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STUDIES ON THE GENUS *TETROCHETUS* LOOSS, 1912 (DIGENEA : HEMIUROIDEA : ACCACOELIIDAE) OCCURRING IN INDIAN MARINE FISHES

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INTRODUCTION

Specimens of the genus *Tetrochetus* Looss, 1912 were collected from four species of fishes from the Bay of Bengal and the Arabian Sea. These fish hosts are : *Coryphaena hippurus* Linn., *Balistes capistratus* Shaw, *Exocoetus volitans* Lacepede and *Diodon hystrix* Linn. A careful study of these specimens reveals that the material from *Coryphaena hippurus* is *Tetrochetus coryphaenae* Yamaguti, 1934, that from *Balistes capistratus* and *Exocoetus volitans* is *T. aluterae* (Hanson, 1955) and that from *Diodon hystrix* is *T. macrorchis* Yamaguti, 1971.

The material has been processed according to the standard method. Diagrams have been drawn with the aid of a Camer lucida. Showing of all the details in them has been considered unnecessary as they are almost identical in each species in the genus under consideration. The more important purpose before the author is to expose those characters which may be helpful in separating them out. All measurements are in micrometers unless otherwise stated. The material is deposited with the National Collections of the Zoological Survey of India, Calcutta.

SYSTEMATIC ACCOUNT

Family : ACCACOELIIDAE ODHNER, 1911

Subfamily : ACCACOELIINAE Odhner, 1911

Genus **Tetrochetus** Looss, 1912

syn. **Paratetrochetus** Hanson, 1955

Tetrochetus coryphaenae Yamaguti, 1934

(Fig. 1)

Host : *Coryphaena hippurus* Linn., Common dolphin-fish (Coryphaenidae).

Location : Intestine.

Locality : Tuticorin (Gulf of Mannar, Bay of Bengal).

Number of specimens : 57, on six slides ; collected on 16.11.75.

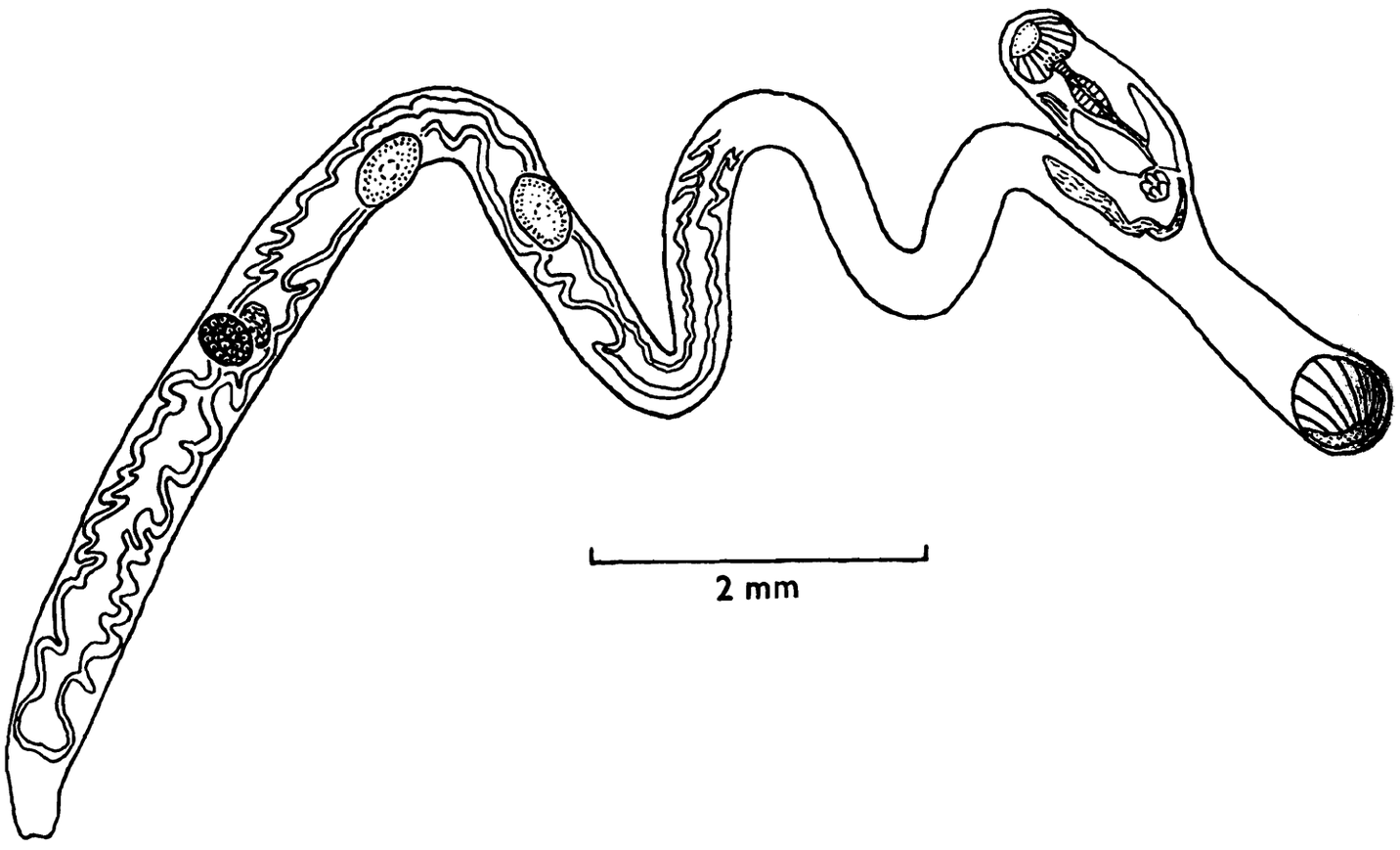

Fig. 1. *Tetrochetus coryphaenae* from *Coryphaena hippurus*. Vitellarium not shown.

Specimens deposited : Z. S. I. Reg. Nos. W 7720/1 to W7725/1

This species is typically thin, slender, much elongated, with sides almost parallel and the size of the testes as compared to the body is small. The present material includes young adults to fully mature specimens of varying sizes. In some specimens the testes may form slight bulges in the wall. The specimens are more or less in agreement with the des-

criptions of Yamaguti (1934, 1970) and Gibson (1976). This is the most slender of all the known species of *Tetrochetus*. Tkachuk (1979) described *Tetrochetus lesnoyi* in fishes *Allocyttus verrucosus*, *Neocyttus rhomboidalis* and *Cyttosoma boops* (family Oreosomatidae) from Southeast Atlantic. He observed that, althoug it comes close to *T. coryphaenae* Yamaguti, 1934 in general morphology and anatomy, his species differs from Yamaguti's considerably in larger body (6.786 – 16.2 × 1.782 – 1.980 mm), oral sucker (0.702 – 0.900 × 0.612 – 0.900 mm), ventral sucker (1.152 – 1.710 × 0.810 – 1.296 mm), testes (0.594 – 0.900 × 0.486 – 0.702 mm and 0.612 – 0.756 × 0.576 – 0.720 mm), and much larger eggs (0.056 – 0.064 × 0.024 – 0.032 mm). Keeping in view the accounts of *T. corypharnae* by Yamaguti (1934, 1974) and Gibson (1976), and *T lesnoyi* Tkachuk, 1979, the former is definitely slenderer with smaller eggs than the latter. Therefore, the present author concurs with Tkachuk (1979) that *T. lesnoyi* is distinguisable from *T. coryphaenae*.

Tetrochetus aluterae (Hanson, 1955) Yamaguti, 1958

(Fig. 2)

Hosts and Localities : *Balistes capistratus* Shaw, Trigger fish (Balistidae) from Gopalpur and Paradip (Bay of Bengal) and Tuticorin (Gulf of Mannar, Bay of Bengal) ; *Exocoetus volitans* Lacépède, Flying fish (Scomberesocidae) from Tuticorin (Gulf of Mannar, Bay of Bengal).

Location : Intestine.

Number of specimens : 10 from *B. capistratus*, on 10 slides, collected on 3.2.65, 18.5.72 and 29.5.72. 7 from *E. volitans*, on 3 slides, collected on 17.11.75.

Specimens deposited : Z. S. I. Reg. Nos. W7726/1 to W7738/1

These specimens are in various stages of maturity i.e. immature, young adults and fully mature. Of these, only three from *B. capistratus* and all from *E. volitans* are worth studying. They broadly conform to the description of *T. aluterae*, differing only slightly in various body measurements. This is medium-sized (max. length 3.64 mm), cylindrical to subcylindrical, attenuates from testicular region anteriorly, and definitely broader (max. width. 0.76 mm) in

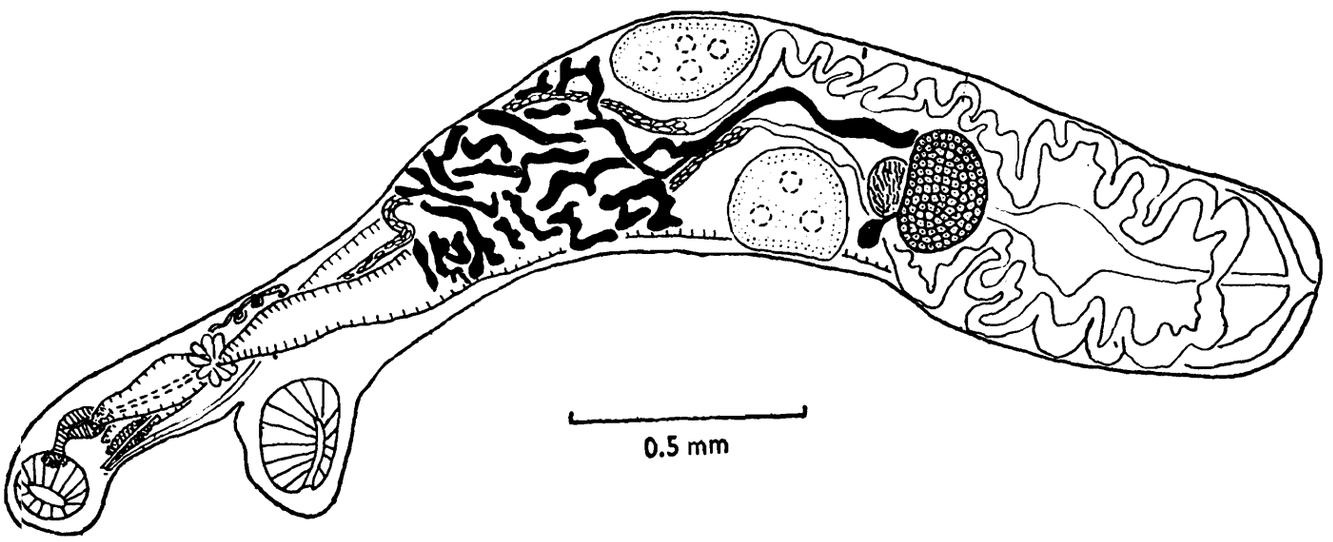

Fig. 2. *Tetrochetus aluterae* from *Balistis capistratus.*

comparision, to *T. coryphaenae.* In a somewhat contracted specimen the pregonadal attenuation is absent. Sucker length ration 1 : 1.29-1.48. Anterior testis 227-354 long, 140-291 in depth ; posterior testis 224-372 long, 140-300 in depth ; Ovary 105-242 long, 140-301 in width. Eggs 21-35 × 14-16.

Tetrochetus mitnevi Zubtschenko, 1978 in *Zeus faber* (Zeidae) and *Decapterus* sp. (Carangidge) from North Atlantic looks like that contracted specimen of *Terochetus aluterae* (Hanson, 1955) in the present material in which pregonadal attenuation of body has consequently disappeared although there is slight difference in the egg size (Holotype 0.030-0.034 mm × 0.016-0.019, Paratypes 0.020-0.035 × 0.016-020 mm in *T. mitneve*). *Tetrochetus scomheresoxis* Nikolaeva, 1966, in *Scomberesox saurus* (Fam. Scomberesocidae) from the Mediterranean and other seas was not compared with *T. aluterae*

(Hanson, 1955). It is quite probable that on further investigations, these two species may not prove to be unidentical.

Tetrochetus macrorohis Yamaguti, 1970.
(Fig. 3)

Host	:	*Diodon hystrix* Linn., Porcupine puffer (Diodontidae).
Location	:	Intestine.
Locality	:	Trivandrum (Arabian Sea).
Number of specimens	:	2, on one slide ; collected by Dr. T. D. Soota and party on 28.1.1976.
Specimens deposited	:	Z.S.I. Reg. No. W7739/1

Important measurements : Body 8.167-11.00 mm long, 1.677-1.980 mm wide. Acetabulum borne on a short peduncle, 605-688 long, 567-618 wide. Oral sucker 371-467 long,

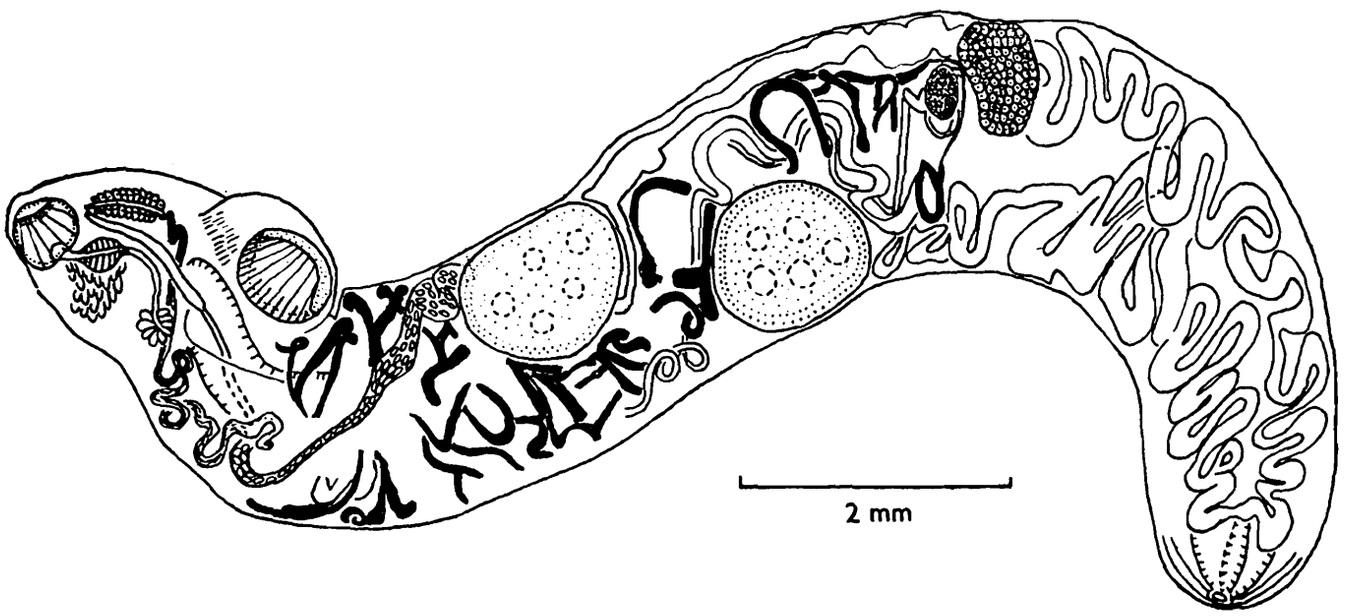

Fig. 3. *Tetrochetus macrochis* from *Diodon hystrix*.
First anterior limb of uterus not shown.

398-481 wide. Acetabulum distinctly larger than oral sucker. Prepharynx absent. Testes two, antero-dorsal and postero-ventral in position situated near body wall, diagonally disposed in middle region of hindbody, 825-1196 long, 618-948 wide. Ovary 495-756 long, 536-577 wide. Mehils'

gland anterior to ovary. Vitelline reservoir near overy ; vitellarium tubular, branched, between overy and base of acetabular peduncle. Proximal part of ascending uterus forms uterine seminal receptacle, it then descends to slightly short of posterior end of body, crosses transversely and then ascends again, distal part forming metraterm ventral to pars prostatica. Both the ducts open separately into small genital atrium. Eggs 21-31 × 14-24.

This species is robust, quite large and broadest of all the species described so far. The body is greatly elongated with almost parallel or subparallel sides. The testes are very large, sometimes forming slight bulges in the body wall. With these characters, this species can be distinguised from the previous two species in the collection.

It was originaally described by Yamaguti (1970) from the Hawaiian fishes *Xanthichthys ringens* (type host), *Diodon* sp. (*hystrix* ?) and *Sphaeroides cutaneous*. Radhakrishnan and Nair (1979) identified their specimens from *Diodon hystrix* from Trivandrum, Arabian Sea, as *Tetrochetus coryphaenae* Yamaguti 1934, but the measurements (particularly the large size of testes in relation to the body length and width) such as body length 6.1-7.2 mm, width 1.28-1.6 mm ; oral sucker 0.268 × 0.32-0.352 mm ; acetabulum 0.32-0.48 mm ; anterior testis 0.576-0.640 × 0.480-0-496 mm ; posterior testis 0.560 × 0.627 × 0.480-0.512 mm ; overy 0.352-0.4 × 0.4.0.412 mm ; eggs 0.028 × 0.02 mm ; given by them indicate their specimens could only be *T. macrorchis*.

Further, *T. macorchis* has great similarity to *T. hamadai* Fukui and Ogata, 1935 reported from the intestine of a different pufferish, *Spheroides spadiceus*, from Mamotori, Japan, It has body size 5.3-15-5 mm long, 1.2-3.21 mm wide, and the eggs are 21—27 × 16—19. It was twice further reported from Japan (Maisaka, Sizouka prefecture and Taizi, Wakayma Prefecture from the same species of host by Yamaguti 1938, 1951 respectively). The measurements of the specimens from Wakayama Prefecture are : body 5.3—10 × 1.2—1.8 mm ; oral sucker 0.3—0.52 mm long ; ventral sucker 0.95—1.1 mm

long, 0.8—1.0 mm deep ; testes 0.4—0.18 mm long, 0.6—0.88 mm deep ; eggs 24—27 × 16—19. Yamaguti (1970) distinguised *T. hamadai* from his own species, *T. macrochis*, both from different pufferfishes, in larger body and smaller eggs. To my mind, the two species further differ from one another in more characters. *T. hamadai* has much smaller ventral sucker than than the oral sucker, testes are much smaller as compared to body length causing no bulges on the body wall, and the vitellarium extends posteriorly behind the ovary, whereas in *T. macorchis*, ventral sucker if not much larger than the oral sukcer, the testes are much larger and may cause bulges on the body wall and the vitellarium does not extend posteriorly behind the ovary. It is likely that further information on *Tetrochetus* material from various pufferfishes (family Tetraodontidae) may prove *T. macrorchis* to be identitical with *T. hamadai*.

Tkachuk (1979) has compared his species, *T. lesnoyi*, with *T. hamadai* Fukui and Ogata, 1935 and found that the former is distinct from the latter on the basis of larger body, gonads and other structures including eggs. Moreover, *T. lesnoyi* has been reported from non-puffer fishes and *T. hamadai* has been reported from puffers.

Although, it is easier to distinguish between Indian species of *Tetrochetus* when their different populations are present before the investigator, but it may be rather difficult to identify *Tetrochetus* material when the investigator is confronted with a single population only. However, an attempt is made here to provide a key to separate the Indian species of *Tetrochetus* with the help of a combination of characters in fully mature specimens.

Key to species of *Tetrochetus* from Indian fishes.

1. Body narrow, slender, elongated ; sides almost parallel ; testes small as compared to body length and width ; ventral sucker larger than oral sucker ... *T. coryphaenae*

	Body broader, not slender and narrow; testes medium-sized or large as compared to body length and width; ventral sucker tending to be equal to oral sucker of definitely larger than oral sucker ...	2
2.	Body usually attenuated from pregonadal level to base of acetabular peduncle; testes medium—sized as compared to body length; ventral sucker almost equal to oral sucker ...	*T. aluterae*
	Body robust, broader and usually large as compared to body length, sometimes pressing body wall so as to from bulges on surface; ventral sucker definitely larger than oral sucker ...	*T. macrorchis*

Thus, three distinct species of *Tetrochetus* occur in the fishes of the Bay of Bengal and the Arabian Sea.

Nahhas and Cable (1964) identified their specimens from *Diodon hystrix* as *Tetrochetus coryphaenae* from Jamaica, Caribben Sea, but they neither furnished morphological and morphometric details nor provided an illustration of the specimens. They should be studied afresh in the light of Yamaguti's (1970) report on *Tetrochetus macrorchis* and the present communication.

Discussion

Hanson (1955) proposed the genus *Paratetrochetus* to distinguish it from *Tetrochetus* in having a pharynx "with slender anterior extension projecting into lumen of conical elevation in base of oral cavity; small bulb-like muscular addition at posterior end of pharynx." Yamaguti (1958, 1871) and Bray and Gibson (1977) considered the former to be a synonum of the latter. Siddiqi and Cable (1960) held a similar view, and reported their specimens collected from Puerto Real, Mona Is. (Puerto Rico) from the fish hosts *Caryphaena hippurus* and *Acanthocybium solandri* as *T. aluterae* (Hanson, 1955). Accepting Hanson's genus as valid,

Purukhin (1964) described another species, *Paratetrochetus hansoni*, from the Gulf of Tonkin, North Viet-Nam. Skrjabin (1959) also accepted the validity of *Paratetrochetus*. He placed it nearer to *Rhynchopharynx* Odhner 1928 than to *Tetrochetus*, and catagorised *Paratetrochetus* along with *Rhychopharynx* under the subfamily Rhynchopharynginae Yamaguti, 1958, and perferred to keep *Tetrochetus* under a separate subfamily Tetrochetinae Looss, 1912 instead of keeping the latter genus in the subfamily Accacoeliinae Odhner, 1911 as did Yamaguti (1958, 1971). However, Yamaguti (1971) did not decide the fate of the subfamily Tetrochetinae Looss, 1912. Bray and Gibson (1971) considered all the existing accacoeliid genera under only one subfamily, Accacoeliinae (synonymising with it the subfamilies Tetrochetinae Looss, 1912, Accacladiinae Yamaguti, 1958, Orophocotylinae Yamaguti, 1958, Rhynchopharynginae Yamaguti, 1958, and Guschanskianinae Skrjabin, 1959), and erected a new genus *Paraccacladium* undea a new Paraccacladiinae. The new genus is based on the description of a new species *Paraccacladium jamiesoni*. the specimens of which were collected from the rectum of *Coryphaenoides rupestris* off the West coast of Great Britain. This system of classification of the family Accacoeliidae has been followed here. The synonymy of *Paratetrochetus* with *Tetrochetus* has been established beyond doubt as the anterior prolongation of the pharynx into the base of the oral sucker is a feature of all accacoeliids, and thus there is no prepharynx in the genus just as in other hemuroid genera.

Ten species have so far been described under the genus *Tetrochetus* Looss, 1972 :

T. raynerii (Nardo, 1833) Looss, 1912, emend. Bray and Gibson, 1977 ; the type species,
T. hamadai Fukui and Ogata, 1935,
T. coryphaenae Yamaguti, 1934,
T. proctocolus Manter, 1940,
T. aluterae (Hanson, 1955) Yamaguti, 1958 ; (Syn. : *Paratetrochetus aluterae* Hanson),

T. hansoni (Parukhin, 1964), (Syn, : *Partetrochetus hansoni* Parukhin),
T. scomberesoxis Nicolaeva, 1966,
T. macororchis Yamaguti, 1970,
T. mitnevi Zubtschenko, 1978, and
T. lesnoyi Tkachuk, 1979.

Of these, *T. raynerii*, and *T. hansoni* have oral sucker distinctly larger than the acetabulum. They are excluded from consideration here. *T. hamadai*, *T. coryphaenae*, *T. proctocolus*, *T. scomberesoxis*, *T. mocrorchis*, *T. mitnevi* and *T. lesnoyi* have oral sucker distinctly smaller than the acetablum. In *T. aluterae* the suckers are almost equal with a tendency towards a slightly larger acetabulum. Bray and Gibson (1977) emended the species name *T. raynarianum*. While describing *T. macrorchis*, Yamaguti (1970 ; p. 91) stated "Pars prostatica narrow, sigmoid, uniting with the uterus just before opening at level of posterior end of oral sucker". It means that at least a very short hermaphrodictic duct is formed. Contrary to this, Bray and Gidson (1977 : 86), while giving the salient features of *Tetrochetus* state, "Male and female ducts open together into shallow genital atrium", i.e. without uniting with each other. Further, while redescribing *T. raynerii* (Nardo, 1933), the type species, from the original material, they state "There is no sign of sinus organ, sinus sac or hermaphroditic duct", and the metraterm runs straight ventral to the pars prostatica, the two ducts open together but separately into the base of the shallow genital atrium. The present studies also show no evidence or trace of the male and female ducts uniting together before entering the genital atrium.

Skrjabin (1959) gave a key to the species of the genus *Tetrochetus* separating *T. coryphaenae* and *T. proctocelus* on the basis of the measurements of the suckers and body. Yamaguti (1970) also gave a key to the species of *Tetrochetus* from Hawaiian fishes separating *T. coryphaenae*, *T. aluterae* and *T. macrorchis*. The author used the characters such as the sizes of the suckers, shapes and sizes of body and sizes

of testes in relation to the lengths and widths of body. Siddiqi and Cable (1960) identified their specimens from the fish host *Coryphaena hippurus* and *Acanthocybium solandri* as *T. aluterae* except for a slight difference in egg size. The present study of the specimens of *Tetrochetus* from four different host fishes also reveals that species in the geuus can be distinguished only on the basis of the nature and size of the body, size of the testes with respect to the body, and size of the suckers.

SUMMARY

Specimens of worms belonging to the genus *Tetrochetus* Looss, 1912 were collected from the marine fishes *Coryphaena hippurus*, *Balistes capistratus*, *Exocoetus volitans* (Bay of Bengal) and *Diodon hystrix* (Arabian Sea). They have been identified as *T coryphaenae* Yamaguti, 1934 (from *Coryphaena hippurus*), *T. aluterae* (Hanson, 1955) Yamaguti, 1958 (from *Balistes capistratus* and *Exocoetus volitans*) and *T. macrorchis* Yamaguti, 1971 (from *Diodon hystrix*). Thus, three species of *Tetrochetus* belonging to the family Accacoeliidae Looss, 1912 are reported to occur so far in the marine fishes of the Bay of Bengal and the Arabian Sea. Although it is difficult to distinguish the species of the genus *Tetrochetus* thus far known, some combinations of characters are given with the help of which, at least, the present three species can be separated. Even by seeing the mounted specimens with the naked eye, these three species can be separated.

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