoral wing overlaps posterior third of testicular zone ventrally, originating opposite to ends of crural branches and vitellaria terminations: a worm 6 mm long had 60 pairs of clamps (up to 50 or 65 μ near middle), 32 testes; atrium with prickles, two lateral groups conspicuous.

C. (C.) bassensis (Murray, 1931) comb. n., on *Platycephalus bassensis* with euhaptor and metahaptor one third of the total length, metahaptoral wings bordered anteriorly by clamps and originating behind end of vitellaria and confluent crura, indicated by two small clamps figured and at same level as unusual crossing-over of main excretory ducts running laterally to tip of the euhaptor: crura with external branches only, oral pouches aseptate but floor (sic) with spinules in two rows about twice size of pharynx; atrium heart-shaped and prickly; unarmed vagina typical; 18 testes.

Notaster subgen. n.—*Caenomicrocotyle* species with free ventral metahaptoral wing, preatrial bulb a prickly atrium masculinum, penis unarmed, halo of spines surrounding single dorsal vulva. Monotypic with *Caenomicrocotyle (Notaster) australiensis* (MacCallum, 1921) comb. n., on *Pomatomus saltatrix* from SE Australian waters: Metahaptor about equal to euhaptor, originating at end of tapered body-end containing ends of equal crura and surrounding vitellaria (neither enter haptor proper), its frills closely parallel and with about 65 pairs of simple clamps in a worm 4 mm long; pharynx slightly less than aseptate oral suckers; similarly, minute scattered spines cover the atrium and wide halo round dorsal vaginal pore.

15) *Dinotaster* gen. n.—*Caenomicrocotylinae* with metahaptor less than euhaptor, atrium and muscular penis lack prickles or spines (analogous to *Nudimascus*), though single dorsal unarmed vaginal pore is flanked by pair of dorsal suckers containing protrusible spiny

lobe directed medially (spiny edges would meet on sides of muscular genital atrium of similar-sized partner). Monotypic, with *Dinotaster centrodoni* (Brown, 1929) comb. n. on *Pagellus centrodonus* from English Channel: extremely extensible worm, particularly haptor region which in large worms may be twice body-proper, in smaller worms about 2 mm long (type series 2.5-4.5 mm had 60-80 pairs of clamps) in Sproston's collection from Cornwall in January, had up to 37 pairs, 50-63 μ wide in middle of rows, but in formative zone between euhaptor and metahaptor wing odd clamps occasionally were only 34 μ wide; post-larval worms occurred in winter retaining protohaptor with two dissimilar pairs of anchors each 41.5 μ long with up to eight pairs of clamps developed, older worms were shedding the protohaptor; all clamps showed kinked angles on dorsal jaw-rami. Vaginal suckers were not fully developed in worms less than 2 mm long, vaginal canal long, joining the transverse vitelline ducts.

16) *Diurix* gen. n.—Caenomicrocotylinae with conspicuously long metahaptor (like fish-tail, hence derived Greek name 'two-tailed') but mainly characterized by slender spines on cuticularized rim of atrium, penis being small and unarmed. Monotypic, with *Diurix leiognathi* (Tripathi, 1959) comb. n., on *Leiognathus ruconius*, from Madras: Elongated diamond-shaped haptor at least half total length of small but contractile worms (1.15 mm long); metahaptor broad at origin with symmetrically pointed euhaptor, metahaptor's anterior pointed tip on level with apex of testicular zone; vitellaria surrounding ends of crura probably do not enter haptor proper but mark level of potential pivoting of body on fixed euhaptor-metahaptor; 5-7 tandem testes, atrium masculinum elongate-ovate containing four erectile spines based on cuticularized atrial lip (slender 19 μ long), penis apparently small and unarmed (analogous to *Atrio stella* in Microcotylinae), vagina single middorsal with unarmed vulva and no suckers; oral pouches aseptate ovoid and barely larger than pharynx; total of 38 clamps counted on each side of euhaptor and metahaptor.

17) *Paradiurix* gen. n.—Caenomicrocotylinae with conspicuous metahaptor reaching level of posterior third of testicular zone, atrium masculinum unique in shape of cuticularized flask with two cuticularized arms at base, whole complex surrounded by sphincter (probably analogous, at least, with hardened prostatic ducts in base of cuticularized penis-complex in *Microcotyloides* Fujii)—flask-shaped structure may be end of penis itself, as interpreted by Yamaguti, who did not refer to its analogue. Vagina median dorsal with short duct dividing to meet the lateral vaginal ducts: unarmed vulva nearer ovary than to male terminalia; ovary with single arch but very long proximal limb; 7-12 testes; oral pouches septate considerably larger than pharynx; four sticky glandpits on preoral lip; richly-branched, equal crura enter euhaptor, (as long as metahaptor), 20-25 clamp-pairs, up to 80 μ except at the tips of eu- and meta-haptor (first-formed clamps) and odd small clamps in middle of lateral rows (formative zone). MOLO-

typic with *Paradiurix acanthogobii* (Yamaguti, 1940) comb. n., on *Acanthogobius flavimanus* (T. & S.), from Japan.

Bychowskicotylinae subfam. n.—Microcotylidae, in which clamps show incipient asymmetrical modification of jaw-sclerites. Monotypic.

18) **Bychowskicotyla** gen. n.—With a typical euhaptor as simple extension of body with rather numerous graded clamps, discovered by Bychowsky (1957 : Fig. 309) to have dorsal jaw-rami, particularly on abaxial side, developing cup-like expansions in shoulder region in more anterior, larger clamps; ventral jaw-rami on same side are also wider near top, but have lost shoulder-flange on that side, space being occupied apparently by muscles from top of dorsal jaw-ramus; posterior clamps much smaller and unmodified; width-ratio to the larger is 1:2.85, according to Bychowsky's figure, but original description gave sizes $56\text{--}84\ \mu$, in worms with 65-100 clamps on each side; with single species *Bychowskicotyla mormyri* (Lorenz, 1878) comb. n., on *Pagellus mormyrus* L. Genital atrium described with two kinds of erect spines in broken corona: arch of 10 uncinat slender spines $70\ \mu$ long, two lateral-posterior groups of 5-6 each of $35\ \mu$ spines (analogous to that in *Atrio stella*, since penis is apparently unarmed): the single vagina opens middorsally in unarmed bulb; 16-18 testes; and rather large septate oral pouches.

Thus, in the 18 genera and 14 subgenera, there are at least 83 species, the supraspecific arrangement is indicated in Table 1. For the following species of *Microcotyle sensu lato* there is insufficient data at hand:—*M. agonostomi*, *M. arripis*, *M. odacis*, *M. aparasitaginae*, and *M. temnodontis*—all described by Sandars, 1945; and the two species erected by Pearce (1951), *M. atrynetri* and *M. petrili*.

Microcotyle scorpis Sandars, 1944, on *Scorpius aequipinnis*, has such an asymmetrical haptor that it appears to indicate its relation to Heteraxininae, there being 34 clamps on the right side and only 20 on the left—the numerical ratio being 59%, and within the limits set for that group; the penis corona of inwardly curved spines, the aseptate oral pouches, and general appearance are characters which do not contraindicate the transfer as *Heteraxine scorpis* (Sandars) comb. n. provisionally, as a transitional species sharing haptoral characters only with *Zeuxapta*, and penis characters with some far more typical *Heteraxine* spp.

The 10 other species of *Microcotyle sensu lato* which have previously been transferred to genera outside Microcotylinae are for convenience listed below:

Original <i>Microcotyle s. lato</i>	Present Genus
<i>M. acanthophallus</i> MacCallum & MacCallum, 1913	= <i>Gotocotyla</i> (<i>Lithidiototyle</i>)
<i>M. carangis</i> MacCallum, 1913	= <i>Gemocotyle</i> (<i>Heteromicrocotylidae</i>)
<i>M. chiri</i> Goto, 1895	= <i>Prosomicrocotyla</i> (<i>Microcotylidae</i>)
<i>M. gotoi</i> Yamag., 1934	= <i>Prosomicrocotyla</i> (<i>Microcotylidae</i>)

<i>M. incisa</i> Linton, 1910	= <i>Microcotyloides</i> Fujii, 1944 (Microcotylidae)
<i>M. incomparabilis</i> MacCallum, 1917	= <i>Hargisiella</i> (Heteromicrocotylidae)
<i>M. pyragraphorus</i> MacCallum & MacCallum, 1913	= <i>Pyragraphorus</i> (Heteromicrocotylidae)
<i>M. reticulata</i> Goto, 1895	= <i>Dictydenteron</i> (Heteromicrocotylidae)
<i>M. scorpiis</i> Sandars, 1944	= <i>Heteraxine</i> (Axinidae)
<i>M. seriola</i> Yamaguti, 1940	= <i>Zeuxapta zyxi aginata</i> Unnith., 1957 (Axinidae)
<i>M. truncata</i> Goto, 1895	= <i>Yamaguticotyla</i> (Gastrocotylidae)
<i>M. acanthurum</i> Par. & Per., 1896	= <i>Gotocotyla</i> (Gastrocotylidae)
<i>Pseudomicrocotyle elagatis</i> Sandars, 1947	= <i>Gotocotyla</i> (Gastrocotylidae)
<i>Gonoplusius carangis</i> Sandars, 1944	= same, in Heteraxininae (Axinidae)

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