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ON A NEW GASTROCOTYLID TREMATODE, *ENGRAULICOLA FORCIPOPENIS* GEN. *ET* SP. NOV. ON WHITE-BAIT, FROM SOUTHERN INDIA

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FIVE specimens of the monogenetic trematode described in this paper were obtained in the last quarter of 1953, at Trivandrum, from the gills of *Anchoviella bataviensis* (Hardenberg). The following description is based on the study of borax carmine stained balsam mounts of these specimens, regarded as a type s.eries. Two of them (Fig. 1 D & E) demonstrate only the extreme shortening and bulging of the body resulting from intense contraction of these highly muscular worms, while the others are moderately extended. The reproductive organs have been chiefly studied in A, probably a somewhat younger worm, since they are. less obscured by vitellaria, and there are fewer clamps than in B & C.

The general appearance is that of a ' treed' boot. The clamp-bearing haptor is developed only on one side, the other being practically inhibited. In the living worm this haptoral region is greatly extended, nearly horizontally away to the opposite side of the worm to which it belongs. In three of the specimens the haptor-frill was developed on the left side and in two (B & E) on the right side of the worm. The body proper pivots about the constricted region opposite the anterior end of the haptor and posterior to the testicular zone. Thus, while the clamp-row is fixed vertically along a gill-filament, the body has a generous arc of free movement along the cibo-respiratory current of the fish through and over the gill lamellae (the habitual postures of microcotylid and gastrocotylid worms on the gills of fishes are nicely illustrated in papers by Llewellyn—1956, 1957 *b).*

In specimens A, B & C the total length of the body axis including the bent part from near the middle of the clamp-row to the posterior tip of the haptor is respectively about 1.9,2.9, and 2.2 mm., while the straight length from the anterior to the posterior edge of the specimen A, for instance is only 1.3 mm. The maximum width, in the ovarian zone is 0.64 mm. in A, and from 0.52 to 0.82 mm. in the others. The abruptly tapered neck region seems to be independently extensible and its length is perhaps normally between one-sixth and one-fifth of the total axial length of the worm.

The haptor is usually bent across the body axis at about a right-angle, its length in A, C & D is 0.85 mm., but in older specimen B, 1.47 mm ; or in all, very nearly half the total axial length of the worm. At its tapered tip it bears a short lappet-like protohaptor (a term proposed by Sproston & Unnithan (1960) to denote the anchor-lobe of the larval haptor) slightly extensible; the finger-like end bearing two dissimilar pairs of anchors, quite typical in shape compared with the two larger pairs in the related *Engrauliscobina thrissocles* Tripathi (1959) Sproston & Unnithan, (1960). The larger anchors have long handles and lunate cusped ends of about the same length. In specimens A & B they are 29.4 *n* and in C & D 25.2 /* long (Fig. 2 C). The more distal pair have very short roots, and the slightly curved claw is

directed more or less horizontally outwards and backwards and the tangential length is 12.6 *n* in all the specimens, both absolutely smaller than in *Engrauliscobina thrissocles,* but of similar relative size. The distal pair of larval hooks of this species are not visible in the present species.

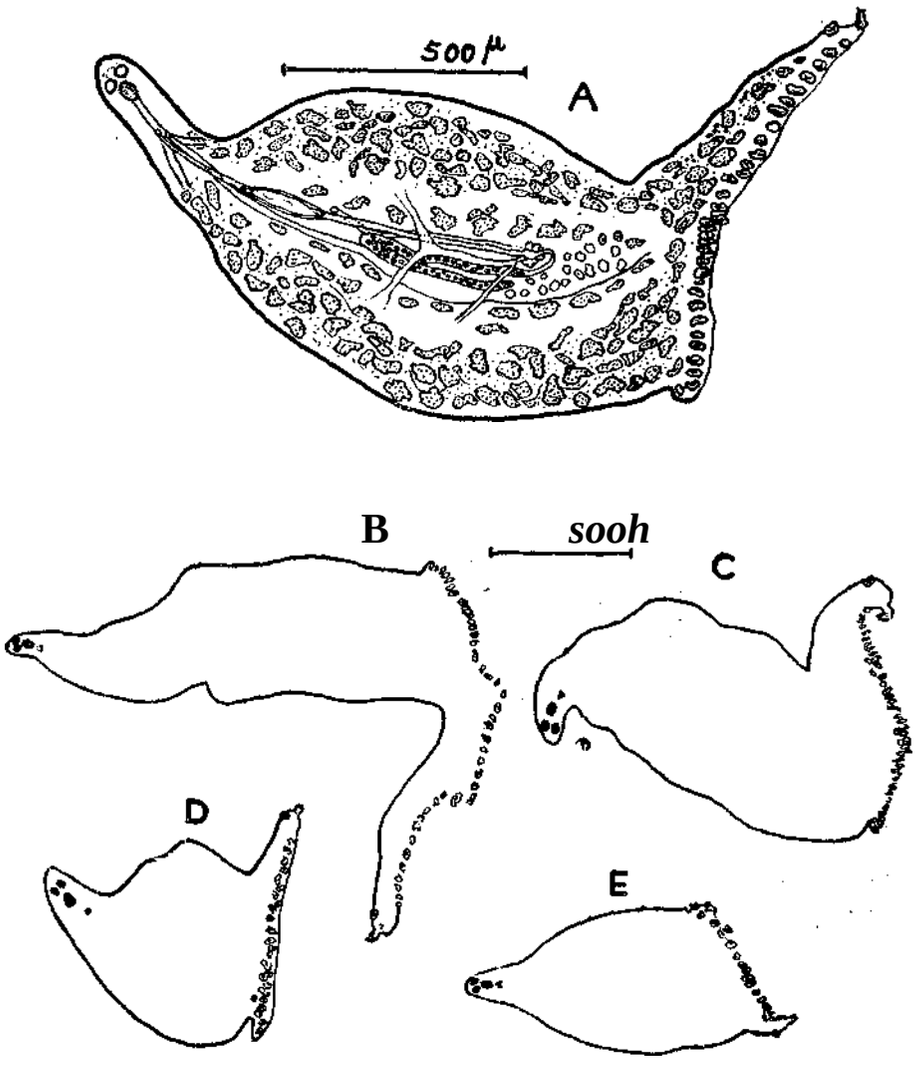

Fig. 1. A—The whole worm—type specimen, ventral view. B, C, D & E—Outline figures of 4 other specimens of the type series, ventral view.

The clamps are typically gastrocotylid in that there is a pair of oblique braces extending across the dorsal region of the clamp cavity, their outer ends articulating along the jaw rami of the dorsal jaw, often much nearer the hinge of the jaws (Fig.

2 D, E & F). They are slightly sigmoid with their inner ends rounded and posteriorly directed near the meridian, but seldom in contact, but are however very clearly articulated to the ends of the legs of the ' Y ' shaped crutch, derived from the cuticularization of the tendon arising from the short dorsal arm of the median spring. The ventral end of the median spring is no wider than its narrow arm, but there is a minutely bifurcated tip caused by the short ligaments from the edge of the ventral lip. There is a hint that there may be incipient dorsal plates in the thick capsule wall associated with the end of the spring as it passes to the crutch. There are no rib-like thickenings of the fibres in the ventral wall as in *Pricea* and *Pseudaxine* spp. Typically the clamps are twice as wide as long, increasing in size from the tip of the haptor towards the middle and then there is only a slight diminution in size to the end, where a minute clamp occurs often submarginally in all the specimens. Also in all of them there is a solitary clamp on the other side of the protohaptor ; a token of the inhibited row of that side ; analogous to the condition in the unrelated *Axinoa aberrans* (Goto) Sproston & Unnithan (I960), but homologous to the two clamps remaining in this position in *Engrauliscobina.*

The following table shows the actual sizes of the smallest (distal) and the largest (middle) clamps and the size of the solitary clamp :

TABLE I

Ranges of damp-size {in /*) *and number in* 5 *specimens*

Specimen	A	B	C	D	E
Smallest clamps	21x33	25x46	25x42	25x50.5	33.5x42
Middle clamps	21x50.5	33,5x63	29.5x63	33.5x84	42x63
Solitary clamp	33.5x37	25x37	25x42	25x33.5	30X30
Total number	33-1	44-1	39-1	29-1	25-1

A nearer approximation to reality of the size of these highly contractile worms Would be an expression of their area which have been computed approximately from suitable micrometer measurements. There is found to be a fairly close direct relation between the areas of the worms and the number of clamps. The number of clamps may therefore, be used as a measure of the size (age) in these worms and for that matter in all microcotylids and gastrocotylids; as a relative index it is probably more reliable than length and width ranges.

The simple subterminal mouth (Fig. 2 A) lacks conspicuous glands round its lips ; it opens out over the more or less rounded oral pouches, which are aseptate and lack denticles or papillae on their rims : they vary from 37x25 /*i* to 50x37 /*. The pharynx is considerably larger and a highly muscular ovoid, preceded by a very short prepharynx ; its range is 50 X 38 *fi* to 59 x 42 /i for the two specimens A & C. The relative areas of the oral pouch and pharynx have been calculated for each of A-E (unclear in B—omitted) and the values are 50%, 77%, 61% and 50%. The oesophagus lacks diverticula and bifurcates into the two immediately branching crura at the base of the neck region, almost half its length behind the genital terminalia. Anastomoses between the crural branches are not clear due to their interstices being densely packed with vitelline follicles extending over the whole part bf the body behind the genital atrium. The crura are confluent just beyond the end of the testicular zone.

The fields of the gonads are rather narrow, but the body is widest in the zone. The ovarian field begins as a rule at a distance behind the neck equal to the length of the latter. The ovary is an elongated loop with its distal limb descending, containing maturing oocytes showing clearly their zona pellucida and occupies the

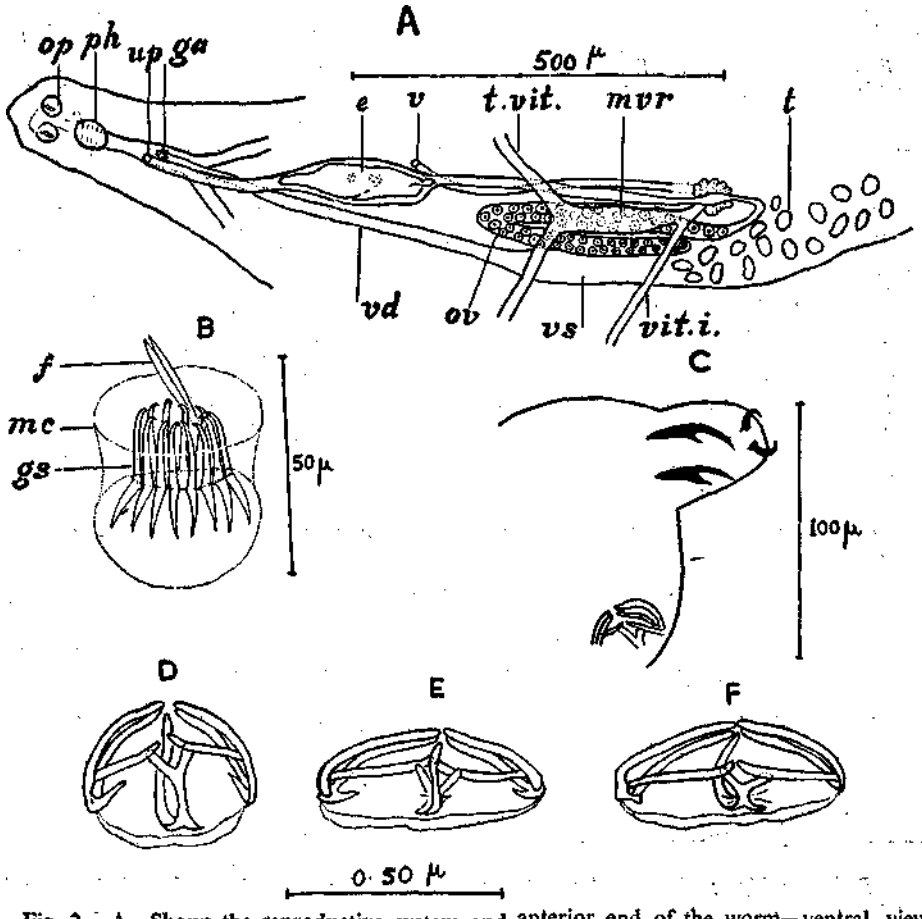

Fig. 2. A—Shows the reproductive system and anterior end of the worm—ventral view. B—Penis and genital atrium. C—The protohaptor showing the anchors and position of the solitary clamp. D—Solitary clamp, dorsal view. E—Typical clamp, ventral view. F—Typical clamp, dorsal view. *e*. Egg, *f*. Forceps-like spine at the end of the penis, *ga*. Genital atrium, *gs*. Corona of genital spines, *mc*. Membranous collar, *mvr*. Median vitelline reservoir, *op*. Oral pouch, *ov*. Ovary, *ph*. Pharynx, *t*. Testes, *t. vit*. Transverse vitelline canal, *up*. Uterine pore, *v*. Vaginal pore, *vd*. Vas deferens, *vit. i*. Vitello-intestinal canal, *vs*. Vesicula seminalis.

middle third of the body proper, even extending into the posterior third, overlapping the anterior end of the testicular zone on the left side. The testicular field is just narrow, but shorter as a rule.

The testes are in 14-18 rounded follicles arranged in two irregular rows. The Wasa efferentia cannot be traced but the origin of the vas deferens is distended for'at

least half its course along the right side of the ovary : this is interpreted as a functional vesicula seminalis, but is without specially muscular walls (Fig. 2 A). It opens into the round genital artium, (Fig. 2 B) surrounded by a muscular bulbous and surmounted by a corona of more or less erect spines with incurving tips and long clawed bases embedded in the atrial bulbous ejaculatorius. The penis is apparently the feebly muscular end of the vas deferens, but at its tip and emerging from the midst of the corona are two forceps-like spines. These are most highly characteristic of the species and are apparently unique in the family ; they vary from 12.6 /t to 22 /* in length (but 16.8 /t in three of the five worms). The spines of the corona are very typical of the family, particularly like those in *Gastrocotyle* and *Pseudaxine* spp. and their number is invariably 12. The diameter of the atrium is 16-18 /t but it is surrounded and enclosed by a ventrally projecting membranous and finely muscular collar : another unique feature in this species.

The transverse vitelline ducts are nearly horizontal and are confluent to form the median vitelline reservoir (Fig. 2 A). Before entering the region of the ootype, the vitelline duct gives off the vitello-intestinal canal obliquely forwards to the right, as is usual. The ootype is obscured by highly chromophilic Mehlis' gland cells, nor can the entrance of the vaginal canal be made out, but the oviduct makes a backward loop and enters the ootype-complex posteriorly. At the end of the ovary is a constriction and the oviduct has muscular walls ; this region is the oocapt or ovijector, from which eggs are ejected into the distal oviduct and thence to the fertilization chamber. The uterus arises from the left side of the ootype-complex and proceeds straight forwards to the ventral uterine pore just anterior to the atrium masculinum.

The shell of the egg is apparently elaborated during the passage up the uterus, for in specimen A while the posterior filament is clear there is no anterior filament. One of the eggs in C also has a 50 /t filament on its pointed posterior pole but the rounded anterior end is without one ; but another egg, higher in the uterus has two slightly longer polar filaments. The sizes of these eggs are respectively : 201x50 *it,* 168x75 /t and 210x84 /t (exclusive of the polar filaments).

The vaginal pore was visible in only one worm (A). It is unarmed, opening on the dorsal surface about midway between the intestinal bifurcation and the transverse vitelline ducts and to the left of the median line just dorsal to the uterus. It can be traced intermittently behind the transverse vitelline ducts and in this worm can be seen just anterior to the Mehlis' gland-complex behind which it is hidden.

Relationships : When the notes on this species were drafted and the drawings made, I was unaware of *Engrauliscobina thrissocles* Tripathi (1959) Sproston & Unnithan (1960) on *Thrissocles tnystax* from Puri (Bay of Bengal). It is evident that *Engraulicola forcipopenis* gen. et sp. nov. is closely related to the former, but I do not consider them congeneric mainly for the following reasons;

1. The presence in *Engraulicola* of a pair of forceps-like spines at the tip of the penis and a cylindrical sheath surmounting the atrial bulb.
2. The haptor-frill in *Engraulicola* is adherent to the body only up to the testicular zone, whereas in *Engrauliscobina* it is practically co-extensive with the gonad zone.

In genera where the haptor-friil embraces the less flexible part of the "body, including the gonad zones, the pivoting of the body proper on the fixed clamp-row(s)

invariably induces a torque in the body resulting in bizarre asymmetry, transient or permanent according to the rigidity of the body wall, for example in *Thoracocotyle ovalis* Tripathi (1956) (nom. emend. 1959), and in *Vallisia* spp. In *Engrmdiscobina*, there is asymmetry for the same reason, which may well be more marked in flexed and extended specimens, since the zone of pivoting involves the least flexible region ; the middle of the gonad zone. Whereas in *Engraulicola* the zone of pivoting being flexible, posterior to the thick gonad zone, no marked somatic distortion occurs and even the most extended and flexed worms would retain an approximate symmetry of the body proper.

It is noteworthy that the token clamps in both the genera on Engraulidae are about as wide as long, since they are not subjected to the exigencies of crowding ; which has opposite effects in the two genera, the one with clamps much longer than wide and in the new genus about twice as wide as long.

The forceps-like spines on the penis may be analogous to the extremely long vagina-dilators of the atrium musculinum (as interpreted by Unnithan 1960) in *Heterapta heterapta* Unnithan and *H. chorinemi* (Tripathi) Unnithan, the multi-spined penis in this genus being protrusible between them. The only parallel (probably an homology) is the hitherto unsubstantiated observation of the original authors of *Pseudaxine trachuri* Par. & Per 1890 ; a corona of slender spines was shown on the penis head, protrusible through a corona of very short spines round the inner rim of a muscular atrium (see Fig. 109 c in Sproston 1946).

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Generic diagnosis of *Engraulicola* gen. n. : Gastrocotylidae, in which there is a unilateral haptor-frill and a single token clamp on the inhibited side ; the proto-haptor persists as a finger-like lobe bearing two dissimilar pairs of anchors, one with a root as long as its lunate end and the other with vestigial roots. Clamps are without conspicuous plates in dorsal wall or ribs ventrally ; wider than long. Haptor-frill barely embraces the end of the testicular zone ; hence the zone of pivoting on the fixed clamp-row is in a flexible region of the body and the symmetry of the latter is not disturbed. Testes in irregular rows of rounded follicles. Vas deferens with a proximal dilatation ; penis weak but carrying a pair of forceps-like spines round the muscular atrial bulb, itself surmounted by a delicate cylindrical sheath projecting centrally beyond the atrial spines. Dorsal vagina unarmed, slightly to the left of the median line, not far in front of the ovary, its duct leading directly to the ootype-complex. Oral pouches aseptate and about half the size of the pharynx. Eggs with filaments, shorter than the egg, at each pole. Parasites on the gills of *Anchoviella* species. Monotypic with *Engraulicola forcipopenis* sp. nov. on *A. bataviensis* (Hardenberg), from Trivandrum (Arabian sea).

Phylogenetically this is a particularly interesting genus since all other Gastrocotylidae, except *Engrauliscobina* (also on Engraulidae) occur on higher Perciformes: Carangidae, Scomberomoridae, etc. This apparent migration of gastrocotylid worms to hosts on the lower branches of the phylogenetic tree of fishes, has been suggested by Sproston (1960) as predator-prey transfer : the dense shoals of the clupeoid prey being favourably exposed to infection by ancestors of these gastrocotylids infecting the predators, in the same watermass, practically simultaneously with the shoals of Anchovies or white-baits (which increase the probability of infection by the rapid reusage of the water by the hinder members of the shoal). The problem now emerges as to the independent transfer of ancestors of these two genera on clupeoids, or whether one has evolved from the other, since *Thrissocles* spp. do occupy the same watermasses, from time to time, as do *Anchoviella* spp,,

though they are not now commonly caught together in large quantities in Indian' coastal waters.

SUMMARY

Engraulicola forcipopenis gen. *et* sp. nov., on the gills of *Anchoviella bataviensis* (Hardenberg) from Trivandrum is described and figured : a highly contractile gastrocotylid, its wide body dark with vitellaria and dense melanotic deposits. One side of the haptor is inhibited leaving a solitary token clamp at the side of the terminal ' protohaptor' bearing two dissimilar pairs of anchors ; the haptor-frill is bent almost at right-angles across the end of the body, extending laterally on the opposite side. A narrow neck carries aseptate oral pouches and a pharynx twice their size, also the bulbous atrium musculinum with its corona of 12 nearly erect spines, through which is protruded the head of the small penis with its unique pair of pointed forceps-like spines ; the whole atrium being surmounted by a membranous collar projecting ventrally beyond it. A dorsal unarmed vagina opens nearer the ovary and leads direct to the ootype-complex ; eggs with bipolar filaments.

Asymmetry of the body is avoided by the pivoting axis of the same in relation to the fixed clamp-row lying in a flexible zone behind the testes, unlike in the related *Engrauliscobina thrissocles* where asymmetry exists due to the pivoting axis being in the least flexible part of the body embracing the gonad zone.

While in *Engrauliscobina* the clamps are much longer than wide, the reverse is the effect of their crowding in *Engraulicola.* Both genera are exceptional among gastrocotylidae in occurring on clupeoid fishes and the host-parasite phylogenetic problems are referred to.

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REFERENCES

LLEWELLYN, J. 1956. The host-specificity, micro-ecology adhesive attitudes and comparative morphology of some trematode gill-parasites. *Jour. Mar. biol. Ass. U.K.,* 35 : 3-127.

————. 19576. Host-specificity of monogenetic trematodes. *Ire. Symp. Specif, parasites vert., U.I.S.E. (U.N.S.C.O.),* No. 32 : 199-212,

SPROSTON, N. G. 1946. A synopsis of the monogenetic trematodes. *Trans, zool. Soc. London* 25 : 185-600.

————. 1960. Host-ecology correlated with speciation in some monoxenous parasites. (In press).

SPROSTON, N. G., AND UNNITHAN, R. V. 1960. Patterns of secondary growth and a revision of the systematica in Microcotyloidea and Gastrocotylidae (Monogenoidea.) (In Press).

TWPATHI, Y. R. 1956. Studies on the parasites of Indian fishes, part IV: Trematoda: Monogenea, Microcotylidae. *Rec. Indian Mus.,* 52: 231-248.

• • • 1959. Monogenetic trematodes from fishes of India. *Indian J. Helminthology, 9 :* 1-149.

UNNITHAN, R. V. 1960. On the ftjactional morphology of a new fauna of Monogenea on fishes from Trivandrum and environs. Part III, Heteromicrocotylidae (Microcotyloidea). (In Press).