Taxonomic revision of the subfamily Schistorophinae (Nematoda: Acuarioidea) and its North American distribution in waders belonging to the families Charadriidae, Scolopacidae and Recurvirostridae (Aves).

by

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Abstract

The subfamily Schistorophinae Travassos, 1918 is revised. Five species of Schistorophus Railliet, 1916 are recognized: (1) S. longicornis (Hemprich and Ehrenberg in Schneider, 1866) with S. indica (Sanwal, 1952) and S. limosae Mawson, 1968 as its new synonyms; (2) S. skrjabini (Vassilkova, 1926); (3) S. cirripedesmi Rhzhikov and Khokhlova, 1964 with S. brygooi Petter, 1967 and S. lii Daiya, Bondarenko and Gubanov, 1971 as its new synonyms; (4) S. cornutus Sobolev, 1943a and (5) S. guschanskoi Ablasov and Chibichenko, 1962. Redescriptions of S. longicornis, S. skrjabini and S. cirripedesmi are provided.

Schistorophus bicuspis (Rudolphi, 1819), S. laciniatus (Molin, 1860b) Strongylus ambiguus Rudolphi, 1802 and Spiroptera sternae-hirundinis Deslongchamps, 1824 are regarded as species inquirendae. One species, S. acanthocephalica (Molin, 1860a) is considered a synonym of Paracuaria adunca (Creplin, 1846). Four species are transferred to the following genera: (1) Viktorocara capillaris (Molin, 1860c) n. comb. (2) Viktorocara aulieatina (Skrjabin, 1916) n. comb. (3) Stellocaronema spinulosus (Molin, 1860c) n. comb. and (4) Sciadiocara bihamata (Mueller, 1897) n. comb.

Four species of Viktorocara Guschanskaya, 1950a are considered valid. (1) V. capillaris is designated as the type species because the previous one, V. schejkini Guschanskaya, 1950a is considered its synonym. (2) V. limosae Daiya, 1966 with V. numenii Petter, 1967 and V. torea Clark, 1978 as its new synonyms; (3) V. garridoi Barus, 1968 and (4) V. charadrii Belopolskaya, 1953 with V. guschansckoi Leonov, 1958 as its new synonym. Viktorocara aulieatina is regarded as a species inquirenda. Lastly, V. acholonui Schmidt and Kuntz, 1972 is transferred to Ancyracanthopsis, thus becoming A. acholonui (Schmidt and Kuntz, 1972) n. comb. Viktorocara capillaris and V. limosae Daiya, 1966 are redescribed.

Schistogendra Chabaud and Rousselot, 1956 is regarded as a synonym of Quasithelazia Maplestone, 1932. This genus now consists of three species, namely, Quasithelazia tenuis Maplestone, 1932, the type species, Quasithelazia incisa (Chabaud and Rousselot, 1956) n. comb. and Quasithelazia caprona (Bain and Chabaud, 1965) n. comb.

Ancyracanthopsis Diesing, 1861 is emended resulting in the proposal of a new genus Molinacuaria n. gen. to accommodate three species. Ancyracanthopsis now includes the following: (1) A. coronata (Molin, 1860a) is designated as the type species since the previous one A. bilabiata (Molin, 1860a) is regarded here as a synonym. A redescription of A. coronata is provided. (2) A. petrovi Guschanskaya, 1950a and (3) A. buckleyi Ali, 1970. One

species, A. madagascariensis Kung, 1948 is transferred to Sobolevicephalus. Another species A. serrata(Wang, 1966) is transferred back to Sciadiocara to which it was originally assigned, thus becoming Sciadiocara serrata Wang, 1966. The new genus Molinacuaria is regarded as a member of the subfamily Seuratinae. Molinacuaria bendelli (Adams and Gibson, 1969) n. comb. is designated as the type species. The other species are M. acholonui (Schmidt and Kuntz, 1972) n. comb. and M. gallinulae (Wang, 1966) n. comb. Redescriptions of M. bendelli and M. acholonui are provided.

The following species of Sciadiocara Skrjabini, 1916 are recognized: (1) S. umbellifera (Molin, 186Øa); (2) S. bihamata with S. denticulata Gibson, 1972 as its new synonym; (3) S. legendrei Petter, 1967; (4) S. serrata Wang, 1966; (5) S. cucullatus (Wehr, 1934); (6) S. chabaudi Schmidt and Kinsella, 1972 and (7) S. rugosa Schmidt and Kinsella, 1972. Sciadiocara secunda Skrjabin, 1916 is considered a nomen nudum. All species except S. legendrei and S. serrata are redescribed.

Sobolevicephalus Parukhin, 1964 is emended and S. chalcyonis Parukhin, 1964, S. madagascariensis and S. lichtenfelsi n.sp. are recognized. S. chalcyonis is redescribed and S. lichtenfelsi n.sp. is described.

Keys to species of each genus are also provided.

Fourteen species of acuarioids were recovered from 14 of 24 species of waders examined. Cosmocephalus obvelatus (Creplin, 1825) was recovered from the esophagus, Cordonema longifuniculata (Sobolev, 1952), Skrjabinoclava horrida (Rudolphi, 1819) and Echinuria uncinata (Rudolphi, 1819) from the proventriculus and S. skrjabini, V. capillaris, V. limosae, S. umbellifera, S. bihamata, A. coronata, S. lichtenfelsi, Streptocara c. crassicauda (Creplin, 1829), Pectinospirura argentata Wehr, 1933 and Chevreuxia revoluta (Rudolphi, 1819) from under the gizzard lining of the birds.

Seven of the 14 acuarioids recovered are considered parasites of waders, meaning one or more wader species are the important hosts responsible for maintaining these parasites in the bird community. Of the remaining four acuarioids, two are mainly parasites of gulls and two of waterfowl.

The recovery of fourth-stage and moulting fourth-stage larvae of S. horrida in the semipalmated sandpipers and sanderlings indicate that transmission of this acuarioid occurs along the southeastern coast of the United States and that a marine invertebrate is the likely intermediate host. The distribution of V. capillaris, V. limosae, S. umbellifera and A. coronata in waders examined in this study suggests that the wintering ground of these hosts which is along the southern United States and northeastern

South America is the likely location for the transmission of these acuarioids.

The subfamily Schistorophinae is well represented in the waders in North America. This is indicated by the recovery of seven species belonging to five of the six genera of this subfamily. The taxonomic revision of this subfamily and the field data suggest that the waders may have played an important role in the evolution of this subfamily.

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Introduction

The superfamily Acuarioidea consists of the family Acuariidae Railliet, Henry and Sisoff, 1912 which is subdivided into Acuariinae Railliet, Henry and Sisoff, 1912, Seuratinae Chitwood and Wehr, 1932 and Schistorophinae Travassos, 1918. At present, Schistorophinae comprises six genera, namely Schistogendra Chabaud and Rousselot, 1956; Schistorophus Railliet, 1916, Sciadiocara Skrjabin, 1916, Viktorocara Guschanskaya, 1950a, Ancyracanthopsis Diesing, 1861 and Sobolevicephalus Parukhin, 1964 (see Chabaud, 1975 and Parukhin, 1978). Except for Schistogendra all the genera possess cephalic cuticular ornamentations whose morphologies are diagnostic for each genus.

The taxonomy at the generic level has been clarified substantially owing to the works of several authors, notably Inglis (1965), Adams and Gibson (1968), Gibson (1969) and Petter (1967). However, the status of individual species in each genus is unclear. This is predominately due to two factors. Firstly, a total of 12 species including the type species of Schistorophus, Sciadiocara and Ancyracanthopsis was described in the 1880's. Their descriptions were incomplete and no one to our knowledge had reexamined the type specimens to evaluate their validity. Secondly, the species in these genera are not host specific. Even though most of the species are commonly found in waders (Aves: Scolopacidae and Charadriidae), any one species can be found in numerous host species (see Barus et. al. 1978, Adams

and Gibson 1969 and Petter 1967). Despite this, authors such as Mawson (1968) and Smetanina and Alekseev(1968) described new species based on their occurrence in a new host.

Through the kind cooperation of museums in Vienna and Berlin, we were able to borrow the types of most of the species described prior to 1900. In addition, types of more recently described species were made available for study through the courtesy of museums throughout the world. In the present study, 24 species of waders from North America were examined for acuarioid nematodes. A total of 14 species of acuarioids was recovered. Seven of them were identified as members of the subfamily Schistorophinae, six belong to the subfamily Acuariinae and one to the subfamily Seuratinae. The subfamily Schistorophinae is revised based on the study of the type specimens and comparing them to new material. As a result, a new genus Molinacuaria and a new species Sobolevicephalus lichtenfelsi are proposed and 13 species are redescribed. Finally, some aspects of the epizootiology of the acaurioids in waders in North America are discussed. The new genus is named in honour of Dr. R. Molin and the new species in honour of Dr. J.R. Lichtenfels.

Materials and Methods

A total of 22 species of waders belonging to the families Charadriidae, Scolopacidae and Recurvirostridae was collected at the University of Manitoba Field Station, Delta Marsh (50 12'N, 98 12'W), Manitoba. Birds were caught in mist nets (2x2 cm mesh) and killed by compressing the thorax; others were shot (410 gauge, no. 6 shot).

The following birds were examined for worms: 21 semipalmated plovers (Charadrius semipalmatus Bonaparte), 12 killdeer (Charadrius vociferus L.), 1 ruddy turnstone (Arenaria interpres morinella (L.)), 9 short-billed dowitchers (Limnodromus griseus hendersoni (Gmelin)),4 long-billed dowitchers (Limnodromus scolopaceus (Say)), 1 red knot (Calidris canutus rufa (L.)), 27 marbled godwits (Limosa fedoa (L.)), 7 western willets (Catoptrophorus semipalmatus inornatus (Brewster)), 12 lesser yellowlegs (Tringa flavipes (Gmelin)), 20 greater yellowlegs (Tringa melanoleuca (Gmelin)), 1 solitary sandpiper (Tringa solitaria solitaria Wilson), 1 stilt sandpiper (Micropalama himantopus (Bonaparte)), 1 upland sandpiper (Bartramia longicauda (Bechstein)), 21 sanderlings (Calidris alba (Pallas)), 2 dunlins (Calidris alpina pacifica (L.)), 14 spotted sandpipers (Actitis macularia L.), 12 northern phalaropes (Phalaropus lobatus (L.)), 25 wilson phalaropes (Phalaropus tricolor (Vieillot)), 46 least sandpipers (Calidris minutilla (Vieillot)), 23 semipalmated sandpipers (Calidris pusilla (L.)) and 9 American avocets

(Recurvirostra americana Gmelin). Most birds were collected between May and June of 1982 and 1983; some were collected between August and September of 1983.

From August 17 to September 9, 1982 the following birds were examined: 13 least sandpipers, 1Ø semipalmated sandpipers, 3 spotted sandpipers, 5 sanderlings, 2 killdeers, 9 northern phalaropes, 7 short-billed dowitchers, 4 long-billed dowitchers (Limnodromus scolopaceus (Say)), 1 marbled godwit, 2 lesser yellowlegs and 2Ø greater yellowlegs (Tringa melanoleuca (Gmelin)).

All the birds were processed within one hour after collection. Individual birds were weighed and skinned. The skins were put in plastic bags and placed in the refrigerator.

Study skins were prepared within 1Ø days after freezing and were subsequently deposited in the following ornithological collections: (1) Department of Biology, Lakehead University, Thunder Bay, Ontario. (2) Department of Zoology, University of Guelph, Guelph, Ontario. (3) Department of Zoology, University of Manitoba, Winnipeg, Manitoba. (4) University of Manitoba Field Station, Delta, Manitoba. (5) and Manitoba Museum of Man and Nature, Winnipeg, Manitoba.

The carcass was opened, the bird sexed and the esophagus, proventriculus and gizzard removed and placed in large petri dishes containing Ø.9% saline. The organs were opened, the lining of the gizzard peeled and examined for worms using a dissecting scope. Worms recovered were placed in Ø.9% saline in small petri dishes. Worms used for detailed morphologic studies were fixed in hot 7Ø% glycerin - alcohol and cleared in glycerin. Drawings were made using a camera lucida. Worms for scanning electron microscopy were kept in Ø.9% saline in the refrigerator overnight, subsequently fixed in 2.5% Cacodylate buffered glutaral dehyde, washed in Ø.1M Cacodylate buffer and post fixed in 1% Osmium Tetroxide for 2h. They were washed in buffer and dehydrated using an alcohol series of (5Ø%, 75%, 8Ø%, 9Ø% and 1ØØ%), critical point dried with carbon dioxide and placed on metal stubs and coated with gold - palladium. These specimens were examined using a JSM 35C-JEOL Scanning Microscope at the University of Guelph and the Cambridge Stereoscan 6ØØ Scanning Electron Microscope at Lakehead University.

Through the kind cooperation of Dr. Al Bush, University of Brandon, Brandon, Manitoba additional waders were made available for examination. Those collected from Oaklake, Manitoba (49 42'N, 1ØØ 47'W) from May 19-27, 1982 included 1 killdeer, 1 pectoral sandpiper (Calidris melanotos (Vieillot)), 2 upland sandpipers, 2 marbled godwits and 6 western willets. Another 6, 4 and 5 western

willets collected from June 7-10, 1982 from Brooks (50 35'N, 111 53'W), Cowoki Lake (50 35'N, 111 42'W) and Foremost (49 29'N, 111 25'W), Alberta respectively, were also made available for study. These birds were kept in dry ice until they were examined. Nematodes recovered were fixed in 70% glycerin-alcohol and preserved in pure glycerin.

Waders collected by Mr. H.W.R. Copland and Mr. John Christie on behalf of the Manitoba Museum of Man and Nature, Winnipeg, Manitoba were also examined. These included 2 hudsonian godwits (Limosa haemastica (L.)), 1 pectoral sandpiper, 5 short-billed dowitchers and 8 least sandpipers collected on May 20-25, 1983 at Libau, Manitoba (50 16'N, 96 43'W). These birds were frozen until they were examined. No acuarioids were recovered.

Dr. Gilbert Grant of the North Carolina State Museum of Natural History, Raleigh, North Carolina kindly sent preserved gizzards of waders which were collected from Fort Fischer, North Carolina, United States. These included 5 marbled godwits, 2 short-billed dowitchers, 1 willet, 1 killdeer, 1 whimbrel (Numenius phaeopus hudsonicus(L.)) and 3 Gray plovers (Pluvialis squatarola(L.)). Only the gizzards preserved in formalin were made available for study. Nematodes recovered were fixed in 70% glycerin-alcohol and preserved in pure glycerin.

Finally, 12 northern phalaropes from Deer Island, New Brunswick, Canada were made available for examination, through the courtesy of Ms. Francine Mercier a graduate student at the University of Guelph, Guelph, Ontario. These birds were frozen until they were examined. No acuarioids were found.

Specimens were borrowed from the following museums for study: (1) National Museums of Canada Invertebrate Collection (NMCIC), (2) United States National Museum Helminthological Collection (USNMH), (3) Museum National d'Histoire Naturelle, France (MNHN), (4) Commonwealth Institute of Health, Australia (CIHA), (5) British Museum of Natural History (BM), (6) Zoologisches Museum der Humboldt - Universitat zu Berlin, East Germany (ZMB) and (7) Naturhistorisches Museum Wien, Austria (NMW). The specimens borrowed were as follows:

1. Schistorophus longicornis (Hemprich and Ehrenberg in Schneider, 1866)

Host: Numenius arquata

ZMB Coll. No. 797. 2 females. (types).

Coll. No. 8Ø1. 1 female. (type).

Coll. No. 813. 1 male, 4 females. (types).

Coll. No. 828. 4 females. (types).

Host: Numenius arabicus

ZMB Coll. No. 734. 5 females, 1Ø larvae. (types).

Coll. No. 741. 2 males, 11 females. (types).

Coll. No. 818. 5 larvae.

Host: Totanus glottis

ZMB Coll. No. 735. 3 female tails. (types).

Host: Tringa variabilis

ZMB Coll. No. 811. 1 larva.

2. Spiroptera sternae Rudolphi, 1819

Host: Sterna hirundo (type host).

ZMB Coll. No. 203. 1 immature female. (holotype).

3. Schistorophus bicuspis Rudolphi, 1819

Host: Tringa helvetica (type host).

ZMB Coll. No. 163. 1 male. (paratype).

4. Schistorophus bicuspis Rudolphi, 1819

Host: Vanellus malanogaster

ZMB Coll. No. 5596.

5. Spiroptera acanthocephalica Molin, 1860a

Host: Sterna caspia (type host).

NMW Coll. No. 6714. 2 females. (types).

6. Spiroptera spinulosus Molin, 1860c

Host: Glareola austriaca (type host).

NMW Coll. No. 6326. 1 female. (type).

7. Spiroptera capillaris Molin, 1860c

Host: Sterna hirundo (type).

NMW Coll. No. 6715. 2 females. (types).

8. Schistorophus cucullatus Wehr, 1934

Host: Rallus elegans (type host).

USNMH Coll. No. 6268. 1 male, 2 females. (paratypes).

9. Schistorophus brygooi Petter, 1967

Host: Numenius phaeopus (type host).

MNHN Coll. No. 616G. 1 male, 1 female. (paratypes).

10. Spiroptera bilabiata Molin, 1860a

Host: Eurypyga helias (type host).

NMW Coll. No. 6704. 1 female, 3 larvae. (types).

11. Spiroptera coronata Molin, 1860a

Host: Rallus cayennensis (type host).

NMW Coll. No. 7120. 1 anterior region, 1 mid-body

(types).

12. Ancyracanthopsis coronata Molin, 1860a

Host: Rallus elegans

USNMH Coll. No. 29839. 2 males, 3 females.

13. Ancyracanthopsis madagascariensis Kung, 1948

Host: Dryolimnas cuvieri (type host).

BM 2 females. (paratypes).

14. Ancyracanthopsis bendelli Adams and Gibson, 1969

Host: Dendragapus obscurus (type host).

NMCIC Coll. No. 1900-2294. 2 males. (paratypes).

Coll. No. 1900-2295. 2 females. (paratypes).

15. Ancyracanthopsis pileati (Smetanina and Alekseev, 1968)

Host: Halcyon coromanda major

USNMH Coll. No. 63291. 1 male, 2 females.

16 Spiroptera umbellifera Molin, 1860a

Host: Ibis rubra and Totanus melanoleucus

(type hosts).

NMW Coll. No. 6706. 3 females. (types).

17 Sciadiocara denticulata Gibson, 1972

Host: Actitis macularia (type host).

NMCIC Coll. No. 1900-2298. 1 male, 2 females. (paratypes).

18. Sciadiocara rugosa Schmidt and Kuntz, 1972

Host: Anas platyrhynchos (type host)

USNMH Coll. No. 71066. 1 male, 1 female. (paratypes)

19. Sciadiocara chabaudi Schmidt and Kuntz, 1972

Host: Gallinula chloropus cachinnans (type host)

USNMH Coll. No. 71067. 1 male, 1 female. (paratypes).

20. Sciadiocara legendrei Petter, 1967

Host: Numenius phaeopus (type host)

MNHN Coll. No. 616G. 1 female. (paratype).

21. Viktorocara acholonui Schmidt and Kuntz, 1972

Host: Alcippe b. brunea (type host).

USNMH Coll. No. 63290. 1 male. (holotype).

22. Viktorocara shejkini Guschanskaya, 1950a

Host: Pluvialis squatarola

USNMH Coll. No. 71999. 3 males, 5 females.

23. *Viktorocara numenii* Petter, 1967

Host: *Numenius phaeopus* (type host).

MNHN Coll. No. 616G. 1 female (paratype).

24. *Viktorocara limosae* Mawson, 1968

Host: *Limosa lapponica* (type host).

CIHA Coll. No. 1409. 6 males, 6 females, 2 larvae. (paratypes).

25. *Viktorocara garridoi* Barus, 1968

Host: *Quiscalus niger* (type host).

ZMB Coll. No. 6620a,b,c. 2 males, 1 female. (holotype and paratypes).

Results and Discussion

I. Revision of the genus Schistorophus

Schistorophus Railliet, 1916

Synonyms: Antennocara Vassilkova, 1926

Krusadia Sanwal, 1952

Diagnosis:

Acuarioidea; Acuariidae Railliet, Henry and Sisoff, 1912; Schistorophinae Travassos, 1918; Schistorophus Railliet, 1916. Cuticle with transverse striations. Oral opening laterally compressed, with two pairs of teeth present on lateral sides. Pseudolabia prominent with conical apices continuous with anterolateral wall of buccal capsule. Two cephalic papillae and amphid present at base of each pseudolabium. Anterolateral walls of buccal capsule with two pairs of teeth projecting into oral opening. Four sublabia originating between pseudolabia and anterolateral walls of buccal capsule and extending posteriorly beyond base of pseudolabia. Four ptilina in form of delicate horns with pointed tips beginning dorso-ventrally and surrounding sublabia (Fig. 26). Buccal capsule lined with transversely striated cuticle. Deirids small with pointed tips, located posterior to nerve ring. Esophagus divided into muscular and glandular portions. Caudal papillae of male, numerous.

Type Species: Schistorophus longicornis

(Hemprich and Ehrenberg in Schneider, 1866)

Railliet, 1916

Location: Under gizzard lining, mainly of waders.

(1) Schistorophus longicornis

(Hemprich and Ehrenberg in Schneider, 1866)

Railliet, 1916

(Tables 1 and 2; Figs. 1-8)

Synonyms: Tetracanthus longicornis

Hemprich and Ehrenberg, 1866

Ancyracanthus longicornis

(Hemprich and Ehrenberg) Schneider, 1866

Krusadia indica Sanwal, 1952

Schistorophus indica(Sanwal) Inglis, 1965

Schistorophus limosae Mawson, 1968

General:

Ptilina, ranging from 25 to 40um long. Buccal capsule long and lined with transversely striated cuticle. Esophagus divided equally into muscular and glandular portions.

Male:

Table 1. Measurements of Schistorophus spp.

	S. longicornis[a]	S. cirripedesmi[a]	S. skrjabini[b]	S. cornutus[c]	S. guschanskoi[c]
MALE					
N	1	1	12	-	-
Length, mm[1]	6.4	10.1	10.4(9.4-11.1)	6.0-6.5	9.0-10.0
Width	170	130	153(145-165)	215-306	140
Buccal capsule	90	42	68(60-80)	90	54-58
Nerve ring[2]	195	-	196(170-215)	-	-
Excretory pore[2]	245	-	275(250-305)	-	-
Deirids[2]	-	-	250	-	-
Muscular oesophagus	830	640	687(540-750)	815-900	-
Glandular oesophagus	1000	780	758(600-930)	-	-
Total oesophagus	1830	1420	1444(1150-1580)	-	1300
Left spicule	1250	540	490(400-600)	270-330	710-940
Right spicule	150	140	131(105-150)	120-169	120-126
Tail	110	100	138(125-150)	99	-
FEMALE					
N	7	4	10	-	-
Length, mm[1]	9.3(8.0-10.6)*	13.0-18.7	18.1(15.8-19.1)	9.2-9.6	12.8-19.1
Width	241(220-290)	170-255	255(220-280)	-	180-210
Buccal capsule	92(80-105)	55-75	76(65-95)	105	84-109
Nerve ring[2]	224(205-235)	195-220	223(194-250)	-	-
Excretory pore[2]	290(275-310)	320	317(300-370)	-	-
Deirids[2]	248(235-260)	265	291(254-312)	-	-
Muscular oesophagus	1122(990-1200)	860-1000	978(870-1170)	-	-
Glandular oesophagus	1319(1250-1400	660-1200	925(840-1000)	1360-1375	-
Total oesophagus	2441(2190-2700)	1520-2000	1903(1820-2170)	-	1100-1200
Vulva, mm[2]	5.8(5.2-6.2)	8.8-8.9	9.6(8.5-11.6)	5.7-5.9	6.9-7.1
Tail	94(90-100)	60-70	55(52-65)	175-180	-
Vagina vera length	46(40-65)	120	154(145-165)	-	-
Vagina uterina length	773(550-985)	480	105(65-160)	-	-
Eggs	-	-	36(32-39)x22(21-23)	-	41x21
Ptilina length	31(25-40)	81(50-125)	259(170-400)	60-75	220-290

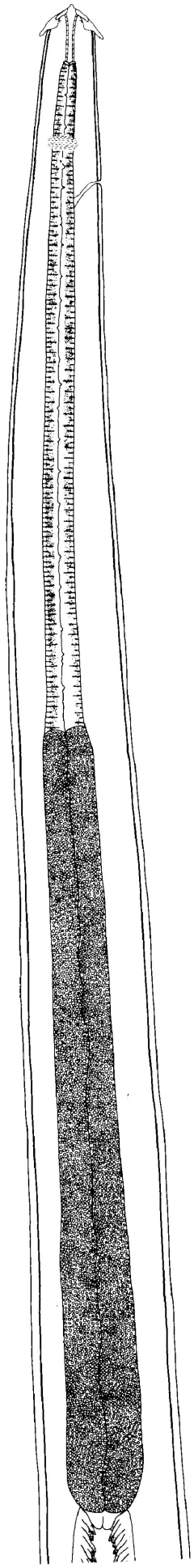
a. Measurements from museum specimens
b. Measurements from present study
c. Measurements from original description

[1] Measurements in micrometers, unless stated otherwise
[2] Distance to anterior end
* Mean with range in parentheses

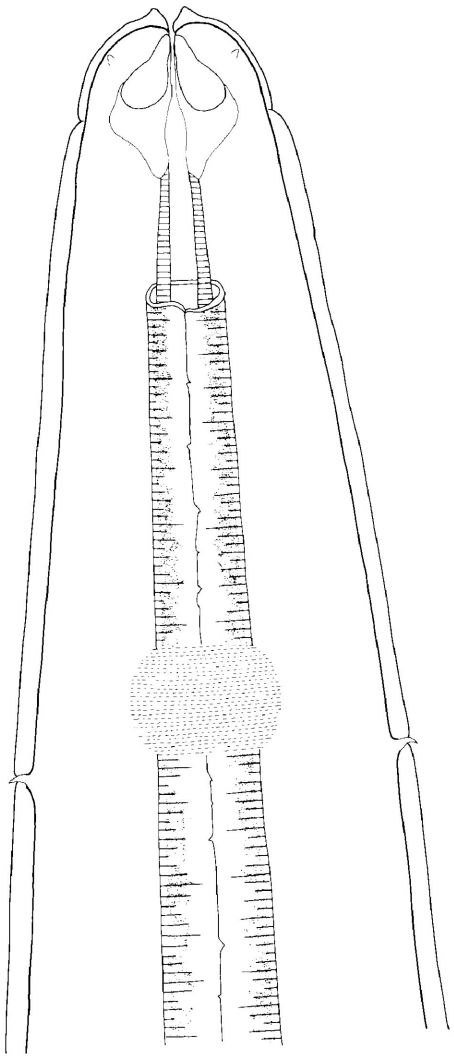
Table 2. Hosts and geographic distribution of *Schistorophus* spp.

Species	Hosts	Localities	Source
S. longicornis	*Numenius a. arquata*	Egypt	Hemp. & Ehrenb. in Schneider, 1866
	Tringa t. totanus	Puhtu, near Estonia	Jogis, 1963
	Capella g. gallinago	Tuva, central Siberia	Sonin and Larchenko, 1974
	Charadrius h. hiaticula	Murgab Valley, S. Soviet Union	Meredov and Golovkova, 1978
	Limosa lapponica baueri	Queensland, Australia	Mawson, 1968
	Caprimulgus i. indicus	Krusadia Is., India	Sanwal, 1952
S. cirripedesmi	*Charadrius semipalmatus*	Antigua	Clapham, 1945
	Catoptrophorus semipalmatus	"	"
	Himantopus mexicanus	"	"
	Numenius a. arquata	Egypt	Hemp. & Ehrenb. in Schneider, 1866
	Numenius p. phaeopus	Europe	Petter, 1967
	Tringa spp.	Chuvash and Tatar Reps., W. USSR	Skrjabin et. al. 1965
	T. t. totanus	Tuva, central Siberia	Sonin and Larchenko, 1974
	Arenaria i. interpres	Vrangelya Is. N. E. Siberia	Leonov and Shevtsova, 1970
	L. l. baueri	Kamchatka, E. Siberia	Daiya et. al., 1971
	N. a. orientalis	China	Li, 1934
	Charadrius leschenaulti	Vietnam	Rhizhikov and Khokhlova, 1964
	Larus argentatus	Yenisey R., C. Soviet Union	Sergeeva, 1969
S. skrjabini	*Catoptrophorus s. inornatus*	Manitoba and Alberta, Canada	Present study
	N. p. variegatus	N. E. Siberia	Guschanskaya and Krotov, 1952
	Numenius madagascariensis	Primorsk region, W. Soviet Union	Oshmarin, 1963
	Larus canus heinei	Kazakhstan, S. Soviet Union	Vassilkova, 1926
	Rissa brevirostris	N. E. Siberia	Guschanskaya and Krotov, 1952
	Rissa tridactyla	unknown	Barus et. al., 1978
	Stercorarius longicaudus	"	" " "
S. cornutus	*Xenus cinereus*	Gorkov region, W. Soviet Union	Sobolev, 1943a
	" "	River Ob, N.W. Soviet Union	Barus and Sonin, 1977
	" "	Yenisey R., C. Soviet Union	Bondarenko, 1969
S. gushanskoi	*T. t. totanus*	Kirghiz region, S. Soviet Union	Ablasov and Chibichenko, 1962
	" " "	Kazakhstan, S. Soviet Union	Gvozdev and Kasymzhanova, 1965
	T. nebularia	" " "	" "
	Charadrius asiaticus	" " "	" "

Figs. 1-4. Schistorophus longicornis. Fig. 1. Anterior region, female, lateral view. Fig. 2. Anterior extremity, female, dorsal view. Fig. 3. Caudal region, female, lateral view. Fig. 4. Caudal region, male, lateral view showing spicules and caudal papillae



1



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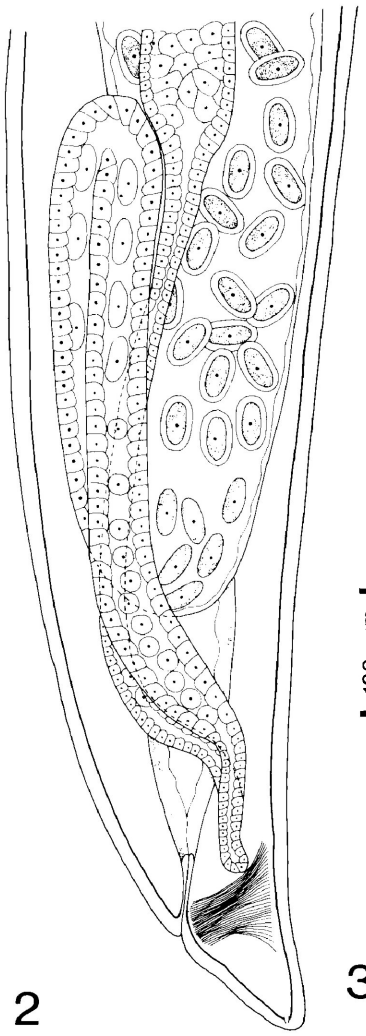


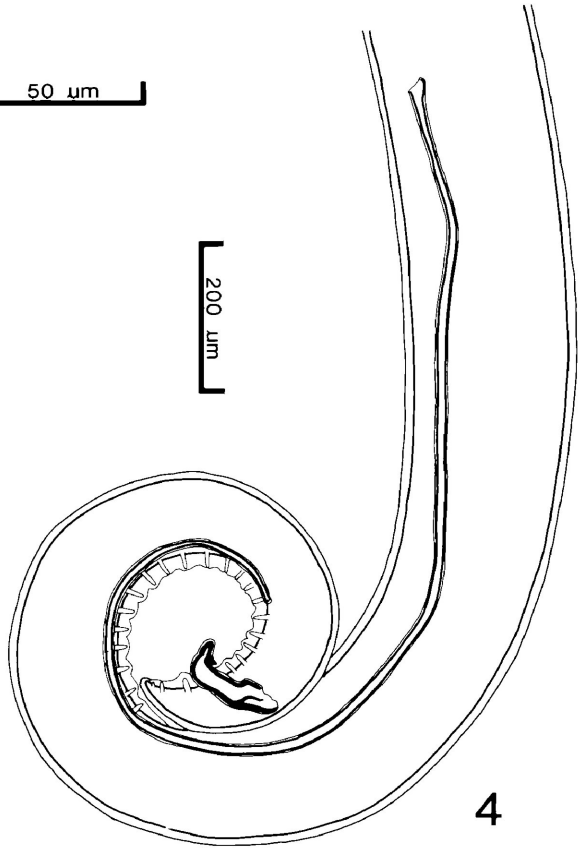
3

100 µm

50 µm

200 µm

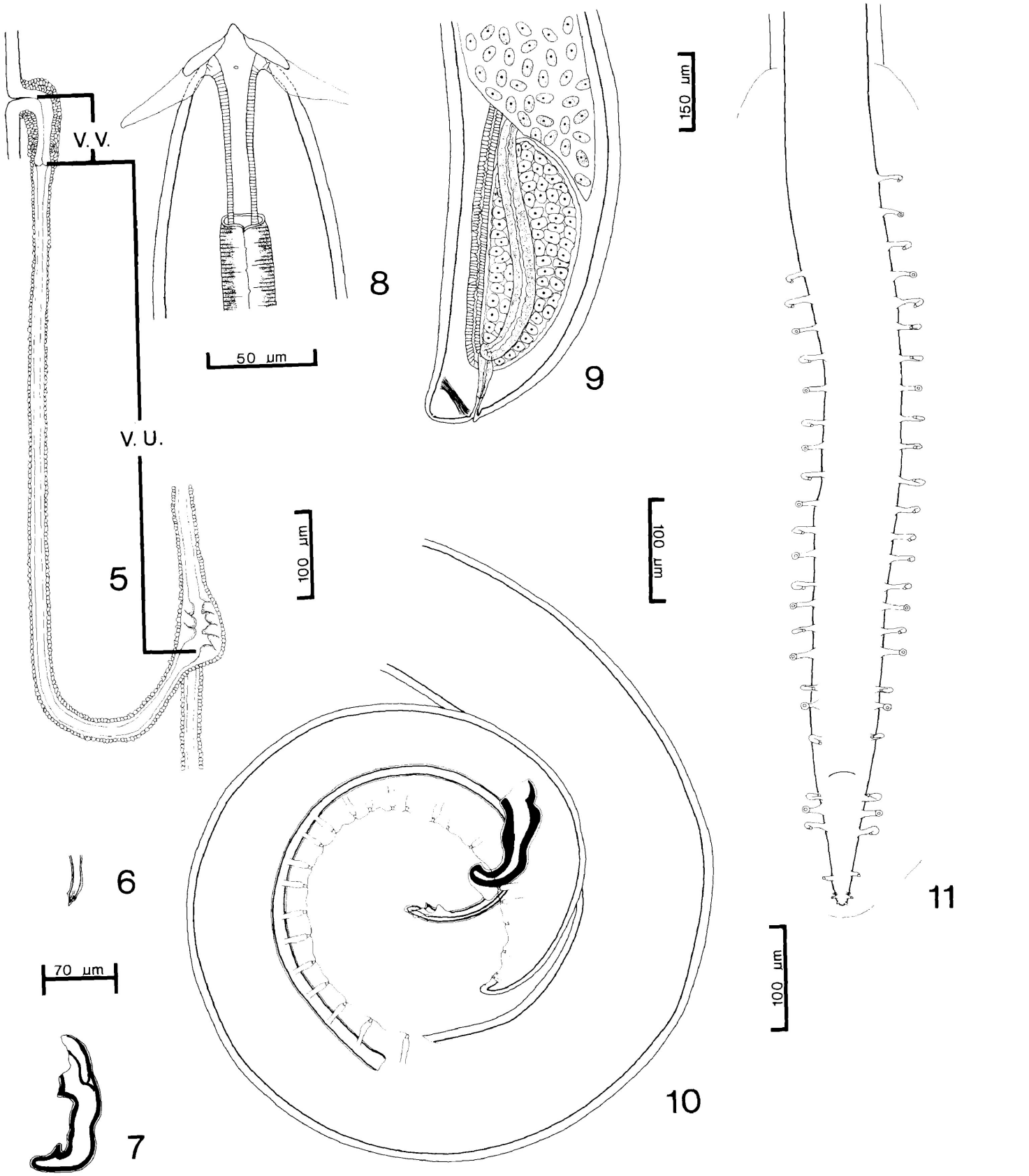
200 µm



4

Figs. 5-8. Schistorophus longicornis. Fig. 5. Vulva, vagina and uteri, lateral view. Fig. 6. Distal end of left spicule, lateral view. Fig. 7. Right spicule, lateral view. Fig.8. Anterior extremity, female, lateral view. Abbreviations: v.v. = vagina vera, v.u. = vagina uterina.

Figs. 9-11. Schistorophus skrjabini Fig. 9. Caudal region, female, lateral view. Fig. 10. Caudal region, male, laterial view showing the spicules and caudal papillae. Fig. 11. Caudal region, male, ventral view showing caudal papillae.


V. V.
V. U.
5
6
7
8
9
10
11
50 µm
100 µm
70 µm
150 µm
100 µm
100 µm

Caudal region tightly coiled. Caudal alae well developed, 20 pairs of preanal and four pairs of postanal pedunculated caudal papillae. Last pair of postanal papillae smaller than others. Spicules unequal and dissimilar. Left spicule long, slender with chisel-like distal end. Right spicule short, L-shaped with triangular process located dorsally near rounded distal end. Tail short with pair of phasmids located at its rounded tip.

Female:

Vulva located in posterior half of body. Vagina lined with cuticle and surrounded by thick muscle fibers. Vagina divided into vagina vera and vagina uterina, with former about one-thirteenth length of latter. Also, vagina vera turning 90 at mid-point. Didelphic, amphidelphic. Uteri convoluted and packed with larvated thick-shelled eggs. Tail short with rounded tip. Phasmids present.

Type host: Numenius sp. (L.). Scolopacidae.

Type specimens: ZMB Coll. No. 741
ZMB Coll. No. 743

Type locality: Egypt.

Comments:

Hemprich and Ehrenberg (in Schneider, 1866) described Ancyracanthus longicornis and listed Numenius a. arquata (L.), Tringa nebularia (= Totanus glottis) and Tringa variabilis as hosts of their new species. They reported that the anterior end of the worm had four cuticular wings located on its dorsal and ventral sides. In addition, the male was 5.Ø-1Ø.Ømm in length, had 2Ø preanal and 4 postanal pedunculated caudal papillae and unequal spicules. The right spicule was short and thick, the length of the left spicule was described as being twice the distance occupied by the 2Ø preanal papillae. The female was 8.Ø-2Ø.Ømm in length and the vulva located in the middle third of the body. A holotype was not designated.

The type material of this species contained in 9 bottles consisted of larvae and adult worms which belong to three distinct species. One bottle (Coll. No. 741) contained 8 female and 1 male whole specimens plus 3 females and 1 male without head ends. Numenius arabicus was listed as the host. All the whole specimens have 4 conical ptilina at their head ends indicating they are members of the genus Schistorophus. The lengths of the ptilina are identical in both the male and female specimens. The whole male specimen has a tightly coiled caudal region bearing 2Ø preanal and 4 postanal pedunculated caudal papillae. The length of space occupied by these papillae is about 6ØØum. The spicules are unequal. The right one is short, thick and has a sharp process near the distal end. The left spicule is long,

slender and 1250um in length. Since the left spicule length of this specimen is identical to that of S. longicornis (ie two times longer than the length of space occupied by the caudal papillae), it seems clear that Hemprich and Ehrenberg must have included this specimen in the original description. We herein, designate the intact male specimen in Coll. No. 741 as the lectotype of S. longicornis. The other specimens without the anterior ends have major dimensions similar to those of the whole specimens and they and the intact female worms are designated as paralectotypes.

Another bottle (Coll. No. 734) contained 9 larvae and 1 female adult worm which were collected from N. arabicus. This adult is indistinguishable from female S. longicornis and is, therefore, regarded as a member of this species.

Three female tails and a fragment of the mid-body of a worm were contained in the bottle (Coll. No. 735) from Tringa nebularia (Gunnerus) (= Totanus glottis). They are not members of S. longicornis.

The rest of the collection consists of the following specimens: 1 female, 1 female without head end (Coll. No. 797), 1 female (Coll. No. 801), 4 females, 1 male (Coll. No. 813) and 4 females (Coll. No. 828) from N.a. arquata (L.); 1 larva (Coll. No. 811) from Tringa variabilis; 5 larvae (Coll. No. 818) from N. arabicus. All these adult worms have ptilina which are 85-150um long. The left

spicule of the lone male is 500um long. In addition to these characters, other major dimensions of these worms are indistinguishable from those of S. cirripedesmi.

Sanwal (1952) proposed a new genus and species, Krusadia indica for 4 males and 2 females recovered from the intestine of a jungle nightjar (Caprimulgus i. indicus Latham) from Krusadia Island, South India. Inglis (1965) synonymized Krusadia with Schistorophus. The original description of K. indica is similar to that of S. longicornis. Specifically, the lengths of both spicules, the chisel-like distal end of the left spicule and the numbers of preanal and postanal pedunculated caudal papillae are similar in both species. On this basis, we regard S. indica as a synonym of S. longicornis.

An examination of the type of S. limosae Mawson, 1968 from Limosa lapponica baueri L. in South Australia, revealed that this species is identical to S. longicornis. The former is, therefore, regarded a synonym of the latter.

(2) Schistorophus skrjabini

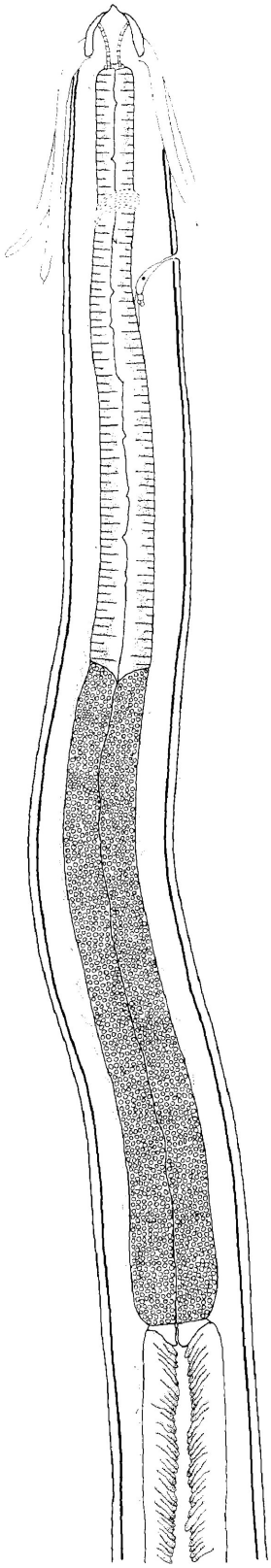
(Vassilkova, 1926) Guschanskaya, 1950b

(Tables 1 and 2; Figs. 9-15 and 26-28)

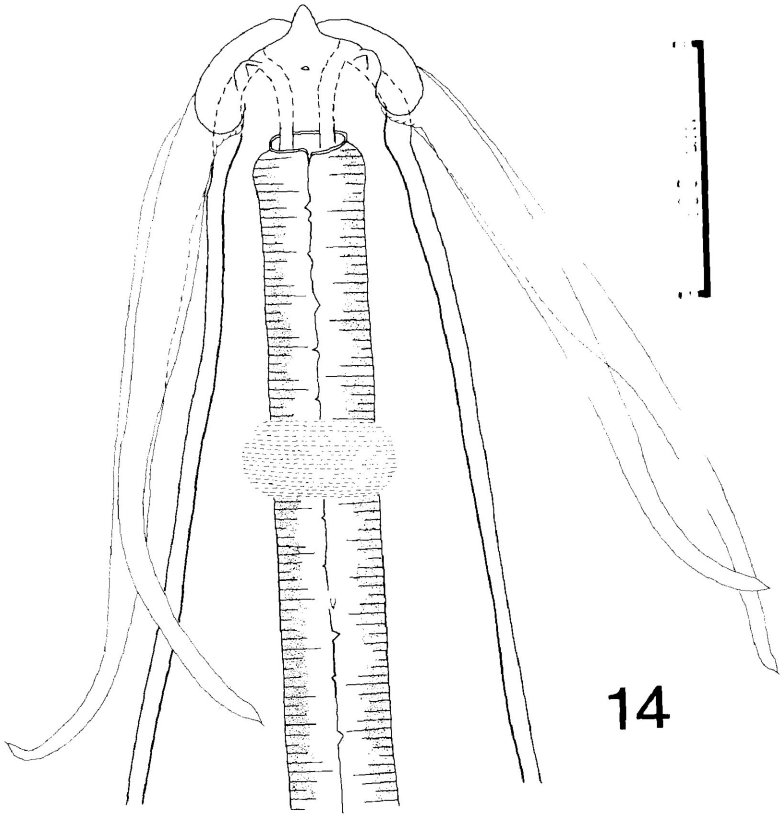
Synonym: Antennocara skrjabini Vassilkova, 1926

General:

Figs. 12-15. Schistorophus skrjabini Fig. 12. Anterior region, male, lateral view. Fig. 13. Vulva, vagina and uteri, lateral view. Fig. 14. Anterior extremity, female, lateral view. Fig. 15. Anterior extremity, female, dorsal view.



200 µm



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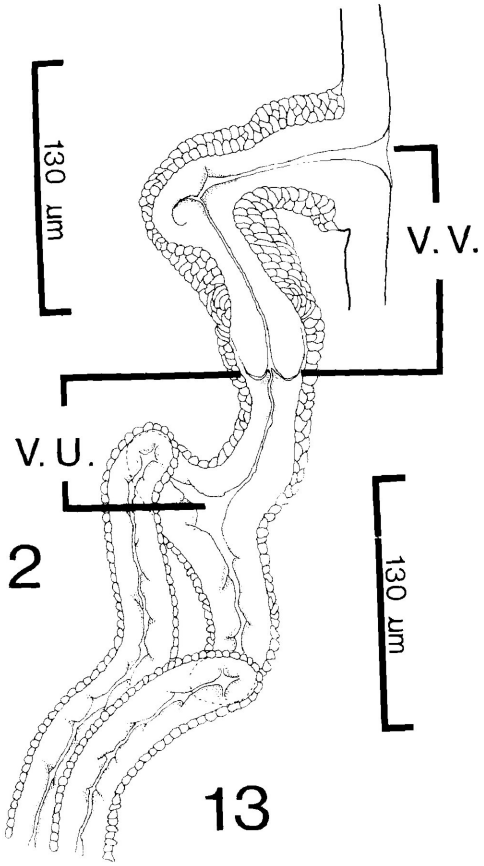


130 µm

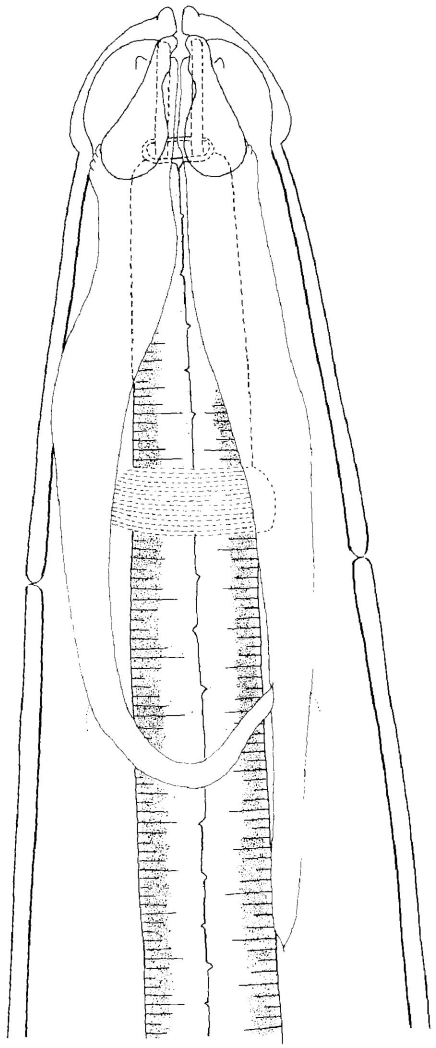
V.V.

V.U.

12

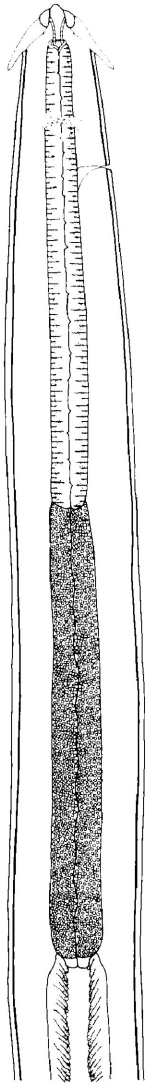
130 µm

13



15

Figs. 16-25. Schistorophus cirripedesmi Fig. 16. Anterior region, female, lateral view. Fig. 17. Caudal region, male, ventral view showing caudal papillae. Fig. 18. Vulva, vagina and uteri, lateral view. Fig. 19. distal end of left spicule, lateral view. Fig. 20. Distal end of left spicule, ventral view. Fig. 21. Caudal extremity, male, ventral view showing tail papillae. Fig. 22. Anterior extremity, female, dorsal view. Fig. 23. Anterior extremity, female, lateral view. Fig. 24. Caudal region, female, lateral view. Fig. 25. Caudal region, male, lateral view showing spicules and caudal papillae.



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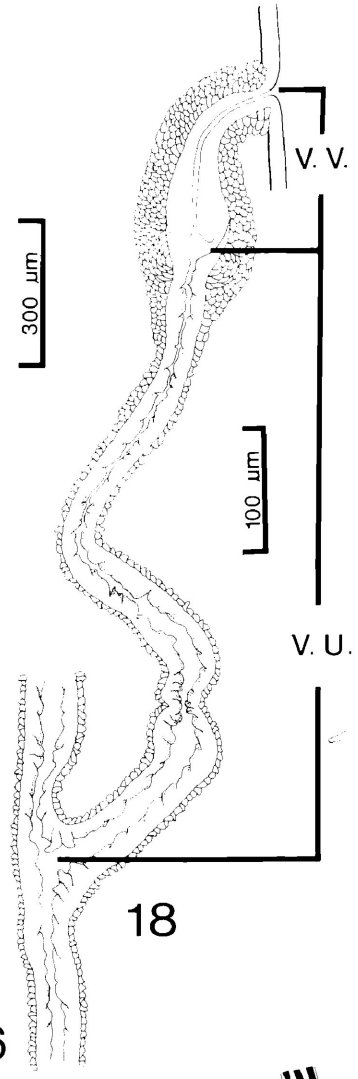

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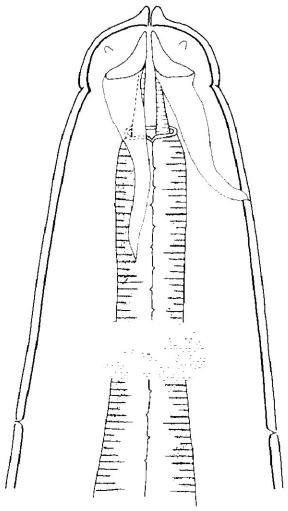

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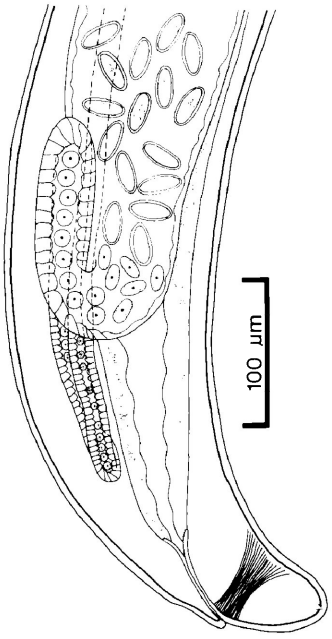

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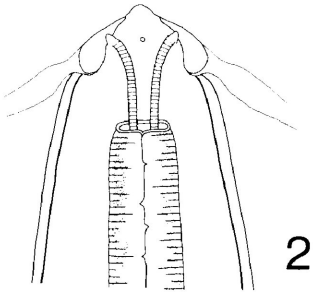

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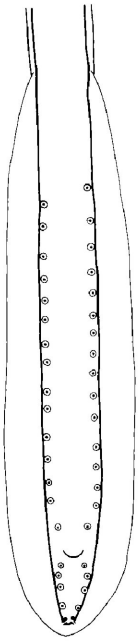

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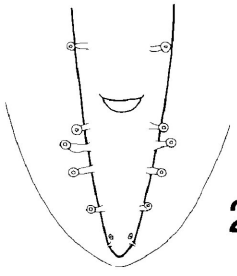

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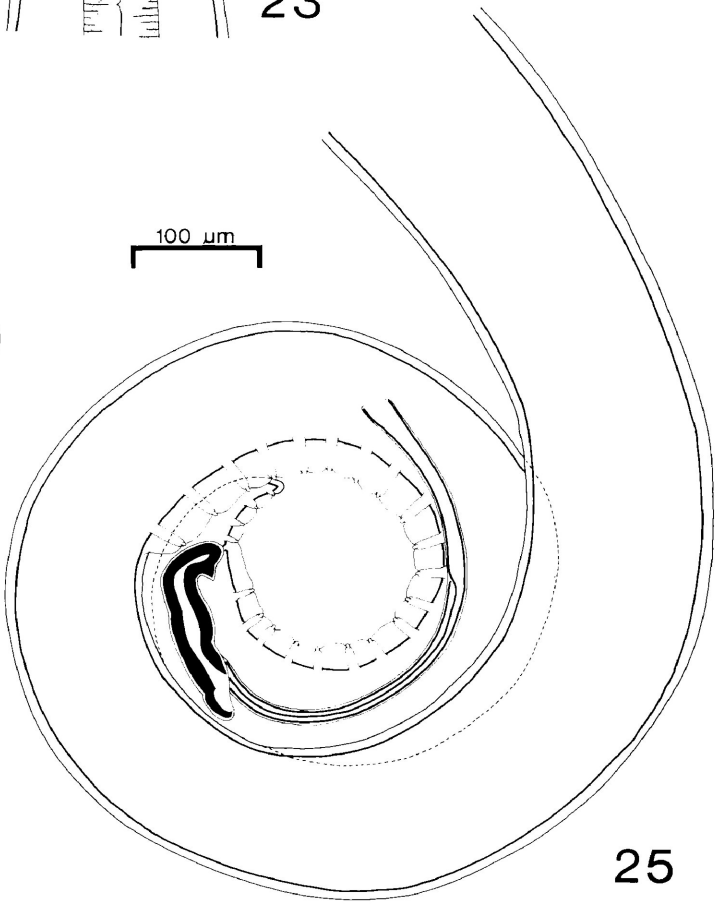
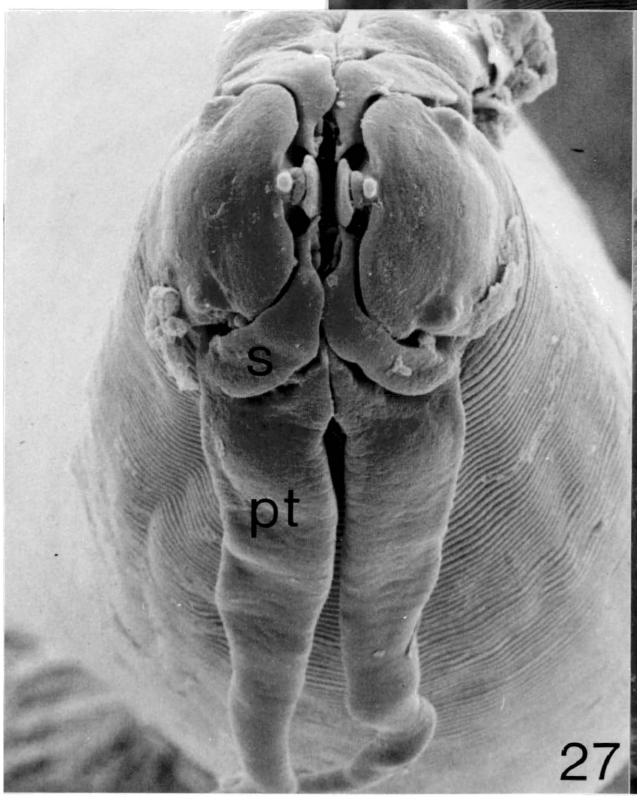


25

Figs. 26-28. Scanning micrographs of Schistorophus skrjabini Fig. 26. Anterior extremity, female, lateral view showing ptilina. Magnification: 330X. Fig. 27. Anterior extremity, male, en face view showing sublabia and ptilina. Magnification: 1200X Fig. 28. Anterior extremity, male, en face view showing pseudolabia and sublabia. Magnification: 2200X. Abbreviations: pt = ptilinum, s = sublabium, ps = pseudolabium.


pt
26


s
pt
27


s
ps

Ptilina, 200-400um long. Buccal capsule short and lined with thick, transversely striated cuticle. Esophagus divided equally into muscular and glandular portions.

Male:

Caudal region tightly coiled. Caudal alae well developed and bearing 18-22 pairs of preanal and six pairs of postanal pedunculated caudal papillae. Occasionally, one to three single papillae located anterior to paired preanal papillae. Fifth pair of postanal papillae smallest and located more ventral than rest of papillae. Spicules unequal and dissimilar. Left spicule long and slender with two sharp processes present immediately anterior to rounded tip of distal end. In addition, cuticular ala twisted once around distal end. Right spicule stout, L-shaped, and cuticular ala of spicule forming a prominent triangular process at ventral side of distal end. Tail short with rounded tip. Phasmids present.

Female:

Vulva located at mid-body. Vagina surrounded by thick muscle fibers, lined by cuticle and divided distinctly into vagina vera and vagina uterina with former more than two times longer than latter. Vagina vera making a 90 turn at mid-point. Didelphic, amphidelphic. Uteri filled with larvated thick-shelled eggs. Tail short. Phasmids present at rounded tip of tail.

Host: Catoptrophorus semipalmatus inornatus.
(Brewster) Scolopacidae.

Prevalence: 34% (10/29)

Intensity: 5.3 (1-9)

Specimens: NMCICP1983-0884

Localities: Delta Marsh, Manitoba, Canada
(50 12'N, 98 12'W)
Oaklake, Manitoba, Canada
(49 42'N, 100 47'W)
Cowoki Lake, Alberta, Canada
(50 35'N, 111 42'W)
Brooks, Alberta, Canada
(50 35'N, 111 53'W)
Foremost, Alberta, Canada
(49 29'N, 111 25'W)
Fort Fischer, North Carolina,
United States (33 57'N, 77 56'W)

Diagnosis:

This species can be differentiated from S. longicornis on the basis of the length of the ptilina. The former has wings which are about ten times longer than those of the latter. In addition, S. skrjabini has a shorter left spicule with a more complex distal end. Lastly, in female S. skrjabini the ratio of the vagina vera to vagina uterina is 2:1 and that of S. longicornis is 1:13.

Comments:

A new genus and species, Antennocara skrjabini, was proposed by Vassilkova (1926) for one female specimen recovered from Larus canus heinei Homeyer in Kazakhstan, Soviet Union. Guschanskaya (1950b) considered this genus to be a synonym of Schistorophus. Later, Guschanskaya and Krotov (1952) described the male of S. skrjabini from the Siberian whimbrel (Numenius phaeopus vagiegatus) and the kittiwake (Rissa brevirostris (Bruch)). Specimens recovered from the western willet were identified as S. skrjabini. This diagnosis is based on the fact that the ptilina in the specimens from Delta Marsh were 259(200-400)um long which is within the range of those of S. skrjabini. Also, the lengths of both spicules were similar to those of S. skrjabini. The original description of this species was, however, incomplete. For example, the spicules were not clearly illustrated and the morphology of the vagina as well as the differential lengths of the vagina vera and vagina uterina were not mentioned. On the basis of new material from Delta Marsh, we have provided a redescription of the species.

(3) Schistorophus cirripedesmi

Rhizhikov and Khokhlova, 1964

(Tables 1 and 2; Figs. 16-25)

Synonyms: Schistorophus laciniatus

Clapham, 1945 not Molin, 1860b

Schistorophus laciniatus

Leonov and Shevtsova, 1970 not Molin, 1860b

Schistorophus brygooi Petter, 1967

Schistoropus lii

Daiya, Bondarenko and Gubanov, 1971

General:

Ptilina, 50-125um in lengths. Buccal capsule short and lined with transversely striated cuticle. Muscular esophagus slightly shorter than glandular esophagus.

Male:

Caudal region tightly coiled. Caudal alae well developed and bearing 15-22 pairs of preanal and four pairs of postanal pedunculated caudal papillae. Last pair of preanal and first pair of postanal papillae located slightly more ventrally than others. One pair of sessile papillae located ventrally, near tip of tail in close proximity to pair of phasmids. Spicules unequal and dissimilar. Left spicule long and slender; in ventral view, distal end blunt, with small process. Right spicule short, heavily sclerotized, L-shaped and a sharp triangular process located ventrally near rounded distal end. Tail short, with rounded tip. Phasmids present.

Female:

Vulva located at posterior half of body. Vagina lined with cuticle and surrounded by muscle fibers. Vagina divided unequally into vagina vera and vagina uterina. Vagina vera about one-quarter length of vagina uterina. Didelphic, amphidelphic. Uteri packed with larvated thick-shelled eggs. Tail short, with slight dorsal curve. Phasmids present near rounded tip of tail.

Host: Numenius arquata arquata (L.). Scolopacidae.

Specimens: ZMB Coll. No. 797
ZMB Coll. No. 801
ZMB Coll. No. 813
ZMB Coll. No. 828

Locality: Egypt.

Diagnosis:

Schistorophus cirripedesmi can be readily distinguished from S. longicornis by the length of the ptilina which in the former range from 50-125um while those of the latter are between 25-40um.

The left spicule of S. cirripedesmi is less than 600um long and has a blunt distal end while that of S. longicornis is over 1.0mm long and has a chisel-like distal end. In the female of S. cirripedesmi the ratio of the vagina vera to the vagina uterina is about 1:4 while that of S. longicornis is about 1:13 or greater.

Schistorophus cirripedesmi is similar to S. skrjabini but can be distinguished from the latter by having shorter ptilina; those of S. cirripedesmi range from 50-125um while those of S. skrjabini are between 200-400um. The distal end of the left spicule of S. cirripedesmi is truncated while that of S. skrjabini is rounded. Finally, there is a marked difference in the ratio of the vagina vera to vagina uterina in the two species.

Comments:

Schistorophus cirripedesmi was described on the basis of specimens recovered from Charadrius leschenaulti Lesson (= Cirripedesmis leschenaulti) in Vietnam. Those specimens in Hemprich and Ehrenberg's collection which do not belong to S. longicornis were compared with the original description of S. cirripedesmi. The ptilina of these specimens have lengths that fall within the range of those of S. cirripedesmi. In addition, the lengths of both spicules are similar to those of the latter. The presence of sharp processes at the ventral sides near the distal end of the L-shaped right spicule and the blunt distal end of the left spicule in these specimens are indistinguishable from those of S. cirripedesmi. Based on these characters and other major dimensions we conclude that Hemprich and Ehrenberg's specimens belong to S. cirripedesmi. We have provided a redescription of this species based on these specimens.

Clapham (1945) reported S. laciniatus from T. melanoleuca, Himantopus himantopus mexicanus (L.) and C. semipalmatus (Gmelin) from Antigua and Leonov and Shevtsova (1970) reported the same species from Arenaria i. interpres (L.) from Vrangelya Island, Soviet Union. Their descriptions, however, are identical to the description of S. cirripedesmi presented in this study. Therefore, we conclude that the specimens collected by these authors are members of S. cirripedesmi

The type of S. brygooi Petter, 1967 from Numenius p. phaeopus (L.) in Europe was examined and compared with S. cirripedesmi. There were no morphological differences between the two species and we, therefore, regard the former as a synonym of the latter.

Schistorophus lii Daiya, Bondarenko and Gubanov, 1971 was described from specimens recovered from L. lapponica baueri in the Soviet Union. Li (1934) reported S. longicornis from Numenius arquata orientalis Brehm in China and Daiya et. al. (1971) regarded these specimens as members of S. lii. The major dimensions of S. lii in the original description are indistinguishable from those of S. cirrepedesmi The specimens described by Li (1934) were also identical to S. cirripedesmi. On this basis, we consider S. lii a synonym of S. cirripedesmi.

Other species

1. Schistorophus cornutus Sobolev, 1943a

Synonym: Antenocara skrjabini Solonitzin, 1928

Type host: Xenus cinerea (Guldenstaedt)
= Terekia cinereus

Type locality: Gorkov Region, USSR.

Diagnosis:

The lengths of the ptilina of this species fall within the range of those of S. cirrepedesmi. But it is differentiated from the latter by the shorter left spicule (270-330um vs. 360-512um) and fewer pairs of preanal papillae (12 vs 15-22). Barus and Sonin (1977) recovered S. cornutus from 10 of 25 X. cinerea and reported that these specimens have conspicuous transverse cuticular ridges along the entire body.

2. Schistorophus guschanskoi Ablasov and Chibichenko, 1962

Type host: Tringa totanus totanus (L.)

Type locality: Kirgiz, USSR

Diagnosis:

The length of the ptilina of this species are identical to those of S. skrjabini. But male S. guschanskoi have a significantly longer left spicule (710-940um vs. 400-600um) and fewer pairs of preanal papillae (10 vs 18-22).

Species inquirendae

1) Schistorophus bicuspis (Rudolphi, 1819) Railliet, 1916

Spiroptera bicuspis was proposed for specimens recovered from Tringa helvetica (=Squatarola helvetica) in Europe by Rudolphi (1819). It was subsequently transferred to Dispharagus by Dujardin (1845), then to Histiocephalus by Linstow (1878) and finally placed in its present genus by Railliet (1916). Railliet also regarded Histiocephalus gracilis Diesing, 1851 as a synonym of S. bicuspis

The bottle (Coll. No. 163) contained one intact male paratype specimen. It was badly preserved and the major morphological characters were indiscernible.

2) Schistorophus laciniatus (Molin, 1860b) Railliet, 1916

Molin (1860b) described a new species Histiocephalus laciniatus based on specimens recovered from Belonopterus chilensis cayennensis (Gmelin) (= Rallus cayennensis) in South America. It was transferred to its present genus by Railliet (1916). The types are lost (Dr. E. Kritscher, pers. comm.). The original description was incomplete and no illustrations were provided.

Species transferred to other genera

1) Schistorophus acanthocephalus (Molin, 1860a) Railliet, 1916.

Molin (1860a) proposed the name Spiroptera acanthocephalica for female specimens recovered from under the gizzard lining of the tern, Hydroprogne t. tschegrava (Lepechin) (= Sterna caspia Pallas). He listed, without giving any reasons, Strongylus ambiguus Rudolphi, 1802 and Spiroptera sternae Rudolphi, 1819, from Sterna h. hirundo L. as synonyms of his new species. Railliet (1916) transferred S. acanthocephalica to the genus Schistorophus and accepted Molin's decision regarding the two synonyms. He also regarded Spiroptera sternae hirundinis

Deslongchamps, 1824 as a synonym of this species. Cram (1927), however, considered ambiguus and sternae as valid and placed Spiroptera capillaris Molin, 1860c from S. h. hirundo into synonymy with S. acanthocephalica instead. Yamaguti (1961) and Skrjabin et. al. (1965) accepted Cram's judgement.

In the original description of acanthocephalica, Molin gave the species length as 19.0mm and width of 200um. He described the anterior extremity as attenuated, and noted the presence of spines on the lateral sides and that the tail was curved. Those lateral spines are probably the deirids. The bottle labelled acanthocephalica (Coll. No. 6714) contained two female specimens. One specimen measured 16.4mm in length, lacked cuticular ornamentations at the anterior end, had large tricuspid deirids and a dorsally curved tail. It was identified as Paracuaria adunca(Creplin, 1846) The other specimen, identified as Streptocara c. crassicauda (Creplin, 1829) was 8.7mm in length, had cordons in the form of a collarette around the cephalic region, deirids with numerous teeth and a short, stout tail. Both species have been reported from terns (see Gibson, 1968 and Barus et. al. 1978). The original description of acanthocephalica is similar to that of P. adunca. On this basis we regard the former as a synonym of the latter, in accordance with the law of priority of the International Nomenclature.

Rudolphi (1802) described a new species Strongylus ambiguus based on specimens recovered from S. h. hirundo. Later in 1819 he transferred this species to Spiroptera and gave it a new name, sternae. We had an opportunity to examine the holotype (Coll. No. 203). It was badly preserved and unidentifiable. We, therefore, considered this species to be a species inquirenda

Spiroptera sternae hirundinis Deslongchamps, 1824 was not listed by Stiles and Hassall (1920) and we regard it also as a species inquirenda.

As indicated earlier, Cram (1927) considered capillaris to be a synonym of acanthocephalica which in the present study is regarded as a synonym of P. adunca. The types of capillaris (Coll. No. 6715) are characterized by the ptilina in the form of triangular shields. These features are diagnostic of the genus Viktorocara Guschanskaya, 1950a. Based on the examination of the type material, we disagree with Cram(1927) and consider the species valid. Consequently, we transfer it to Viktorocara and propose the new combination Viktorocara capillaris (Molin, 1860c) n. comb.

2) Schistorophus spinulosus (Molin, 1860c) Railliet, 1916.

Molin(186Øc) described Filaria spinulosus based on a single female specimen recovered from Glareola austriaca. It was later transferred to its present genus Schistorophus by Railliet (1916). An examination of the type revealed that the cephalic region is surrounded by thick cuticle which is divided posteriorly into eight finger-like projections. In addition, immediately beneath this cuticle on the subdorsal and subventral sides are four pairs of dissimilar cephalic papillae. Also, the vulva is located at the anterior third of the body. These features are characteristic of the genus Stellocaronema Gilbert, 193Ø and we hereby, propose the new combination Stellocaronema spinulosus(Molin, 186Ø) n. comb. for this species.

3) Schistorophus bihamatus (Mueller, 1897) Skrjabin, Sobolev and Ivashkin, 1965.

Mueller (1897) described a new species Ancyracanthus bihamatus based on specimens recovered from S. h. hirundo from West Germany. This species was subsequently transferred to Ancyracanthopsis by Cram (1927) and later placed in its present genus by Skrjabin et. al. (1965). The types are not lodged in the Berlin or Vienna museums (Dr. G. Hartwich and Dr. E. Kritscher, pers. comm.). However, according to the original description, the morphology of the ptilina of this species is characterisitic of the genus Sciadiocara. In addition the male has only 6

pairs of preanal pedunculated papillae and their arrangement along the caudal region is identical to species of Sciadiocara. We, therefore, transfer S. bihamatus to Sciadiocara and propose a new combination Sciadiocara bihamata n. comb.

4) Schistorophus aulieatina Skrjabin, 1916.

Skrjabin (1916) proposed the name Schistorphus aulieatina for three female nematodes recovered from under the gizzard lining of Haematopus ostralegus L. This species is poorly described and the only illustration provided was a dorso-ventral view of the anterior end. This drawing showed the ptilina in the form of triangular shields. These features are characteristic of the genus Viktorocara Guschanskaya, 195Øa. We, therefore transfer S. aulieatina to this genus and propose the new combination Viktorocara aulieatina (Skrjabin, 1916) n. comb.

Key to Species

1-(2) Length of ptilina less than 50um

Length of left spicule greater than 1.0mm

..... S. longicornis

2-(1) Length of ptilina equal or greater than 50um

3-(6) Length of ptilina less than 200um

4-(5) Left spicule less than 450um long

Male with 12 pairs of preanal papillae

.....S. cornutus

5-(4) Left spicule greater than 450um

Male with 15-22 pairs of preanal papillae

.....S. cirrepedesmi

6-(3) Length of ptilina greater than 200um

7-(8) Left spicule greater than 700um

.....S. guschanskoi

8-(7) Left spicule less than 700um

.....S. skrjabini

Discussion

One of the most conspicuous features is the lateral pseudolabia which have conical apices that are continuous with the anterolateral walls of the buccal capsule. Also present are four structures, one on each dorsal and ventral sides of each pseudolabium, which are herein referred as sublabia (Fig.27). They originate between the anterolateral walls of the buccal capsule and the pseudolabia and extend posteriorly beyond the cephalic papillae. Inglis (1965) had

regarded these identical structures in another species of the same subfamily, Ancyracanthopsis madagascariensis Kung, 1948 as the dorsal and ventral lobes of the pseudolabia. However, scanning electron microscopy studies in the present work clearly showed that thay are not part of the pseudolabia. Appy (1981) designated sublabia for four thin structures located in the subdorsal and subventral quadrants of the oral opening of Ascarophis spp. in fishes (Habronematoidea; Cystidicolidae). The sublabia of cystidicolids are different from those in Schistrophus spp. in that they extend from between the anterolateral walls of the buccal capsule and pseudolabia and extend towards the dorsal and ventral sides of the oral opening. Further histological studies on these structures in both groups of nematodes are needed before any conclusions can be drawn regarding their relationship.

Several authors had referred to the conspicuous cuticular structures present at the anterior end of all the genera in Schistorophinae, except Schistogendra, as cephalic ornamentations (Inglis 1965, Adams and Gibson 1969 and Chabaud 1975). These structures are in various forms, each of which is unique to a genus. In this study, the term ptilinum (pl. ptilina) derived from the Greek word ptilon meaning wing-like membrane has been proposed for these cephalic ornamentations.

Out of the 308 individual waders belonging to 24 species which were examined, 34% of western willets were infected with S. skrjabini. This is the first report of this species in North America. In Europe and Asia, this particular species had been reported from two species of waders, three species of larids (Laridae) and one species of jaeger (Stercorariidae)(see Table 2). These birds are primarily aquatic and frequent both freshwater as well as marine habitats. Although the life cycle of S. skrjabini is unknown, its presence in these birds suggests that either a freshwater or marine invertebrate probably serve as the intermediate host.

None of the other four species of this genus was recovered in our survey of acuarioids of waders. A literature review showed that S. cirripedesmi is the only species which has previously been reported in the New World. Clapham (1945) recovered one specimen of this species from one T. melanoleuca, another specimen from one H. h. mexicanus and several females from C. semipalmatus. In contrast, in Europe and Asia, S. longicornis and S. cirripedesmi have been reported from six and nine species of waders, respectively (see Table 2). Meanwhile, S. cornutus has been reported from X. cinereus and S. guschanskoi in four species of waders in the Soviet Union. Therefore, based on the current knowledge of the geographic distribution of Schistorophus, it appears that S. skrjabini and S. cirripedesmi are the only species which occur in

both the New and Old World. The remaining species are confined to the Old World.

II. Revision of the genus Viktorocara

Viktorocara Guschanskaya, 1950

Diagnosis:

Acuarioidea; Acuariidae Railliet, Henry and Sisoff, 1912; Schistorophinae Travassos, 1918; Viktorocara Guschanskaya, 1950a. Medium size worms. Cuticle with transverse striations. Oral opening, laterally compressed with two pairs of teeth present at its lateral sides. Pseudolabia well developed with apices continuous with anterolateral walls of buccal cavity. Two pairs of cephalic papillae and one pair of amphids located at base of pseudolabia. Four sublabia pear-shaped, located on subdorsal and subventral sides of oral opening. Four ptilina with sharp pointed tips beginning at dorso-ventral sides of oral opening, surround interlabia and terminate at base of pseudolabia. Buccal capsule expanded anteriorly and lined with thick transversely striated cuticle. Prominent deirids with pointed tips located near nerve ring. Esophagus distinctly divided into muscular and glandular portions.

Type species: Viktorocara capillaris (Molin, 186Øc) new combination.

Location: Under gizzard lining, mainly of waders.

Comments:

Maplestone (1932) proposed a new genus and species, Quasithelazia tenuis for a single male specimen recovered from a kingfisher (Ceryle smyrnensis) in India. Singh (1949) synonymized Quasithelazia with Schistorophus Railliet, 1916. Later, Skrjabin et. al. (1965) regarded Quasithelazia to be a synonym of Viktorocara. This, however, is incorrect since the former has priority over the latter. Not realizing this mistake, Smogorzhevskaya (1972) considered Schistogendra incisa Chabaud and Rousselot, 1956 as a synonym of V. tenuis. Since incisa is the type species of Schistogendra then Schistogendra (1956) automatically falls into synonymy with Viktorocara (195Ø) which again violates the law of priority rule of the International Code of Zoological Nomenclature. Thus, as it stands now, Schistogendra (1956) and Quasithelazia (1932) are synonyms of Viktorocara (195Ø) and the species incisa (1956) is a synonym of tenuis (1932). We have examined the original description of Q. tenuis and it does not possess any ptilina. Thus, Viktorocara and Quasithelazia are not synonymous. The morphology of the anterior end of Schistogendra, however, is indistinguishable from that of Quasithelazia and we hereby regard Schistogendra a synonym of Quasithelazia. Finally, we recognize Quasithelazia

incisa (Chabaud and Rousselot, 1956) new combination, as valid because the lengths of its left (315um) and right (85um) spicules are shorter than those of Q. tenuis which are 540um and 110um, respectively. Therefore, Quasithelazia Maplestone, 1932 is regarded as valid and it consists of three species, namely, Quasithelazia tenuis Maplestone, 1932 the type species, Quasithelazia incisa (Chabaud and Rousselot, 1956) n. comb. and Quasithelazia caprona (Bain and Chabaud, 1965) n. comb.

(1) Viktorocara capillaris
(Molin, 1860c) new combination
(Tables 1 and 2; Figs. 1-7)

Synonyms: Spiroptera capillaris Molin, 1860c
Cheilospirura capillaris (Molin) Diesing, 1861
Schistorophus capillaris (Molin) Railliet, 1916
Viktorocara schejkini Guschanskaya, 1950a

General:

Buccal capsule long and lined with transversely striated cuticle. Esophagus divided into two portions. Muscular esophagus significantly shorter and narrower than glandular esophagus.

Male:

Table 1. Measurements of Viktorocara spp.

	V. capillaris[a]	V. limosae[a]	V. garridoi[b]	V. charadrii[b]
MALE				
N	20	23	7	2
Length, mm[1]	7.0(5.6-7.8)*	7.3(6.1-8.7)	5.0-5.7**	5.3-5.5
Width	94(80-105)	85(80-90)	150-200	110
Buccal capsule	80(70-88)	114(105-130)	66-81	110
Nerve ring[2]	146(137-163)	170(150-190)	-	-
Excretory pore[2]	205(192-223)	230(205-260)	-	-
Deirids[2]	151(135-178)	160(140-175)	-	66
Muscular oesophagus	403(360-470)	468(370-530)	390-460	270
Glandular oesophagus	1814(1600-2000)	1513(1250-1750)	390-540	830
Total oesophagus	2216(2010-2470)	1981(1670-2250)	780-1000	1100
Left spicule	281(255-320)	684(640-740)	319-404	470
Right spicule	113(100-120)	138(110-160)	105-124	102
Tail	155(135-185)	182(160-240)	110-140	-
FEMALE				
N	10	16	9	3
Length, mm[1]	15.6(13.9-19.7)	19.6(15.0-24.9)	5.7-7.8	12.2-13.2
Width	202(150-230)	144(115-170)	170-300	120
Buccal capsule	79(70-90)	124(110-140)	74-86	85
Nerve ring[2]	159(150-165)	180(160-200)	100-136	-
Excretory pore[2]	228(200-250)	237(200-270)	-	-
Deirids[2]	170(140-185)	174(150-195)	100-136	-
Muscular oesophagus	416(240-530)	569(490-650)	460-550	290
Glandular oesophagus	2087(1750-2400)	1734(1540-2100)	420-620	950
Total oesophagus	2502(2190-2930)	2303(2100-2730)	480-1170	1240
Vulva, mm[2]	9.2(7.9-13.7)	10.5(8.6-13.3)	2.9-3.9	6.7
Tail	164(130-215)	218(180-260)	129-160	-
Vagina vera, length	66(60-70)	157(140-180)	110	-
Vagina uterina, length	104(80-130)	160(120-210)	90	-
Eggs	42(41-43)x26(23-29)	41(40-43)x25(23-28)	41-45x23-28	47x23

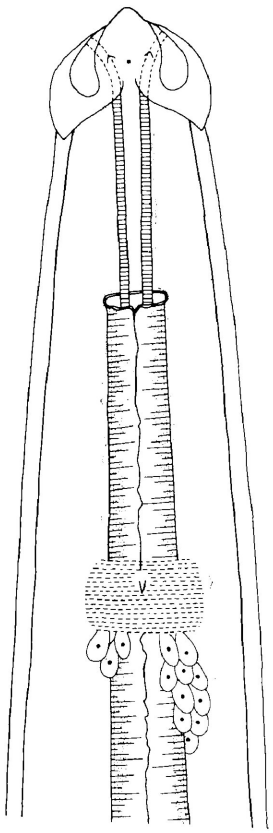
a. Measurements from present study
b. Measurements from original description

[1] Measurements in micrometers, unless stated otherwise
[2] Distance to anterior end
* Mean with range in parentheses
** Range

Table 2. Hosts and geographic distribution of Viktorocara spp.

Species	Hosts	Localities	Source
V. capillaris	Sterna h. hirundo	unknown	Molin, 1860c
	Limosa fedoa	Delta, Manitoba, Canada	Present study
	Charadrius semipalmatus	" " "	" "
	Pluvialis squatarola	North Carolina, U.S.A.	" "
	" "	Quebec, Canada	Gibson, 1972
	Charadrius w. wilsonia	Cuba	Barus and Hernandez, 1971
	Xenus cinereus	U.S.S.R.	Guschanskaya, 1950a
	Calidris alba	Primorsk region, E. Soviet Union	Oshmarin, 1963
	Numenius p. phaeopus	" " " "	" "
	Limosa l. lapponica	" " " "	" "
	Limosa l. limosa	Keta Lake, Central Siberia	Bondarenko, 1969
	Charadrius hiaticula tundra	" " "	" " "
	Larus schistisagus	Kamchatka, E. Siberia	Leonov and Belogurov, 1963
	P. squatarola	Vrangelya Is., N.E. Siberia	Leonov and Shevtsova, 1970
	Calidris c. canutus	" " " "	" " "
	Calidris alpina sakhalina	" " " "	" " "
V. limosae	C. semipalmatus	Delta, Manitoba, Canada	Present study
	L. fedoa	Delta; North Carolina, U.S.A.	" "
	Catoptrophorus semipalmatus inornatus	Delta; Alberta; North Carolina,USA	" "
	Recurvirostra americana	Delta	" "
	P. squatarola	Quebec, Canada	Gibson, 1972
	C. alpina pacifica	British Columbia, Canada	Adams and Gibson, 1969
	N. p. phaeopus	Europe	Petter, 1967
	L. limosa melanuroides	Kamchatka, E. Siberia	Daiya, 1966
	Halcyon smyrnensis fusca	Vietnam	Rhizhikov and Khokhlova, 1964
	L. lapponica baueri	Queensland, Australia	Mawson, 1968
	Haematopus ostralegus unicolor	New Zealand	Clark, 1978
V. charadrii	C. h. tundra	Murmansk, N.E. Soviet Union	Belopolskaya, 1953
	Sterna sandivicensis	Kherson oblast, S. Soviet Union	Leonov, 1958
	Hydroprogne tschegrava	" " " "	" "
	S. h. hirundo	Czechoslovakia	Macko and Barus, 1973
	Larus crassirostris	"	" " "
V. garridoi	Quiscalus niger caribaeus	Cuba	Barus, 1968
	Corvus nasicus	"	Barus and Garridoi, 1968

Figs. 1-7. Viktorocara capillaris Fig. 1. Anterior extremity, female, lateral view. Fig. 2. Anterior extremity, female, dorsal view. Fig. 3. Vulva, vagina and uteri, lateral view. Fig. 4. Caudal region, male, ventral view showing caudal papillae. Fig. 5. Anterior region, female, ventral view. Fig. 6. Caudal region, female, lateral view. Fig. 7. Caudal region, male, lateral view showing spicules and caudal papillae. Abbreviations: v.v. = vagina vera, v.u. = vagina uterina.



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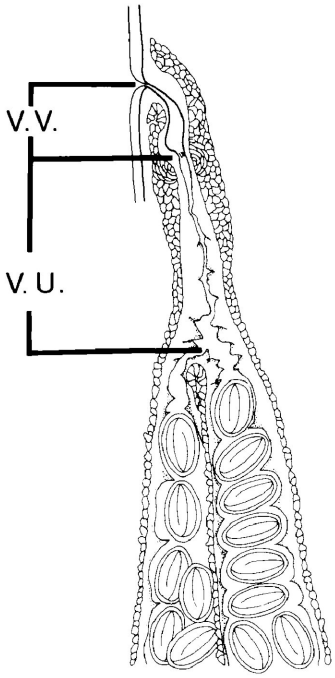

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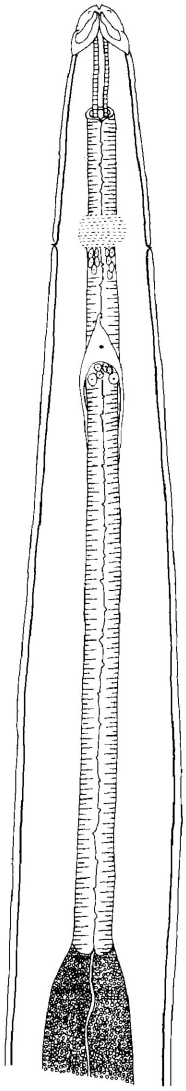

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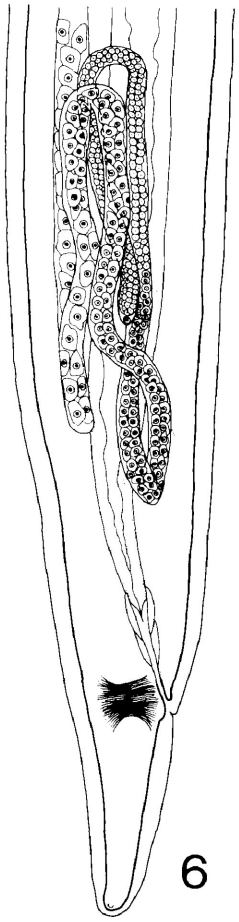

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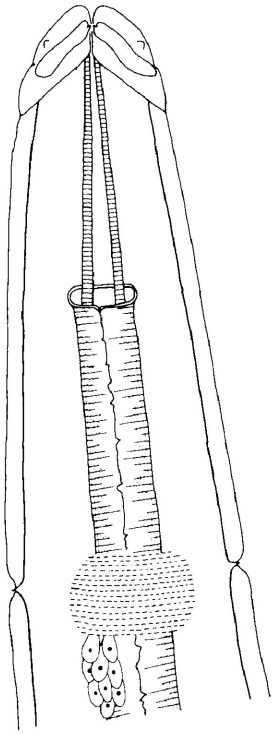

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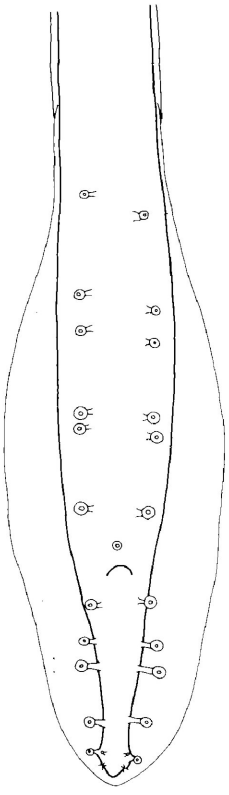

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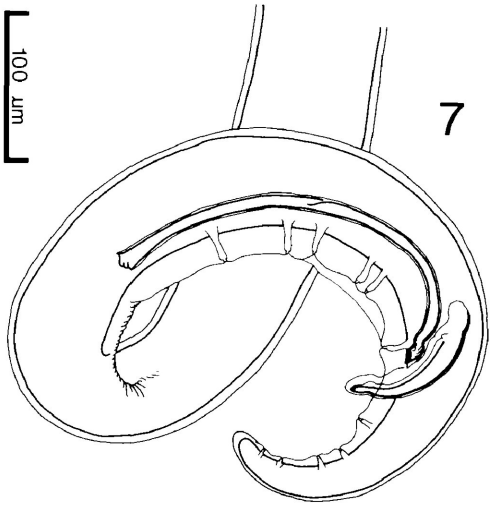


7

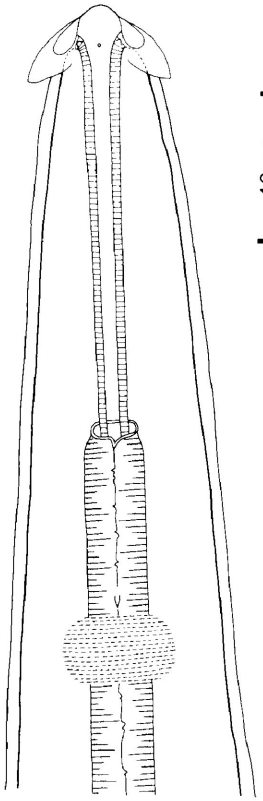
50 µm

100 µm

100 µm

100 µm

Figs. 8-14. Viktorocara limosae Fig. 8. Anterior extremity, female, lateral view. Fig. 9. Anterior extremity, female, dorsal view. Fig. 10. Caudal region, male, ventral view showing caudal papillae. Fig. 11. Vulva, vagina and uteri, lateral view. Fig. 12. Caudal region, female, lateral view. Fig. 13. Anterior region, female, ventral view. Fig. 14. Caudal region, male, lateral view showing spicules and caudal papillae.



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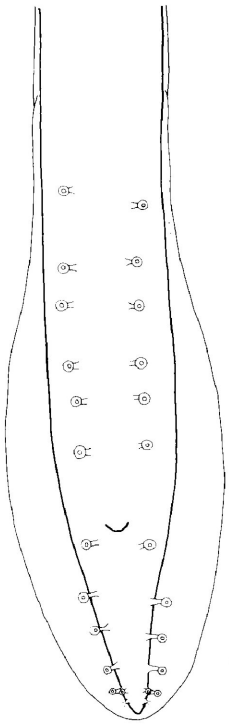

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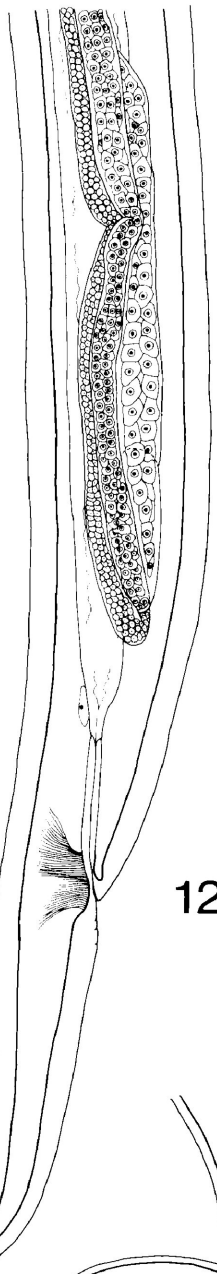

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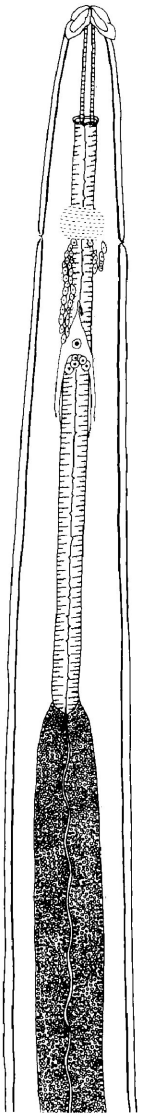

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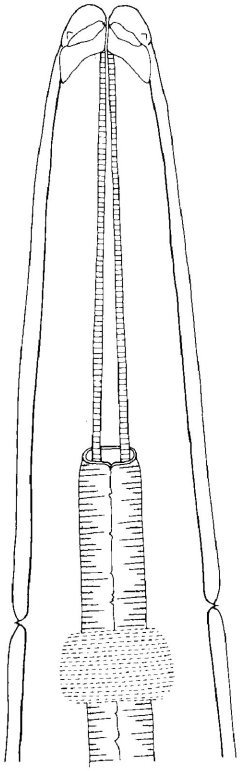

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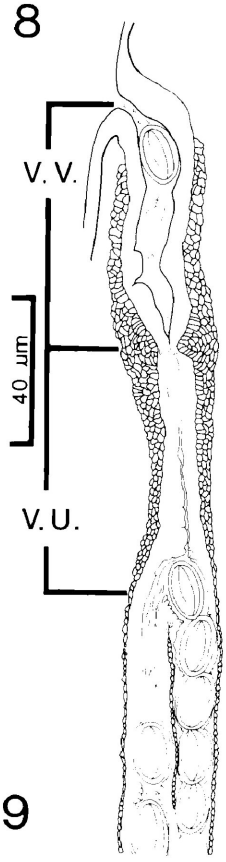

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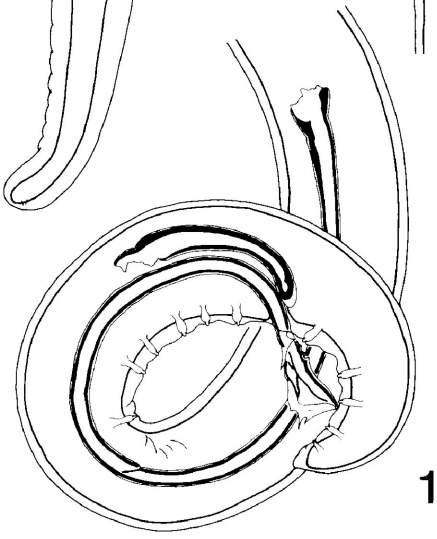


14

Caudal region with strong ventral curve. Caudal alae well developed. Six pairs of preanal and five pairs of postanal pedunculated papillae arranged in two parallel rows, located in caudal alae. Preanal papillae unevenly distributed; a single pair located anteriomost followed by two sets of double pairs and one single pair. One adanal papilla located ventrally just anterior to anus. Postanal papillae arranged in following manner: one single pair located immediately posterior to anus, then a set of double pairs and finally two single pairs. One pair of sessile papillae located ventral to last pair of pedunculated papillae. Phasmids present near rounded tip of tail. Spicules dissimilar and unequal. Right spicule, short and wedged-shaped. Left spicule long, slender with pair of finger-like processes present near pointed tip of distal end.

Female:

Vulva, an inconspicuous slit, located at mid-body. Vagina surrounded by thick muscle fibers and lined with cuticle, divided distinctly into vagina vera and vagina uterina. Vagina vera about one-third length of vagina uterina. Didelphic, amphidelphic. Uteri packed with embryonated thick-shelled eggs. Tail with rounded tip. Phasmids present.

Host: Charadrius semipalmatus Bonaparte Charadriidae.

Prevalence: 19% (4/21)

Intensity: 1.5 (1-3)

Specimens: NMCICP1983-Ø888
USNMH Coll. No. 77931

Locality: Delta Marsh, Manitoba, Canada
(5Ø 12'N, 98 12'W)

Host: Pluvialis squatarola (L.). Charadriidae.

Prevalence: 33% (1/3)

Intensity: 2.Ø

Locality: Fort Fischer, North Carolina, United States
(33 57'N, 77 56'W)

Host: Limosa fedoa L. Scolopacidae

Prevalence: 3% (1/34)

Intensity: 3Ø.Ø

Specimens: NMCICP1983-Ø889
USNMH Coll. No. 7793Ø

Localities: Delta Marsh, Manitoba, Canada
Oaklake, Manitoba, Canada

(49 42'N, 100 47'W)

Fort Fischer, North Carolina,

United States

Comments:

Spiroptera capillaris was described by Molin (1860c) based on three females recovered from the tern S. h. hirundo. The type material of capillaris (Coll. No. 6715) consisted of one female. This specimen was 12.1mm in length. Its buccal capsule, muscular and glandular oesophagus were 55um, 310um and 950um in length respectively. The vulva was located at mid-body and the vagina divided into the vagina vera and vagina uterina. The vagina vera was 65um and the vagina uterina was 140um in length. The tail was 135um long.

Both male and female specimens of Viktorocara were recovered from Gray plovers, semipalmated plovers and marbled godwits. Since the females were identical to the type of capillaris, the males were concluded to be members of this species. One marbled godwit from Delta Marsh, had 27 males and 16 females of Viktorocara. Of these, 20 males and 10 females were identified as members of capillaris and 7 males and 6 females were members of V. limosae Daiya, 1966 after comparing them to the original description.

The original description of V. schejkini Guschanskaya, 1950 was compared with specimens of V. capillaris and V. limosae recovered from the present study. Viktorocara schejkini was found to be indistinguishable from V. capillaris and we regard them as conspecific.

(2) Viktorocara limosae Daiya, 1966

(Tables 1 and 2; Figs. 8-15)

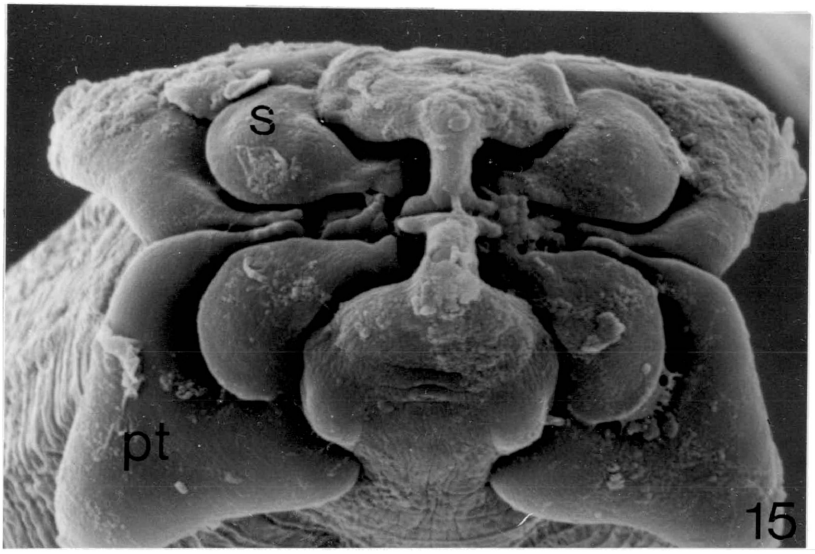
Synonyms: Viktorocara halcyoni
Rhizhikov and Khokhlova, 1964
Viktorocara numenii Petter, 1967
Viktorocara limosae Mawson, 1968
Viktorocara torea Clark, 1978

General:

Buccal capsule, long, slender, expanded anteriorly and lined with transversely striated cuticle. Esophagus distinctly divided into muscular and glandular portions. Muscular portion significantly shorter and more slender than glandular portion.

Male:

Figs. 15. Scanning micrographs of Viktorocara limosae. Anterior extremity, female, en face view. Magnification: 3000X. Abbreviations: pt = ptilinum, s = sublabium.


s
pt
15

Caudal extremity with strong ventral curve. Caudal alae well-developed and bearing six pairs of preanal and six pairs of postanal pedunculated caudal papillae. Preanal papillae evenly distributed. First pair of postanal papillae separated from four pairs which are distributed equally along tail. Last pair considerably smaller and located just ventral to fifth pair. Phasmids near rounded tip of tail. Spicules unequal and dissimilar. Right spicule, short and crescent shape. Left spicule long, slender with well developed cuticular alae which enveloped complex distal end. Tail with rounded tip.

Female:

Vulva located near mid-body. Vagina surrounded by muscle fibers and lined with cuticle. Vagina divided equally into vagina vera and vagina uterina. Didelphic, amphidelphic. Uteri filled with embryonated thick- shelled eggs. Tail, long, slender with dorsally curved rounded tip. Phasmids present.

Host: Limosa fedoa L. Scolopacidae

Prevalence: 21% (7/34)

Intensity: 8.8 (2-22)

Specimens: NMCICP1983-0887

USNMH Coll. No. 77929

Localities: Delta Marsh, Manitoba, Canada

Oaklake, Manitoba, Canada

Fort Fischer, North Carolina,
United States(33 57'N, 77 56'W)

Host: Charadrius semiplamatus Bonaparte.
Charadriidae.

Prevalence: 5% (1/21)

Intensity: 6.Ø

Specimens: NMCICP1983-Ø886

Locality: Delta Marsh, Manitoba, Canada

Host: Catoptrophorus semipalmatus inornatus
(Brewster) Scolopacidae.

Prevalence: 1Ø% (3/29)

Intensity: 4.Ø (1-9)

Localities: Delta Marsh, Manitoba, Canada
Oaklake, Manitoba, Canada
Brooks, Alberta, Canada
(5Ø 35'N, 111 42'W)
Cowoki Lake, Alberta, Canada
(5Ø 35'N, 111 42'W)
Foremost, Alberta, Canada
(49 29'N, 111 25'W)

Fort Fischer, North Carolina,

United States

Host: Recurvirostra americana Gmelin. Scolopacidae.

Prevalence: 11% (1/9)

Intensity: 2.Ø

Locality: Delta Marsh, Manitoba, Canada

Diagnosis:

The length and morphology of the left spicule of V. limosae readily distinguished it from V. capillaris. In addition, female V. limosae has a vagina vera to vagina uterina ratio of 1:3 while that of V. capillaris is 1:1. Finally, the female tail of the latter is more slender and longer than that of the former.

Comments:

Viktorocara limosae Daiya, 1966 was described on the basis of male specimens recovered from Limosa limosa (L.) in the USSR. Viktorocara halcyoni Rhizhikov and Khokhlova, 1964 was described based on female specimens recovered from the kingfisher (Halcyon smyrnensis) in Vietnam. The major dimensions of this species are identical to V. limosae Specifically, the length of the vagina vera was approximately 1ØØum as illustrated in the original

description. We, therefore, consider V. halcyoni a synonym of V. limosae. Parukhin (1964a) misidentified male specimens from the same host (H. smyrnensis) as V. halcyoni. These specimens, however, are characterized by the lack of ptilina and the presence of 11 to 14 pairs of preanal caudal papillae. These features plus the length and distal morphology of the left spicule are indistinguishable from those of Quasithelazia incisa Chabaud and Rousselot, 1956.

Examination of the type of V. numenii Petter, 1967 from Numenius phaeopus (L.) in Europe and the original description of V. torea Clark, 1978 from Haematopus ostralegus finschi in New Zealand revealed that they are identical to limosae. We herein regard V. numenii and V. torea as synonyms of V. limosae. Adams and Gibson (1969) had previously regarded V. limosae Mawson, 1968 from Limosae lapponica baueri (L.) in Australia as a synonym of V. limosae Daiya, 1966

Other species

(1) Viktorocara garridoi Barus, 1968

Type host: Quiscalus niger caribaeus (Todd).

Icteridae.

Type locality: Havana, Cuba.

Diagnosis:

This species can be readily distinguished from V. capillaris by the length and the distal end morphology of the left spicule. Also, in V. garridoi, the length of the muscular esophagus is equal to that of the glandular esophagus. In contrast, the muscular esophagus of V. capillaris is about one-third the length of the glandular esophagus. Finally, the vagina vera of the former is one-third the length of the vagina uterina while the length of the vagina vera of the latter is equal to that of the vagina uterina.

Viktorocara garridoi is similar to V. limosae but can be differentiated from the latter by the following characters: (1) the morphology of the distal end of the left spicule is different in the two species; (2) the esophagus of V. garridoi is divided equally into two portions while in V. limosae, the muscular portion is about one-third the length of the glandular portion; (3) lastly, the male of the former has four pairs of preanal pedunculated caudal papillae but the latter possesses six pairs.

(2) Viktorocara charadrii Belopolskaya, 1953

Synonymn: Viktorocara guschanscoi Leonov, 1958

Type host: Charadrius hiaticula tundra (Lowe).
Charadriidae.

Type locality: USSR.

Diagnosis:

Viktorocara charadrii can be distinguished from all other species in the genus by the length of the left spicule. It is longer than that of V. capillaris and V. garridoi and shorter than that of V. limosae.

Comments:

The original description of V. guschanscoi from Sterna s. sandivicensis (Latham) in the Soviet Union was compared to that of V. charadrii and found to be identical. We therefore consider the former to be a synonym of the latter.

Species inquirenda

1) Viktorocara aulieatina (Skrjabin, 1916)

new combination

Skrjabin (1916) described a new species Schistorophus aulieatina on the basis of three females recovered from Haematopus ostralegus L. in the Soviet Union. Unfortunately, the original description was incomplete; only the total length, the width and the size of the eggs were provided. Moreover, the lengths of the vagina vera and vagina uterina were not given. We consider this species a species inquirenda.

Species transferred to other genera

Viktorocara acholonui Schmidt and Kuntz, 1972

Schmidt and Kuntz (1972) described Viktorocara acholonui on the basis of a single male recovered from Alcippe b. brunnea Gould (Timaliidae) in Taiwan. We have had an opportunity to examine the holotype (Coll. No. 63290). It has a pair of grooves at the cephalic end which begins dorsoventrally and surrounds the pseudolabia. Also present immediately posterior to these grooves, is a cuticular collarette which is delicate and sinuated. These features are characteristic of the genus Ancyracanthopsis

Diesing, 1861. We, therefore, transfer this species to the latter and propose Ancyracanthopsis acholonui n. comb.

Key to Species

1-(2) Male tail with four pairs of preanal papillae.

..... V. garridoi

2-(1) Male tail with six pairs of preanal papillae.

3-(4) Left spicule length greater than 500um.

..... V. limosae

4-(3) Left spicule length less than 500um.

5-(6) Left spicule length less than 350um.

..... V. capillaris

6-(5) Left spicule length between 400 and 500um.

..... V. charadrii

Discussion

This genus consists of four species, three of which are mainly parasites of aquatic or semiaquatic birds. The fourth species, V. garridoi has only been reported from a passerine, Q. n. caribaeus and a corvid Corvus nasicus. in Cuba.

Viktorocara garridoi is morphologically most similar to V. capillaris. Specifically, the lengths of the spicules and the morphology of the left spicule are strikingly similar. This suggests a close relationship between them. Conceivably V. garridoi evolved from V. capillaris. According to Dorst (1974) the major radiation of the passerines, hosts of the former, occurred about 35 million years ago while that of the waders, hosts of the latter, occurred around 65 million years ago. Both hosts of V. garridoi frequent aquatic habitats including salt marshes which are occupied by waders. Perhaps, in this way the passerines first acquired V. capillaris from waders and in time, this parasite evolved into a distinct species, V. garridoi.

III. Revision of the genus Ancyracanthopsis

Ancyracanthopsis Diesing, 1861

Synonyms: Skrjabinobronema Guschanskaya, 1950a

Parahistiocephalus Belopolskaya, 1953

Diagnosis:

Acuarioidea; Acuariidae Railliet, Henry and Sisoff, 1912; Schistorophinae Travassos, 1918; Ancyracanthopsis Diesing, 1861. Filiform worms. Cuticle with transverse

striations. Oral opening, laterally compressed with three pairs of teeth present at lateral walls. Pseudolabia prominent with apices continuous with anterolateral walls of oral opening. Four pear - shaped sublabia located at subdorsal and subventral sides of oral opening. They begin between anterolateral walls of oral opening and pseduolabia and terminate at base of pseudolabia. Ptilina in the form of shields with indentations, beginning dorsoventrally, surrounding sublabia and terminating at lateral lines. Buccal capsule, expanded anteriorly, and lined with transversely striated cuticle. Deirids with pointed tips located anterior to nerve ring. Esophagus divided into muscular and glandular portions. Muscular portion shorter than glandular portion.

Type species: Ancyracanthopsis coronata (Molin, 1860a) Chabaud and Petter, 1959.

Location: Under gizzard linings, mainly of birds.

(1) Ancyracanthopsis coronata

(Molin, 1860a) Chabaud and Petter, 1959

(Tables 1 and 2; Figs. 1-8)

Synonyms: Spiroptera coronata Molin, 1860a

Histiocephalus coronata (Molin)

van Drasche, 1884

Yseria coronata (Molin) Gedoelst, 1919

Skrjabinobronema coronata (Molin)

Table 1. Measurements of *Ancyracanthopsis coronata* from waders collected in North America

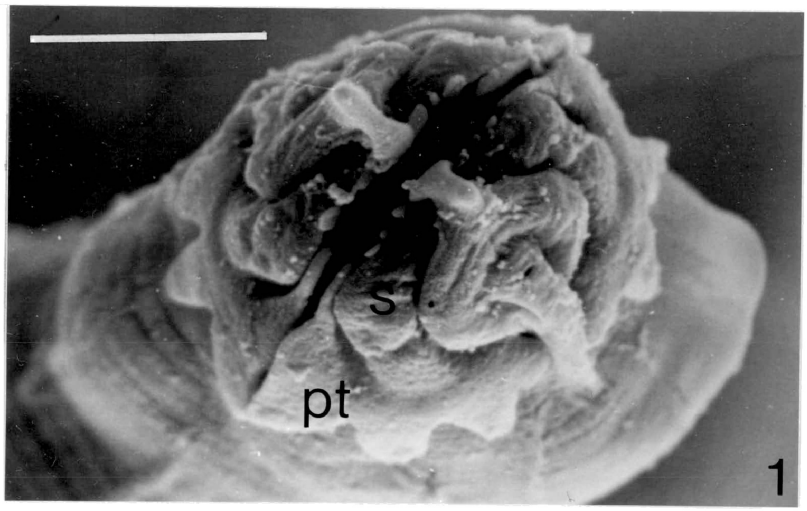
Host	*Catoptrophorus semipalmatus inornatus*	*Limosa fedoa*	*Actitis macularia*
MALE			
N	10	3	2
Length, mm[1]	7.7(6.9-8.2)*	5.5-6.4**	6.3-6.6
Width	96(85-105)	70	70-80
Buccal capsule	52(40-60)	55-60	52-55
Nerve ring[2]	126(117-138)	100-165	102-110
Deirids[2]	99(91-116)	80-140	70-72
Excretory pore[2]	162(147-183)	110-195	127-130
Muscular oesophagus	701(600-800)	470-480	580-620
Glandular oesophagus	1935(1520-2160)	1290-1340	1300-1600
Total oesophagus	2646(2190-2970)	1765-1820	1920-2180
Left spicule	230(200-245)	260-330	190-220
Right spicule	83(70-95)	80-100	80
Tail	144(105-178)	140-170	110
FEMALE			
N	6	3	3
Length, mm[1]	12.7(11.7-13.4)	11.9-18.0	8.0-8.7
Width	103(90-111)	120-150	80-90
Buccal capsule	58(52-66)	62-80	50-60
Nerve ring[2]	139(128-151)	132-135	105-112
Deirids[2]	103(90-111)	98-105	72-75
Excretory pore[2]	180(158-195)	162-165	127-130
Muscular oesophagus	789(655-840)	760-900	500-630
Glandular oesophagus	2070(2000-2110)	2200-2570	1600-1750
Total oesophagus	2859(2765-2930)	2900-3470	2140-2380
Vulva, mm[2]	7.6(7.0-8.1)	7.0-10.0	4.5-5.5
Vagina vera, length	56(49-67)	56-58	50-68
Vagina uterina, length	63(53-69)	50-61	63-84
Tail	161(150-180)	140-220	100-120
Eggs	42(39-44)x25(22-26)	-	42(39-45)x24(23-25)

[1] Units in micrometers, unless stated otherwise
[2] Distance to anterior end
* Mean with range in parentheses
** Range

Table 2. Hosts and geographic distribution of *Ancyracanthopsis* spp.

Species	Hosts	Localities	Source
A. coronata	*Chloroceryle americana*	Brasil	Molin, 1860a
	Belonopterus chilensis cayennensis	"	" "
	Eurypyga h. helias	"	" "
	Tringa melanoleuca	Antigua	Clapham, 1945
	Cassidix mexicanus	Mexico	Adams & Gibson, 1969
	Seiurus n. novaboracensis	"	" "
	Actitis macularia	British Columbia, Canada	" "
	Eudocimus albus	Florida, U.S.A.	Bush and Forrester, 1976
	Rallus e. elegans	Maryland, U.S.A.	Wehr, 1934
	Pluvialis squatarola	North Carolina, U.S.A.	Present study
	A. macularia	Delta; Manitoba, Canada	" "
	Limosa fedoa	" " "	" "
	Catoptrophorus semipalmatus inornatus	Delta; Alberta, Canada	" "
	Numenius phaeopus hudsonicus	Delta	" "
	Numenius p. phaeopus	U.S.S.R.	Guschanskaya, 1950a
	Arenaria i. interpres	Murmansk, N.E. Soviet Union	Belopolskaya, 1953
A. petrovi	*N. p. phaeopus*	U.S.S.R.	Guschanskaya, 1950a
A. buckleyi	*Amaurornis phaenicurus chinensis*	Hyderabad, India	Ali, 1970

Fig. 1. Scanning micrograph of Ancyracanthopsis coronata. Anterior extremity, female, en face view. Bar = 10um. Abbreviations: pt = ptilinum, s = sublabium, ps = pseudolabium.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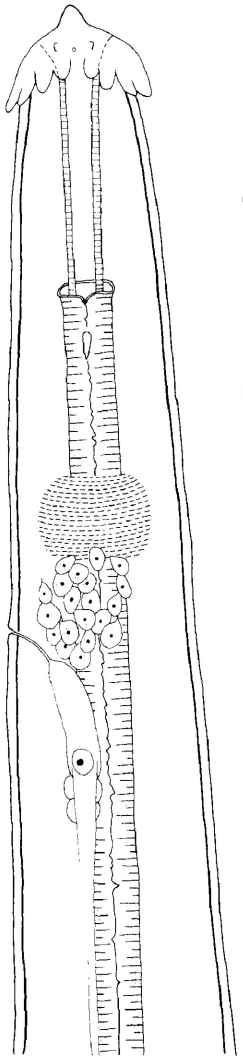
Figs. 2-8. Ancyracanthopsis coronata Fig. 2. Anterior region,, female, lateral view. Fig. 3. Vulva, vagina and uteri, lateral view. Fig. 4. Caudal extremity, female, ventral view. Fig. 5. Caudal region, male, ventral view. Fig. 6. Caudal extremity, female, lateral view. Fig. 7. Anterior region, female, ventral view. Fig. 8. Caudal region, male, lateral view showing spicules and caudal papillae. Abbreviations: v.v. = vagina vera, v.u. = vagina uterina.



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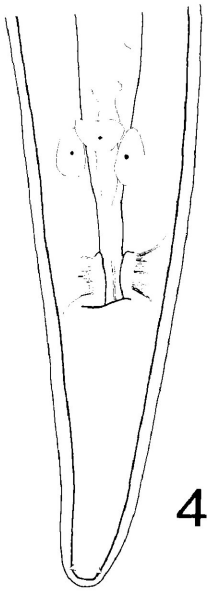

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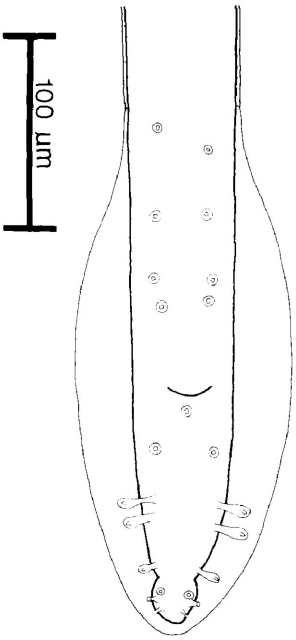

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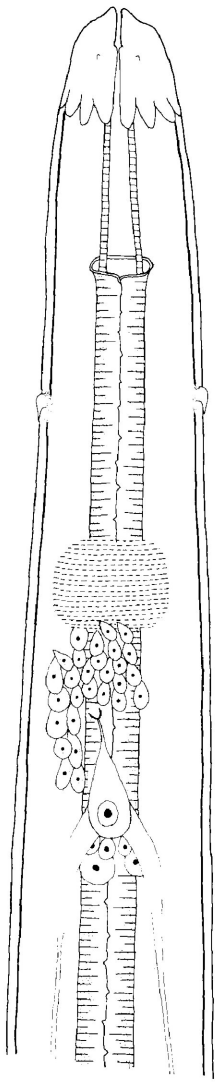

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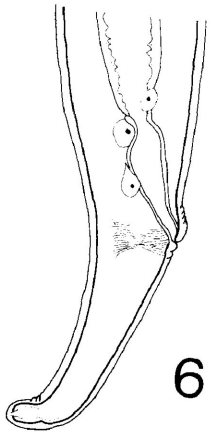

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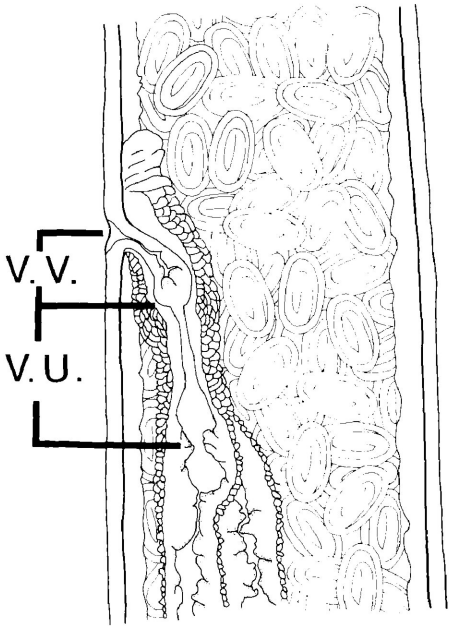

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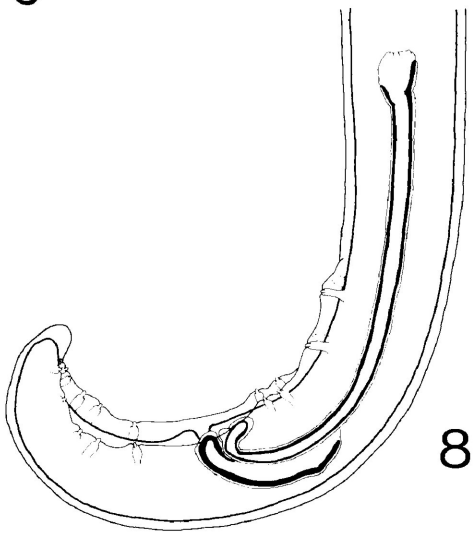


8

Yamaguti, 1961

Ancyracanthus bilabiatus Molin, 1860a

Ancyracanthopsis bilabiatus (Molin)

Diesing, 1861

Yseria quadripartita Clapham, 1945

Ancyracanthopsis quadripartita

(Clapham) Chabaud and Petter, 1959

Skrjabinobronema quadripartita

(Clapham) Yamaguti, 1961

Skrjabinobronema schikhobalovi

Guschanskaya, 1950a

Ancyracanthopsis schikhobalovi

(Guschanskaya) Dollfus and Chabaud, 1957

Parahistiocephalus parvialatus

Belopolskaya, 1953

Ancyracanthopsis parvialatus

(Belopolskaya) Dollfus and Chabaud, 1957

General:

Ptilina, each divided into four equal lobes. Deirids medium sized with pointed tips, located immediately anterior to nerve ring. Muscular esophagus about one - third length of glandular esophagus.

Male:

Caudal region with ventral curve. Caudal alae prominent and bearing four pairs of preanal and five postanal pedunculated caudal papillae. Fourth pair of preanal papillae closely associated with third pair. One sessile papilla located immediately posterior to anus. Second and third pair of postanal pedunculated papillae closely associated with each other. One pair of sessile papillae located just anterior to last pair of pedunculated papillae. Spicules dissimilar and unequal. Right spicule short and crescent shaped. Left spicule slender, long with distal end forming a hook. Also, a triangular process present near rounded tip of distal end. Tail with rounded tip. Phasmids present.

Female:

Vulva, a small slit located at posterior half of body. Vagina surrounded by muscle fibers, lined with cuticle and distinctly divided equally into vagina vera and vagina uterina. Didelphic, amphidelphic. Uteri packed with larvated thick - shelled eggs. Tail slender and rounded tip with slight dorsal curve. Phasmids present.

Host: Catoptrophorus semipalmatus inornatus. (Brewster) Scolopacidae.

Prevalence: 38% (11/29)

Intensity: 10.2 (1-39)

Specimens: NMCICP1983-0885

USNMH Coll. No. 77933

Localities: Delta Marsh, Manitoba, Canada

(50 12'N, 98 12'W)

Oaklake, Manitoba, Canada

(49 42'N, 100 47'W)

Brooks, Alberta, Canada

(50 35'N, 111 53'W)

Foremost, Alberta, Canada

(49 29'N, 111 25'W)

Cowoki Lake, Alberta, Canada

(50 35'N, 111 42'W)

Fort Fischer, North Carolina,

United States (33 57'N, 77 56'W)

Host: Actitis macularia L. Scolopacidae.

Prevalence: 14% (2/14)

Intensity: 8.0 (4-12)

Locality: Delta Marsh, Manitoba, Canada

Host: Limosa fedoa L. Scolopaciade.

Prevalence: 12% (4/33)

Intensity: 2.2 (1-4)

Localities: Delta Marsh, Manitoba, Canada

Oaklake, Manitoba, Canada

Fort Fischer, North Carolina,

United States

Host: Numenius phaeopus hudsonicus (L.).
Scolopacidae.

Prevalence: 100% (1/1)

Intensity: 10.0

Locality: Fort Fischer, North Carolina, United States

Host: Pluvialis squatarola (L.). Charadriidae.

Prevalence: 33% (1/3)

Intensity: 4.0

Locality: Fort Fischer, North Carolina, United States

Comments:

Diesing (1861) proposed the genus Ancyracanthopsis and designated Ancyranthus bilabiata Molin, 186Øa as the type species. This species was described on the basis of specimens recovered from the surfbird (Eurypyga helias helias (Pallas) in Brazil. Another species, A. coronata (Molin, 186Ø) Chabaud and Petter, 1959 was described on the basis of specimens recovered from the kingfisher (Chloroceryle americana americana (Gmelin)) (= Alcedo americanca) and the rail (Belonopterus chilensis cayennensis (Gmelin)) also in Brazil.

The bottle labelled types of coronata (Coll. No. 712Ø) contained a head region and a mid-body section of a nematode. The anterior end of the head region lacked the four lobed ptilina which are characteristic of the genus. The mid-body section was unidentifiable. van Drasche (1884) had apparently examined the types of this species and he provided illustrations of the anterior end showing the four lobed ptilina. Therefore, the specimens we had examined are not the types of coronata and we presumed they are lost. However, on the basis of the work of van Drasche (1884), we conclude that coronata is a member of this genus.

The bottle labelled types of bilabiata (Coll. No. 6704) contained three larvae, three body sections and one adult female. The anterior end morphology of the adult is identical to that of coronata as described by Drasche (1884). The major dimensions of bilabiata are indistinguishable from the new material of coronata which were recovered from waders in this study. We, therefore, conclude that these two species are conspecific. Since coronata was published two months prior to bilabiata, the latter becomes a synonym of the former. Finally, according to the rules of Zoological Nomenclature, we hereby, designate coronata as the type species of Ancyracanthopsis.

Other species

(1)Ancyracanthopsis petrovi Guschanskaya, 1950a

Synonym: Viktorocara petrovi

(Guschanskaya) Skrjabin, sobolev and Ivashkin, 1965

Type host: Numenius p. phaeopus L. Scolopacidae.

Type locality: USSR.

Diagnosis:

This species can be readily differentiated from A. coronata by the morphology of the ptilina. The ptilina of A. petrovi are finely dissected while those of A. coronata are lobed. In addition, A. petrovi has a shorter buccal capsule and six pairs of preanal caudal papillae in the male.

(2)Ancyracanthopsis buckleyi Ali, 1970

Diagnosis:

The bisected ptilina of this species readily distinguishes it from A. coronata and A. petrovi.

Molinacuaria new genus

Diagnosis:

Acuarioidea; Acuariidae; Seuratinae Chitwood and Wehr, 1932; Molinacuaria new genus. Filiform worms. Cuticle with transverse striations. Pseudolabia present with apices continuous with anterolateral wall of buccal capsule. Two cephalic papillae and an amphid present at base of each pseudolabium. Sublabia absent. Two pairs of grooves originate dorsoventrally, extend laterally and terminate at base of pseudolabia. Ptilina in the form of shields with dissected margins located immediately posterior

to grooves. Deirids with pointed tips positioned anterior to nerve ring. Buccal capsule long, narrow and lined with transversely striated cuticle. Esophagus divided into muscular and glandular protions.

Type species: Molinacuaria bendelli
(Adams and Gibson, 1969) new combination

Location: Under gizzard lining of birds.

(1) Molinacuaria bendelli
(Adams and Gibson, 1969) new combination
(Table 3; Figs. 9-14)
Synonym: Ancyracanthopsis bendelli
Adams and Gibson, 1969

General:

Ptilina in the form of shield with irregular, sharp indentations. Deirids with pointed tips positioned anterior to nerve ring. Buccal capsule long, narrow and lined with cuticle. Esophagus divided into two portions. Muscular portion less than half length of glandular portion.

Male:

Caudal extremity coiled. Caudal alae well developed and bearing pedunculated papillae arranged in two parallel rows. Numbers of preanal papillae ranged from nine to 14 pairs; occasionally two or more single papillae located

Table 3. Measurements of Molinacuaria spp.

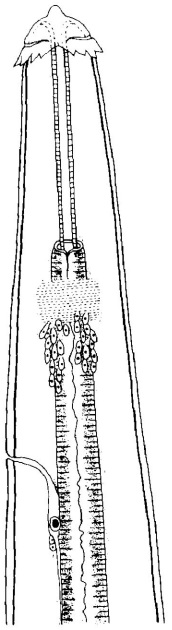
	M. bendelli[a]	M. acholonui[b]	M. gallinulae[a]
MALE			
N	12	1	1
Length, mm[1]	6.0(5.5-7.1)*	6.9	5.4
Width	91(78-106)	65	70
Buccal capsule	122(110-159)	132	87
Nerve ring[2]	166(151-210)	152	122
Deirids[2]	156(135-175)	-	175
Excretory pore[2]	220(196-252)	202	-
Muscular oesophagus	248(199-298)	290	262
Glandular oesophagus	459(362-514)	450	786
Total oesophagus	707(594-778)	740	1048
Left spicule	362(336-420)	410	328
Right spicule	114(108-126)	108	74
Tail	107(84-120)	175	87
FEMALE			
N	15	unknown	unknown
Length, mm[1]	17.3(14.0-22.5)		
Width	157(136-204)		
Buccal capsule	157(125-166)		
Nerve ring[2]	201(174-209)		
Deirids[2]	192(174-201)		
Excretory pore[2]	296(238-322)		
Muscular oesophagus	341(318-384)		
Glandular oesophagus	560(454-619)		
Total oesophagus	899(772-989)		
Vulva, mm[2]	9.2(7.3-11.7)		
Vagina vera, length	115, 120≠		
Vagina uterina, length	185, 165≠		
Tail	240(160-340)		
Eggs	46(42-48)x22(20-24)		

a. Measurements from original description
b. Measurements from holotype
≠ Measurements from paratypes

[1] Units in micrometers, unless stated otherwise
[2] Distance to anterior end
* Mean with range in parentheses

Figs. 9-14. Molinacuaria bendelli Fig. 9. Anterior region, female, lateral view. Fig. 10. Anterior region, female, ventral view. Fig. 11. Distal end of left spicule, lateral view. Fig. 12. Vulva, vagina and uteri, lateral view. Fig. 13. Caudal extremity, female, lateral view. Fig. 14. Caudal region, male, lateral view showing spicules and caudal papillae.

Figs. 15-18. Molinacuaria acholonui Fig. 15. Anterior region, male, lateral view. Fig. 16. Distal end of left spicule, lateral view. Fig. 17. Anterior region, male, ventral view. Fig. 18. Caudal region, male, lateral view showing spicules and caudal papillae.



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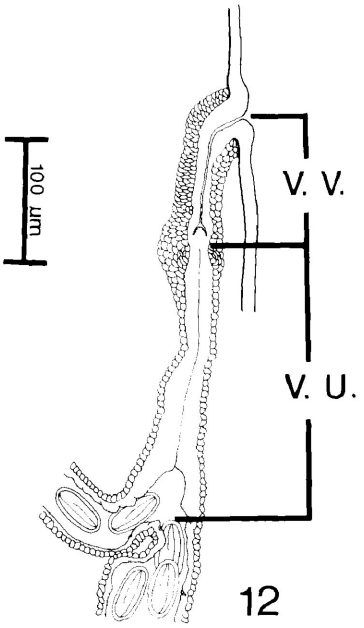

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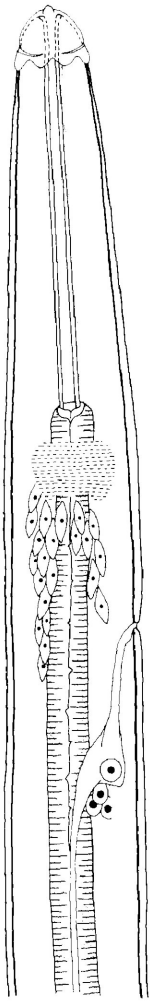

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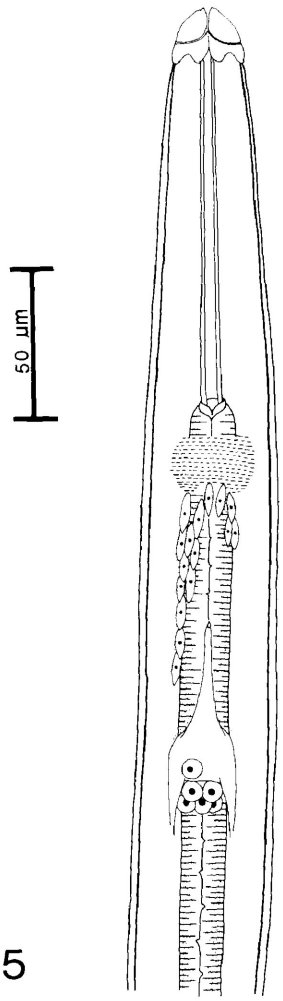

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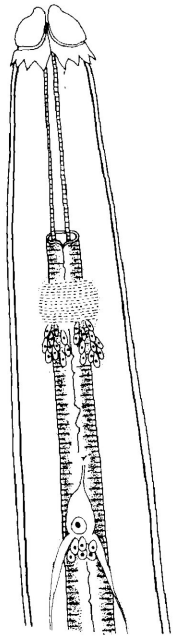

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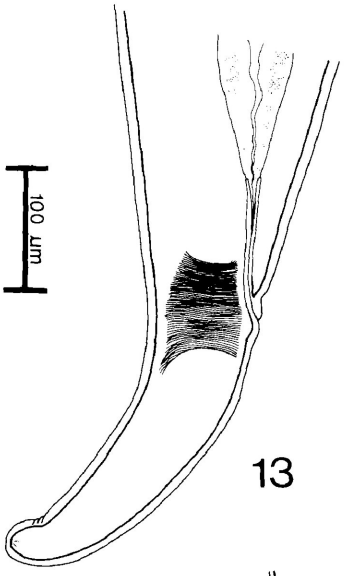

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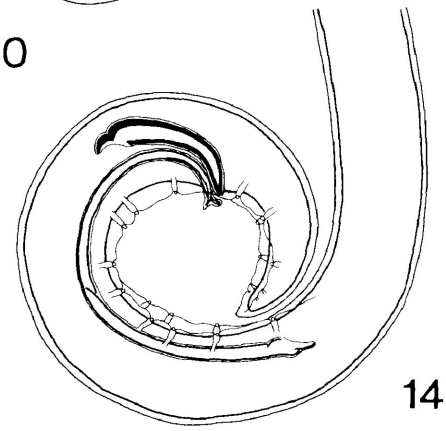

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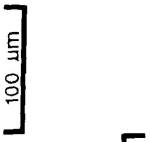
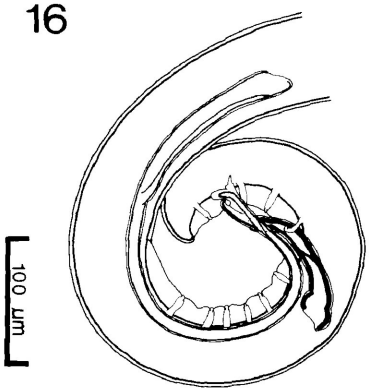




anterior to paired ones. Five pairs of postanal papillae present with adanal pair located more ventral than others. One pair of sessile papillae located just ventral to last pair of postanal pedunculated papillae. Spicules dissimilar and unequal. Right spicule short and crescent shaped. Left spicule long, slender with bifid distal end. Tail with rounded tip. Phasmids present.

Female:

Vulva, a small slit, located at mid - body. Vagina surrounded by muscle fibers, lined with cuticle and divided equally into vagina vera and vagina uterina. Didelphic, amphidelphic. Uteri filled with larvated, thick - shelled eggs. Tail tapered with slight dorsal curve. Phasmids present.

Type host: Dendragapus obscurus fuliginosus (Ridgway). Tetraonidae.

Type locality: Vancouver Island, British Columbia, Canada

(2) Molinacuaria acholonui (Schmidt and Kuntz, 1972) n. comb.

(Table 3; Figs. 15-18)

Synonyms: Viktorocara acholonui

Schmidt and Kuntz, 1972

Ancyracanthopsis acholonui

(Schmidt and Kuntz, 1972) new combination

General:

Ptilina in the form of small, sinuate shields located posterior to grooves. Buccal capsule long, narrow and lined with cuticle. Deirids not observed. Esophagus distinctly divided into two unequal portions. Muscular portion about two - thirds length of glandular portion.

Male:

Caudal extremity coiled. Caudal alae well developed and possessing six pairs of preanal and four pairs of postanal pedunculated caudal papillae. Spicules unequal and dissimilar. Right spicule short and crescent-shaped. Left spicule long and slender. Its distal end bifurcated with a sharp process at tip of main shaft. Tail with rounded tip. Phasmids present.

Female: Unknown

Type host: *Alcippe b. brunnea* Gould. Timaliidae.

Type locality: Taiwan

Diagnosis:

This species can be differentiated from M. bendelli by the morphology of the cuticular shields at the anterior end. In M. acholonui the shields are delicate with sinuated edges while in M. bendelli, they have deeply serrated edges. Moreover, the male of the former has six pairs of preanal while the latter has nine or more pairs. The left spicule of M. acholonui has a sharp process at its distal end while such a feature is absent at the distal end of the left spicule of M. bendelli.

Other species

Molinacuaria gallinulae

(Wang, 1966) new combination

Synonyms: Skrjabinobronema gallinulae Wang, 1966

Ancyracanthopsis gallinulae

(Wang) Adams and Gibson, 1969

Type host: Gallinula chloropus indica Blyth

Type locality: China

Diagnosis:

Molinacuaria gallinulae can be distinguished from M. bendelli by the morphology of the ptilina. In M. bendelli, the ptilina have irregular, sharp indentations while in M.

gallinulae each ptilinum has four lobes. In addition, the esophagus of M. gallinulae is longer than that of M. bendelli. Molinacuaria gallinulae can be differentiated from M. acholonui by the shorter left and right spicules and longer total esophagus.

Species transferred to other genera

1) Ancyracanthopsis madagascariensis Kung, 1948

The types of this species were examined and they are characterized by ptilina in the form of cuticular leaves with sharp indentations. This feature is characteristic of the genus Sobolevicephalus Parukhin, 1964b and we, therefore, transfer this species to the latter and propose a new combination Sobolevicephalus madagascariensis n. comb.

2) Ancyracanthopsis serrata (Wang, 1966) Schmidt and Kinsella, 1972

Wang (1966) described a new species Sciadiocara serrata based on specimens recovered from the crows (Corvus toquatus Lesson and C. macrorhynchus colonorum Swinhoe) in China. Schmidt and Kuntz, (1972) transferred it to its present genus. According to the original description, this species

has four prominent sublabia and the ptilina are oval - shaped with serrated edges. The oval - shaped ptilina are characteristic of the genus Sciadiocara and we, therefore, transfer this species back to the genus where it was originally assigned.

Key to species of Ancyracanthopsis

1-(2) Males with four pairs of preanal pedunculated caudal papillae ..... A. coronata

2-(1) Males with more than four pairs of pedunculated caudal papillae.

3-(4) Ptilina with numerous indentations.
.....A. petrovi

4-(3) Ptilina bissected .....A. buckleyi

Key to species of Molinacuaria

1-(2) Ptilina with sharp irregular indentations.
..... M. bendelli

2-(1) Ptilina with three rounded indentations.

..... M. gallinulae

3-(2) Ptilina with sinuate edges..... M. acholonui

Discussion

Ancyracanthopsis consists of three species. The type species, A. coronata is the most well studied. It is non-host specific, having been recovered from 16 species of hosts belonging to 8 families. It has been reported predominately in the New World and its presence in the Old World is restricted to the Soviet Union. The second species A. petrovi has only been recovered from N. p. phaeopus in the Soviet Union (Guschanskaya, 1950). The last species A. buckleyi has only been recovered from A. p. chinensis in India (Ali, 1970)

The genus Molinacuaria is characterized by the absence of sublabia and the presence of grooves located immediately anterior to the delicate ptilina. These grooves are absent in all the six genera assigned to the subfamily Schistorophinae. However, similar grooves are present at the anterior end of the monotypic genus, Ingliseria cirrohamata Gibson, 1968 of the subfamily Seuratinae. The grooves in the latter species are located immediately posterior to four delicate and serrated cuticular

ornamentations which are quite similar in form to the ptilina of Molinacuaria. Moreover, all the members of Seuratinae lack sublabia at their anterior ends. Therefore, on this basis, we regard Molinacuaria as a member of Seuratinae. This genus consists of three species, two of which are found in terrestrial birds. The type species, M. bendelli was found in D. o. fuliginosus in British Columbia, Canada while M. acholonui was recovered from A. b. brunnea in Taiwan. The third species, M. gallinulae occurs in G. c. indicus in China.

IV. Revision of the genus Sciadiocara

Sciadiocara Skrjabin, 1916

Diagnosis:

Acuarioidea; Acuariidae Railliet, Henry and Sisoff, 1912; Schistorophinae Travassos, 1918; Sciadiocara. Cuticle with transverse striations. Pseudolabia well developed with apices continuous with anterolateral walls of oral opening. Four cephalic papillae and two amphids located at bases of pseudolabia. Four pear-shaped sublabia positioned at subdorsal and subventral sides of oral opening. Ptilina in the form of rounded shields, present. They begin dorsoventrally, surround sublabia and terminate

at base of pseudolabia. Buccal capsule short and expanded anteriorly. Deirids, inconspicuous and located immediately posterior to nerve ring. Esophagus divided into muscular and glandular portions. Caudal region of male possessing six pairs of preanal and five pairs of postanal pedunculated caudal papillae.

Type species: Sciadiocara umbellifera (Molin, 1860a) Skrjabin, 1916

(1) Sciadiocara umbellifera (Molin, 1860a) Skrjabin, 1916

(Tables 1 and 2; Figs. 1-9)

Synonyms: Spiroptera umbellifera Molin, 1860a
Schistorophus umbellifera (Molin) Railliet, 1916
Spiroptera tantali rubri Molin, 1860
Spiroptera totani Molin, 1860

General:

Buccal capsule short and lined with transversely striated cuticle. Muscular esophagus significantly longer than glandular esophagus.

Male:

Table 1. Measurements of Sciadiocara spp.

	S. umbellifera[a]	S. legendrei[b]	S. bihamata[a]	S. serrata[b]	S. cucullatus[b]	S. rugosa[b]	S. chabaudi[b]
MALE							
N	2	1	2	-	1	2	1
Length, mm[1]	6.0, 6.5	5.3	4.0, 4.4	6.8-7.1**	9.4	8.0, 9.0	9.0
Width	130	80	82, 110	115-140	-	175	160
Buccal capsule	30, 40	35	50, 48	70-80	100	85, 90	110
Nerve ring[2]	120	-	95, 96	-	220	180, 200	160
Excretory pore[2]	-	-	126	-	-	260, 280	270
Deirids[2]	110	95	105, 106	-	-	240	220
Muscular oesophagus	1980, 2120	980	800, 860	1440-1560	810	655, 750	475
Glandular oesophagus	1140, 1220	1050	610, 660	1360-1460	1420	850	960
Total oesophagus	3200, 3260	2030	1410, 1520	1800-2020	2230	-	1435
Left spicule	510, 520	255	355, 365	480-560	600	360, 380	340
Right spicule	240, 245	70	130, 115	135-160	180	120	110
Tail	140, 200	75	120, 105	122-136	-	110, 115	110
FEMALE							
N	7	1	3	-	1	2	1
Length, mm[1]	10.6(8.4-12.9)*	13.3	6.1-6.8	15.5-16.8	28.0	18.0, 19.0	14.0
Width	207(180-260)	170	140-180	210-226	315	240, 320	215
Buccal capsule	42(40-50)	40	50-55	68-88	115	95, 120	130
Nerve ring[2]	165	-	105	140-146	-	240, 280	208
Excretory pore[2]	185	-	-	-	-	400	320
Deirids[2]	177	-	120-125	-	-	360	270
Muscular oesophagus	2501(1950-2950)	1060	880-970	1440-1820	810	800, 1000	650
Glandular oesophagus	1396(1270-1540)	900	640-700	1240-1640	1880	870, 1200	1310
Total oesophagus	3897(3220-4490)	1960	1570-1660	2680-3460	2690	-	1960
Vulva, mm[2]	6.4(5.5-7.5)	5.9	3.2-3.7	7.8-9.0	14.3	9.0, 9.5	7.0
Tail	108(90-130)	120	75-80	160-176	150	150	160
Vagina vera, length	100, 120	60	40-85	-	110	100	65
Vagina uterina, length	200, 190	210	80-155	-	280	160	120
Eggs	48(45-50)x21(20-23)	40x28	41(38-42)x21(20-23)	42-45x24-25	48x32	43-45x25-27	-

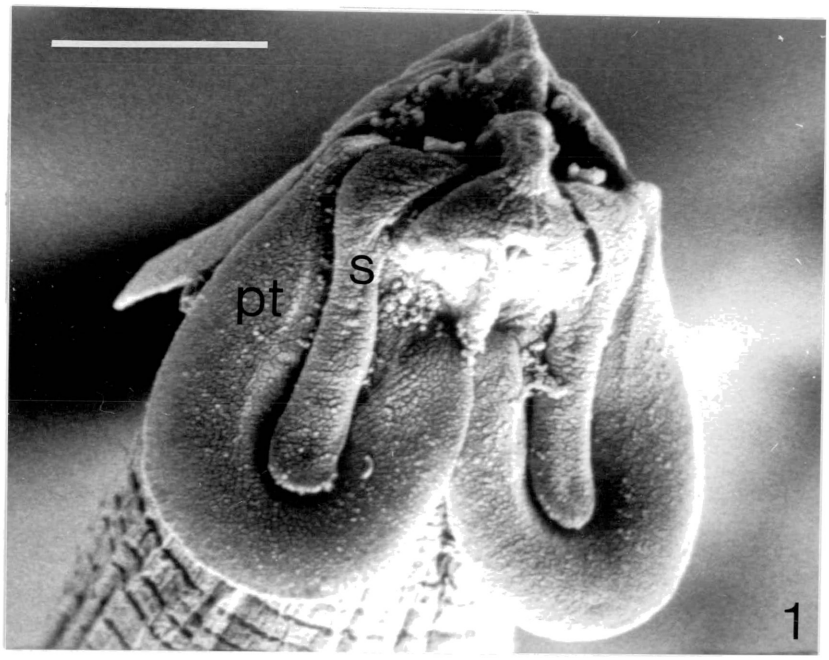
a. Measurements from present study
b. Measurements from original description
[1] Distance in micrometers, unless stated otherwise
[2] Distance to anterior end

* Mean with range in parentheses
** Range

Table 2. Hosts and geographic distribution of Sciadiocara spp.

Species	Hosts	Localities	Source
S. umbellifera	Eudocimus rubra	Brasil	Molin, 1860a
	Tringa melanoleuca	"	" "
	Eudocimus albus	Florida, U.S.A.	Bush and Forrester, 1976
	Catoptrophorus s. inornatus	Delta, Manitoba, Canada	Present study
	Pluvialis squatarola	North Carolina, U.S.A.	" "
	" "	Quebec, Canada	Gibson, 1972
	Actitis macularia	Habana, Cuba	Barus, 1969
	Larus genei	Azov Sea, S. Soviet Union	Sergeeva, 1969
	Gelochelidon n. nilotica	Kherson oblast, S. Soviet Union	Leonov, 1958
	Tringa t. totanus	Tuva, central Siberia	Sonin and Larchenko, 1974
	" " "	Estonia	Jogis, 1963
	Xenus cinereus	Keta Lake, central Siberia	Bondarenko, 1969
	Numenius p. phaeopus	Keta Lake, central Siberia	" "
	Arenaria i. interpres	Vrangelya Is., N. E. Siberia	Leonov and Shevtsova, 1970
	Actitis hypoleucus	Amursko-Ussuriiskii, E. Siberia	Oshmarin, 1963
	Calidris alpina sakhalina	" " " "	" "
S. legendrei	N. p. phaeopus	Europe	Petter, 1967
	Capella media	Europe	Skrjabin, 1916
	Larus n. scopulinus	New Zealand	Clark, 1978
	Calidris canutus rogersi	N. Territory, Australia	Mawson, 1968
S. bihamata	A. macularia	British Columbia, Canada	Gibson, 1972
	" "	Delta, Manitoba, Canada	Present study
	A. hypoleucus	Europe	Sobolev, 1949
	G. n. nilotica	W. Germany	Mueller, 1897
S. serrata	Corvus toquatus	China	Wang, 1966
	C. macrorhynchus colonorum	"	" "
S. cucullatus	Rallus elegans	Virginia, U.S.A.	Wehr, 1934
S. rugosa	Anas platyrhynchos fulvigula	Florida, U.S.A.	Schmidt and Kinsella, 1972
	" " "	" "	Kinsella and Forrester, 1972
S. chabaudi	Gallinula chloropus cachinnans	Florida, U.S.A.	Schmidt and Kinsella, 1972
	Porphyrula martinica	" "	" " "
	E. albus	" "	Bush and Forrester, 1976

Fig. 1. Scanning micrograph of Sciadiocara umbellifera. Anterior extremity, female, lateral view. Bar = 10um. Abbreviations: pt = ptilinum, s = sublabium, ps = pseudolabium.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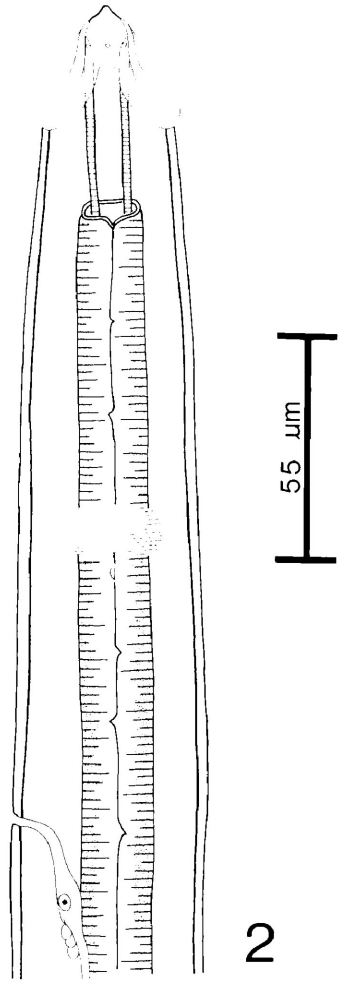
Figs. 2-9. Sciadiocara umbellifera Fig. 2. Anterior extremity, male, lateral view. Fig. 3. Caudal extremity, female, lateral view. Fig. 4. Anterior extremity, male, ventral view. Fig. 5. Right spicule, lateral view. Fig. 6 Vulva, vagina and uteri, lateral view. Fig. 7. Distal end of left spicule, lateral view. Fig. 8. Distal end of right spicule, ventral view. Fig. 9. Caudal region, male, ventral view showing caudal papillae. Abbreviations: v.v. = vagina vera, v.u. = vagina uterina.



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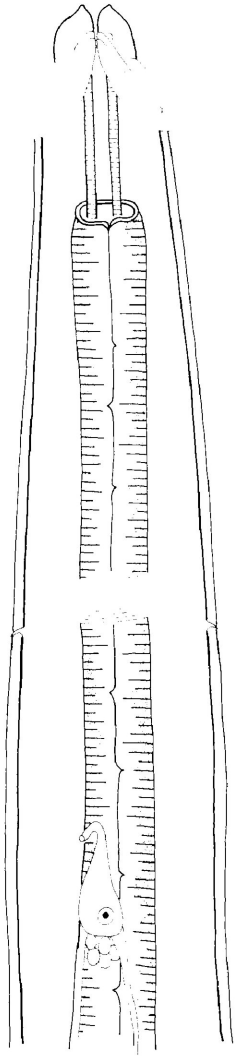

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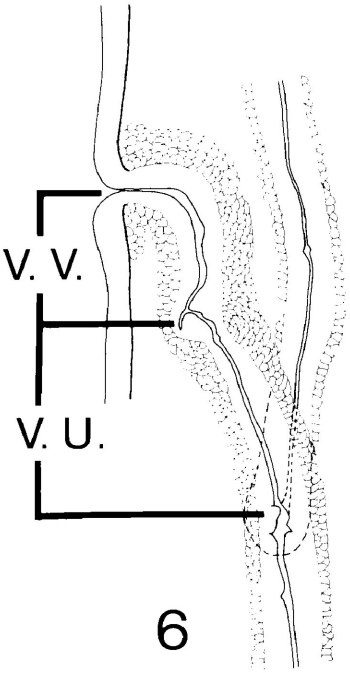

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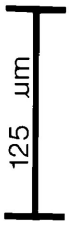

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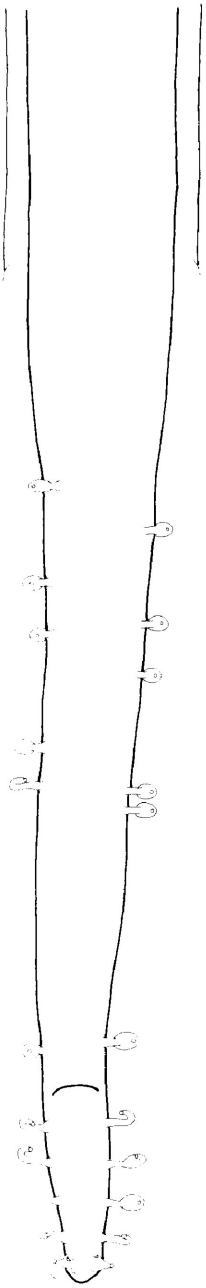

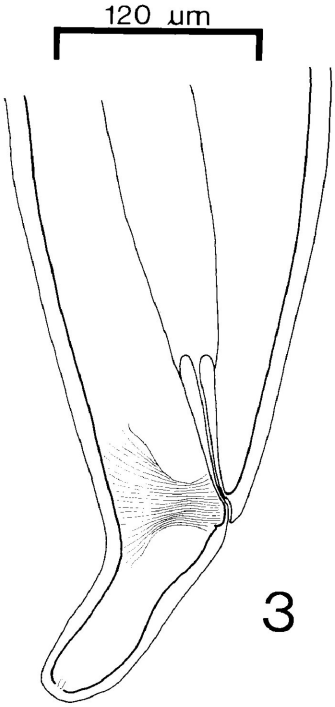

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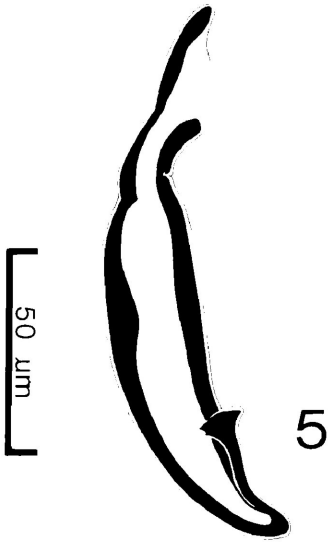

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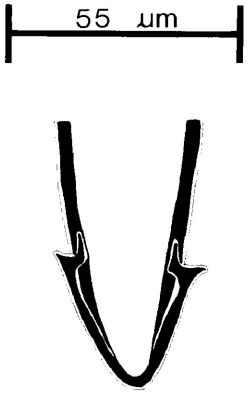

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Caudal extremity curved ventrally. Caudal alae well developed and bearing six pairs of preanal and five pairs of postanal pedunculated caudal papillae. Single pair of sessile papillae located immediately ventral to last pair of pedunculated papillae. Spicules unequal and dissimilar. Left spicule long, slender and distal end consisting of three sclerotized projections surrounded by prominent cuticular alae. Right spicule crescent shaped with a pair of lateral wings near rounded distal end. Tail short with rounded tip. Phasmids present.

Female:

Vulva round and located near mid-body. Vagina surrounded by muscle fibers and divided equally into vagina vera and vagina uterina. Tail dorsally curved with rounded tip. Phasmids present.

Host: Catoptrophorus semipalmatus inornatus. (Brewster) Scolopacidae.

Prevalence: 17% (5/29)

Intensity: 4.0(4-10)

Specimens: NMCICP1983-0883
USNMH Coll. No. 77926

Localities: Delta Marsh, Manitoba, Canada
(50 12'N, 98 12'W)
Oaklake, Manitoba, Canada
(49 42'N, 100 47'W)

Brooks, Alberta, Canada

(5Ø 35'N, 111 53'W)

Cowoki Lake, Alberta, Canada

(5Ø 35'N, 111 42'W)

Foremost, Alberta, Canada

(49 29'N, 111 25'W)

Fort Fischer, North Carolina,

United States (33 57'N, 77 56'W)

Host: Pluvialis squatarola (L.). Scolopacidae.

Prevalence: 1ØØ% (3/3)

Intensity: 2.3 (1-4)

Locality: Fort Fischer, North Carolina, United States

Comments:

Molin (186Øa) described Spiroptera umbellifera from Eudocimus rubra (L.) (= Ibis rubra) and Tringa melanoleuca (Gmelin) (= Totanus melanoleucus) in Brazil. Skrjabin (1916) proposed the genus Sciadiocara and designated umbellifera as its type species. He also provided a redescription of S. umbellifera based on specimens recovered from Capella media (Latham) (= Scolopax major) in Turkestan, Soviet Union. Subsequently, Cram (1927) and Skrjabin et. al. (1965) accepted the redescription of this

species by Skrjabin (1916).

The types (Coll. No. 6706) consisted of one complete female and two decapitated females. The major dimensions of the complete female are as follows: Length, 12.5mm; buccal capsule, 40um long; nerve ring, 200um from anterior end; muscular and glandular esophagus 3.1mm and 1.6mm long, respectively; vulva 7.4mm from anterior end; vagina vera 100um in length and vagina uterina 150um long.

In the present study, specimens of Sciadiocara were recovered from the western willet and Gray plover. The major dimensions of these females were indistinguishable from those of the type of S. umbellifera. On this basis, we conclude that the males and females from these two waders were members of this species. These specimens were also compared with those from C. media as described by Skrjabin (1916) and major differences were discovered. Specifically, males from C. media had left and right spicules which were 330um and 81um in length, respectively. On the other hand, the left and right spicules of S. umbellifera recovered from the present study were 5.0,520um and 240,245um long, respectively. Specimens from C. media were compared with the original description of S. legendrei Petter, 1967 and found to be identical. They are therefore, regarded as members of S. legendrei.

Gibson (1972) had synonymized S. legendrei from Numenius p. phaeopus (L.) from Europe with S. umbellifera. The paratype (female) of S. legendrei, (Coll. No. 616G) was examined and its vagina vera was 60um and vagina uterina was 210um in lengths; thus the ratio of the vagina vera to the vagina uterina is approximately 1:3.5. In contrast, this ratio in S. umbellifera is approximately 1:2. Furthermore, from the original description of S. legendrei, the lengths of both spicules and the muscular esophagus are also significantly different from those of S. umbellifera. On this basis, we herein regard S. legendrei as valid.

(2) Sciadiocara bihamata

(Mueller, 1897) new combination

(Tables 1 and 2; Figs. 10-18)

Synonyms: Ancyracanthus bihamatus Mueller, 1897

Ancyracanthopsis bihamata

(Mueller) Cram, 1927

Schistorophus bihamatus (Mueller)

Skrjabin, Sobolev and Ivashkin, 1965

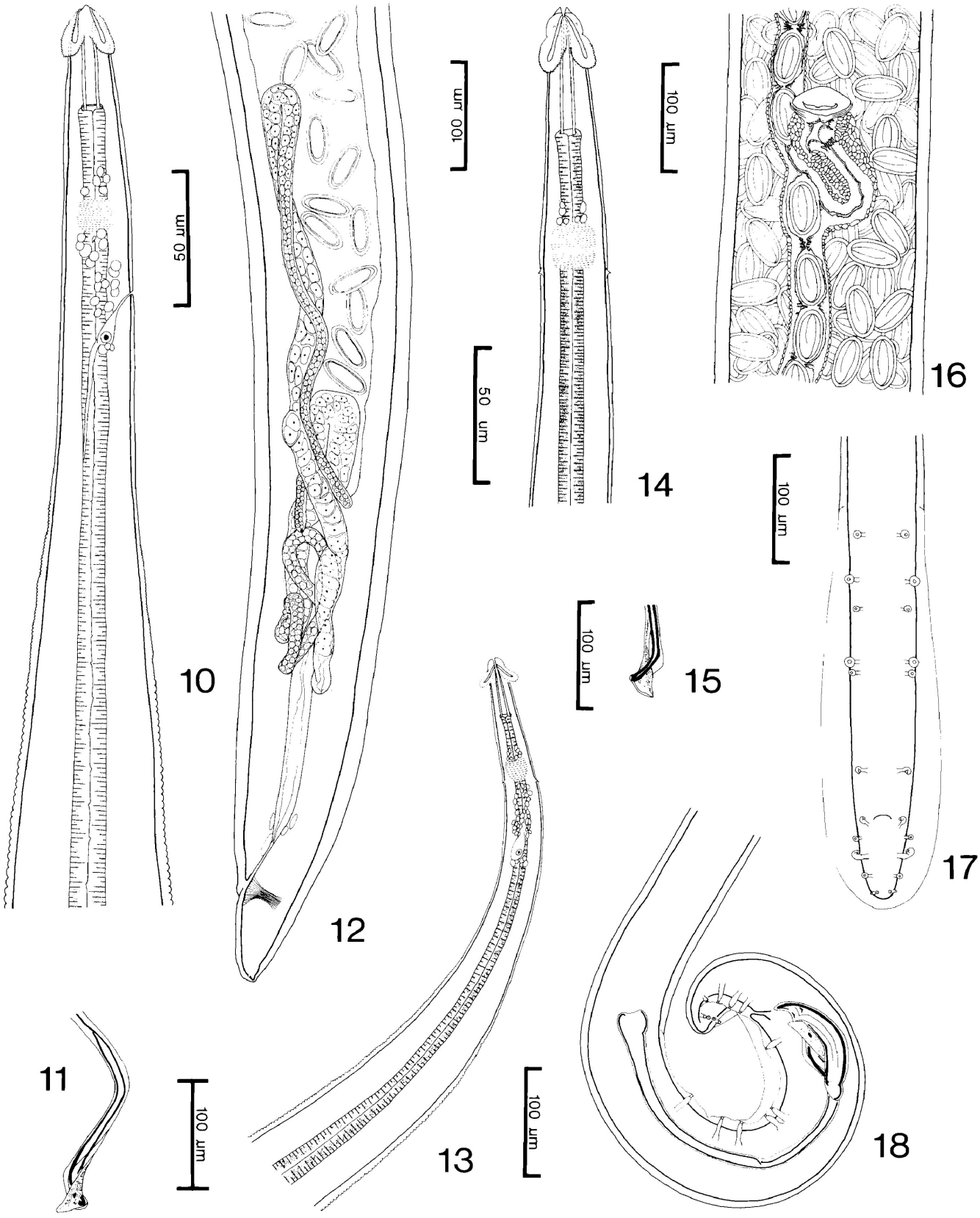
Sciadiocara umbellifera

Sobolev, 1949 not Molin, 1860a

Sciadiocara denticulata Gibson, 1972

General:

Figs. 10-18. Sciadiocara bihamata Fig. 10. Anterior extremity, male, lateral view. Fig. 11. Distal end of left spicule, right side of lateral view. Fig. 12. Caudal extremity, female, lateral view. Fig. 13. Anterior extremity, female, ventral view showing the attenuation of anterior region with longitudinal cuticular striations. Fig. 14. Anterior extremity, female, dorsal view. Fig. 15. Distal end of left spicule, left side of lateral view. Fig. 16. Vulva, vagina and uteri, ventral view. Fig. 17. Caudal region male, ventral view showing caudal papillae. Fig. 18 Caudal extremity, male, lateral view showing spicules and caudal papillae.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100 um
15
100 um
17
11
100 um
13
100 um
18

Filiform worms. Anterior extremity, strongly attentuated. Cuticle at anterior third of worm with longitudinal striations while rest of body cuticle with transverse striations. Ptilina in form of oval-shaped shields with fine serrated edges. Buccal capsule, short and lined with cuticle. Deirids, small and positioned just posterior to nerve ring. Esophagus divided into two portions. Muscular portion slightly longer than glandular portion.

Male:

Caudal extremity with strong ventral curve. Caudal alae well developed and bearing six pairs of preanal and five pairs of postanal pedunculated caudal papillae. Third and fifth pair of preanal papillae, slightly smaller with the fifth in close proximity to fourth pair. First pair of postanal pedunculated papillae located more ventrally than others. One pair of sessile papillae located just ventral to last pair of postanal pedunculated papillae. Spicules unequal and dissimilar. Right spicule, short, crescent shape and possessing two sharp processes near pointed distal end. Left spicule long, slender with distal end bending ventrally and spicular ala twisting once around it. Tail, short with rounded tip. Phasmids present.

Female:

Vulva, an inconspicuous slit, located at mid-body. Vagina surrounded by muscle fibers and lined with cuticle. Vagina divided distinctly into vagina vera and vagina uterina. Vagina vera slightly more than half length of vagina uterina. Didelphic, amphidelphic. Uteri packed with larvated thick-shelled eggs. Tail, short with rounded tip. Phasmids present.

Host: Actitis macularia L. Scolopacidae.

Prevalence: 7% (1/14)

Intensity: 5.Ø

Specimens: NMCICP1983-Ø881 (neotype)
NMCICP1983-Ø882

Locality: Delta Marsh, Manitoba, Canada

Diagnosis:

Sciadiocara bihamata is small and filiform while S. umbellifera is medium size and robust. The serrated edges of the cuticular shields also readily differentiate the former from the latter. Furthermore, the muscular esophagus of S. bihamata is only slightly longer than the glandular esophagus. In contrast, the muscular portion of S. umbellifera is significantly longer than the glandular portion. Both the spicules of S. bihamata are shorter than those of S. umbellifera and the morphology of the distal end of the left spicule is also different in the two species.

Comments:

Mueller (1897) described A. bihamatus based on specimens recovered from the tern (Gelochelidon n. nilotica (Gmelin)) (= Sterna risoria) in West Germany. The types have been lost (Dr. Hartwich, personal communication) but Mueller provided adequate illustrations of this species. For instance, the conspicuous attenuation of the anterior portion of the worms, the characteristic position of the preanal caudal papillae of the male tail and the morphology of the distal end of the left spicule were well documented. Sobolov (1949) identified nematodes recovered from the Eurasian sandpiper (Actitis hypoleucas (L.)) in Europe as S. umbellifera. The morphometric measurements of these specimens, however, were indistinguishable from those of S. bihamata. They are thus regarded as members of this species.

The types of S. denticulata Gibson, 1972 from the spotted sandpiper in British Columbia, Canada were studied and compared with the original description of S. bihamata. On this basis, we considered S. denticulata as a synonym of S. bihamata. In the present study, specimens of S. bihamata were recovered from the spotted sandpiper in Delta Marsh, Manitoba, Canada. We have provided a redescription of the species and designated a male specimen from this series of worms as a neotype and deposited it in the National Museums of Canada (Coll. No. NMCICP1983-Ø881).

(3) *Sciadiocara cucullatus*

(Wehr, 1934) Schmidt and Kinsella, 1972

(Tables 1 and 2; Figs. 19-23)

Synonyms: *Schistorophus cucullatus* Wehr, 1934

Viktorocara cucullatus

(Wehr) Skrjabin, Sobolev and Ivashkin, 1965

General:

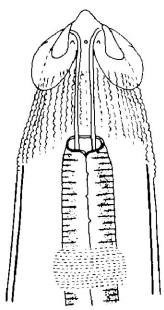
Thin, triangular cuticular plates surrounding anterior region of body. They begin immediately behind pseudolabia and terminate at junction of buccal capsule and esophagus. Buccal capsule short and expanded anteriorly. Deirids, inconspicuous and located just posterior to nerve ring. Muscular esophagus about one half length of glandular esophagus.

Male:

Caudal extremity tightly coiled. Caudal alae well developed and bearing five preanal and four postanal pedunculated caudal papillae arranged in two parallel rows. First four pairs of preanal papillae located equi distant. Last pair just adjacent to fourth pair. Postanal papillae arranged in following manner; one set of double pairs followed by two single pairs. Spicules unequal and dissimilar. Right spicule, short, crescent shaped and with rounded distal end. Left spicule, long and slender with simple rounded distal end. Tail with rounded tip. Phasmids present.

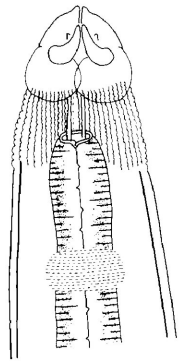
Figs. 19-23. Sciadiocara cucullatus Fig. 19. Anterior extremity, female, lateral view. Fig. 20. Anterior extremity, female, dorsal view. Fig. 21. Caudal region, male, lateral view showing spicules and caudal papillae. Fig. 22. Vulva, vagina and uteri, lateral view. Fig. 23. Caudal extremity, female, lateral view.

Figs. 24-30. Sciadiocara chabaudi Fig. 24. Distal end of left spicule, lateral view. Fig. 25. Caudal region, male, lateral view showing spicules and caudal papillae. Fig. 26. Anterior extremity, male, lateral view. Fig. 27. Anterior extremity, male, dorsal view. Fig. 28. Vulva, vagina and uteri, lateral view. Fig. 29. Caudal extremity, female, lateral view. Fig. 30. Anterior region, male, lateral view.



125 µm

19



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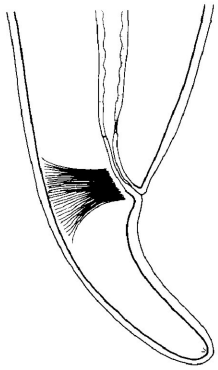
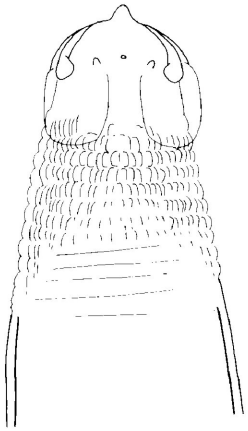


23

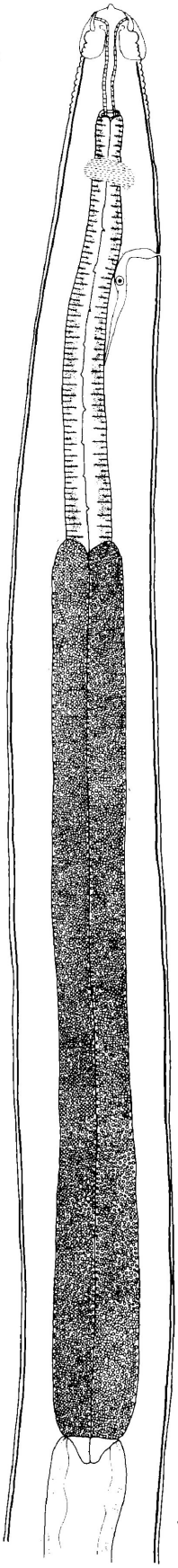
125 µm



26

55 µm

150 µm



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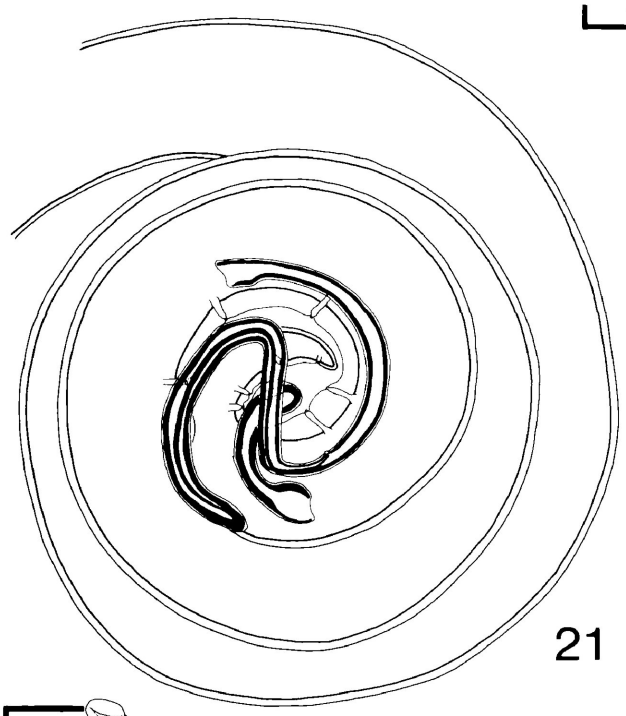

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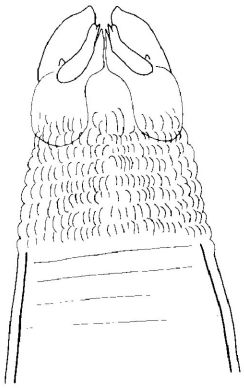
125 µm

24

40 µm



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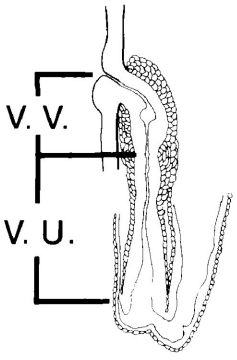
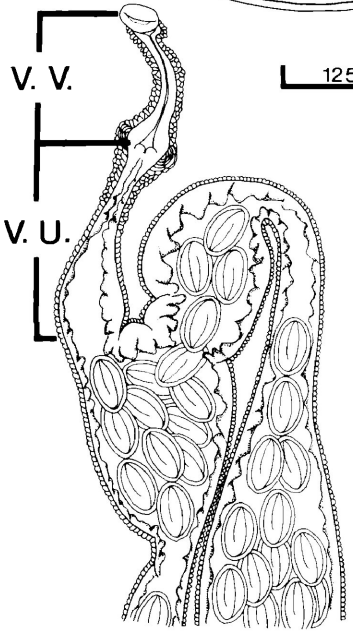


V. V.

V. U.

28

125 µm

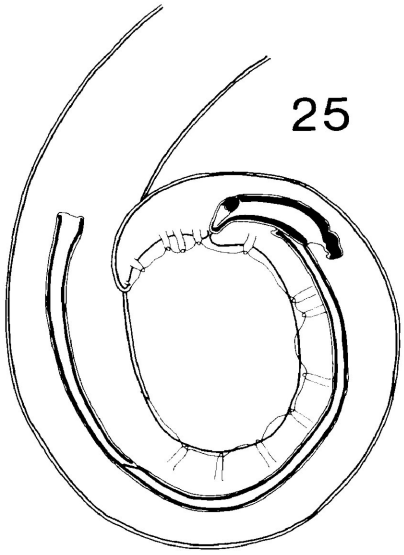


V. V.

V. U.

125 µm

22



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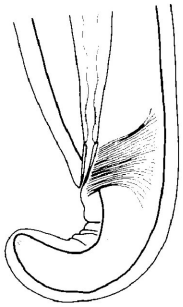


100 µm

29

Female:

Vulva, an inconspicuous slit, located at mid-body. Vagina surrounded by muscle fibers, lined with cuticle and divided into vagina vera and vagina uterina. Length of vagina vera about one third that of vagina uterina. Didelphic, amphidelphic. Uteri filled with larvated, thick-shelled eggs. Tail with ventral curve. Phasmids present at rounded tip of tail.

Type host: Rallus e. elegans Audubon. Rallidae.

Type locality: Virginia, United States

Comments:

The presence of the cuticular plates which surround the anterior extremity of the worms, readily distinguishes this species from S. umbellifera, S. bihamata and S. legendrei.

(4) Sciadiocara chabaudi

Schmidt and Kinsella, 1972

(Tables 1 and 2; Figs. 24-30)

General:

Triangular cuticular plates surround anterior extremity. They begin behind pseudolabia and extend posteriorly to buccal capsule-esophageal junction. Buccal capsule short, expanded anteriorly and lined with cuticle. Deirids, small and located near nerve ring. Esophagus divided into muscular and glandular portions. Length of muscular portion less than half that of glandular portion.

Male:

Caudal region curved ventrally. Caudal alae well developed and bearing eight pairs of preanal and five pairs of postanal pedunculated caudal papillae. Preanal papillae consisted of four single pairs followed by one double pair and another single pair. First three pairs of postanal papillae separated from last two pairs. Spicules unequal and dissimilar. Right spicule short with processes present on lateral sides of distal end. Left spicule long, slender with simple pointed distal end. Tail with rounded tip. Phasmids present.

Female: Unknown.

Type hosts: Gallinula chloropus cachinnans Bangs. Rallidae.

Porphyrula martinica (L.). Rallidae.

Type locality: Florida, The United States

Diagnosis:

This species is similar to S. cucullatus but can be differentiated from the latter by the length and morphology of the distal end of the left spicule. Also, S. chabaudi has eight pairs of preanal pedunculated caudal papillae while S. cucullatus has four.

(5) Sciadiocara rugosa

Schmidt and Kinsella, 1972

(Tables 1 and 2; Figs. 31-39)

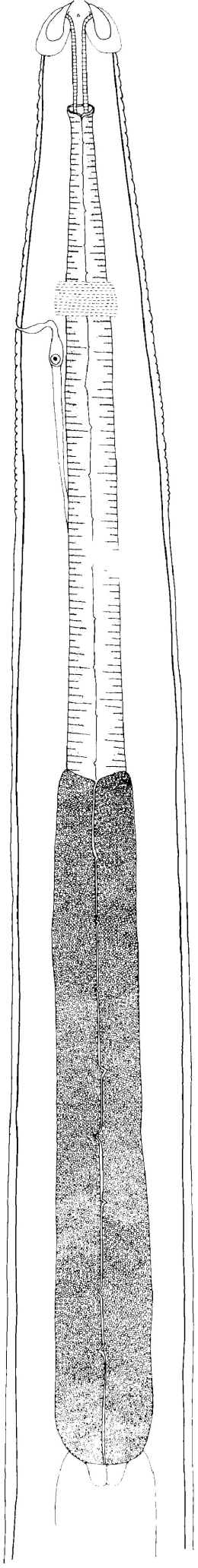
General:

Triangular cuticular plates surround anterior extremity. They begin behind pseudolabia and extend posteriorly to three quarters length of muscular esophagus. Small deirids with pointed tips located near nerve ring. Esophagus divided equally into muscular and glandular portions.

Male:

Caudal extremity with strong ventral curve. Caudal alae well developed. Six pairs of preanal and five pairs of postanal pedunculated papillae arranged in two parallel rows along caudal alae. Preanal papillae distributed as three single pairs followed by one double pair and one single pair closed to anus. First three pairs of postanal papillae

Figs. 31-39. Sciadiocara rugosa Fig. 31. Anterior region, female, lateral view. Fig. 32. Anterior extremity, female, lateral view showing the thin cuticular plates. Fig. 33. Right spicule, lateral view. Fig. 34. Anterior extremity, female, dorsal view. Fig. 35. Caudal extremity, male, ventral view. Fig. 36. Caudal extremity, female, lateral view. Fig. 37. Distal end of left spicule, lateral view. Fig. 38. Vulva, vagina and uteri, lateral view. Fig. 39. Caudal region, male, lateral view showing spicules and caudal papillae.



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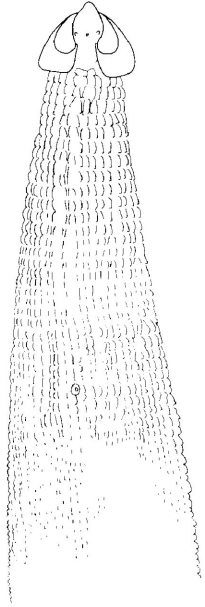

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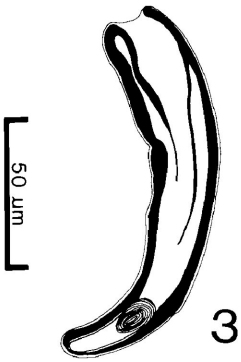

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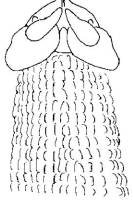

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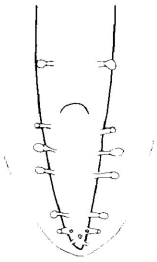

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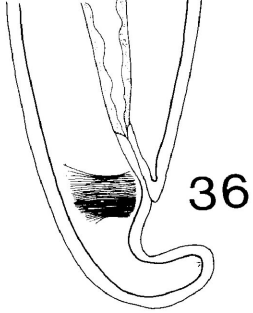

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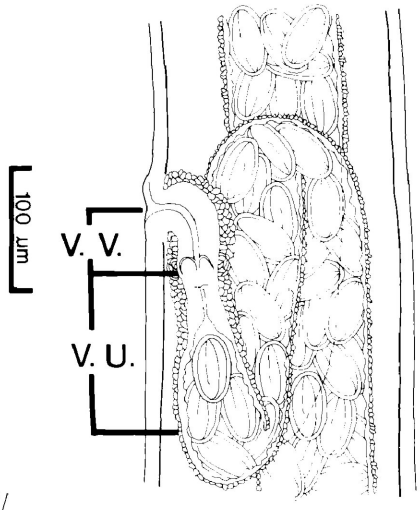

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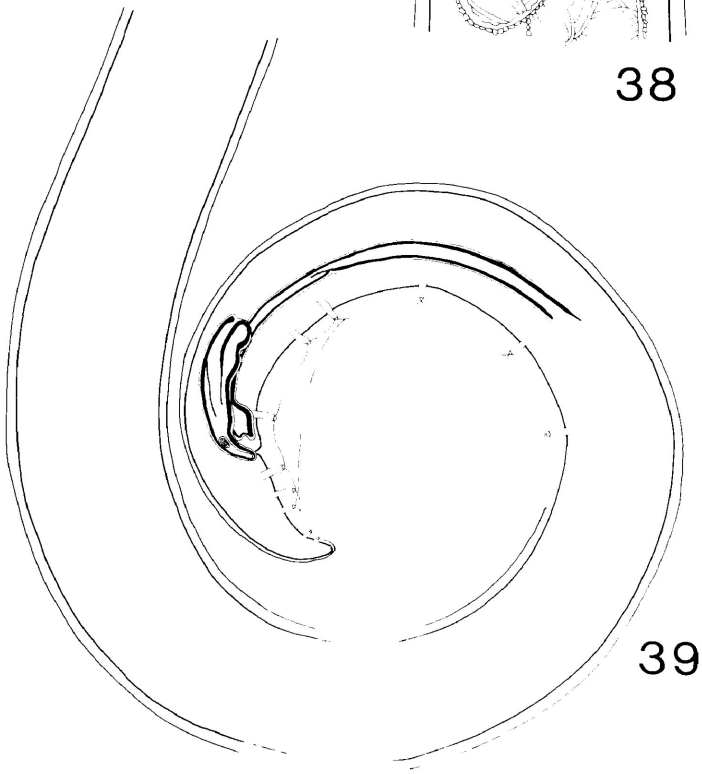


39

separated from last two pairs. One pair of sessile papillae located ventral to last pair of postanal pedunculated papillae. Spicules dissimilar and unequal. Right spicule short with rounded processes located on lateral sides of distal end. Left spicule long, slender with a club-shaped distal end. Tail with rounded tip. Phasmids present.

Female:

Vulva, an inconspicuous slit, located at mid-body. Vagina surrounded by muscle fibers, lined with cuticle and divided into vagina vera and vagina uterina. Vagina vera about two-third length of vagina uterina. Didelphic, amphidelphic. Uteri packed with larvated, thick-shelled eggs. Tail short with strong ventral curve. Phasmids present.

Type host: Anas playtyrhynchus fulvigula. Anatidae.

Type locality: Florida, United States

Diagnosis:

Sciadiocara rugosa can be distinguished from S. cucullatus by the following: The cuticular plates in S. rugosa extend significantly further along the body than those of S. cucullatus. The left spicule of the former is shorter and its morphology different from that of the latter. The esophagus of S. rugosa is divided equally into the muscular and glandular portions while in S. cucullatus,

the muscular esophagus is about one-half the length of the glandular esophagus. Finally, the ratio of the length of the vagina vera to the vagina uterina of S. rugosa is 1:3 while that of S. cucullatus is 2:3.

This species is distinct from S. chaubaudi by having those cuticular plates which extends to the midddle of the muscular esophagus. The distal end morphology of the left spicule is also different between the two species. The left spicule of S. chabaudi has a simple, pointed distal end while that of S. rugosa is club-shaped. The muscular esophagus of S. chabaudi is less than half the length of the glandular esophagus. In constrast, the muscular esophgeal length of S. rugosa is equal to that of the glandular esophagus. Finally, the length of the vagina vera is about two-thirds that of the vagina uterina in female S. rugosa while the vagina vera of S. chabaudi is about half the length of the vagina uterina.

Other species

1) Sciadiocara legendrei, Petter, 1967

Synonyms: Sciadiocara umbellifera

Skrjabin, 1916 not Molin, 1860a

Sciadiocara tarapunga Clark, 1978

Type host: *Numenius phaeopus phaeopus* (L.).
Scolopacidae.

Type locality: Europe.

Diagnosis:

This species can be differentiated from *S. umbellifera* by the following: The muscular esophagus of *S. legendrei* is only slightly longer than the glandular esophagus while in *S. umbellifera* the muscular portion is significantly longer than the glandular portion. The lengths of both spicules of the two species are significantly different. The morphology of the distal end of the left spicule of each species is also distinct. Finally, in *S. legendrei* the ratio of the vagina vera to the vagina uterina is 1:3.1 while that of *S. umbellifera* is 1:1.6.

Sciadiocara legendrei can be distinguished from *S. bihamata* by the lack of serration at the edges of the ptilina. Furthermore, the length of the left spicule of the former is shorter than that of the latter. Finally, the morphology of the distal end of the left spicule is different in the two species. The lack of triangular cuticular plates around the anterior end of this species, easily distinguishes it from *S. cucullatus*, *S. chabaudi* and *S. rugosa*.

Comments:

The original description of S. tarapunga Clark, 1978 from the red-billed gull (Larus novachollandiae scopulinus Forster) from New Zealand is indistinguishable from the type of S. legendrei. We therefore, regard the former to be a synonym of the latter.

2) Sciadiocara serrata Wang, 1966

Synonym: Ancyracanthopsis serrata (Wang) Schmidt and Kinsella, 1972

Type hosts: Corvus toquatus Lesson. Corvidae.

C. macrorhynchus colonorum Swinhoe. Corvidae.

Type locality: China

Diagnosis:

This species can be readily distinguished from S. umbellifera and S. legendrei by the markedly serrated edges of the ptilina. It can be distinguished from S. bihamata by the general size of both sexes. Males of S. serrata are twice and females about three times longer than those of S. bihamata, respectively. Furthermore, the male of S. serrata has longer left and right spicules and four more pairs of preanal caudal papillae than S. bihamata. The lack of triangular cuticular plates around the anterior end of this species readily distinguishes it from S. cucullatus, S. chabaudi and S. rugosa.

nomen nudum

The species S. secunda Skrjabin, 1916 from the crow (Corvus monedula) was proposed without a description and we, hereby, regard it as a nomen nudum.

Key to species of Sciadiocara

1-(8) Thin, triangular cuticular plates absent from anterior region of body.

2-(5) Ptilina without serrated edges.

3-(4) Left and right spicules greater than 500um and 200um long, respectively.

..... S. umbellifera

4-(3) Left and right spicules less than 500um and 100um long, respectively. ..... S. lengendrei

5-(2) Ptilina with serrated edges.

6-(7) Total lengths of males less than 6.0mm and females less than 10.0mm.

Left spicule less than 400um long.

..... S. bihamata

7-(6) Total lengths of males greater than 6.0mm and

females greater than 10.0mm.

Left spicule greater than 400um long.

..... S. serrata

8-(1) Thin, triangular cuticular plates present at anterior region of body.

9-(10) Cuticular plates extend to three quarters length of muscular esophagus.

..... S. rugosa

10-(9) Cuticular plates extend to buccal capsule-esophageal junction.

11-(12) Left spicule, 600um long. ..... S. cucullatus

12-(11) Left spicule, 340um long. ..... S. chabaudi

Discussion

Since Molin(1860) recovered S. umbellifera from E. ruber and T. melanoleuca in Brazil, this species has been reported from three species of waders and one species of ibis in North America (see Table 2). In the present study, it was present in the western willet and Gray plover. In Europe, it has been reported from Estonia, across the Soviet Union to the eastern coast of Siberia. Here, its hosts included six species of waders and two species of larids.

Sciadiocara legendrei has been reported from Europe, Australia and New Zealand. Thus, in the Old World, the geographic ranges of these species overlap. Now that these two species are well characterized, previous reports of S. umbellifera which only listed its presence should be validated. The results of such studies would provide a better understanding of the relationship between the two species.

Sciadiocara bihamata is not common in waders. In North America, it was recovered from 17% of the spotted sandpipers examined by Gibson. In Europe, it has been reported from A. hypoleuca and G. n. nilotica.

The status of S. serrata is unclear. It has only been reported from Corvus spp. in China. Morphologically, its serrated ptilina are similar to those of S. bihamata.

The remaining three species, S. cucullatus, S. rugosa and S. chabaudi have only been reported from southern United States. They all possess triangular cuticular plates at their anterior extremities. Further studies are needed before we can understand their relationships within this genus.

V. Revision of the genus Sobolevicephalus

Sobolevicephalus Parukhin, 1964b

Synonym: Smetaleksenema Schmidt and Kuntz, 1972

Diagnosis:

Acuarioidea; Acuariidae Railliet, Henry and Sisoff, 1912; Schistorophinae Travassos, 1918; Sobolevicephalus Parukhin, 1964. Cuticle with transverse striations. Oral opening, circular with two pairs of teeth at lateral sides. Pseudolabia well developed with conical apices continous with anterolateral walls of buccal capsule. One pair of cephalic papillae and an amphid present on each pseudolabium. Prominent sublabia present on subdorsal and subventral sides of oral opening which extend posteriorly beyond base of pseudolabia. Ptilina in the form of leaves with irregular indentations begin dorsoventrally and surround sublabia. Deirids, small with pointed tips located at nerve ring. Buccal capsule, short and lined with transversely striated cuticle. Esophagus divided equally into muscular and glandular portions.

Type species: Sobolevicephalus chalcyonis Parukhin, 1964b

Location: Under gizzard linings of birds.

(1) Sobolevicephalus chalcyonis Parukhin, 1964b

(Table 1; Figs. 1-5)

Synonyms: Hadjelia chalcyonis (Parukhin) Chabaud, 1975

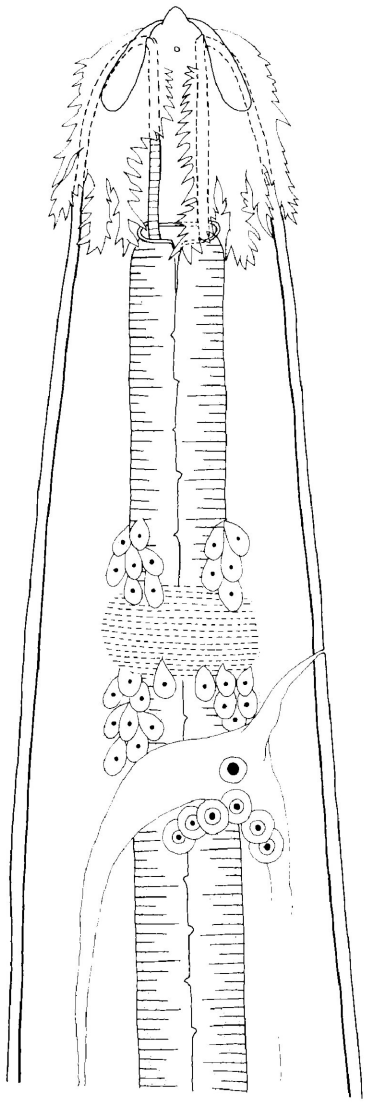
Table 1. Measurements of Sobolevicephalus spp.

	S. chalcyonis[a]	S. lichtenfelsi[b]	S. madagascariensis[c]
MALE			
N	1	15	1
Length, mm[1]	5.5	8.6(7.1-9.4)*	6.1
Width	125	172(160-190)	120
Buccal capsule	40	53(50-60)	32
Nerve ring[2]	120	180(150-200)	-
Excretory pore[2]	-	238(195-270)	-
Deirids[2]	110	178(150-200)	-
Muscular oesophagus	1370	1107(935-1205)	810
Glandular oesophagus	1260	1207(1100-1400)	1157
Total oesophagus	2630	2113(1385-2605)	-
Left spicule	730	1616(1355-1685)	300
Right spicule	160	197(180-210)	100
Tail	125	258(230-280)	-
FEMALE			
N	3	12	2
Length, mm[1]	6.9-8.0**	14.1(12.8-14.8)	14.4
Width	160-180	269(170-340)	270
Buccal capsule	40-45	55(50-60)	37-40
Nerve ring[2]	120-135	198(180-211)	-
Excretory pore[2]	130	277(265-291)	-
Deirids[2]	100-125	206(190-226)	-
Muscular oesophagus	1780-1970	1300(1150-1430)	815, 973
Glandular oesophagus	1615-1750	1441(1250-1600)	1709, 1953
Total oesophagus	3530-3585	2748(2480-2980)	-
Vulva, mm[2]	4.5-4.8	7.9(6.9-9.5)	7.4
Tail	60-85	100(85-122)	102, 131
Vagina vera, length	114	535(360-900)	50
Vagina uterina, length	250	186(120-250)	250
Eggs	-	39(30-40)x20(19-21)	39-40x25-28

a. Measurements from museum specimens
b. Measurements from present study
c. Measurements from original description

[1] Measurements in micrometers, unless stated otherwise
[2] Distance to anterior end
* Mean with range in parentheses
** Range

Figs. 1-5. Sobolevicephalus chalcyonis Fig. 1. Anterior region, female, lateral view. Fig. 2. Caudal region, female, lateral view. Fig. 3. Vulva, vagina and uteri, lateral view. Fig. 4. Anterior extremity, female, dorsal view. Fig. 5. Caudal region, male, lateral view showing spicules and caudal papillae. Abbreviations: v.v. = vagina vera, v.u. = vagina uterina.



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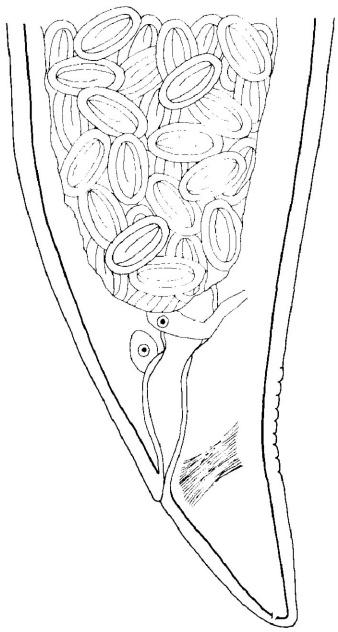

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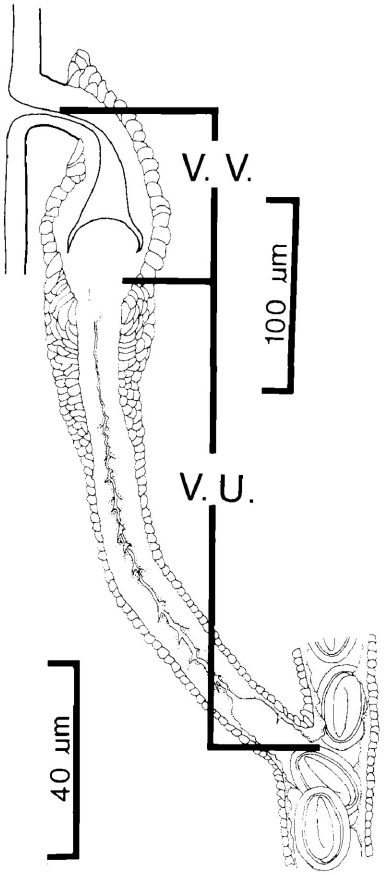

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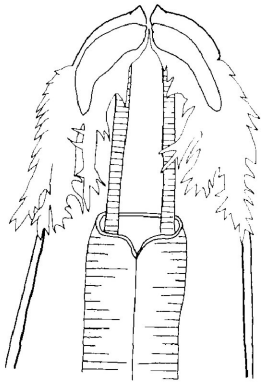

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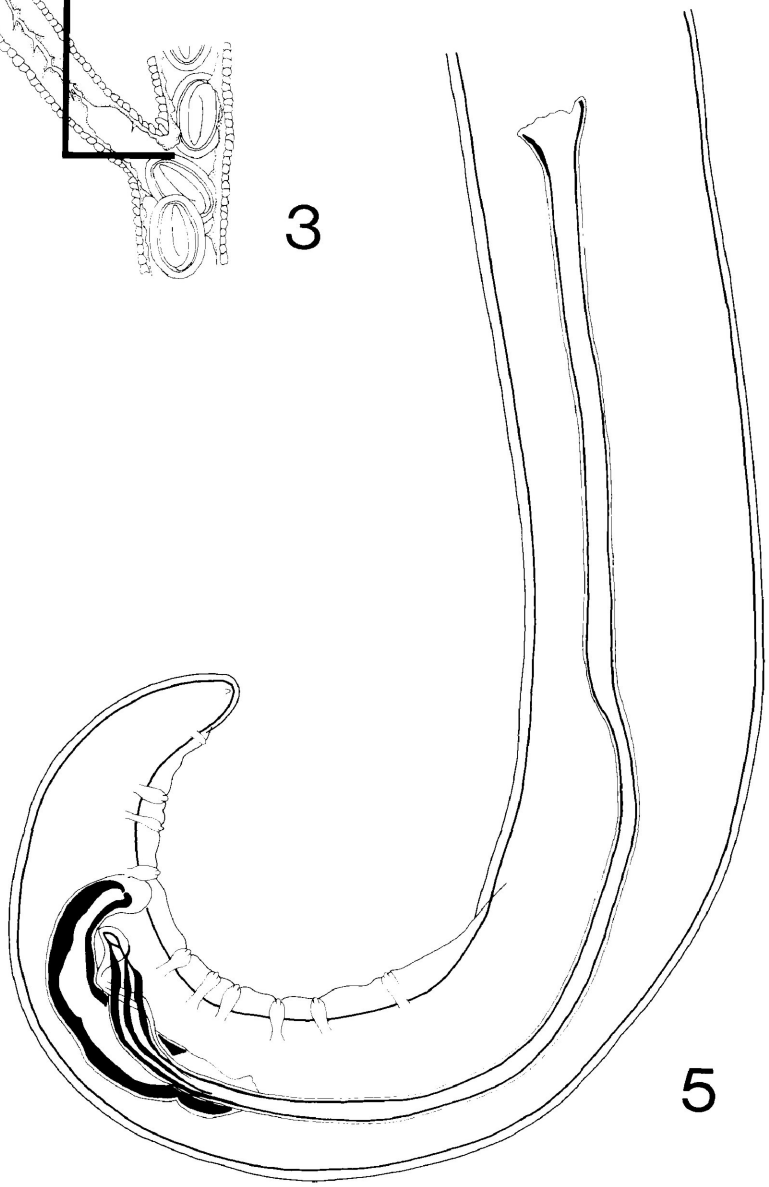


5

Skrjabinobronema pileati

Smetanina and Alekseev, 1968

Sobolevicephalus pileati

(Smetanina and Alekseev) Smetanina, 1972

Smetaleksenema pileati

(Smetanina and Alekseev)

Schmidt and Kuntz, 1972

Ancyracanthopsis pileati

(Smetanina and Alekseev) Chabaud, 1975

General:

Four ptilina in the form of leaves with irregular indentations and serrated edges.

Male:

Caudal region tightly coiled. Caudal alae prominent, bearing six pairs of preanal and four pairs of postanal pedunculated caudal papillae. Preanal papillae arranged in following manner; a single pair located anteriomost followed by two sets of double pairs and one single pair. First pair of postanal located immediately posterior to anus, followed by one set of double pairs and last single pair of smaller papillae. One pair of sessile papillae present just ventral to last pair of postanal pedunculated papillae. Spicules unequal and dissimilar. Left spicule, long with a cuticular flange twisted once around distal end. Right spicule short, crescent shaped with rounded distal end. Tail with rounded tip. Phasmids present.

Female:

Vulva located at posterior half of body. Vagina lined with cuticle, surrounded by muscle fibers and distinctly divided into vagina vera and vera uterina. Vagina vera approximately one half length of vagina uterina. Didelphic, amphidelphic. Uteri packed with larvated thick - shelled eggs. Tail, short with rounded tip. Phasmids present.

Host: Halcyon coromanda major (Temminck and Schlegel). Alcedinidae.

Locality: Taiwan.

Comments:

Smetanina and Alekseev (1968) described a new species Skrjabinobronema pileati based on a female recovered from a kingfisher (Halcyon pileata (Boddaert)) in Rimsky-Korsakov Island, USSR. Adams and Gibson (1969) in their revision of Ancyracanthopsis placed Skrjabinobronema into synonymy but commented that S. pileati does not belong to the former genus. Later, Schmidt and Kuntz (1972) identified pileati from H. cormanda major in Taiwan and also noting its unique ptilina, proposed a new genus Smetaleksenema and designated pileati as the type species. Concurrently, Smetanina (1972) after examining additional material of pileati, placed the species into synonymy with Sobolevicephalus chalcyonis Parukhin, 1964 which belongs to the subfamily Histiocephalinae (Habronematoidea). Chabaud (1975) in the CIH Keys was apparently unaware of Smetanina's (1972)

decision and synonymized Smetaleksenema with Ancyracanthopsis and Sobolevicephalus with Hadjelia Gendre, 1922. Finally Parukhin (1978) unaware of the preceding works of Smetanina (1972) and Chabaud (1975) regarded pileati and chalcyonis as conspecific, and correctly synonymized Smetaleksenema with Sobolevicephalus and transferred the latter to the subfamily Schistorophinae.

Sobolevicephalus lichtenfelsi n.sp.

(Table 1; Figs. 6-14)

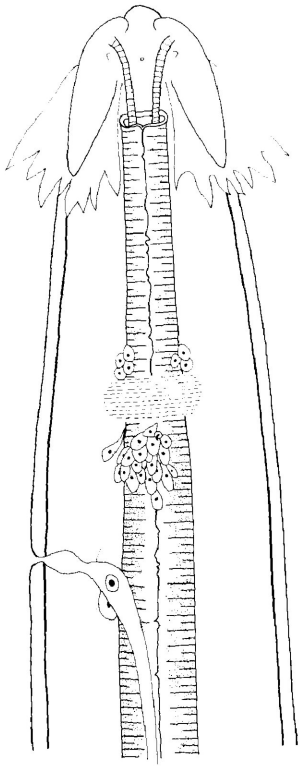
General:

Four ptilina in the form of leaves with irregular, sharp indentations. Deirids, small with pointed tips located immediately posterior to nerve ring.

Male:

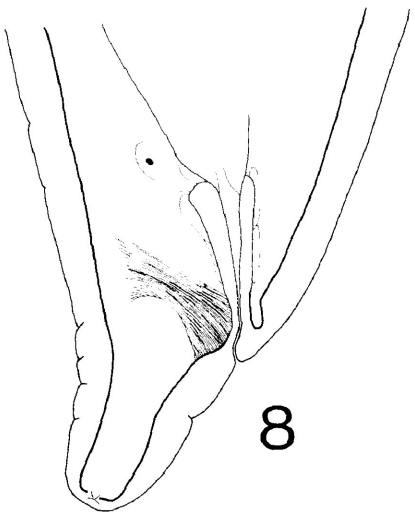
Caudal region tightly coiled. Caudal alae, prominent and bearing six pairs of preanal and five pairs of postanal pedunculated papillae. Occasionally, a single papilla located anterior to paired ones and or seven pairs of preanal papillae present. Two pairs of postanal papillae located immediately posterior to anus, followed by three single pairs with the last pair being the smallest. One pair of sessile papillae located ventrally of last pair of

Figs. 6-12. Sobolevicephalus lichtenfelsi n.sp. Fig. 6. Anterior extremity, female, lateral view. Fig. 7. Anterior extremity, female, ventral view. Fig. 8. Caudal extremity, female, lateral view. Fig. 9. Caudal extremity, male, ventral view showing caudal papillae. Fig. 10. Caudal region, male, lateral view showing spicules and caudal papillae. Fig. 11. Distal end of left spicule, lateral view. Fig. 12. Vulva, vagina and uteri, lateral view.



100 µm

6



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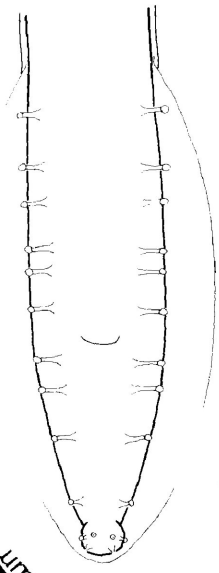

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11

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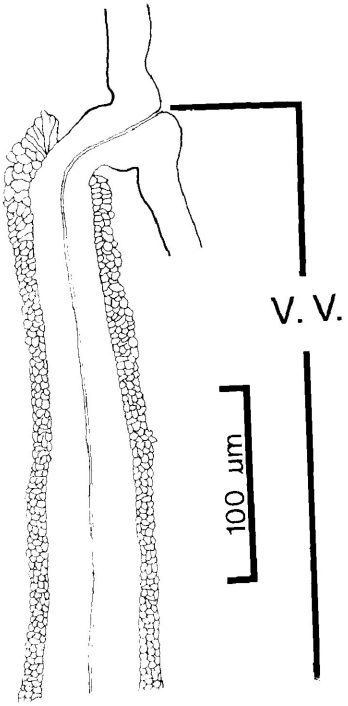
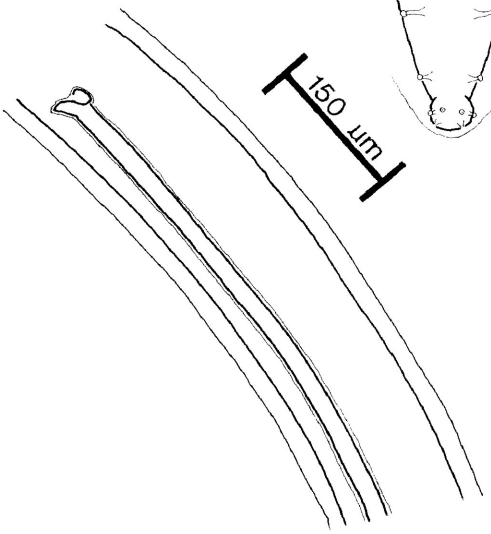
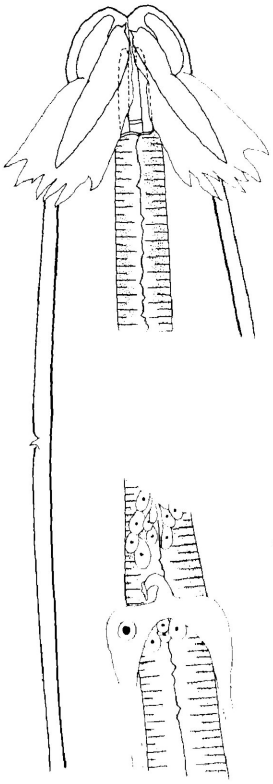


V. V.

100 µm

150 µm





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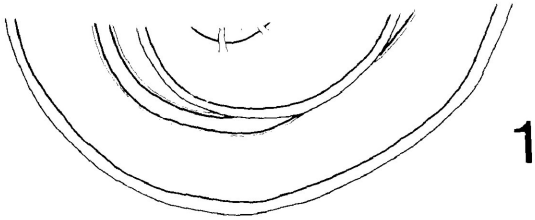
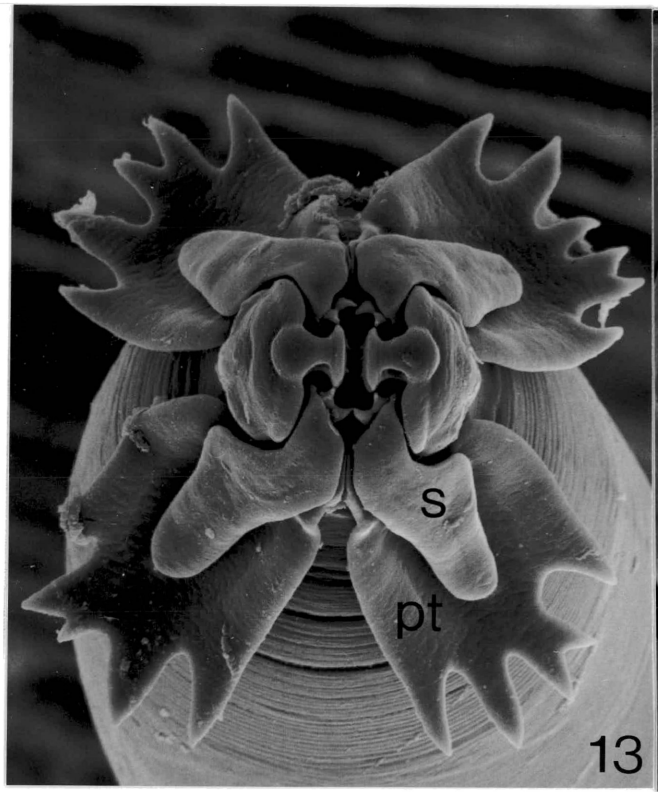


10

12

Figs. 13-14. Scanning micrographs of Sobolevicephalus lichtenfelsi n.sp. Fig. 13. Anterior extremity, male, en face view. Fig. 14. Anterior extremity, male, en face view showing oral opening surrounded by two pairs of sharp bisected teeth. Abbreviations: pt = ptilinum, s = sublabium, ps = pseudolabium.



13

14

pedunculated papillae. Spicules, unequal and dissimilar. Right spicule short and crescent shaped. Left spicule, long, slender with simple pointed distal end. Tail with rounded tip. Phasmids present.

Female:

Vulva in posterior third quarter of body. Vagina lined with thick cuticle, surrrounded by muscle fibers and divided into vagina vera and vagina uterina with a ratio of 2:1. Didelphic, amphidelphic. Uteri surrounded with thin muscle fibers and packed with larvated, thick - shelled eggs. Tail, short with slight dorsal curve. Phasmids present at rounded tip of tail.

Type host: Limosa fedoa (L.). Scolopacidae.

Prevalance: 32% (11/34)

Intensity: 4.4 (1-13)

Specimens: NMCICP1983-Ø878 (holotype)
NMCICP1983-Ø879 (paratypes)
USNMH Coll. No. 77927 (paratypes)

Type locality: Delta Marsh, Manitoba, Canada
(5Ø 12'N, 99 19'W)

Other localities: Oaklake, Manitoba, Canada
(49 42'N, 1ØØ 47'W)
Fort Fischer, North Carolina,
United States (33 57'N, 77 56'W)

Other host: Catoptrophorus semipalmatus inornatus (Gmelin). Scolopacidae.

Prevalence: 24% (7/29)

Intensity: 9.6 (1-54)

Specimens: NMCICP1983-0880
USNMH Coll. No. 77928

Localities: Delta Marsh, Manitoba, Canada
Oaklake, Manitoba, Canada
Brooks, Alberta, Canada
(50 35'N, 111 53'W)
Cowoki, Alberta, Canada
(50 35'N, 111 42'W)
Foremost, Alberta, Canada
(49 29'N, 111 25'W)
Fort Fischer, North Carolina,
United States

Diagnosis:

Sobolevicephalus lichtenfelsi n.sp. can be readily distinguished from S. chalcyonis by the difference in the morphology of the ptilina. In the former the ptilina are rather rigid, with irregular rounded indentations while those of the latter are delicate with sharp, irregular indentations and serrated edges. In addition, the left spicule of S. lichtenfelsi is twice as long as that of S. chalcyonis. Also the spicule of the former has a simple

distal end while that of the latter has a complex distal end which is surrounded by conspicuous alae. Furthermore, the ratio of the vagina vera to vagina uterina of the new species is 2:1 while that of S. chalcyonis is 1:2.

Other species

Sobolevicephalus madagascariensis

(Kung, 1948) new combination

Synonyms: Ancyracanthopsis madagascariensis Kung, 1948

Skrjabinobronema sinica Wang, 1966

Type host: Dryolimnas cuvieri cuvieri (Pucheran). Rallidae.

Type locality: Madagascar, Africa.

Diagnosis:

Sobolevicephalus madagascariensis can be readily distinguished from S. chalcyonis by its rigid ptilina which have sharp regular indentations in contrast to those of the latter which are delicate, serrated with irregular indentations. This species is similar to S. lichtenfelsi but can be differentiated from the latter by the length and morphology of the left spicule. The length of the left spicule of S. madagascariensis is one fifth that of S.

lichtenfelsi. The spicule of the former has a trifid distal end in comparison to the simple and truncated distal end in the latter.

Key to Species of Sobolevicephalus

1-(2) Ptilina with serrated edges

..... S. chalcyonis

2-(1) Ptilina without serrated edges.

3-(4) Left spicule greater than 1.0mm in length.

..... S. lichtenfelsi

4-(3) Left spicule less than 400um in length.

..... S. madagascariensis

Discussion

The genus presently consists of three species each of which occurs in a distinct group of hosts and occupys a very well defined geographic area. The type species, S. chalcyonis is a parasite of kingfishers and its distribution is confined to Asia. Parukhin (1964b) reported this species in H. smyrnensis fusca (Boddaert) in Vietnam. Its presence in H. coromanda major in Taiwan was reported by Schmidt and

Kuntz (1972). Finally, Smetanina and Alekseev (1968) recovered it in H. pileati in Rimsky- Korsakov Island, Soviet Union.

The second species, S. madagascariensis, has only been reported in D. c. cuvieri in Madagascar by Kung (1948). The third species, S. lichtenfelsi n.sp. occurs in North America and is found in the western willet and marbled godwit.

Morphologically, S. chalcyonis is more similar to S. lichtenfelsi than to S. madagascariensis. The size of the ptilina relative to the length of the body is the same in both species. In addition, the numbers and distribution of the caudal papillae in the males are identical. This may suggests a close relationship between these two species. Discovery of this genus in waders in Europe or Asia will probably provide us with a better understanding of this relationship.

VI. Field Studies

A total of 14 species of acuarioids was recovered from 14 of 24 species of waders (Table 1). The worms included one species recovered from the esophagus, three from the

Table 1. Prevalence and intensity of acuarioids in waders from North America

Location in host	Acuarioid spp.	Hosts (Sample Size)													
		Pluvialis squatarola (3)	Charadrius semipalmatus (21)	Calidris minutilla (54)	C. pusilla (23)	C. alba (21)	Actitis macularia (14)	Phalaropus tobatus (24)	P. tricolor (25)	Tringa flavipes (12)	T. melanoleuca (20)	Limosa fedoa (34)	Catoptrophorus s. inornatus (29)	Numenius p. hudsonicus (1)	Recurvirostra americana (14)
Oesophagus	Cosmocephalus obvelatus	-	5 (1)	-	-	-	-	-	-	33 (2-4)	15 (1-3)	-	43 (1-2)	-	22 (1-3)
Proventriculus	Cordonema longifuniculata			2 (1)								29 (1-22)			
	Skrjabinoclava horrida		5 (4)		43 (1-76)	33 (4-55)	7 (1)		4 (4)				88 (2-76)	100 (1)	
	Echinuria uncinata								8 (1-7)			3 (1)			
Under gizzard lining	Schistorophus skrjabini												34 (1-9)		
	Viktorocara capillaris	33* (2)	19 (1-3)									3 (30)			
	Viktorocara limosae		5 (6)									21 (2-22)	10 (1-9)		11 (2)
	Sciadiocara umbellifera	100 (1-4)	-										17 (4-10)		
	Sciadiocara bihamata						7 (5)								
	Ancyrcanthopsis coronata	33 (4)					14 (4-12)					12 (1-4)	38 (1-39)	100 (10)	
	Sobolevicephalus lichtenfelsi											32 (1-13)	24 (1-54)		
	Streptocara c. crassicauda							4 (1)			5 (1)	3 (1)	55 (1-18)		
	Pectinospirura argentata												3 (1)		
	Chevreuxia revoluta														22 (1-8)

*Prevalence in percent subtended by range of intensity in parentheses

proventriculus and 1Ø from under the gizzard lining of the birds.

Cosmocephalus obvelatus (Creplin, 1825) was recovered from the esophagus of western willet, lesser yellowlegs, greater yellowlegs, semipalmated plover and avocet. The highest prevalence(43%) was found in the western willet, although the lesser yellowlegs had a slightly higher mean intensity than the former (Table 1).

From the proventriculus, Cordonema longifuniculata (Sobolev, 1952) was recovered only from one least sandpiper and 29% (1Ø/26) of marbled godwit. The western willet had the highest prevalence (88%) of Skrjabinoclava horrida (Rudlophi, 18Ø9) in comparison to the other six infected waders. Two semipalmated sandpipers were infected with larvae of S. horrida. One bird had eight fourth-stage larvae and the other bird had three moulting fourth-stage larvae. Both the birds were also infected with adult worms. Six sanderlings were infected with larvae of S. horrida. One bird had four fourth-stage and 16 moulting fourth-stage larvae; one had three and one; one had 11 and four; two had one and two, respectively. One bird had only one fourth-stage larva. Finally, Echinuria uncinata (Rudolphi, 1819) was only recovered from the western willet.

The largest number of acuarioid species were found under the gizzard lining. The western willet was the only wader which was infected with S. skrjabini. Two species of

Viktorocara were recovered from the present study. One of them, V. capillaris was found in three wader species with the Gray plover having the highest prevalence and mean intensity. On the other hand, V. limosae was recovered from four wader species with the marbled godwit being the most heavily infected. Sciadiocara umbellifera was recovered from all three Gray plovers and 17% (5/29) of western willet. One spotted sandpiper was found to harbour S. bihamata. Ancyracanthopsis coronata was found in five wader species with the western willet harbouring the highest prevalence and mean intensity. Sobolevicephalus lichtenfelsi was only recovered from the marbled godwit and western willet with the former having a higher prevalence and the latter a higher mean intensity. Greater yellowlegs, northern phalaropes and mabled godwits each had only one Streptocara c. crassicauda (Creplin, 1829). However, the western willet had a prevalence of 55% (16/29) and a mean intensity of 4.7. One female Pectinospirura argentata Wehr, 1933 was found in one western willet. Finally, only the avocet (22%, 2/9) was infected with Chevreuxia revoluta (Rudolphi, 1819).

The western willet and marbled godwit harboured the highest number of species of acuarioids, totalling nine and eight, respectively (Table 1). With the exception of P. argentata which was found in only one bird, the prevalence of the rest of the acuarioid species in the western willet was equal or greater than 10%. In contrast, even though the

marbled godwit harboured eight species of acuarioids, only four of them had prevalence greater than 1Ø%. It is interesting to note that four of the acuarioid species which inhabit under the gizzard lining were found in both hosts. Both prevalence and mean intensity of V. limosae were greater in the marbled godwit. Although the prevalence of S. lichtenfelsi was higher in the marbled godwit, its mean intensity in this host was only half that in the western willet. Lastly, the prevalence and mean intensity of both S. c. crassicauda and A. coronata were higher in the western willet.

No acuarioids were found in the killdeer (N=14), short-billed dowitcher (16), long-billed dowitcher (4), hudsonian godwit (2), dunlin (2), solitary sandpiper (1), stilt sandpiper (1), red knot (1), upland sandpiper (3), pectoral sandpiper (2) and ruddy turnstone (1).

Discussion

The present study indicates that waders, especially those belonging to the families Scolopacidae, Charadriidae and Recurvirostridae, in North America are hosts to a variety of acuarioid nematodes. Fourteen species of acuarioids were found, of which one was recovered from the esophagus, three from the proventriculus and ten from under

the lining of the gizzard. At present the superfamily Acuarioidea consists of 34 genera. Two genera are found in mammals and the remaining in birds (Chabaud, 1975, Mawson, 1982, Gupta and Kazim, 1978 and present study). Of the 32 genera in birds, 27 of them occur beneath the lining of the gizzard, 3 in the esophagus and 2 in the proventriculus. The two genera found in mammals inhabit the stomach.

In general, acuarioids of birds are not very host specific and are capable of developing in a variety of unrelated hosts. For example, Cosmocephalus obvelatus has been reported from 10 families of birds (see review by Anderson and Wong, 1981). However, a close evaluation of the host records, usually shows that a particular acuarioid is reported most frequently from one group of host (e.g. waders or gulls) in which the prevalence and intensity of infection are high. This group of major hosts are likely responsible for maintaining the parasite in the bird community. Others, less frequently and less heavily infected, can be considered minor or incidental hosts. The importance of particular groups of birds as hosts of acuarioids is probably determined by the hosts' feeding habits.

In the present study, waders are considered the major hosts of seven of the 14 acuarioids recovered. These acuarioids include C. longifunculata, S. horrida, V. capillaris, V. limosae, S. umbellifera, A. coronata and S. lichtenfelsi. The life histories of these seven

acuarioids are not known. However their North American distribution in waders provides some circumstantial evidence indicating their possible intermediate hosts and the most likely geographic locations of their transmission.

Fourth and moulting fourth-stage larvae of S. horrida were recovered from the semipalmated sandpiper examined between May 20-24, 1982 and the sanderling between June 2-5, 1982 and 1983. The final moult (i.e. the presence of moulting fourth - stage larvae) of E. uncinata and C. obvelatus occurred between 9-20 days post infection (Austin and Welch, 1972 and Wong and Anderson, 1982C). If S. horrida has a similar rate of development, then these birds must have acquired this parasite in early May. Bush and Forrester (1976) reported S. horrida from the white ibis, a resident of Florida and Wong and Anderson (1982b) concluded that ring-billed gulls acquired this parasite at their wintering ground which is along the southeastern coast of the United States. Therefore, the semipalmated sandpipers and sanderlings probably acquire S. horrida from the southeastern coast of the United States. According to the A.O.U. Checklist (1983), this region is part of the winter ranges of these two waders. It also indicates that transmission occurs in early spring. The life cycle of this acuarioid is unknown but since it has only been found in birds which inhabit the coastal area during the winter, we can conclude that its appropriate intermediate host is probably a marine invertebrate.

Besides S. horrida, another acuarioid of waders which also inhabits the proventriculus is C. longifunculata. It is interesting to note that C. longifunculata was found in the least sandpiper (prevalence; 2%) and the marbled godwit (39%) but was absent in all the hosts of S. horrida (see Table 1). This apparent host seggregation could be a result of the two parsites utilizing very different invertebrates as their intermediate hosts. Since no larval C. longifunculata were recovered, the season in which transmission occurs cannot be determined. This information is important because its primary host, the marbled godwit spends its summer in a freshwater environment in the prairies and overwinters along the east coast of North and South America (Johnsgard, 1981). Therefore, if transmission occurs during the summer, then a freshwater invertebrate is the likely intermediate host of C. longifunculata. Otherwise it would utilize a marine invertebrate if transmission occurs during the winter.

Viktorocara capillaris, V. limosae, S. umbellifera and A. coronata were found in waders (Gray plover, semipalmated plover) which breed in the arctic tundra as well as in waders (spotted sandpiper, marbled godwit and western willet) which breed in the temperate zone of North America. If transmission occurs during the summer, it would have to take place in both breeding locations of their hosts or they could occur in the temperate zone and the waders breeding in the arctic tundra would acquire the parasites

during their fall migration. The semipalmated plovers were examined between Aug. 17-26, 1982 during their fall migration through Delta Marsh, Manitoba. No immature adult worms were recovered. This suggests that transmission of V. capillaris and V. limosae does not occur in the tundra. Since the marble godwit, western willet and spotted sandpiper were not examined in the fall, we cannot rule out the possibility of transmission occurring in the late summer in the temperate zone. However, a more likely location for transmission of these acuarioids is on the wintering grounds. According to Johnsgard (1981) these five waders overwinter from the coast of southern United States to the coast of Argentina and occupy this area for approximately six months.

Sobolevicephalus lichtenfelsi was commonly found in the marbled godwit and the western willet. This is not surprising because these waders have overlapping breeding and wintering ranges and they occupy similar habitats. Both species of hosts were examined between late May and late June, 1982, 1982 except for three western willet examined on July, 25 1982. Although no immature worms were recovered from these birds, however, the possibility of S. lichtenfelsi completing its life cycle in the summer months cannot be rule out. This can only be confirmed by the absence of this parasite in young of the year birds. Unfortunately, none was available for this study.

Cosmocephalus obvelatus was found most commonly in lesser yellowlegs and western willet. This is not surprising since both hosts consume amphipods and small fish which serve as intermediate and paratenic hosts of this parasite, respectively (Wong and Anderson, 1982b) Although C. obvelatus is essentialy a parasite of gulls (Laridae), it has been reported from numerous fish eating birds belonging to nine families throughout the world (see Anderson and Wong, 1981). This, however, is the first report of this species in waders. Pectinospirura argentata was found in one western willet. According to Wong and Anderson (1982b), it is mainly a parasite of gulls and is widely distributed around the world. Streptocara c. crassicauda was common in the western willet but sporadic in the Wilson phalarope, greater yellowlegs and marbled godwit. This acuarioid is mainly a parasite of waterfowl and utilizes freshwater amphipods, especially species of Gammarus, as its intermediate host (Macdonald, 1969). Infection with E. uncinata was rare in waders, being found only in only Wilson phalarope and one marbled godwit. This parasite is predominately found in waterfowl and utilizes Daphnia pulex as its intermediate host (Austin and Welch, 1972).

Three species of acuarioids are not well known in North America and they were found in only one species of host in the present study. Sciadiocara bihamata was recovered from one spotted sandpiper (N=14). The only previous report of

this species in North America is by Gibson (1972) who also reported one spotted sandpiper infected. Unfortunately prevalence data was not indicated. Since S. bihamata is small and delicate with males averaging 4.Ømm and females 7.Ømm in lengths, they could have been easily overlooked by previous workers. However, further studies on waders not examined in this study and other bird species which share their habitats with the spotted sandpiper may reveal the major host of S. bihamata.

Schistorophus skrjabini was found only in the western willet. This is the first report of this parasite in North America. In the Old World, it had been reported from waders (Numenius phaeopus variegatus, N. madagascariensis), gull (Larus canus heinei), kittiwakes (Rissa brevirostris, R. tridactyla) and long-tailed jaeger (Stercorarius longicaudus). Since prevalence and intensity data of these infections were not available we therefore cannot evaluate the relative importance of these hosts to the overall transmission of S. skrjabini. However, since the kittiwakes and jaeger are strictly marine birds, we can assume that a marine invertebrate is the likely intermediate host of this acuarioid. Therefore, S. skrjabini in North America is probably tramsitted in the wintering ground of the western willet which is along the coast of North and South America.

Chevreuxia revoluta is not well known in North America. The only previous report of this parasite is by Barus (1966) who found it in a stilt (Himantopus himatopus mexicanus) in Cuba.

In this study, the western willet harbours the greatest number of acuarioids, totalling nine. Furthermore, except for P. argentata which was found in only one bird, the prevalence of infection of the other eight acuarioids was at least 10% or greater. The diverse feeding habit of the western willet is probably one of the most important factors contributing to this wader's high parasite load. Stenzel et. al. (1976) reported that during the winter, the western willet in Bolinas Lagoon, California fed over the entire tidal flat, from areas with very fine sand and considerable organic debris to channels, basins to sediments consisting of pebbles. Furthermore, they are distributed equally amongst emerged, edged and submerged microhabitats of the tidal flats. The diet of the willet during the the winter included gastropods, bivalves, amphipods, polychaetes, terrestrial insects and occasionally frogs and fish. Unfortunately, no similar detail diet analysis of the western willet wintering in eastern United States is available. Birds from both populations were examined, however, their sample sizes were too small to permit them to be analyzed separately. Although the diet of the western willet during the summer is not well known, however since it breeds in the prairies it would consumme freshwater

invertebrates and vertebrates. Therefore, the western willet occupys a wide range of microhabitats and as a result has a variable diet. This no doubt bring it in contact with other waders as well as many unrelated birds. In this way, the western willet is exposed to a wider array of parasites than other waders which have more specialized habitat requirements.

The acuarioid subfamily Schistorophinae is well represented in this study. This is indicated by the recovery of seven species belonging to five of the six genera which are presently assigned to this subfamily. These seven species include Schistorophus skrjabini, Viktorocara capillaris, V. limosae, Sciadiocara umbellifera, S. bihamata, Ancyracanthopsis coronata and Sobolevicephalus lichtenfelsi. As shown above, the waders are the major hosts of five of these seven species. A review of the host distributions of the remaining 17 species assigned to this subfamily, revealed that six of them also utilize waders as their major hosts. Thus, 11 of 24 species of this subfamily are found predominately in waders. This suggests that this subfamily of acuarioids was successful in exploiting the available niches of the waders resulting in the present diversification of this group of nematodes.

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