

# Description of Nine Species of the Family Cephalobidae (Nematoda, Rhabditida) and Morphometric Analysis in the Genus *Acrobeles* von Linstow, 1877

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**Abstract:** During the survey of the natural areas in Northeastern Iran (Semnan Province) nine species of cephalobid were found. *Acrobeles andalusicus*, *A. ciliatus*, *A. undulatus*, *Chiloplacus demani*, *C. minimus*, *Eucephalobus hooperi*, *Heterocephalobellus magnificus*, *Pseudacrobeles variabilis* and *Zeldia punctata* were recorded for first time from Iran. In addition, correlations of morphometric data within the species of the genus *Acrobeles* VON LINSTOW, 1877 were obtained with SPSS 13. The results showed that body length has high significant correlation with all morphometric data indexed in the measurement table. Furthermore, ovary with postuterine sac and spermatheca, and position of the vulva has significant correlation in females. The body length has correlation just with rectum and spicules in males. However body length has significant correlation with b index in females and c index in males only. In study of ratios, the results revealed that b and c' are more reliable to evaluate the species. Descriptions, measurements and illustrations are presented for all the species.

**Key words:** *Acrobeles*, *Eucephalobus*, *Heterocephalobellus*, morphology, taxonomy, *Chiloplacus*, correlation, *Zeldia*

## Introduction

The family Cephalobidae was established by FILIPJEV (1934). After that many scientists worked on this family worldwide (e. g. RASHID *et al.* 1985, BOSTRÖM, 1990, ABOLAFIA and Peña-SANTIAGO, 2002, 2003). Representatives of this group are bacterial feeders (YEATES *et al.* 1993) and are abundant in different type of soil. During the project on cephalobids in Semnan province (Northeastern Iran), we found several species belonging to this group. However, studies of nematodes belonging to the order Rhabditida CHITWOOD 1933 started several year

ago (SHOKOOHI *et al.* 2007a, b, c, 2008, SHOKOOHI and ABOLAFIA 2011).

The present paper, a part of the series on rhabditids from Iran, deals with nine known species belonging to the family Cephalobidae FILIPJEV, 1934, collected in Semnan province of Iran. The genera *Heterocephalobellus* RASHID, GERAERT & SHARMA 1985, *Zeldia* THORNE, 1937 and respectively, the species are new geographic records for Iran. All species presented in this paper (except *Acrobeles andalusicus* ABOLAFIA & PEÑA-SANTIAGO 2004) are reported

for first time from Iran. In addition, correlation of morphometric data of *Acrobeles* species discussed here also provided.

## Material and Methods

The nematodes were extracted from soil samples by BAERMANN'S (1917) funnel technique and centrifuge method according to JENKINS (1964). They were fixed with hot 4% formaldehyde solution and processed to anhydrous glycerine according to DE GRISSE (1969). Measurements were taken using an ocular micrometer and drawings were made using a drawing tube attached to the microscope. The terminology used for morphology of stoma and spicules follows the proposals by DE LEY et al. (1995) and ABOLAFIA and PEÑA-SANTIAGO (2006), respectively. Correlation of morphometric data was done with SPSS 13 software using two tailed Pearson correlation.

### Taxonomy

#### *Pseudacrobeles (Pseudacrobeles) variabilis* (STEINER, 1936) STEINER, 1938

(Fig. 1A-D & 2A, F, K)

**Measurements.** See Table 1.

Population from Damghan, province of Semnan (4♀♀)

**Female.** Body length 0.54-0.61 mm, almost cylindrical, ventrally curved after fixation. Cuticle annulated; annuli 1-2  $\mu$ m wide. Lateral fields with three incisures, occupying 15-17% of midbody diameter, fading out anterior to the phasmid. Head region continuous with the neck with six lips provided every one of an acute cephalic probolae; labial probolae present, three, very low. Amphid openings oval. Stoma cephaloboid with well distinct parts, having cheilostom with bar-shape rhabdia. Pharynx cephaloboid; corpus cylindrical, 2.7-3.1 times isthmus length, with procorpus longer than metacarpus; isthmus narrower than metacarpus; basal bulb ovoid, with valvular apparatus at middle part. Nerve ring located at level of isthmus, at 67% of neck length. Excretory pore located at level of metacarpus, 53-56 annuli from lip region. Deirids located at level of isthmus, at 60-65 annuli from lip region or 76-79% of neck region. Cardia conoid, surrounded by intestinal tissue. Reproductive system monodelphic-prodelphic, located on the right side of intestine. Ovary more or less straight, with only one row of oocytes. Oviduct short, less than a half of the corresponding

body diameter. Spermatheca well developed, offset, with length 1.3-1.5 times that of corresponding body diameter. Postuterine sac with length 0.7-1.1 times that of the corresponding body diameter. Vulva not protruding, located posterior to mid part of body. Rectum 1.3-1.4 times the anal body diameter. Tail conical-elongate, with acute terminus, with lateral field ending before the phasmid level. Phasmids at 17-24% of tail length.

**Male.** General morphology similar to female, body length 0.50 mm long, curved ventrally after fixation. Reproductive system monorchid. Tail conical with mucro, curved ventrad at distal part. Genital papillae four pairs: one pair dorsally, one pair laterally, and two pairs near tail terminus. Spicules curved ventrally: manubrium bent ventrally and rounded; calamus with thin walls; and lamina curved ventrad bearing hump. Gubernaculum long and well developed, slightly curved ventrally.

**Distribution.** The material studied has been recovered from the soil around roots of *Malus* sp. and weed in Damghan (province of Semnan, Iran).

**Remarks.** The material examined here of *P. (P.) variabilis* agreed well with original description of this species by STEINER (1936), although having slightly shorter body (0.54-0.61 mm vs 0.65-0.67 mm), and female tail (71-86  $\mu$ m vs 100  $\mu$ m). Our specimens fit well with those studied by DE LEY et al. (1993), however, they have longer tail in males (71-86  $\mu$ m vs 62-99 in females, and 44-45  $\mu$ m vs 20-39 in males). ABOLAFIA and PEÑA-SANTIAGO (2002) studied this species with longer spermatheca (26-36  $\mu$ m vs 48  $\mu$ m).

This is the first record of the species in Iran.

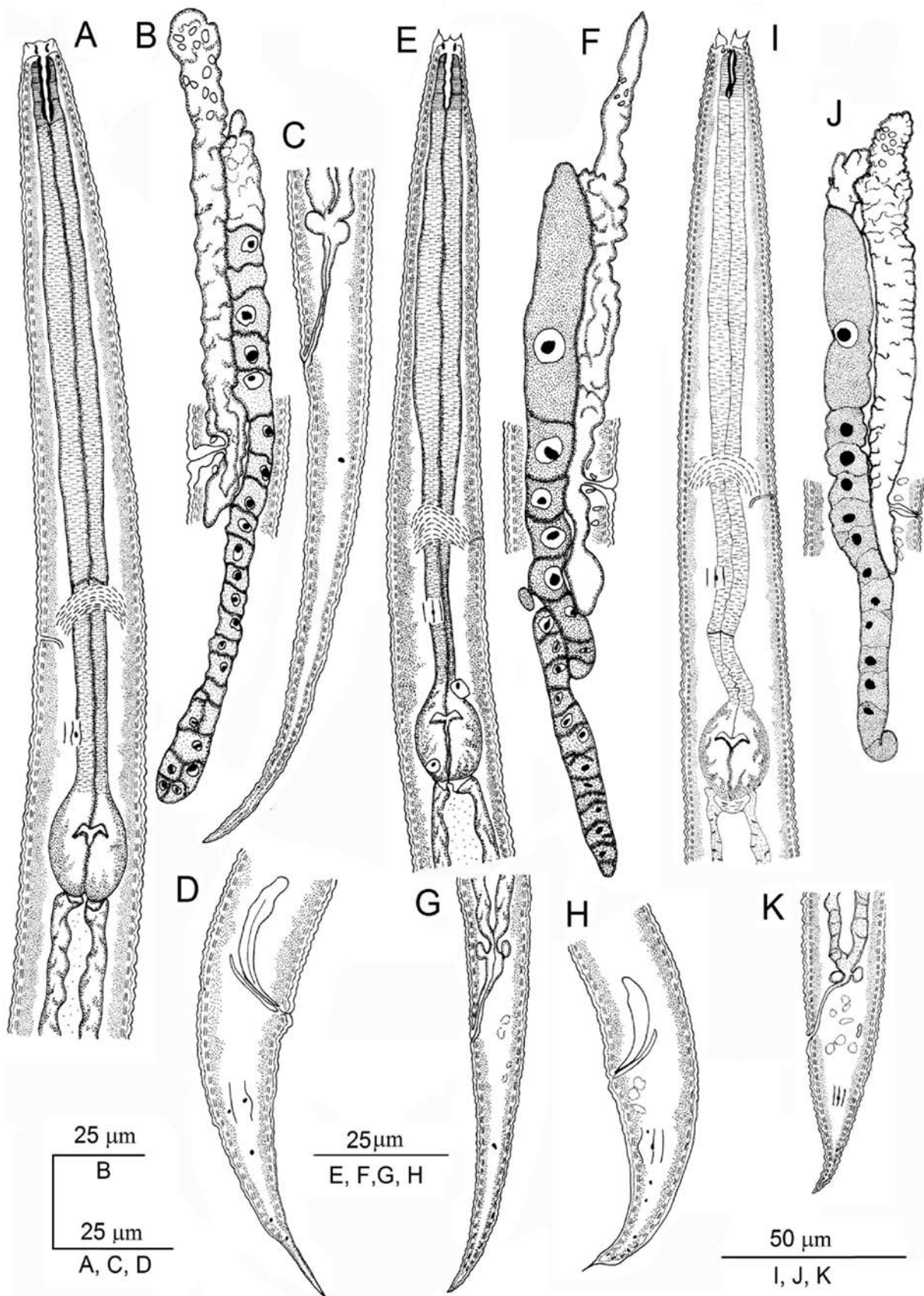
#### *Eucephalobus hooperi* MARINARI-PALMISANO, 1967

(Fig. 1E-H & 2B, G, L)

**Measurements.** See Table 2.

Population from Semnan, province of Semnan (11♀♀)

**Female.** Body length 0.40-0.53 mm, almost cylindrical, ventrally curved after fixation. Cuticle annulated; annuli 1-2  $\mu$ m wide. Lateral fields with three longitudinal incisures, occupying 13-17% of midbody diameter. Head region continuous with the neck, three high labial probolae present, bifurcated with acute prongs. Amphid openings circular. Stoma cephaloboid with well distinct parts. Pharynx cephaloboid; corpus cylindrical, 3.1-3.7 times isthmus length, with



**Fig. 1.** *Pseudacrobeles (Pseudacrobeles) variabilis* (STEINER, 1936) STEINER, 1938. A: Neck. B: Female reproductive system. C: Female posterior end. D: Male posterior end. *Eucephalobus hooperi* MARINARI-PALMISANO, 1967. E: Neck. F: Female reproductive system. G: Female posterior end. H: Male posterior end. *Zeldia punctata* (THORNE, 1925) THORNE, 1937. I: Neck. J: Female reproductive system. K: Female posterior end.

procorpus longer than metacarpus; isthmus narrower than metacarpus; basal bulb ovoid, with valvular apparatus at middle part. Nerve ring located at level of metacarpus, at 67-70% of neck length. Excretory pore opening located at level of metacarpus, 52-56 annuli from lip region. Deirids located at level of isthmus, at 57-71 annuli from lip region or 75-76% of neck region. Cardia conoid, surrounded by intestinal tissue. Reproductive system monodelphic-prodelphic, located on the right side of intestine. Ovary more or less straight, with only one row of oocytes. Oviduct short. Spermatheca well developed, offset, with length 0.6-2 times that of corresponding body diameter. Postuterine sac with length 0.6-0.9 times that of the corresponding body diameter. Vulva not protruding, located posterior to mid part of body. Rectum 1.3-1.4 times the anal body diameter. Tail conical-elongate, with acute terminus, with lateral lines fading out near tail terminus. Phasmids at 34-42% of tail length.

**Male.** General morphology similar to female, body curved ventrally after fixation. Reproductive system monorchid. Tail conical bearing mucro, curved ventrad at distal part. Genital papillae including four pairs: one pair dorsally, one pair laterally, and two pairs near tail terminus. Spicules curved ventrally, manubrium bent ventrally and rounded; calamus with thin walls; and lamina curved ventrad with hump. Gubernaculum long and well developed, curved ventrally slightly.

**Other material examined** (5 ♀♀, see Table 2). Similar to population from Semnan, except for the shorter body, pharynx, and tail.

**Distribution.** The material studied has been found in association with *Malus* sp. and weed in Damghan, and in sediments of Damghan River in Semnan (province of Semnan).

**Remarks.** Iranian specimens of *E. hooperi* are similar to the original description of the species by MARINARI-PALMASO (1967). They differ by having longer tail ( $c=8.6-12.3$  vs  $c=9.2-10$ ). In comparison to the material examined by ABOLAFIA and PEÑA-SANTIAGO (2002) it has longer female body (403-531  $\mu\text{m}$  vs 310-483  $\mu\text{m}$ ), and spermatheca (11-50  $\mu\text{m}$  vs 5-25  $\mu\text{m}$ ). Our material fit perfectly with those studied by BOSTRÖM (1990).

This is the first record of the species in Iran.

***Heterocephalobellus magnificus* (ANDRÁSSY, 1987)  
DE LEY, SIDDIQI & BOSTRÖM, 1993**  
(Fig. 3 & 4)

**Measurements.** See Table 1.

Population from Abr forest (Shahrood), province of Semnan (6 ♀♀)

**Female.** Body length 0.89-1.04 mm, almost cylindrical, ventrally curved after fixation. Cuticle annulated; annuli 1-2  $\mu\text{m}$  wide. Lateral fields with three incisures, occupying 15-19% of midbody diameter. Head region set off by constriction with the neck, with six lips group two by two; labial probolae thick and rounded. Amphid openings very small. Stoma cephaloboid with well distinct parts. Pharynx very long, generally with loop and cephaloboid; corpus cylindrical, 4.6-5.4 times isthmus length, with procorpus longer than metacarpus; isthmus narrower than metacarpus; basal bulb ovoid, with valvular apparatus at middle part. Nerve ring located at level of isthmus, at 42-53% of neck length. Excretory pore opening located at level of metacarpus, 58-63 annuli from lip region. Deirids located at level of bulb, at 66-71 annuli from lip region or 50-63% of neck region. Cardia conoid, surrounded by intestinal tissue. Reproductive system monodelphic-prodelphic, located on the right side of intestine. Ovary with flexure, having only one row of oocytes. Oviduct short. Spermatheca well developed, offset, with length 1.7-3.0 times that of corresponding body diameter. Posterior uterine sac with length 6.0-6.4 times that of the corresponding body diameter. Vulva not protruding, located posterior to mid part of body. Rectum 1.7-2.0 times the anal body diameter. Tail conical-elongate, with acute terminus. Phasmids at 34-42% of tail length.

**Male.** General morphology similar to female, body curved ventrally after fixation. Reproductive system monorchid. Tail conical with acute tip, curved ventrad at distal part. Genital papillae including four pairs: one pair dorsally, one pair laterally, and two pairs near tail terminus. Spicules curved ventrally, manubrium bent ventrally and rounded; calamus with thin walls; and lamina curved ventrad. Gubernaculum long and well developed, curved ventrally slightly.

**Distribution.** The material studied has been found in association with weeds in Abr forest, Shahrood (province of Semnan, Iran).

**Remarks.** The Iranian *H. magnificus* fit well with the material studied by ANDRÁSSY (2005); however, they differed in having slightly longer body in males (0.79-0.87 mm vs 0.74-0.78 mm), and tail ( $c'=1.7-2.1$  vs  $c'=1.6-1.7$ ).

**Table 1.** Measurements of *Pseudacrobeles (Pseudacrobeles) variabilis* (STEINER, 1936) STEINER, 1938, *Heterocephalobellus magnificus* (ANDRÁSSY, 1987) DE LEY, SIDDIQI & BOSTRÖM, 1993, *Chiloplacus demani* (THORNE, 1925) THORNE, 1937, *Chiloplacus minimus* (THORNE, 1925) ANDRÁSSY, 1959, and *Zeldia punctata* (THORNE, 1925) THORNE, 1937. All measurements in  $\mu\text{m}$  and the format: mean  $\pm$  standard deviation (range).

Species	<i>P. variabilis</i>			<i>H. magnificus</i>			<i>C. demani</i>				<i>C. minimus</i>		<i>Z. punctata</i>		
	Damghan		Shahrood	Shahrood		Shahrood	Damghan		Shahrood		Shahrood	Forest tree		Damghan	
Habitat	<i>Maltis</i> sp. & Weed			Weed			<i>Salix</i> sp.				Forest tree		Weed		
Character	Females	Males	Females	Females	Males	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
n	4	2	6	6	3	3	11	2	2	1	3	1	3	10	
L	578.0 $\pm$ 30.9 (544-608)	504	939.7 $\pm$ 51 (895-1039)	839.7 $\pm$ 43.8 (792-878)	32.3 $\pm$ 0.5 (31.7-32.7)	689.8 $\pm$ 49.4 (600-786)	(646-662)	(23.6-23.9)	(641-648)	587	341.7 $\pm$ 36.5 (314-383)	587	774.3 $\pm$ 26.1 (726-805)		
a	27.2 $\pm$ 0.8 (26.1-28)	26.5	32.1 $\pm$ 2.6 (28.9-35.8)	32.3 $\pm$ 0.5 (31.7-32.7)	3.5 $\pm$ 0.3 (3.2-3.8)	22.4 $\pm$ 1.4 (20.3-24.6)	3.8	(22.1-22.3)	3.6	22.6	22 $\pm$ 1.9 (20.5-24.2)	22.6	23.6 $\pm$ 2.4 (19.8-26.9)		
b	3.9 $\pm$ 0.2 (3.7-4.1)	3.6	3.6 $\pm$ 0.1 (3.4-3.8)	3.5 $\pm$ 0.3 (3.2-3.8)	22.9 $\pm$ 0.9 (22-23.6)	3.8 $\pm$ 0.1 (3.5-3.9)	15.1 $\pm$ 1.3 (13.3-16.5)	14.4	3.6	3.6	3 $\pm$ 0.4 (2.5-3.2)	3.6	3.4 $\pm$ 0.3 (2.5-3.8)		
c	7.4 $\pm$ 0.2 (7.1-7.7)	11.2	22.1 $\pm$ 1.2 (20.2-23.1)	22.9 $\pm$ 0.9 (22-23.6)	1.9 $\pm$ 0.2 (1.7-2.1)	2.4 $\pm$ 0.2 (2.1-2.8)	2.2	(2.4-2.8)	2.1	2.1	2.9 $\pm$ 0.1 (2.8-2.9)	2.1	2.1 $\pm$ 0.2 (1.8-2.5)		
c'	3.7 $\pm$ 0.2 (3.4-3.9)	2.6	2.7 $\pm$ 0.2 (2.4-2.9)	1.9 $\pm$ 0.2 (1.7-2.1)	—	64.9 $\pm$ 1.3 (63-67)	—	(65-66)	—	—	65.2 $\pm$ 1.3 (64-66)	—	65 $\pm$ 1.8 (60-67)		
V	60 $\pm$ 3 (58-65)	—	64.8 $\pm$ 0.7 (64-66)	2.7 $\pm$ 0.5 (2-3)	2.7 $\pm$ 0.6 (2-3)	4.9 $\pm$ 0.7 (4-6)	5	(3-4)	4	4	3.3 $\pm$ 0.6 (3-4)	4	4.1 $\pm$ 0.7 (4-6)		
Labial probolae	1	(1-2)	2.7 $\pm$ 0.5 (2-3)	9.8 $\pm$ 0.8 (9-11)	9 $\pm$ 1 (8-10)	9.2 $\pm$ 0.8 (8-10)	9	(8-9)	8	8	5.3 $\pm$ 0.6 (5-6)	8	10.4 $\pm$ 1 (9-12)		
Lip region diam.	5	5-6	9.8 $\pm$ 0.8 (9-11)	11.8 $\pm$ 1.6 (11-15)	11.3 $\pm$ 1.5 (10-13)	13.1 $\pm$ 1 (11-14)	13	(11-13)	12	12	8.7 $\pm$ 1.2 (8-10)	12	13 $\pm$ 1.1 (11-14)		
Stoma	12.8 $\pm$ 1 (12-14)	(11-13)	11.8 $\pm$ 1.6 (11-15)	192.8 $\pm$ 29.7 (140-218)	181.7 $\pm$ 7.6 (173-187)	121 $\pm$ 10.2 (97-136)	(113-117)	(117-121)	108	108	65.3 $\pm$ 3.1 (62-68)	108	168.6 $\pm$ 9.5 (153-180)		
Pharyngeal corpus	95.3 $\pm$ 6.2 (89-102)	(86-91)	95.3 $\pm$ 6.2 (89-102)	35.3 $\pm$ 4.1 (30-40)	21 $\pm$ 1.7 (20-23)	35.5 $\pm$ 2.4 (31-39)	(36-38)	(21-24)	35	35	21 $\pm$ 4 (17-25)	35	22.8 $\pm$ 1.5 (20-25)		
Isthmus	32.3 $\pm$ 0.5 (32-33)	31	35.3 $\pm$ 4.1 (30-40)	21 $\pm$ 1.7 (20-23)	238 $\pm$ 10.6 (226-246)	180.7 $\pm$ 13.1 (152-201)	(172-176)	(180-182)	165	165	118.7 $\pm$ 32.4 (98-156)	165	227.7 $\pm$ 31.2 (203-312)		
Bulb	18.3 $\pm$ 1.3 (17-20)	17	21.3 $\pm$ 1.5 (20-23)	137 $\pm$ 18.7 (101-152)	124.3 $\pm$ 5.7 (118-129)	122.2 $\pm$ 11.7 (91-134)	(116-123)	(103-104)	94	94	69.3 $\pm$ 9.9 (58-76)	94	131.3 $\pm$ 7.2 (122-149)		
Pharynx length	146.8 $\pm$ 8.2 (138-157)	(136-140)	261 $\pm$ 13.8 (243-282)	138.8 $\pm$ 19.4 (104-157)	129.3 $\pm$ 2.9 (126-131)	145.2 $\pm$ 9.5 (126-158)	(137-139)	(120-125)	109	109	76.3 $\pm$ 10.6 (65-86)	109	152.4 $\pm$ 6 (141-160)		
Nerve ring to ant. end	93.5 $\pm$ 4.4 (88-97)	89-95)	137 $\pm$ 18.7 (101-152)	157.2 $\pm$ 19.1 (122-177)	148 $\pm$ 4.4 (143-151)	1.9 $\pm$ 0.7 (1-3)	2	(2-3)	2	2	1	2	1.8 $\pm$ 0.4 (1-2)		
Excretory pore to ant. end	97.5 $\pm$ 4.2 (93-102)	(91-96)	138.8 $\pm$ 19.4 (104-157)	1.8 $\pm$ 0.4 (1-2)	1	1.5 $\pm$ 0.5 (1-2)	(1-2)	(1-2)	2	2	1	2	1.2 $\pm$ 0.4 (1-2)		
Deirid to ant. end	112.8 $\pm$ 4.2 (108-117)	(103-111)	157.2 $\pm$ 19.1 (122-177)	12.5 $\pm$ 1 (11-14)	11.3 $\pm$ 0.6 (11-12)	11.3 $\pm$ 0.6 (10-12)	11	(13-14)	10	10	7.7 $\pm$ 0.6 (7-8)	10	13.1 $\pm$ 0.6 (12-14)		
Annuli width	1.3 $\pm$ 0.5 (1-2)	1	1.8 $\pm$ 0.4 (1-2)	8.5 $\pm$ 0.6 (8-9)	26 $\pm$ 1 (25-27)	30.8 $\pm$ 2.2 (27-34)	(27-28)	(27-28)	26	26	15.7 $\pm$ 2.5 (13-18)	26	33.1 $\pm$ 3.6 (27-38)		
Cuticle thickness	1.3 $\pm$ 0.5 (1-2)	1	1.8 $\pm$ 0.4 (1-2)	29.3 $\pm$ 1.4 (27-31)	19.3 $\pm$ 1.5 (18-21)	19.1 $\pm$ 1.1 (18-21)	21	(17-19)	20	20	10.3 $\pm$ 0.6 (10-11)	20	20.4 $\pm$ 1.3 (19-23)		
Body diameter: Neck base	8.5 $\pm$ 0.6 (8-9)	(8-9)	12.5 $\pm$ 1 (11-14)	15.8 $\pm$ 0.8 (15-17)	5.3 $\pm$ 0.6 (5-6)	4.2 $\pm$ 1 (3-6)	4	(5-6)	5	5	3.5 $\pm$ 0.7 (3-4)	5	6.4 $\pm$ 0.5 (6-7)		
Midbody	21.3 $\pm$ 1 (20-22)	19	29.3 $\pm$ 1.4 (27-31)	4.8 $\pm$ 0.8 (4-6)	9.8 $\pm$ 1 (9-11)	9.1 $\pm$ 1.1 (8-11)	—	(9-11)	—	—	5 $\pm$ 1 (4-6)	—	11.1 $\pm$ 1 (10-13)		
Anus	12 $\pm$ 1.6 (10-14)	17	15.8 $\pm$ 0.8 (15-17)	9.8 $\pm$ 1 (9-11)	—	—	—	—	—	—	—	—	—		
Lateral field	3.8 $\pm$ 1 (3-5)	(3-4)	4.8 $\pm$ 0.8 (4-6)	—	—	—	—	—	—	—	—	—	—		
Vagina	6.5 $\pm$ 0.6 (6-7)	—	9.8 $\pm$ 1 (9-11)	—	—	—	—	—	—	—	—	—	—		

Table 1. Continued.

Species	<i>P. variabilis</i>		<i>H. magnificus</i>		<i>C. demani</i>				<i>C. minimus</i>		<i>Z. punctata</i>	
	Damghan <i>Matis</i> sp. & Weed		Shahrood Weed		Damghan <i>Salix</i> sp.		Shahrood <i>Daucus</i> sp.		Shahrood Forest tree		Damghan Weed	
Character	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males
n	4	2	6	3	11	2	2	1	3	3	10	
Ovary	150 ± 13 (136-166)	-	195.5 ± 22.7 (160-220)	-	247.1 ± 53.5 (141-336)	-	(191-207)	-	86.3 ± 27 (60-114)	-	203 ± 48.4 (130-295)	
Anterior genital branch	86.8 ± 4.3 (91-100)	-	164 ± 29.9 (116-198)	-	134.9 ± 19.1 (92-167)	-	(134-144)	-	57.7 ± 11.8 (44-65)	-	105.9 ± 11.6 (82-123)	
Spermatheca	28.3 ± 2.6 (26-32)	-	69.2 ± 18.6 (47-93)	-	40.5 ± 10 (27-61)	-	(32-48)	-	15.7 ± 4.5 (11-20)	-	21.5 ± 7.9 (12-36)	
Postuterine sac	19.5 ± 4.2 (14-24)	-	177 ± 15.3 (163-201)	-	24.9 ± 2.8 (20-29)	-	(23-28)	-	10.7 ± 2.3 (8-12)	-	19.7 ± 3.2 (15-26)	
Rectum	19.5 ± 3.9 (14-23)	(23-27)	29.2 ± 3 (26-34)	31.7 ± 4 (27-34)	24.5 ± 3.1 (21-31)	(29-30)	(24-27)	35	12.7 ± 0.6 (12-13)	35	22.9 ± 2.6 (19-27)	
Tail	78.8 ± 6.6 (71-86)	(44-45)	42.7 ± 2.7 (39-46)	36.7 ± 3.1 (34-40)	45.8 ± 2.7 (41-50)	(45-46)	(45-47)	41	29.7 ± 2.1 (28-32)	41	43.2 ± 3.2 (37-48)	
Vulva to anterior end	340.8 ± 15 (328-357)	-	609 ± 33.5 (578-674)	-	447.8 ± 34.7 (379-510)	-	(421-423)	-	222 ± 22.9 (202-247)	-	501.3 ± 28.5 (441-539)	
Spicules	-	26	-	25.3 ± 3.1 (22-28)	-	(27-29)	-	28	-	-	-	
Gubernaculum	-	14	-	13.7 ± 1.5 (12-15)	-	(11-13)	-	15	-	-	-	

This is the first record of the genus and its species in Iran.

***Chiloplacus demani* (THORNE, 1925) THORNE, 1937**

(Fig. 2C, H, M & 5A-E)

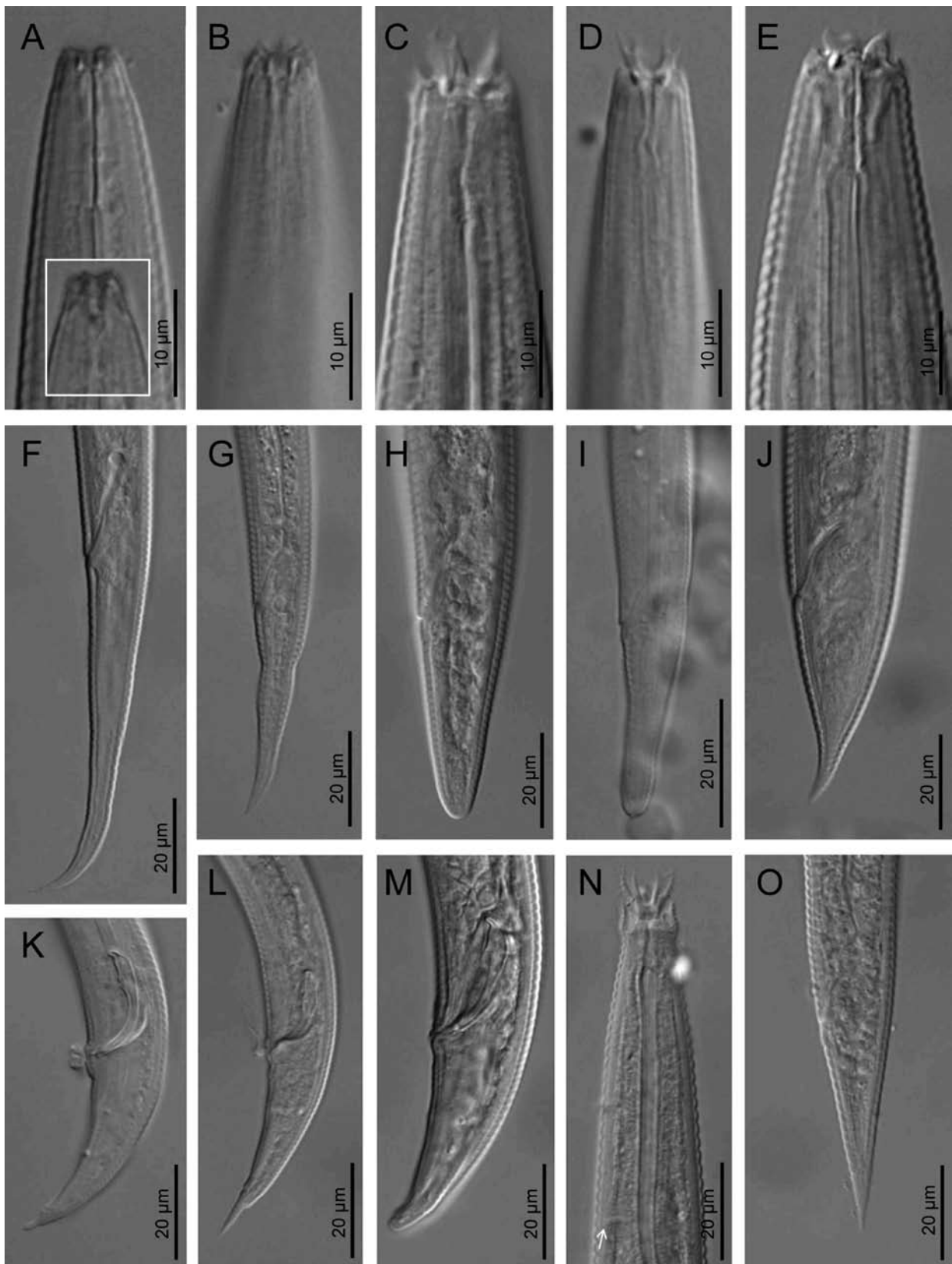
**Measurements.** See Table 1.

Population from Damghan, province of Semnan (11♀♀)

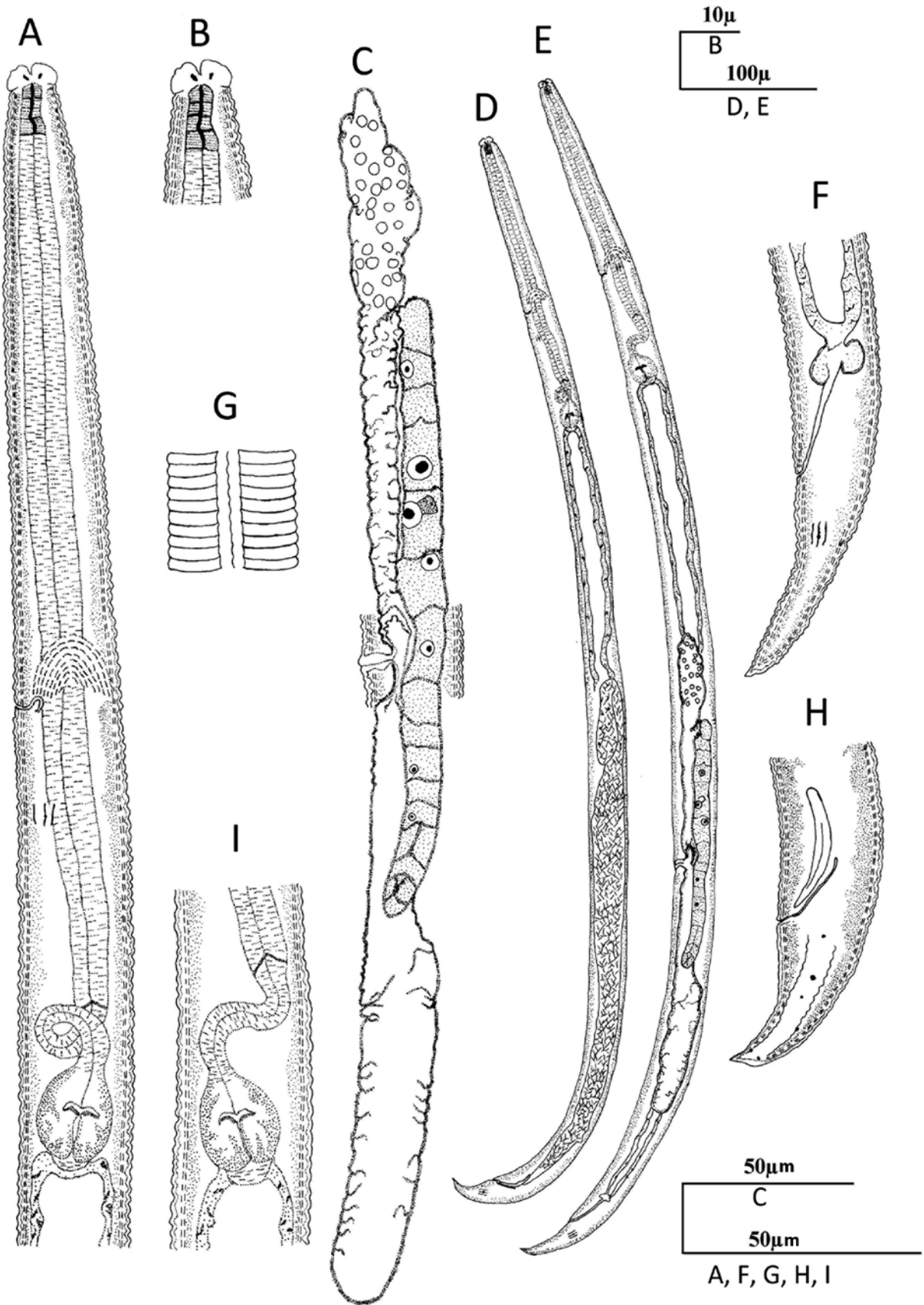
**Female.** Body length 0.60-0.79 mm, almost cylindrical, ventrally curved after fixation. Lateral fields with three incisures, occupying 11-18% of midbody diameter. Primary axils U-shaped and secondary axils V-shaped. Head region set off with the neck, three high labial bifurcated probolae present. Bifurcation occurs in two third of the labial probolae. Amphid openings indistinct. Stoma cephaloboid. Pharynx cephaloboid; corpus cylindrical, 3.1-3.4 times isthmus length, with procorpus longer than metacarpus; isthmus narrower than metacarpus; basal bulb ovoid, with valvular apparatus at middle part. Nerve ring located at level of isthmus, at 60-67% of neck length. Excretory pore opening located at level of isthmus, 52-57 annuli from lip region. Deirids located at level of bulb, at 60-66 annuli from lip region or 79-83% of neck region. Cardia conoid, surrounded by intestinal tissue. Reproductive system monodelphic-prodelphic, located on the right side of intestine. Ovary more or less straight, with only one row of oocytes. Oviduct short. Spermatheca well developed, offset, with length 1.0-1.7 times that of corresponding body diameter. Postuterine sac with length 0.7-0.9 times that of the corresponding body diameter. Vulva not protruding, located posterior to mid part of body. Rectum 1.1-1.4 times the anal body diameter. Tail subcylindrical, with rounded terminus. Phasmids at 50% of tail length.

**Male.** General morphology similar to female, body curved ventrally after fixation. Reproductive system monorchid. Tail subcylindrical, curved ventrad at distal part. Genital papillae including four pairs: one pair dorsally, one pair laterally, and two pairs near tail terminus. Spicules curved ventrally, manubrium bent ventrally and rounded; calamus with thin walls; and lamina curved ventrad. Gubernaculum long and well developed, curved ventrally slightly.

**Other material examined** (2 ♀♀, 1 ♂ see Table 1). Similar to population from Semnan, however, they have shorter body, pharynx and tail.



**Fig. 2.** *Pseudacrobeles* (*Pseudacrobeles*) *variabilis* (STEINER, 1936) STEINER, 1938. A: Anterior end and detail of cephalic probolae. F: Female posterior end. K: Male posterior end. *Eucephalobus hooperi* MARINARI-PALMISANO, 1967. B: Anterior end. G: Female posterior end. L: Male posterior end. *Chiloplacus demani* (THORNE, 1925) THORNE, 1937. C: Anterior end. H: Female posterior end. M: Male posterior end. *Chiloplacus minimus* (THORNE, 1925) ANDRÁSSY, 1959. D: Anterior end. I: Female posterior end. *Zeldia punctata* (THORNE, 1925) THORNE, 1937. E: Anterior end. J: Female posterior end. *Acrobeles ciliatus* VON LINSTOW, 1877. N: Anterior end (arrow points excretory pore). O: Female posterior end.



**Fig. 3.** *Heterocephalobellus magnificus* (ANDRÁSSY, 1987) DE LEY, SIDDIQI & BOSTRÖM, 1993. A: Neck. B: Lip region. C: Female reproductive system. D: Entire male. E: Entire Female F: Female posterior end. G: Lateral field. H: Male posterior end. I. Posterior part of pharynx.

**Distribution.** The material studied has been found in association with *Salix* sp. in Damghan, and in Abarsej (Shahrood), in the rhizosphere of *Daucus* sp. (both in the province of Semnan, Iran).

**Remarks.** The material examined here fits well with those studied by THORNE (1925), COOMANS (1962), ABOLAFIA and PEÑA-SANTIAGO (2003), and ANDRÁSSY (2005). Iranian population of *C. demani* in comparison to the same species studied by ANDRÁSSY (2005) having shorter female (0.67-0.78 mm vs 0.62-0.84 mm).

This is the first record of the species in Iran.

***Chiloplacus minimus* (THORNE, 1925) ANDRÁSSY, 1959**

(Fig. 2D, I & 5F-H)

**Measurements.** See Table 1.

Population from Abr forest (Shahrood), province of Semnan (3♀♀)

**Female.** Body length 0.31-0.38 mm, almost cylindrical, ventrally curved after fixation. Lateral fields with three incisures, occupying 22-23% of midbody diameter. Primary axils U-shaped and secondary axils V-shaped. Head region set off with the neck, three high labial bifurcated probolae present. Bifurcation occurs in one third of the labial probolae respectively. Amphid openings indistinct. Stoma cephaloboid with well distinct parts. Pharynx cephaloboid; corpus cylindrical, 2.7-3.6 times isthmus length, with procorpus longer than metacarpus; isthmus narrower than metacarpus; basal bulb ovoid, with valvular apparatus at middle part. Nerve ring located at level of isthmus, at 47-68% of neck length. Excretory pore located at level of isthmus, 46-51 annuli from lip region. Deirids located at level of bulb, at 58-62 annuli from lip region or 55-66% of neck region. Cardia conoid, surrounded by intestinal tissue. Reproductive system monodelphic-prodelphic, located on the right side of intestine. Ovary with flexure, with only one row of oocytes. Oviduct short. Spermatheca well developed, offset, with length 0.8-1.1 times that of corresponding body diameter. Postuterine sac with length 0.6-0.7 times that of the corresponding body diameter. Vulva not protruding, located posterior to mid part of body. Rectum 1.1-1.2 times the anal body diameter. Tail subcylindrical, with rounded terminus. Phasmids at 47-50% of tail length.

**Male.** Not observed.

**Distribution.** The material studied has been found in association with weed in Abr forest,

Shahrood (province of Semnan, Iran).

**Remarks.** Iranian specimens of *C. minimus* fit perfectly with those examined by THORNE (1925) and ABOLAFIA and PEÑA-SANTIAGO (2003), however they have longer pharynx (98-156 µm vs 88-113 µm). This species was transferred to the genus *Acrobelophis* by Andrassy (1984), differentiated from *Chiloplacus* to have six free conoid lips (vs more or less flattened and fused two by two). However, this character is not too much apparent in this species (see BOSTRÖM, 1985, and ABOLAFIA and PEÑA-SANTIAGO, 2003), being this species maintained within *Chiloplacus* genus by De Ley (1997), who synonymized both genera.

This is the first record of the species in Iran.

***Zeldia punctata* (THORNE, 1925) THORNE, 1937**

(Fig. 1I-K & 2E, J)

**Measurements.** See Table 1.

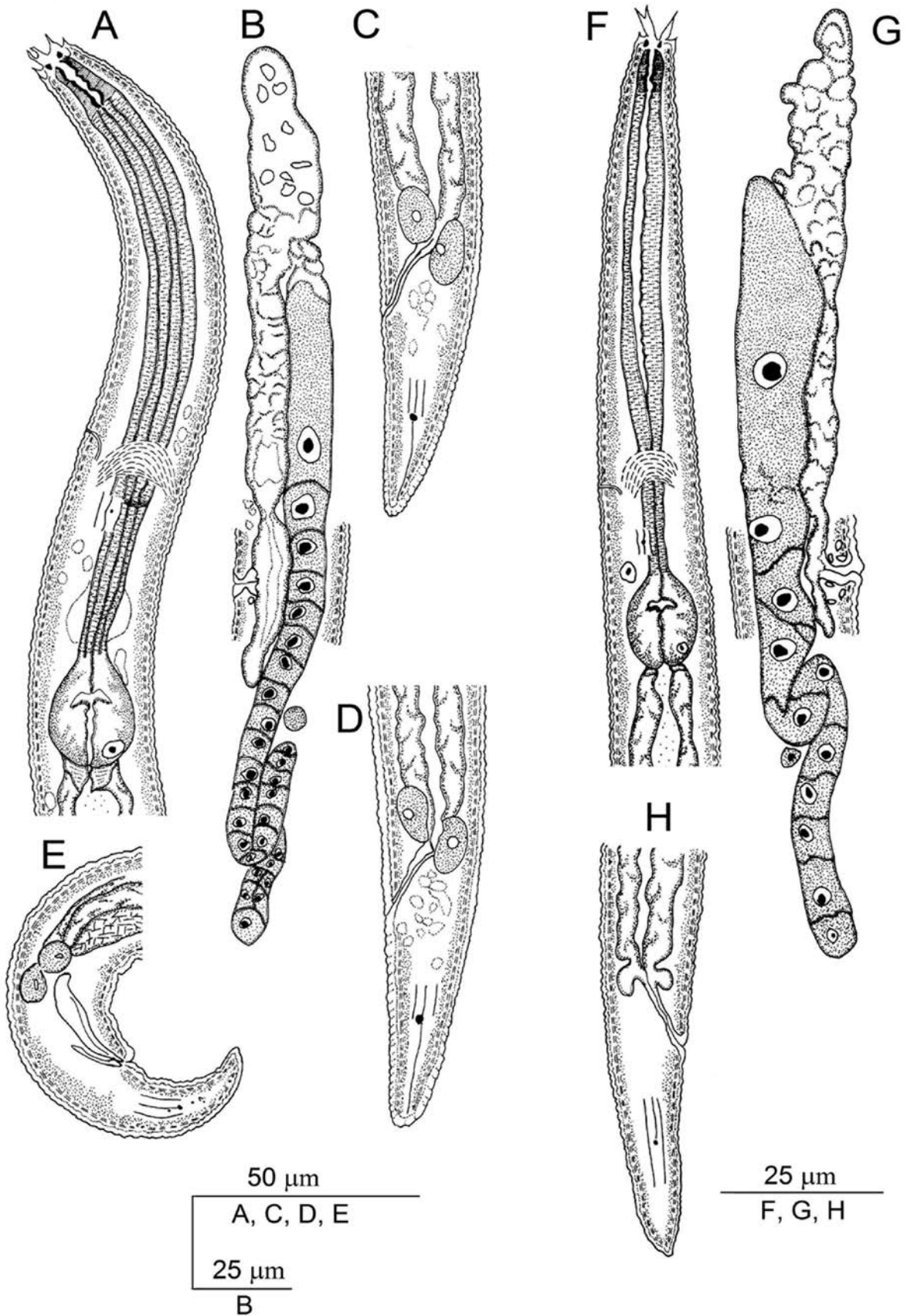
Population from Damghan, province of Semnan (10♀♀)

**Female.** Body length 0.73-0.80 mm, almost cylindrical, ventrally curved after fixation. Lateral fields with three incisures, occupying 18-22% of midbody diameter. Primary axils U-shaped and secondary axils V-shaped. Head region continuous with the neck, bearing three broadened and bifurcated high labial probolae, which having acute terminus. Amphid openings indistinct. Stoma cephaloboid with well distinct parts. Pharynx cephaloboid; corpus cylindrical, 7.2-7.6 times isthmus length, with procorpus longer than metacarpus; isthmus narrower than metacarpus; basal bulb ovoid, with valvular apparatus at middle part. Nerve ring located at level of isthmus, at 46-59% of neck length. Excretory pore opening located at level of isthmus, 54-62 annuli from lip region. Deirids located at level of bulb, at 63-70 annuli from lip region or 51-69% of neck region. Cardia conoid, surrounded by intestinal tissue. Reproductive system monodelphic-prodelphic, located on the right side of intestine. Ovary with flexure, with only one row of oocytes. Oviduct short. Spermatheca well developed, offset, with length 0.4-0.9 times that of corresponding body diameter. Postuterine sac with length 0.6-0.7 times that of the corresponding body diameter. Vulva not protruding, located posterior to mid part of body. Rectum 0.7 times the anal body diameter. Tail conical with concave in ventral side. Phasmids at 42% of tail length.

**Male.** Not observed.



**Fig. 4.** *Heterocephalobellus magnificus* (ANDRÁSSY, 1987) DE LEY, SIDDIQI & BOSTRÖM, 1993 (LM). A: Neck. B: Female reproductive system. C: Lip region. D: Anterior end. E: Lateral field. F: Female posterior end. G: Male posterior end.



**Fig. 5.** *Chiloplacus demani* (THORNE, 1925) THORNE, 1937. A: Neck. B: Female reproductive system. C, D: Female posterior end. E: Male posterior end. *Chiloplacus minimus* (THORNE, 1925) ANDRÁSSY, 1959. F: Neck. G: Female reproductive system. H: Female posterior end.

**Distribution.** The material studied has been found in association with weed in Damghan (province of Semnan, Iran).

**Remarks.** The Iranian population of *Z. punctata* is similar to the specimens studied by DE BRUIN and HEYNS (1993); however, it differs from them by having shorter tail ( $c'=1.8-2.5$  vs  $c'=3.2-3.4$ ). In comparison to the materials examined by TAHSEEN *et al.* (1999) ours differs by having somewhat shorter body in female (0.73-0.81 vs 0.79-0.91 mm), and tail (37-48  $\mu\text{m}$  vs 48-63  $\mu\text{m}$ ). TABASSUM and SHAHINA (2002) studied this species which its morphology and morphometric were similar to the Iranian specimens. In comparison to the material examined by ANDRÁSSY (2005) our specimens having shorter body length (vs 0.64-0.94 mm) and longer pharynx (203-312  $\mu\text{m}$  vs 210-230  $\mu\text{m}$ ).

The genus and its species are recorded for first time from Iran.

***Acrobeles andalusicus* ABOLAFIA & PEÑA-SANTIAGO, 2004**

(Fig. 6A-D & 7)

**Measurements.** See Table 2.

Population from Damghan, province of Semnan (5♀♀)

**Female.** Body length 0.77-0.83 mm, almost cylindrical, ventrally curved after fixation. Cuticle "single" but with a refrigent punctation under every annulus, this more apparent at anterior body end. Lateral fields with three incisures, occupying 14% of midbody diameter. Primary axils U-shaped and secondary axils V-shaped. Head region set off with the neck, three high labial probolae present, each prongs having 4 tines at inner margins and 5 at outer margins, and two elongate apical tines which adopt V shape under light microscope. Amphid openings circular. Stoma cephaloboid with well distinct parts. Pharynx cephaloboid; corpus cylindrical, 4.0 times isthmus length, with procorpus longer than metacorpus; isthmus narrower than metacorpus; basal bulb ovoid, with valvular apparatus at middle part. Nerve ring located at level of isthmus, at 64-70% of neck length. Excretory pore opening located at level of isthmus, 46-51 annuli from lip region. Deirids located at level of bulb, at 51-57 annuli from lip region or 69-70% of neck region. Cardia conoid, surrounded by intestinal tissue. Reproductive system monodelphic-prodelphic, located on the right side of intestine. Ovary with flexure, with only one row of oocytes.

Oviduct short. Spermatheca well developed, offset, with length 0.9-1.2 times that of corresponding body diameter. Postuterine sac with length 0.6 times that of the corresponding body diameter. Vagina with inner walls with medium fold, this poorly marked in some specimens. Vulva not protruding, located posterior to mid part of body. Rectum 0.9-1.0 times the anal body diameter. Tail conical. Phasmids at 47% of tail length.

**Male.** General morphology similar to female, body curved ventrally after fixation. Reproductive system monorchid. Tail conical, curved ventrad at distal part. Genital papillae including four pairs: one pairs dorsally, one pair laterally, and two pairs near tail terminus. Spicules curved ventrally, manubrium bent ventrally and rounded; calamus with thin walls; and lamina curved ventrad bearing hump slightly. Gubernaculum long and well developed, curved ventrally slightly.

**Distribution.** The material studied has been found in association with the rhizosphere of the weed in Damghan (province of Semnan, Iran).

**Remarks.** The measurements fit well with the original measurements of the species provided by ABOLAFIA and PEÑA-SANTIAGO (2004), and SHOKOOHI *et al.* (2007), although the examined specimens having shorter female body (772-832 vs 853-1250  $\mu\text{m}$ ), vagina with inner walls medium folders less developed (vs well developed), female tail (65-72 vs 72-113  $\mu\text{m}$ ), and spicules (47-52 vs 55-78  $\mu\text{m}$ ). In comparison with material examined by SHOKOOHI *et al.* (2007) having shorter gubernaculum (20-25 vs 29-41). These differences are due to geographical distributions.

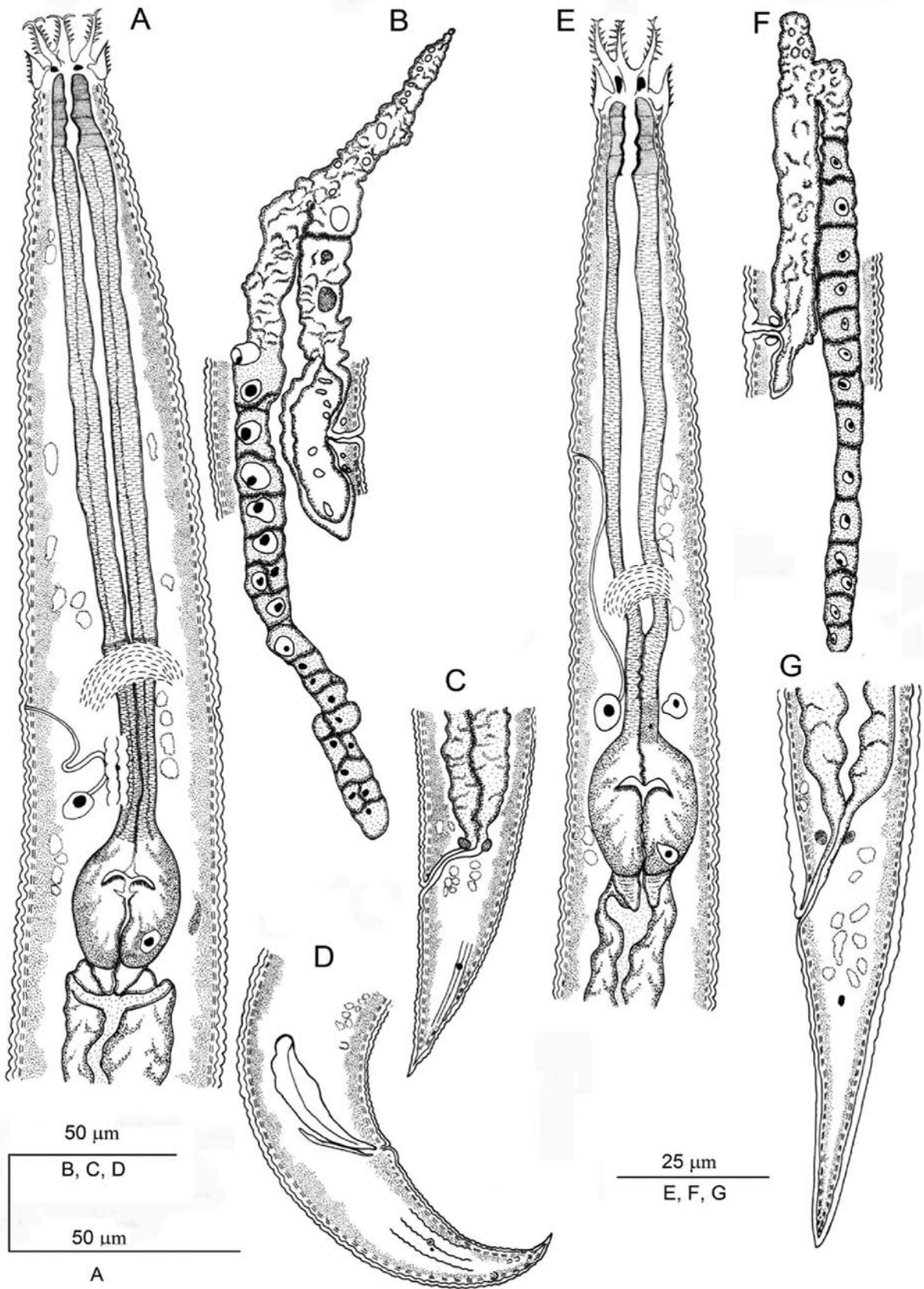
***Acrobeles ciliatus* VON LINSTOW, 1877**

(Fig. 2N, O & 6E-G)

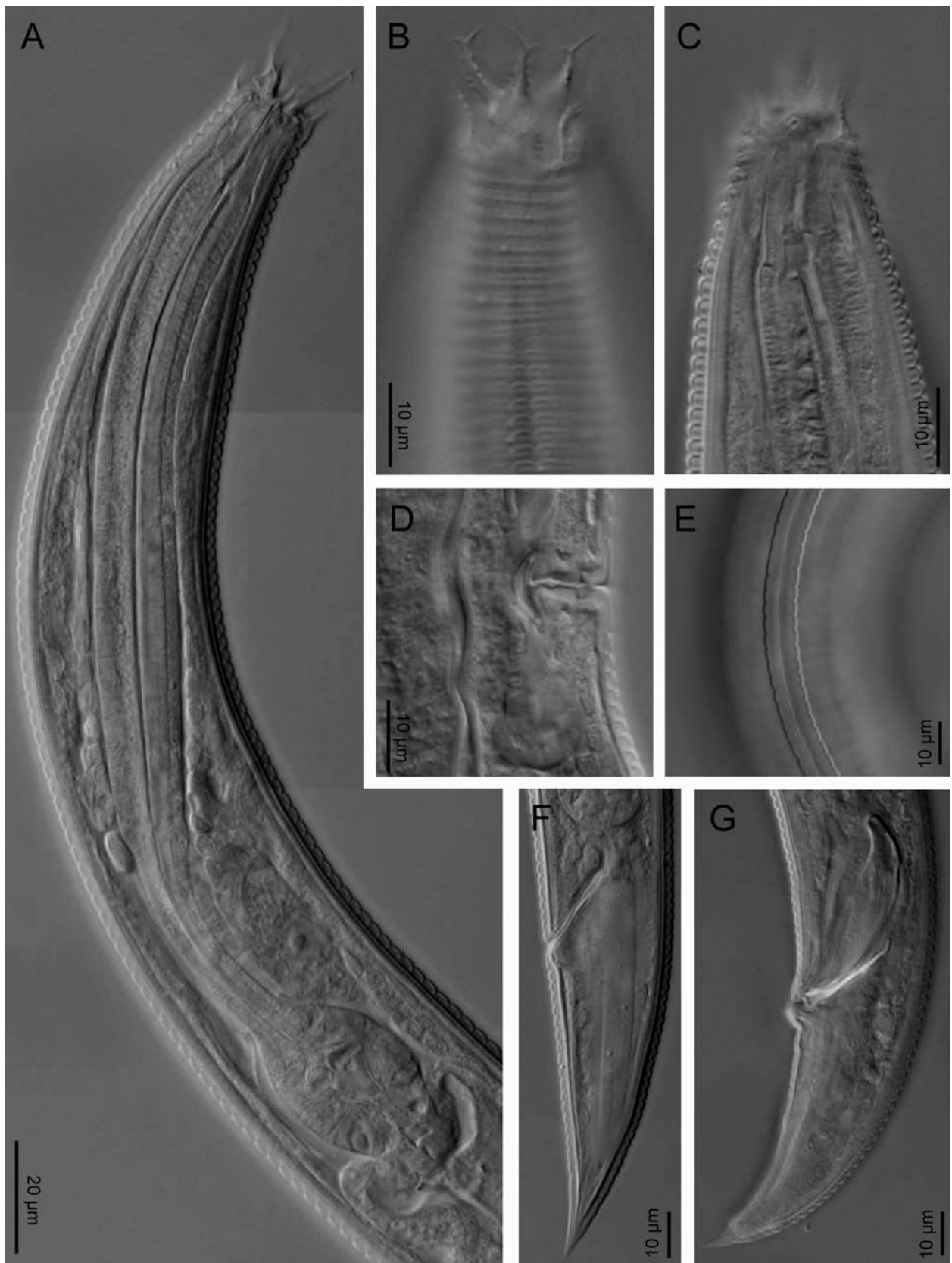
**Measurements.** See Table 2.

Population from Damghan, province of Semnan (5♀♀)

**Female.** Body length 0.40-0.42 mm, almost cylindrical, ventrally curved after fixation. Cuticle single. Lateral fields with two incisures, occupying 12-15% of midbody diameter. Primary axils U-shaped and secondary axils V-shaped. Head region set off with the neck, three high labial probolae present, each having 5 tines at inner margins and 5-7 at outer margins, and two elongate apical tines which adopt V shape under light microscope. Amphid openings circular. Stoma cephaloboid with well distinct parts.



**Fig. 6.** *Acrobeles andalusicus* ABOLAFIA & PEÑA-SANTIAGO, 2004. A: Neck. B: Female reproductive system. C: Female posterior end. D: Male posterior end. *Acrobeles ciliatus* VON LINSTOW, 1877. E: Neck. F: Female reproductive system. G: Female posterior end.



**Fig. 7.** *Acrobeles andalusicus* ABOLAFIA & PEÑA-SANTIAGO, 2004 (LM). A: Neck. B: Lip region. C: Anterior end showing the cuticle layers. D: Vaginal region. E: Lateral field. F: Female posterior end. G: Male posterior end.

Pharynx cephaloboid; corpus cylindrical, 3.7-4.9 times isthmus length, with procorpus longer than metacarpus; isthmus narrower than metacarpus; basal bulb ovoid, with valvular apparatus at middle part. Nerve ring located at level of isthmus, at 61-68% of neck length. Excretory pore opening located at level of isthmus, 23-28 annuli from lip region. Deirids located at level of bulb, at 40-46 annuli from lip region or 82-85% of neck region. Cardia conoid, surrounded by intestinal tissue. Reproductive system monodelphic-prodelphic, located on the right side of intestine. Ovary with flexure, with only one row of oocytes. Oviduct short. Spermatheca well developed, offset, with length 0.5-0.7 times that of corresponding body diameter. Postuterine sac with length 0.4-0.6 times that of the corresponding body diameter. Vulva not protruding, located posterior to mid part of body. Rectum 0.9-1.6 times the anal body diameter. Tail conical. Phasmids at 48% of tail length.

**Male.** Not found.

**Other material examined** (4♀♀, see Table 2).

Very similar to those studied in Toyedarvar region population, however having shorter body length and longer pharynx.

**Distribution.** The material studied has been found in Damghan in association with the rhizosphere of pistachio (*Pistacia vera* L.) and barberry (*Berberis* sp.), and in soil with weed in Shahrood (province of Semnan, Iran).

**Remarks.** This species is well known and has been studied by many scientists (e.g. VINCIGUERRA 1972, ANDRÁSSY 1953, 1958, 1962, KIRJANOVA 1951, LOOF 1971, MEYL 1953, RASHID *et al.* 1990, BOSTRÖM 1992, and ABOLAFIA and PENA-SANTIAGO 2004). However, VINCIGUERRA (1972), BOSTRÖM (1992), and ANDRÁSSY (2005) studied this species with longer female body (0.44-0.65  $\mu\text{m}$  vs 405-423  $\mu\text{m}$ ). In comparison with specimens examined by ABOLAFIA and PENA-SANTIAGO (2003) Iranian material of *A. ciliatus* has shorter postvulvar sac (7-16  $\mu\text{m}$  vs 25-53  $\mu\text{m}$ ), spermatheca (14-27  $\mu\text{m}$  vs 24-51  $\mu\text{m}$ ), and tail in female (41-55  $\mu\text{m}$  vs 35-64  $\mu\text{m}$ ). In comparison with the population studied by ANDRÁSSY (2005), our specimens have longer females (0.44-0.65 mm vs 0.40-0.42 mm).

This species is recorded for first time from Iran.

***Acrobeles undulatus* LOOF, 1964**

(Fig. 8 & 9)

**Measurements.** See Table 2.

Population from Damghan, province of Semnan (5♀♀)

**Female.** Body length 0.32-0.37 mm, almost cylindrical, ventrally curved after fixation. Cuticle single, slightly tessellated, this more apparent at neck region. Lateral fields with three incisures, occupying 12-15% of midbody diameter. Primary axils U-shaped and secondary axils V-shaped. Head region set off with the neck, three high labial probolae present, each prongs having 5-7 visible tines at inner margins and 7 at outer margins, and two elongate apical tines which adopt V shape under light microscope. Amphid openings circular. Stoma cephaloboid with well distinct parts. Pharynx cephaloboid; corpus cylindrical, 3.4-3.8 times isthmus length, with procorpus longer than metacarpus; isthmus narrower than metacarpus; basal bulb ovoid, with valvular apparatus at middle part. Nerve ring located at level of isthmus, at 62-66% of neck length. Excretory pore opening located at level of isthmus, 30-31 annuli from lip region. Deirids located at level of bulb, at 36-38 annuli from lip region or 78-83% of neck region. Cardia conoid, surrounded by intestinal tissue. Reproductive system monodelphic-prodelphic, located on the right side of intestine. Ovary with flexure, with only one row of oocytes. Oviduct short. Spermatheca well developed, offset, with length 0.5-0.8 times that of corresponding body diameter. Postuterine sac with length 0.5 times that of the corresponding body diameter. Vulva not protruding, located posterior to mid part of body. Rectum 0.7 times the anal body diameter. Tail conical. Phasmids at 32-40% of tail length.

**Male.** Not found.

**Distribution.** The material studied has been found in association with the rhizosphere of *Berberis* sp. in Damghan (province of Semnan, Iran).

**Remarks.** The material examined is similar to the original description of the species provided by LOOF (1964) although our specimens have longer females (0.32-0.37 mm vs 0.49-0.65 mm). The other difference with the original description is the position of the phasmids (more posterior to the anus vs near the anus level).

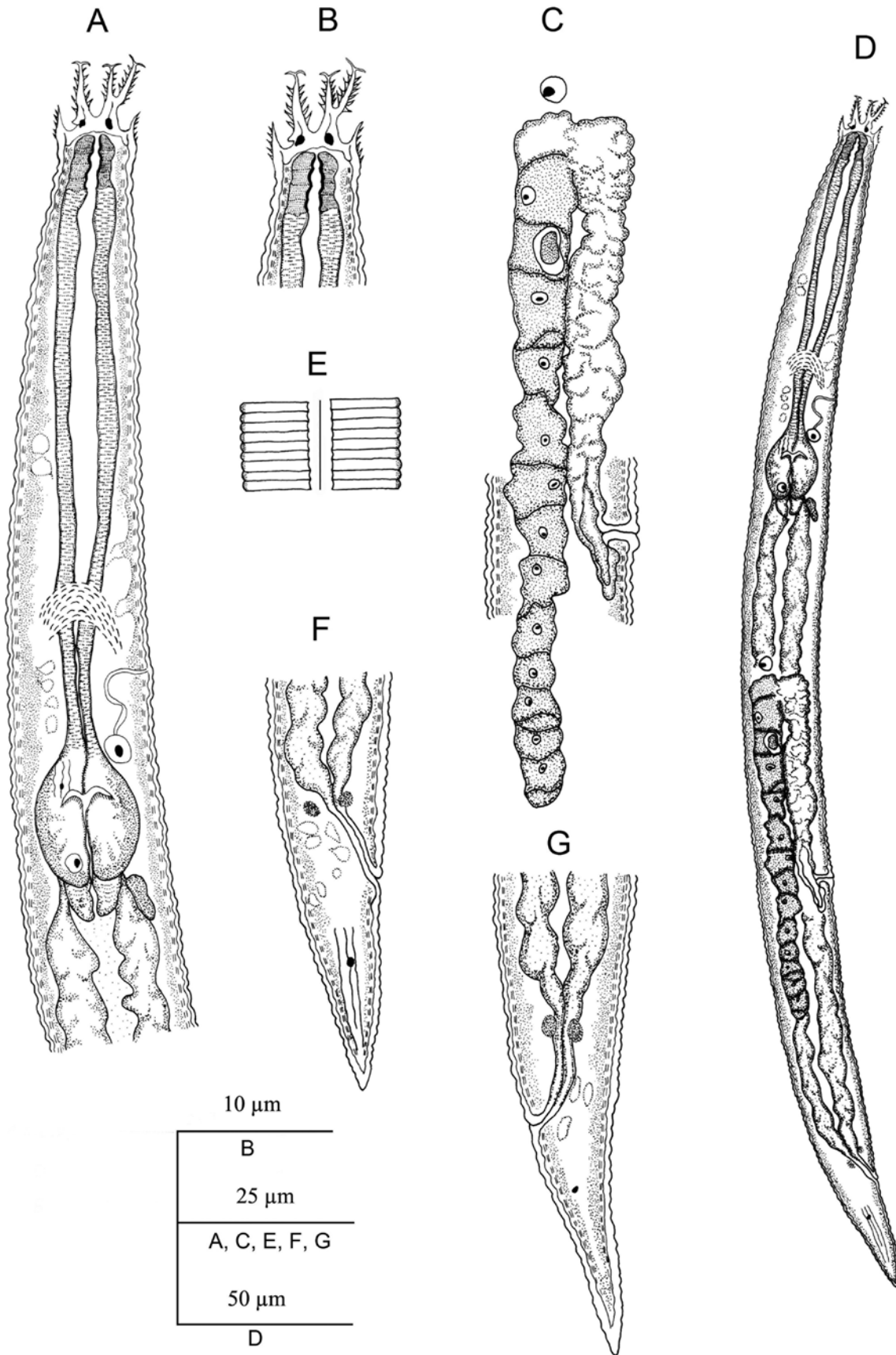
This species is recorded for first time from Iran.

**Morphometric analysis on the genus *Acrobeles***

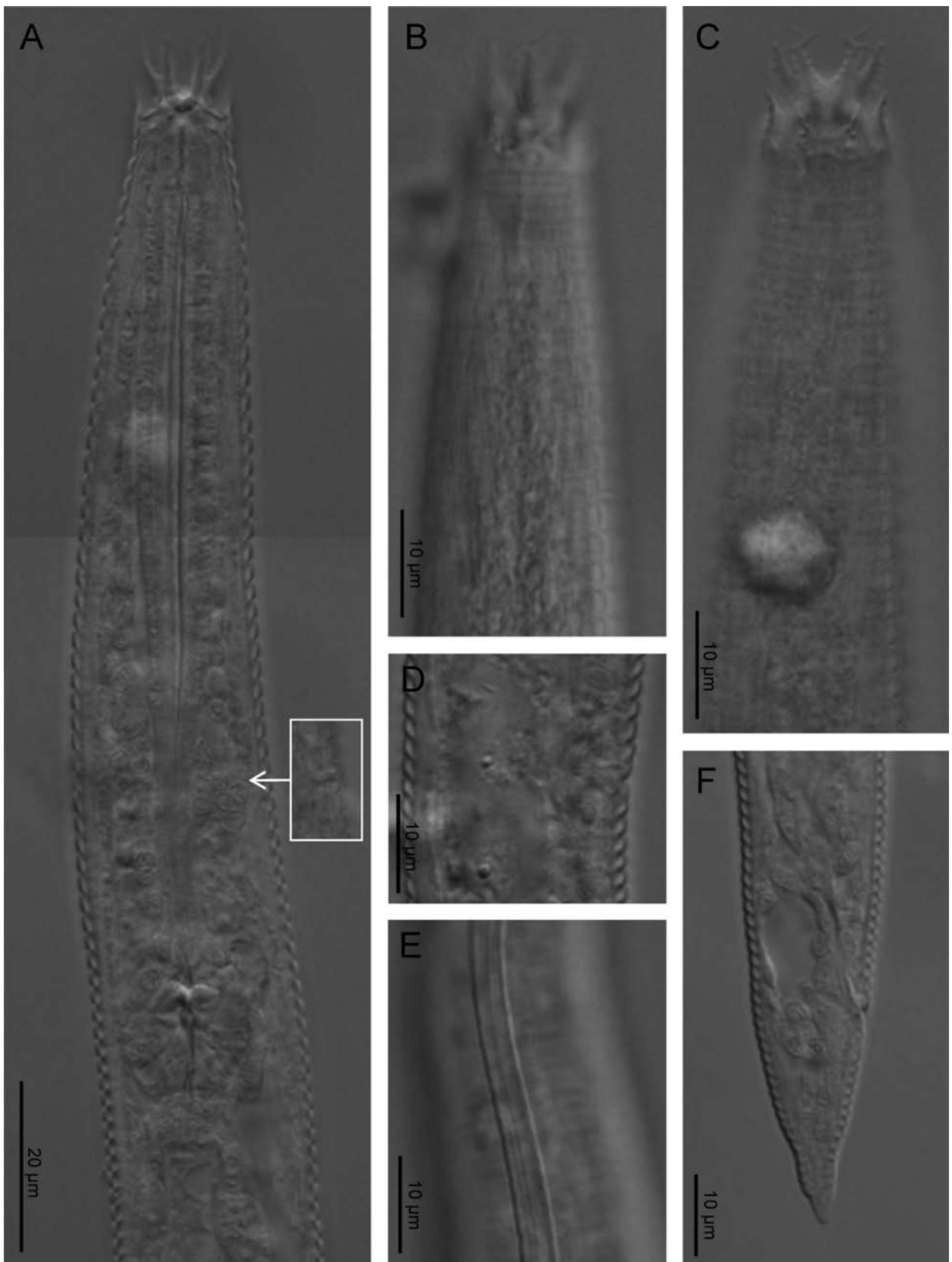
**Table 2.** Measurements of *Eucephalobus hooperi* MARINARI-PALMISANO, 1967, *Acrobeles andalusicus* ABOLAFIA & PEÑA-SANTIAGO, 2004, *A. ciliatus* VON LINSTOW, 1877 and *A. undulatus* LOOF, 1964. All measurements in  $\mu\text{m}$  and the format: mean  $\pm$  standard deviation (range).

Species	<i>E. hooperi</i>			<i>A. andalusicus</i>			<i>A. ciliatus</i>			<i>A. undulatus</i>	
	Semman	Sediments of the River		Damghan		Soil		Damghan		Shahrood	Damghan
Locality										Weed	<i>Berberis</i> sp.
Habitat										Females	Females
Character	Females	Males		Females	Males		Females			Females	Females
n	11	3		5	6		5		4	4	5
L	465.6 $\pm$ 40 (403-531)	476.7 $\pm$ 30.6 (450-510)		443 $\pm$ 29.8 (410-484)	800.2 $\pm$ 27.2 (772-839)		413.2 $\pm$ 8.1 (405-423)		406 $\pm$ 24.3 (379-437)	424 $\pm$ 7.5 (415-432)	345.8 $\pm$ 19.2 (317-367)
a	23.9 $\pm$ 2.2 (20.5-27.6)	26.1 $\pm$ 2.1 (23.7-27.6)		22.6 $\pm$ 1 (21.8-24.1)	17.3 $\pm$ 1.7 (15.7-19.5)		16.3 $\pm$ 0.1 (16.2-16.5)		16.9 $\pm$ 0.9 (15.8-18.1)	17.1 $\pm$ 0.4 (16.6-17.5)	15.7 $\pm$ 1.8 (12.7-17.4)
b	3.6 $\pm$ 0.2 (3.4-3.9)	3.7 $\pm$ 0.4 (3.4-4.1)		3.6 $\pm$ 0.2 (3.4-3.9)	3.6		3.2 $\pm$ 0.1 (3.1-3.3)		3 $\pm$ 0.1 (2.8-3.1)	3.3 $\pm$ 0.1 (3.2-3.4)	2.9 $\pm$ 0.2 (2.6-3.2)
c	9.8 $\pm$ 1.1 (8.6-12.3)	11.4 $\pm$ 0.7 (10.7-12.1)		9.5 $\pm$ 0.1 (9.2-9.5)	11.8 $\pm$ 0.4 (11.6-12.6)		9.5 $\pm$ 0.4 (8.8-9.9)		8.2 $\pm$ 0.6 (7.5-8.7)	8.1 $\pm$ 0.4 (7.7-8.6)	12.8 $\pm$ 1.4 (11.3-14.1)
c'	4 $\pm$ 0.6 (3.2-4.8)	2.8 $\pm$ 0.3 (2.5-3.1)		4 $\pm$ 0.3 (3.8-4.5)	2.4 $\pm$ 0.1 (2.3-2.6)		2.8 $\pm$ 0.2 (2.7-3.1)		3.6 $\pm$ 0.2 (3.3-3.9)	3.4 $\pm$ 0.2 (3.1-3.7)	2 $\pm$ 0.2 (1.9-2.3)
V	63.4 $\pm$ 1.2 (61-65)	-		64.6 $\pm$ 0.9 (64-66)	63.4 $\pm$ 1 (62-64)		61.7 $\pm$ 0.8 (61-63)		61.5 $\pm$ 0.6 (61-62)	61 $\pm$ 1 (60-62)	65.9 $\pm$ 0.8 (65-67)
Labial probolae	1	1		1.2 $\pm$ 0.4 (1-2)	12.2 $\pm$ 0.8 (11-13)		10.8 $\pm$ 1.1 (10-12)		10.8 $\pm$ 1.5 (9-12)	10.5 $\pm$ 0.6 (10-11)	8.6 $\pm$ 0.5 (8-9)
Lip region diam.	5.3 $\pm$ 0.6 (4-6)	4.7 $\pm$ 0.6 (4-5)		5.2 $\pm$ 0.4 (5-6)	17.4 $\pm$ 0.5 (17-18)		10.6 $\pm$ 0.5 (10-11)		11.5 $\pm$ 1.3 (10-13)	11.8 $\pm$ 0.5 (11-12)	10.8 $\pm$ 0.8 (10-12)
Stoma	10.8 $\pm$ 0.9 (10-12)	11.3 $\pm$ 0.6 (11-12)		10 $\pm$ 1.2 (9-12)	18.8 $\pm$ 1.1 (18-20)		10 $\pm$ 0.7 (9-11)		10.5 $\pm$ 0.6 (10-11)	10.5 $\pm$ 0.6 (10-11)	8.8 $\pm$ 0.4 (8-9)
Pharyngeal corpus	85.3 $\pm$ 5.7 (78-99)	86 $\pm$ 7.8 (81-95)		82 $\pm$ 1.9 (80-84)	148.8 $\pm$ 8.2 (141-161)		83.2 $\pm$ 4.3 (79-90)		88.3 $\pm$ 3.9 (83-92)	81.5 $\pm$ 3.5 (78-85)	78.2 $\pm$ 5.8 (73-87)
Isthmus	25.5 $\pm$ 3.5 (21-31)	26 $\pm$ 1 (25-27)		24.6 $\pm$ 1.9 (22-27)	38.4 $\pm$ 2.1 (35-40)		21.4 $\pm$ 3.1 (16-24)		24.8 $\pm$ 1.9 (22-26)	24.8 $\pm$ 3.5 (21-29)	22 $\pm$ 2.2 (19-25)
Bulb	17 $\pm$ 1.2 (15-19)	16 $\pm$ 1 (15-17)		16.6 $\pm$ 1.5 (15-19)	34.6 $\pm$ 2.8 (32-38)		23.2 $\pm$ 0.8 (22-24)		23.3 $\pm$ 1.3 (22-25)	22.5 $\pm$ 2.1 (20-25)	20.4 $\pm$ 0.5 (20-21)
Pharynx length	128.4 $\pm$ 7.9 (118-141)	129.3 $\pm$ 7.8 (123-138)		123.4 $\pm$ 4.3 (118-129)	222.6 $\pm$ 87 (213-236)		128.6 $\pm$ 3.4 (124-132)		136.8 $\pm$ 5 (132-142)	128.3 $\pm$ 2.4 (125-130)	119.2 $\pm$ 4.3 (114-125)
Nerve	86.5 $\pm$ 6.9 (79-99)	84.7 $\pm$ 7.6 (78-93)		83.2 $\pm$ 2.6 (80-86)	148.4 $\pm$ 10.6 (137-165)		81.2 $\pm$ 5.5 (76-90)		83.3 $\pm$ 4.9 (78-90)	81.7 $\pm$ 6.7 (76-89)	79.2 $\pm$ 4.8 (71-83)
ant_end	86.5 $\pm$ 7.5 (73-97)	90.7 $\pm$ 4.2 (86-94)		83 $\pm$ 3.9 (79-88)	138.8 $\pm$ 13.4 (121-152)		68.4 $\pm$ 3.1 (65-73)		55 $\pm$ 6.4 (50-64)	59.5 $\pm$ 7 (52-66)	85 $\pm$ 4.5 (78-90)
pore to ant_end	97.1 $\pm$ 5.4 (89-107)	101.3 $\pm$ 4 (97-105)		87 $\pm$ 4.6 (82-91)	158.8 $\pm$ 9.2 (147-167)		106 $\pm$ 4.3 (102-112)		100 $\pm$ 6.7 (91-107)	101.5 $\pm$ 9.5 (92-112)	98.2 $\pm$ 5.6 (89-104)
Annuli width	1.2 $\pm$ 0.4 (1-2)	1		1	2.8 $\pm$ 0.4 (2-3)		1.8 $\pm$ 0.8 (1-3)		2	1.3 $\pm$ 0.5 (1-2)	1.4 $\pm$ 0.5 (1-2)

Species	<i>E. hooperi</i>				<i>A. andalusicus</i>				<i>A. ciliatus</i>				<i>A. undulatus</i>	
	Semnan		Damghan		Damghan		Soil		Damghan		Shahrood		Damghan	
Locality	Sediments of the River		<i>Malus</i> sp. and Weed		Soil		Soil		<i>Pistacia vera</i>		Weed		<i>Berberis</i> sp.	
Habitat	Females	Males	Females	Weed	Females	Males	Females	Males	Females	Females	Females	Females	Females	Females
Character	11	3	5		5	6	5	6	5	4	4	4	5	
n	1.1 ± 0.3 (1-2)	1	1		2	1.8 ± 0.8 (1-3)	1.2 ± 0.4 (1-2)	1.5 ± 0.6 (1-2)	1.2 ± 0.4 (1-2)	1.5 ± 0.6 (1-2)	1 ± 0 (1-1)	1 ± 0 (1-1)	1	
Cuticle thickness	7.9 ± 0.8 (7-9)	8	9.8 ± 4.6 (7-18)		18.8 ± 0.8 (18-20)	16.8 ± 1 (16-18)	11.4 ± 0.5 (11-12)	12 ± 1.2 (11-13)	11.4 ± 0.5 (11-12)	12 ± 1.2 (11-13)	11.8 ± 0.5 (11-12)	11.8 ± 0.5 (11-12)	11.6 ± 0.9 (11-13)	
Body diameter: Neck base	19.6 ± 2.7 (16-24)	18.3 ± 1.2 (17-19)	19.6 ± 1.8 (17-22)		46.6 ± 3.4 (42-50)	42 ± 2.3 (40-45)	25.4 ± 0.5 (25-26)	24 ± 1.6 (22-26)	25.4 ± 0.5 (25-26)	24 ± 1.6 (22-26)	24.8 ± 1.0 (24-26)	24.8 ± 1.0 (24-26)	22.2 ± 1.8 (20-25)	
Midbody	12.1 ± 1.3 (10-14)	15 ± 1.7 (14-17)	11.4 ± 1.1 (10-13)		28.2 ± 1.5 (26-30)	31.8 ± 1.6 (30-34)	15.4 ± 0.5 (15-16)	13.8 ± 1 (13-15)	15.4 ± 0.5 (15-16)	13.8 ± 1 (13-15)	15.5 ± 0.6 (15-16)	15.5 ± 0.6 (15-16)	13.4 ± 0.5 (13-14)	
Anus	3.3 ± 0.7 (2-4)	3.3 ± 0.6 (3-4)	3.3 ± 0.6 (3-4)		6.8 ± 0.4 (6-7)	6.5 ± 0.5 (6-7)	3.2 ± 0.5 (3-4)	3.3 ± 0.5 (3-4)	3.2 ± 0.5 (3-4)	3.3 ± 0.5 (3-4)	4 ± 0 (4-4)	4 ± 0 (4-4)	3	
Lateral field	5.9 ± 0.9 (5-8)	-	5.8 ± 0.4 (5-6)		13.6 ± 1.1 (12-15)	-	6 ± 0.7 (5-7)	6.5 ± 0.6 (6-7)	6 ± 0.7 (5-7)	6.5 ± 0.6 (6-7)	7.5 ± 1.0 (7-9)	7.5 ± 1.0 (7-9)	5 ± 1 (4-6)	
Vagina	129.8 ± 32.5 (84-172)	-	107 ± 17 (81-124)		224 ± 32.7 (187-277)	-	144.4 ± 48.9 (101-216)	93.3 ± 24.6 (78-130)	144.4 ± 48.9 (101-216)	93.3 ± 24.6 (78-130)	98.5 ± 5.7 (92-105)	98.5 ± 5.7 (92-105)	86.2 ± 9.8 (70-96)	
Ovary	83.5 ± 15.5 (64-116)	-	74.6 ± 6.9 (71-87)		137 ± 16 (111-153)	-	54.4 ± 9.6 (41-67)	62.5 ± 10.4 (56-78)	54.4 ± 9.6 (41-67)	62.5 ± 10.4 (56-78)	44 ± 18.6 (28-69)	44 ± 18.6 (28-69)	57.6 ± 7.9 (44-64)	
Anterior genital branch	25.2 ± 11.2 (11-50)	-	23.8 ± 2.9 (19-26)		46.4 ± 8.4 (38-60)	-	16.4 ± 2.5 (14-20)	22 ± 3.7 (18-27)	16.4 ± 2.5 (14-20)	22 ± 3.7 (18-27)	15 ± 2 (13-17)	15 ± 2 (13-17)	14.8 ± 4.9 (10-22)	
Spermatheca	17.6 ± 3.6 (10-23)	-	17.8 ± 2.3 (15-20)		29.4 ± 3.6 (25-34)	-	13.8 ± 2.3 (10-16)	8 ± 1 (7-9)	13.8 ± 2.3 (10-16)	8 ± 1 (7-9)	10 ± 1.4 (9-11)	10 ± 1.4 (9-11)	10.2 ± 1.1 (9-12)	
Postuterine sac	17.1 ± 1.4 (14-19)	22 ± 1 (21-23)	16 ± 1 (15-17)		27.6 ± 2.5 (25-30)	38.5 ± 1.9 (36-41)	14.8 ± 1.3 (14-17)	16 ± 1.6 (14-18)	14.8 ± 1.3 (14-17)	16 ± 1.6 (14-18)	17 ± 3.2 (13-20)	17 ± 3.2 (13-20)	16.2 ± 2 (14-18)	
Rectum	48.1 ± 5.9 (40-61)	42 ± 2 (40-44)	47 ± 3.4 (43-51)		67.8 ± 2.7 (65-72)	69.8 ± 2.6 (67-73)	43.4 ± 1.8 (41-46)	49.8 ± 3.8 (47-55)	43.4 ± 1.8 (41-46)	49.8 ± 3.8 (47-55)	52.3 ± 2.6 (50-55)	52.3 ± 2.6 (50-55)	27.2 ± 1.8 (26-30)	
Tail	294.7 ± 22 (257-325)	-	286.6 ± 22 (262-319)		507 ± 9.9 (495-519)	-	254.8 ± 6.7 (247-265)	249.8 ± 14.7 (235-270)	254.8 ± 6.7 (247-265)	249.8 ± 14.7 (235-270)	257.3 ± 6.3 (248-262)	257.3 ± 6.3 (248-262)	228 ± 12.1 (212-244)	
Vulva to anterior end	-	19 ± 1 (18-20)	-		-	48.8 ± 1.9 (47-52)	-	-	-	-	-	-	-	
Spicules	-	10.6 ± 1.1 (10-12)	-		-	22.8 ± 1.9 (20-25)	-	-	-	-	-	-	-	
Gubernaculum	-	-	-		-	-	-	-	-	-	-	-	-	



**Fig. 8.** *Acrobeles undulatus* LOOF, 1964. A: Neck. B: Lip region. C: Female reproductive system. D: Entire female. E: Lateral field. F, G: Female posterior end.



**Fig. 9.** *Acrobeles undulatus* LOOF, 1964 (LM). A: Neck and detail of excretory pore. B: Cuticle at anterior end. C: Lip region. D: Vagina region. E: Lateral field. F: Female posterior end.

The results based on two tailed Pearson correlation in the genus *Acrobeles* showed that some morphometric data has significant correlation with other ones. Some important morphometric data such as body length, ovary, spermatheca, postuterine sac, gubernaculum and spicules were considered to understand the correlation with each other. However, other data also were used in this study (Table 3). In this genus 23 individuals for females belong to three species (*A. ciliatus*, *A. andalusicus* and *A. undulatus*) and six individuals belong to males of *A. andalusicus* were analyzed to find the correlation between the

morphometric data of the species. Based on results we can observe that body length has high correlation with other morphometric data in females. Unlike, body length has no correlation with some important morphometric data such as de Man indexes except b index in females. Interestingly b index has mines correlation ( $r = -0.96$ ,  $P \leq 0.01$ ) with pharynx in males. Ratios c and c' with tail and V with vulva position having no correlation in females. Ovary also has significant correlation with spermatheca, postuterine sac ( $r = 0.78$ ,  $P \leq 0.01$ ) and vulva position ( $r = 0.84$ ,  $P \leq 0.01$ ). Tail, gubernaculum, and spicules

**Table 3.** Correlation of morphometric data based on two tailed Pearson correlation of females of *Acrobeles* von Linsow, 1877 species from Iran.

	Body length	a	b	c	c'	V
Body length	1	0.368	0.828**	0.293	-0.201	-0.007
a	0.368	1	.459*	-0.029	0.278	-0.417*
b	0.828**	.459*	1	0.137	-0.078	-0.253
c	0.293	-0.029	0.137	1	-0.929**	0.816**
c'	-0.201	0.278	-0.078	-0.929**	1	-0.837**
V	-0.007	-0.417*	-0.253	0.816**	-0.837**	1
Labial probolae	0.676**	0.328	0.571**	-.172	0.212	-0.447*
Lip region diameter	0.949**	0.327	0.744**	0.322	-0.233	0.075
Stoma	0.978**	0.337	0.772**	0.261	-0.172	0.020
pharyngeal corpus	0.980**	0.332	0.720**	0.336	-0.235	0.083
Isthmus	0.922**	0.423*	0.728**	0.296	-0.154	-0.015
Bulb	0.959**	0.274	.747**	0.236	-0.172	-0.009
Pharynx length	0.990**	0.335	0.743**	0.309	-0.209	0.043
Excretory pore-ant. End	0.857**	0.155	0.643**	0.664**	-.593**	0.428*
Nerve ring-ant. end	0.972**	0.392	0.781**	0.385	-0.267	0.106
Deirid-ant. end	0.943**	0.301	0.712**	0.321	-0.261	0.081
Annuli width	0.663**	0.255	0.504*	0.220	-0.139	0.015
Cuticle thickness	0.731**	0.336	0.522*	0.130	-0.010	-0.077
Body diameter: neck base	0.950**	0.168	0.676**	0.345	-0.295	0.150
Body diameter: midbody	0.970**	0.143	0.778**	0.305	-0.269	0.086
Body diameter: anus	0.979**	0.226	0.813**	0.326	-0.292	0.071
Lateral field	0.967**	0.333	0.808**	0.364	-0.257	0.069
Vagina	0.955**	0.293	0.822**	0.176	-0.092	-0.055
Ovary	0.846**	0.291	0.802**	0.301	-0.275	-0.062
Spermatheca	0.918**	0.328	0.713**	0.278	-0.172	0.040
Anterior genital branch	0.917**	0.241	0.646**	0.404	-0.302	0.169
Postuterine sac	0.928**	0.222	0.792**	0.354	-0.336	0.082
Rectum	0.905**	0.364	0.650**	0.382	-0.277	0.174
Tail	0.846**	0.419*	0.767**	-0.252	0.328	-0.464*
Vulva-anterior end	0.997**	0.333	0.810**	0.353	-0.264	0.066

\*: significant at 5%

\*\* : significant at 1%

**Table 4.** Correlation of morphometric data based on two tailed Pearson correlation of males of *Acrobeles* VON LINNÉ, 1758 species from Iran.

	Body length	a	b	c	c'
Body length	1	0.647	0.187	0.897*	-0.650
a	0.647	1	0.672	0.656	-0.654
b	0.187	0.672	1	0.201	-0.056
c	0.897*	0.656	0.201	1	-0.812*
c'	-0.650	-0.564	-0.056	-0.812*	1
Labial probolae	0.697	0.399	-0.206	0.697	-0.354
Lip region diameter	0.541	0.199	-0.074	0.533	0.000
Stoma	0.208	0.000	0.431	0.348	0.000
Pharyngeal corpus	0.515	-0.023	-0.470	0.654	-0.766
Isthmus	0.604	0.501	0.402	0.566	0.000
Bulb	0.693	-0.072	-0.232	0.495	-0.186
Pharynx length	0.085	-0.519	-0.962**	0.048	-0.129
Excretory pore-ant. End	0.678	0.873*	0.459	0.841*	-0.659
Nerve ring-ant. end	0.470	0.503	0.405	0.711	-0.334
Deirid-ant. end	0.916	0.938	0.803	0.808	-0.486
Annuli width	-0.763	-0.583	0.056	-0.519	0.447
Cuticle thickness	-0.192	-0.547	-0.516	-0.478	0.728
Body diameter: neck base	0.779	0.209	-0.302	0.732	-0.371
Body diameter: midbody	0.710	-0.076	-0.334	0.566	-0.320
Body diameter: anus	0.700	0.466	0.147	0.529	-0.684
Lateral field	0.383	0.317	-0.403	0.580	-0.667
Rectum	-0.866*	-0.433	-0.264	-0.600	0.293
Tail	0.050	-0.153	-0.092	-0.397	0.499
Gubernaculum	0.512	0.205	0.129	0.196	-0.282
Spicules	0.847*	0.335	-0.333	0.753	-0.564

\*: significant at 5%

\*\*: significant at 1%

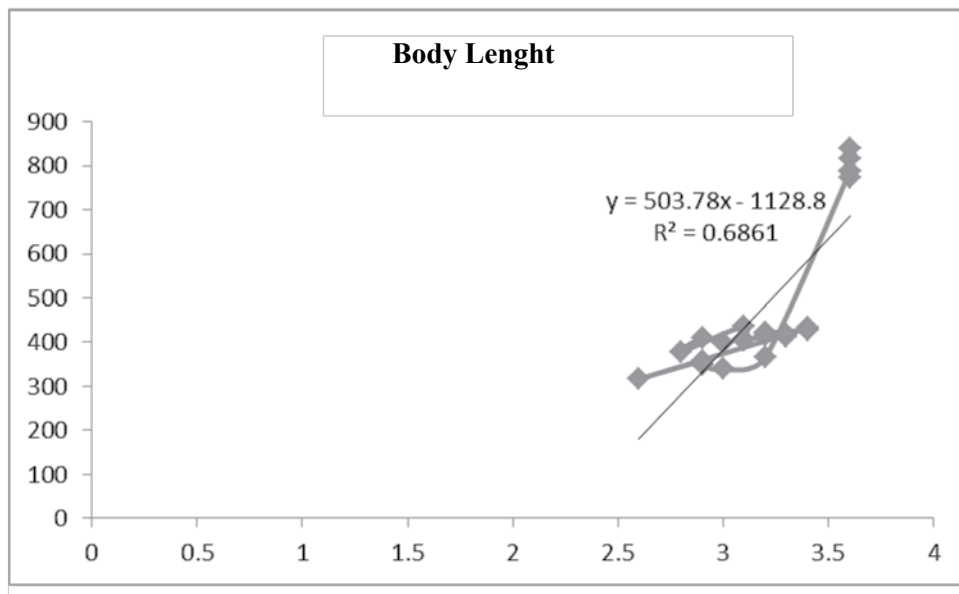
having no correlation together. These results demonstrate that spicules and c index are more important character to evaluate the species in males which correlated to body length. The same results observed by AMIRZADI *et al.* (2011) in different population of the *Eucephalobus* BASTIAN, 1865. Their results showed that stoma ( $r = 0.518$ ), corpus ( $r = 0.625$ ), pharynx ( $r = 0.774$ ), and spermatheca ( $r = 0.526$ ) having significant correlation ( $P \leq 0.01$ ) with body length. Furthermore, the vulva position having high correlation with body length ( $P \leq 0.01$ ;  $r = 0.975$ ) in females. In males also corpus ( $r = 0.762$ ), basal bulb ( $r = 0.703$ ), and pharynx ( $r = 0.861$ ) having significant correlation with body length ( $P \leq 0.01$ ) (Table 4). FORTUNER (1990) also revealed that the features related to body size (length and ratios a and b) show high correlation to each other. ARMENTEROS *et al.* (2009) during the morphometrical analyzing in the monhys-

terid nematode belong to the genus *Terschellingia* DE MAN (1888) showed that features related to the tail (relative to anal body diameter) and length and shape of spicules can be considered of diagnostic value. FORTUNER (1984) noted that index V is always useful while other indexes (e.g. a, c and c') are often useful in the species of the genus *Helicotylenchus* STEINER, 1945. Also our study indicated that b and c' are more useful in *Acrobeles* species (Table 5). However, the ratio b is more correlated to body length (Fig. 10) as indicated in regression line. These data revealed that indexes b and c' can due to variability of the species of the genus *Acrobeles*. The question is that why some features related to the morphology have high significant correlation. As those features decrease or increase simultaneously. In answer to this question we can say that these features may control by a gene cluster. On the other hand the genes responsible for

**Table 5.** Coefficients of variation between ratios and body length in the species studied.

Species	Number	a	b	c	c'	V
<i>Acrobeles andalusicus</i>	5 females	0.775	0.580	0.384	0.964**	-0.970**
<i>Acrobeles andalusicus</i>	6 males	0.647	0.187	0.897*	-0.650	-
<i>Acrobeles ciliatus</i>	13 females	0.183	0.740**	0.090	-0.170	-0.103
<i>Acrobeles undulatus</i>	5 females	0.859	0.859	0.894*	-0.357	-0.531

\* significant at 5%  
 \*\* significant at 1%



**Fig. 10.** Regression line of the ratio b.

spicules, gubernaculum, and tail morphology are located at the same position or having tight linkage. Unlikely, for some features that having no correlation or mines significant correlation (e.g. pharynx with b index in males,  $r = -0.96$ ,  $P \leq 0.01$ ) the genes responsible for these features are located at different loci or having high genetic distance. In conclusion, morphometric data of these species belong to the

genus *Acrobeles* demonstrated that some important morphometric characters are depend on body length while increasing in body length cause of increasing in other character simultaneously.

**Acknowledgments:** We would like to thank Dr. Zolala and Dr. Khezri for fruitful comments in statistical analysing of the data.

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Received: 12.11.2011

Accepted: 28.09.2012