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Four New Species of Acanthocephalans from Birds in Vietnam

OMAR M. AMIN,[1,4] NGUYEN VAN HA,[2] AND RICHARD A. HECKMANN[3]

[1] Institute of Parasitic Diseases, P.O. Box 28372, Tempe, Arizona 85285, U.S.A.
(e-mail: omaramin@aol.com),
[2] Institute of Ecology and Biological Science, Nghiado, Caugiay, Hanoi, Vietnam
(e-mail: hanv_iebr@yahoo.com.vn), and
[3] Department of Integrative Biology, Brigham Young University, Provo, Utah 84602, U.S.A.
(e-mail: Richard_heckmann@byu.edu)

ABSTRACT: During November 2000, a collection of acanthocephalans from 6 species of birds in Quang Ninh Province, Vietnam, included 4 new species. The new taxa described included 1 in Archiacanthocephala (Gigantorhynchida: Gigantorhynchidae): *Mediorhynchus lanius* n. sp. from *Lanius schach* Linnaeus (long-tailed shrike) and 3 in Palaeacanthocephala (Polymorphida: Plagiorhynchidae): *Plagiorhynchus* (*Prosthorhynchus*) *digiticephalus* n. sp. from *Porzana fusca* Linnaeus (ruddy-breasted crake), *Plagiorhynchus* (*Prosthorhynchus*) *megareceptaclis* n. sp. from *Gallinago gallinago* Linnaeus (common snipe) and *Myophonus coeruleus* (Scopoli) (whistling thrush), and *Porrorchis tyto* n. sp. from *Gorsachius melanolophus* Raffles (Malayan night-heron) and *Tyto* sp. (barn owl). Comparisons with related taxa were made, and host relationships were discussed where applicable.

KEY WORDS: New acanthocephalans: *Mediorhynchus lanius* n. sp., *Prosthorhynchus digiticephalus* n. sp., *Prosthorhynchus megareceptaclis* n. sp., *Porrorchis tyto* n. sp., birds, Vietnam.

The Institute of Ecology and Biological Sciences (IEBS), Hanoi, Vietnam, has been undertaking a large Faunistic Research Program (FRP) over the last few years. The parasitology component of this program included the examination of a variety of vertebrate hosts for helminth parasites in the various provinces of Vietnam. One of us (N.V.H.) was instrumental in carrying out the FRP under which the reported specimens of acanthocephalans from birds were collected and made available. The FRP has provided new openings for international collaborative research in parasitology sponsored by IEBS, and other collections of acanthocephalans from amphibians, reptiles, and mammals are reported elsewhere (Amin et al., 2008a, b). Most of the land vertebrate and bird hosts were examined for the first time, and the acanthocephalans recovered represent new taxa. Additionally, a few more acanthocephalans were reported from Vietnam, e.g., Amin et al. (2000, 2004). A total of only 28 species of Acanthocephala (17 species in Echinorhynchida, 7 in Gyracanthocephala, and 4 in Neoechinorhynchida) has been reported from Vietnamese fishes to date (Arthur and Te, 2006) but those from birds are unknown.

MATERIALS AND METHODS

The reported material was collected under a study of the ecology and biology of birds in the Quang Ninh Province of Vietnam (106°15′–107°00′N, 20°15′–21°15′W) in November 2000. Live and dead birds were examined, and their viscera were placed in 70% ethanol. Parasite species, host species, related collection information, and infection parameters are summarized in Table 1.

Upon receipt of specimens in our U.S. laboratory, worms were punctured with a fine needle and subsequently stained in Mayer's acid carmine, destained in 4% hydrochloric acid in 70% ethanol, dehydrated in ascending concentrations of ethanol (24 hr each), and cleared in graduated (increasing) concentrations of terpineol in 100% ethanol to 100% terpineol, then 50% terpineol and 50% Canada balsam (24 hr each). Whole worms were mounted in Canada balsam. Some thick specimens that were not sufficiently clear were sliced before mounting to improve the visibility of internal structures.

Measurements are in micrometers, unless otherwise stated, as range values followed by the mean in parentheses. Length measurements are given before the width; the latter refers to maximum width. Trunk length does not include the neck, proboscis, or bursa. Eggs refer only to fully developed ripe eggs removed from the body cavity. Specimens were deposited in the United States National Parasite Collection (USNPC), Beltsville, Maryland, U.S.A.

RESULTS AND DISCUSSION

The new taxa described in this work include 4 new species of acanthocephalans from 6 species of birds collected in the Quang Ninh Province in November 2000 (Table 1). The taxa described belong in two classes organized according to the taxonomic scheme of Amin (1985), listed below, and treated alphabetically.

[4] Corresponding author.

Table 1. Acanthocephalans collected from birds in Quang Ninh Province, Vietnam, during November 2000.

Acanthocephalan species	Worms collected	Host species	Birds examined	Mean/host	Study material
Archiacanthocephala: Gigantorhynchida:					
Mediorhynchus lanius n. sp.	12	*Lanius schach* (long-tailed shrike)	2	6.0	5
Palaeacanthocephala: Polymorphida:					
Plagiorhynchus (*Prosthorhynchus*) *digiticephalus* n. sp.	1	*Porzana fusca* (ruddy-breasted crake)	1	1.0	1
Plagiorhynchus (*Prosthorhynchus*) *megareceptaclis* n. sp.	16	*Gallinago gallinago* (common snipe)	2	8.0	12
	6	*Myophonus coeruleus* (whistling thrush)	1	6.0	6
Porrorchis tyto n. sp.	2	*Gorsachius melonolophus* (Malayan night-heron)	1	2.0	2
	41	*Tyto* sp. (barn owl)	3	13.7	8
Palaeacanthocephala: Heteramorphida n. ord.:					
Pyrirhynchus heterospinus n. gen., n. sp.	18	*Actitis hypoleucos* (common sand piper)	2	9.0	9

Class Archiacanthocephala Meyer, 1931
Order Gigantorhynchida Southwell and Macfie, 1925
Family Gigantorhynchidae Hamann, 1892
Mediorhynchus lanius n. sp.
Class Palaeacanthocephala Meyer, 1931
Order Polymorphida Petrochenko, 1956
Family Plagiorhynchidae Glovan, 1960
Subfamily Plagiorhynchinae Meyer, 1931
Plagiorhynchus (*Posthorhynchus*) *digiticephalus* n. sp.
Plagiorhynchus (*Prosthorhynchus*) *megareceptaclis* n. sp.
Subfamily Porrorchinae Golvan, 1956
Porrorchis tyto n. sp.

In addition, specimens of 1 new species and genus in a new family and new order were collected but are reported elsewhere. Three specimens of an unrecognizable archiacanthopcephalan lacking proboscides were collected from *Chrysocolaptes lucidus* Scopoli, greater flame-back. No further identification was possible.

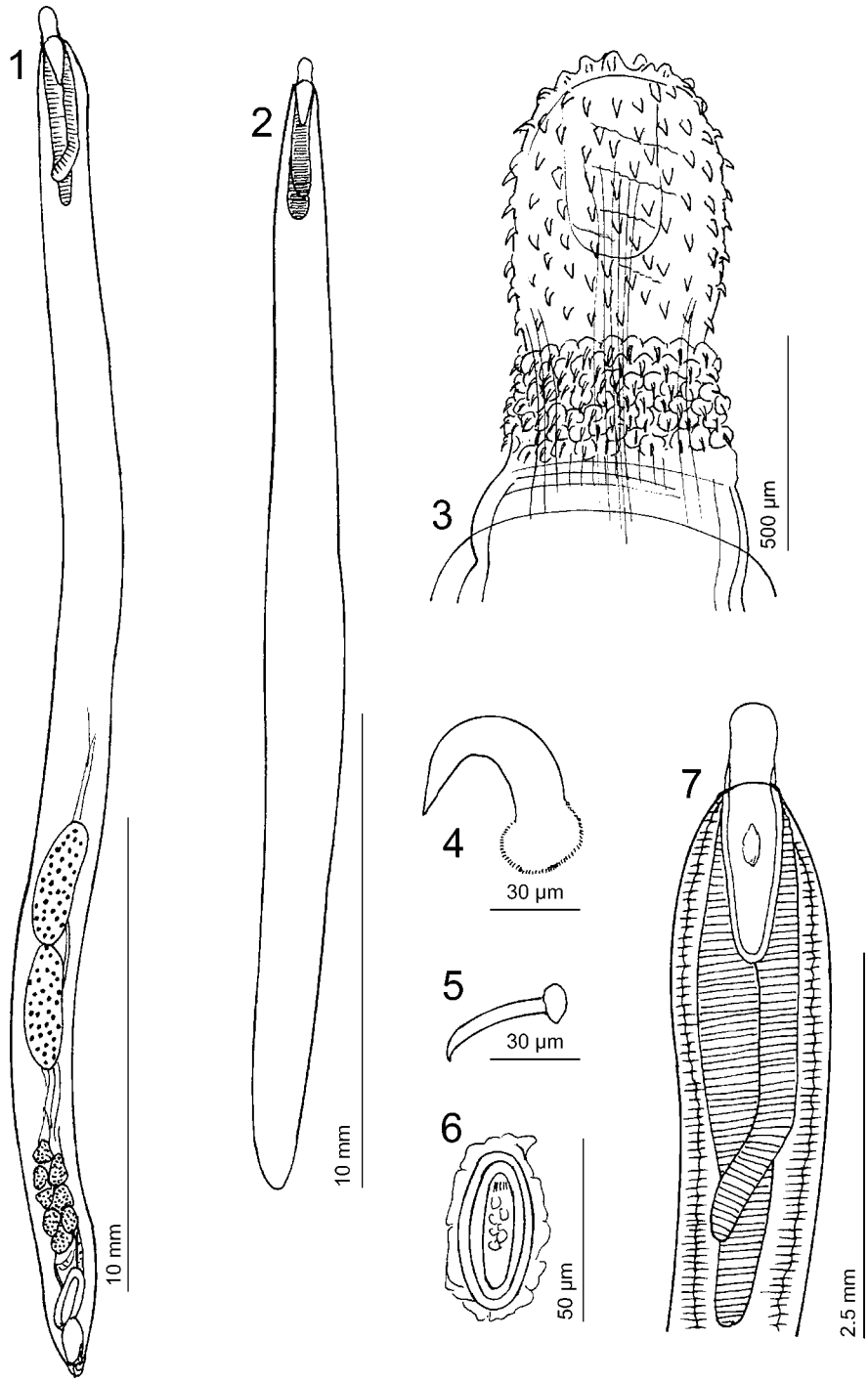
Mediorhynchus lanius n. sp. (Figs. 1–7)

Of the 12 worms collected from 2 long-tailed shrikes, *Lanius schach* Linnaeus, 5 (1 male, 4 females) were made available for study. All specimens were sexually mature with sperm and eggs. The host, *L. schach*, is a common resident throughout the Indo-Malayan ecozone and feeds on lizards, insects, small birds, and rodents in scrubby and cultivated areas (Robson, 2000).

Description

General: Gigantorhynchidae. With characters of the genus *Mediorhynchus* as described by Van Cleave (1916) and discussed by Schmidt and Kuntz (1977) and Amin and Dailey (1998): Trunk cylindrical, elongate, thick, strait, with heavy shoulders (Figs. 1, 2). Many small hypodermal nuclei associated with lacunar branches along pseudosegmentation. Anterior proboscis ovoid to cylindrical with rooted hooks. Posterior proboscis wider with rootless spines (Fig. 3). Hooks and spines transparent, embedded basally in papillated cuticular folds. Hook roots flask shaped with rounded larger posterior ends (Fig. 4). Proboscides with relatively more spines than hooks arranged in near longitudinal rows appearing in spiral rows. Spines slender with stubby basal discs but no true roots (Fig. 5). Neck unarmed, conically shaped, widest at junction with broad anterior trunk. Proboscis receptacle attached anteriorly at junction between anterior and posterior proboscis, conically shaped posteriorly, with cerebral ganglion near its middle, almost twice as long as proboscis. Lemnisci subequal, relatively short, broad, flat, tongue shaped (Fig. 7). Gonopore terminal in both sexes.

Male (holotype)*:* Trunk 28.75 mm long by 1.45 mm wide. Proboscis 790 long by 343 wide anteriorly with 22 rows of 6 hooks each and 29 rows of 4 or 5 spines each; a total of 132 hooks and 130 spines. Hooks 45, 40, 40, 37, 35, 35 long from anterior. Spines 37, 37, 34, 30, 30 long from anterior. Proboscis receptacle 1,250 long by 530 wide. Longer lemniscus 3,375



Figures 1–7. *Mediorhynchus lanius* n. sp. from *Lanius schach*. **1.** Male, holotype; pseudosegmentation not shown. **2.** Female, allotype; reproductive system obscured by eggs. (Eggs and pseudosegmentation not shown.) **3.** Proboscis of allotype female; posterior proboscis somewhat contracted. **4.** Lateral view of a ventral anterior proboscis hook and root. **5.** Lateral view of a ventral posterior proboscis spine and stub. **6.** Egg. **7.** Anterior portion of holotype male showing the proportional sizes of the proboscis, receptacle, and lemnisci.

long by 400 wide; shorter lemniscus 2,950 long by 325 wide. Reproductive system in posterior half of trunk. Testes oblong, contiguous. Anterior testis 2,625 long by 650 wide; posterior testis somewhat longer, 3,000 long by 650 wide. Cement glands 8 in 1 elongate cluster (Fig. 1), each gland 625–750 (700) long by 350–475 (425) wide. Saefftigen's pouch 1,300 long by 520 wide.

Female (allotype and 3 paratypes)*:* Trunk 18.12–25.00 (22.04) mm long by 1.62–1.70 (1.67) mm wide. Proboscis 625–905 (787) long by 416–468 (429) wide with 22–24 rows of 6–7 hooks each and 32–34 rows of 5–6 spines each; a total of 132–168 (151) hooks and 160–204 (177) spines. Hooks 37–45 (41), 37–43 (40), 37–45 (41), 40–45 (42), 42–47 (44), 40–45 (42), 37–43 (40) long from anterior. Spines 32–35 (33), 32, 35–37 (36), 35–37 (36), 35–37 (36), 30–34 (32) long from anterior. Proboscis receptacle 1,186–1,737 (1,461) long by 416–437 (426) wide. Longer lemniscus 2,700–3,625 (3131) long by 416–572 (489) wide; shorter lemniscus 2,392–3,550 (2780) long by 416–551 (503) wide. Reproductive system hidden by eggs. Eggs ovoid with concentric shells and sculptured outer membrane, 45–47 (46) long by 20–24 (22) wide (Fig. 6).

Taxonomic summary

Type host: Lanius schach Linnaeus, 1758 (long-tailed shrike).

Type locality: Quang Ninh Province (106°15′–107° 00′N, 20°15′–21°15′W).

Site of infection: Intestine.

Type specimens: USNPC no. 99979 (holtype male), no. 99980 (allotype female), no. 99981 (paratype females).

Etymology: The new species is named for the generic name of the host.

Remarks

Van Cleave (1916) described the genus *Mediorhynchus* and included it along with *Centrorhynchus* Lühe, 1911 in Centrorhynchidae Van Cleave, 1916 based on the insertion of the anterior end of the proboscis receptacle at mid-proboscis in both genera. Later, Travassos (1917) assigned the concept of *Mediorhynchus* to the family Gigantorhynchidae Hamann, 1892. Van Cleave (1916), Petrochenko (1958), Yamaguti (1963), Schmidt and Kuntz (1977), Amin (1985), and Golvan (1994) included 3, 20, 23, 30, 45, and 55 species in *Mediorhynchus*, respectively. Golvan's (1994) list included a few synonyms. The 3 latter authors as well as a more recent search dismissed a total of 20 species as invalid, unrecognizable, or synonyms. These are:

1. *Mediorhynchus alaudae* (Rudolphi, 1819) (synonym of *M. micracanthus* (Rudolphi, 1819)).
2. *Mediorhynchus alecturae* (Johnston and Edmonds, 1947) (junior synonym of *M. papillosus* Van Cleave, 1916).
3. *Mediorhynchus armenicus* Petrochenko, 1958 (synonym of *M. micracanthus* (Rudolphi, 1819)).
4. *Mediorhynchus bakeri* Byrd and Kellogg, 1971 (synonym of *M. papillosus*).
5. *Mediorhynchus bullocki* Gupta and Jain, 1973 (synonym of *M. orientalis* Belopolskaya, 1953).
6. *Mediorhynchus cambellensis* Soota, Srivastava and Ghosh, 1969 (unrecognizable).
7. *Mediorhynchus colini* Webster, 1948 (junior synonym of *M. papillosus* Van Cleave, 1916).
7. *Mediorhynchus colini* Webster, 1948 holotype is labeled *Disteganius colini* Lehmann (1953); a new genus and species from a bobwhite quail. No description was provided, therefore, the genus and species become *nomina nuda*.
8. *Mediorhynchus grandis* Van Cleave, 1916 reported from an Australian parrot by Kelly and Finnie (1972) is a misidentification.
9. *Mediorhynchus lagodekhiensis* Kuraschvili, 1955 (may be valid but lacks important measurements).
10. *Mediorhynchus lophurae* Wang, 1966 (description not available).
11. *Mediorhynchus passeris* Das, 1951 (maybe valid but discrepancies between description and drawings suggest synonymy with *M. micracanthus* (Rudolphi, 1819)).
12. *Mediorhynchus pauciuncinatus* Dollfus, 1950 (unrecognizable juvenile female).
13. *Mediorhynchus pintoi* Travassos, 1923 (unrecognizable female fragments),
14. *Mediorhynchus segmentatus* (Marval, 1902) (junior synonym of *M. taeniatus* (von Linstow, 1901), Dollfus, 1936).
15. *Mediorhynchus selengensis* Harris, 1973 (synonym of *M. gallinarum* (Bhalerao, 1937)).
16. *Mediorhynchus sharmai* Gupta and Lata, 1967 (a juvenile from fish is *Centrorhynchus*).
17. *Mediorhynchus sipocotensis* Tubangui, 1935 reported by Baker and Hamon (1968) in Indiana is probably *M. robustus* Van Cleave, 1916.
18. *Mediorhynchus tanagrae* Rudolphi, 1819 (=*Echinorhynchus tanagrae* Rudolphi, 1819) (unidentifiable).

19. *Mediorhynchus vaginatus* (Diesing, 1851) Meyer, 1933 (unrecognizable).

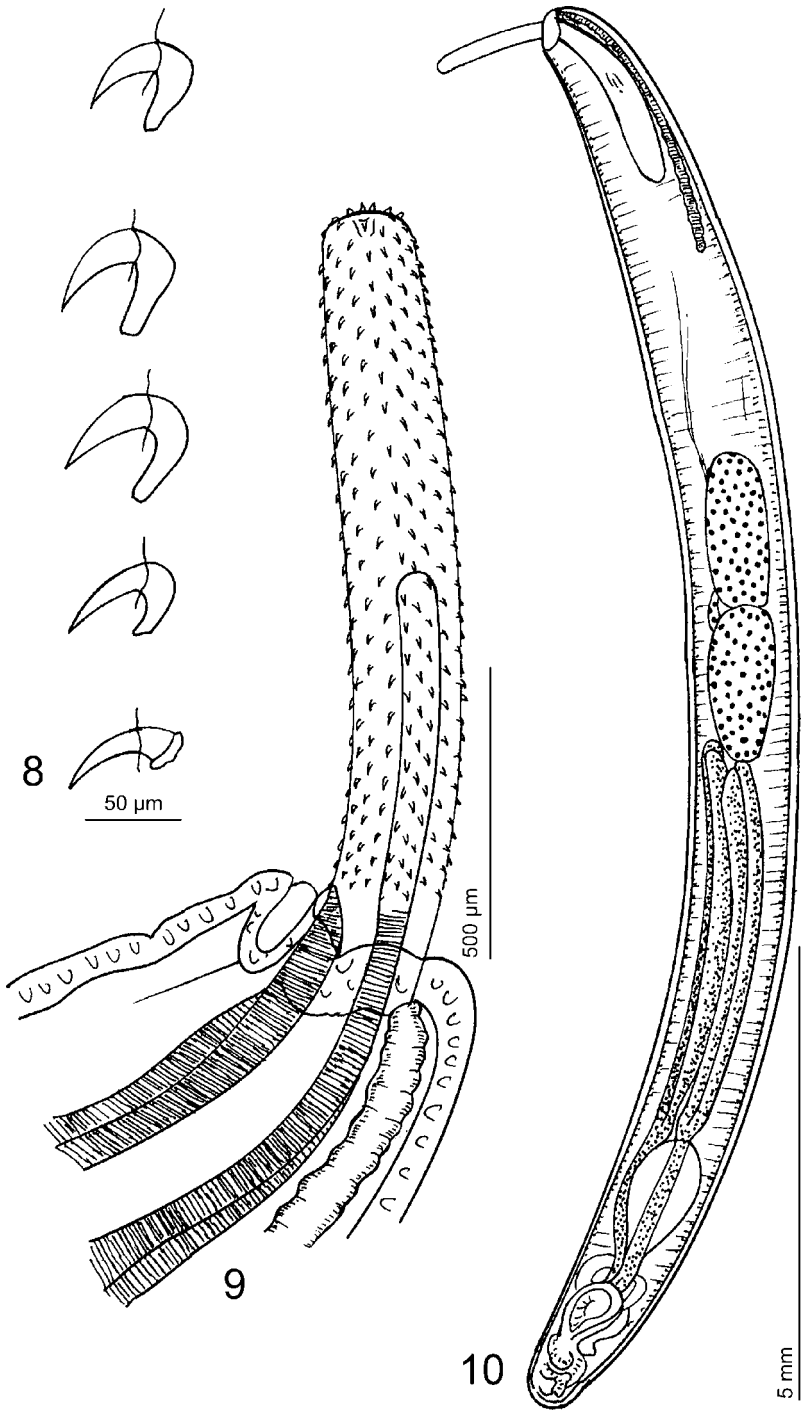
20. *Mediorhynchus zosteropis* (Porta, 1913) Meyer, 1933 (unidentifiable).

Schmidt and Kuntz (1977) included 30 species of *Mediorhynchus* in their key, and 3 new species were described since the latest listing of 55 species by Golvan (1994). These are *Mediorhynchus colluricinclae* Smales, 2002 from *Colluricincla harmonica* in Australia; *Mediorhynchus fatimaae* Khan, Bilqees and Muti-Ur- Rahman, 2004 from *Butastur teesa*; and *Mediorhynchus nickoli* Khan, Bilqees and Muti-Ur-Rahman, 2004 from *Milvus migrans migrans* in Karachi, Pakistan. After considering the descriptions of the 30 species included in the Schmidt and Kuntz (1977) key, our new species was found to be most similar to *Mediorhynchus robustus* Van Cleave, 1916 from passeriform birds in the U.S.A. (Van Cleave, 1916, 1947). However, *M. robustus* comprises markedly smaller and more robust worms (male 7.0 × 1.25 mm, female 16.0 × 2.4 mm) with more truncated and slender anterior proboscis (diameter 156 in males, 200 in females), thin and cylindrical lemnisci, testes in middle of trunk, and markedly smaller eggs (38 × 16) and hooks (25 long in males, 32 long in females).

Other species of *Mediorhynchus*, especially those described from Asia since the revision of Schmidt and Kuntz (1977) was published, are distinguished from *M. lanius* n. sp. by the following features. Specimens of *Mediorhynchus channpettae* George and Nadakal, 1984 from *Dinopium benghalense* in Kerala, India, are robust, broader anteriorly, and pseudosegmented posteriorly, with cone-shaped proboscis having 16–25 rows of 7–12 hooks each (middle hooks 50–58 long) and 40–45 rows of 8–14 spines each, and with oval testes. Specimens of *Mediorhynchus empodius* (Skrjabin, 1913) Van Cleave, 1924 (nec Meyer, 1932) from *Ardea*, *Numida*, and *Choriotis* in Turkestan are pseudosegmented with 14 rows of 5–6 hooks each and 26 rows of 3 spines each; hooks are 32 long. Specimens of *Mediorhynchus fatimaae* from Karachi, Pakistan, are pseudosegmented with 10–12 rows of 6–8 hooks each and 10 rows of 7–8 spines each (on one side according to drawing), long and slender lemnisci, testis widely separated at the middle of the trunk, and elongate eggs. Specimens of *Mediorhynchus gallinarum* from *Gallus gallus* in India, Philippines, New Guinea, and Celebes are large (30.0–50.0-mm-long males, 65.0–70.0-mm-long females) with 18 rows of 5 hooks each and relatively large 64–68 × 40–43 eggs. Specimens of *Mediorhynchus lagodekhiensis* Kuraschvili, 1955 from *Garrulus glandarius krynicki* in Central Asia are long (males 27.0 mm long, females 77.0–83.0 mm long) with 13 rows of 9 hooks each and elongate oval testes 2,943 × 640 in midbody. Specimens of *Mediorhynchus lophurae* Wang Pu Qin, 1966 from *Lophura nycthenura fokiensis* in Fukien, China, are pseudosegmented with 12 rows of 5 hooks each and 28 rows of 5–6 spines each, slender 5.2-mm-long lemnisci, and large eggs, 84–87 × 45–52. Specimens of *Mediorhynchus mariae* George and Nadakal, 1984 from *Acridotheres tristis* in Kerala, India, are robust, broader anteriorly, and pseudosegmented posteriorly with cone-shaped proboscis having 18–24 rows of 10–14 hooks each (middle hooks 58–64 long) and 20–25 rows of 7–10 spines each, and long and slender lemnisci. Specimens of *Mediorhynchus nickoli* are cylindrical and pseudosegmented with rectangular proboscis having 10 rows of 7–8 hooks each (55–57 long) and 7 rows of 6–8 spines each (on one side according to drawing), long and slender lemnisci, widely spaced testes in mid-trunk, and slender eggs 46–51 × 8–15. Specimens of *Mediorhynchus orientalis* from *Charadrius dubius* in Central Asia and India to Taiwan and Indonesia have an elongate trunk broader at middle and a conical truncate proboscis having 16–24 rows of 4–7 hooks each (anterior hooks largest, 30–50 long) and 32–50 rows of 3–6 spines each, long cylindrical lemnisci, and ovoid testis near mid trunk. Specimens of *Mediorhynchus petrotschenkoi* Gvozdev and Soboleva, 1966 from *Phasianus colchicus* in Central Asia are long (males 20.0–40.0 mm long, females 40.0–90.0 mm long) with anterior pseudosegmentation, a proboscis having a total of only 40–48 (45–66 long) hooks with expanded serrated roots basally, ovoid testes separated from each other and from cement glands, long slender lemnisci, and large eggs 49–99 × 32–49. Females of *Mediorhynchus rajasthanensis* Gupta, 1976 from *Choriotis nigriceps* in India are 60.0–75.0 mm long, cylindrical, and pseudosegmented, and males are 9.0 mm long and broader anteriorly but not pseudosegmented, with truncate proboscis having 12 rows of 4 hooks each (hooks 100–120 long) and (at least) 30 rows of 14–15 spines each, long, unequal, and slender lemnisci, and large eggs 62–81 × 31–50.

Plagiorhynchus (*Prosthorhynchus*) *digiticephalus* n. sp. (Figs. 8–10)

Only 1 male specimen of this new species was collected from the intestine of a ruddy-breasted crake, *Porzana fusca* Linnaeus. *Porzana fusca* inhabits swamps and wetlands across south Asia from the



Figures 8–10. *Plagiorhynchus* (*Prosthorhynchus*) *digiticephalus* n. sp. from *Porzana fusca*. **8.** Lateral view of ventral proboscis hooks and roots 1, 6, 12, and 18, and basal spine of holotype male. **9.** Proboscis of holotype male showing the anterior extension of the proboscis receptacle as a noncellular digitiform process extending into the posterior half of the proboscis. **10.** Male, holotype.

Indian subcontinent east to south China, Japan, and Indonesia, and feeds on shoots, berries, insects, and snails (Grimmett et al., 1999). This acanthocephalan species is a taxonomic curiosity being described from only 1 specimen with the most unusual anatomical structure in the proboscis.

Description of holotype male

With characters of the genus *Plagiorhynchus* and the subgenus *Prosthorhynchus*. Trunk cylindrical, slender, slightly pseudosegmented throughout, gradually tapering at both ends, with a slight curvature ventrad (Fig. 10), 15.0 mm long by 1.25 mm wide. Proboscis cylindrical, dome-shaped anteriorly, directed ventrad, with 20 rows of 22 or 23 rooted hooks each (Fig. 9). Hooks smallest anteriorly, increase in size to hooks 7–12 then become slightly smaller posteriorly; length from anterior 37, 45, 50, 52, 52, 52, 55, 55, 55, 58, 55, 55, 52, 52, 47, 47, 47, 47, 45, 47, 47, 45, 42. Anterior 19 or 20 hooks with simple posteriorly directed roots about as long as hook blades. Roots in posterior 3 or 4 circles become gradually shorter with posteriormost hook root becoming extremely short, stubby, or absent (Fig. 8). Proboscis receptacle double walled, long, 2,125 long by 354 wide, with cerebral ganglion in its middle third. Anterior end of receptacle extends anteriorly into much of proboscis as prominent, unattached, nonmuscular noncellular digitiform process (Fig. 9). Lemnisci long, cylindrical, narrow anteriorly 4,500 long by 156 wide. Testes oblong, equal, contiguous, just anterior to mid-trunk. Anterior testis 1,625 long by 700 wide, posterior testis 1,700 long by 750 wide. Cement glands 4, parallel, almost equal in length, contiguous with posterior testis anteriorly, 6,250 long by 166 wide, in 2 pairs, each pair joining 1 common cement duct just anterior of Saefftigen's pouch and joining with pouch posteriorly. Saefftigen's pouch 1,700 long by 625 wide. Gonopore terminal.

Taxonomic summary

Type host: Porzana fusca Linnaeus, 1766, ruddy-breasted crake.

Type locality: Quang Ninh Province (106°15′–107° 00′N, 20° 15′–21°15′W), Vietnam.

Site of infection: Intestine.

Type specimen: USNPC no. 99982 (holotype male).

Etymology: The new species is named for the unique digitiform process in the proboscis.

Remarks

In their taxonomic study of the genus *Plagiorhynchus* Lühe, 1911, Amin et al. (1999) recognized 21 species of the subgenus *Prosthorhynchus* Kostylew, 1915 as valid and provided a key to all 21 species. No new species have been described since. The new species is distinguished from all other species of *Prosthorhynchus* with its unique digitiform process that appears to originate from the anterior end of the receptacle and extends into the proboscis as an unattached nonmuscular structure. Considering the descriptions of all 21 species of *Prosthorhynchus*, especially the proboscis armature, and based on the key of Amin et al. (1999), *Plagiorhynchus* (*Prosthorhynchus*) *digiticephalus* n. sp. is closest to 5 other species of the subgenus but can be separated from them as follows. Males of *Plagiorhynchus* (*Prosthorhynchus*) *angrensis* (Travassos, 1926) from *Saltator maximus* (Müller) in Brazil are 4.0 mm long with a curved probosci having 18 rows each with 20 hooks that gradually diminish in size from apex to base, testes 400–430 long, and intertwined 0.5-mm-long cement glands. The 7.0-mm-long male specimens of *Plagiorhynchus* (*Prosthorhynchus*) *longirostris* (Travassos, 1926) from Passeriformes (antbirds) in Brazil have proboscis hooks in 20 rows each with 19–20 hooks that become smaller from apex to base, 700–870 long testes, and 1.5-mm-long cement glands. Male specimens of *Plagiorhynchus* (*Prosthorhynchus*) *malayensis* (Tubangui, 1935) Schmidt and Kuntz, 1966 from gruiform birds in Luzon, Philippines, and Taiwan are 10.0–13.0 mm long with proboscides having 16–19 rows of 20–22 hooks each, anterior hooks 33–56 long, hook roots rectangular but with manubria anetriorly. Lemnisci shorter, 2.36–3.33 mm long, testes in middle of trunk, anterior testis up to 1.15 mm long, cement glands shorter and of unequal length 2.12–4.24 mm long, Saefftigen's pouch smaller, 1.21–1.36 mm long by 0.45–0.48 mm wide, and genital pore ventro-subterminal; see Figure 5 in Tubangui (1935) and redescriptions by Schmidt and Kuntz (1966) and Amin et al. (1999). Male specimens of *Plagiorhynchus* (*Prosthorhynchus*) *rossicus* Kostylew, 1915 from *Vanellus* sp. Bonaparte, 1842 in SSSR are not known but females from Russia are small and plump, 4.6 × 1.0–2.0 with an anteriorly wider cylindrical proboscis having ?16–18 rows each with 20–22 hooks that are somewhat larger dorsally than ventrally and very small (13 long) basally. Male specimens of *Plagiorhynchus* (*Prosthorhynchus*) *schmidti* Glovan 1994 (=*Prosthorhynchus rectus* (Linton, 1892) Sprehn,

1942) from *Larus* sp. Linnaeus, 1758 in Mexico are 8.8 mm long with a cylindrical 1.9-mm-long proboscis having 24 rows each with 20 hooks that increase in size from apex to base (53, 70, and 82 long anteriorly, at middle and basally, respectively).

We consider the digitiform process to be more than just a mere curiosity. It appears to have a functional aspect to it that remains to be identified, and should be viewed in a biomechanical context. However, there is not enough material to elucidate that function, and we do not feel that the erection of a new genus is justified at this time.

Plagiorhynchus (*Prosthorhynchus*) *megareceptacils* n. sp. (Figs. 11–18)

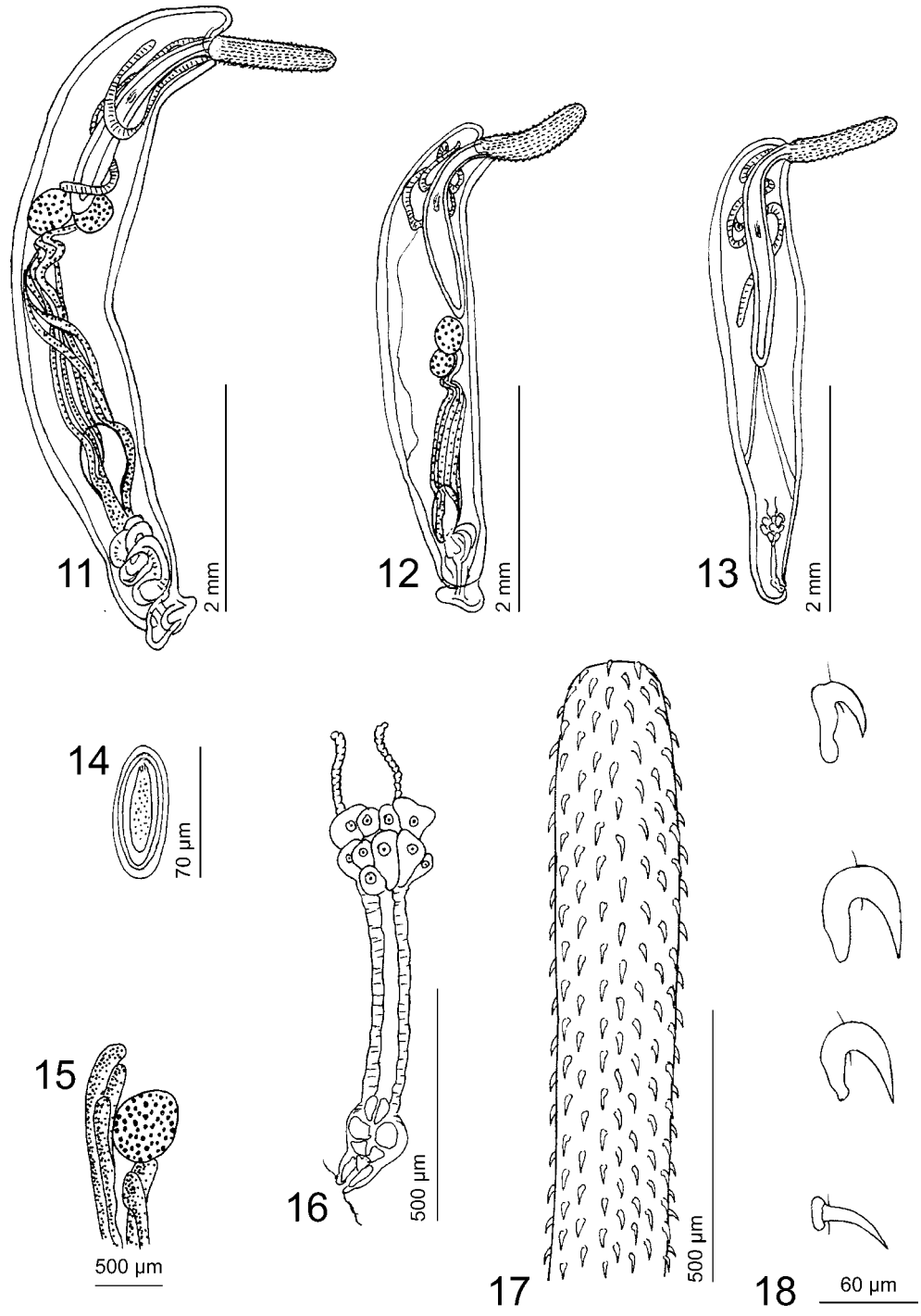
Sixteen specimens were collected from 2 common snipes, *Gallinago gallinago* Linnaeus, of which 12 (7 males, 5 females) were examined. The common snipe is a migrant bird that lives in marshes and bogs of North America, Europe, and Asia and eats insects, earthworms, and plant material (Bezener, 2000). One individual whistling thrush, *Myophonus coeruleus* (Scopoli) was also infected with 6 female specimens that were all examined. Whistling thrushes are partly migratory hill birds that inhabit the Indo-Chinese region and feed on a variety of aquatic invertebrates (Grimmett et al., 1999). The following description is based on material from *G. gallinago* and a comparison with the female specimens from *M. coeruleus* is also made.

Description

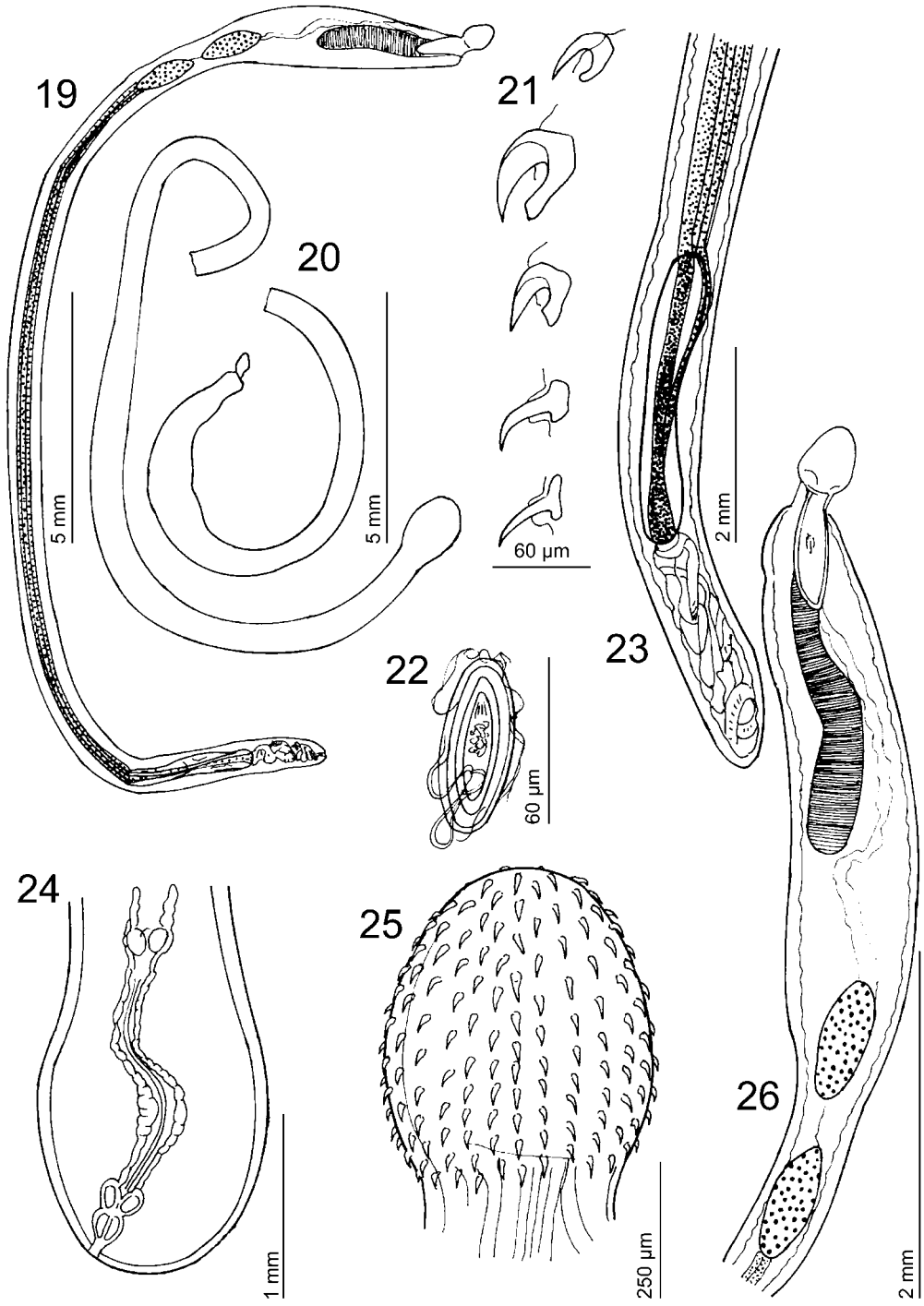
General: With characters of the genus *Plagiorhynchus* and the subgenus *Prosthorhynchus*. Shared structures larger and proboscis hooks more numerous in females than in males. Trunk somewhat short, slightly fusiform in males but more elongate in females (Figs. 11–13). Proboscis long, cylindrical, directed ventrad with 17–20 rows of 16–19 hooks each; anterior 12–14 hooks with simple posteriorly directed roots about as long as blades, but becoming shorter posteriorly; posterior 3–5 hooks markedly more slender and spine-like with knob-like roots. Hooks shortest most anteriorly, relatively longer and most robust at middle and gradually decrease in size posteriorly through most basal spines (Fig. 18). Proboscis receptacle double-walled with cerebral ganglion at its middle third, long, more than one third of trunk length and almost twice as long as proboscis. Lemnisci unequal, long, cylindrical, extending into posterior half of female trunk and to or just past posterior testis.

Males (based on 7 sexually mature specimens from *G. llinago):* Trunk 4.30–5.95 mm long by 0.77–1.00 mm wide at middle. Proboscis 1,040–1,144 long by 218–270 wide with 17–20 (18) rows of 14 rooted hooks and 2–4 rootless spines (total of 16–18 hooks and spines/row) (17.2). Length of hooks from anterior 42–47 (45), 55–61 (58), 52–65 (58), 60–67 (63), 60–70 (63), 60–65 (63), 62–65 (64), 62–65 (64), 52–65 (60), 57–60 (58), 57–62 (60), 57–60 (59), 57–60 (58), 57–62 (60); and of spines 55–64 (58), 50–60 (52), 48–62 (52), 50. Proboscis receptacle 1,664–2,050 (1,805) long by 218–275 (245) wide, 30–39% (35%) of trunk length and 146–197% (166%) length of proboscis. Longer lemniscus 2,080–2,236 (2,158) long by 94–114 (104) wide; shorter lemniscus 1,872–1,976 (1,924) long by 62–72 (67) wide. Testes usually pre-equatorial, small, round overlap each other often at posterior end of receptacle, organized in tandem, obliquely or parallel (Figs. 11, 12). Anterior testis 354–520 (418) long by 250–354 (319) wide, posterior testis 354–534 (446) long by 218–395 (333) wide. Cement glands 6, in 2 sets of 3 each, of unequal length, staggering; 1 set just posterior to anterior testis (1,560–3,625 [2,636] long by 42–104 [75] wide) and 1 set just posterior to posterior testis (Fig. 15) (1,040–3,250 [2,154] long by 42–104 [75]) wide. Cement gland ducts of each set of 3 glands join into a separate common duct reaching to posterior end of Saefftigen's pouch (Figs. 11, 12) 600–1,1040 (876) long by 229–426 (321) wide. Bursa 177–395 (287) long by 385–520 (470) wide. Gonopore terminal.

Females (based on 3 gravid females and 2 with unripe eggs or with ovarian balls only)*:* Trunk 4.00–6.82 (5.59) mm long by 0.72–1.05 (0.93) wide. Proboscis 1,000–1,186 (1,081) long by 198–291 (238) wide with 17–18 (17.6) rows of 12–14 rooted hooks and 3–5 rootless spines (total of 16–19 hooks and spines) (17.7). Length of hooks from anterior 57–65 (61), 60–71 (67), 65–72 (70) 62–72 (69), 65–75 (70), 62–82 (72), 62–82 (72), 62–71 (68), 62–67 (65), 60–67 (65), 62–65 (63), 60–62 (61), 65, 65, and of spines 57, 55, 52–62 (58), 52–62 (57), 55–57 (56), 57, 57. Proboscis receptacle 1,770–2,184 (1,956) long by 177–302 (238) wide, 28–48% (37%) of trunk length and 161–197% (166%) length of proboscis. Longer lemniscus 2,625–3,328 (2,976) long by 88–104 (96) wide, shorter lemniscus 2,250–3,172 (2,711) long by 104 wide. Reproductive system 912–1,196 (1,010)



Figures 11–18. *Plagiorhynchus* (*Prosthorhynchus*) *megareceptaclis* n. sp. from *Gallinago gallinago*. **11.** Male, holotype. **12.** Male, paratype; note different position of testes. **13.** Female, paratype. **14.** Egg. **15.** Anterior portion of cement glands in a monorchid male, note typical organization of 2 sets of 3 glands each staggering behind each of the testes. **16.** Reproductive system of a paratype female, note prominent uninuleated glands at the base of the uterine bell. **17.** Proboscis of holotype male. **18.** Lateral view of ventral proboscis hooks and roots 1, 6, and 12, and basal spine on proboscis of holotype male.



Figures 19–26. *Porrorchis tyto* n. sp. from *Tyto* sp. **19.** Male, holotype. **20.** Female, allotype. **21.** Lateral view of ventral hooks and roots 1, 4, 6, and 8, and basal spine from proboscis of the holotype male. **22.** Egg. **23.** Detail of the posterior portion of the reproductive system of a paratype male. **24.** Reproductive system of the allotype female. **25.** Proboscis of the holotype male. **26.** Anterior portion of holotype male.

Table 2. Comparison between *Porrorchis tyto* n. sp. and *Porrorchis elogantus* Fukui, 1929.

	Porrorchis tyto n. sp.		*Porrorchis elongates* Fukui, 1929			
Reference	This paper		Fukui (1929)		Schmidt and Kuntz (1967)	
Worm sex	Males	Females	Males	Females	Males	Female
Host	*Tyto* sp. and *Gorsachius melanolophus*		*Nycticorax nycticorax*		*Gorsachius melanolophus*	
Locality	Quang Ninh Province, Vietnam		Shizuoka, Japan		Taiwan & Philippines	
Specimens	4 (2 deposited)	6 (2 deposited)	11 (lost)	11 (lost)	12 (5 plesiotypes exam.)	
Trunk L×W (mm)	24,1–26.8 (25.45) × 1.07–1.10 (1.09)	21.75–46.75 (30.33) × 1.02–1.30 (1.17)	11–38 × 0.5–1.5	30–55 × 0.83–0.9	33–44 × 1.5–2	35–55 × 2–2.5
Pseudosegmentation	Conspicuous	Conspicuous	Not reported	Not reported	Conspicuous	Conspicuous
Anterodorsal hump	Unremarkable	Unremarkable	Prominent	Prominent	Prominent	Prominent
Anterior trunk	With marked swelling especially in males		With very slight swelling		With very slight swelling	
Proboscis L×W	520–562 (541) × 452–478 (465)	520–624 (582) × 437–478 (464)	830–900 × 580–710	740–900 × 660–740	825–900 × 520–700	740–900 × 556–740
Anterior proboscis	Dome-shaped	Dome-shaped	Flattened	Flattened	Flattened	Flattened
Hook/spine rows × no./raw	25–27 (26) × 10–11 (10.5)	25–29 (27) × 10–11 (10.5)	32–34 × 13–14	32–34 × 12–13	28–34 × 11–14	28–34 × 11–14
Hooks/ roots	5–7/ all with simple roots shorter than blades anteriorly and posteriorly but equal otherwise		6/ ant. 2 hooks with rudiment. roots (Fig. 25)		6/ all with longer simple roots (Fig. 2)	
Spines/roots	5–6/ with ant. manubria or rudimentary		4–5/ with ant. Manubria (Fig.25)		4–5 / with ant. manubria	
Hook/spine L	**40–60 (50), 55–77 (66)**	**60–67 (63), 67–82 (75),**	None given	None given	Anterior/ middle hooks	
from anterior	**57–77 (71), 62–80 (72),**	**77–87 (79), 70–80 (75),**	—	—	**70–72/ 78–88** long in	
(Spines not bolded)	**57–77 (71), 62–80 (72),**	**57–72 (59)** 50–55 (52),	—	—	both sexes. Basal spines 55–78 long (longest post.)	
	50–62 (54), 52–57 (54)	45–55 (49), 45–50 (47),	—	—		
	45–60 (53), 47–57 (49),	42–48 (45), 40–42 (41),	—	—	—	—
	40–50 (45), 40–50 (44), 45	37–42 (40)	—	—	—	—
Neck L×W	208–260 (234) × 312–343 (327)	208–260 (232) × 333–406 (361)	"very short and unarmed"		"Neck very short"	
Roboscis receptacle L×W	1,127–1,196 (1,160) × 325–354 (339)	978–1,275 (1,136) × 343–385 (368)	1,450–2,240 × 350–550	1,940–2,240 × 450–620	1,650–1,800 × 630–660	1,650–1,800 × 630–660
Lemnisci L×W	2080–2750 (2415) × 165–364 (260); stout, not reaching ant. testis	3224 × 198	2–3 times as long as receptacle; long cylindrical, reaching between testes		4500–4800 long; long cylindrical, reaching between testes	

Table 2. Continued.

Reference	*Porrorchis tyto* n. sp.		*Porrorchis elongates* Fukui, 1929			
	This paper		Fukui (1929)		Schmidt and Kuntz (1967)	
Worm sex	Males	Females	Males	Females	Males	Female
Ant. testis L×W	825–1,025 (950) × 350–450 (408)	—	820–1,600 × 460–870	—	1,350–1,800 × 510–570	—
Post. testis L×W	875–1,175 (1,017) × 375–425 (392)	—	900–1,780 × 500–1,000	—	Not given	—
Testes position	Close to each other	—	Widely separated	—	Widely separated	—
Cement gland L×W	13,500–14,875 (14,187) × 156–208 (182)	—	Very long, up to post. testis	—	Extending to post. Testis	—
Saefftigens pouch (ant.) L×W	850–1,375 (1,075) × 350–475 (392)	—	Anterior; not given	—	Anterior: not given	—
Saefftigens pouch (post.) L×W	1,600–1,875 (1742) × 425–582 (486)	—	Posterior not given	—	Posterior: not given	—
Egg	—	57–72 (62) × 27–32 (29)	—	35–60 × 18–28	—	60–65 × 26–28
Gonopore	Terminal	Markedly subterminal	Terminal (Fig. 21)	Not given or shown	Terminal	Terminal

L × W = length × width.

long, with prominent uninucleated glands (not lateral pockets) at base of uterine bell (Fig. 16). Gonopore subterminal. Eggs elliptoid with concentric shells and no prolongation of fertilization membrane (Fig. 14), 62–77 (71) long by 32–35 (34) wide.

Females from *M. coeruleus* were larger than those from *G. gallinago:* Their trunk measured 6.20–8.00 (7.32) mm long by 0.70–0.83 (0.74) wide; proboscis 1,144–1,175 (1,154) long by 229–281 (246) wide; receptacle 2,288–2,600 (2,489) long by 260–395 (347) wide, 32–37% (34%) of trunk length and 195–227% (216%) length of proboscis ($N = 6$).

Taxonomic summary

Type host: Gallinago gallinago Linnaeus, 1758, common snipe.

Other host: Myophonus coeruleus (Scopoli, 1786), whistling thrush.

Type locality: Quang Ninh Province (106°15′–107° 00′N, 20°15′–21°15′W), Vietnam.

Site of infection: Intestine.

Type specimens: USNMPC no. 99983 (holotype male and allotype female on same slide), no. 99984 (paratypes), all from *G. gallinago*.

Etymology: The new species is named for its unusually long proboscis receptacle compared to trunk length.

Remarks: The number of cement glands in this species (6) and in *P.* (*P.*) *digiticephalus* (4) falls within the commonly reported range of 3–6 glands in the genus *Plagiorhynchus* (Lühe, 1911) Schmidt and Kuntz, 1966 as documented by Schmidt and Kuntz (1966).

The morphological variability of *P. megareceptaclis* from the snipe and thrush hosts examined falls within the expected range of variability that could be affected by the geographical distribution of different host species as has been previously demonstrated by Amin and Dailey (1998) and Amin et al. (1999). We find no justification for the erection of new taxa.

Considering the descriptions of all known species of *Prosthorhynchus* and the key of Amin et al. (1999), the new species comes closest to *Prosthorhynchus gallinagi* Schachtachtinskaia, 1953 described from *Capella gallinago* (Linnaeus, 1758) in Azerbaidjan SSR, as well as *P. longirostris* Travassos, 1926 from *Phoencothraupes*, *Platycichla*, *Hypodalus*, *Conopophaga*, and *Formicivora* in Brazil. Females of *P. gallinagi*, however, are twice as long as male specimens of *P. gallinagi* and females of *P. megareceptaclis*, with the proboscis receptacle representing only 16% of trunk length compared to 28–48% in *P. megareceptaclis*. The proboscis of *P. gallinagi* has 15 hooks per row with the largest middle hooks and roots measuring only 58–59 and 41 in length, respectively, compared to 16–19 hooks per row measuring up to 82 at middle, and with comparable size roots in *P. megareceptaclis*. In *P. longirostris*, males are cylindrical with postequatorial testes in tandem and the proboscis is broader anteriorly with 20 rows each with 19–20 hooks that decrease in size from apex to base. Some of the remaining species have proboscis receptacles comparable in size to those of *P. megareceptaclis* but their relative length compared to trunk length is usually small. This ratio is, however greater than 20% in only 3 species: *Prosthorhynchus angerensis* from *S. maximus* in Brazil (28%), *Prosthorhynchus asymmetricus* Belopolskaia, 1983 from carrier pigeon in the coast of the Baltic Sea (34%), and *Prosthorhynchus gracilis* Petrochenko, 1958 from *Vanellus*, *Sturnus*, *Coracias*, and *Actitis* in Armenian SSSR (28%). Our new species is further separated from the latter 3 species as follows. For comparison with *P. angrensis*, see the remarks section of *P. digiticephalus* and also note that the testes of *P. angrensis* are contiguous but distant from the proboscis receptacle and that the 0.5-mm-long cement glands are intertwined flagellum. In *P. asymmetricus*, the trunk is plump, females have filamentous lemnisci as long as receptacle, an asymmetrical vaginal sphincter, with terminal gonopore, and the proboscis has 16 rows each with 13 hooks that decrease in size posteriorly. Females of *P. gracilis* are twice as long as males, the proboscis is at obtuse angle to body axis and with 20 rows each with 16 hooks that are shorter than roots in hooks nos. 5 to 13 from anterior, and with only 3 S-shaped cement glands up to 1.3 mm long and testes that are distant from the proboscis receptacle.

Porrorchis tyto n. sp. (Figs. 19–26)

Eight (3 males, 5 females) of 41 specimens collected from 3 barn owls and 2 specimens (1 male, 1 female) from 1 Malayan night-heron (Table 1) proved to belong to a new species of *Porrorchis* Fukui, 1929 (=*Pseudoporrorchis* Joyeux and Baer, 1925), which is described below based on specimens from *Tyto* sp. Barn owls are birds of the open country that occur worldwide and feed on voles, frogs, and

insects; all are terrestrial animals (Bruce, 1999) whereas the Malayan night heron is found in forests and lowland vegetation in south, east, and southeast Asia and feeds on insects, earthworms, and aquatic invertebrates (Kushlan, 2005).

Description (based on 3 males and 5 females from *Tyto* sp.)

General: With characters of the genus. Shared characters larger in females than in males. Trunk aspinose, long, uniformly cylindrical but with slight anterodorsal hump and marked swelling anteriorly and at posterior end of female (Figs. 19, 20, 26). Body wall with small scattered hypodermal nuclei and internal pseudosegmentation. Proboscis ovoid, widest below middle, narrows anteriorly to dome-shaped anterior margin (Fig. 25), with 25–29 rows each having 10–11 hooks and spines (5–7 hooks and 4–6 spines). Middle hooks robust. Hooks with simple posteriorly directed roots shorter than blades anteriorly and posteriorly but equal at middle. Spines with peltate stubby or rudimentary roots anteriorly but with small simple roots having anterior manubria basally (Fig. 21). Neck of moderate size. Proboscis receptacle doubled-walled with cerebral ganglion at middle. Lemnisci equal, stout, may extend to level of anterior testis.

Males: Anterior trunk swelling extends up to anterior testis. Testes pre-equatorial, close together and to proboscis receptacle, in tandem or slightly oblique, equal, oblong (Figs. 19, 26). Cement glands 4, long, tubular, between distal end of posterior testis and anterior end of Saefftigen's pouch. Latter pouch with constriction. Cement glands in 2 pairs. Paired cement glands join posteriorly into 1 cement duct. Both cement ducts join into 1 common duct near posterior end of Saefftigen's pouch (Fig. 23). Gonopore terminal. Measurements and other features in Table 2.

Females: Anterior swelling in anterior fifth of trunk; posterior swelling expanded fan-shaped. Gonopore subterminal (Fig. 24). Eggs elliptoid with concentric shells; outermost membrane sculptured (Fig. 22). Measurements and other features in Table 2.

Taxonomic summary

Type host: Tyto sp., owl.

Other host: Gorsachius melanolophus Raffles, 1822, Malayan night heron.

Type locality: Quang Ninh Province (106°15′–107°00′N, 20°15′–21°15′W), Vietnam.

Site of infection: Intestine.

Type specimens: USNPC no. 99985 (holotype male), no. 99986 (allotype female); no. 99987 (paratypes).

Etymology: The new species is named for the type host.

Remarks: The 2 specimens collected from *G. melanolophus* were larger worms than those from *Tyto* sp. Measurements from the male specimen were as follows: proboscis 707 × 520 with 28 rows of 11 or 12 hooks each; proboscis receptacle 1,716 × 426; Lemniscus 2,600 × 291; anterior testis 1,225 × 500; posterior testis 1,400 × 525. Measurements from the female specimen: trunk 37.50 mm × 1.40 mm; proboscis 676 × 489; receptacle 1,487 × 520; and eggs were about the same size, 60–69 (63) × 26–27 (27). The differences in measurements of specimens from the 2 different host species are considered to be of intraspecific nature and do not constitute grounds for the erection of new taxa. Similar conclusions regarding *P. megareceptaclis* (above) were also reached.

Of all the species of *Porrorchis*, *P. tyto* n. sp. comes closet to *Porrorchis elongates* Fukui, 1929 originally described from *Nycticorax nycticorax nycticorax* (Linnaeus, 1758), the night heron, in Japan. Schmidt and Kuntz (1967) provided a more detailed description of the same species from other hosts, including 2 subspecies of *G. melanolophus* in Taiwan and Philippines. The presence of *P. tyto* in Vietnam and the closely related *P. elongates* in the islands of Taiwan and Philippines, from the same host species, raises some interesting evolutionary questions regarding isolation, diversification, and speciation. Whereas *N. nycticorax* is of almost cosmopolitan distribution in swamps, marshes, and lakes of North Central and South America, Europe, Africa, and Asia, *G. melanoloplus* is more regionally distributed in wooded habitats of south, east, and southeast Asia. However, related ornithological questions are beyond the scope of the present treatment.

Distinguishing features separating *P. tyto* from *P. elongates* are shown in Table 2. The most significant differences include the anterodorsal hump, proboscis armature, shape and position of lemnisci, testes, and female gonopore, and size of proboscis, hooks and spines, proboscis receptacle, and testes.

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