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ON SOME NEW AND ALREADY KNOWN SPECIES OF THE
SUBGENUS *NEODIPLOSTOMUM* RAILLIET, 1919
(TREMATODA: DIPLOSTOMATIDAE) FROM BIRDS IN INDIA

by

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SUMMARY

Neodiplostomum (Neodiplostomum) aquilai n. sp.

Body length, 1.67-3.89 mm, bisegmented; anterior segment extremely thin with the narrowest breadth in the region between the acetabulum and the tribocytic organ and its outline resembling the basal part of a violin; ratio of the length; posterior segment/ anterior segment = 0.43-0.79; suckers feebly developed; tribocytic organ circular to elliptical; anterior testis asymmetrical, posterior testis bilobed. Vitellaria extend from the level of the acetabulum or a little in front of it to that of the caecal termination. Bursa copulatrix without genital cone. Eggs, $95-100 \times 60-75 \mu$.

Its validity has been discussed.

Host: *Aquila rapax* (Temm.)

Locality: Simla.

Neodiplostomum (Neodiplostomum) lati n. sp.

Body length, 1.97-2.56 mm, bisegmented; anterior segment broader than long; ratio of the length: posterior segment/anterior segment =

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1.21-1.4; tribocytic organ transversely elliptical; testes symmetrically bilobed and transversely elongated; ovary submedian. Vitellaria reaching anteriorly the level of the intestinal fork. Bursa copulatrix without genital cone. Eggs, 88-95 $\times$ 65-70 μ .

Its validity has been discussed.

Host: *Milvus migrans* (Bodd.)

Locality: Simla.

Neodiplostomum (*Neodiplostomum*) *kuluensis* n. sp.

Body length, 2.56-3.72 mm and bisegmented; ratio of the length: posterior segment/anterior segment = 0.72-1; acetabulum transversely elongated; tribocytic organ longitudinally elliptical; gonads in the first half of the posterior segment. Vitellaria reaching posteriorly at the level of the anterior edge of the bursa copulatrix or a little in front of the ends of the intestinal caeca. Bursa copulatrix without genital cone. Eggs, 90-100 $\times$ 55-60 μ .

Its validity has been discussed.

Host: *Pseudogyps bengalensis* (Gm.).

Locality: Kulu.

Neodiplostomum (*Neodiplostomum*) *reflexum* Chandler et Rausch, 1947 has been redescribed from a new host. *Accipiter badius* for the first time in India.

In *N. (N.) mehrai* (Vidyarthi, 1938) Bhalerao, 1942 variations have been noted and the genital pore has been observed terminal also.

N. (N.) canaliculatum (Nicoll, 1914) Dubois, 1937 has been redescribed from a new host, *Bubo bubo bengalensis* for the first time in India.

N. (N.) spathoides Dubois, 1937 has been redescribed from a new host, *Accipiter badius* in India.

N. (N.) rufeni Chatterji, 1942, has been redescribed from a new host, *Circus macrourus*.

N. (N.) attenuatum attenuatum (Linstow, 1906) La Rue, 1926 has been redescribed for the first time in India. Variations have been noted in it.

INTRODUCTION

The authors examined 196 birds belonging to different orders for the collection of trematodes from different altitudes, commencing from sea shore of Pamban to Vyaskund at an altitude of 11,000 feet above the sea level, covering places; Pamban, Island (Tamil Nadu), Plains of Chandigarh, Kharar (Punjab), Kashipur (Uttar Pradesh), Renuka lake, Sirmoorital, Amboya, Simla and adjoining hills, Kulu Valley, Palchan, Dhundi and Vyaskund (Himachal Pradesh) in India.

The entire collection comprised 33 species of trematodes (Strigeids) representing 12 genera. In this paper the authors have given account of three new and six already known spe-

cies of the subgenus *Neodiplostomum* RAILLIET, 1919. The validity of the new forms has been discussed. The already known forms have been redescribed and variations found in them have been recorded. In respect of certain forms new hosts and localities are given.

RESULTS

Family Diplostomatidae Poirier, 1886

Subfamily Diplostomatinae Monticelli, 1888 ex Poirier, 1886

Tribe Diplostomatini Dubois, 1936 ex Poirier, 1886

Genus *Neodiplostomum* Railliet, 1919

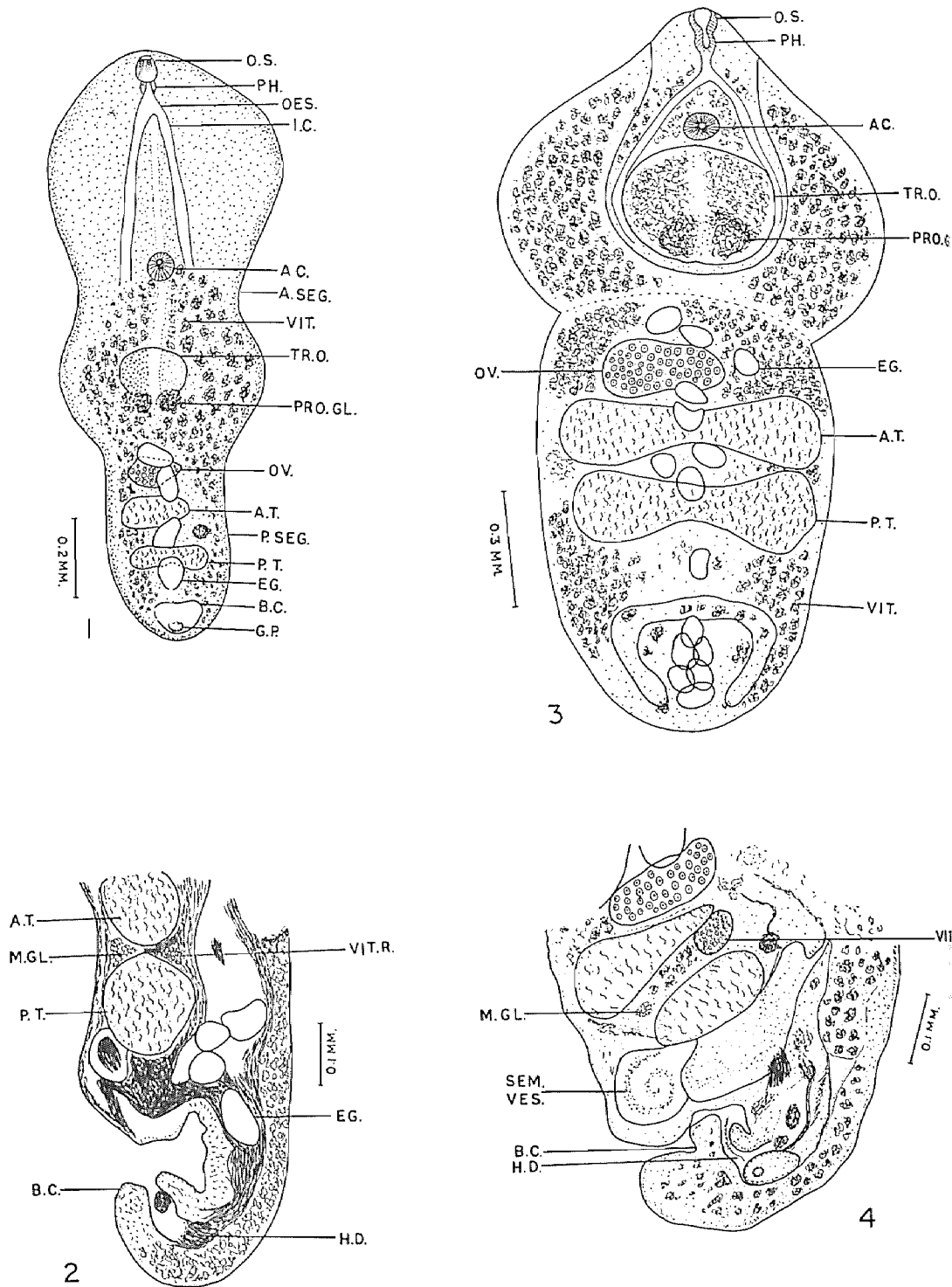
Subgenus *Neodiplostomum* Railliet, 1919

Neodiplostomum (*Neodiplostomum*) *aquilai* n. sp.

(Figs. 1-2)

Three specimens of Tawny Eagle, *Aquila rapax* (Temm.) were examined at Simla (Himachal Pradesh) India and all the three were found infected with *Neodiplostomum* (*Neodiplostomum*) *aquilai* n. sp. As many as thirty specimens of this new fluke were recovered from them.

The fluke, 1.67 - 3.89 mm long, is divided into anterior and posterior segments by a constriction. The anterior segment, 1.14-2.31 $\times$ 0.55-1.23 mm, is extremely thin. The breadth, in the region between the acetabulum and the tribocytic organ, is the narrowest due to slight invagination of the lateral margins and presents a characteristic outline of the posterior part of a violin (Musical instrument). The posterior segment, 0.53-1.61 $\times$ 0.22-0.89 mm, is subcylindrical. The ratio of the length of the posterior segment to that of the anterior is 0.43-0.79. The oral sucker, 55-90 $\times$ 60-105 μ , is feeble and terminal. The acetabulum, 60-100 $\times$ 85-110 μ , is also very feeble and its anterior edge lies at 37-50/100 of the anterior segment. The ratio of the length of the acetabulum to that of the oral sucker is 1.28-1.5. The tribocytic organ, 285-760 $\times$ 209-513 μ , is circular to elliptical and its anterior edge lies at 56-75/100 of the first



Figs. 1-2.—*Neodiplostomum (Neodiplostomum) aquilai* n. sp. 1, entire; 2, a portion of s. s. showing the position of testes, the Mehli's gland, the vitelline reservoir, the hermaphroditic duct and the bursa copulatrix.
Figs. 3-4.—*Neodiplostomum (Neodiplostomum) lali* n. sp. 3, entire; 4, a portion of s. s. showing the hermaphroditic duct, the bursa copulatrix and other structures.

segment. The ratio of the length of the anterior segment to that of the tribocytic organ is 3-4.93. The proteolytic gland lies at the base of the tribocytic organ. In some of the specimens, the prepharynx measures up to $10\ \mu$ in length. The pharynx is $60-75 \times 70-100\ \mu$ in size. The oesophagus is moderate. The intestinal caeca terminate near posterior end of the body.

The anterior testis, $75-228 \times 125-494\ \mu$, is asymmetrical and its anterior edge lies at 17-34/100 of the posterior segment. The posterior testis, $80-304 \times 152-608\ \mu$ is slightly bilobed and its posterior edge lies at 56-66/100 of the second segment. The seminal vesicle is post-testicular. The ovary, $70-247 \times 80-437\ \mu$, is oval to reniform and its anterior edge lies at 3-14/100 of the second segment. The uterus does not extend beyond the inter-segmental constriction. Mehli's gland and vitelline reservoir are intertesticular. The vitelline follicles extend from the level of the acetabulum or a little in front of it to that of the ends of the intestinal caeca. They are densely distributed in the anterior segment particularly in the region of the tribocytic organ, sparse in the gonadal region and form more or less two masses in the region of the bursa copulatrix. The bursa copulatrix is spacious and its anterior edge lies at 66-82/100 of the second segment. The hermaphroditic duct, formed by the union of the ejaculatory duct and the distal end of the uterus, opens directly into the genital atrium. The genital pore is dorsal and terminal. The eggs, $95-100 \times 60-75\ \mu$, are oval.

Host: *Aquila rapax* (Temm.)

Location: Small intestine.

Locality: Simla (Himachal Pradesh) India.

Discussion: The new species, *Neodiplostomum (Neodiplostomum) aquilai* with its extremely thin anterior segment resembling the base of a violin (outline), stands well apart from *N. (N.) ellipticum ellipticum* (Brandes, 1888) La Rue, 1926; *N. (N.) morchelloides* Semenov, 1927; *N. (N.) aluconis* Tuban-gui, 1933; *N. (N.) tytense* Patwardhan, 1935; *N. (N.) ellipticum globiferum* Verma, 1936; *N. (N.) biovatum* Dubois, 1937; *N. (N.) canaliculatum* (Nicoll, 1914) Dubois, 1937; *N. (N.) conicum* Dubois 1937; *N. (N.) microcotyle* Dubois, 1937; *N. (N.) obscurum* Dubois, 1937; *N. (N.) travassosi* Dubois, 1937; *N. (N.)*

japonicum Dubois, 1938; *N. (♂) laruei* Vidyarthi, 1938; *N. (♂) strigis* Yamaguti, 1939; *Neodiplostomum* sp. Lal, 1939 sp. inq.; *N. (N.) brachypteris* Chatterji, 1942; *N. (N.) mehrai* (Vidyarthi, 1938) Bhalerao, 1942; *N. (N.) rufeni* Chatterji, 1942; *N. (♂) eudynamis* Chatterji, 1942; *N. calaophilum* Dubois, 1944 sp. inq.; *N. (N.) americanum* Chandler et Rausch, 1947; *N. (N.) reflexum* Chandler et Rausch, 1947; *N. (N.) berghaani* Bisseru, 1956; *N. (♂) garnhami* Gupta, 1957; *N. (♂) dollfusi* Dubois, 1958; *N. (♂) rousseloti* Dubois, 1958; *N. (♂) corvinum* Dubinina et Kulakova, 1960; *N. (N.) magnitesticulatum* (Bisseru, 1957) Dubois, 1962; *N. (N.) pearsoni* Dubois, 1962; *Neodiplostomum* sp. Pavlov, 1962 sp. inq.; *N. (♂) oriolinum* Oshmarin, 1963; *Neodiplostomum* sp. 1. Oshmarin, 1963 sp. inq.; *N. (N.) migrans* Dubois et Richard, 1964; *N. (N.) attenuatum micropharyngeum* Dubois et Richard, 1964; *N. (N.) toruligenitale* Dubois, 1964; *N. (N.) duboisi* Richard, 1965; *N. (N.) tamarini* Dubois, 1966; *N. (N.) subaequipartitum* Dubois et Pearson, 1967; *N. (N.) sudarikovi* Nguyen Thi Le, 1969; *N. (N.) lineatum* Dubois, 1970 (syn. *N. pseudattenuatum*, Yamaguti, 1933 and *Posthodiplostomum milvi* Fotedar et Raina, 1964).

The new species *Neodiplostomum (Neodiplostomum) aquilae* differs from *N. (♂) mehranum* Vidyarthi, 1938 in the size of the eggs and symmetry of the anterior testis. (In the new species the eggs measure $95-100 \times 60-75 \mu$ and the anterior testis is unlobed whereas, in the latter, the eggs, $84 \times 33-50 \mu$ and the anterior testis bilobed). The new species, however, approaches *N. (N.) spathoides* Dubois, 1937 slightly in the outline of the anterior segment but differs from it in the host range, posterior extent of the vitellaria, musculature of the suckers, shape and position of the posterior testis in relation to the anterior testis. The new species has been recovered from *Aquila rapax* at Simla (6,000 ft, above the sea-level) whereas, *N. (N.) spathoides* had been reported from various birds viz., *Accipiter gentilis*; *A. nisus*; *Aquila chrysaetos*; *A. clanga*; *A. heliaca*; *Buteo buteo*; *B. lagopus*; *B. rufofuscus augur*; *Circus gallicus*; *Circus aeruginosus*; *C. cyaneus*; *C. macrourus*; *C. pygargus*; *Dryotriorchis spectabilis batesi*; *Falco vespertinus*; *Haliaeetus albicilla*; *H. vocifer*; *Milvus migrans*; *M. migrans aegyptius* and *Torgos calvus* in different parts of the world. In the new species, the vitellaria in the posterior seg-

ment, extend up to the termination of the caeca i. e., a little in front of the posterior extremity, suckers are feebly muscular, testes are more or less apart, the posterior one is slightly bilobed without forming the horse-shoe shaped structure whereas, in *N. (N.) spathoides*, the vitellaria extend up to the posterior extremity of the body, suckers are well developed, testes are proximate and the second testis is distinctly bilobed forming a horseshoe shaped structure and the two lobes are united by a dorsal commissure.

In view of the above differences, *Neodiplostomum (Neodiplostomum) aquilae* has been considered as a new species and named after the generic name of its host.

Neodiplostomum (Neodiplostomum) lali n. sp.

(Figs. 3-4)

Ten specimens of this fluke were recovered from the small intestine of a Pariah Kite, *Milvus migrans* (Boddaert) examined at Simla (Himachal Pradesh) India.

The fluke, 1.97-2.56 mm in length, is distinctly bisegmented into anterior and posterior segments by a constriction. The anterior segment, $0.79-1.14 \times 0.96-1.17$ mm, is broader than long and its lateral margins are strongly incurved ventrally. The posterior segment, $1.17-1.42 \times 0.72-0.85$ mm, is cylindrical. The ratio of the length of the posterior segment to that of the anterior is 1.21-1.4. The oral sucker, $70-90 \times 70-90 \mu$, is terminal and circular in outline. The acetabulum measures $75 \times 90-95 \mu$ and its anterior edge lies at 34-35/100 of the first segment. The tribocytic organ, $304-418 \times 380-456 \mu$, is transversely elliptical and its anterior edge lies at 42-45/100 of the same segment. The ratio of the length of the anterior segment to that of the tribocytic organ is 2.62-2.83. A feeble mass representing the proteolytic gland is present at the base of the tribocytic organ. The pharynx measures $65-70 \times 60-70 \mu$. The oesophagus, $30-45 \mu$ in length, is distinct. The intestinal caeca terminate near posterior extremity.

The testes are symmetrical, bilobed and transversely elongated. The anterior testis measures $190-228 \times 665 \mu$ and its

anterior edge lies at 24-23/100 of the second segment. The posterior testis measures $209-380 \times 646-779 \mu$ and its posterior edge lies at 51-58/100 of the same segment. The seminal vesicle is post-testicular. The ovary, $152 \times 304 \mu$ in size, is pretesticular, sub-median and its anterior edge lies at 11-13/100 of the second segment. Mehlis' gland and vitelline reservoir are intertesticular. The vitellaria commence at the level of the intestinal fork and extend up to the posterior extremity of the fluke. The anterior edge of the bursa copulatrix lie at 74/100 of the second segment. The hermaphroditic duct is curved and opens directly into the genital atrium. The genital pore is dorsal and subterminal. The eggs, $88-95 \times 65-70 \mu$, are oval.

Host. *Milvus migrans* (Boddaert)

Location. Small intestine

Locality. Simla (Himachal Pradesh) India.

Discussion: *Neodiplostomum* (*Neodiplostomum*) *lali* n. sp. differs from all other forms of the subgenus *Neodiplostomum* Railliet, 1919 except *N. (N.) aluconis* Tubangui, 1933; *N. (N.) canaliculatum* (Nicoll, 1914) Dubois, 1937; *N. (N.) conicum* Dubois, 1937; *N. (♂) mehranum* Vidyarthi, 1938; *N. (N.) americanum* Chandler et Rausch, 1947; *N. (♂) dollfusi* Dubois, 1958; *N. (♂) corvinum* Dubinina et Kulakova, 1960; *N. sp.* Pavlov, 1962 sp. inq., in the development and symmetry of the testes. In the new species *Neodiplostomum* (*Neodiplostomum*) *lali*, both testes are transversely elongated, distinctly bilobed and symmetrically developed, whereas in the other already known species as given above, either only one (anterior or posterior) testis is bilobed, symmetrical or both are unlobed and asymmetrical.

The new species further stands apart from *N. (N.) canaliculatum*; *N. (N.) conicum*; *N. (♂) mehranum*; *N. (N.) americanum*; *N. (♂) dollfusi*; *N. (♂) corvinum* and *N. (♂) oriolinum* in the shape, size of the anterior segment and its ratio in relation to the length of the posterior segment. In the new species, the anterior segment is transversely oval, broader than long and shorter than the posterior segment, the ratio of the length of the posterior segment to that of the anterior is 1.21-1.4, whereas in the latter species, it (anterior segment) is elon-

gated, longer than broad and also longer in relation to the length of the posterior segment and the ratio of the length of the posterior segment to that of the anterior is hardly one.

The new species, *Neodiplostomum* (*Neodiplostomum*) *lali* can also be distinguished from *N. (N.) aluconis* Tubangui, 1933 and *N. sp.* Pavlov, 1962 sp. inq., in the host range, geographical distribution, body length, shape of the tribocytic organ and in the extent of vitellaria. The new species, reported here has been recovered from *Milvus migrans* (Boddaert) at Simla (Himachal Pradesh) India and it measures 1.97-2.56 mm in entire length. The tribocytic organ in the new species, is transversely elliptical and vitellaria extend from the level of the intestinal fork to posterior extremity of the body, whereas the already known forms i. e. *N. (N.) aluconis* and *Neodiplostomum sp. (sp. inq.)* had been reported from different hosts in countries other than India; *N. (N.) aluconis* is 7 mm in maximum length and *N. sp. (sp. inq.)* of Pavlov measures up to 1.5 mm. The tribocytic organs in the latter forms are longitudinally elliptical; the vitellaria in *N. sp. (sp. inq.)* of Pavlov extend from the level of the pharynx hardly up to posterior extremity and in *N. (N.) aluconis*, they extend from posterior border of the acetabulum to posterior extremity of the body.

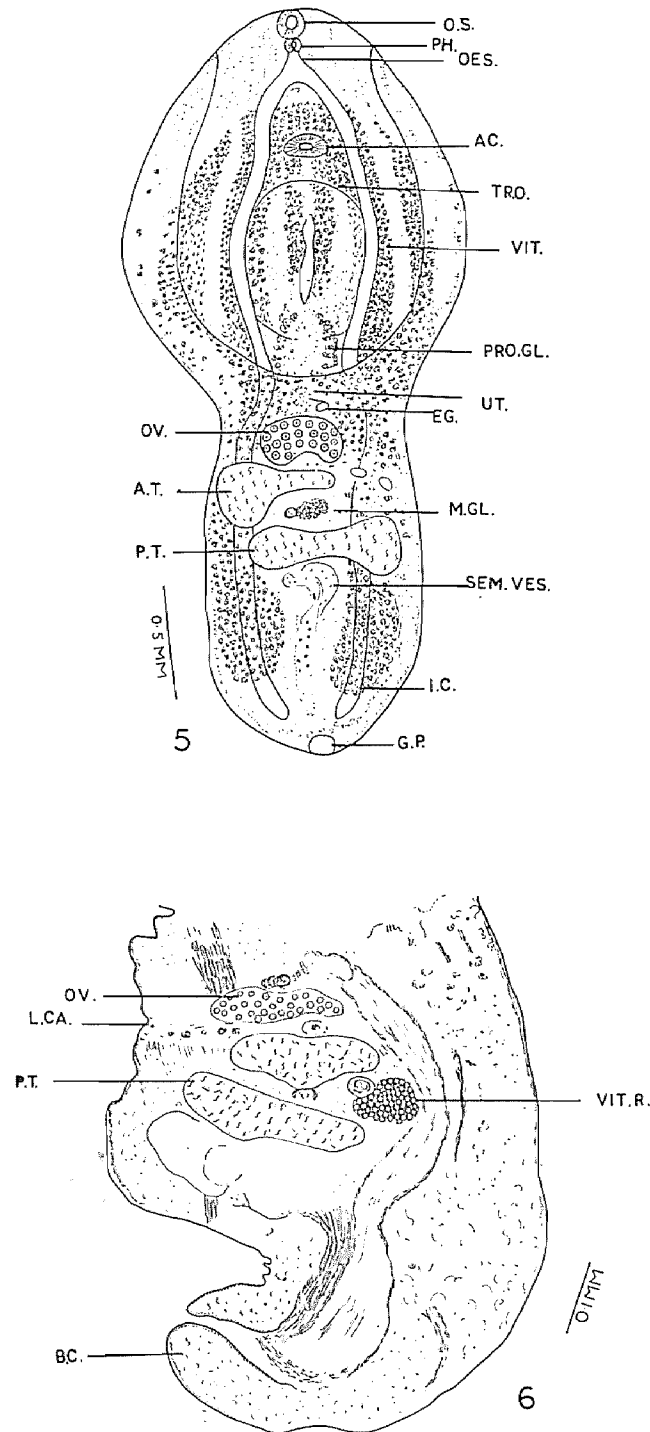
In view of the above differences *Neodiplostomum* (*Neodiplostomum*) *lali* has been considered as a new species and designated after Professor M. B. Lal, Helminthologist, Vice-Chancellor of Lucknow University, Lucknow, India.

Neodiplostomum (*Neodiplostomum*) *kuluensis* n. sp.

(Figs. 5-6)

Seven specimens of this fluke were recovered from the small intestine of a common vulture, *Pseudogyps bengalensis* (Gmelin) at the altitude of 6,000 ft. above the sea-level in Kulu Valley (Himachal Pradesh) India.

The fluke, 2.56-3.72 mm in length, is divided into anterior and posterior segments by a marked lateral constriction. The anterior segment (oval to spathaceous), $1.48-1.86 \times 1.36-1.55$



Figs. 5-6.—*Neodiplostomum* (*Neodiplostomum*) *kuluensis* n. sp. 5, entire; 6, a portion of s. s. showing the arrangement of gonads, Laurer's canal, vitelline reservoir and the bursa copulatrix.

mm, is spinose along its lateral margins, which are incurved ventrally to form a marked ventral curvature. The posterior segment, $1.23-1.36 \times 0.85-0.98$ mm, is cylindrical and its posterior extremity is blunt to round. The ratio of the length of the posterior segment to that of the anterior is 0.72-1. The oral sucker, $105-125 \times 105-125 \mu$, is terminal and round. The acetabulum situated $45-75 \mu$ in front of the tribocytic organ, measures $80-105 \times 130-195 \mu$; it is transversely elongated and its anterior edge lies at 30-40/100 of the anterior segment. The tribocytic organ $494-855 \times 399-494 \mu$, is longitudinally elliptical and its anterior edge is located at 44-54/100 of the same segment. The ratio of the length of the anterior segment to that of the tribocytic organ is 2-2.69. A feeble mass representing the proteolytic gland is noticed at the base of the tribocytic organ. The pharynx measures $100-115 \times 105-120 \mu$ and is followed by the oesophagus which measures $30-40 \mu$ in length. The intestinal caeca, $30-40 \mu$ in diameter, terminate a little in front of posterior extremity.

The gonads lie in the first half of the posterior segment. The anterior testis, $222-286 \times 570-760 \mu$, is claviform and presents a strong amphitexy. The posterior testis, $228-323 \times 684-893 \mu$ in size, is unlobed, bilobed or exceptionally trilobed and its posterior edge lies at 40-48/100 of the second segment. The seminal vesicle is post-testicular. The ovary, $133-171 \times 361-513 \mu$, is pre-testicular, median to submedian, reniform in outline and its anterior edge lies at 0-6/100 of the same segment. The ascending limb of the uterus extends up to or little beyond the intersegmental constriction. Mehlis' gland and vitelline reservoir are intertesticular. The vitellaria commence at the level mid between the acetabulum and the intestinal fork or of the acetabulum to that of the anterior edge of the bursa copulatrix or a little in front of the ends of the intestinal caeca. Laurer's canal is present and opens dorsally. Anterior edge of the bursa copulatrix lies at 54-56/100 of the posterior segment. The hermaphroditic duct opens directly into the genital atrium. The genital pore is terminal or subterminal. The eggs are oval and $90-100 \times 55-60 \mu$ in size.

Host. *Pseudogyps bengalensis* (Gmelin).

Location. Small intestine.

Locality. Kulu Valley (Himachal Pradesh) India.

Discussion: The new species *Neodiplostomum* (*Neodiplostomum*) *kuluensis* stands apart from all the known species of the subgenus *Neodiplostomum* Railliet, 1919 in the position of the posterior testis except *N. (N.) tytense* Patwardhan, 1935; *N. (N.) spathoides* Dubois, 1937; *N. (N.) berghaani*, Bisseru, 1956 and *N. (N.) toruligenitale* Dubois, 1964. In the new species, the posterior testis lies within the first half of the posterior segment and its posterior edge lies at 40-48/100 of the second segment, whereas in all other species the entire posterior testis does not lie within the first half of the posterior segment and its posterior edge is situated behind the first half of the posterior segment.

Neodiplostomum (*Neodiplostomum*) *kuluensis* n. sp. differs from *N. (N.) spathoides* and *N. (N.) toruligenitale* in the shape, size of the anterior segment and the extent of vitellaria. In the new fluke, the length of the anterior segment is nearly equal to that of the posterior segment, largely oval and its vitellaria extending posteriorly up to the anterior level of the bursa copulatrix or a little in front of the caecal termination, whereas in the latter species, the anterior segment is longer in relation to the length of the posterior segment, elongated and spatuliform; the vitellaria extend up to posterior extremity of the body. The new species also differs from *N. (N.) tytense* in the distribution of vitellaria and the curvature of the anterior segment. In the new species, the vitellaria are more or less uniformly distributed in the body and the lateral margins of the anterior segment are distinctly incurved ventrally whereas in *N. (N.) tytense*, the vitellaria in the posterior segment are scanty (mainly confining ventrolaterally) and extending up to the ends of the caeca and the lateral margins of the anterior segment do not seem to be incurved ventrally.

The new species approaches *N. (N.) berghaani* Bisseru, 1956 in the shape of the body, segmental ratio, anterior extent of vitellaria and in the position of gonads but again it deviates from it (*Neodiplostomum* (*Neodiplostomum*) *berghaani*) in its host, geographical distribution, width of the acetabulum, sha-

pe of the tribocytic organ and in the length of the body. *Neodiplostomum* (*Neodiplostomum*) *kuluensis* n. sp. has been recovered from *Pseudogyps bengalensis* (Gmelin) at the height of 6,000 ft in Kulu Valley (India); its acetabulum measures $80-105 \times 130-195 \mu$; tribocytic organ is elliptical and the body is 2.56-3.72 mm in length. *N. (N.) berghaani* Bisseru, on the other hand had been reported from *Terathopius ecaudatus* (Daud.) in Zambia; its acetabulum measures $50 \times 65 \mu$; tribocytic organ is circular and the body is 1.43 mm in maximum length.

In view of the above differences *Neodiplostomum* (*Neodiplostomum*) *kuluensis* has been considered as a new species and named after the place of its host.

***Neodiplostomum* (*Neodiplostomum*) *reflexum* Chandler et Rausch, 1947**

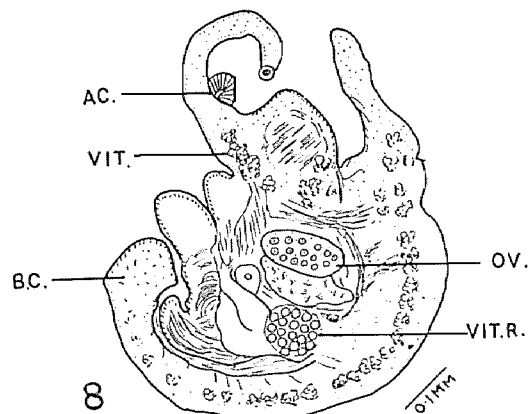
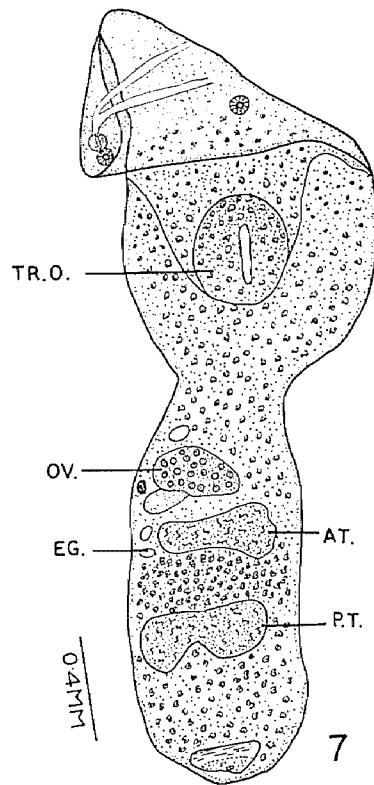
Syn. *Neodiplostomum delicatum* Chandler et Rausch, 1947

(Figs. 7-8)

Nine specimens of *Neodiplostomum* (*Neodiplostomum*) *reflexum* Chandler et Rausch, 1947 were recovered from a Shikra, *Accipiter badius* (Gmelin) at Chandigarh in India.

Shape and size: body, 1.97-3.72 mm long and is divided into anterior and posterior segments; anterior segment, spatuliform, $1.29-2.09 \times 0.74-1.27$ mm, its entire lateral margins are spinose and incurved ventrally; posterior segment, $0.68-1.63 \times 0.32-0.89$ mm and subcylindrical in outline. Ratio of the length of the posterior segment to that of the anterior: 0.45-0.88. Suckers: oral, terminal, $40.80 \times 50.82 \mu$; acetabulum, $55-115 \times 55-110 \mu$ and its anterior edge lies at 43-52/100 of the anterior segment. Tribocytic organ: $200-627 \times 175-570 \mu$; longitudinally elliptical and its anterior edge lies at 57-68/100 of the same segment. Gut: prepharynx, absent or measures up to 10μ in length; pharynx, $45-65 \times 37-70 \mu$; oesophagus, $25-30 \mu$ in length; caeca terminate near posterior extremity.

Reproductive systems: anterior testis, $160-300 \times 320-600 \mu$ and asymmetrical; posterior testis, roughly bilobed, $150-300 \times 400-618 \mu$ and its posterior edge lies at 62-69/100 of the posterior segment. Seminal vesicle is post-testicular. Ovary, oval to



Figs. 7-8.—*Neodiplostomum* (*Neodiplostomum*) *reflexum* Chandler et Rausch, 1947. 7, entire; 8, median s. s. showing different structures.

reniform, pretesticular, $100-250 \times 175-415 \mu$ and its anterior edge lies at 11-16/100 of the second segment. Mehlis' gland and vitelline reservoir are intertesticular. Vitellaria extend from the level of the acetabulum (42-51/100) to posterior extremity. The anterior edge of the bursa copulatrix lies at 77-89/100 of the second segment. The hermaphroditic duct is curved and opens at the genital pore which is subterminal. Eggs: oval, $85-105 \times 50-60 \mu$ in size.

Host. *Accipiter badius* (Gmelin).

Location. Small intestine

Locality. Chandigarh, India

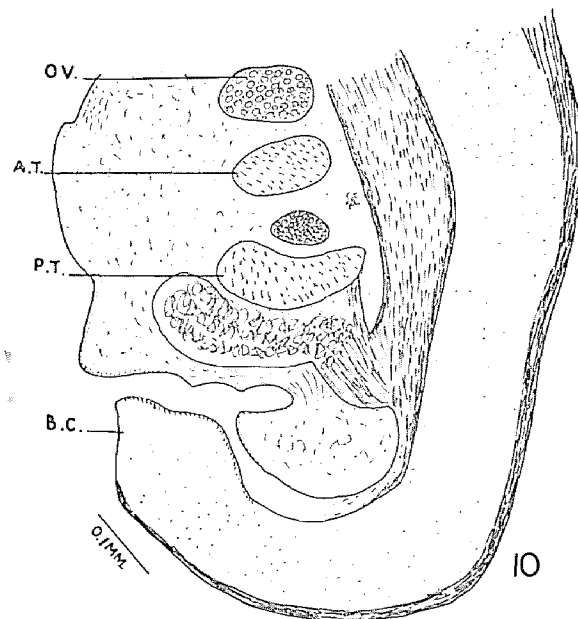
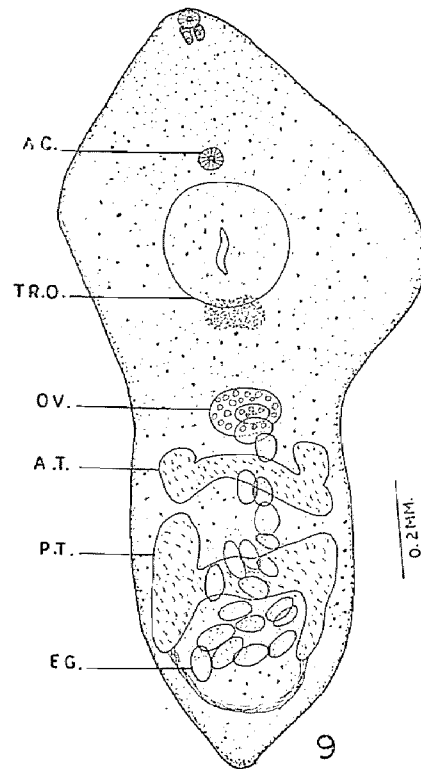
Remarks: *Neodiplostomum* (*Neodiplostomum*) *reflexum* Chandler et Rausch, 1947 is being reported for the first time in India and a new host, *Accipiter badius* (Gmelin) has also been found for it. Earlier this fluke had been recorded in United States of America and Canada in *Bubo virginianus* (Gm.); *Nyctes scandiaca* (L.), *Otus asio* (L.) and *Strix varia* Barton. Further the specimens studied by the authors in this country, have been seen with spines on their entire lateral margins and not confined only to the first half of the anterior segment as in the original description.

Neodiplostomum (*Neodiplostomum*) *mehrai* (Vidyardhi, 1938) Bhalerao, 1942

Syn. *Neodiplostomoides mehrii* Vidyardhi, 1938; *Neodiplostomum gumbudia* Gogate, 1940; *Neodiplostomum mehrii* (Vidyardhi, 1938) Bhalerao, 1942; *Neodiplostomoides milvii* Saxena, 1954; *Neodiplostomum milvi* (Saxena, 1954) Sudarikov et Skrjabin, 1960.

(Figs. 9-10)

Three specimens of *Neodiplostomum* (*Neodiplostomum*) *mehrai* (Vidyardhi, 1938) Bhalerao, 1942 were recovered from the small intestine of a Pariah Kite, *Milvus migrans* (Boddaert) examined at Simla (Himachal Pradesh) India.



Figs. 9-10.—*Neodiplostomum* (*Neodiplostomum*) *mehrai* (Vidyarthi, 1938) Bhalerao, 1942. 9, entire; 10, a portion of s. s. showing the gonads and the bursa copulatrix.

Shape and size: Body, 1.67-1.71 mm in length, is divided into anterior and posterior segments by a feeble lateral constriction; anterior segment, $0.85 \times 0.68-0.76$ mm; posterior segment, $0.81-0.85 \times 0.43-0.49$ mm. Ratio of the length of the posterior segment to that of the anterior: nearly 1. Suckers: oral, $40-60 \times 55-90 \mu$, terminal; acetabulum, $55-70 \times 55-70 \mu$ and its anterior edge lies at 37/100 of the anterior segment. Tribocytic organ: $250 \times 225 \mu$, possesses a median longitudinal slit. Proteolytic gland, a small mass, situated at the base of the tribocytic organ. Gut: prepharynx absent; pharynx, $45-60 \times 55-70 \mu$.

Reproductive systems: anterior testis, claviform, $200 \times 395 \mu$; posterior testis, winding, H-shaped, $315 \times 380 \mu$ and its posterior edge lies at 75/100 of the posterior segment. Seminal vesicle, post-testicular. Ovary, $145 \times 160 \mu$, pre-testicular, median and oval in outline. Vitelline reservoir is intertesticular. Vitellaria extend from the level a little behind the pharynx to a little in front of posterior extremity. Genital bulb is absent. Hermaphroditic duct opens directly into the genital atrium. Genital pore is terminal or subterminal.

Eggs: thick-shelled, oval, $90-95 \times 50-60 \mu$ in size.

Host. *Milvus migrans* (Boddaert).

Location. Small intestine.

Locality. Simla (Himachal Pradesh) India.

Remarks: In the present specimen of *Neodiplostomum* (*Neodiplostomum*) *mehrai* (Vidyarthi, 1938) Bhalerao, 1942; the genital pore may be terminal also instead of subterminal only, as mentioned by the previous workers. The geographical distribution of this fluke extends to Simla hills. Earlier it had been reported from Allahabad and Pilibhit. The genital bulb is absent.

Neodiplostomum (*Neodiplostomum*) *canaliculatum* (Nicoll, 1914) Dubois, 1937

Syn. *Hemistoma spathula* Stiles and Hasall, 1894; *Hemistomum canaliculatum* Nicoll, 1914; *Hemistomum cochleare* Krause, 1914 and *Neodiplostomum cochleare* (Krause, 1914) Dubois, 1932.

(Fig. 11)

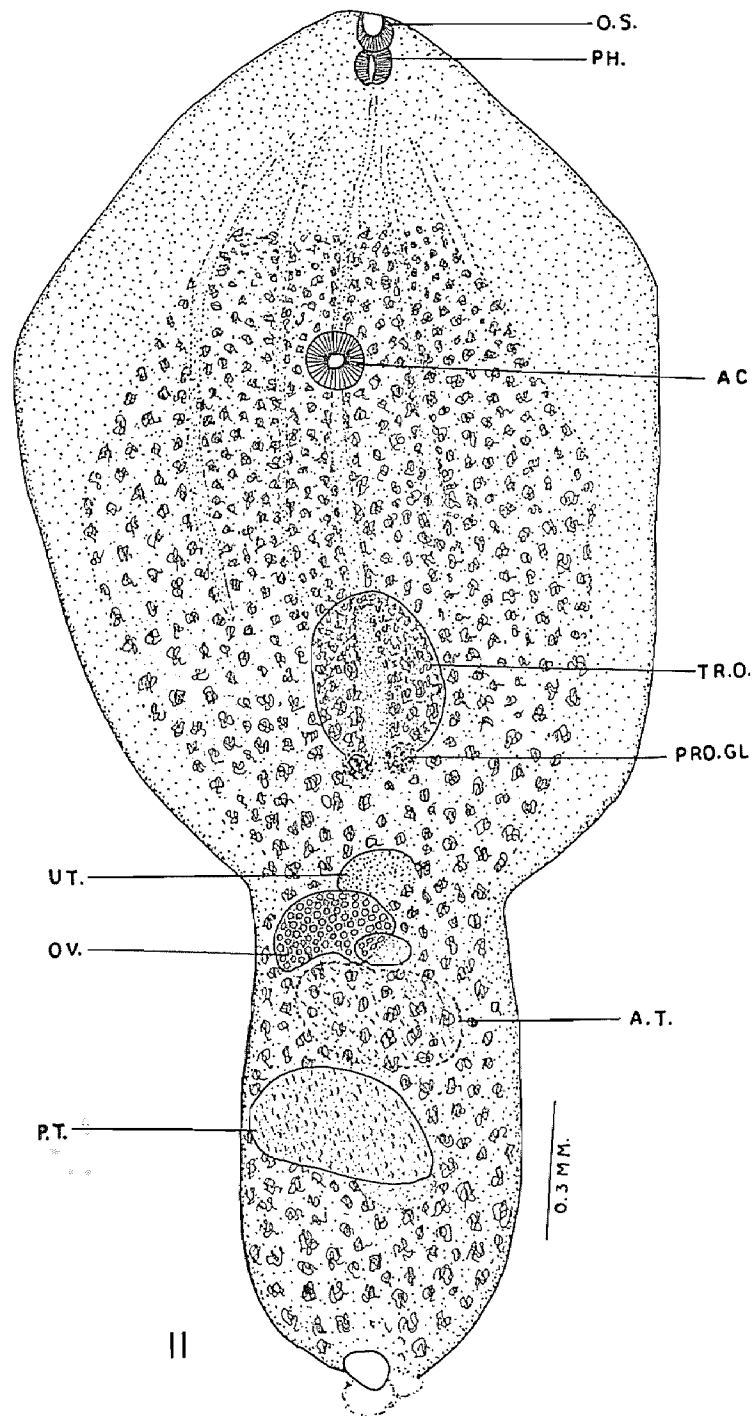


Fig. 11.—*Neodiplostomum* (*Neodiplostomum*) *canaliculatum* (Nicoll, 1914) Dubois, 1937. II, a whole mount preparation

As many as one dozen specimens (including 5 juvenile ones) of *Neodiplostomum* (*Neodiplostomum*) *canaliculatum* (Nicoll, 1914) Dubois, 1937 were recovered from the small intestine of the Indian Great Horned Owl, *Bubo bubo bengalensis* Franklin, captured in the outskirts of the Panjab University enclave, Chandigarh, India.

Shape and size: body, 1.63-3.02 mm long, is divided into anterior and posterior segments; anterior segment, 1.14-1.80 × 0.64-1.17 mm, oval, posterior segment, relatively narrow, 0.49-1.21 × 0.26-0.62 mm, subcylindrical. Ratio of the length of the posterior segment to that of the anterior: 0.43-0.67. Suckers: oral, terminal, 50-65 × 55-75 μ ; acetabulum, 80-105 × 80-110 μ and its anterior edge lies at 37-50/100 of the anterior segment. Tribocytic organ: 175-300 × 175-290 μ , circular to longitudinally elliptical and its anterior edge lies at 61-70/100 of the same segment. Ratio of the length of the anterior segment to that of the tribocytic organ is 4-5.5. Proteolytic gland: feeble mass, at the base of the tribocytic organ. Gut: prepharynx absent; pharynx, 50-80 × 50-70 μ ; oesophagus, up to 75 μ in length.

Reproductive systems: anterior testis, 130-170 × 165-275 μ , oval posterior testis, 130-225 × 230-400 μ , oval to roughly bilobed and its posterior edge lies at 51-59/100 of the second segment. Seminal vesicle, post-testicular. Ovary, 60-200 × 150-300 μ , oval, intersegmental or lies in the beginning of posterior segment. Uterus: extends upto 100 μ in the anterior segment behind the tribocytic organ. Vitelline reservoir is intertesticular. Vitellaria extend from the level, or little in front of the acetabulum (24-29/100) up to posterior extremity of the fluke. Anterior edge of the bursa copulatrix lies at 61-62/100 of the second segment. Hermaphroditic duct opens directly into the genital atrium. Genital pore is terminal. Eggs: oval, 90-95 × 65-70 μ in size.

Host. *Bubo bubo bengalensis* Franklin

Location. Small intestine.

Locality. Chandigarh, India.

Remarks: *N. (N.) canaliculatum* (Nicoll, 1914) Dubois, 1937 is being reported for the first time in India from a new host,

Bubo bubo bengalensis Franklin. Earlier it had been recorded in Egypto-Sudan, delta of Volga and Ukraine from *Bubo bubo ascalaphus* Sav. and *Asio flammeus* (Pont.) Its uterus has been observed extending up to $100\ \mu$ in the anterior segment behind the tribocytic organ.

Neodiplostomum (*Neodiplostomum*) *spathoides* Dubois, 1937

Syn. *Diplostomum spathula* Brandes, 1888; *Hemistomum spathula* Krause, 1914; *Neodiplostomum cochleare* Gohar, 1934; *Neodiplostomum* (*Neodiplostomum*) *prudhoei* Bissleru, 1956; *Neodiplostomum palumbarii* Furmaga, 1957; *Neodiplostomulum minor* Shevchenko, 1957 nec Dubini-na, 1950; *Neodiplostomulum* sp. No. 2 Odening, 1961 and *N. (N.) elani* Gupta, N. K., and Mehrotra, V., 1970.

(Fig. 12)

Two specimens of *Neodiplostomum* (*Neodiplostomum*) *spathoides* Dubois, 1937 were recovered from the small intestine of a Shikra, *Accipiter badius* (Gmelin) at Taradevi (Himachal Pradesh) India.

Shape and size: body, 1.74-2.45 mm in total length, is divided into two segments; anterior segment, $0.95\text{--}1.38 \times 0.60\text{--}0.70$ mm, spatuliform and its lateral margins are incurved ventrally; posterior segment, relatively short and narrow, $0.79\text{--}1.06$ or $0.47\text{--}0.57$ mm and cylindrical; ratio of the length of the posterior segment to that of the anterior: 0.77-0.84. Suckers: oral, terminal, $55\text{--}75 \times 60\text{--}70\ \mu$; acetabulum, $65\text{--}85 \times 65\text{--}105\ \mu$ and its anterior edge lies at $42/100$ of the anterior segment. Tribocytic organ: elliptical, $342\text{--}570 \times 342\text{--}418\ \mu$ its anterior edge lies at $52\text{--}54/100$ of the same segment. Ratio of the length of the anterior segment to that of the tribocytic organ is 2.43-2.77. Gut: prepharynx absent; pharynx, $60\text{--}70 \times 50\text{--}60\ \mu$; oesophagus up to $55\ \mu$.

Reproductive systems: anterior testis, claviform, $185 \times 250\ \mu$; posterior testis, bilobed, horse-shoe-shaped $150\text{--}200 \times 405\text{--}$

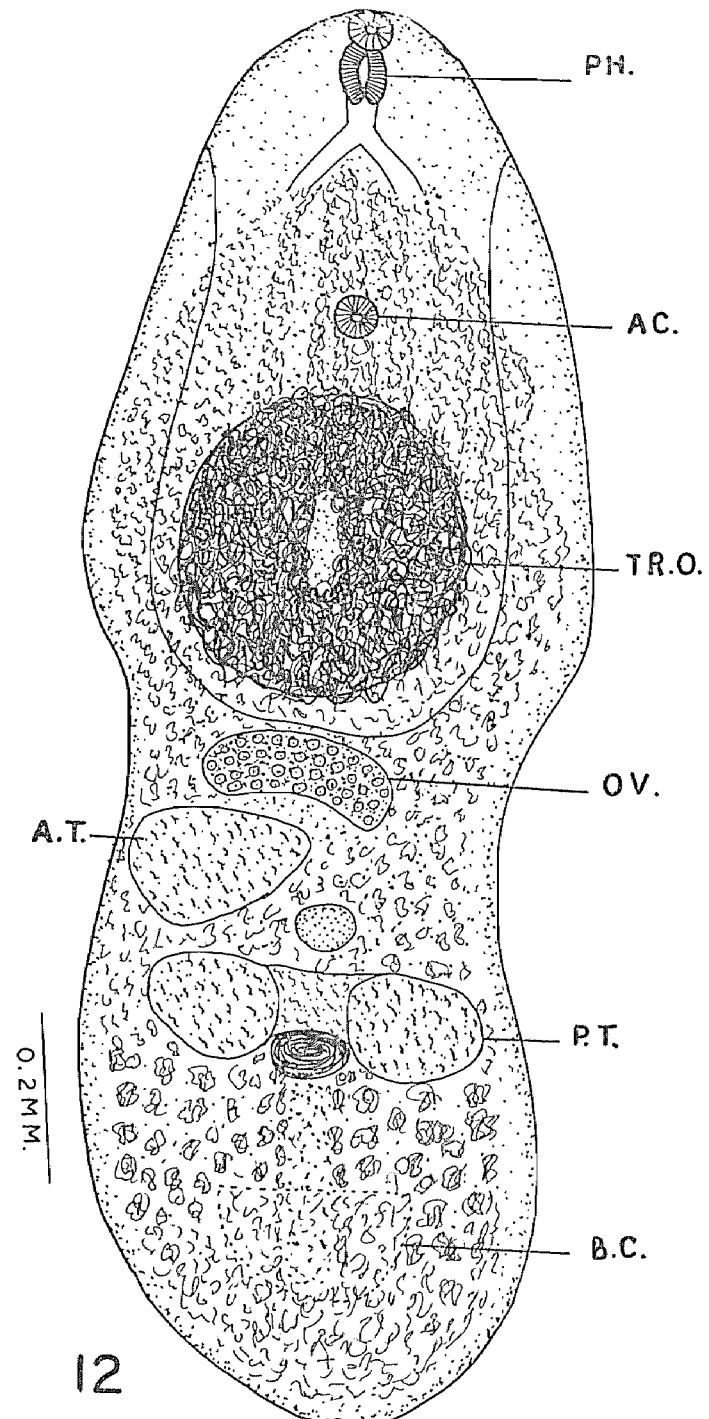


Fig. 12.—*Neodiplostomum* (*Neodiplostomum*) *spathoides* Dubois, 1937.
12, a whole mount preparation.

430 μ , and its posterior edge lies at 55-59/100 of the posterior segment. Seminal vesicle, post-testicular. Ovary, oval to reniform, 105-190 $\times$ 220-280 μ and its anterior edge lies at 0.3/100 of the posterior segment. Vitelline reservoir, intertesticular. Vitellaria extend from the level little behind the intestinal fork (22-26/100) to the posterior extremity. Anterior edge of the bursa copulatrix lies at 62-68/100 of the same segment. Eggs: oval, 60-80 $\times$ 65-95 μ in size.

Host. *Accipiter badius* (Gmelin)

Location. Small intestine

Locality. Taradevi (Himachal Pradesh) India.

Remarks: A new host, *Accipiter badius* (Gmelin) for *Neodiplostomum* (*Neodiplostomum*) *Spathoides* Dubois, 1937 is being reported. Earlier this species was reported from various hosts other than *Accipiter badius*.

***Neodiplostomum* (*Neodiplostomum*) *rufeni* Chatterji, 1942**

Syn. *Neodiplostomum refeni* Chatterji, 1942

(Figs. 13-14)

One specimen of Pale Harrier, *Circus macrourus* (Gmelin) examined in the department of Zoology, Panjab University, Chandigarh, was found infected by one dozen specimens of *Neodiplostomum* (*Neodiplostomum*) *rufeni* Chatterji, 1942.

Shape and size: body, 3.19-3.83 mm in length, is divided into anterior and posterior segments; anterior segment, 1.52-1.90 $\times$ 1.01-1.23 mm, oval and spinose along the lateral margins; posterior segment, 1.67-1.93 $\times$ 0.66-0.85 mm, cylindrical. Ratio of the length of the posterior segment to that of the anterior; 1.02-1.1. Suckers: oral, terminal, 65-75 $\times$ 75-85 μ ; acetabulum 90-110 $\times$ 100-115 μ and its anterior edge lies at 36-44/100 of the anterior segment. Tribocytic organ: 380-570 $\times$ 228-380 μ , longitudinally elliptical and its anterior edge lies at

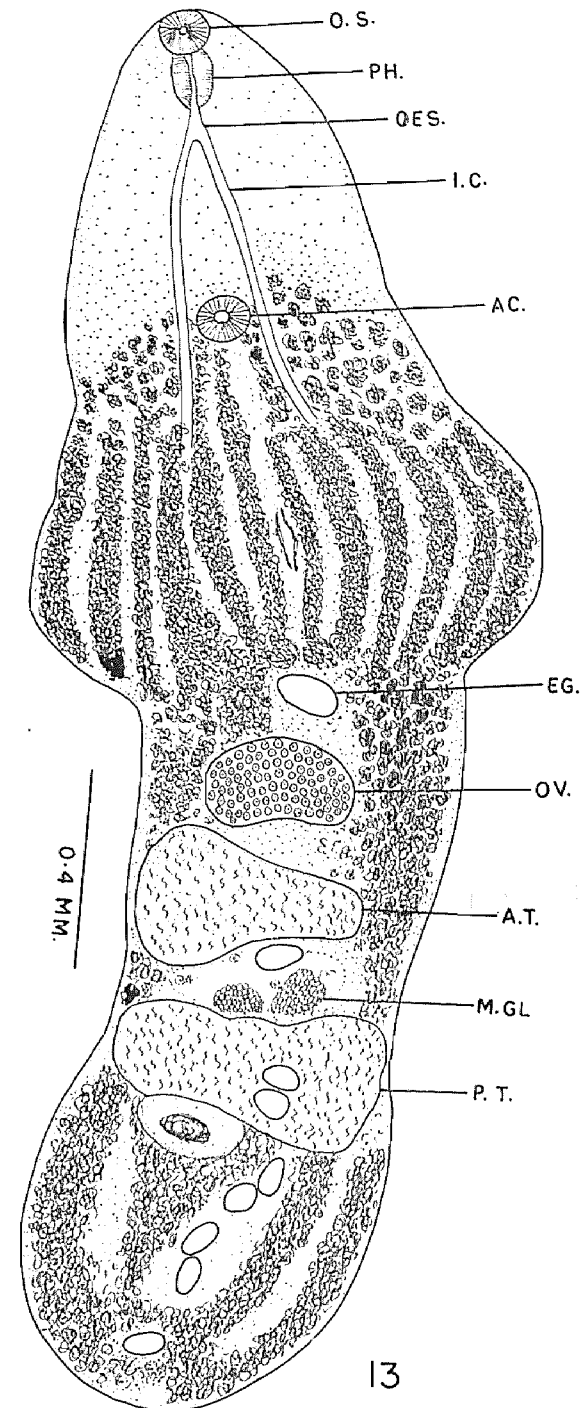


Fig. 13.—*Neodiplostomum* (*Neodiplostomum*) *rufeni* Chatterji, 1942.
13. entire.

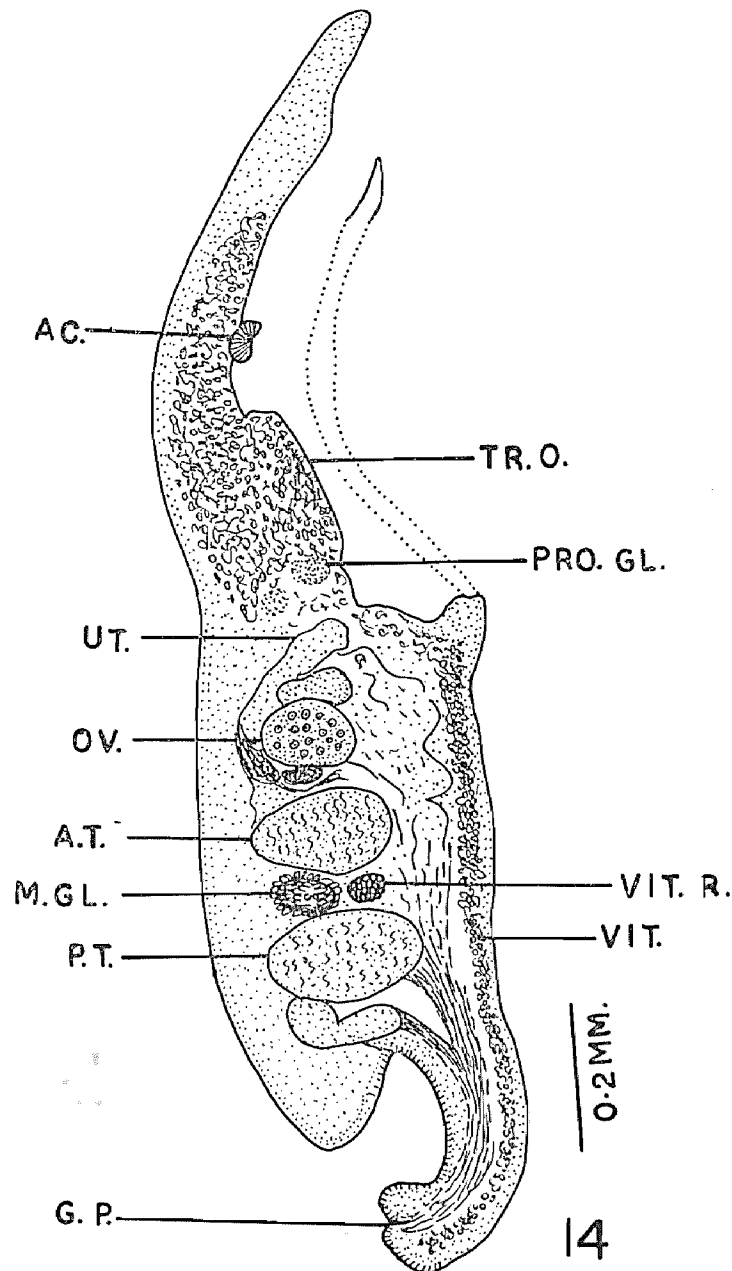


Fig. 14.—*Neodiplostomum* (*Neodiplostomum*) *rufeni* Chatterji, 1942.
14, a s. s. showing partly internal anatomy.

55-63/100 of the same segment. Proteolytic gland: a feeble mass lies at the base of the tribocytic organ. Gut: prepharynx absent; pharynx, $65-90 \times 70-90 \mu$; oesophagus, $60-100 \mu$; caeca terminate near posterior extremity.

Reproductive systems: anterior testis, $190-361 \times 437-627 \mu$, claviform; posterior testis, $190-342 \times 475-703 \mu$, bilobed, symmetrical and its posterior edge lies at 56-62/100 of posterior segment. Seminal vesicle, post-testicular, ovary, $190-285 \times 323-399 \mu$ and its anterior edge lies at 9-12/100 of the second segment. Mehlis' gland and vitelline reservoir are intertesticular. Vitellaria extend from the level of the acetabulum or little in front of it to posterior extremity of the body. The anterior edge of the bursa copulatrix lies at 68-69/100 of the second segment. Hermaphroditic duct opens subterminally at the genital pore.

Eggs: $70-105 \times 60-65 \mu$ in size.

Host: *Circus macrourus* (Gmelin).

Location: Small intestine

Locality: Chandigarh, India.

Remarks: A new host, *Circus macrourus* (Gmelin) is being reported for *N. (N.) rufeni* Chatterji, 1942. Earlier it was recorded from *Buteo rufinus* (Cretzsch.); *Accipiter badius* (Gm.); *Falco tinnunculus* L. (experimental).

Neodiplostomum (*Neodiplostomum*) *attenuatum attenuatum* (Linstow, 1906)
La Rue, 1926

Syn. *Holostomum spathula* Creplin, 1829; *Hemistomum spathula* (Creplin, 1829) Diesing, 1850; *Conchosoma spathula* (Creplin, 1829) Stoss, 1898; *Holostomum fallax* Mehlis (nomen. ineditum in Zool. Mus. Univ. Berlin); *Hemistomum attenuatum* Linstow, 1906; *H. cochlear* Dubois, 1928; *H. pseudattenuatum* Dubois, 1928; *Neodiplostomum attenuatum* (Linstow, 1906) Dubois, 1932; *N. pseudattenuatum* (Dubois, 1928) Dubois, 1932; *N. paraspithula* No-

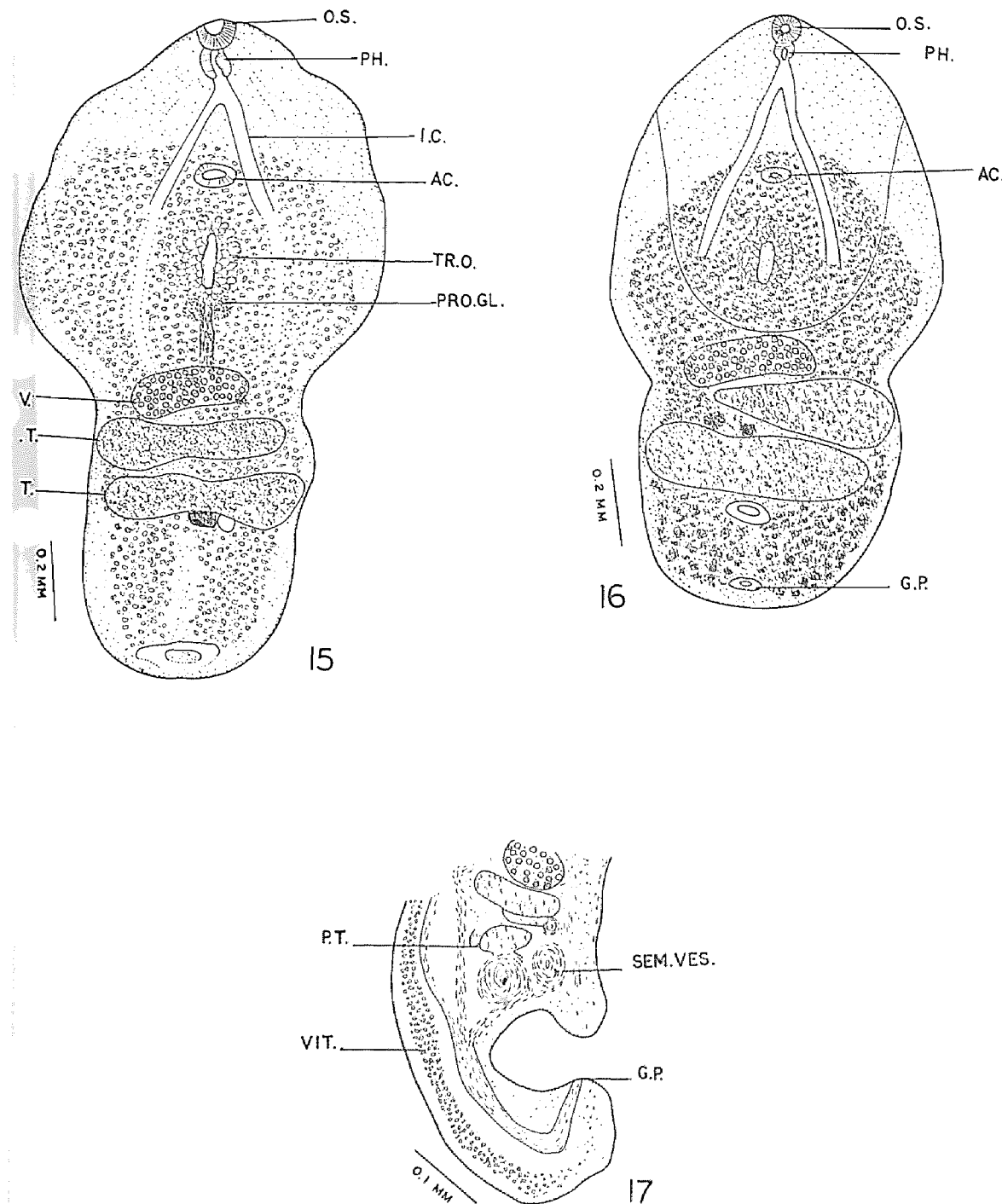
ble, 1936; *N. (N.) paraspithula* Noble, 1936; *N. inaequipartitum* Dubois, 1937; *N. krausei* Dubois, 1937; *N. (Conodiplostomum) Krausei* Dubois, 1937; *N. krausei ovatum* Dubois, 1938; *N. (N.) butenois* Dubois et Rausch, 1948; *N. butenonis* Dubois et Rausch, 1950; *N. (N.) attenuatum* (Linstow) Dubois, 1953; *N. (N.) pseudattenuatum* (Dubois) Sudarikov in Skrjabin, 1960; *Neodiplostomum* sp. 1 Odening, 1960 and *Neodiplostomum* sp. 1 Odening, 1961.

(Figs. 15-17)

Two specimens of Pariah Kite, *Milvus migrans* (Boddaert) were examined at an altitude of 4,000 ft above the sea - level i. e., at Tutikandi, Simla (Himachal Pradesh), India and as many as seventeen specimens of *Neodiplostomum* (*Neodiplostomum*) *attenuatum attenuatum* (Linstow, 1906) La Rue, 1926 were recovered from them.

Shape and size: body, 1.44-1.84 mm long, bisegmented by a constriction; anterior segment, 0.66-1.04 × 0.66-0.83 mm. Oval to cochleariform; posterior segment, 0.66-0.91 × 0.41-0.58 mm. ovoid to subcylindrical. Ratio of the length of the posterior segment to that of the anterior: 0.75-1.17. Suckers: oral, 60-85 × 65-81 μ , acetabulum, 60-80 × 60-105 μ and its anterior edge lies at 36-48/100 of the anterior segment. Tribocytic organ: elliptical to nearly circular with a median aperture, 200-300 × 125-209 μ and its anterior edge lies at 52-61/100 of the same segment. Ratio of the length of the anterior segment to that of the tribocytic organ is 3.42-3.95. Proteolytic gland: feeble mass at the base of the tribocytic organ. Gut: pharynx, 55-85 × 40-70 μ , globular to elliptical, strongly muscular; oesophagus, 20-45 μ long.

Reproductive systems: anterior testis, 130-200 × 215-513 μ and asymmetrical; posterior testis bilobed, 125-220 × 300-513 μ and its posterior edge lies at 51-60/100 of the second segment. Seminal vesicle, post-testicular. Ovary, oval to reniform, 100-135 × 215-310 μ , lies at the beginning of the posterior segment. Mehlis' gland and vitelline reservoir are intertesticular. Vitellaria extend from the level of the acetabulum or a little in front of it to that of the posterior extremity of the body forming two small masses in the region of the bursa copulatrix.



Figs. 15-17.—*Neodiplostomum* (*Neodiplostomum*) *attenuatum attenuatum* (Linstow, 1906) La Rue, 1926. 15, entire- acetabulum bigger than oral sucker; 16, another similar specimen showing acetabulum smaller than oral sucker; 17, a portion of s. s. showing vitellaria, the seminal vesicle and the genital pore,

Anterior edge of the bursa copulatrix lies at 67-80/100 of the posterior segment. Hermaphroditic duct opens directly into the genital atrium. Genital pore is subterminal. Eggs: 88-95 × 61-70 μ in size.

Host. *Milvus migrans* (Boddaert).

Location. Small intestine.

Locality. Tutikandi, Simla (Himachal Pradesh) India.

Remarks: *N. (N.) attenuatum attenuatum* (Linstow, 1906) La Rue, 1926 is being recorded for the first time in India. Earlier it had been reported from Holarctic region.

RESUMEN

El trabajo estudia tres nuevas especies y de otras seis ya conocidas del subgénero *Neodiplostomum* Railliet, 1919. Se discute la validez de las nuevas especies y se redescubren las especies conocidas, exponiéndose las variaciones detectadas. Con respecto a algunas especies se dan nuevos hospedadores y localidades.

ABBREVIATIONS

A.SEG.—anterior segment; A. T.—anterior testis; AC.—acetabulum; B.C.—bursa copulatrix; EG.—egg; G.P.—genital pore; H.D.—hermaphroditic duct; I.C.—intestinal caecum; L.CA.—Laurer's canal; M.GL.—Mehlis' gland; O.S.—oral sucker; OES.—oesophagus; OV.—ovary; P.SEG.—posterior segment; P.T.—posterior testis; PH.—pharynx; PRO.GL.—proteolytic gland; SEM.VES.—seminal vesicle; TR.O.—tribocytic organ; UT.—uterus; VIT.—vitellaria; VIT.R.—vitelline reservoir.

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