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New data on the morphology and taxonomy of some spiruridan nematodes (Spirurida) parasitising fishes in Jammu and Kashmir, India

František Moravec[1], **Anshu Chaudhary**[2], **Mumtaz Ahmed**[2] and **Hridaya Shanker Singh**[2,3]

[1] Institute of Parasitology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic;

[2] Molecular Taxonomy Laboratory, Department of Zoology, Chaudhary Charan Singh University, Meerut, Uttar Pradesh, India;

[3] Vice Chancellor, IIMT University, Ganga Nagar, Meerut, Uttar Pradesh, India

Abstract: Adult specimens of five little-known species of spiruridan nematodes (Spirurida) were collected during occasional examinations of some fishes from the Poonch River in Jammu and Kashmir, India: *Procamallanus* (*Spirocamallanus*) *bilaspurensis* Gupta et Duggal, 1973 in *Mastacembelus armatus* (Lacépède) (Mastacembelidae, Synbranchiformes), *Rhabdochona* (*Rhabdochona*) *indica* Moravec, Scholz, Ash et Kar, 2010 in *Crossocheilus latius* (Hamilton) (Cyprinidae, Cypriniformes), *Rhabdochona* (*Rhabdochona*) *turkestanica* (Skryabin, 1917) in *Schizothorax richardsonii* (Gray) (Cyprinidae, Cypriniformes) and both *Rhabdochona* (*Rhabdochona*) *hospeti* Thapar, 1950 and *Rhabdochona* (*Globochona*) cf. *chodukini* Osmanov, 1957 in *Tor putitora* (Hamilton) (Cyprinidae, Cypriniformes); besides these, unidentifiable physalopterid larvae were recorded from *M. armatus* and *T. putitora*. Their detailed light and electron microscopical studies revealed some taxonomically important, previously not observed features and made possible their redescription. Fourth-stage larvae of *P.* (*S.*) *bilaspurensis* and *R.* (*R.*) *turkestanica* are described for the first time. The latter is resurrected as an independent species. The following are considered to be *species inquirendae*: a total of nine poorly described species of *Rhabdochona* Railliet, 1916 from *T. putitora* in Balochistan, Pakistan, all listed in the monograph of Kakar et al. (2011), plus an additional 15 species of the genus reported from cyprinids and a catfish in the same region (Balochistan) by the same authors. Also three congeneric species from India (*R. nemacheili* Rautela et Malhotra, 1982, *R. putitora* Kaur et Khera, 1991 and *R. tori* Gupta et Srivastava, 1982) and one from Pakistan (*R. charsaddiensis* Siddiqi et Khattak, 1984) should be considered as *species inquirendae* due to their poor descriptions. The names of *Rhabdochona putitori* Anjum, 2013, *R. indusi* Soofi, Birmani et Dharejo, 2017 and *R. sindhicus* Soofi, Birmani, Dharejo, Abbasi et Ghachal, 2020 are invalid according to the International Code of Zoological Nomenclature.

Keywords: Parasitic nematode, Camallanidae, *Procamallanus*, Rhabdochonidae, *Rhabdochona*, Physalopteridae, freshwater fish, Poonch River, South Asia

From a zoogeographical point of view, the territory of the Indian State of Jammu and Kashmir, as well as the neighbouring north-eastern parts of Pakistan and Afghanistan, represents an interesting area, where the Palaearctic and Oriental faunas come into contact (Moravec and Amin 1978). Despite this fact, data on the nematode fauna of fishes in this region are rather scarce (Sood 2017). After the war between India and Pakistan in 1947–1948, the Poonch District was divided into two parts, one went to Pakistan and the other became a part of the Indian State of Jammu and Kashmir.

The present samples of fish nematodes were collected from a very rare site in India, the Poonch River (drainage system of the Indus River) that flows near the Line of Control (LOC) (boundary between India and Pakistan); the samples were collected with great difficulty by the Indian co-authors from the border line (near the LOC) of the Poonch River in January, 2021. Closer examinations of these nematodes showed that they represented five species of hitherto little-known spiruridan species of the families Camallanidae and Rhabdochonidae and unidentifiable larvae of the Physalopteridae. Their detailed morphology and taxonomic evaluation are presented below. The results of molecular studies on these species will be published later.

MATERIALS AND METHODS

Fish were caught in the Poonch River, Jammu and Kashmir, India, close to the border near the LOC (33°30'N, 75°00'E) in January, 2021. The live nematodes obtained were washed in physiological saline and then fixed in hot 70% ethanol. For light microscopical examination (LM), they were cleared with glyc-

Address for correspondence: F. Moravec, Institute of Parasitology, Biology Centre of the Czech Academy of Sciences, Branišovská 31, 370 05 České Budějovice, Czech Republic. E-mail: moravec@paru.cas.cz

erine. Drawings were made with the aid of a Zeiss microscope drawing attachment. Specimens used for scanning electron microscopical examination (SEM) were postfixed in 1% osmium tetroxide (in phosphate buffer), dehydrated through a graded acetone series, critical-point-dried and sputter-coated with gold; they were examined using a JEOL JSM-7401F scanning electron microscope at an accelerating voltage of 4 kV (GB low mode). All measurements are in micrometres unless otherwise indicated. The voucher specimens were deposited in the Helminthological Collection of the Institute of Parasitology, Biology Centre of the Czech Academy of Sciences, České Budějovice, Czech Republic (IPCAS). The nematode classification system adopted follows the Key to Nematode Parasites of Vertebrates (Anderson et al. 2009, Gibbons 2010). The fish nomenclature follows FishBase (Froese and Pauly 2021).

RESULTS

Family Camallanidae Railliet et Henry, 1915

***Procamallanus* (*Spirocamallanus*) *bilaspurensis* Gupta et Duggal, 1973** Figs. 1–3

Description: Small nematodes with thick, transversely striated cuticle. Mouth aperture oval, surrounded by 6 flat, crescentic elevations and 8 submedian cephalic papillae arranged in 2 circles, each formed by 4 papillae; papillae of external circle distinctly larger (Figs. 1E,B,D). Pair of small lateral amphids present (Figs. 1E, 2B). Buccal capsule yellowish, thin-walled, slightly longer than wide, with simple, well-developed basal ring. Basal part of proper capsule somewhat thickened, appearing as another narrow ring just anterior to basal ring. Inner surface of whole capsule provided with numerous, weakly-developed, interrupted spiral thickenings forming short, irregularly arranged, sometimes indistinct ridges (Fig. 1A–D). Muscular oesophagus somewhat shorter than glandular oesophagus; posterior ends of both parts of oesophagus only slightly expanded. Deirids small, simple, situated slightly anteriorly to level of nerve ring (Figs. 1A–D, 2A,F). Excretory pore somewhat anterior to mid-way between nerve ring and posterior end of muscular oesophagus. Tail of both sexes conical. Males considerably smaller than gravid female.

Male (five specimens): Length of body 3.65–3.99 mm, maximum width 109–136. Buccal capsule including basal ring 78–87 long and 72–84 wide; width/length ratio of capsule 1 : 1.04–1.21; basal ring 12–15 long and 48–66 wide. Length of muscular oesophagus 381–422, maximum width 66–81; length of glandular oesophagus 422–544, maximum width 60–66; length ratio of muscular and glandular oesophagus 1 : 1.11–1.33. Length of entire oesophagus and buccal capsule represents 24–27% of body length. Deirids, nerve ring and excretory pore 129–165, 171–186 and 219–291, respectively, from anterior extremity. Posterior end of body curved ventrally, provided with caudal alae supported by pedunculate papillae; anteriorly alae interconnected by mound which forms structure resembling pseudosucker, and reach posteriorly to base of terminal projections on caudal extremity (Figs. 1G,H,K, 3E–G). Preanal papillae: 7 pairs of subventral pedunculate papillae and 1 pair of ventral sessile papillae situated anterior to cloacal opening; postanal papillae: 4 pairs of subventral pedunculate papillae, followed by pair of large lateral phasmids situated close to tail tip (Figs. 1G,H,K, 3A–G). Spicules similar in shape, unequal, with sharply pointed distal ends; large (right) spicule well-sclerotised, 135–159 long; small (left) spicule poorly sclerotised and, therefore, hardly visible, 90–99 long (Figs. 1G,H,K, 3D). Length ratio of spicules 1 : 1.55–1.61. Gubernaculum small, well-sclerotised, 24–33 long in lateral view; in dorsoventral view, gubernaculum somewhat Y-shaped, with right arm somewhat longer than left arm (Fig. 1H). Tail conical, 39–57 long, with rounded tip (Figs. 1G,H, 3A–C).

Gravid female (one larvigerous specimen): Length of body 7.28 mm, maximum width 150. Buccal capsule including basal ring 93 long and 90 wide; width/length ratio of capsule 1 : 1.03; basal ring 15 long and 66 wide. Length of muscular oesophagus 503, maximum width 90; length of glandular oesophagus 571, maximum width 66; length ratio of muscular and glandular parts of oesophagus 1 : 1.14. Length of entire oesophagus and buccal capsule representing 16% of body length. Deirids, nerve ring and excretory pore 165, 207 and 330, respectively, from anterior extremity. Vulva postequatorial, 4.00 mm from anterior extremity (at 55% of body length). Vagina directed posteriorly from vulva (Fig. 1F). Uterus filled with numerous first-stage larvae; cephalic end of larvae provided with dorsal tooth, 4 cephalic papillae and pair of amphids (Fig.2G). Tail conical, 129 long, bearing 3 (1 dorsal and 2 subventral) minute terminal rounded lobes 3 long (Figs. 1I,J, 2E); pair of small lateral papilla-like phasmids present at short distance anterior to tail tip (Figs. 1I, 2E).

Female fourth-stage larva (one specimen): Length of body 1.07 mm, maximum width 48. Buccal capsule colourless, thin-walled, 33 long including basal ring and 27 wide; width/length ratio of capsule 1 : 1.22; basal ring 6 long, 21 wide; inner surface of capsule smooth, with about 4 short, narrow longitudinal ridges outlined at anterior half of capsule in lateral view (Fig. 1L). Muscular oesophagus 207 long, 30 wide; glandular oesophagus 204 long, 33 wide; length ratio of muscular and glandular parts of oesophagus 1 : 0.99. Entire oesophagus and buccal capsule representing 38% of body length. Deirids, nerve ring and excretory pore 72, 102 and 168, respectively, from anterior extremity. Primordium of vulva situated 648 from anterior end of body, at 60% of entire body length. Tail conical, 80 long, with 3 distinct, sharply pointed terminal projections 9 long (Fig. 1M).

Host: Zig-zag eel *Mastacembelus armatus* (Lacépède) (Mastacembelidae, Synbranchiformes).

Site of infection: Intestine.

Locality: Poonch River, Jammu and Kashmir part of India, near Line of Control (border between India and Pakistan).

Material examined: 7 nematode specimens.

Deposition of voucher specimens: IPCAS N-1260.

Remarks. *Procamallanus* Baylis, 1923 includes a large number of species described from freshwater and

marine fishes of the tropical and subtropical regions (De and Moravec 1980). Although very many nominal species were described from freshwater fishes in southern and south-eastern Asia, mainly in India (see, e.g., Sood 2017), the actual species composition in this region remains almost unknown because of taxonomic confusion caused by inadequate or erroneous species descriptions. Unfortunately, as mentioned by Sood (2017), there are doubts on the availability of the type or voucher specimens from most (if not all) the sources.

Numerous species of *Procamallanus* were often reported from only one host species in the same zoogeographical region. Thus, for example, 19 species of *Procamallanus* were reported from the catfish *Heteropneustes fossilis* (Bloch) in India and neighbouring countries (Bangladesh, Pakistan, Sri Lanka) (Sood 2017); six of these were later synonymised with *P. spiculogubernaculus* Agrawal, 1958 by De and Moravec (1980). On the other hand, representatives of this genus parasitising freshwater fishes in other zoogeographical regions, e.g. in the Ethiopian or Neotropical Regions, are known to exhibit a certain degree of host specificity in terms of their definitive host (Moravec 1998, 2019).

Sood (2017) listed the following six species of *Procamallanus* from *M. armatus* in India and Pakistan: *P. bilaspurensis* Gupta et Duggal, 1973, *P. fulvidraconis* Li, 1935, *P. gubernaculus* Khera, 1955, *P. kalriai* Rehana et Bilqees, 1969 and *P. meszarosi* (Arya, 1984). Of these, *P. fulvidraconis*, *P. gubernaculus* and *P. kalriai* (*species inquirenda* – see Sood 2017) were originaly described from catfishes and their later records from *M. armatus* in Pakistan (Nawaz at al. 2007) were evidently based on misidentifications. Judging from their morphology and measurements (e.g., the situation of deirids anterior to the nerve ring level, length of the right spicule erroneously reported as the left spicule, presence of seven pairs of preanal pedunculate papillae and a conspicuous inflation of caudal alae anterior to the beginning of these papillae, female tail with three small caudal projections), the present nematodes from India are most similar to *P. bilaspurensis*, except for the presence of discontinuous ridges in the buccal capsule, not reported for *P. bilaspurensis*. However, in contrast to the majority of *Procamallanus* species possessing spiral ridges in the capsule, these ridges are interrupted and poorly developed in the present specimens (as also occurs, e.g., in *P. bagarii* Karve et Naik, 1951 or *P. fulvidraconis* – see Moravec and Sey 1988a, Moravec et al. 2003), so that they were probably overlooked by Gupta and Duggal (1973) when describing *P. bilaspurensis*. Therefore, the present specimens are considered to belong to this species. The present data show that *P. bilaspurensis* should be placed in the subgenus *Spirocamallanus* Olsen, 1952 based on the presence of spiral ridges in the buccal capsule in both the males and females (Moravec and Thatcher 1997).

The inadequately described *P. meszarosi* from *M. armatus* in India (Arya 1984) shows some features characteristic of *P. bilaspurensis* (presence of interrupted ridges in the buccal capsule or the location of the deirids just anterior to the nerve ring), but its right spicule is reported to be longer (230–250 μm), the buccal capsule is markedly narrow and the preanal papillae are more numerous. Nevertheless, this species should be considered a *species inquirenda*, even though its conspecificity with *P. bilaspurensis* cannot be excluded, because of its poor description.

The original description of *P. bilaspurensis* was based on LM, and some taxonomically important features were given inaccurately or were not observed at all. The number and distribution of cephalic papillae, the presence of weakly developed and interrupted spiral ridges in the buccal capsule, the location of the excretory pore and the correct number and distribution of male cadal papillae are reported here for the first time. The morphology of *P. bilaspurensis* is rather similar to that of *P. fulvidraconis* (both species have already been studied by SEM), but the latter differs in the distinctly narrower buccal capsule, deirids situated well posterior to the level of the nerve ring and in having a longer right spicule (Moravec et al. 2006). Furthermore, their hosts belong to different fish families and orders (Mastacembelidae, Synbranchiformes *vs* Bagridae, Siluriformes) of fishes.

The fourth-stage larva of *P. bilaspurensis* is described here for the first time.

Family Rhabdochonidae Travassos, Artigas et Pereira, 1928

Rhabdochona (*Rhabdochona*) *indica* Moravec, Scholz, Ash et Kar, 2010 Figs. 4, 5

Syn.: *Rhabdochona moraveci* Katoch et Kalia, 1992 (= a homonym of *Rhabdochona moraveci* Puylaert, 1973 and *R. moraveci* Duggal et Kaur, 1987).

Description: Medium-sized nematodes with transversely striated cuticle (Fig. 5C). Oral aperture hexagonal, with 4 distinct submedian sublabia, surrounded by 4 small submedian cephalic papillae and pair of lateral amphids (Figs. 4D, 5A,B). Prostom funnel-shaped, without basal teeth (Fig. 4A–C,F). Anterior margin of prostom armed internally with 14 small, forwardly directed teeth (3 dorsal, 3 ventral and 4 on each side, latter forming pairs; each pair consists of 1 large and 1 small tooth) (Figs. 4B–C,F, 5A,B). Vestibule rather short (Fig. 4A–C, F). Deirids small, bifurcate, situated at level of base of prostom (Figs. 4C,E,F, 5C). Tail in both sexes conical, with rounded tip (Figs. 4I,K,M, 5D–H).

Male (six specimens): Length of body 5.96–8.35 mm, maximum width 136–354. Prostom 27–30 long and 21–24 wide in lateral view. Length of vestibule including prostom 87–99. Muscular oesophagus 233–312 long, maximum width 36–45; glandular oesophagus 1.47–2.26 mm long, maximum width 66–87; length ratio of both parts 1 : 5.2–7.5 (Fig. 4A,B). Length of vestibule with prostom and entire oesophagus represents 26–34% of body length. Deirids, nerve ring and excretory pore 30–39, 141–189 and 225–267, respectively, from anterior extremity. Preanal papillae unstable in number; subventral preanal papillae in combinations: 5 + 6, 6 + 6, 6 + 7 and 8 + 8; lateral preanal papillae absent. Of 6 postanal pairs of papillae, sec-

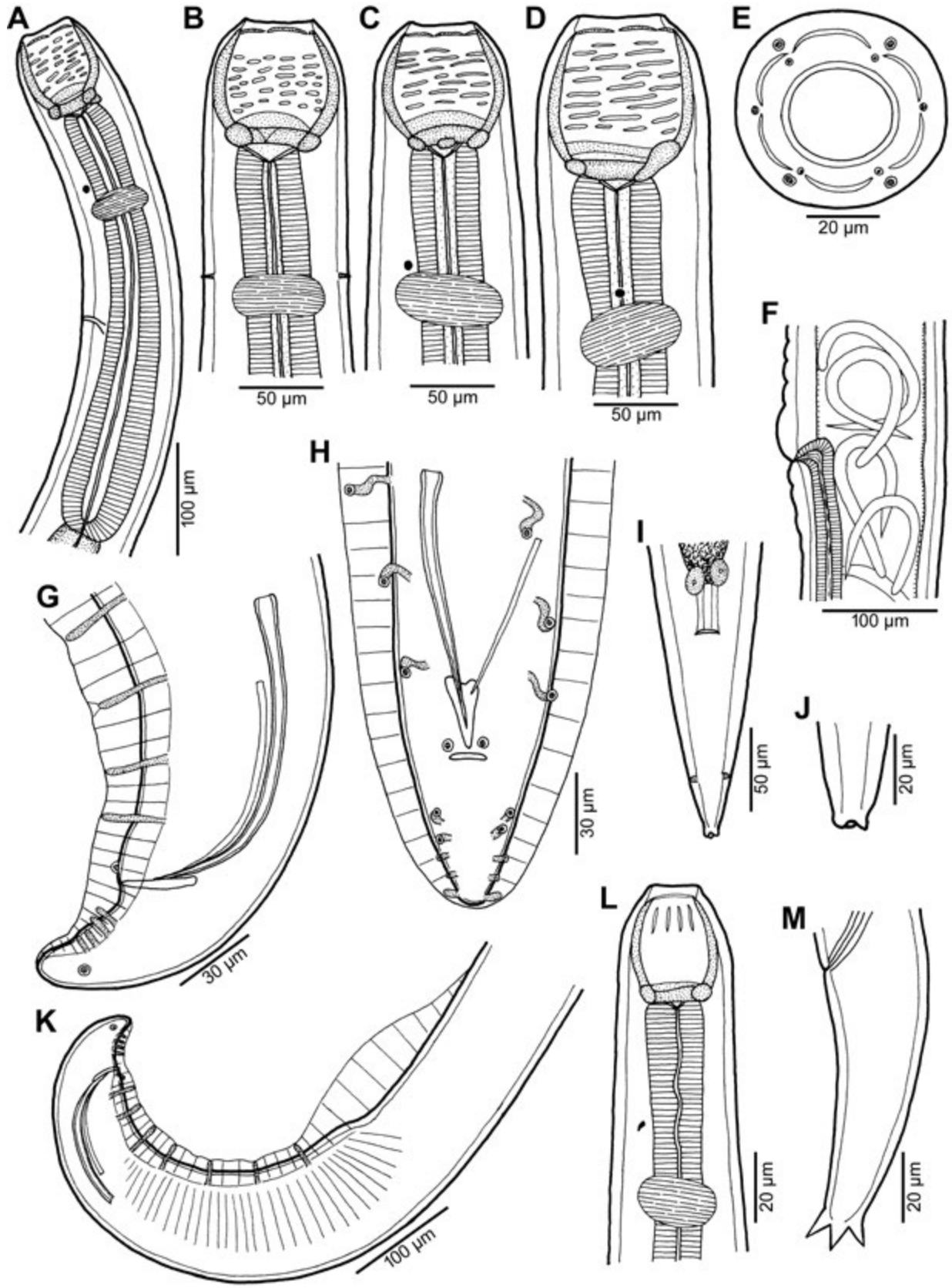

Fig. 1. *Procamallanus* (*Spirocamallanus*) *bilaspurensis* Gupta et Duggal, 1973 from Mastacembelus armatus. **A** – anterior end of male, lateral view; **B**, **C** – anterior end of male (enlarged), dorsoventral and lateral views, respectively; **D**, **E** – cephalic end of gravid female, lateral and apical views, respectively; **F** – vulva, lateral view; **G**, **H** – caudal end of male, lateral and ventral views, respectively; **I** – female tail, ventral view; **J** – tail tip of female; **K** – posterior end of male, lateral view; **L** – anterior end of fourth-stage larvae, lateral view; **M** – tail of fourth-stage larva, lateral view.

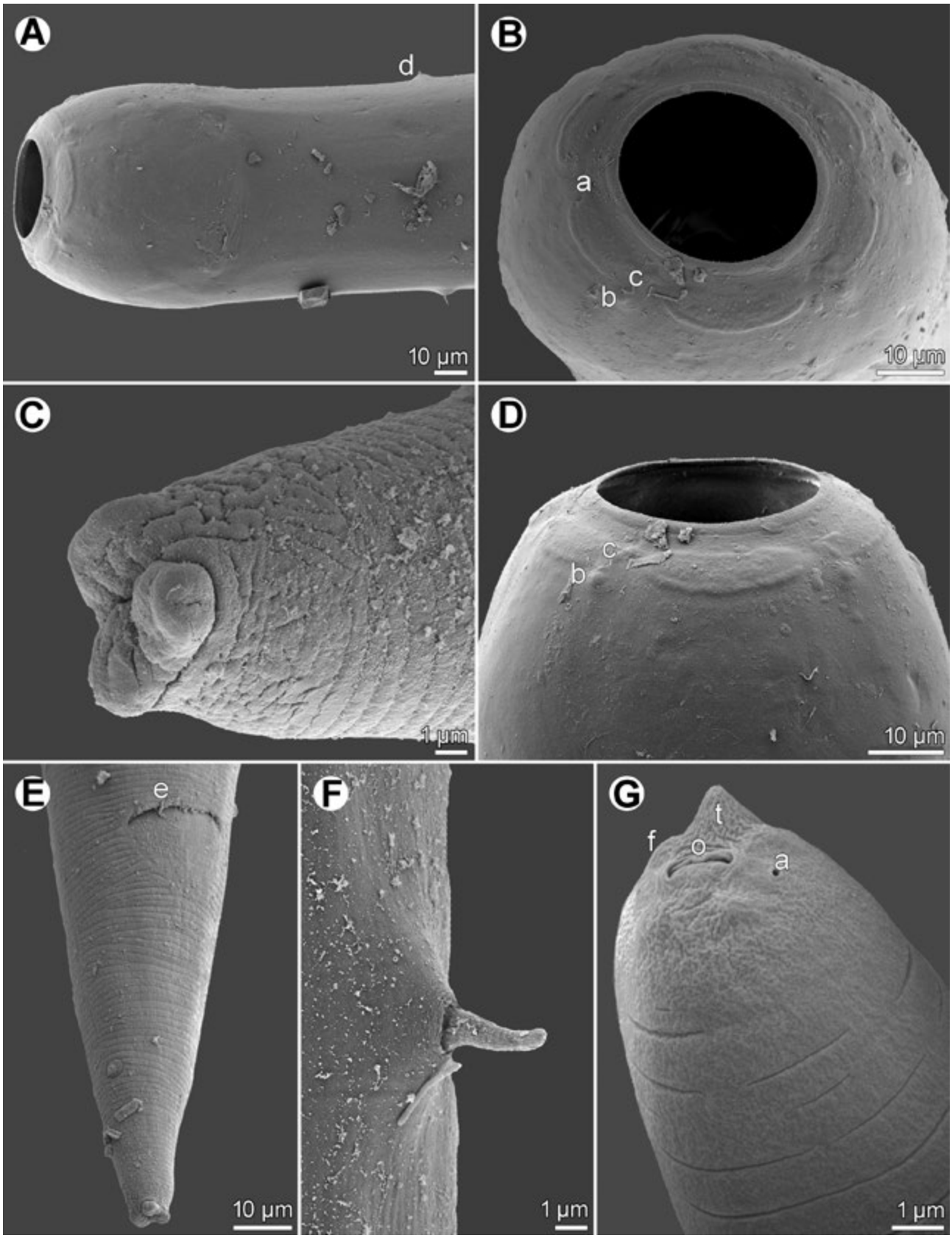

Fig. 2. *Procamallanus* (*Spirocamallanus*) *bilaspurensis* Gupta et Duggal, 1973 from *Mastacembelus armatus* (Lacépède), scanning electron micrographs of gravid female. **A** – anterior end, dorsoventral view; **B** – cephalic end, apical view; **C** – tail tip, sublateral view; **D** – cephalic end, dorsoventral view; **E** – tail, ventrolateral view; **F** – deirid; **G** – cephalic end of larva from uterus, subventral view. *Abbreviations*: a – amphid; b – external cephalic papilla; c – internal cephalic papilla; d – deirid; e – anus; f – cephalic papilla of larva; g – phasmid; o – oral opening; t – dorsal larval tooth.

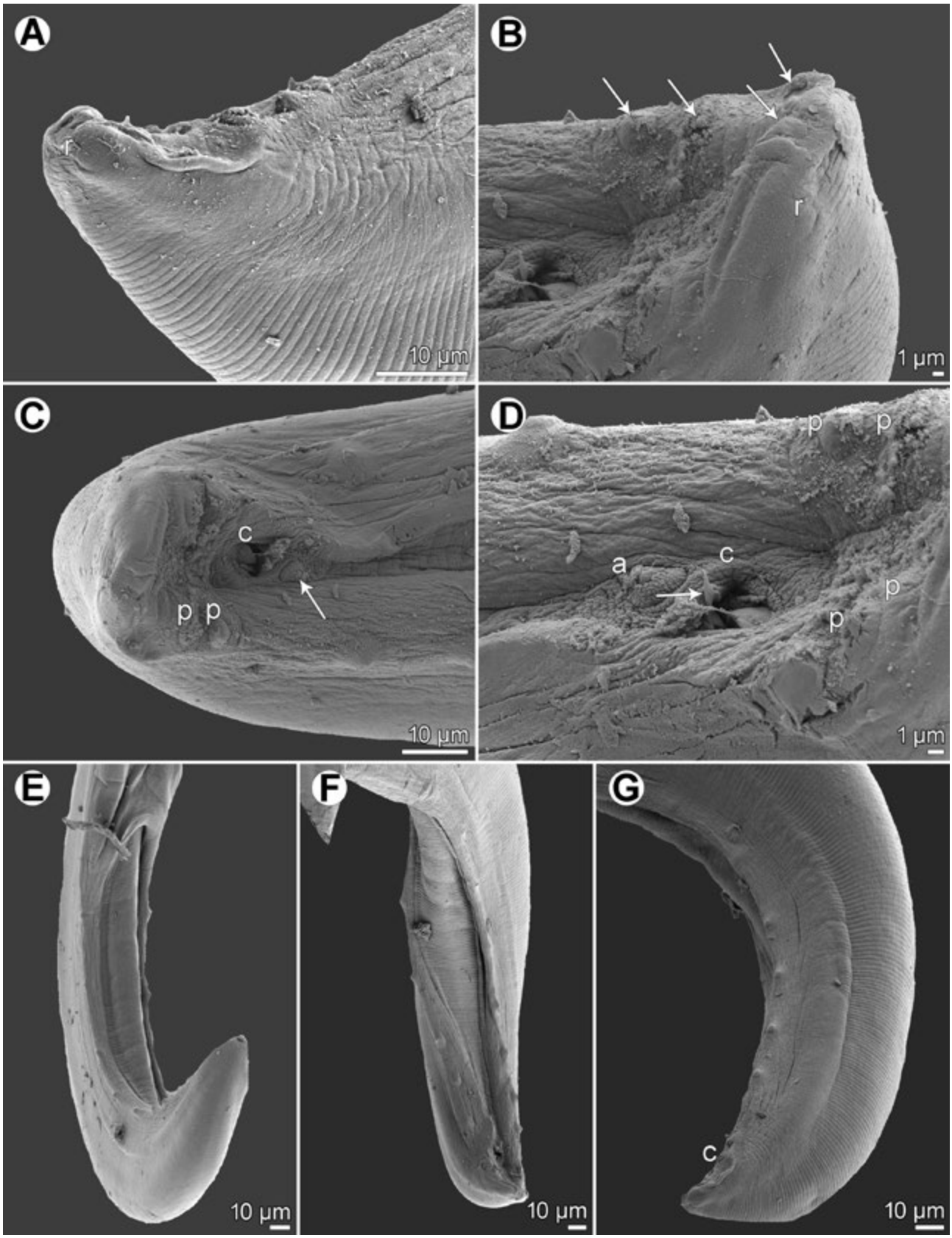

Fig. 3. *Procamallanus* (*Spirocamallanus*) *bilaspurensis* Gupta et Duggal, 1973 from *Mastacembelus armatus* (Lacépède), scanning electron micrographs of male posterior end. **A** – caudal end, lateral view; **B** – tail, ventrolateral view (arrows indicate postanal papillae); **C** – tail, ventral view (arrow indicates ventral preanal papilla); **D** – region of cloaca, ventrolateral view (arrow indicates protruding end of spicule); **E**, **F** – posterior end of body, subventral and ventral views, respectively; **G** – posterior end of body (enlarged), lateral view. *Abbreviations*: a – ventral preanal papilla; c – cloaca; p – postanal papilla; r – phasmid.

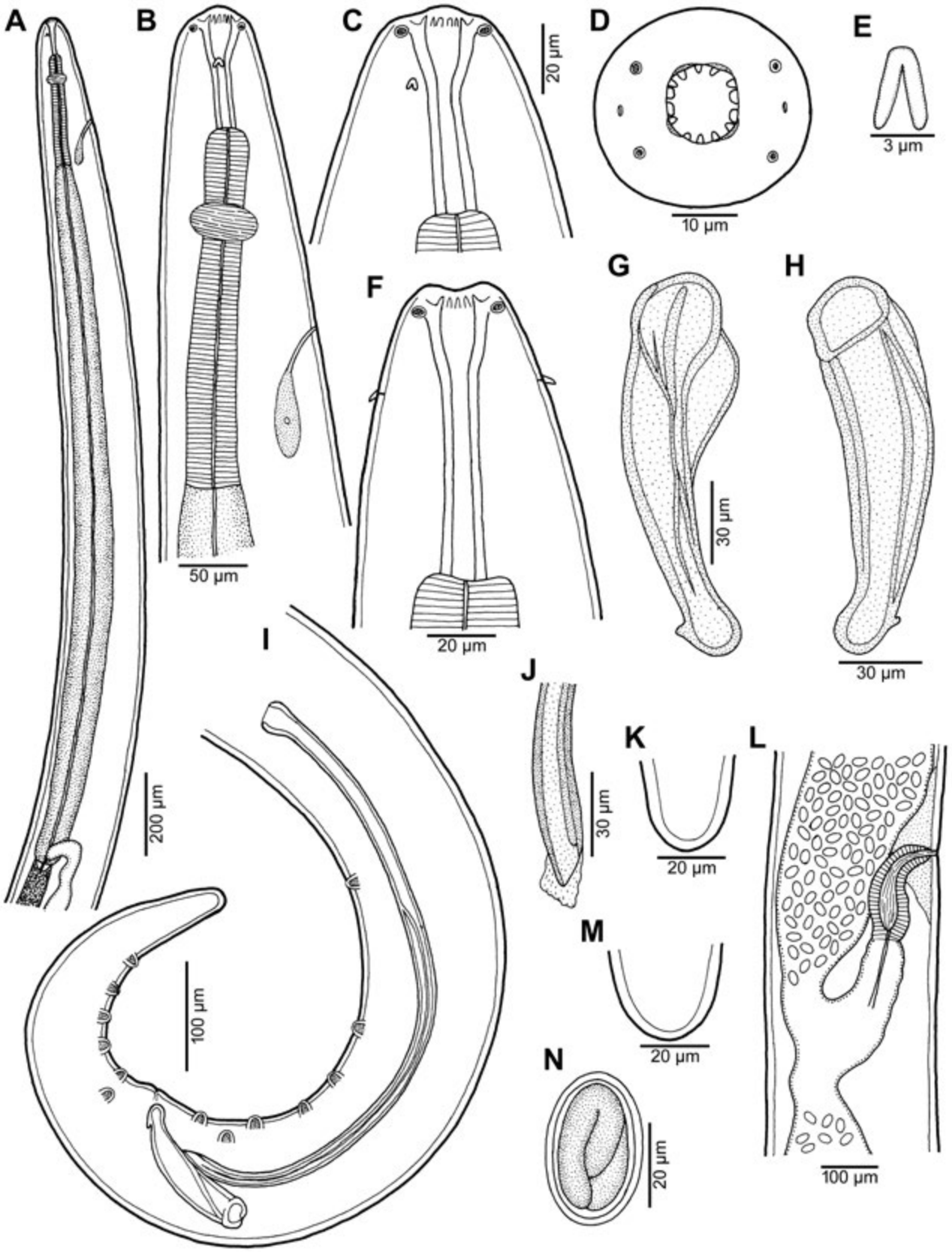

Fig. 4. *Rhabdochona* (*Rhabdochona*) *indica* Moravec, Scholz, Ash et Kar, 2010 from *Crossocheilus latius* (Hamilton). **A** – anterior end of male, lateral view; **B** – anterior end of male (enlarged), lateral view; **C**, **D** – cephalic end of gravid female, lateral and apical views, respectively; **E** – deirid; **F** – cephalic end of male, dorsolateral view; **G**, **H** – right spicule, lateral views (in two different specimens); **I** – posterior end of male, lateral view; **J** – distal tip of left spicule; **K** – tail tip of male; **L** – region of vulva, lateral view; **M** – tail tip of female; **N** – mature egg.

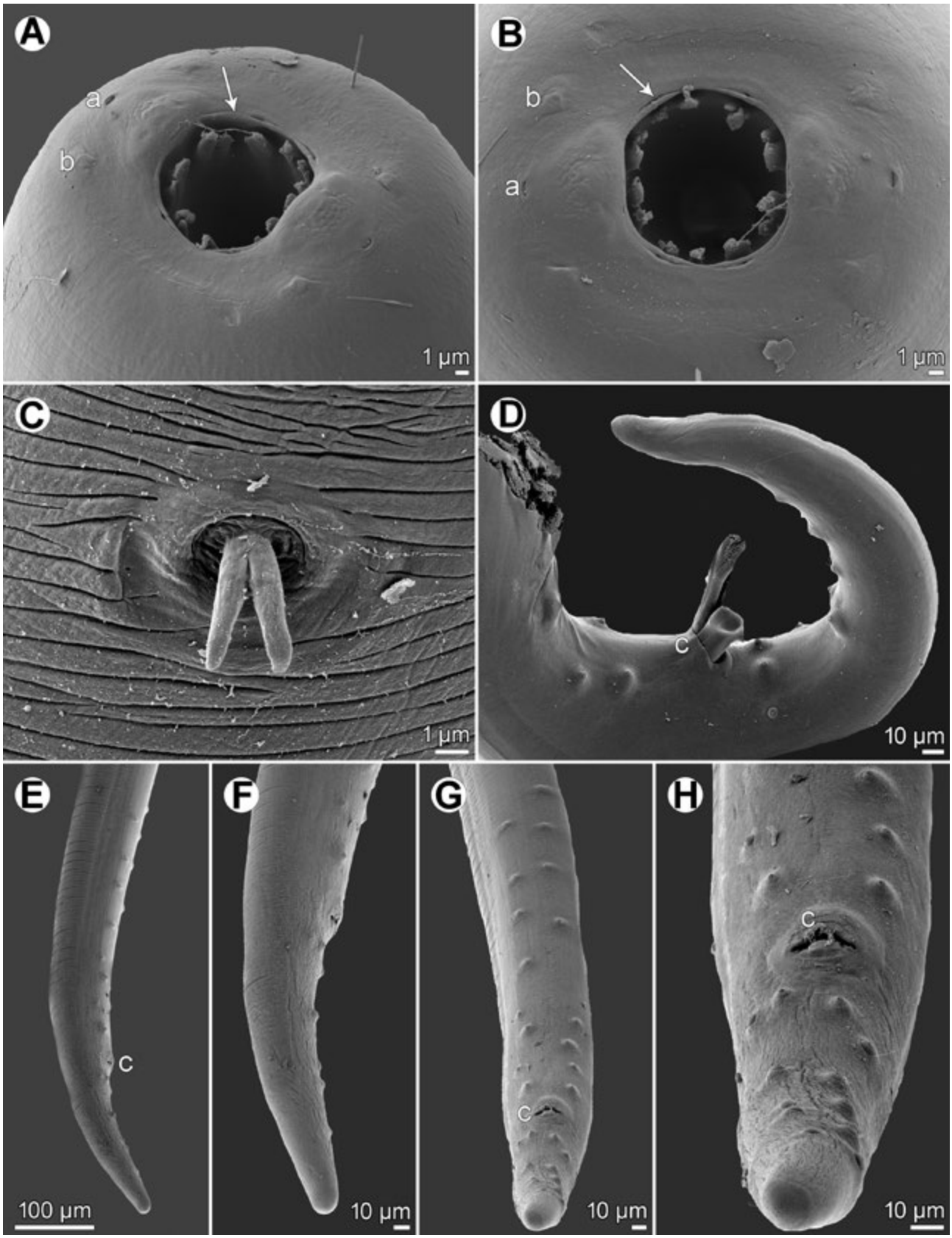

Fig. 5. *Rhabdochona* (*Rhabdochona*) *indica* Moravec, Scholz, Ash et Kar, 2010 from *Crossocheilus latius* (Hamilton), scanning electron micrographs. **A**, **B** – cephalic end of female, subapical and apical views, respectively (arrows indicate sublabia); **C** – deirid; **D** – tail of male, sublateral view (note extruded spicules); **E** – male posterior end, latearl view; **F** – tail of male, lateral view; **G** – male posterior end, ventral view; **H** – tail of male, ventral view. *Abbreviations*: a – amphid; b – cephalic papilla; c – cloaca.

ond pair somewhat lateral, remaining subventral (Figs. 4I, 5D–H). Longitudinal ventral cuticular ridges (area rugosa) absent. Left spicule 606–720 long; its shaft 192–291 long, representing 32–40% of entire spicule length; distal tip of spicule lanceolate, provided with fine cuticular membrane (Figs. 4I,J, 5D). Right spicule 144–150 long, with minute dorsal barb close to rounded distal tip (Figs. 4G–I, 5D). Length ratio of spicules 1 : 4.04–4.80. Tail 273–396 long, with rounded extremity (Figs. 4I,K, 5D–H).

Female (five gravid specimens with mature, embryonated eggs; measurements of three nongravid specimens without eggs in parentheses): Length of body 13.60–14.47 (8.68–9.25) mm, maximum width 340–381 (218–272). Prostom 42–48 (33–39) long and 33–39 (27–30) wide (Fig. 4C). Length of vestibule including prostom 123–144 (90–102). Muscular oesophagus 405–450 (300–330) long, maximum width 60–66 (48–60); glandular oesophagus 2.71–2.99 (1.77–1.97) mm, maximum width 108–156 (81–84); length ratio of both parts 1 : 6.5–7.2 (1 : 5.4–6.1). Length of vestibule with prostom and entire oesophagus represents 23–26% (24–27%) of body length. Deirids, nerve ring and excretory pore 36–60 (36–45), 192–219 (165–180) and 285–375 (252–282), respectively, from anterior extremity. Vulva postequatorial, 7.34–7.71 (4.80–5.30) mm from anterior extremity, at 52–55% (53–59%) of body length. Vagina directed posteriorly from vulva (Fig. 4L). Fully developed eggs (containing larva) oval, thick-walled, size 36–42 × 21–24; thickness of wall 2–3; egg surface smooth (Fig. 4N). Tail 313–381 (218–258) long, with rounded tip (Fig. 4M).

Host: Stone roller *Crossocheilus latius* (Hamilton) (Cyprinidae, Cypriniformes).

Site of infection: Intestine.

Locality: Poonch River, Jammu and Kashmir part of India, near Line of Control (border between India and Pakistan).

Material examined: Fourteen nematodes from three fish (intensity 3–8).

Deposition of voucher specimens: IPCAS N-1257.

Remarks. Kumar et al. (1988) were the first to report nematodes of *Rhabdochona* Railliet, 1916 from the cyprinid *Crossocheilus latius* (Hamilton) in India, but, apparently, these were incorrectly identified as *R. hellichi* (Šrámek, 1901). Later Katoch and Kalia (1992) inadequately described *Rhabdochona moraveci* Katoch et Kalia, 1992 from *C. latius* and *Schizothorax esocinus* Heckel (both Cyprinidae) from Himachal Pradesh, India. However, because this name is a homonym of *R. moraveci* Puylaert, 1973 and *R. moraveci* Duggal et Kaur, 1987 (= syn. of *R. hospeti*) (see Puylaert 1973, Duggal and Kaur 1987), Moravec et al. (2010) renamed this species as *R. indica* Moravec, Scholz, Ash et Kar, 2010.

As reported by Moravec et al. (2010), *R. moraveci* of Katoch and Kalia (1992) was probably based on specimens belonging to two different species, one from *C. latius* (type host) and another one from *S. esocinus*; specimens from the latter host were most probably conspecific with those reported by Fotedar and Dhar (1970) as *Filochona kasmirensis* (= *Rhabdochona turkestanica* (Skryabin, 1917)), recorded as a frequent parasite of *S. esocinus*.

Some taxonomically important morphological features of *R. indica* were given inaccurately (e.g., the number of anterior prostonal teeth) in the original species description by Katoch and Kalia (1992) or were not observed at all (e.g., the location of the excretory pore). As compared with other congeners, this species is mainly characterised by having a markedly short vestibule, a rather large prostom armed with 14 anterior prostomal teeth and without basal teeth, bifurcate deirids situated at the level of the base of prostom, a rather long left spicule, the unusual shape of the right spicule (with a widely rounded distal tip and the presence of a minute dorsal barb), rounded tail tips in both sexes and smooth mature eggs (without filaments or swellings). *Rhabdochona indica* has been studied by SEM in this paper for the first time. This is the second record of this parasite species since its original description nearly 30 years ago (later this was included in the key to the Indian species of *Rhabdochona* by Katoch and Kalia 1993).

Rhabdochona (*Rhabdochona*) *turkestanica* (Skryabin, 1917) Krepkogorskaya, 1927 Figs. 6, 7

Syns: *Ichthyospirura turkestanica* Skryabin, 1917; *Rhabdochona denudata filamentosa* Bykhovskaya-Pavlovskaya, 1936, pro parte; *R. kashmirensis* Thapar, 1950; *R. schizothoracis* Siddiqi et Khattak, 1984; *R. hellichi turkestanica* (Skryabin, 1917) Moravec, Scholz et Ash, 2010.

Description: Medium-sized nematodes with transversely striated cuticle (Fig. 7F–H). Oral aperture hexagonal, with 4 distinct submedian sublabia, surrounded by 4 small submedian cephalic papillae and pair of lateral amphids (Figs. 6D, 7A,B). Prostom funnel-shaped, with small basal teeth (Fig. 6A–C). Anterior margin of prostom armed internally with 14 small, forwardly directed teeth (3 dorsal, 3 ventral and 4 on each side, latter forming pairs) (Figs. 6A–D, 7A,B). Vestibule rather long (Fig. 6A–C). Deirids small, bifurcate, situated somewhat anterior to mid-length of vestibule (Figs. 6A–C, 7H). Tail of both sexes conical, with pointed tail tip (Fig. 6H,I).

Male (five specimens): Length of body 6.20–8.19 mm, maximum width 109–136. Prostom 21–24 long and 15–18 wide in lateral view. Length of vestibule including prostom 123–147. Muscular oesophagus 294–330 long, maximum width 24–27; glandular oesophagus 1.90–3.46 mm long, maximum width 78–99; length ratio of both parts 1 : 6.2–8.2 (Fig. 6A). Length of vestibule with prostom and entire oesophagus represents 34–39% of body length. Deirids, nerve ring and excretory pore 45–57, 153–186 and 240–300, respectively, from anterior extremity. Preanal papillae unstable in number; subventral preanal papillae present in combinations: 9 + 7, 9 + 9, 11 + 9 and 11 + 10; in addition, 2 pairs of lateral preanal papillae situated between second and third and third, and fourth pairs of subventrals (counting from cloaca). Five of 6 postanal pairs of papillae subventral, second pair lateral (Figs. 6G,K, 7C,E,G). Longitudinal ventral cuticular ridges (area rugosa) well-deve-

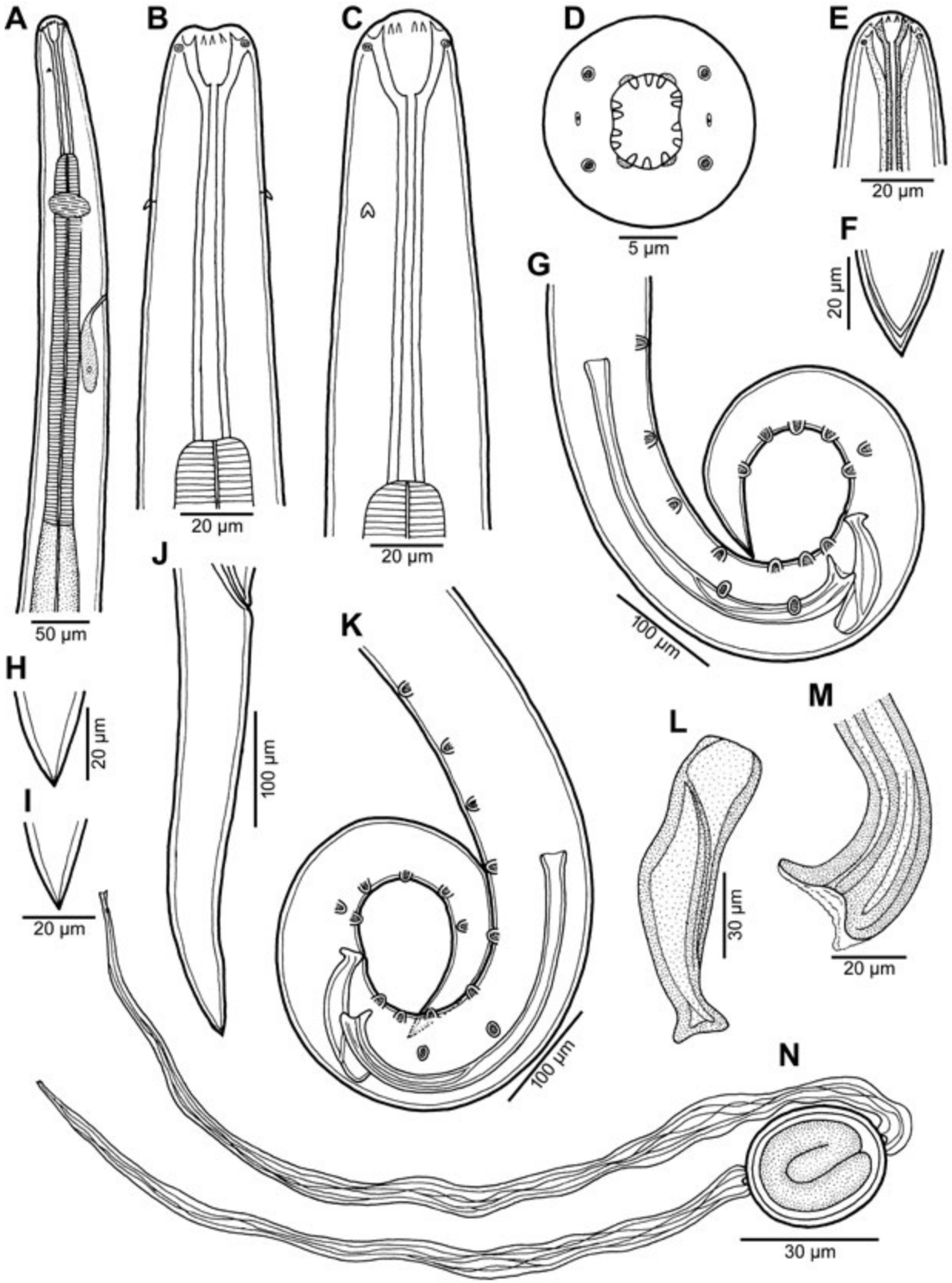

Fig. 6. *Rhabdochona* (*Rhabdochona*) *turkestanica* (Skryabin, 1917) from *Schizothorax richardsonii* (Gray). **A** – anterior end of female, lateral view; **B**, **C** – vestibule of male and female, dorsoventral and lateral views, respectively; **D** – cephalic end, apical view; E, F – anterior end and tail tip of moulting fourth-stage larva, lateral views; **G** – posterior end of male, lateral view; **H**, **I** – tail tip of male and female, respectively, lateral views; **J** – female tail, lateral view; **K** – posterior end of male (another specimen), lateral view; **L**, **M** – right spicule and distal end of left spicule, respectively, lateral views; **N** – fully developed egg.

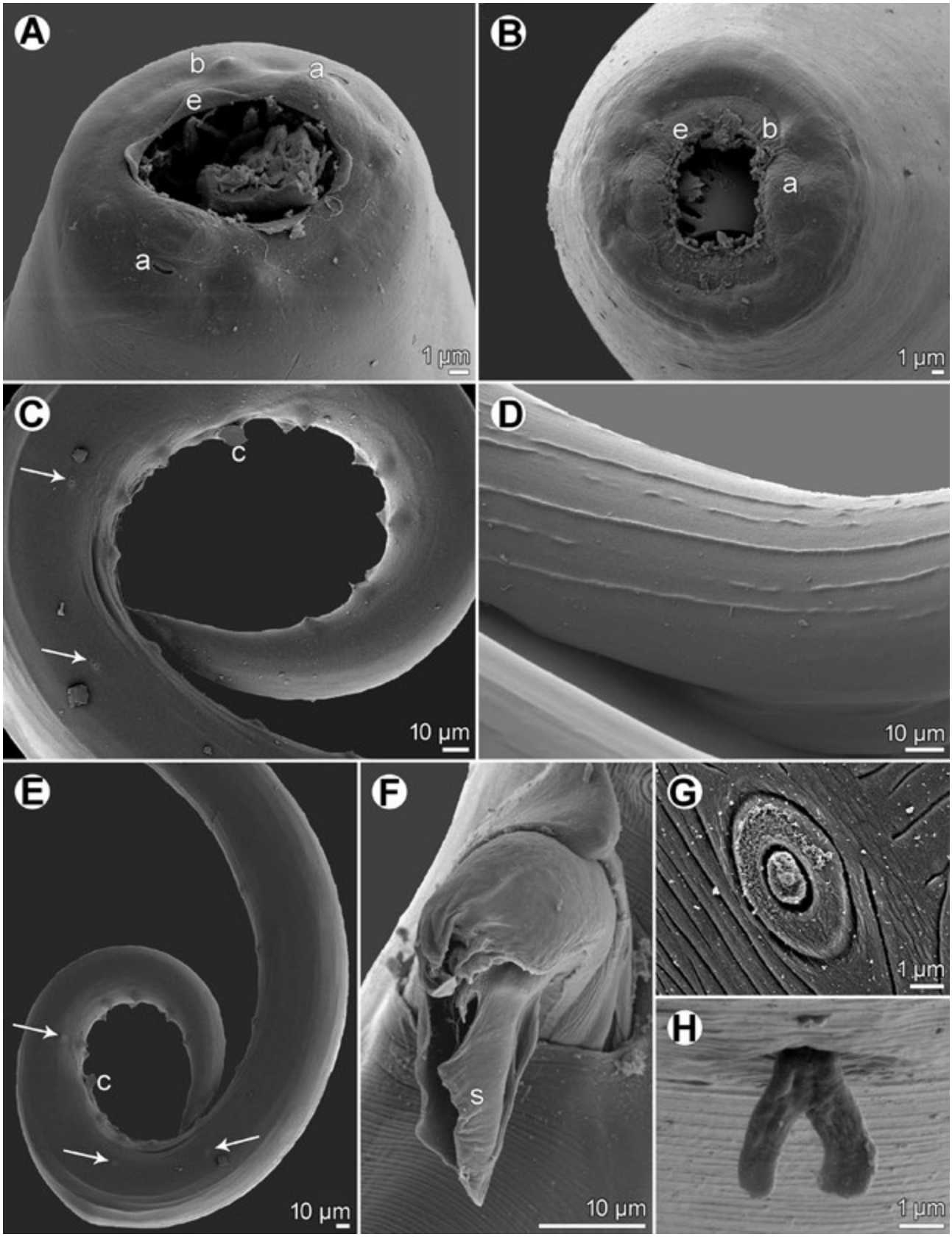

Fig. 7. *Rhabdochona* (*Rhabdochona*) *turkestanica* (Skryabin, 1917) from *Schizothorax richardsonii* (Gray), scanning electron micrographs. **A**, **B** – cephalic end, subapical and apical views, respectively; **C** – caudal region of male, lateral view (arrows indicate lateral preanal papillae); **D** – ventral precloacal ridges (area rugosa), subventral view; **E** – posterior end of male, lateral view (arrows indicate lateral papillae); **F** – distal tip of left spicule, sublateral view; **G** – lateral preanal papilla; **H** – deirid. *Abbreviations*: a – amphid; b – cephalic papilla; c – cloaca; e – sublabium; s – left spicule.

loped (Fig. 7D). Left spicule long, 390–462 long; its shaft 233–249 long, representing 53–62% of entire spicule length; distal tip of spicule widely bifurcate, provided with fine cuticular membrane (Figs. 6G,K,M, 7F). Right spicule 123–129 long, with distinct dorsal barb at distal tip (Fig. 6G,K,L). Length ratio of spicules 1 : 3.17–3.76. Tail 291–393 long (Figs. 6G,K, 7C,E).

Female (six gravid specimens with mature, embryonated eggs; measurements of two nongravid specimens without eggs in parentheses): Length of body 9.74–14.99 (5.03–5.44) mm, maximum width 150–231 (95–117). Prostom 24–30 (15–18) long and 18–21 (12–15) wide (Fig. 6A,C). Length of vestibule including prostom 126–150 (105–117). Muscular oesophagus 312–405 (258–305) long, maximum width 27–39 (18–21); glandular oesophagus 2.43–3.26 (1.67–1.97) mm, maximum width 90–123 (69–84); length ratio of both parts 1 : 6.7–8.6 (1 : 5.5–7.6). Length of vestibule with prostom and entire oesophagus represents 25–32% (41–43%) of body length. Deirids, nerve ring and excretory pore 48–63 (51–81), 174–216 (153–159) and 240–396 (222–228), respectively, from anterior extremity. Vulva postequatorial, 5.51–7.62 (3.10–3.31) mm from anterior extremity, at 51–56% (61–62%) of body length. Vagina directed posteriorly from vulva. Fully developed eggs (containing larva) oval, thick-walled, size 33–36 × 21–27; thickness of wall 2. Each egg bears small, distinct protuberance at each pole provided with broad filament of fibrous structure *c*. 300 long (Fig. 6N). Tail 204–245 (114–183) long, with pointed tip (Fig. 6J,I).

Fourth-stage larva (one female larva undergoing last moult): Body 4.13 long, maximum width 90. Vestibule including prostom 96 long. Prostom funnel-shaped, 9 long and 9 wide, provided with 6 anterior teeth; minute basal teeth present; in addition to old prostom typical of fouth larval stage, newly formed, somewhat larger (18 × 12) prostom of youg adult is already visible beneath (Fig. 6E). Muscular oesophagus 255 long, maximum width 18; glandular oesophagus 1.36 mm, maximum width 51; length ratio of both parts 1 : 5.3. Length of vestibule with prostom and entire oesophagus represents 41% of body length. Deirids, nerve ring and excretory pore 51, 144 and 198, respectively, from anterior extremity. Developing vulva postequatorial, 2.53 mm from anterior extremity, at 61% of body length. Tail conical, 114 long; newly formed tail of adult already visible inside old, shed cuticle at tail tip (Fig. 6F).

Host: Snowtrout *Schizothorax richardsonii* (Gray) (Cyprinidae, Cypriniformes).

Site of infection: Intestine.

Locality: Poonch River, Jammu and Kashmir part of India, near Line of Control (boundary between India and Pakistan).

Material examined: Thirty-three nematodes from two hosts (intensity 14 and 19).

Deposition of voucher specimens: IPCAS N-1258.

Remarks. Based on morphological similarity, Moravec (1975) synonymised the Central Asiatic species *Rhabdochona turkestanica* and *R. filamentosa* Bykhovskaya-Pavlovskaya, 1936, and *R. kashmirensis* from Kashmir, with the European species *R. hellichi*. Later *R. hellichi* was reported from *Schizothorax* spp. and *Salmo trutta oxianus* Kessler from the basins of the Indus and Amu-Darya Rivers in Afghanistan by Moravec and Amin (1978) and from *Schizothorax plagiostomus* Heckel and *S. richardsonii* in India by Soota and Sarkar (1981) and Kumar et al. (1988), respectively. Sood (1988) also synonymised *R. schizothoracis*, a species described from *Schizothorax* spp. in Pakistan, with *R. hellichi* (see also Moravec et al. 2010).

However, molecular studies of Černotíková et al. (2011) revealed that *R. hellichi* specimens from *Barbus barbus* (Linnaeus) in Europe (Czech Republic) and those from *Schizothorax* sp. in India are genetically distant. Therefore, according to Moravec et al. (2010), the nematodes previously reported as *R. hellichi* or under synonyms from Central and South Asia represented a distinct subspecies, *R. h. turkestanica*. Subsequently, *R. h. turkestanica* was reported from *S. plagiostomus* from Himachal Pradesh, India (Kalia et al. 2013, Kumari et al. 2016). Nevertheless, since *R. hellichi* may represent a complex of several cryptic species and the shape of the left spicule distal tip (the main distinguishing feature between these two forms) is now considered an important taxonomic feature in *Rhabdochona*, we propose to elevate the subspecies *R. h. turkestanica* to a valid species, *R. turkestanica*.

The morphology and measurements of the present specimens are very similar to those reported for *R. h. turkestanica* from *Schizothorax* sp. in West Bengal and Sikkim, India (Moravec et al. 2010) and those previously studied (as *R. hellichi*) by the senior author of this paper from fishes of former Soviet Central Asia (Kirghizia, Tadjikistan) and Afghanistan (Moravec 1975, Moravec and Amin 1978). As mentioned by Moravec (1975), certain differences found in the dimensions of body among nematodes from different hosts, and, for example, in the length of the left spicule, seem to be influenced by the size of the fish host. Whereas the body length of males in the present material from *S. richardsonii* was approximately 6–8 mm and their left spicule measured 390–462 µm, those reported by Moravec et al. (2010) from *Schizothorax* sp. were approximately 10–11 mm long and their left spicule measured 570–576 µm. In contrast to the present specimens, the males of the latter form had only one pair (*vs* two pairs) of lateral preanal papillae and the ventral process of the left spicule tip was distinctly longer. However, these differences seem to be within the intraspecific variability of *R. turkestanica*.

The fourth-stage larva of *R. turkestanica* is described in this paper for the first time. This is characteristic of the presence of six anterior prostomal teeth, as is known for this larval stage in the majority of other congeneric species, e.g., in *R. hospeti* Thapar, 1950 (see Moravec 2010, Moravec et al. 2010).

Ichthyospirura (= *Rhabdochona*) *turkestanica* was originally inadequately described solely from females found by Skryabin (1917) in *Schizothorax curvifrons* Heckel (syn. *S. intermedius* McClelland) in Centra Asia. According to Moravec et al. (2010), this nematode parasite is distributed in basins of the Amu-Darya and Indus Rivers in Central Asia (Kirghizia, Turkmenia, Tadjikistan), Afghanistan, Pa-

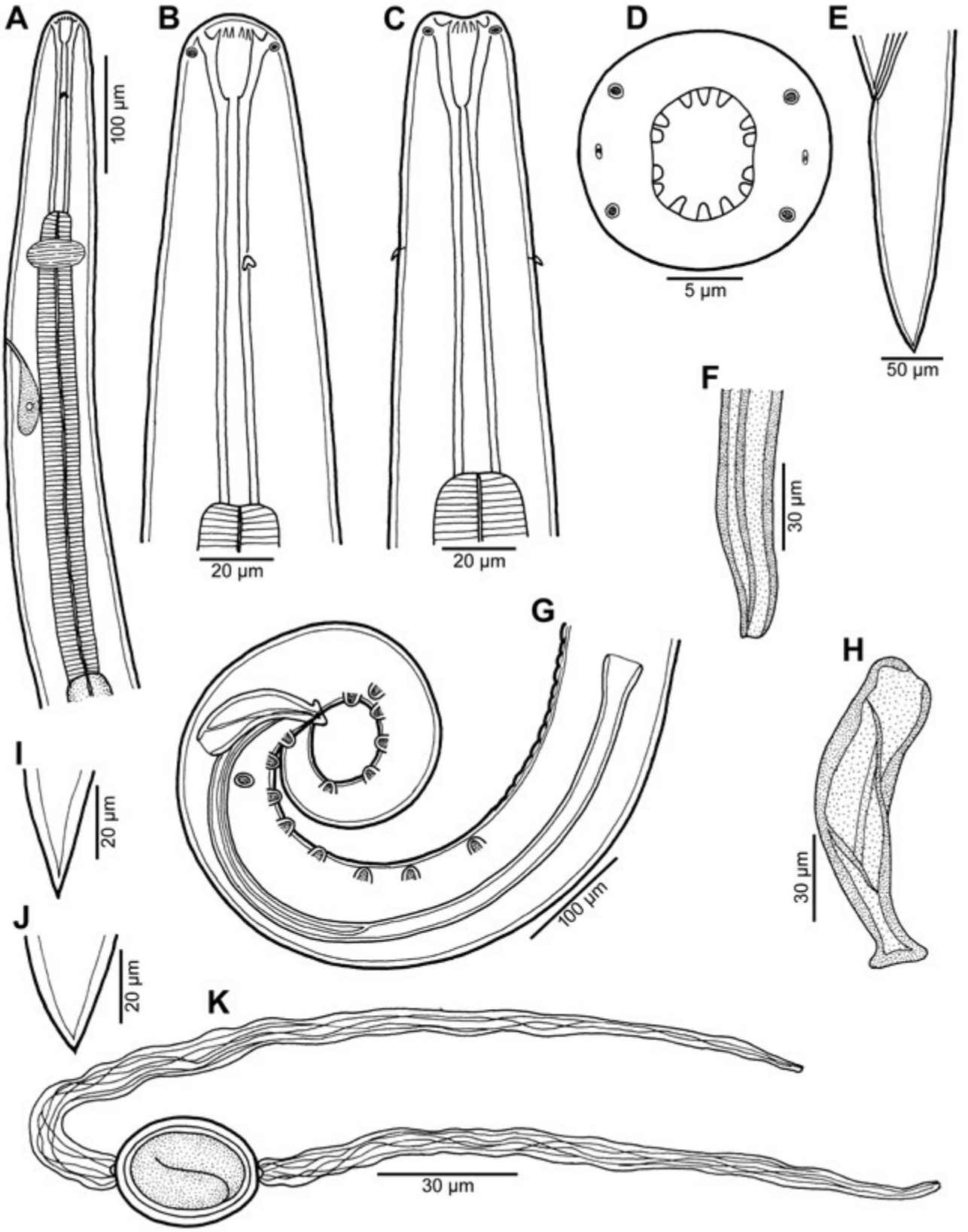

Fig. 8. *Rhabdochona* (*Rhabdochona*) *hospeti* Thapar, 1950 from *Tor putitora* (Hamilton). **A** – anterior end of female, lateral view; **B**, **C** – vestibule, lateral and dorsoventral views, respectively; **D** – cephalic end, apical view; **E** – female tail, lateral view; **F** – distal end of left spicule, lateral view; **G** – posterior end of male, lateral view; **H** – right spicule, lateral view; **I**, **J** – tail tip of male and female, respectively, lateral views; **K** – fully developed egg.

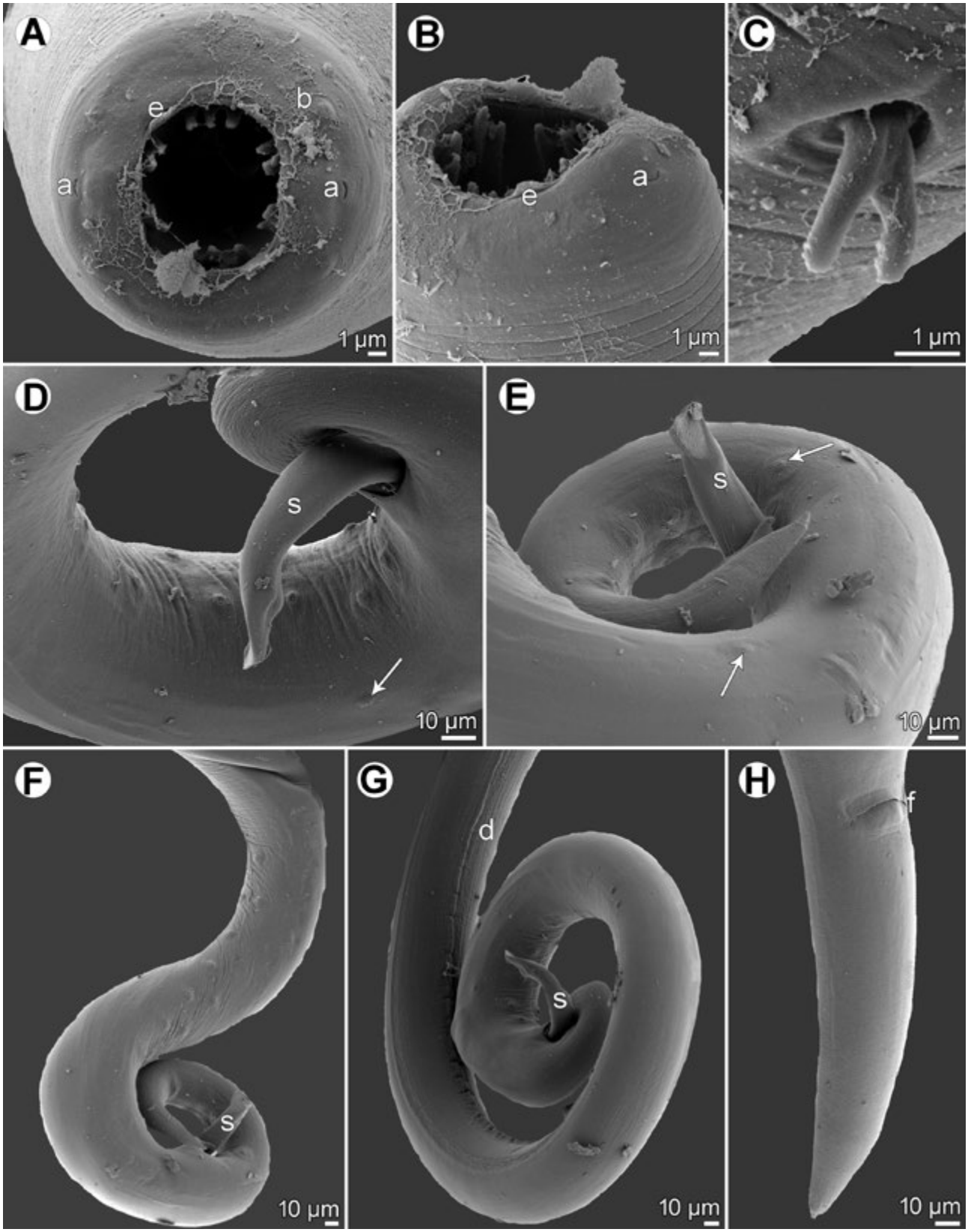

Fig. 9. *Rhabdochona* (*Rhabdochona*) *hospeti* Thapar, 1950 from *Tor putitora* (Hamilton), scanning electron micrographs. **A**, **B** – cephalic end, apical and subapical views, respectively; **C** – deirid; **D**, **E** – different regions of male caudal end (ventrolateral view; note different shapes of left spicule tip in different positions) (arrows indicate lateral papillae); **F**, **G** – posterior end of male in different positions (two different specimens); **H** – female tail, subventral view. *Abbreviations*: a – amphid; b – cephalic papilla; d – ventral precloacal cuticular ridges (area rugosa); e – sublabium; f – anus; s – distal tip of left spicule.

kistan and northern India (Kashmir), where it parasitises mainly species of *Schizothorax* (*S. curvifrons* – type host, *S. esocinus*, *S. labiatus* (McClelland), *S. plagiostomus*, *S. pseudaksaiensis* Herzenstein), the related *Schizopyge* (*S. niger* (Heckel)) and *Schizopygopsis* (*S. stoliczkai* Steindachner) and, less often, other cyprinids and other fishes. The present finding of *R. turkestanica* in *S. richardsonii* confirms the presence of this parasite in this host species in India, previously already recorded by Kumar et al. (1988), reporting it as *R. hellichi* (see above).

Three other species of *Rhabdochona* (*R. himalayi* Fotedar et Dhar, 1977, *R. nemacheili* Rautela et Malhotra, 1982 and *R. teleostei* (Singh et Maulik, 1992)) have been reported from *S. richardsonii* in India (see Sood 2017), but because of their poor descriptions, all these nematodes should be considered *species inquirendae*. In addition, Malhotra (1989, 1990) reported from *S. richardsonii* in India *Rhabdochona* (*R.*) *himalayii* (Singh et Malhotra) and *R.* (*F.*) *nayari* Malhotra, Banerjee et Chaubey, two species which have never been formally established. Taking into accout a certain degree of host specificity in *Rhabdochona* spp. (see Moravec 2010), it may well be that, in fact, specimens of *R. turkestanica* were misidentified in all these cases.

Rhabdochona (*Rhabdochona*) *hospeti* Thapar, 1950

Figs. 8, 9

Syns: *Rhabdochona barbi* Karve et Naik, 1951; *R. penangensis* Furtado, 1965; *R. ghaggari* Sood, 1972; *R. alii* Kalyankar, 1972; *R. labeonis* Kalyankar, 1972; *Comephoronema mackiewiczi* Malhotra et Rautela, 1984; *Rhabdochona moraveci* Duggal et Kaur, 1987, nec *R. moraveci* Puylaert, 1973.

Description: Medium-sized nematodes with transversely striated cuticle (Fig. 9A–C). Oral aperture hexagonal, with 4 distinct submedian sublabia, surrounded by 4 small submedian cephalic papillae and pair of lateral amphids. Prostom funnel-shaped, with small basal teeth (Fig. 8A–C). Anterior margin of prostom armed internally with 14 small, forwardly directed teeth (3 dorsal, 3 ventral and 4 on each side, latter forming pairs) (Figs. 8A–D, 9A,B). Vestibule rather long (Fig. 8A–C). Deirids small, bifurcate, situated near mid-length of vestibule (Figs. 8A–C, 9C). Tail of both sexes conical, with pointed tail tip (Figs. 8E,I,J, 9E,H).

Male (six specimens): Length of body 7.34–9.04 mm, maximum width 114–147. Prostom 21–24 long and 18 wide in lateral view (Fig. 8C). Length of vestibule including prostom 123–165. Muscular oesophagus 246–339 long, maximum width 24–30; glandular oesophagus 2.50–3.41 mm long, maximum width 93–126; length ratio of both parts 1 : 8.6–10.7. Length of vestibule with prostom and entire oesophagus represents 37–43% of body length. Deirids, nerve ring and excretory pore 63–75, 156–195 and 207–240, respectively, from anterior extremity. Preanal papillae: 6–9 pairs of subventral preanal papillae1 pair of lateral papillae situated between second and third (counting from cloaca). Five of 6 postanal pairs of papillae subventral, second pair lateral (Figs. 8G, 9D–G). Longitudinal ventral cuticular ridges (area rugosa) well developed (Fig. 9G). Left spicule long, 606–690 long; its shaft 330–381 long, representing 51–60% of entire spicule length; distal tip somewhat narrowed, provided with cuticular membrane (Figs. 8F,G, 9D–G). Right spicule 117–129 long, with distinct dorsal barb close to distal tip (Fig. 8G,H). Length ratio of spicules 1 : 5.02–5.75. Tail 225–385 long (Figs. 8G,I, 9E).

Female (six specimens with mature, embryonated eggs; measurements of specimens with immature, non-embryonated eggs in parentheses): Length of body 11.56–14.92 (8.70–12.08) mm, maximum width 190–231 (136–204). Prostom 24–27 (24–27) long and 18–21 (18–21) wide (Fig. 8A,B). Length of vestibule including prostom 135–150 (108–156). Muscular oesophagus 318–393 (330–357) long, maximum width 30–36 (30–33); glandular oesophagus 3.51–4.37 (2.94–3.78) mm, maximum width 129–174 (105–150); length ratio of both parts 1 : 9.5–13.0 (1 : 8.9–11.1). Length of vestibule with prostom and entire oesophagus represents 30–34% (33–39%) of body length. Deirids, nerve ring and excretory pore 66–81 (63–78), 171–195 (129–198) and 237–249 (195–255), respectively, from anterior extremity. Vulva usually postequatorial, 6.49–8.41 (4.84–6.94) mm from anterior extremity, at 34–57% (56–59%) of body length. Vagina directed posteriorly from vulva. Fully-developed eggs (containing larva) oval, thick-walled, size 33–36 × 24–27; thickness of wall 2. Each egg bears distinct small protuberance on each pole provided with broad, fibrous filament up to 360 long (Fig. 8K). Tail 204–245 (114–183) long, with pointed tip (Figs. 8E,J, 9H).

Host: Putitor mahseer *Tor putitora* (Hamilton) (Cyprinidae, Cypriniformes).

Site of infection: Intestine.

Locality: Poonch River, Jammu and Kashmir part of India, near Line of Control (boundary between India and Pakistan).

Material examined: Twenty-nine nematode specimens from three hosts (intensity 4–19).

Deposition of voucher specimens: IPCAS N-39.

Remarks. The morphology of the present specimens is, more or less, in agreement with that of *R. hospeti*, as redescribed by Moravec and Amin (1978) from *Tor putitora* (Hamilton) in Afghanistan and Moravec et al. (2010) from *Tor* sp. in Sikkim, India. Originally this species was described by Thapar (1950) from a single female typified by filamented eggs, found in *Tor tor* (Hamilton) at Madras, India. While revising Eurasian species of *Rhabdochona*, Moravec (1975) designated the following five inadequately described species as junior synonyms of *R. hospeti*: *R. alii*, *R. barbi*, *R. ghaggari* and *R. labeonis* from India, and *R. penangensis* from Malaysia. This was followed by Soota and Sarkar (1981) and Soota (1983). Nevertheless, Sood (1988, 2017) again considered *Rhabdochona alii*, *R. barbi*, *R. ghaggari* and *R. labeonis* to be valid species, pointing out that *R. ghaggari* differs from *R. hospeti* in having non-filamented eggs. However, filaments are present only on fully developed eggs (already containing a larva) (Moravec 2007), whereas only immature eggs of *R. ghaggari*

were illustrated with the original description of this nematode by Sood (1972) (see Moravec 1975).

Moravec et al. (2010) reported an additional six species of *Rhabdochona* from India and Pakistan as junior synonyms of *R. hospeti*, of which *R. bifidum* Kakar et Bilqees, 2007, *R. bolani* Kakar, Bilqees et Ahmad, 2008, *R. cephalodiverticula* Kakar, Bilqees et Ahmad, 2008 and *R. uvaginus* Kakar et Bilqees, 2007, all from fishes in Pakistan, were previously designated as *species inquirendae* by Moravec (2010). However, an additional five species of *Rhabdochona*, *R. annai* Kakar, Bilqees et Khan, 2011, *R. bowispicula* Kakar et Bilqees, 2011, *R. mujibi* Kakar et Bilqees, 2009, *R. spinicauda* Kakar et Bilqees, 2011 and *R. spinispiculum* Kakar et Bilqees, 2011, were reported from *T. putitora* in Balochistan, Pakistan (Kakar et al. 2011). Thus, a total of nine (!) poorly described species of this genus is reported from *T. putitora* in Balochistan in the monograph of Kakar et al. (2011). Because of some evidently unreliable and misleading data in the descriptions of these species, all these species should be considered *species inquirendae* or *species dubiae*, rather than synonyms of *R. hospeti*. Nevertheless, considering the host species and the geographical region (drainage system of the Indus River) of these nematode parasites, it is highly probable that all the above-mentioned "species" of *Rhabdochona* from Balochistan belonged, in the fact, to *R. hospeti*.

In addition to the above-mentioned *Rhabdochona* spp. from *T. putitora*, the monograph of Kakar et al. (2011) also provides a review of 15 other congeners from five species of cyprinids and one from a catfish in Balochistan: *Rhabdochona bifurcatum* Kakar, Bilqees et Ahmad, 2011, *R. bilqeesae* Kakar, Bilqees et Khan, 2011, *R. dimicrospiculum* Kakar et Bilqees, 2011, *R. gubernaculus* Kakar, Bilqees, Kamran et Mukhtar, 2010, *R. haspani* Kakar, Bilqees, Khan et Mukhtar, 2011, *R. heckmanni* Kakar, Bilqees et Khan, 2011, *R. hingoli* Kakar et Bilqees, 2008, *R. kharani* Kakar, Bilqees et Kakar, 2006, *R. magnavesicula* Kakar et Bilqees, 2008, *R. milesi* Kakar, Bilqees et Nawaz 2008, *R. nushkiai* Kakar et Bilqees, 2007, *R. pakistanica* Kakar, Bilqees et Khan, 2011, *R. ritai* Kakar, Bilqees et Khan, 2011, *R. spatulatum* Kakar et Bilqees, 2011 and *R. watsoniai* Kakar et Bilqees, 2007. Also all these species should be taken for *species inquirendae* for the reasons mentioned above; four of them were already designated as *species inquirendae* by Moravec (2010).

Kakar et al. (2011) listed *Rhabdochona* spp. in three subgenera, *Rhabdochona* (21 species), *Filochona* Saidov, 1953 (one species) and *Globochona* Moravec, 1972 (two species). However, *Filochona* is now considered a synonym of *Rhabdochona* according to the taxonomic system proposed by Moravec (1975), where subgenera are based mainly on the numbers and arrangement of anterior prostomal teeth and the shape and structure of the female tail. However, neither *R. spinicauda* nor *R. ritai* have features characteristic of *Globochona*, in which these were placed. The numbers of prostomal teeth were reported by those authors to be 6–10 in individual species of *Rhabdochona* from Balochistan studied by LM, but these numbers seem to be doubtful and misleading. The authors did not mention how these numbers were established. It is very difficult to examine the cephalic end of such small nematodes in apical view by LM (e.g., with the use of Anderson's (1958) method) and at present the only reliable method is the use of SEM.

Also some other morphological features reported for *Rhabdochona* spp. from Balochistan are evidently erroneous, such as the location of the nerve ring at the level of the vestibule or the posterior end of the muscular oesophagus (in eight species), or the nerve ring is not mentioned at all (three species), the situation of deirids at the level of the muscular oesophagus (five species), the presence of up to nine pairs of postanal papillae in *R. nushkiai*, sometimes the rectangular (!) shape of eggs and eggs of all species without filaments (?), no data are provided on some taxonomically important features such as the shapes of deirids, location of the excretory pore, etc. Consequently, as mentioned above, all the 24 species of *Rhabdochona* reviewed by Kakar et al. (2011) are considered to be *species inquirendae*.

Four other species of *Rhabdochona* (*R. bosei* Sahay, 1966, *R. nemacheili*, *R. putitora* Kaur et Khera, 1991 and *R. sarana* Karve et Naik, 1951) have been reported from *T. putitora* in India and one (*R. charsaddiensis* Siddiqi et Khattak, 1984) from the same host species in Pakistan (see Sood 2017). However, *R. bosei* Sahay, 1966 is a junior synonym of *R. garuai*, a parasite of catfishes (Moravec 1975), whereas *R. nemacheili*, *R. putitora* and *R. charsaddiensis* should be considered *species inquirendae* because of their poor desriptions, although the specimens of these species might, in fact, belong to *R. hospeti*. The names of three other poorly described congeneric species, *Rhabdochona indusi* Soofi, Birmani et Dharejo, 2017 and *R. sindhicus* Soofi, Birmani, Dharejo, Abbasi et Ghachal, 2020 from *Rita rita* (Hamilton) in the Indus River, Sindh, Pakistan (Soofi et al. 2017, 2020), and *R. putitori* Anjum, 2013 from *T. putitora* in India (Anjum 2013), are invalid based on the present rules of the International Code of Zoological Nomenclature (Articles 8.5 and 16.4 concerning e-publications and type fixation, respectively). Specimens of the latter were collected from the same host species (*T. putitora*) and from the same river (Poonch River) as those of the present material, so that they most probably belonged to *R. hospeti*.

According to Moravec et al. (2010), *R. hospeti* mainly parasitises fishes of the genus *Tor* Gray and is widely distributed in India, Pakistan and in the Indus River basin in Afghanistan, occurring also in Malaysia. Two other species of *Rhabdochona* were reported from congeneric hosts in India, *R. barbi* Karve et Naik, 1951 from *T. khudree* (Syskes) and *R. tori* Gupta et Srivastava, 1982 from *T. tor* (Hamilton) (Sood 2017). Whereas the former species is a synonym of *R. hospeti* (see above), the latter should be considered a *species inquirenda* because of its poor description.

Rhabdochona hospeti is very similar to *Rhabdochona gnedini* Skryabin, 1948, a species with insufficiently known morphology, parasitising mainly cyprinids of the

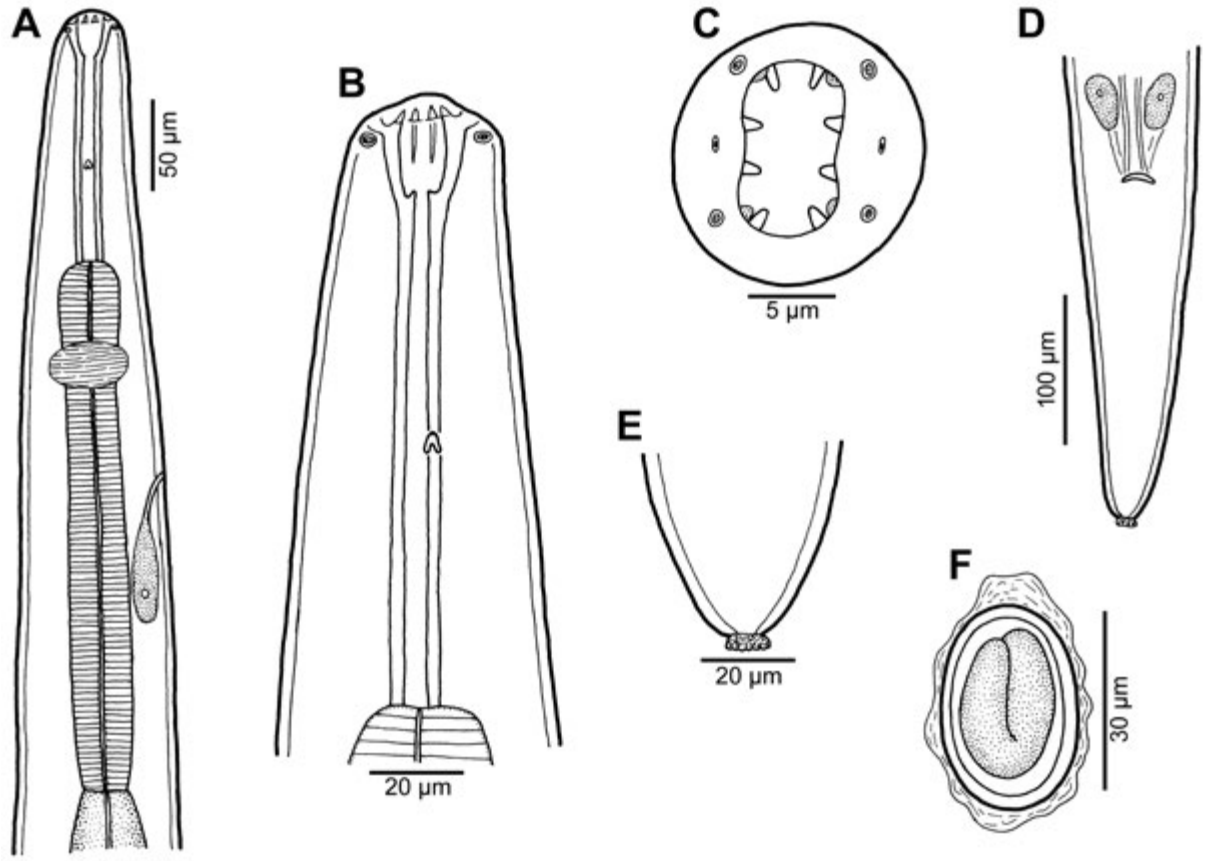

Fig. 10. *Rhabdochona* (*Globochona*) cf. *chodukini* Osmanov, 1957 from *Tor putitora* (Hamilton), gravid female. **A** – anterior end, lateral view; **B**, **C** – cephalic end, lateral and apical views, respectively; **D** – tail, ventral view; **E** – tail tip, ventral view; **F** – fully developed egg.

genera *Barbus* Cuvier et Cloquet and *Luciobarbus* Heckel in the basins of the Caspian and Aral Seas (Moravec 1975).

***Rhabdochona* (*Globochona*) cf. *chodukini* Osmanov, 1957** Figs. 10, 11

Description: Female (one ovigerous specimen with mature eggs): Medium-sized nematode with transversely striated cuticle (Fig.11B,D,H). Length of body 10.62 mm, maximum width 245. Oral aperture oval, somewhat dorsoventrally elongated, surrounded by 4 small submedian cephalic papillae and pair of lateral amphids; 4 small submedian sublabia present. Prostom funnel-shaped, 24 long and 21 wide; small basal prostomal teeth present (Fig. 10B). Anterior margin of prostom armed internally with 8 fairly large, forwardly directed teeth (2 dorsal, 2 ventral and 2 on each side) (Figs. 10A–C, 11A,B). Length of vestibule including prostom 147 (Fig. 10A,B); surface of vestibule finely transversely striated. Muscular oesophagus 315 long, maximum width 36 (Fig. 10A); glandular oesophagus 4.37 mm long, maximum width 189; length ratio of both parts 1 : 13.9. Length of vestibule with prostom and entire oesophagus represents 45% of body length. Deirids bifurcate, situated 81 from anterior extremity (Figs. 10A,B, 11E,G). Nerve ring and excretory pore 195 and 261, respectively, from anterior end of body (Fig. 10A). Vulva postequatorial, 6.25 mm from anterior extremity, at 59% of body length (Fig. 11F). Vagina directed posteriorly from vulva. Fully-developed eggs elongate-oval, thick-walled, containing larva (Figs. 10F, 11F); eggs 36–39 long and 21–24 wide, thickness of their wall 3. Surface of mature eggs provided with very fine, irregular, lobular gelatinous coating (Fig. 10F). Tail conical, 272 long, its tip provided with distinct, rather broad ring-shaped formation 3 long and 9 wide in lateral view (Figs. 10D,E, 11C,D,H).

Host: Putitor mahseer *Tor putitora* (Hamilton) (Cyprinidae, Cypriniformes).

Site of infection: Intestine.

Locality: Poonch River, Jammu and Kashmir part of India, near Line of Control (boundary between India and Pakistan).

Material examined: One nematode from a single fish host (in co-infection with four specimens of *R. hospeti*).

Deposition of voucher specimen: Not deposited (used for SEM).

Remarks: Only a single specimen (gravid female) of this nematode was obtained from *T. putitora*. In possessing eight anterior prostomal teeth and a cuticular ornamentation on the tail tip, it belongs to the subgenus *Globochona* as defined by Moravec (1975). Since no conspecific males were collected, the present specimen is provisionally assigned to *R. chodukini*, a parasite of *Luciobarbus brachycephalus* (Kessler), *L. capito* (Güldenstädt) (both Cyprinidae) and some other fish species in the Aral Sea basin (Amu-Darya and Syr-Darya Rivers and triburaries) (e.g.,

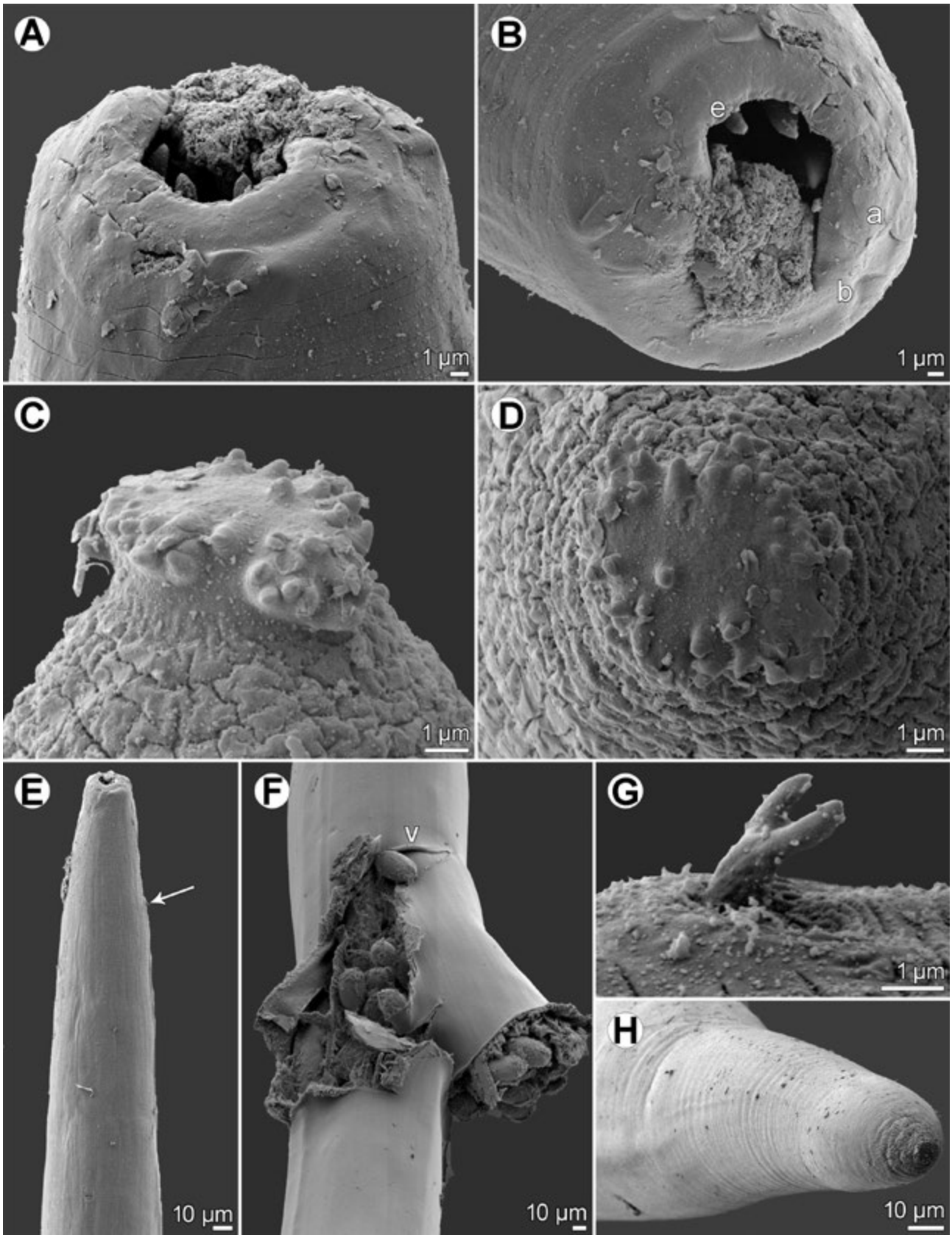

Fig. 11. *Rhabdochona* (*Globochona*) cf. *chodukini* Osmanov, 1957 from *Tor putitora* (Hamilton), scanning electron micrographs of gravid female. **A**, **B** – cephalic end, dorsoventral and apical views, respectively; tail tip, lateral and apical views, respectively; **C**, **D** – female tail tip, lateral and apical views, respectively; **E** – anterior end of body, subventral view (arrow indicates deirid); **F** – broken region of vulva with visible eggs, ventral view; **G** – deirid; **H** – distal part of tail, ventral view. *Abbreviations*: a – amphid; b – cephalic papilla; e – sublabium; v – vulva.

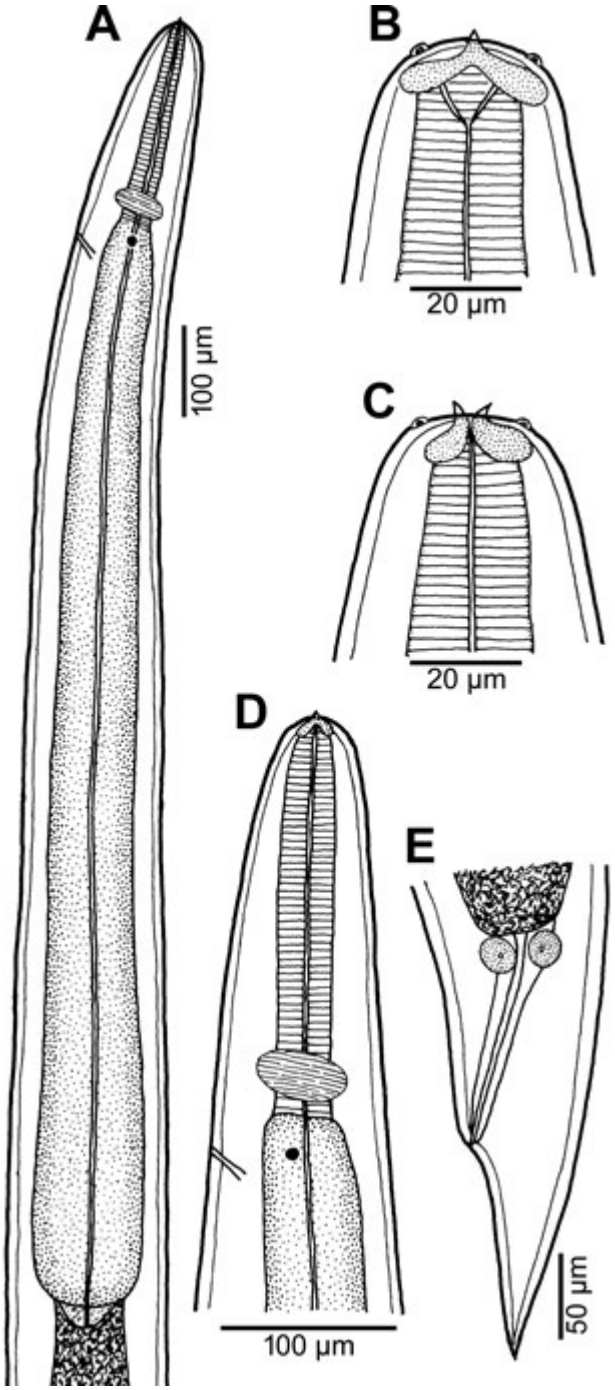

Fig. 12. Physalopteridae gen. sp. larva from *Tor putitora* (Hamilton). **A** – anterior end, lateral view; **B**, **C** – cephalic end, lateral and dorsoventral views, respectively; **D** – anterior end (enlarged), lateral view; **E** – tail, lateral view.

Osmanov 1957, Dzhalilov 1964, Moravec 1975). The body length and other measurements of the present specimen are almost exactly the same as those of gravid females of *R. chodukini* as redescribed by Moravec (1975). According to Dzhalilov (1964), the fully developed eggs of *R. chodukini* are provided with 6–12 ribbon-like filaments coming out irregularly from the whole surface of the egg, which are visible under high magnifications only and using the phase-contrast microscope. Probably such "filaments" are identical with the lobular gelatinous coating observed on the eggs of the present specimen from India.

Rasheed (1965) considered *R. chodukini* to probably be conspecific with *R. sarana* Karve et Naik, 1951, described solely from females collected in *Systomus sarana* (Hamilton) in Poona, India (Karve and Naik 1951) and later also reported in India from *Labeo rohita* (Hamilton) by Kalyankar (1972) and from *T. putitora* by Kumar et al. (1988). Whereas the nematodes collected by the latter authors from the same host species (*T. putitora*) were apparently conspecific with the present specimen, the only female from *L. rohita* was described as having "three spines" at the tail tip and, consequently, its identification as *R. sarana* is questionable. Until the male of *R. sarana* is described, *R. chodukini* should be considered a separate species (Moravec 1975); none of these has been studied by SEM to date.

Also morphologically similar is *R. puntii* González-Solís, Chavan, Kannewad et Gyananath, 2014, a species described from the related cyprinid hosts *Puntius sophore* (Hamilton) and *Neolissochilus hexastichus* (McClelland) (also occurs in the catfish *Wallago attu* (Bloch et Schneider)) in Maharashtra, India (González-Solís et al. 2014). However, when compared with *R. chodukini* and *R. sarana*, its gravid females are markedly longer (approximately 17–26 mm *vs* 12–14 mm and 9–12 mm, respectively) and the structure of their cuticular ornamentation on the tail tip appears to be different (formed by a crown of 18 short outgrowths and six larger cenral mucrons).

Family Physalopteridae Railliet, 1893

Physalopteridae gen. sp. third-stage larvae Figs. 12, 13

Description (five specimens from *T. putitora*; measurements of five specimens from *M. armatus* in parentheses): Body fusiform, whitish, 7.03–8.53 (6.87–10.01) mm long, 231–313 (218–313) wide. Cuticle finely transversely striated, especially at anterior half of body. Cephalic end rounded, with 2 feebly outlined lateral lips, each provided with small terminal tooth 3–6 (3) long, 2 submedian cephalic papillae and lateral amphid (Figs. 12B–D, 13A,B). Terminal teeth may be slightly asymmetrical to each other in apical view; each tooth posteriorly connected to large, dorsoventrally extended sclerotised structure (Figs. Fig. 12B–D). Oesophagus divided into short, narrow muscular portion 225–237 (210–272) long, 30–48 (36–54) wide, and long, posteriorly expanded posterior glandular part 1.09–1.41 (1.20–1.47) mm long, 150–204 (150–204) wide; entire oesophagus 1.31–1.70 (1.37–1.74) mm long, representing 18–22% (17–21%) of body length. Nerve ring encircles muscular oesophagus near its posterior end, 204–243 (213–240) from anterior extremity (Fig. 12A,D). Small deirids and excretory pore situated at 270–309 (not measured) and 294–312 (326–394), respectively, from anterior extremity (Fig. 12A,D). Tail conical, 105–171 (136–218) long, with sharply pointed tip (Figs. 12E, 13E).

Hosts: Putitor mahseer *Tor putitora* (Hamilton) (Cyprinidae, Cypriniformes) and zig-zag eel *Mastacembelus armatus* (Lacépède) (Mastacembelidae, Synbranchiformes).

Site of infection: Intestine.

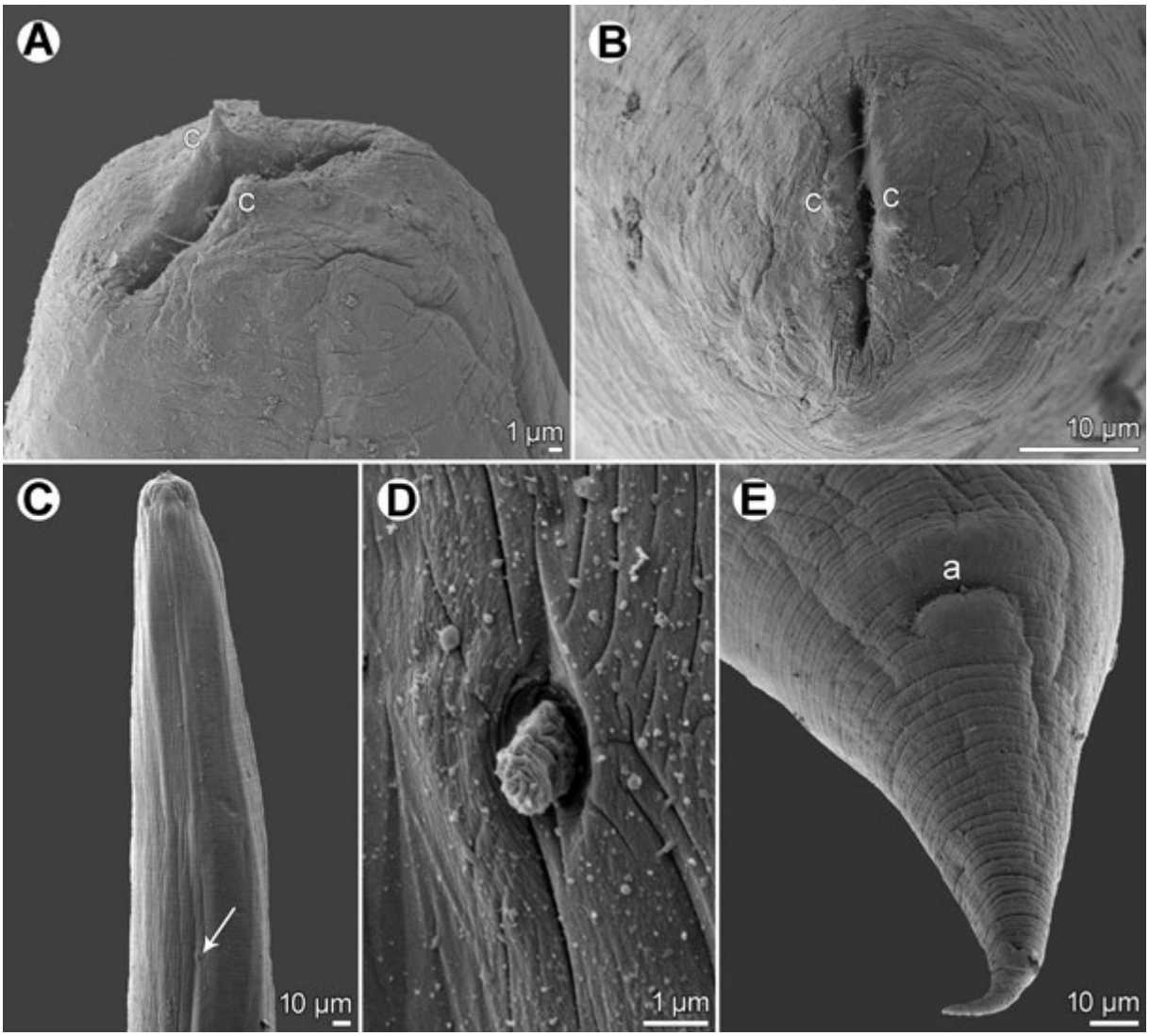

Fig. 13. Physalopteridae gen. sp. larva from *Tor putitora* (Hamilton), scanning electron micrographs. **A**, **B** – subapical and apical views, respectively; **C** – anterior end, lateral view (arrow indicates deirid); **D** – deirid; **E** – tail, ventral view. *Abbreviations*: a – anus; c – cephalic tooth.

Locality: Poonch River, Jammu and Kashmir, India near Line of Control (border between India and Pakistan).

Material examined: Nineteen nematodes from two specimens of *T. putitora* (intensity 4 and 15) and 25 from one specimen of *M. armatus*.

Deposition of voucher specimens: IPCAS N-1259.

Remarks: The general morphology of these larvae indicates that they belong to the family Physalopteridae. Since the genera of this family differ from one another mostly in characters found only in adults, the generic identification of these larvae is impossible. All adult forms of this family parasitising fishes belong to the subfamily Proleptinae Schulz, 1927, of which only representatives of *Heliconema* Travassos, 1919 occur in marine, brackish-water and freshwater fishes, whereas those of *Proleptus* Dujardin, 1845 and *Paraleptus* Wu, 1927 are parasites of elasmobranchs. Adults of other species of the Physalopteridae are parasites of amphibians, reptiles, birds and mammals (Skryabin and Sobolev 1964, Anderson 2000, Anderson et al. 2009).

Moravec and Amin (1978) were the first to describe such a physalopterid larva collected from the abdominal cavity of the cyprinid *Barilius vagra* (Hamilton) caught in the Kabul River (Indus River drainage system), Afghanistan. They speculated that it might belong to *Heliconema*, whose freshwater members are known largely from the Oriental Region. They considered *B. vagra* to serve as a paratenic host for this nematode and some predatory fishes (*Mastacembelus* Scopoli, *Channa* Scopoli) occurring in the same locality as its possible definitive host(s).

However, the morphology of these larvae seems to be somewhat different from that of *Heliconema* larvae (Katahira and Nagasawa 2015) and it cannot be excluded that these larvae may attain maturity in a terrestrial host (Moravec and Van As 2015). In every case, fishes acquire the infection while feeding on invertebrate intermediate hosts (crustaceans or aquatic insects) harbouring the nematode's infective third-stage larvae. Consequently, fishes serve only as paratenic hosts, which, along with intermediate

hosts, are the source of infection for the definitive host (Moravec and Van As 2015).

Similar larvae, free or encapsulated in the host's abdominal cavity of several species of freshwater anguillid, channid, cichlid, cyprinid, synbranchiid and siluriform fishes, have been reported, under the name Proleptinae or Physalopteridae gen. sp. larvae, from Afghanistan, Thailand, Vietnam and China in Asia (Moravec and Amin 1978, Moravec and Sey 1988b, Moravec et al. 2003, 2006) and from Botswana, Africa (Moravec and Van As 2015).

DISCUSSION

The present study again confirms the fact that, regardless of the large number of mostly taxonomic and faunistic papers treating freshwater fish nematodes in South Asian countries (Sood 2017), knowledge of the real fauna of these parasites in this region is still scarce. Although Sood (2017), in his comprehensive monograph, stated that the nematode fauna of fishes in South Asia is "fairly well known", his survey again documented the unsatisfactory situation in the taxonomy of these parasites in this region, where, usually without a critical evaluation of previous data, a number of additional, mostly poorly described, species are continuously newly established, resulting in an apparent inflation of taxa. For example, Kakar et al. (2011) reported 17 (!) poorly described species of *Rhabdochona* from three species of fishes in Balochistan, Pakistan, although representatives of this genus are known to exhibit a rather high degree of host specificity (Moravec 2010). This considerably complicates the correct species identification of these parasites by subsequent researchers. Therefore, future detailed taxonomic revisions in individual groups of these nematodes will undoubtedly reduce considerably the number of valid species of fish nematodes in this region.

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