

Research Paper

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Redescription of *Thubunaea schukurovi* Annaev, 1973 from *Ablepharus chernovi*, with notes on the members of *Thubunaea* (Spirurida: Physalopteridae) from the Palaearctic and Indomalayan realms

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Abstract

The spirurid nematode *Thubunaea schukurovi* Annaev, 1973 (Physalopteridae) is redescribed by means of light microscopy and scanning electron microscopy from *Ablepharus chernovi* collected in Çamlıyayla, Turkey. This is the first record of the species from this host and the first record of the genus *Thubunaea* from Turkey. The taxonomic status of the species of the genus *Thubunaea* from the Palaearctic and Indomalayan realms is reviewed based on their original morphological descriptions; as a result, *Thubunaea dessetae* Barus & Tenora, 1976, a parasite of *Saara hardwickii* (Gray) (Agamidae) in Afghanistan, is transferred to the genus *Pseudabbreviata* as *Pseudabbreviata dessetae* (Barus & Tenora, 1976) n. comb. Several species described in India, that is, *Thubunaea singhi* Deshmukh, 1969 and *Thubunaea brooki* Deshmukh, 1969, both from *Hemidactylus brookii* Gray (Gekkonidae), and *Thubunaea aurangabadensis* Deshmukh, 1969 and *Thubunaea syedi* Deshmukh, 1969, both from *Hemidactylus giganteus* Stoliczka, are considered members of the genus *Physalopteroides*; therefore, the following new combinations are proposed: *Physalopteroides singhi*, *Physalopteroides brooki*, *Physalopteroides aurangabadensis* and *Physalopteroides syedi*. *Thubunaea hemidactylae* Oshmarin & Demshin, 1972 from *Hemidactylus frenatus* Duméril & Bibron in Vietnam is considered a member of the genus *Physalopteroides* as *P. hemidactylae* (Oshmarin & Demshin, 1972) n. comb.

Introduction

Nematodes of the genus *Thubunaea* Seurat, 1914 (Spirurida: Physalopteridae) are intestinal parasites of lizards and ophidians in the Old World and the New World (Bain *et al.*, 2014). *Thubunaea schukurovi* Annaev, 1973 was described as a parasite of *Eremias velox* (Pallas, 1771) (Lacertidae) and *Ablepharus deserti* Strauch, 1868 (Scincidae) in Turkmenistan by Annaev (1973), who commented that the new species is morphologically similar to *Thubunaea smogorzhevskiorum* Sharpilo, 1966 (the name of the species was corrected here, see below) described from *Lacerta agilis* L. (Lacertidae) in Ukraine by Sharpilo (1966). Both Annaev (1973) and Sharpilo (1976) recognized the females reported as *Thubunaea* sp. from *E. velox* and *Eremias arguta* (Pallas, 1773) in the Republic of Kalmykia (Russia) by Markov *et al.* (1962) as belonging to *T. schukurovi*. Additionally, Sharpilo (1976) reported *T. schukurovi* from *E. velox* in Uzbekistan, *Eremias pleskei* Nikolsky, 1905 in Azerbaijan and *Eremias buechneri* Bedriaga, 1907 in China. In the same work, Sharpilo (1976) also made a note on the morphological similarity between *T. smogorzhevskiorum* and *T. schukurovi* and their possible conspecificity; however, he further remarked that the latter species seems to occur only in ‘xerophilic lizards’ and that the two species differ in some morphometric characters, although these were not specified. *Thubunaea schukurovi* is also reported from *E. arguta* (Pallas, 1773) in Astrakhan Oblast, Russia, by Ganshchuk (2013). Despite of all these subsequent reports of *T. schukurovi*, the morphology of the species remained known only from its original description and the textual description of the females provided by Markov *et al.* (1962).

In the present study, *T. schukurovi* is reported for the first time from *Ablepharus chernovi* Darevsky, 1953. A detailed morphological description of the collected material by means of light microscopy and scanning electron microscopy (SEM) is provided. In addition, we review the other known species of *Thubunaea* from the Near East, Europe and Asia and propose new generic allocations for six species described originally in this genus.

Materials and methods

Nematodes were collected from the stomach of one *A. chernovi* (paratype, coll. number NHMW 19639: 1) from Çamlıyayla (= Namrun), northern Mersin, Turkey (leg.

Ressler et al.) preserved in the Herpetological Collection of The First Zoological Department at the Naturhistorisches Museum, Vienna (NHMW). Five intact females, one posterior end of a male specimen and one anterior extremity of a specimen of unknown sex were available for morphological examination. Nematodes were studied as temporary mounts in glycerol under a compound light microscope. Specimens used for SEM were dehydrated through a graded ethanol series, immersed in hexamethyldisilazane for 20 min, air-dried, coated with gold-palladium in an Emitech K500X sputter coater and examined using a Tescan LYRA 3 XMU FEG/SEMxFIB microscope at an accelerating voltage of 10 kV. All measurements are in micrometres unless otherwise indicated. Metrical data are given as the range followed by the mean in parentheses. The nematodes were deposited in the collection Evertebrata Varia at the NHMW – four females preserved in ethanol (NHMW-ZOO-EV-A-21520), one male posterior end preserved in ethanol (NHMW-ZOO-EV-A-21521) and an SEM stub with anterior, mid-body and posterior fragments of a single female and one anterior end of a specimen of unknown sex (NHMW-ZOO-EV-M-5875).

Results

Female (based on five females, unless otherwise indicated): total length 8.41–10.29 mm (8.97 mm); body cylindrical, tapering at anterior end (fig. 1A); maximum body width 235–280 µm (248 µm); body width at vulva 183–260 µm (216 µm) and anal body width 103–140 µm (116 µm). Body cuticle 5–10 µm thick, with fine transverse striation approximately 1 µm apart. Mouth opening laterally compressed by two rounded, inconspicuous pseudolabia each bearing three similar in size teeth, one pair of large rounded cephalic papillae and single amphid (figs 1B, C, and 2A); one specimen with atypical anterior extremity bearing one pair of median teeth and one sublateral tooth (fig. 2B). Buccal cavity 24–30 µm (27 µm) long, laterally compressed. Deirids small, simple, approximately 2 µm in diameter (fig. 2C), left and right deirids situated at 105–128 µm (116 µm) and 108–125 µm (117 µm, $n = 4$) from anterior end, respectively. Excretory pore at 150–178 µm (165 µm) from anterior extremity. Nerve ring, hardly distinct at 95–113 µm (103 µm) from anterior extremity. Total length of oesophagus 1188–1370 µm (1246 µm), that is, 13.3–14.7% (13.9%) of body length; muscular part 130–167 µm (149 µm) long, maximum width 35–46 µm (40 µm); glandular part 1040–1190 µm (1083 µm) long, maximum width 88–120 µm (104 µm); ratio of muscular to glandular oesophagus 1:5.4–8.3 (1:6.9). Vulva situated at 879–1235 (1015 µm) from anterior extremity (fig. 1A); area around vulvar opening with distinct cuticular rugosities (fig. 2D). Detailed vaginal morphology obscured by uteri. Genital tract didelphic–opisthodelphic, two spermathecae situated near posterior end (fig. 1D). Eggs 39–41 × 30–31 µm, thick-shelled, with developed first-stage larva (fig. 1E). Tail 40–63 µm (51 µm) long, with round base and conical posterior part 23–33 µm (27 µm) long (fig. 1D); posterior part invaginated in the rounded base, likely due the fixation.

Male (based on a single posterior end): tail 172 µm long; body width at cloaca 99 µm; cloaca slit-like. Caudal alae, 202 µm long, extending from lateral body surface at level 80 µm anterior to cloaca to 50 µm to posterior end (fig. 1F). Area rugosa composed of numerous tubercles with diameter of 3–5 µm, tubercles appear on level 35 µm anterior to right caudal ala and extend posteriorly to level of phasmids (figs 1F and 2E–G). Caudal papillae five pairs of precloacal papillae, one pair of add-cloacal papillae; post-cloacal

papillae seven on right and nine left (figs 1F and 2E–G). First four pairs of precloacal papillae and add-cloacal pair of papillae pedunculate; fourth and seventh post-cloacal papillae on left and second, fifth and seventh post-cloacal papillae on right somewhat pedunculate; other papillae sessile (fig. 1F). Spicules and gubernaculum absent.

Discussion

Both *T. smogorzhevskiorum* and *T. schukurovi* were originally described as possessing weakly sclerotized spicules, which were not illustrated and their size was not provided because, according to the authors, these were not successfully measured. Some subsequent studies listed both species among the *Thubunaea* spp. without spicules (Burse & Goldberg, 1991; Pazoki & Rahimian, 2014; Garduño-Montes de Oca et al., 2017; Ramallo et al., 2017) although, to the best of our knowledge, there are no morphological studies on these species documenting the lack of spicules.

Female nematodes from *A. chernovi*, studied by us, correspond well to those of *T. schukurovi* in their dimensions (see table 1) as well as by the shape of the tail characterized with a rounded base that is twice as long as the conical tail extremity. The posterior fragment of the male in our material also resembles that of *T. schukurovi* in the length of the tail and the distribution and appearance of the tubercles of the area rugosa. We did not observe any specific cuticularization that can be interpreted as spicules. Despite this, based on the morphological similarities discussed above, we consider our sample conspecific with *T. schukurovi*. Establishing the presence or absence of weakly sclerotized spicules in males of *T. smogorzhevskiorum* needs further investigation.

Thubunaea schukurovi seems to be a smaller nematode than *T. smogorzhevskiorum* (table 1). In addition to the size differences, scrutiny of the descriptions of the two species and the material studied here reveals several characters that can be useful for their differentiation. Tubercles composing the area rugosa of *T. schukurovi* are distributed between the level anteriorly twice as distant from the cloaca than the first pair of precloacal papillae, which posteriorly reach the level of phasmids. In contrast, the area rugosa of *T. smogorzhevskiorum* extends from a level that is slightly anterior to the first pair of caudal papillae to the tip of the tail. The vulva of *T. schukurovi* is situated more anteriorly than that of *T. smogorzhevskiorum*. Females of both species have a rounded tail with a conical posterior part; however, in *T. schukurovi*, the conical part is half as long as the base of the tail, whereas in *T. smogorzhevskiorum* the length of the conical distal part is about one-quarter of the length of the rounded part. Our record of *T. schukurovi* from *A. chernovi* in xerophytic and meso-xerophytic habitats also confirms the conclusion of Sharpilo (1976) that this species is adapted as a parasite of lacer-tids and scincids in dry habitats.

This is the first record of *T. schukurovi* from Turkey. To the best of our knowledge, the only other record of the genus *Thubunaea* in Turkey is that of an unidentified species collected from *Phoenicolacerta laevis* (Gray, 1838) (Lacertidae) by Birlık et al. (2016). Jablonski et al. (2021) listed *Thubunaea baylisi* as a parasite known also from *Laudakia caucasia* (Eichwald, 1831) in Turkey referring to the study by Yildirimhan et al. (2006); however, in the latter paper, the authors reported the oxyurid nematode *Telandros baylisi* Chatterji, 1935 (Pharyngodonidae) from the same host but not *T. baylisi*.

Below we discuss some taxonomic issues concerning members of the genus *Thubunaea* from the Palaearctic and Indomalayan realms.

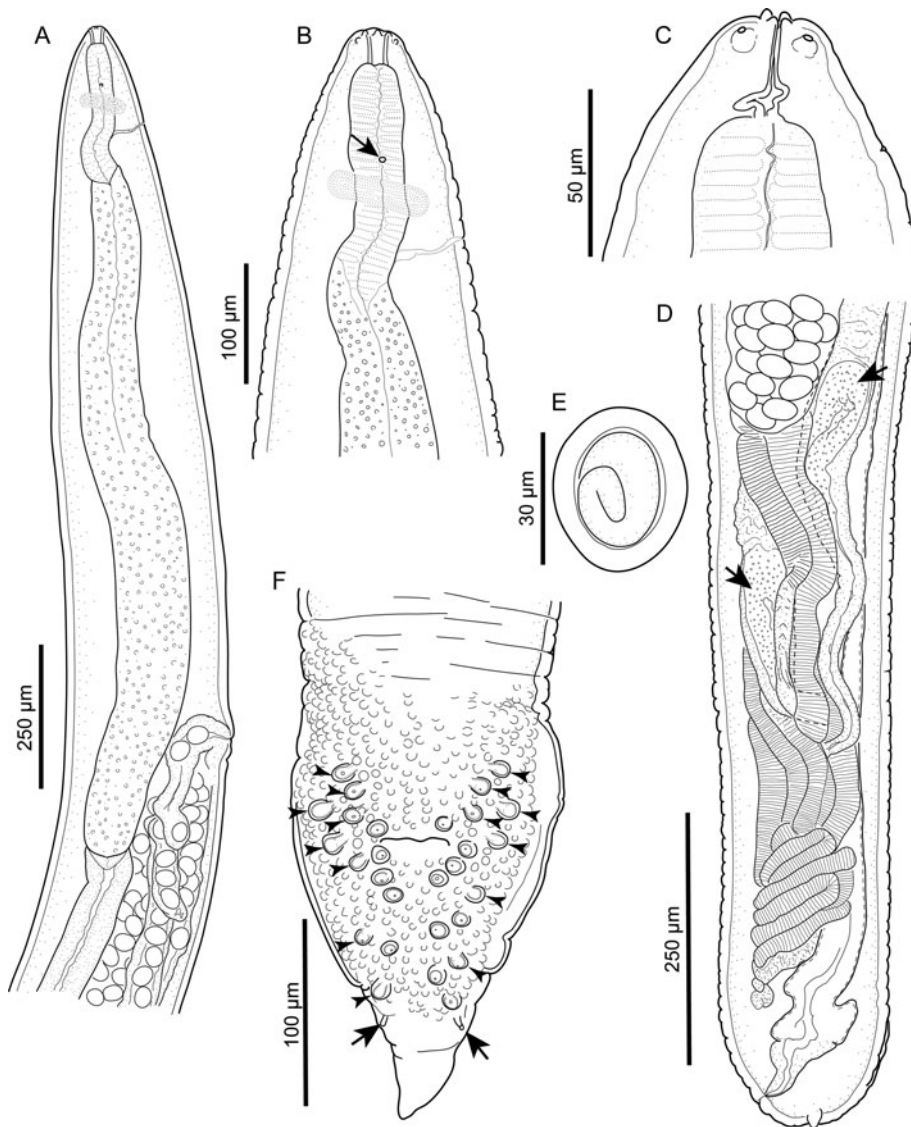


Figure 1. *Thubunaea schukurovi*. (A) Anterior extremity, female, lateral view – note vulva situated anterior to oesophago–intestinal junction; (B) head region, female, lateral view – note deirid (arrow); (C) head region, female, dorsal view; (D) posterior extremity, female, lateral view – note two spermathecae (arrows); (E) egg; (F) tail, male, ventral view – note pedunculate papillae (arrowheads) and phasmids (arrows).

Thubunaea pudica Seurat, 1914, the type-species of the genus, was described from unidentified species of chameleon, *Cerastes vipera* (L.) (Viperidae) and *Scincus scincus* (L.) (= *Scincus officinalis* Laur.) (Scincidae) (type host was not designated) in Algeria by Seurat (1914). Only the nominotypical subspecies of the common chameleon, *Chamaeleo chamaeleon chamaeleon* (L.), occurs in Algeria (see Sindaco, 1998; Bauer *et al.*, 2017) hence it should be regarded as one of the hosts of the species.

Thubunaea baylisi Akhtar, 1939 was described from a host referred to as ‘*Agama* sp.’ in Afghanistan (Akhtar, 1939). All members of the genus *Agama* Daudin, as currently defined, are sub-Saharan species, whereas the type host of *T. baylisi* could belong to one of the few other genera of the subfamily Agaminae occurring in Afghanistan (see Wagner *et al.*, 2016). Therefore, the type host of the species should be referred to as Agaminae gen. sp. Sharpilo (1976) re-examined the material reported as *Foleyella skrjabini* Skarbilovitsch, 1948 in Skrjabin *et al.* (1949), from unidentified terrestrial species of Colubridae in Kyrgyzstan and recognized it as conspecific with *T. baylisi*. In Skrjabin *et al.* (1949), *F. skrjabini* was illustrated but textual description and differential diagnosis were not provided; a

reference was made to an unpublished work of Skarbilovitsch from 1947. Thus, the *F. skrjabini* in Skrjabin *et al.* (1949) does not satisfy the International Code of Zoological Nomenclature (1999, Article 13.1.1) and should be treated as *nomen nudum*.

Thubunaea smogorzhevskiorum was originally spelt as ‘*smogorzhevskii*’; however, the species was named after husband and wife Leonid A. Smogorzhevski and Lidiya A. Smogorzhevskaya (see Sharpilo, 1966). Therefore, we amended the spelling based on Art. 31.1.2 of the International Code of Zoological Nomenclature (1999).

Foleyella schikhobalowi Skarbilovitsch in Skrjabin *et al.* (1949) from *Elaphe* sp. was published as a *nomen nudum*. Skarbilovitsch (1950) provided textual description of the material and listed as its hosts *Elaphe* sp. and *Lacerta* sp. collected from Kyrgyzstan, however a differential diagnosis was not provided and thus the requirements of the International Code of Zoological Nomenclature (1999, Article 13.1.1) for a valid publication of a new species were not met. Sharpilo (1976) considered this material conspecific to *T. smogorzhevskiorum*.

Burseley & Goldberg (1991) and Ramallo *et al.* (2017) listed *Thubunaea mirzai* Narayan, 1941 as a species known from the

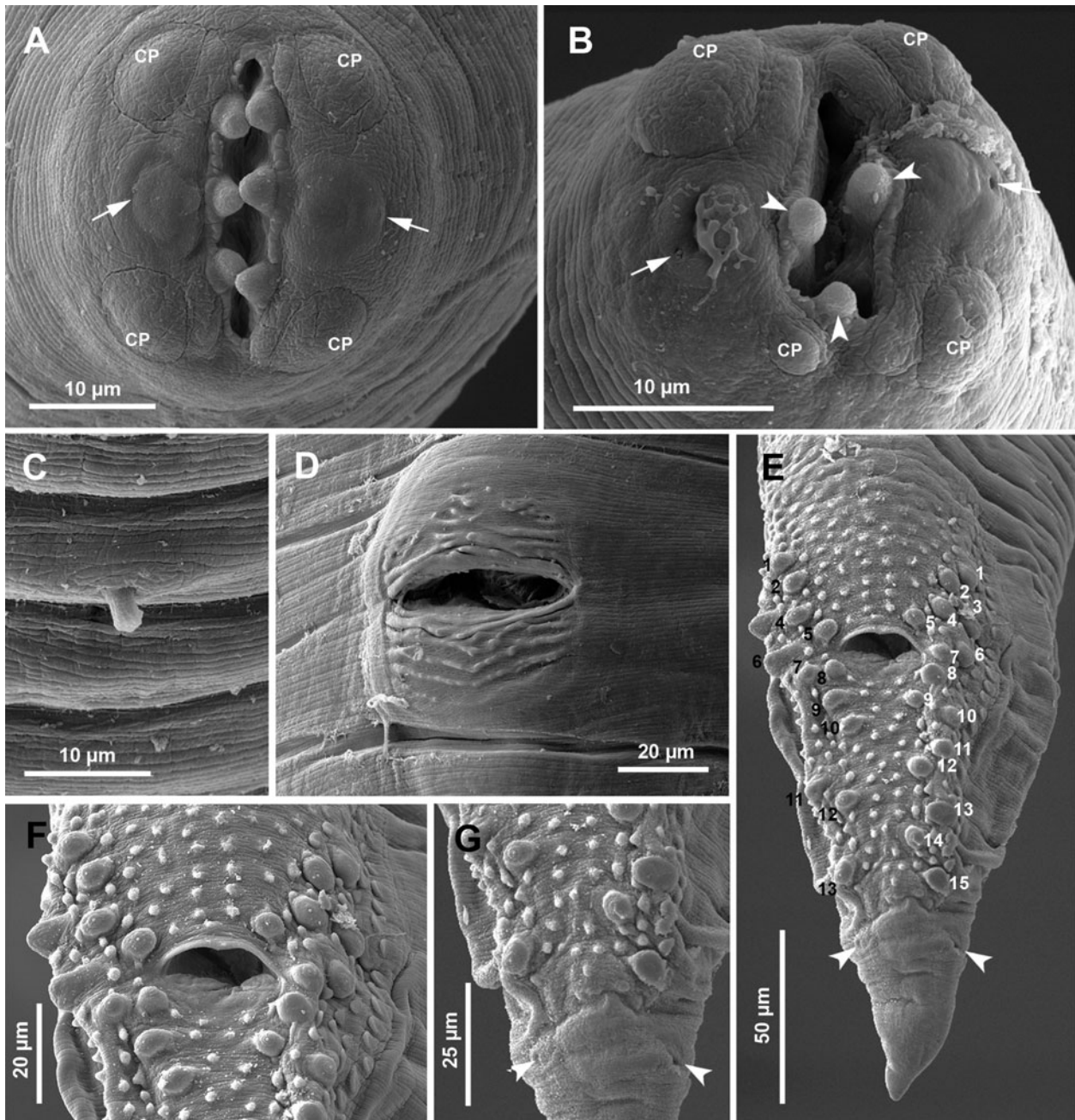


Figure 2. *Thubunaea schukurovi*, scanning electron microscopy micrographs. (A and B) anterior end, female, apical view – note cephalic papillae (cp), amphids (arrows) and specimen on fig. 2B is abnormally developed and has only three teeth (arrowheads); (C) deirid; (D) vulva; (E) posterior extremity, male, ventral view – note phasmids (arrowheads) and caudal papillae are numbered; (F) cloacal region, male; and (G) detail of tail with phasmids, male, ventral view.

Indomalayan realm. The name *T. mirzai* seems to be published only in an abstract from a conference, which does not constitute a published work within the meaning of the International Code of Zoological Nomenclature (1999, Article 9.10) and should be treated as a *nomen nudum*.

Thubunaea dessetae Barus & Tenora, 1976, a parasite of *Saara hardwickii* (Gray, 1827) (= *Uromastix hardwickii* Gray, 1827) (Agamidae) in Afghanistan, as described by Barus & Tenora (1976), is characterized by a pair of well-developed and rounded pseudolabia each armed with a single large lateral tooth and a pair of smaller sublateral teeth, cuticular cervical inflation posterior to

the pseudolabia, sclerotized buccal cavity, female reproductive system with four uteri and a peri-cloacal area rugosa in males. These characters correspond to the morphology of *Pseudabbreviata* Lichtenfels & Quigley, 1968 (see Lichtenfels & Quigley, 1968), members of which are also parasites of reptiles, mainly agamids (Sharpilo, 1976; Moravec & Baruš, 1990). Therefore, we transfer *T. dessetae* to the genus *Pseudabbreviata* as *Pseudabbreviata dessetae* (Barus & Tenora, 1976) n. comb. Whereas the genus *Thubunaea* are distinct with not well-defined rounded pseudolabia, each armed with three similar in size teeth, absence of cervical inflation, none-sclerotized buccal cavity, didelphic female

Table 1. Metrical data of *Thubunaea smogorzhevskiorum* and *Thubunaea schukurovi* from various host and localities.

Species	<i>T. smogorzhevskiorum</i>					<i>T. schukurovi</i>			
	Sharpilo (1966)		Sharpilo (1976)	Skarbilovitsch (1950) ^a		Annaev (1973)		Markov <i>et al.</i> (1962)	Present study
Host	<i>Lacerta agilis</i>		<i>Coronella austriaca</i>	<i>Elaphe</i> sp., <i>Lacerta</i> sp.		<i>Ablepharus deserti</i>	<i>Eremias velox</i> , <i>Ablepharus deserti</i>	<i>E. velox</i> , <i>Eremias arguta</i>	<i>Ablepharus chernovi</i>
Locality	Ukraine		Ukraine	Kyrgyzstan		Turkmenistan		Russia	Turkey
Sex	Male	Female	Female	Male	Female	Male	Female	Female	Female
	<i>n</i> = 3	<i>n</i> = 10	<i>n</i> = 10	<i>n</i> = 1	<i>n</i> = ?	<i>n</i> = 1	<i>n</i> = ?	<i>n</i> = ?	<i>n</i> = 5
Body length, mm	11.0–13.0	22.5–26.0	22.5–29.5	9.81	20.53–22.95	7.8	7.2 (8.5)–15.7 ^b	16.0–21.1	8.4–10.3
Body width	300	380–460	450–550	306	527	296	336–392	408	235–280
Nerve ring	210–220	180–200	240–250	228	315	168	112 (115)–140 ^b	191–237	95–113
Deirids	190–200	200–250	200–230	120, 160	125–160	168	112 (145)–162 ^b	195–237	105–128
Vulva	Not applicable (N/A)	2000–2800	Anterior to oesophago-intestinal junction	N/A	1560–1970	N/A	756 (924)–1064 ^b	Anterior to oesophago-intestinal junction	879–1235
Buccal cavity	36	32–41	38–45	52	52	36	28	43–56	24–30
Entire oesophagus, length	1700–1900	2200–2600	2900–3300	1360	2074–2470	1218	910 (1274)–1652 ^b	1283–2183	1181–1370
Muscular oesophagus, length	270–280	290–350	300–330	Not provided	Not provided	210	126–196	306–326	130–167
Glandular oesophagus, length	Not provided	1900–2300	Not provided	Not provided	Not provided	1008	784–1456	979–1.783	1040–1190
Tail length	290	140–160	140–160	306	115–122	285	90–112 (42–61) ^c	143–206	40–63
Caudal alae	560	N/A	N/A	N/A		460	N/A	N/A	N/A

^aPublished as *Foleyella schikhobalovi* (not valid name) in Skarbilovitsch (1950).^bThe smallest value of the range in the textual description differs from that provided in the table by Annaev (1973); in our Table 1 the latter is given in parentheses.^cThe length of the contracted tails is given in parentheses.

reproductive system and males with an area rugosa composed of irregularly distributed tubercles covering most of the ventral side of the caudal alae.

Thubunaea hemidactylae Oshmarin & Demshin, 1972 from *Hemidactylus frenatus* Duméril & Bibron, 1836 (Gekkonidae) in Vietnam was described with two lateral pseudolabia, one rounded and unarmed and the other bearing one large apical tooth and two smaller submedian teeth which do not project out from the pseudolabia; a weakly-developed cephalic collaret behind the pseudolabia; a short buccal cavity, a relatively short muscular oesophagus and a long and thick glandular oesophagus; a nerve situated slightly anterior to the junction between the muscular and glandular oesophagus; caudal alae with an area rugosa composed of numerous rounded tubercles; males with three precloacal pairs of papillae and six pairs of postcloacal papillae, and two spicules dissimilar in size; and females with a vulva situated anterior to the mid-length of the glandular oesophagus and with didelphic uteri (Oshmarin & Demshin, 1972). This morphology corresponds to that of the genus *Physalopteroides* Wu & Liu, 1940 (see Chabaud & Brygoo, 1960), hence we treat this species as *Physalopteroides hemidactylae* (Oshmarin & Demshin, 1972) n. comb. Indeed, Oshmarin & Demshin (1972) considered the species morphologically close to *Thubunaea dactyluris* [now accepted as *Physalopteroides dactyluris* (Karve, 1938) Chabaud & Brygoo, 1960] described from *Hemidactylus flaviviridis* Rüppell, 1835 and *Calotes versicolor* (Daudin, 1802) (Agamidae) in India (see Karve, 1938).

Deshmukh (1969) described four species of *Thubunaea* from Gekkonidae in India, that is, *Thubunaea singhi* and *Thubunaea brooki* both from *Hemidactylus brookii* Gray, 1845 and *Thubunaea aurangabadensis* and *Thubunaea syedi* both from *Hemidactylus giganteus* Stoliczka, 1871. Deshmukh (1969) textually described the four species as having two symmetrical lips, each bearing three conical teeth and according to the author they should be regarded as members of the genus *Thubunaea* as defined by Chabaud & Brygoo (1960). The descriptions of *T. aurangabadensis*, *T. syedi* and *T. brooki* were accompanied with illustrations of the anterior extremities in dorsoventral view, which reveals that their pseudolabia are not symmetrical. Further illustrations of the cephalic end in apical view of *T. aurangabadensis* and *T. syedi* were provided showing that one large apical (lateral) tooth and two smaller sub-median teeth present only on one of the two pseudolabia. The anterior extremity of *T. singhi* was illustrated in lateral view and one large apical (lateral) tooth and two smaller sub-median teeth are present at least on one of the two pseudolabia. These likely correspond to the three interno-lateral teeth following the terminology in Chabaud (1975). In addition, all four species described by Deshmukh (1969a) were illustrated with well-defined pseudolabia demarked with a groove or possibly a cephalic collarette at their base. The asymmetrical pseudolabia, armed with more pronounced and of different size teeth on one of the pseudolabia is a characteristic of the genus *Physalopteroides*, members of which are often described with well-defined pseudolabia and a cephalic collarette at their base (see Bursey & Goldberg, 2001; Bursey & Goldberg, 2016). All other species within the genus *Thubunaea* are characterized by two rounded, inconspicuous pseudolabia each bearing three similar in size teeth and there is no groove of cephalic collarette at their base (Seurat, 1914; Baylis, 1926; Ortlepp, 1931; Telford Jr, 1965; Sharpilo, 1966; Babero & Matthias, 1967; Annaev, 1973; Bursey & Goldberg, 1991; Moravec *et al.*, 1997; Pazoki & Rahimian, 2014;

Garduño-Montes de Oca *et al.*, 2017; Ramallo *et al.*, 2017). Based on the above discussion, we consider the species described by Deshmukh (1969a) as belonging to the genus *Physalopteroides* and propose the new combinations *Physalopteroides singhi*, *Physalopteroides brooki*, *Physalopteroides aurangabadensis* and *Physalopteroides syedi*. Their validity needs further taxonomic revision along with *Physalopteroides versicoloris* Deshmukh, 1968 described from *Calotes versicolor* (Daudin) in India in a separate study by Deshmukh (1969b). It should be noted that *P. versicoloris* has pseudolabia very similar in appearance with those of *P. brooki*, *P. aurangabadensis* and *P. syedi*.

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Competing interests. None.

Ethical standards. Not applicable.

References

- Akhtar SA (1939) On some nematode parasites from Afghanistan. *Proceedings of the Indian Academy of Sciences* **10**(1), 287–291.
- Annaev D (1973) New nematode *Thubunaea schukurovi* n. sp. (Physalopteridae, Nematoda) obtained from the lizards of Turkmenistan. *Izvestia Akademii Nauk Turkmenskoi SSR, Series of Biological Sciences* **1**(1), 72–75. [In Russian.]
- Babero BB and Matthias D (1967) *Thubunaea cnemidophorus* n. sp., and other helminths from lizards, *Cnemidophorus tigris*, in Nevada and Arizona. *Transactions of the American Microscopical Society* **86**(2), 173–177.
- Bain O, Mutafchiev Y and Junker K (2014) Order Spirurida. pp. 661–732. In Schmidt-Rhaesa A (Ed.) *Handbook of zoology: Gastrotricha, Cycloneuralia and Gnathifera*. Berlin, Boston, De Gruyter.
- Barus V and Tenora F (1976) *Thubunaea dessetae* n. sp. (Nematoda: Physalopteridae) from *Uromastix* [sic] *hartwicki* (Reptilia) in Afghanistan. *Acta Universitatis Agriculturae* **24**(3), 519–523.
- Bauer AM, Deboer JC and Taylor DJ (2017) Atlas of the reptiles of Libya. *Proceedings of the California Academy of Sciences, Series 4* **8**(1), 155–318.
- Baylis HA (1926) On a new species of the nematode genus *Thubunaea*. *Annals and Magazine of Natural History* **18**(106), 361–364.
- Bırlık S, Yildirimhan HS, Sümer N, Kumlutaş Y, Ilgaz Ç, Durmuş SH, Güçlü Ö and Candan K (2016) Helminth fauna of Lebanon lizard, (Gray, 1838), (Squamata: Lacertidae) from Southern Turkey. *Helminthologia* **53**(3), 262–269.
- Bursey CR and Goldberg SR (1991) *Thubunaea intestinalis* n. sp. (Nematoda: Spiruroidea) from Yarrow's spiny lizard, *Sceloporus jarrovii* (Iguanidae), from Arizona, U.S.A. *Transactions of the American Microscopical Society* **110**(3), 269–278.
- Bursey CR and Goldberg SR (2001) *Physalopteroides arnoensis* n. sp. (Nematoda: Physalopteridae) and other intestinal helminths of the mourning gecko, *Lepidodactylus lugubris* (Sauria: Gekkonidae), from Arno Atoll, Republic of the Marshall Islands, Oceania. *Journal of Parasitology* **87**(1), 135–138.
- Bursey CR and Goldberg SR (2016) A new species of *Physalopteroides* (Nematoda: Physalopteridae) in *Emoia atrocostata* (Squamata: Scincidae) from Peninsular Malaysia. *Comparative Parasitology* **83**(2), 221–226.
- Chabaud AG (1975) Keys to genera of the order Spirurida. Part 1. Camallanoidea, Dracunculoidea, Gnathostomatoidea, Physalopteridae,

- Rictularioidea and Thelazioidea. pp. 1–27. In Anderson RC, Chabaud AG, Willmott S (Eds) *CIH keys to the nematode parasites of vertebrates*. Farnham Royal, Commonwealth Agricultural Bureaux.
- Chabaud AG and Brygoo ER** (1960) Nématodes parasites de caméléons Malgaches [Parasitic nematodes of Malagasy chameleons]. *Mémoires de l'Institut Scientifique de Madagascar, Series A* **14**(1), 125–159. [In French.]
- Deshmukh PG** (1969a) Four new species of *Thubunaea* Seurat, 1914 from wall lizards. *Marathwada University Journal* **8**(1), 161–171.
- Deshmukh PG** (1969b) *Physalopteroides versicoloris* n. sp. from garden lizard *Calotes versicolor*. *Rivista di Parassitologia* **30**(2), 125–128.
- Ganshchuk SV** (2013) Helminths of reptiles of northern Caspian Region. *Vestnik Tomskogo Gosudarstvennogo Universiteta* **18**(6), 2992–2993.
- Garduño-Montes de Oca EU, López-Caballero JD and Mata-López R** (2017) New records of helminths of *Sceloporus pyrocephalus* Cope (Squamata, Phrynosomatidae) from Guerrero and Michoacán, Mexico, with the description of a new species of *Thubunaea* Seurat, 1914 (Nematoda, Physalopteridae). *ZooKeys* **716**(1), 43–62.
- International Commission on Zoological Nomenclature (ed.)** (1999) *International code of zoological nomenclature*. 4th edn. 306 pp. London, International Trust for Zoological Nomenclature.
- Jablonski D, Bursey CR, Basit A, Farooqi J, Masroor R and Goldberg SR** (2021) A contribution to the nematode fauna of two agamid lizards from Afghanistan. *Helminthologia* **58**(1), 115–118.
- Karve JN** (1938) Some nematode parasites of lizards. pp. 251–258. In *Livro Jubilar Do Professor Lauro Travassos. Editado Para Commemorar o 25 Aniversario de Suas Atividades Cientificas (1913–1938)*. Rio de Janeiro, Brazil.
- Lichtenfels JR and Quigley D** (1968) *Pseudabbreviata nudamphida* gen. et sp. n. (Nematoda: Physalopteridae) from an African 'lizard'. *Journal of Parasitology* **54**(6), 1092–1094.
- Markov GS, Ivanov VP, Nikulin VP and Chernobai VF** (1962) Helminth parasites of reptiles from Volga delta and Caspian steppe. *Trudy Astrakhanskogo Zapovednika* **6**(1), 145–172. [In Russian.]
- Moravec F and Baruš V** (1990) Some nematode parasites from amphibians and reptiles from Zambia and Uganda. *Acta Societatis Zoologicae Bohemoslovacae* **54**(1), 177–192.
- Moravec F, Salgado-Maldonado G and Mayen-Peña E** (1997) *Thubunaea ctenosauri* sp. n. (Nematoda: Physalopteridae) from the iguanid lizard *Ctenosaura pectinata* and other lizard helminths from Mexico. *Journal of the Helminthological Society of Washington* **64**(2), 240–247.
- Ortlepp RJ** (1931) *Thubunaea fitzsimonsi* sp. n. a fourth species of the genus *Thubunaea* Seurat, 1914. *Journal of the South African Veterinary Association* **2**(2), 128–131.
- Oshmarin PG and Demshin NI** (1972) Helminths of domestic and some wild animals in Vietnam. *Trudy Biologo-Pochvennogo Instituta; Dal'nevostochnyi Nauchnyy Tsent AN SSSR* **11**(1), 5–115. [In Russian.]
- Pazoki S and Rahimian H** (2014) New species of *Spauligodon* Skrjabin, Shikhobalova & Lagodovskaja, 1960 and *Thubunaea* [sic] Seurat, 1914 (Nematoda) from the gastro-intestinal tract of lizards in Iran. *Systematic Parasitology* **89**(3), 259–270.
- Ramallo G, Goldberg S, Bursey C, Castillo G and Acosta JC** (2017) *Thubunaea eleodori* sp. nov. (Nematoda: Physalopteridae) from *Liolaemus eleodori* (Sauria: Liolaemidae) from Argentina. *Parasitology Research* **116**(1), 293–297.
- Seurat L-G** (1914) Sur un nouveau nématode parasite des reptiles [On a new parasitic nematode of reptiles]. *Comptes Rendus Hebdomadaires des Séances et Mémoires de la Société de Biologie* **76**(1), 724–727. [In French.]
- Sharpilo VP** (1966) A new representative of the genus *Thubunaea* (Nematoda. Physalopteridae) a parasite of lizard. pp. 42–46. In *Parazity, Promezhnutachnye Khoziaeva and Perenoschiki* [Parasites, intermediate hosts and vectors]. Kiev, Izdatel'stvo 'Naukova Dumka'. [In Russian.]
- Sharpilo VP** (1976) *Parasitic worms of the reptilian fauna of the USSR: systematics, chorology, biology*. 287 pp. Kiev, Izdatel'stvo 'Naukova Dumka'. [In Russian.]
- Sindaco R** (1998) Annotated checklist of the reptiles of the Mediterranean countries, with keys to Asiatic and African species. Part I-Turtles, crocodiles, amphisbaenians and lizards. (Reptilia). *Annali del Museo Civico di Storia Naturale 'G. Doria', Genova* **92**(1), 85–190.
- Skarbilovitch TS** (1950) Notes on the helminths of amphibians and reptiles in Southern Kirghizia. *Trudy Gel'mintologicheskoi Laboratorii. Akademiya Nauk SSSR* **4**(1), 108–132. [In Russian.]
- Skrjabin KI, Shikhobalova NR and Sobolev AA** (1949) *Spirurata and Filariata. Vol 1. Opredelitel' Paraziticheskikh Nematod* [Spirurata and Filariata. Vol 1. Key to parasitic nematodes]. 519 pp. Moscow-Leningrad, Izdatel'stvo Akademii Nauk SSSR. [In Russian.]
- Telford SR Jr** (1965) A new species of *Thubunaea* (Nematoda: Spiruroidea) from California lizards. *Jikken Igaku Zasshi = Japanese Journal of Experimental Medicine* **35**(1), 111–114.
- Wagner P, Bauer AM, Leviton AE, Wilms TM and Böhme W** (2016) A checklist of the amphibians and reptiles of Afghanistan. *Proceedings of the California Academy of Sciences* **63**(13), 457–565.
- Yildirimhan HS, Goldberg SR and Bursey CR** (2006) Helminth parasites of the Caucasian agama, *Laudakia caucasia*, and the rougtail rock agama, *Laudakia stellio* (Squamata: Agamidae), from Turkey. *Comparative Parasitology* **73**(2), 257–262.