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REDESCRIPTION AND SYSTEMATIC STUDIES ON *PROCAMALLANUS* (*PROCAMALLANUS*) *ELATENSIS* FUSCO & OVERSTREET, 1979 FROM THREE RED SEA *SIGANUS* SP. FISHES

By

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Abstract

As part of an on-going study of the helminthes parasitizing fish from the Red Sea; Hurghada, Egypt, *Procamallanus (Procamallanus) elatensis* Fusco & Overstreet, 1979 was collected from three different *Siganus* fish species (*S. rivulatus, S. luridus & S. sutor*). It was morphologically elucidated and examined by light and scanning electron microscopy which indicated evident previous erroneous descriptions of both the anterior position of the excretory pore at nerve ring level and absence of deirids, to be excretory pore somewhat posterior to junction of the oesophageal parts and presence of a posterior pair of deirids, located posterior to mid-body level by small distance.Furthermore, the present detailed comparisons against the most similar *Procamallanus* species, casted doubt about the validity of *P. sigani* Yamaguti, 1935 and *P. lonis* Yamaguti, 1941 which could be considered as two different biological variations of *Procamallanus* (*P.*) *elatensis.*

Keywords: Egypt, Red Sea fishes, *Procamallanus (Procamallanus) elatensis*, *Siganus* species, SEM

Introduction

The genus *Procamallanus* was created by Baylis, 1923 with *P. laeviconchus* (Wedl, 1862) as its type species. While creating this genus he also described *Procamallanus spiralis* from a single male specimen from a siluroid fish *Hetrobranchus anguillaris* from the Nile River at Cairo. Annereaux (1946) developed a key for 22 existing species of the genus *Procamallanus* at that time. In 1952, Olsen divided the genus into two subgenera *Procamallanus* and *Spirocamallanus* where the genus *Procamallanus* was restricted to those species having a smooth buccal capsule lining whilst *Spirocamallanus* was characterized by spiral thickening on the inner wall of the buccal capsule. Khera (1955) and Ali (1956, 1960) modified the key developed by Annereaux (1946) for the identification of the species of the original genus *Procamallanus* without consideration to Olsen (1952) division. Shing (1960) indicated the validity of both genera *Procamallanus* and *Spirocamallanus.* They also commented on Ali (1956, 1960) keys particularly about including *P. gubernaculus* in *Procamallanus* subgenera and not in *Spirocamallanus* in spite of having only one spicule. Sahay (1966) presented a key representing a modification of Annereaux's, Khera's and Ali's keys to genus *Procamallanus.* In this key, the taxonomical structure of the genus *Procamallanus* was reassigned to include five subgenera; *Aspiculus* (Ali, 1960), *Monospiculus* (Ali, 1956) *Isospiculus* (Ali, 1956), *Procamallanus* Baylis, 1923 &)Ali, 1956) and *Spirocamallanus* Olsen, 1952.

Several attempts were made to construct a key to the subgernera of this genus. Moravec & Thatcher (1997) presented five subgenera: *Procamallanus* Baylis, 1923*; Spirocamallanus* Olsen, 1952*; Spirocamallanoides* (Mor avec and Sey, 1988)*; Punctocamallanus* (Moravec and Scholz, 1991) and *Denticamallanus* (Moravec and Thatcher, 1997). This math was exactly the most recent taxonomic structuring adapted by Gibson (2017).

The most known species of *Procamallanus* reported from the Red Sea region was *Procamallanus* (*Procamallanus*) *elatensis* (Fusco and Overstreet, 1979; Abdou *et al,* 1995; Abdou *et al,* 2001; Al-Jahdali, 2012).

Materials and Methods

Fish specimens were collected from Northern Red Sea, Off Sharm El-Naga, Makadi

Bay, Southern Hurghada, Egypt (Depth = 0.5-2.5cm) and were transported as alive as possible with good aeration and cooling immediately to the laboratory of Parasitology, Zoology Department, Faculty of Science, South Valley University at Qena Governorate, Egypt. Fishes were identified according to criteria established by Randall (1982), Lieske and Myers (1994, 1996) and Lieske *et al.* (2004) and more confirmed through the fish base website (http://www.fishbase.org). The gastrointestinal tract was untangled with fingers (Justine *et al,* 2012). The whole digestive system and the remaining other viscera were opened longitudinally. Macroscopic and microscopic examination of different organs was carried out for detection of any visible nematod parasites. The collected parasites were cleaned by washing several times with isotonic saline solution. The relaxed nematodes were preserved in bottles containing mixture of 70% alcohol and 5% glycerin. Coiled nematodes were transferred into warm 70% alcohol heated to 60˚C. The nematodes were mounted on slides with few drops of lactophenol and the parasite was covered by a cover slip. Identification of the encountered worms was done according to the keys of the nematode parasites of vertebrates (Yorke *et al.,* 1926; Anderson, 2000; Anderson *et al.,* (2009).

For SEM studies specimens were fixed for 6 hours at 4˚C in 2.5% glutaraldehyde in 0.1 M sodium cacodylate buffer, washed several times in the same buffer at 4°C. post fixed in 1% osmium tctroxide (OSO4) for 2 hours at 4"C, washed two times in cacodylate buffer, dehydrated in ascending grades of ethanol series and transferred into pure acetone. Samples were then processed in a critical point drier "Bomer - 900" with Freon 13. Samples were sputter coated with gold in a Technics Hummer V (Lee, 1993) and viewed with a JEOL JSM-5400LV SEM operated at 15 kV in electron microscopy unit, Assiut University

Results

Incidence: Out of 94 collected; three different *Siganus* fish species [(70) *S. rivulatus,* (8) *S. luridus* &(16) *S. sutor*]; 58, 6 & 12 fishes respectively were found infected with *Procamallanus* (*Procamallanus*) *elatensis* (Fusco and Overstreet, 1979) in their small intestine; worm burden was 1-35, 1-4, 8-18 /fish host respectively..

Morphological re-description: Based on 14 mature specimens; 5 males & 9 females (Pls 1, 2 & 3), measurements, morphometric percentages and morphometric ratios (Tab. 1).

Alive specimens were reddish fixed specimens light yellowish brown to somewhat deep brown. Medium-sized nematodes with finely transversely striated cuticle extending from posterior region of buccal capsule to posterior extremity of body, Maximum width at mid-body level or slightly anterior, Mouth aperture circular, dorso-ventrally elongate, surrounded by thin translucent membrane with six flat, crescent-shaped elevations and four submedian cephalic papillae (Pl. 1B&C; Pl.2A-C; Pl.3A&B). Small lateral amphids present with origins external to those of papillae. Buccal capsule sclerotized, greenish light yellow-brown, thick-walled, barrel shaped, with well-developed basal ring; basal, narrowed part of buccal capsule proper anterior to basal ring somewhat thickened, forming apparent circular ledge (Pl. 1A-C; Pl.2A-C; Pl. 3A). The buccal capsule borders well-differentiated from inside part by its dark color whereas, the inner surface of capsule has more light color, Also, inner surface of capsule smooth, without any spiral ridges (Pl.1A-C; Pl. 2A-C; Pl. 3A&B). Oesophagus divided into two parts; anterior muscular portion moderately club-shaped and posterior glandular portion elongate, ending with paired bilobed valves. Both oesophageal parts slightly swelled near their posterior ends, Intestine brown, narrow [Pl. 1A; Pl, 2A). Anterior deirids small, simple, situated some distance anterior to nerve ring level (Pl. 3A), Nerve ring situated at the end first third level of muscular oesophagus or at the beginning of its second half (Pl. 1C; Pl. 2 B&C), Excretory pore

somewhat posterior to junction of both oesophageal parts (Pl. 3C&D), Tail of both sexes conical.

Male: Testis straight, with anterior tip blunt end near region of upper intestine, Posterior end of body ventrally arcuate, provided with wide, vesiculated caudal alae of striated margins and supported by papillae; the anterior portion of alae interconnected by mound, forming thus a kind of pseudo sucker, and posteriorly reaching to tail, Papillae eight pairs in number, pedunculate, elongate, symmetrical and differentiated into two groups; a) pre-cloacal group represented by 3 equally spaced subventral pairs and decreasing in size posteriorly. b) Post-cloacal group of 5 anterior sub-ventral (Pl. 1D&E & Pl, 3E&F), A pair of lateral phasmids of slightly smaller and immediately posterior to last pair of post-cloacal papillae (Pl. 1D&E). Spicules similar in shape, unequal, tapering posteriorly, with smooth surface, each with conspicuous posterior curvature with blunt alated distal tip [Plate 3 E&G]; small spicule somewhat less sclerotized. Gubernaculum V-shaped with well sclerotized plate joining right side with shorter left side (Pl. 1D). Tail conical, with rounded tip.

Female: Vulva pre-equatorial. Anterior vulva lip somewhat elevated, Vagina muscular, straight, extending posteriorly from vulva, Uterus J-shaped, and saccular, Oviducts usually straight, directed posteriorly. Ovaries straight, directed posteriorly. Rectum is moderately short, and surrounded by four rectal glands arranged into two columns of two along length of rectum. Tail is conical, with blunt tip and two slightly outlined protuberances (Pl. 2D-G; Pl.3H).

Ultra-structure: Using SEM revealed in both genders that; the cephalic head (anterior extremity) is bulb-like. Mouth aperture rounded surrounded by small thin peribuccal collar with a hexagonal peripheral margin and supported with six flat, crescent-shaped cephalic plates. Two groups of cephalic papillae; the inner group consisted of six small spherical papillae, each one situated over the anterior extremity of each the cephalic plate whereas, the outer group consisted of four spherical large papillae which distributed among the bases of the cephalic plates. Two small amphids were observed adjacent to and on opposite sides of the peribuccal collar (Pl. 3A&B).

The cuticle is provided with transverse striations extending from posterior region of the cephalic head to posterior extremity of body. Several longitudinal wavy thickenings from the cuticle extend from the beginning of transverse striations level anteriorly and ramify to several smaller branched near the base of the cephalic plates (Pl. 3C&D). Deirids divided into two pairs; anterior deirids represented by a pair of small, dorso-ventrally flattened structures at about the end of the first tenth of body length (Pl. 3A). The other posterior pair of deirids is slightly smaller, dorso-ventrally flattened and situated posterior to mid-body level by small distance (Pl. 3B).

The male posterior end is ventrally arcuate, forming 1-2 coils, provided with two asymmetrical lateral alae extended on both sides of posterior end. Caudal papillae are eight pairs, with symmetrical spherical end differentiated into two groups; a) pre-cloacal group represented by 3 equally spaced subventral pairs and decreasing in size posteriorly. b) Post-cloacal group of 5 anterior subventral pairs; 2^{nd} & 5^{th} pair are the smallest (Pl. 3 F). A pair of lateral phasmids of was slightly smaller than and immediately posterior to last pair of post-cloacal papillae (Pl. 3E). The large spicule erected well from the cloaca, tapering posteriorly, with conspicuous posterior curvature and smooth surface; small spicule retracted inside cloaca (Pl. 3 E&G). Tail conical, with rounded tip (Pl. 3E).

The posterior end of the female straight with conical tail ended with blunt tip and two slightly outlined protuberances. The anus opening represented by a narrow transvers slit-like opening (Pl. 3H).

Discussion

The incidence of infection in siganid fishes in the present study indicates that the present parasite is a very common inhabitant of the siganid fishes in Red Sea at Hurghada. With the following characteristics: not heterogenetic, parasitic forms sexually differentiated, esophagus not consisting of a narrow tube running through the center of single cells and not dilated posteriorly into a bulb, male posterior end without copulatory bursa, head without any lobes, presence of chitinous buccal cavity, vulva posterior mid-level of body by a small distance and parasitic in alimentary canal give evidence that collected specimens belong to the Superfamily Camallanoidea Travassos, 1920. Furthermore, the combined features; sexual dimorphism not marked, cephalic head without any appendages and presence of large chitinous buccal cavity place newly collected specimens inside the family Camallanidae Railliet & Henry, 1915 (Yorke *et al,* 1926)
The smooth and continuous buccal capsule without differentiation into paired lateral valves indicated that the present specimens belong to the genus *Procamallanus* Baylis, 1923 (Sahay and Narayan, 1967) and absence of the internal spiral thickenings from the buccal capsule places the present specimens inside the subgenus *Procamallanus* Baylis, 1923 (Sahay, 1966; Moravec and Thatcher, 1997).

Concerning the comparison among newly collected specimens with the previously described forms of the subgenus *Procamallanus,* great similarity and a high converge with *Procamallanus (Procamallanus) elatensis* (Fusco and Overstreet, 1979) in overall appearance and almost body parts dimensions in both genders was found. However, large number of allometric measurements were almost similar including; maximum body width, buccal capsule length, both muscular and glandular oesophagus length, pre-nerve ring distance, tail length, caudal alae length and rectum length as a percentage of body length. Moreover, great similarities in ratios of buccal capsule width/ length, glandular oesophagus/muscular oesophagus length and spicules length.

On the other hand, the present specimens exhibit some difference against the previously described *P. elatensis* by Fusco and Overstreet (1979); excretory pore somewhat posterior to junction of both oesophageal parts not anterior to nerve ring and present specimens have a pair of posterior deirids located posterior to mid-body level by small distance. The present SEM showed some difference from that of Abdou *et al.* (2001) including: i) the top of the mouth is characterized by a scleretized plate but not attached by three arms to the inner edge of the collar; ii) the excretory pore located posterior to junction of both oesophageal parts not opening in the first third of the body; iii) no lateral papillae on the lateral side of the worm body observed and iv) the total number of papillae on male posterior end in the present study was 8 pairs (3 pre-cloacal pairs & 5 post-cloacal pairs) not 12 pair (4 pre-cloacal pairs, 4 lateral papillae pairs & 4 post-cloacal pairs).

In the present study, the specimens are very similar to *P. elatensis* and with detailed morphometric features consistent with Moravec and Justine (2011) data and confirmed that the position of the excretory pore anterior to the level of nerve ring (Fusco and Overstreet, 1979) or it opens in the first third of the body (Abdou *et al,* 2001) and the absence of deirids (Fusco and Overstreet, 1979) in *P. elatensis* were evidently erroneous. According to the host-parasite data several species of subgenus *Procamallanus* were reported from several *Siganus* fish spp. off the Indo-Pacific region. Three of them were the most similar to present material *P. elatensis*: *P. sigani* Yamaguti, 1935 [from *S. fus-cescens* off Inland Sea of Japan and Pacific coast of Mie and Wakayama Prefectures (Yamaguti, 1935); from both *S. guttatus* and *S. oramin* off North Borneo, Malaysi a (Myer and Kuntz,1969), from *S. sutor* off the Kenyan coast (Martens and Moens,

1995; Geets and Ollevier, 1996) and off Kilifi (Aloo *et al.*, 2004); *P. lonis* (Yamaguti, 1941) from *S. unimaculatus* off Okinawa, Japan (Yamaguti,1941); from both *S. lineatus* and *S. punctatus* off the Great Barrier Reef, Australia (Lester & Sewell, 1989)]; *P. annulatus* Yamaguti, 1955 [from *Siganus* sp. off Celebes, Indonesia (Yamaguti, 1955); from *S. stellatus* off Colombo Sri Lanka (Parukhin, 1971); from *S. lineatus* off New Caledonia (Moravec and Justine, 2011).

The incomplete original descriptions of both *P. sigani* and *P. lonis*, their overlapped measurements with *P. elatensis* specimens and absence of modified new descreptions of both two species with poor conditions of their type specimens preventing their re-examination (Moravec and Justine, 2011), casted doubt about the validity of both *P. sigani* and *P. lonis* and considering them as two different biological variations of *P. elatensis.*

Generally, *P. elatensis* is differentiated from the previously described and redescribed species by the largest value of length ratio of spicules (1:1.78-3.30), spicules with blunt tips, the gubernaculum V-shaped and weakly sclerotized and presence of posterior deirids; *P. sigani* can be differentiated by absence of a both gubernaculum and a distinct ledge adjacent to the buccal capsule's basal ring (Yamaguti, 1935); *P. annulatus* characterized by small spicules length ratio (1:1.1−1.5), gubernaculum non-bifurcated and strongly sclerotized (Yamaguti, 1955; Moravec and Justine, 2011); *P. lonis* is the most similar species to *P. sigani* but differs from it in having pointed spicules, caudal alae continuous anteriorly not separated and presence of a distinct ledge adjacent to the buccal capsule's basal ring (Yamaguti, 1941). The previously discussed morphological changes and differences in allometric measurements between Fusco and Overstreet (1979) measurements and present study may be attributed to; 1) the differences in overall size of the worms which could simply reflect differences in the age of the worms which affect several measurement. (2) All previously described and present specimens collected at different distant times, so the environmental conditions and changes should best be taken in consideration.

The host-parasite data indicated that *P. sigani* is the only known nematode parasite reported from *Siganus sutor*. Hence, *Siganus sutor* is herein reported as a new host record of *Procamallanus (Procamallanus) elatensis* (Fusco and Overstreet, 1979.

Conclusion: As part of an on-going study of the helminthes parasitizing fish from the Red Sea; Hurghada, Egypt, *Procamallanus (Procamallanus) elatensis* Fusco and Overstreet, was collected from three different *Siganus* fish species (*S.rivulatus, S. luridus & S. sutori*). It was morphologically elucidated and examined by light and scanning electron microscopy which indicated evident previous erroneous descriptions of both the anterior position of the excretory pore at nerve ring level and absence of deirids to be excretory pore somewhat posterior to junction of both oesophageal parts and presence of a posterior pair of deirids, located posterior to mid-body level by small distance. Also, the present light and SEM studies added and corrected many morphometric and fine details of the parasite and casted doubt about validity of *P. sigani* Yamaguti, 1935 & *P. lonis* Yamaguti, 1941 that could be considered as two different biological variations of *Procamallanus (P) elatensis.*

Conclusion

The parasite was for the first time reported from Red Sea fishes at Hurghada with addition of many morphometric and ultra-structural details and *Siganus sutor* is reported as a new fish host record of *Procamallanus* (*Rocamallunus) elatensis.*

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Table 1: Comparison of measurements, morphometric percentages and morphometric ratios of *Procamallanus* (*procamallanus*) *elatensis* of present specimens and previously described forms.

Reference	Fusco & Overstreet, 1979	El Abdou *et al.*, 2001	Present study
Host(s)	*Siganus rivulatus & Siganus luridus*	*Siganus rivulatus & Siganus luridus*	*Siganus rivulatus, Siganus luridus & Siganus sutor*
Locality	Northern Gulf of Aquaba	Hurghada, Egypt	Sharm EL-Naga, Egypt
Measured Parasite number	29;11 ♂ & 18 ♀	10; 5 ♂ & 5♀	14; 5 ♂ & 9 ♀
Site of infection	Intestine, Abdominal cavity	intestine	intestine
Male measurements			
Body Length [L]	12,600−15,800	8,000−10,000 (9,000)	13,910−14,370 (14,140)
Maximum body Width [W]	216−309	200−250 (230)	189−239 (214)
Maximum body Width %*	(1.7−2)[b]	(2.5)[b]	1.4−1.7 (1.5)
Buccal capsule Length	111−137	100−120 (110)	101−106 (104)
Buccal capsule Length%*	(0.8−0.9)[b]	(1.2−1.3 (1.2))[b]	0.7−0.8 (0.7)
Buccal capsule Width	87−111	90−100 (90)	70−82 (76)
buccal capsule width: buccal capsule Length ratio	(1:1.23−1.28)[b]	(1:1.11−2.08 (1:2.09))[b]	1:1.29−1.44 (1:1.37)
Basal ring length	[42][a]	–	28−31 (30)
Basal ring breadth	[78][a]	–	50−52 (51)
circular ledge height	[20][a]	–	13−17 (15)
Muscular oesophagus L	337−525	370−450 (410)	356−396 (376)
Muscular oesophagus L%*	(2.7−3.3)[b]	(4.5−4.6 (4.6))[b]	2.6−2.8 (2.7)
Muscular oesophagus W	93−117	60−90 (80)	73−77 (75)
Glandular oesophagus L	662−946	560−780 (660)	555−600 (578)
Glandular oesophagus L%*	(5.3−6)[b]	(7−7.8 (7.3))[b]	4−4.2 (4.1)
Glandular oesophagus W	95−155	60−90 (80)	77−94 (86)
Muscular oesophagus L: glandular oesophagus L	(1:1.80−1.96)[b]	(1:1.51−1.73 (1:1.61))[b]	1:1.52−1.56 (1:1.54)
Total oesophagus length	1,098−1,255	950−1,190 (1,090)	911−996 (954)
Total oesophagus length L%*	8−9	(11.8−11.9)[b]	6.5−6.9 (6.7)
Entire oes. & buccal capsule L	(1,208−1,392)[b]	1,050 −1,310 (1200)[b]	1,001−1,006 (1,004)
Entire oes. & buccal capsule L%*	(8.8−9.6)[b]	(13.1 (13.3))[b]	7.0−7.2 (7.1)
nerve ring L	–	–	33−37 (35)
nerve ring breadth	36−48	90	61−77 (69)

Table (1): Continued

Pre-Nerve ring distance	253−321	120	188−195 (192)
Pre-Nerve ring distance%*	(2)[b]	(1.2−1.5 (1.3))[b]	1.3−1.4 (1.4)
Pre-excretory pore ring distance	–	–	495−524 (510)
Pre-excretory pore ring distance%*	–	–	3.4−3.8 (3.6)
Large spicule length	420-486	290-570 (420)	204−336 (270)
Small spicule length	138-195	200-220 (210)	69−189 (129)
Small spicules: large specule Length	1:2.40-3.30 (1: 2.90)	(1:1.45-2.59 (1:2))[b]	1.78−2.96 (2.37)
Gubernaculum length	41-63	–	31−86 (59)
Tail length	143-205	500−550 (520)	112−115 (114)
Tail length%*	(1.1-1.3)[b]	(0.5−0.6 (0.6))[b]	0.7−0.8 (0.8)
Pre-Nerve ring distance	253-321	120	188−195 (192)
Caudal alae length	–	290−400 (340)	395−412 (404)
Caudal alae length%*	–	(3.6−4 (3.58))[b]	2.8−2.9 (2.9)
Female measurements			
Body Length [L]	20,400−27,700	20,000−25,000 (22,500)	27,490−31,260 (28,940)
Maximum body width [W]	358−445	460−580 (520)	376−427 (394)
Maximum body width %*	(1.6−1.8)[b]	(2.2−2.3 (2.3))[b]	1.2−1.6 (1.4)
Buccal capsule Length	136−173	130−150 (140)	115−133 (121)
Buccal capsule Length%*	(0.5−0.7)[b]	(0.6−0.7 (0.6))[b]	0.4−0.5 (0.4)
Buccal capsule Width	113−136	110−140 (130)	91−101 (95)
buccal capsule width: buccal capsule Length ratio	1:1.20−1.27	(1:1.07−1.18 (1:1.08))[b]	1:1.23−1.32 (1:1.27)
Basal ring Length	[34][a]	–	26−30 (28)
Basal ring breadth	[58][a]	–	58−64 (61)
circular ledge height	[15][a]	–	13−25 (18)
Muscular oesophagus L	488−593	460−540 (500)	378−411 (393)
Muscular oesophagus L%*	(2.1−2.4)[b]	(2.2−2.3 (2.2))[b]	1.3−1.5 (1.4)
Muscular oesophagus W	74−130	100−120 (111)	105−114 (108)
Glandular oesophagus L	772−1214	730−910 (810)	599−804 (695)
Glandular oesophagus L%*	(3.8−4.4)[b]	(3.6−3.7 (0.36))[b]	1.9−2.9 (2.4)
Glandular oesophagus W	68−136	–	119−132 (124)
Muscular oesophagus L : Glandular oesophagus L	(1:1.58−2.05)[b]	(1:1.591.69 (1:1.62))[b]	1:1.53−1.96 (1:1.76)
Total oesophagus length	1,292−1,307	1,040−1,300 (1,150)	990−1,215 (1,088)
Total oesophagus length L%*	6−8	(5.1−5.2 (5.2))[b]	3.2−4.4 (3.8)

Explanation of figures

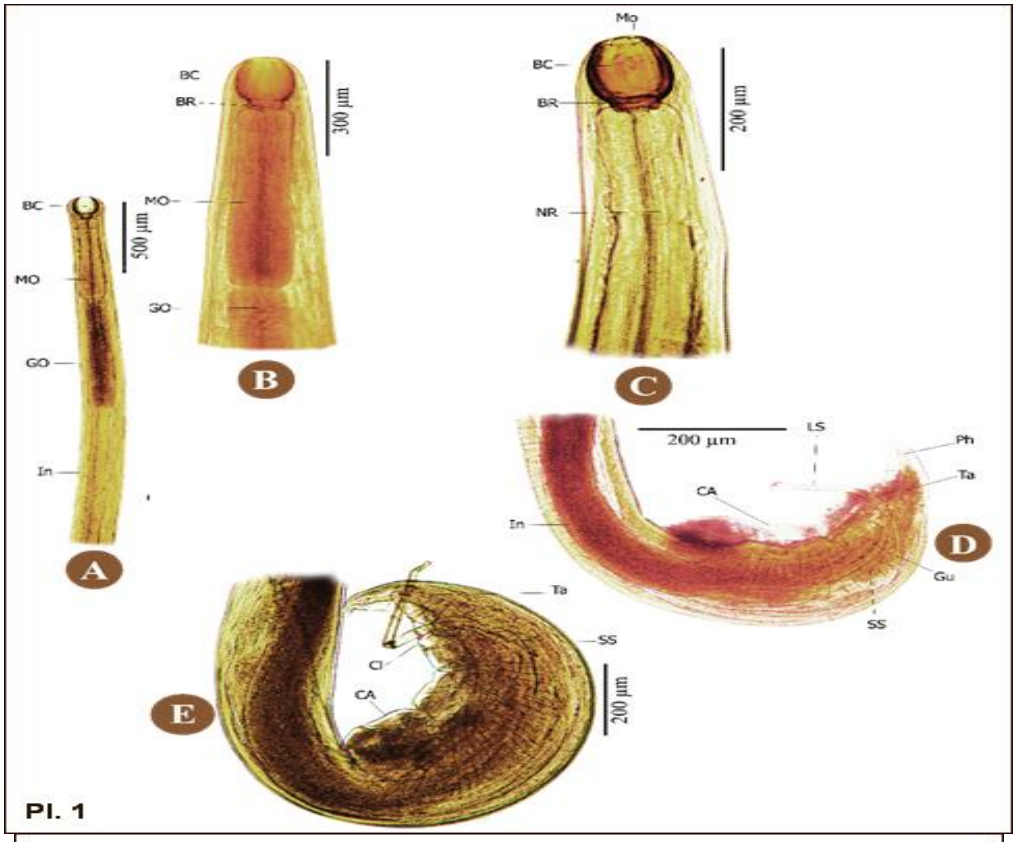
Plate 1: Photomicrographs of adult male of nematode parasite *Procamallanus (procamallanus) elatensis* infecting *Siganus rivulatus* showing: A- Ventral view of anterior extremity. B- Enlarged cephalic end revealing buccal capsule. C- Enlarged cephalic end revealing the nerve ting, basal ring, buccal capsule and moth opening. D- Ventrolateral view of posterior extremity disclosing caudal alae, spines and gubernaculum. E- Lateral view of posterior extremity disclosing caudal alae, spines and cloaca.

Abbreviations; BC, buccal capsule; BR, basal ring; Ca, caudal alae; Cl; cloaca; GO, glandular oesophagus; Gu, gubernaculum; In, intestine; LS, long spine; MO, muscular oesophagus; Mo, mouth; NR, nerve ring; Ph, phasmid; SS, short spine Ta, tail.

Plate 2: Photomicrographs of adult female of nematode parasite *Procamallanus (procamallanus) elatensis* showing: A- Ventral view of anterior extremity showing buccal capsule and oesophagus portions. B- & C- Enlarged cephalic end revealing buccal capsul, nerve ting, basal ring & moth opening. D- Ventral view of posterior extremity disclosing long tail. E- & G- Ventrolateral view of posterior extremity disclosing rectum & anus. F- Ventral view of posterior extremity disclosing rectum, Phasmid & anus.

Abbreviations; An, anus; BC, buccal capsule; BR, basal ring; Ca, caudal alae; Cl; cloaca; GO, glandular oesophagus; In, intestine; MO, muscular oesophagus; Mo, mouth; NR, nerve ring; Ph, phasmid; Pr, proctodeum; Re, rectum; Ta, tail.

Plate 3: SEM adult nematode parasite *Procamallanus (procamallanus) elatensis* showing: A- Buccal capsule with lateral amphids and anterior deirids. B- Cephalic end revealing buccal capsule and excretory pore cover by Tegumental rounded process. C- High magnifications of body at mid of anterior third of body revealing striated cuticle. D- High magnifications of excretory pore region cover by tegumental rounded process. E- High magnifications of posterior extremity of male revealing long spine and caudal alae. F- Enlarged portion of tail of male showing caudal papillae. G- High magnifications of spine surface. H- Posterior extremity of female revealing transverse anus.


BC
BR
300 µm
BC
MO
500 µm
MO
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GO
In
A
B
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Ta
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Cl
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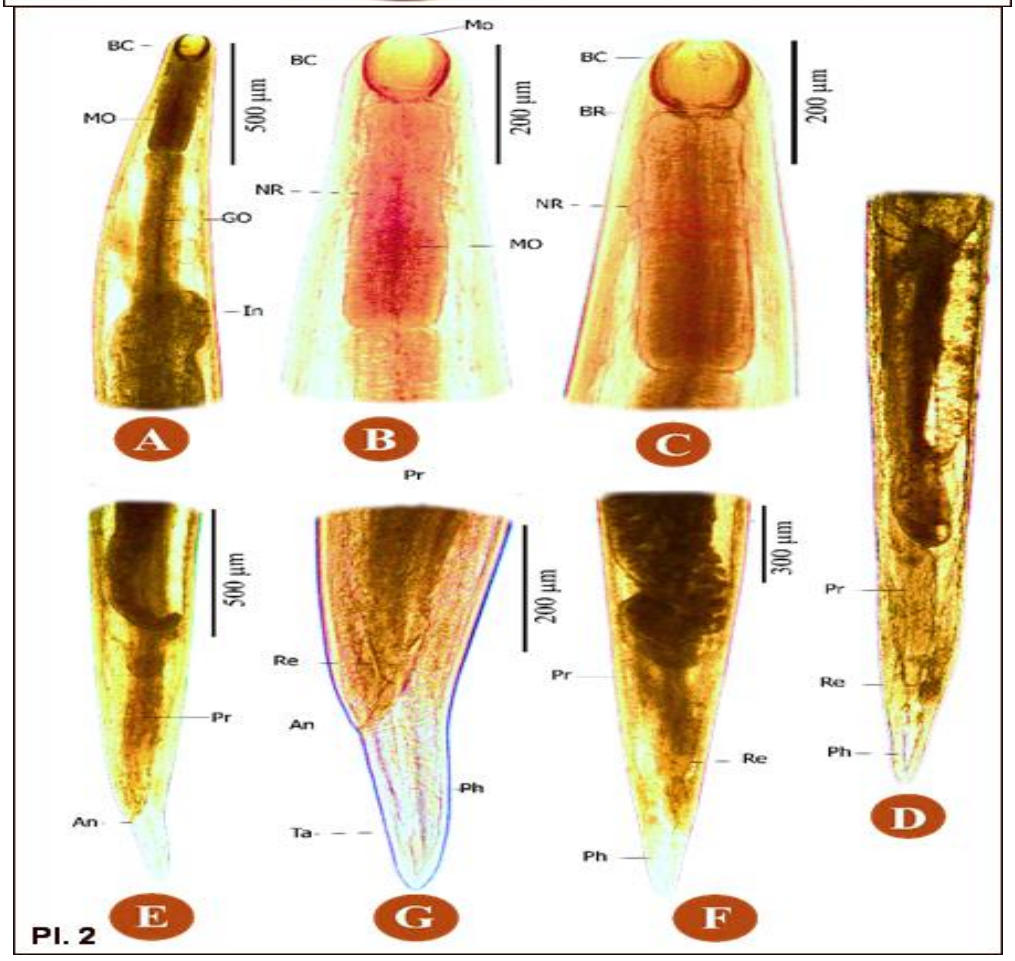
Pl. 1


BC
MO
500 µm
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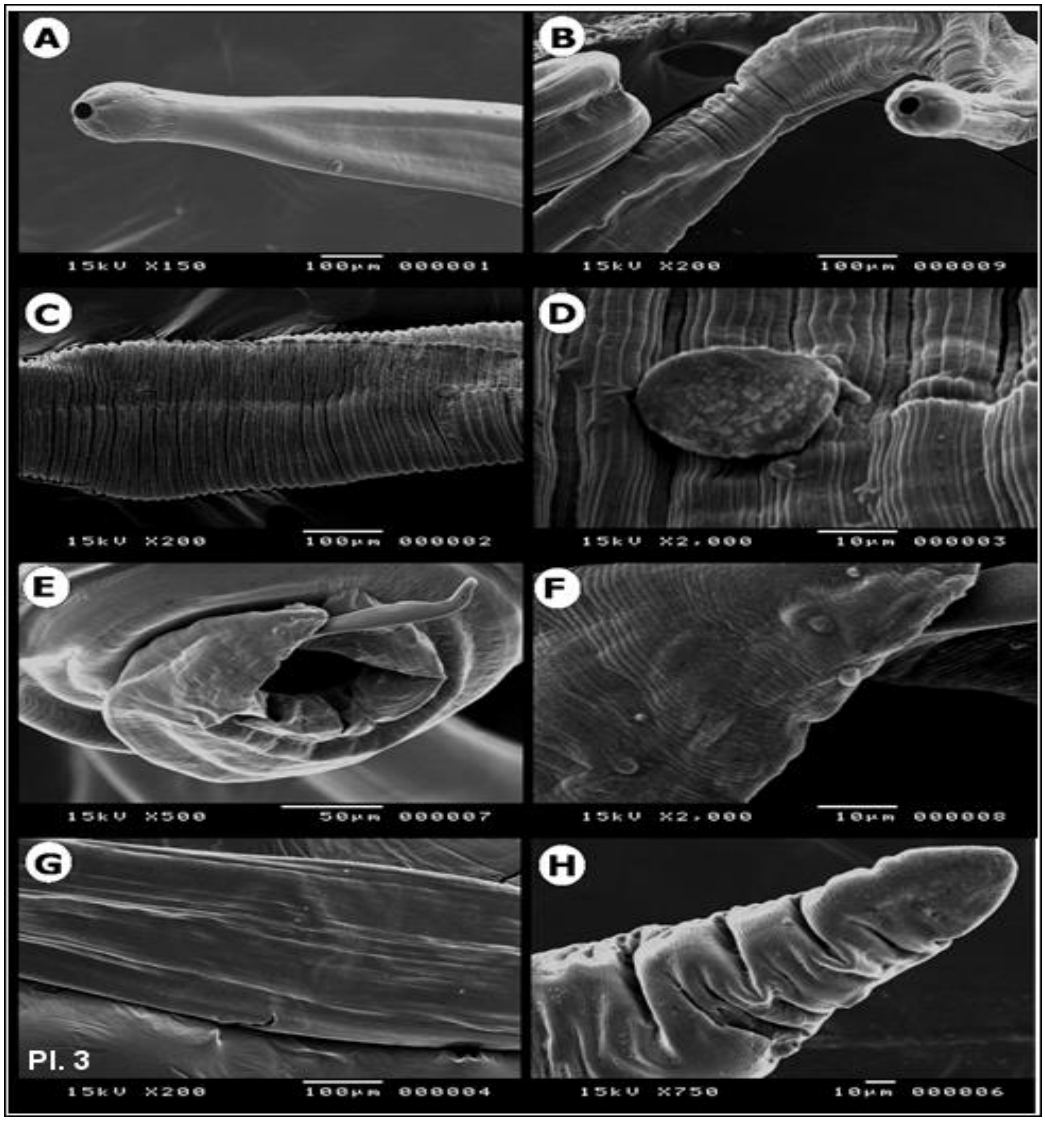
A
15kV X150 100µm 000001
B
15kV X200 100µm 000009
C
15kV X200 100µm 000002
D
15kV X2,000 10µm 000003
E
15kV X500 50µm 000007
F
15kV X2,000 10µm 000008
G
Pl. 3
15kV X200 100µm 000004
H
15kV X750 10µm 000006