

To the fauna of the free-living nematodes (Nematoda) of high-mountain water bodies of the Western Himalayas and the Pamir

К фауне свободноживущих нематод (Nematoda) высокогорных водоёмов Западных Гималаев и Памира

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Seventeen species of the nematodes, typical for the Palaearctic fauna, from the orders Tobrilida, Dorylaimida, Mononchida, Monhysterida, Chromadorida and Plectida were recorded for the first time in water bodies of the Western Himalayas and the Pamir.

В водоёмах Западных Гималаев и Памира было обнаружено 17 характерных для палеарктической фауны видов нематод из отрядов Tobrilida, Dorylaimida, Mononchida, Monhysterida, Chromadorida and Plectida.

Key words: free-living nematodes, Himalayas, Pamir, biogeography, new records

Ключевые слова: свободноживущие нематоды, Гималаи, Памир, биogeография, новые находки

INTRODUCTION

The free-living freshwater nematofauna of mountain lakes situated over 3.500 m have been very poorly studied (Tsalolikhin, 1998). Actually, only three articles were dedicated to the freshwater nematodes of highlands (Tsalolikhin, 1998; Andrásy, 1978; Steiner, 1920). The situation is somewhat better with the alpine nematode fauna of mosses and lichens (Gadea, 1961, 1965; Micoletzky, 1929; Zullini, 1973, etc.). In high mountain lakes of the Eastern Himalayas (Nepal) 26 species of the free-living nematodes have been found, including a new species (Andrásy, 1978; Tsalolikhin, 1983). A species composition of the nematodes of the Pamir mountain range is closely related to the same of the Himalayas. The Western Himalayan Biogeographic Expedition of the St Petersburg Association of Scientists and Scholars under guidance of Dr. L.Ja. Borkin (20 April – 14 May 2013) collected additional information on alpine

water bodies of the Himalayas, and the International Pamir Biological Expedition granted by the National Geographic Society (July – August 2013) added new data on the nematode fauna of the Pamir.

MATERIAL AND METHODS

Benthos samples were taken from six water bodies in the Western Himalayas and from seven ones in the Central Pamir. A distribution of the nematodes in water bodies is presented in Table 1.

List of water bodies where nematodes were found

The Western Himalayas (Jammu and Kashmir State, India):

- 1) Mansar Lake: 665 m; 75.151°E, 32.696°N (22.IV.2013);
- 2) Wullar Lake: 1506 m; 74.56° E, 34.378°N (1.V.2013);

- 3) Tsomo Riri Lake: 4469 m; 78.15°E, 33.768°N (10.V.2013);
 4) Nubra River: 3152 m; 77.54°E, 34.777°N (7.V.2013);
 5) Spring: 3148 m; 77.555°E, 34.758°N (7.V.2013);
 6) Termal spring: 4381 m; 78.315°E, 33.223°N (10.V.2013).
The Pamir (Gorno-Badakhshan Autonomous Region, Tajikistan):
 7) Rangkul Lake: 3752 m; 74.264°E, 38.471°N (30.VII.2013);
 8) Karakul Lake: 3883 m; 73.554°E, 39.017°N (2.VIII.2013);
 9) Khargush Lake: 4213 m; 73.068°E, 37.431°N (21.VII.2013);
 10) Ail-Utek spring: 3659 m; 73.04°E, 38.558°N (31.VII.2013);
 11) Issyk-bulok termal spring: 3720 m; 72.977°E, 37.771°N (24.VII.2013);
 12) Kokuybel puddle: 3595 m; 73.067°E, 38.506°N (1.VIII.2013);
 13) Karasu puddle: 3749 m; 73.973°E, 38.176°N (27.VII.2013).

Table 1. Distribution of freshwater nematodes in the Western Himalayas and the Pamir.

Species	Water bodies (listed in "Material and methods" section)												
	West Himalayas						Central Pamir						
	1	2	3	4	5	6	7	8	9	10	11	12	13
Tobrilida													
<i>Tobrilus gracilis</i> (Bast., 1865)			+										+
<i>T. helveticus</i> (Hofmaenner, 1914)							+						
<i>Brevitobrilus vibratus</i> (Sukul, 1967)	+												
<i>Neotobrilus tantloji</i> (Sukul, 1971)												+	
<i>Tripyla glomerans</i> Bast., 1865		+											
Dorylaimida													
<i>Dorylaimus fodori</i> Andrassy, 1988							+		+			+	
<i>Crocodylaimus borchuk</i> Tsalolikhin, 2014				+		+							
<i>Laimydorus</i> sp.								+					
<i>Labronema ferox</i> Thorne, 1939							+						
Mononchida													
<i>Mononchus truncatus</i> Bast., 1865													+
<i>Mononchus</i> sp.		+											
Monhysterida													
<i>Monhystera wangi</i> Wu et Hoeppl, 1929	+		+		+								
<i>Eumonhystera similis</i> (Buetschli, 1873)				+									
Chromadorida													
<i>Achromadora terricola</i> (de Man, 1880)													+
<i>Prodesmodora</i> sp.					+								
Plectida													
<i>Plectus palustris</i> de Man, 1880									+				+
<i>Plectus rhizophilus</i> de Man, 1880				+									

The following abbreviations, except for most commonly accepted ones, are used in the descriptions of the species and in tables: cl-I – a distance between the cloaca and the first supplement; Q – the length of the gonad; Sp – a spicule length, SR – the length of the supplement row; Sp/cl-I – a ratio of a spicule length to a distance between the cloaca and the first supplement; Sp/SR – a ratio of a spicule length to the length of the supplement row; SR/L – a ratio of the length of the supplement row to a body length; Suppl/SR – a ratio of a distance between the supplements to the length of the supplement row and V-an/cd – a ratio of a distance between the vulva and the anus to a tail length. Roman numerals in the last five columns of Table 4 denote a ratio of a distance between the supplements to the length of supplement row, in percentage terms. All measurements were made in micrometers.

RESULTS

Brief descriptions of some notable species are given below.

Tobrilus gracilis (Bastian, 1865) (Figs 1–6)

Description. Females (n = 8): L = 1519–1891 (1710±47) µm, a = 23.4–30.5 (27±1.2), b = 3.9–5.4 (4.7±0.15), c = 7.4–9.6 (8.6±0.3), c' = 5–7, V = 41–51 (45±1)%. Head 28–30 (29±0.5) µm wide, cephalic setae 10–16 (13±1) µm long, buccal cavity 9–10 × 11–13 µm, total depth of stoma 21–28 (25±1) µm. Oesophagus 320–440 (364±15) µm long, NR = 30%. Female reproductive system: Q₁ = 170–245 µm, Q₂ = 210–265 µm; V-an/cd = 3.4–4.4 (3.7±0.1). Rectum 35–49 (45±2) µm long, tail 170–245 (200±8) µm long, subterminal seta absent.

Males (n = 6): L = 1430–1883 (1610±77) µm, a = 28.3–38.4 (32.9±2), b = 4.3–5.8 (5.1±0.3), c = 11.6–17.4 (13.5±1), c' = 3–4. Head 22–26 (24±0.5) µm wide, cephalic setae 11–12 µm long, buccal cavity 7–9 × 10–11 µm, total depth of stoma 19–21 µm.

Oesophagus 265–363 (320±21) µm long, NR = 33%. Tail 108–130 (120±4) µm long, subterminal seta absent.

Notes. The Himalayan *T. gracilis* is somewhat smaller compared with “typical” specimens of the species, their parametric data almost completely coincide (Tables 2, 3), particularly for the supplementary apparatus (Tsalolikhin, 1998).

Tobrilus helveticus (Hofmaenner, 1914)

Description. Females (n = 3): 1690–1825 (1777) µm, a = 26–30.3 (28.2), b = 4.9–5.7 (5.3), c = 7.7–9.2 (8.3), c' = 5.4–6.3 (6), V = 46–49 (48)%. Head 20–25 (23) µm wide, cephalic setae 5 µm long, buccal cavity 6–9 (7) × 9 µm, total depth of stoma 19–23 (21) µm. Oesophagus 294–370 (335) µm, NR = 32–35 (33)%. Female reproductive system underdeveloped; V-an/cd = 3–4. Rectum 29–36 (33) µm long, tail 196–220 (212) µm long, subterminal seta absent.

Notes. The specimens from the Pamir mainly differ from “typical” *T. helveticus* in a slightly shorter tail. Several specimens of *T. helveticus* with short tails were found in Po River, Italy (Zullini, 1974) and in Volga River (Gagarin, 1993).

Brevitobrilus vibratus (Sukul, 1967) (Figs 7–12)

Description. Females (n = 2): 990–1137 µm, a = 20.7–29.1, b = 5.1–5.4, c = 6.7–7.1, c' = 7–8, V = 43–45%. Head 17–23 µm wide, cephalic setae 4 µm long, buccal cavity 8–9 × 11–13 µm, total depth of stoma 22–28 µm, distance between tops of onchia 6 µm. Oesophagus 196–212 µm, NR = 39–49%. Females gonads two, ovaries reflexed: Q₁ = 98–136 µm, Q₂ = 98–155 µm, eggs 45 × 23–30 µm; V-an/cd = 3. Rectum 26–30 µm long, tail 147–159 µm long, subterminal setae absent.

Male: L = 1194 µm, a = 44, b = 5.8, c = 11.1, c' = 4, suppl. 6. Head 21 µm wide, cephalic setae 5 µm long. Oesophagus 204 µm long, tail 108 µm long, subterminal setae absent.

Notes. The rare species, originally described from India (Sucul, 1967), is morphologically very similar to *B. stefanskii* (Micoletzky 1925), and it was the reason for a synonymisation of these two names (Tsalolikhin, 2001). The differences between these two species consist in sizes of the spicules: 26 μm vs 30–40 μm and in the index sp/cl-I: 124 vs 113, respectively.

Both species belong to the *stefanskii*-group (group A) of the genus *Brevitobrilus* Tsalolikhin, 2001. Apart from India, *B. vibratus* was also found in Mongolia (Tsalolikhin, 1985). Comparative measurements of the supplementary apparatus of *B. vibratus* and *B. stefanskii* are presented in Table 4. Data for *B. stefanskii* are given by Micoletzky (1925) and Tsalolikhin (2001).

Table 2. Comparative measurements of *Tobrilus gracilis*.

Characters	Data for species by Tsalolikhin, 2009	Specimens from Tso Moriri Lake
Females		(n = 8)
L	1670–3300 (2185)	1519–1891 (1710 \pm 47)
<i>a</i>	19.6–40 (25.5)	23.4–30.5 (27 \pm 1.2)
<i>b</i>	4.4–6.7 (5.4)	3.9–5.4 (4.7 \pm 0.15)
<i>c</i>	7–15.4 (9.9)	7.4–9.6 (8.6 \pm 0.3)
V%	40–54 (45)	41–51 (45)
<i>c'</i>	4–5 (4.7)	5–7.5 (6.5)
NR%	27–34 (31)	30
Oesophagus	339–530 (425)	320–440 (364 \pm 15)
Tail	190–283 (218)	170–245 (200 \pm 8)
V-an/cd	(4.4)	3.4–4.4 (3.7 \pm 0.1)
Q ₁	(280)	170–245 (220)
Q ₂	(280)	210–280 (227)
Rectum	(53)	35–49 (45 \pm 2)
Head	31–40 (35)	28–30 (30 \pm 1)
Cephalic setae	10–13 (12)	10–16 (13 \pm 1)
Cephalic setae/head,%	30–40 (37)	45
Buccal cavity (width)	11–13 (12)	9–10
Stoma (depth)	23–28 (25)	21–28 (25 \pm 1)
Males		(n = 6)
L	1460–2600 (1954)	1430–1883 (1610 \pm 77)
<i>a</i>	20–45 (31)	28.3–38.4 (32.9 \pm 2)
<i>b</i>	4.3–6.6 (5.4)	4.3–5.8 (5.1 \pm 0.3)
<i>c</i>	10.4–17 (14)	11.6–17.4 (13.5 \pm 1)
NR%	31–34 (33)	33
Oesophagus	330–413 (370)	265–363 (320 \pm 21)
Trophico-genital part	1133–1716 (1438)	1030–1412 (1170 \pm 68)
Tail	120–160 (146)	108–130 (120 \pm 4)

Table 3. Measurements of supplementary apparatus of *Tobriulus gracilis*.

Suppl/SR	Data for species by Tsalolikhin, 2009	Specimens from Tso Moriri Lake
Cl-I	15–30 (20)	17–22 (20)
I-II	12–17 (14)	15–17 (16)
II-III	8–12 (10)	9–12 (11)
III-IV	6–12 (9)	7–10 (9)
IV-V	4–10 (8)	9–11 (9)
V-VI	6–10 (8)	9–12 (11)
VI-VII	10–16 (13)	9–12 (10)
VII-VIII	15–20 (17)	11–21 (14)
Sp/cl-I, %	70–80 (74)	66–83 (79)
SR/L, %	12–20 (17)	11–17 (14)
Sp/SR, %	13–19 (15)	9–16 (15)
Sp, μm	36–40 (38)	28–37 (33)
SR, μm	256–397 (328)	207–245 (221)

Neotobriulus tantloji (Sukul, 1971)
(Figs 13–15)

Description. *Juvenile:* 920 μm , $a = 23$, $b = 4.7$, $c = 10.6$. Head 16 μm wide, cephalic setae 4 μm long, buccal cavity $4 \times 4 \mu\text{m}$, total depth of stoma 18 μm , distance between tops of onchia 6 μm . NR = 40%.

Notes. This very rare species was found only once in a thermal spring in India. One female and three juveniles were described by Sukul, (1971). The author listed the following characters of larvae: L = 760 – 940 μm , $a = 22.8 - 26.4$, $b = 4.2 - 4.4$, $c = 6.8 - 7.7$. The measurements of the juvenile from the Pamir corresponds these date, but Pamirian specimen has the shorter tail. It is

noteworthy that this specimen was found in the thermal spring as well as the type specimens of *N. tantloji*.

Tripyla glomerans Bastian, 1865

Notes. The species from Wuler Lake in the Western Himalayas is presented only by juveniles. The range of the species is extremely wide but does not extend beyond the Eastern Hemisphere; it can be reliably regarded as the Palaearctic species (Tsalolikhin, 1983). It has been previously recorded for the Himalayas (Andrássy, 1978).

Dorylaimus fodori Andrásy, 1988

Notes. The species was described from paddy field in Bangalor State, India (Andrássy, 1988). The finding in the Pamir extended the range of the species and indicated a wide distribution of it in Asia. The main morphometric characters of the species are presented in Table 5.

Crocodyrlaimus borchuk
Tsalolikhin, 2014

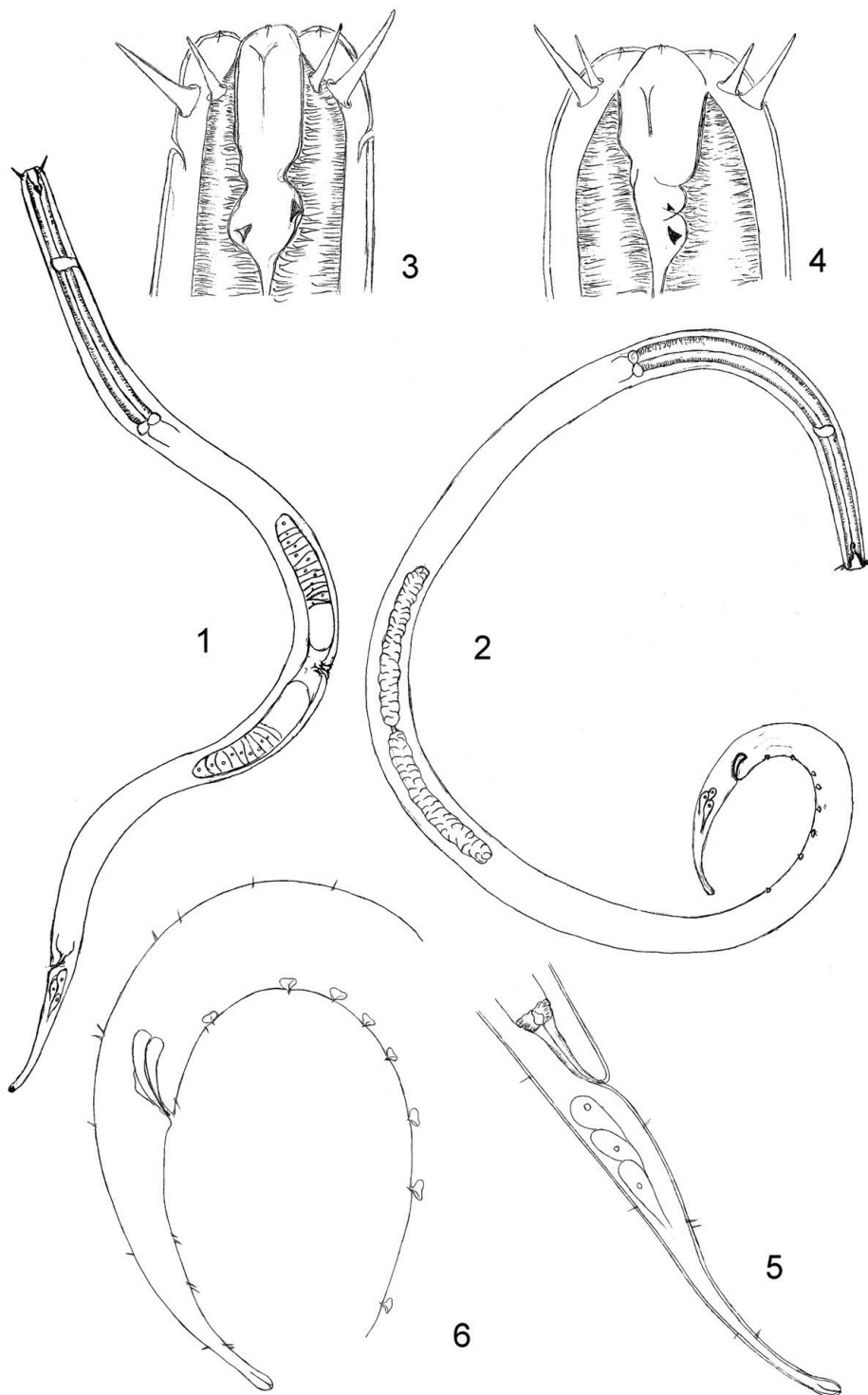
Notes. The species was described from the Nubra River, the Western Himalayas (Tsalolikhin, 2014b). The main morphometric characters of the species are presented in Table 6.

Laimydorus sp.

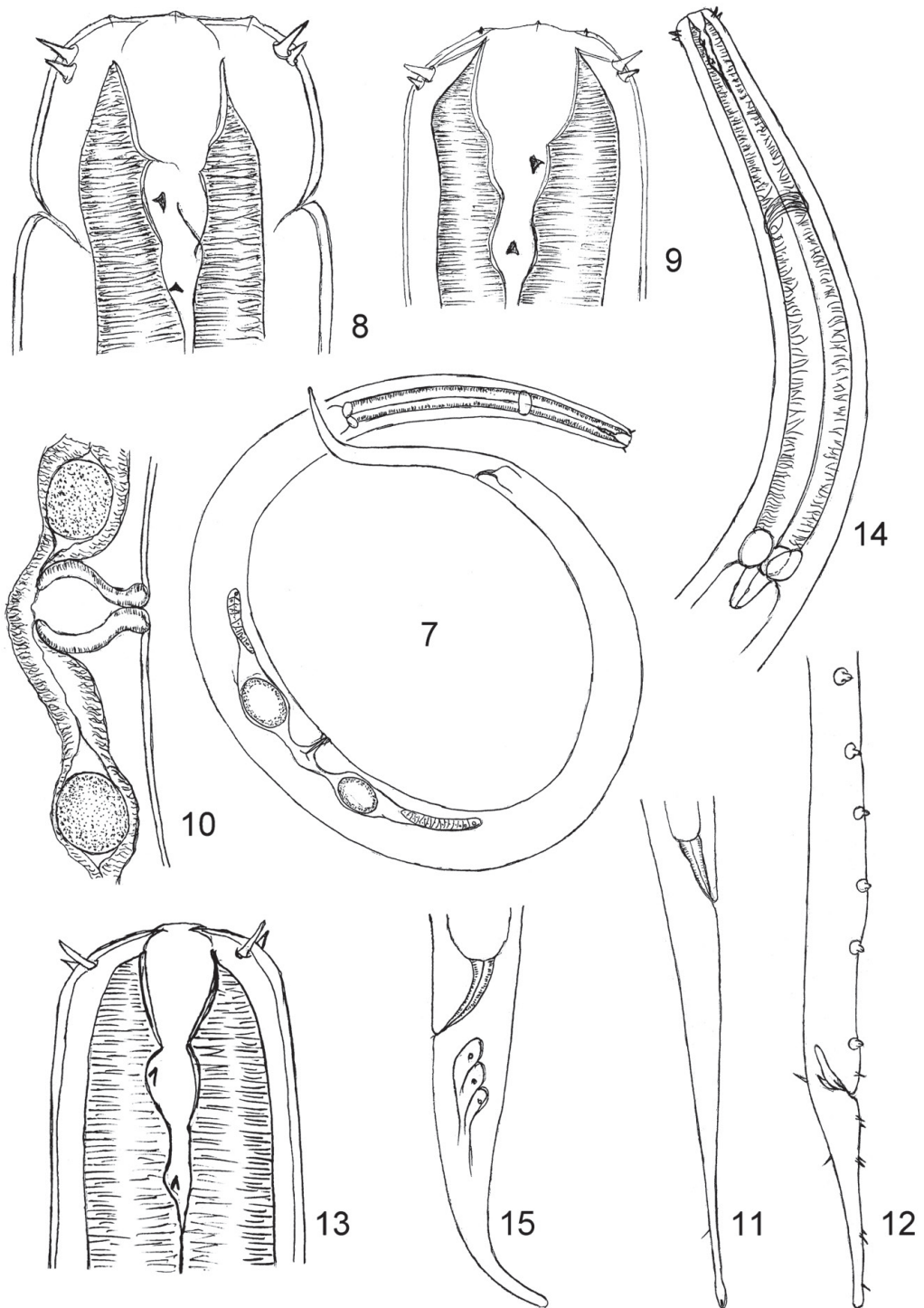
Description. *Female:* L = 1886 μm , $a = 33.1$, $b = 4.7$, $c = 11.6$, $c' = 5.6$, $V = 45\%$. Head 17 μm wide; spear 23 μm long. Oesophagus 402 μm long; V-an/cd = 5.4, $Q_1 = 282 \mu\text{m}$, $Q_2 = 302 \mu\text{m}$. Rectum 49 μm long, prerectum 74 μm long. Tail 163 μm long.

Table 4. Measurements of the supplementary apparatus of *Brevitobriulus vibratus* and *B. stefanskii*.

Species	Sp, μm	SR, μm	SR/L	Sp/SR	Sp/cl-I	cl-I	I-II	II-III	III-IV	IV-V	V-VI
<i>B. vibratus</i>	26	180	15	14	63	12	23	15	17	15	17
<i>B. stefanskii</i>	35	220	17	16	87	18	20	15	15	15	16



Figs 1–6. *Tobrilus gracilis*. 1, entire body of female; 2, entire body of male; 3, head, dorsal view; 4, head, lateral view; 5, tail of female; 6, posterior end of male body.



Figs 7–15. Nematodes of genera *Brevitobrilus* and *Neotobrilus*. 7–12, *Brevitobrilus vibratus*. 13–15, *Neotobrilus tantloyi*. 7, entire body of female; 8, head, dorsal view; 9, 13, head, lateral view; 10, vulvar section; 11, 15, tail of female; 12, posterior end of male body; 14, oesophagus.

Table 5. Measurements of *Dorylaimus fodori*.

Characters	Males (n=6)	Females (n=5)
L	3561–4310 (3842±126)	4130–4940 (4540±167)
Oesophagus	796–922 (858±23)	825–970 (897±31)
Tail	35–47 (42±2)	214–291 (260±19)
Prerectum+rectum	388–485 (455±19)	337–355 (345±9)
Spicula	74–97 (82±4)	–
Supplements	44	–
Head	18–19	18–19
Spear	43 × 5	45 × 5
<i>a</i>	34.5–53.2 (42.7±1.4)	33.2–50.9 (45.9±4.3)
<i>b</i>	4.2–4.9 (4.5±0.1)	4.7–5.4 (5.1±0.1)
<i>c</i>	75.8–110 (92.1±7.2)	9.3–16.9 (15.1±2)
<i>c'</i>	0.7–1 (0.9±0.05)	5.4–7.1 (5.9±0.4)
V%	–	41–46 (43±1)
V-an/cd	–	8.3–9.4 (8.8±0.3)

Table 6. Measurements of *Crocodyrlaimus borchuk*.

Characters	Males (n=4)	Females (n=4)
L	1560–1720 (1654)	1582–1883 (1776)
Oesophagus	294–345 (314)	279–326 (306)
Tail	61–82 (72)	120–136 (129)
Prerectum	115–120 (118)	80–90 (87)
Rectum	30–40 (35)	32–36 (34)
Spicula	35–38 (37)	–
Supplements	18	–
SR	65–68 (67)	–
Head	10–11	10–11
Spear	14–16 (15)	14–16 (15)
Vagina	–	24–27 (26)
Q ₁	–	250–340
Q ₂	–	250–340
Egg	–	65–80 × 26–27
<i>a</i>	42–48.4 (45.5)	38.6–45.1 (43.3)
<i>b</i>	5.0–5.6 (5.3)	5.4–6.2 (5.8)
<i>c</i>	61–82 (72)	13.3–15.7 (14.0)
V%	–	43–48 (45)
<i>c'</i>	1	6.3–7.8 (7.2)
V-an/cd	–	6–8
NR%	32–37 (35)	36

***Labronema ferox* Thorne, 1939**

Description. Females (n = 2): L = 2207–2782 μm , $a = 22.7\text{--}25.3$, $b = 3.6\text{--}3.9$, $c = 63\text{--}80$, $c' = 0.8$, $V = 48\text{--}50\%$. Head 24–25 μm wide; spear 35–36 \times 5 μm , aperture of spear 13 μm (1/3 length of spear); guiding ring doubl. Oesophagus 620–704 μm ; NR = 45%. Female reproductive system underdeveloped, depth of vagina 50 μm , V-an/cd = 31–40. Rectum 65–68 μm long, prerectum 100–110 μm long. Tail 35 μm long.

Notes. The species was described from the U.S.A. (Thorne, 1939) but was also recorded for the Himalayas (Zullini, 1973). In addition, *L. loeffleri* Andr ssy, 1978, a species close related with *L. ferox*, was found in the Himalayas in the Western Lobuche Lake at an altitude of 5180 m.

***Monhystera wangi* Wu et Hoepfly, 1929**

Description. Females (n = 8): 742–930 (856 \pm 22) μm , $a = 28.2\text{--}32.3$, $b = 5.4\text{--}7.4$ (6.5 \pm 0.2), $c = 4.9\text{--}5.7$ (5.2 \pm 0.1), $c' = 7\text{--}11$ (9 \pm 0.5), $V = 55\text{--}62$ (59 \pm 1)%.

Male: L = 781 μm , $a = 33.9$, $b = 6.2$, $c = 5.8$, $c' = 7$, spic. 30 μm , gub. 6 μm . Head 10–12 μm wide, cephalic setae very delicate, 3–4 μm long, stoma almost funnel-shaped. Center of amphid situated at 7–8 μm from the anterior body end, diameter of amphid 4 μm . Oesophagus cylindrical but widening towards the base (especially in male), 114–146 (132 \pm 3) μm long; oesophago-intestinal glands large. NR = 50–54%. Female reproductive system monodelphic, 320–350 μm long, egg 45–50 \times 10–21 μm , depth of vagina 23 μm ; V-an/cd = 1–1.2. Rectum 16–23 (19 \pm 1) μm long. Female tail 140–182 (164 \pm 5) μm long, male tail 135 μm long. Paracloacal cuticle plicated.

Notes. The species was described from fresh water bodies in South China (Wu & Hoepfly, 1929) and recorded for Mongolia (Tsalolikhin, 1985) and the Pamir (Tsalolikhin, 1998).

***Achromadora terricola* (de Man, 1880)**

Description. Female: L = 926 μm , $a = 25.7$, $b = 6.3$, $c = 8$, $c' = 5.3$, $V = 48\%$. Head

18 μm wide, cephalic setae 5 μm long, center of amphid situated at 14 μm from the anterior body end, diameter of amphid 5 μm . Oesophagus 147 μm long, bulbus 28 \times 24 μm . V-an/cd = 3.1. Rectum 48 μm long. Tail 117 μm long.

Notes. This widely distributed species was previously twice recorded for the Himalayas (Andr ssy, 1978; Zullini, 1973).

***Prodesmodora* sp.**

Description. Female: L = 857 μm , $a = 26.8$, $b = 7.2$, $c = 5.7$, $c' = 8.8$, $V = 42\%$. Head 19 μm wide, cephalic setae very thin, about 3 μm long, center of amphid situated at 18 μm from the anterior body end, diameter of amphid about 4 μm . Oesophagus 119 μm long, bulbus 23 \times 19 μm . NR = 57%. Female reproduction system didelphic: $Q_1 = 146$ μm (egg 57 \times 23 μm), $Q_2 = 126$ μm (egg 58 \times 23 μm); V-an/cd = 2.3. Rectum 31 μm long, tail 150 μm long, anal body diameter 17 μm .

Notes. In this female the length of the rectum is nearly twice as long as the anal diameter. The long rectum within the genus is only in *P. terricola* Altherr, 1952 and *P. minuta* Schneider, 1937, however, in the first species the rectum length is 3–4 times as an anal body diameter, whereas in the last species a body length is much shorter than in the Himalayan specimen. In *P. minuta*, the rectum is either shorter or less than 1.5 times as an anal body diameter. This character allows me to consider the described specimen as a new species; however, the single specimen is not sufficient for naming and describing a new species. The genus *Prodesmodora* Micoletzky, 1923 is widely distributed around the world. *P. circulata* (Micoletzky, 1913) is most frequently found in fresh (and brackish) water bodies but reliability of identification of this species is questionable in some cases (Tsalolikhin, 2014a).

Other species included in Table 1, were collected as single specimens and usually as larvae. Species such as *Tripyla glomerans* Bastian, 1865, *Mononchus truncatus* Bas-

tian, 1865, and *Eumonhystera similis* (Bütschli, 1873) have been previously found in the Himalayas. They are universally distributed or belong to the Palearctic, Ethiopian and Sino-Indian Regions (Tsalolikhin, 1983).

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