

Nematodes of the order Dorylaimida from Andalucía Oriental, Spain.

The genus *Carcharolaimus* Thorne, 1939 with description of *C. eximius* sp. n. and a compendium of the genus

Reyes PEÑA SANTIAGO and Gracia LIÉBANAS

Departamento de Biología Animal, Escuela Universitaria de Formación del Profesorado de EGB, Virgen de la Cabeza nº 2, 23008 Jaén, Spain.

Accepted for publication 2 November 1993.

Summary – This paper deals with the taxonomy of two species belonging to the genus *Carcharolaimus* Thorne, 1939, one new and another previously known, which have been found in natural areas from Southeastern Spain. *C. eximius* n. sp. is characterized by its body 1.93-2.39 mm long, $a = 45.2-48.1$, lip region width $22.5-24 \mu\text{m}$, labial portion of the cheilostome $14.5-16 \times 7.5-8 \mu\text{m}$ and presenting teeth and denticles, odontostyle $15-16 \mu\text{m}$ long, pharyngeal bulb surrounded by a patent sheath, female genital system amphidelphic, $V = 49.5-54.3$, female tail rounded conoid ($23-28 \mu\text{m}$, $c = 68.8-94.2$, $c' = 0.8-1.0$), and males unknown. *C. banaticus* Krnjaic & Loof, 1975 is reported for the first time in Spain and new measurements and illustration of this species are presented. Finally, a compendium-table of the species hitherto classified under *Carcharolaimus* is presented and the taxonomy of the genus is briefly discussed.

Résumé – *Nématodes Dorylaimida d'Andalousie Orientale, Espagne. Le genre Carcharolaimus Thorne 1939 : description de C. eximius n. sp. et compendium des espèces du genre* – Une nouvelle espèce et une autre déjà décrite appartenant au genre *Carcharolaimus* Thorne, 1939 ont été trouvées dans la région sud-est de l'Espagne. *C. eximius* n. sp. est caractérisé par : $L = 1,93-2,39$ mm; $a = 45,2-48,1$; diam. région labiale = $22,5-24 \mu\text{m}$; partie labiale du cheilostome = $14,5-16 \times 7,5-8 \mu\text{m}$; présence de dents et de denticules; odontostyle = $15-16 \mu\text{m}$; bulbe pharyngien entouré par une gaine; appareil génital femelle amphidélphique; $V = 49,5-54,3$; queue de la femelle conoïde-arrondie, longue de $23-28 \mu\text{m}$; $c = 68,8-94,2$; $c' = 0,8-1,0$; mâles non observés. *C. banaticus* Krnjaic & Loof, 1975, dont les mesures et illustrations sont données, est signalé pour la première fois en Espagne. Un compendium en forme de tableau est donné pour les espèces jusqu'ici rangées dans le genre *Carcharolaimus*. La taxinomie du genre est brièvement discutée.

Key-words : Taxonomy, description, *Carcharolaimus*, Nematoda, Spain.

During a nematological survey carried out in 1990-92 several populations belonging to the genus *Carcharolaimus* Thorne, 1939 were found in natural areas of Andalucía Oriental, Spain (provinces of Almería, Granada, Jaén and Málaga). Two different species, one new and another previously known, have been identified and are described below.

The nematodes were extracted from soil samples by Flegg's method (1967), killed by heat, fixed in 4% formaldehyde and processed to anhydrous glycerol according to Seinhorst (1959, 1962) or Siddiqi (1964).

Carcharolaimus eximius * sp. n.

(Figs 1 & 2)

MEASUREMENTS

See Table 1.

DESCRIPTION

Female : Very slender nematodes of medium to great size, generally over 2 mm long. Body practically cylin-

dric, tapering very slightly towards both extremities. Habitus of fixed specimens ventrally curved, more clearly in the posterior body region and adopting a J-shape. Outer cuticle relatively thin and with fine transverse striations which are more conspicuous in cervical and caudal regions. Inner cuticle thicker than the outer cuticle. Lateral chord occupying 28-34% of the midbody diameter. Beneath the lateral chord numerous easily visible glandular bodies each connecting with a relatively coarse lateral pore opening at the body surface, normally at the middle of the lateral chord; 93-109 glandular bodies ($n = 5$) : 23-26 in the pharyngeal region, 21-31 from cardia to vulva, and 47-54 from vulva to anus. Lip region marked off by a deep constriction, 2.2-2.8 times as wide as high or scarcely more than half of the body diameter at base of the pharynx. Lips rather separated and rounded. Labial and cephalic papillae conspicuous but not interrupting the lip region contour. Amphid cup-shaped; amphidial aperture a spindle-shaped slit, at level of the cephalic constriction and occupying somewhat more than two-fifths of the lip region diameter.

* From *eximius* = prominent, peculiar, rare.

Table 1. Measurements and diagnostic features of the females of two species of the genus *Carcharolaimus* Thorne, 1939 found in Spain (all measurements in μm except *L* in mm).

Species	<i>C. eximius</i> n. sp.		<i>C. banaticus</i> Krnjaic & Loof, 1975 prop. El Alquíán Almería
	Holotype	Paratypes	
n	1	8	10
L	2.21	2.19 ± 0.14 (1.93–2.39)	1.40 ± 0.14 (1.21–1.67)
a	48.0	46.9 ± 1.12 (45.2–48.1)	31.3 ± 2.99 (25.5–35.4)
b	4.4	4.4 ± 0.24 (3.9–4.7)	3.9 ± 0.40 (3.0–4.5)
c	88.3	85.9 ± 7.06 (68.8–94.2)	56.8 ± 3.90 (52.7–62.2)
V	49.5	51.6 ± 1.57 (49.5–54.3)	49.3 ± 2.16 (46.7–54.0)
G1	8.4	8.1 ± 0.9 (6.7–9.6)	9.7 ± 2.2 (7.4–15.5)
G2	9.5	8.6 ± 0.9 (6.6–9.7)	10.0 ± 1.8 (6.5–12.2)
c'	0.9	0.9 ± 0.01 (0.8–1.03)	0.83 ± 0.04 (0.8–0.9)
Lip region width	24.5	23.7 ± 0.7 (22.5–25)	29.4 ± 1.2 (28–32)
– – height	8.5	9.6 ± 0.6 (8.5–10.5)	12.6 ± 0.54 (12.5–14)
Amphid aperture	10	9.6 ± 0.53 (8.5–10)	10.5 ± 0.89 (9.5–12.5)
Odontostyle	15.5	15.6 ± 0.66 (15–16)	19.4 ± 0.54 (19–20.5)
Guid. ring-ant. end	15.5	15.5 ± 0.34 (15–16)	18.4 ± 0.64 (17.5–19)
Nerve ring-ant. end	154	148 ± 6.4 (138–154)	108 ± 10.2 (97–134)
Neck length	500	504 ± 9.3 (487–520)	364 ± 37.6 (311–410)
Pharyngeal bulb	280	286 ± 7.2 (273–300)	222 ± 21.8 (187–249)
Cardia length	20	20.3 ± 0.9 (19–22)	17.5 ± 1.4 (16–19)
Body diam. neck base	38	39.7 ± 1.0 (38–41)	44.5 ± 1.5 (42–47)
– – midbody	46	46.8 ± 2.3 (45–50)	45.1 ± 1.7 (42–47.5)
– – anus	27	27.5 ± 0.7 (27–29)	29.7 ± 1.9 (27–33)
Lateral chord	14	14.8 ± 1.5 (12–17)	12.9 ± 1.8 (10.5–15.5)
Anterior ovary	61	76.4 ± 16.6 (60–105)	108 ± 37.5 (64–170)
Anterior branch	185	176 ± 9.4 (161–185)	137 ± 34.2 (95–210)
Posterior ovary	83	87.9 ± 14.7 (65–115)	106 ± 31.6 (72–172)
Posterior branch	209	197 ± 10.1 (188–209)	141 ± 32.4 (83–193)
Vagina length	19	18.8 ± 1.5 (17–22)	14.3 ± 1.5 (12–16)
Prerectum	34	33.4 ± 7.9 (28–53)	?
Rectum	32	29.7 ± 1.4 (28–32)	29.0 ± 1.3 (27–31)
Tail	25	25.7 ± 1.5 (23–28)	24.5 ± 2.4 (21–29)
Vulva-ant. end	1 093	1 131 ± 66 (1 047–1 246)	689 ± 72 (567–836)

Cheilostome in two, heavily sclerotized parts; anterior (labial) part forming a wide basket-like structure measuring $14.5\text{--}16 \times 7.5\text{--}8 \mu\text{m}$ and presumably (a transverse section has not been obtained) consisting of six curved plates (appearing in lateral view as robust ribs) with several small teeth at the posterior portion and numerous denticles on the walls; posterior (postlabial) portion a chamber-like structure $8\text{--}9 \mu\text{m}$ wide and $6 \mu\text{m}$ long, also formed by (six) plates adjoining the guiding ring at their bases, and the walls lacking teeth or denticles. Guiding ring simple but distinct. Odontostyle dorylaimid, relatively robust and about two-thirds of the lip region width long; its dorsal side slightly longer than the ventral one, the aperture occupying about half of the total length. Odontophore rod-like, length about 1.7 times the odontostyle in the holotype but the exact measurement uncertain as the junction with the pharyngeal lining is often obscure. Anterior part of the pharynx slender but muscular and with lumen abnormally wide; around the junction between the posterior end of the odontophore and the pharyngeal lining presence of a small swelling, then the pharynx becoming more slender and widening again just before the basal bulb in a second swelling, appearing separated from the basal bulb by a short isthmus-like portion. Basal bulb cylindrical, muscular, about 11 times as long as wide and occupying 55–58 % of the total pharyngeal length; pharyngeal lining thicker than in the anterior part but the lumen narrower; an obvious non-muscular sheath enveloping the entire bulb and partially the cardia. Locations of pharyngeal nuclei and outlets are: DO = 46.5–49.6; S1N1 = 73.3–74.8; S2N = 86.5–88.2; DN = 50.5–52.5; S1N2 = 74.5–76.7; S2O = 85.9–87.6; DO–DN = 2.9–4.0. Cardia elongated, cylindrical, terminal part conical; portion adjacent to the base of the pharyngeal bulb surrounded by a strong (apparently muscular) ring enveloped by the bulb sheath. Intestine not directly in contact with the pharyngeal bulb but joining the cardia at the middle or slightly anterior. Genital system didelphic-amphidelphic. Ovaries reflexed, with few oocytes and relatively short, since the flexures not reaching the oviduct-uterus junction. Oviduct joining the ovary subterminally and consisting of a slender part without visible lumen and a poorly developed *pars dilatata*. Oviduct and uterus separated by a weak sphincter. Uterus a tube a little wider than the oviduct and almost as long as this but without special modifications. Vagina practically spherical, as long as wide and extending inwards about two-fifths of the corresponding body diameter; vagina wall adjacent to the vulva not sclerotized whereas the other part circled by weak musculature. Vulva a longitudinal slit. Spermatozoa not observed. Prerectum scarcely longer than the anal body diameter. Rectum almost equal to anal body diameter. Tail rounded-conoid, ventrally almost straight, dorsally convex. Caudal pores probably three pairs which are situated as illustrated in Fig. 2 E.

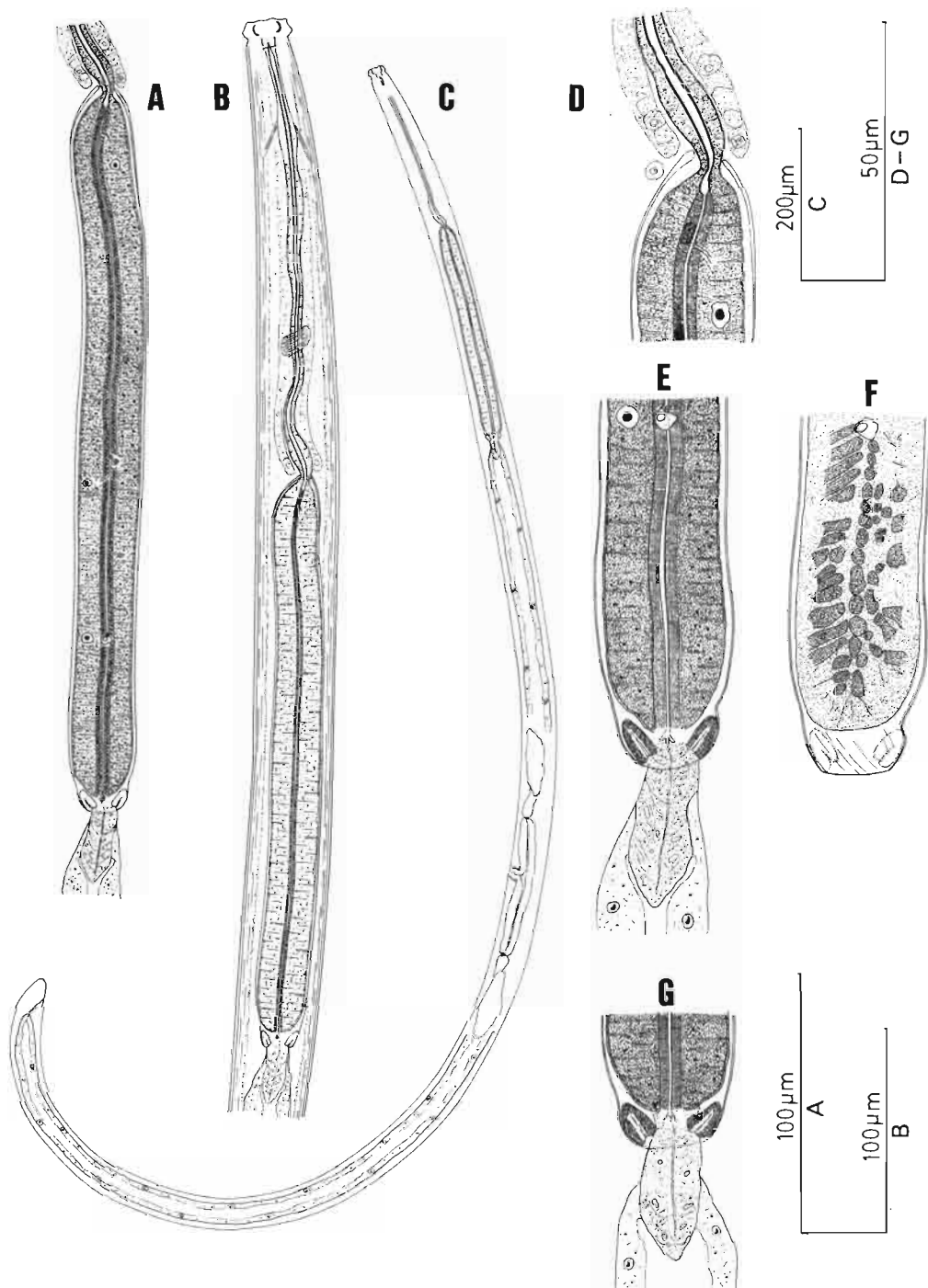


Fig. 1. *Carcharolaimus eximius* n. sp., female. A : Pharyngeal bulb; B : Neck region; C : Entire; D : Junction between both parts of the pharynx; E-G : Cardias region.

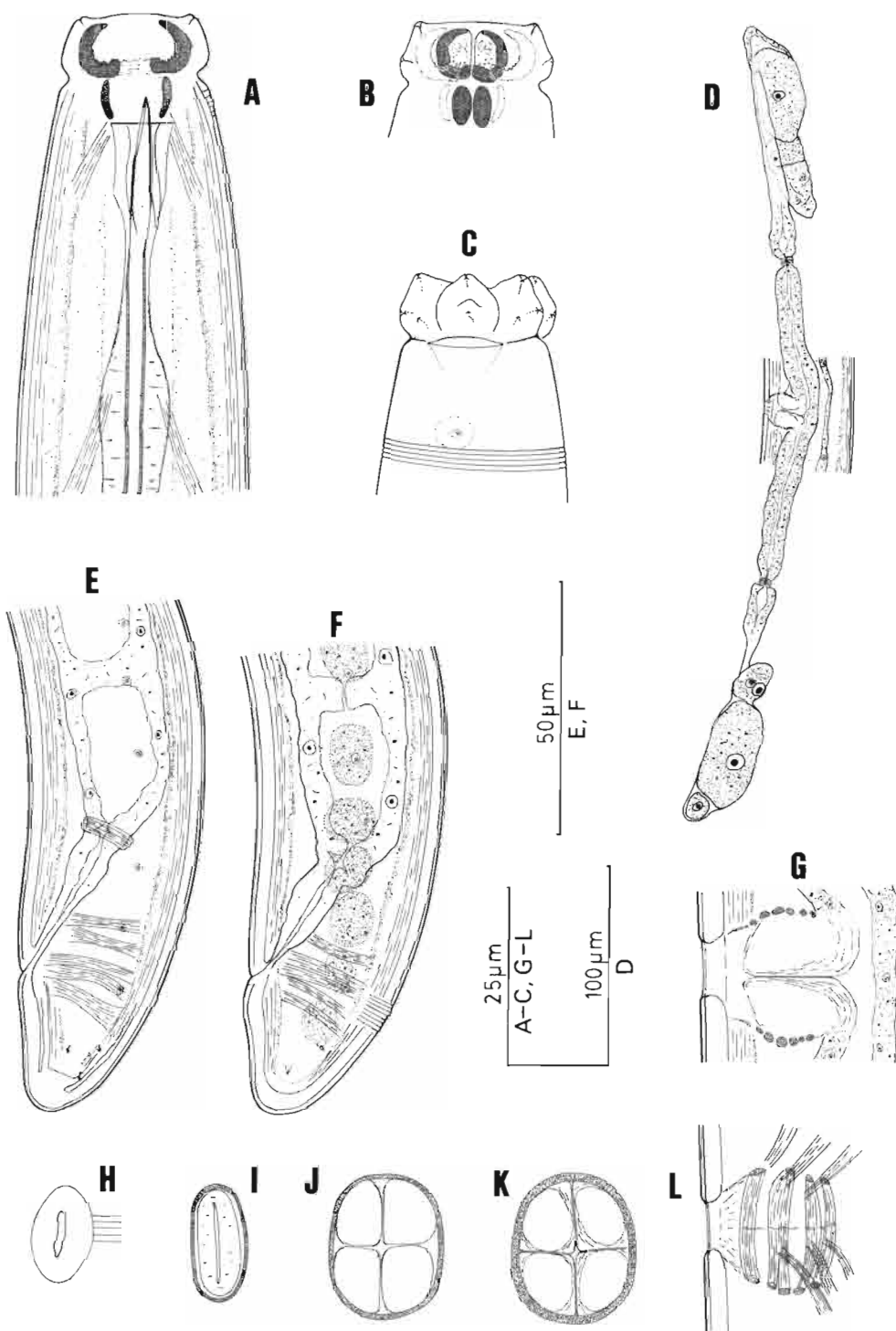


Fig. 2. *Carcharolaimus eximius* n. sp., female. **A, B** : Lip region in median view; **C** : Same, in surface view; **D** : Genital system; **E, F** : Tail; **G, I-L** : Vagina; **H** : Vulva.

Male : Unknown.

Juveniles : Similar in general morphology to adults.

DIAGNOSIS AND RELATIONSHIPS

C. eximius n. sp. is characterized by having a medium to large size (L = 1.93-2.39), very slender body (a = 45.2-48.1), lip region diameter 22.5-24 µm, labial portion of the cheilostome 14.5-16 × 7.5-8 µm and presenting denticles and teeth, odontostyle 15-16 µm long, pharyngeal bulb enveloped by a prominent sheath, fe-

male genital system amphidelphic, V = 49.5-54.3, female tail rounded-conoid (23-28 µm, c = 68.8-94.2, c' = 0.8-1.0), and males unknown.

C. eximius n. sp. is easily distinguished from all the previously known species of the genus by the presence of a distinct sheath enveloping the pharyngeal bulb. On the other hand, only three other species have been described as having longitudinal vulva: *C. banaticus* Krnjaic & Loof, 1975, *C. masoodi* Jairajpuri, 1968 and *C. mujtabei* Jairajpuri, 1968. From *C. banaticus* the new species differs by its longer body (*vs* L = 1.23-1.76),

Table 2. Measurements and diagnostic features of the species hitherto classified under *Carcharolaimus* Thorne, 1939.

Species	L	a	b	c	V	odontostyle (µm)	teeth or dent. (*)	vulva (**)	tail (µm)	spicules (µm)	distribution	reference
<i>aberrans</i>	1.7	35	4	35	54	20	+	T	49 C (***)	-	Puerto Rico	Thorne, 1967
<i>banaticus</i>	1.2-1.7	30-46	2.9-4.0	57-82	47-54	17-19	+	L	23	-	Yugoslavia	Krnjaic & Loof, 1975
	1.5	29	3.4	58	51	21			26		Italy	Vinciguerra & Zullini, 1980
	1.2-1.7	25-35	3.0-4.5	53-62	47-54	19-20.5			21-29		Spain	Present paper
											Hungary	Andrássy, 1987
										Netherlands	Bongers, 1988	
<i>bedienseis</i>	1.7-1.9	32-43	3.9-4.3	62-79	45-52	19-24	+	T	28	-	India	Sultan & Singh, 1981
<i>crassicosatus</i>	2.0	51	3.8	93	54	19	-	p	22	-	South Africa	Heyns & Argo, 1969
<i>dentatus</i>	2.2	40	5.0	83	48	?	+	T	26	-	USA	Thorne, 1939
											Netherlands	Loof & Coomans, 1970
											Hungary	Andrássy, 1982
<i>discus</i>	2.7	43	4	86	45	16	+	T	31	-	Puerto Rico	Thorne, 1967
<i>drepanodon</i>	1.5-1.9	42-46	3.5-3.9	71-81	48-51	18-23	-	T	24	-	Venezuela	Loof, 1964
<i>eximius</i>	1.9-2.4	45-48	3.9-4.7	68-94	49-54	14-16	+	L	23-28	-	Spain	Present paper
<i>formosus</i>	2.4	47	4.0	80	57	18	+	T	29	-	Brazil	Lordello, 1957
	2.4-2.5	50-51	4.1-4.2	84-90	53-61	19			?		Argentina	Andrássy, 1963
<i>lucidus</i>	1.6-1.7	34-43	3.6-4.4	48-61	51-55	13-15	+	T	32	38-41	Australia	Sauer, 1967
<i>masoodi</i>	1.6-1.8	44-55	4.3-5.0	70-88	48-54	11-13	?-	L	20-24	-	India	Jairajpuri, 1968
											India	Bajaj & Bhatti, 1982
<i>mujtabei</i>	1.5-1.6	31-34	3.5-4.0	64-73	48	20-21	?-	L	21-24	-	India	Jairajpuri, 1968
											India	Bajaj & Bhatti, 1982
<i>multicosatus</i>	0.9-1.1	28-31	3.2-3.6	44-54	53-57	12	-	T	21	-	Australia	Sauer, 1967
<i>parvus</i>	0.9-1.2	31-33	3.1-4.1	36-42	52-55	10-12	-	T	23 C	-	Mexico	Zullini, 1973
<i>pizai</i> (****)	1.6	25	?	?	?	?	+	?	?	-	Brazil	Lordello, 1953
<i>ramirezi</i>	2.2	38	4.0	67	49	20	+	T	33	-	Puerto Rico	Thorne, 1967
<i>symmetricus</i>	1.5-1.8	44-51	3.9-4.6	70-84	51-56	12-14	+	T	22	-	India	Sultan & Singh, 1981
<i>taurus</i>	1.2-1.3	29-36	3.0-3.3	39-40	52-53	12-13	-	T	30	33	Australia	Sauer, 1967
<i>tenuicosatus</i>	1.46	35	4.8	81	50.5	13	-	T	18	-	South Africa	Heyns & Argo, 1969
<i>teres</i>	1.4-2.0	37	5.0	50	48	?	+	T	?29-42	-	USA	Thorne, 1939

(*) Presence of teeth or denticles in the labial portion of the cheilostome.

(**) T = transversal; L = Longitudinal; p = pore-like.

(***) Only two species (*C. aberrans* and *C. parvus*) present conical tail.

(****) Original description of this species was not available to the authors.

Note : The species *C. rotundicauda* (de Man, 1880) Thorne, 1939 was transferred to *Aetholaimus* Williams, 1962 by Coomans and Loof (1978).

narrower lip region (*vs* 28-32 μm , see below) and shorter odontostyle (*vs* 17-21 μm); from *C. masoodi* it can be separated by having longer body (*vs* L = 1.57-1.85), presence of teeth or denticles in the labial part of the cheilostome (*vs* absence), and longer odontostyle (*vs* 11-13 μm); from *C. mujtabai* it is distinguished by the longer (*vs* L = 1.52-1.60) and more slender (*vs* a = 31-34) body and shorter odontostyle (*vs* 20-21 μm). Table 2 permits comparison of the new species with other species included in the genus.

TYPE HABITAT AND LOCALITY

Soil around a mediterranean brushwood in Órgiva, province of Granada, Spain.

TYPE MATERIAL

Holotype and two female paratypes in collection of the Departamento de Biología Animal, Universidad de Granada, Granada, Spain. Two female paratypes in each of the following two collections: Laboratoire de Biologie Parasitaire, Muséum National d'Histoire Naturelle, Paris, France; and Instituut voor Dierkunde, Rijksuniversiteit Gent, Belgium.

Carcharolaimus banaticus Krnjaic & Loof, 1975 (Fig. 3)

MEASUREMENTS

See Table 1.

DESCRIPTION

Female: Moderately slender to slender nematodes of medium size (L = 1.21-1.66 mm). Body cylindrical, tapering very slightly towards both extremities but more visibly towards the posterior. Habitus of fixed specimens frequently straight but sometimes ventrally curved to C-shaped. Outer cuticle with fine transverse striations. Inner cuticle wider than the outer one. Lateral chord occupying about one-fourth of the midbody diameter. 90-106 glandular bodies present along the entire body (n = 3): 29-32 in the pharyngeal region, 19-24 from cardias to vulva, and 35-55 from vulva to anus. Lip region set off by a deep constriction, 2.2-2.7 times as wide as high or two-thirds of the body diameter at neck base. Lips separated and somewhat angular. Labial and cephalic papillae distinct. Amphid cup-shaped, occupying one-third of the lip region width. Cheilostome heavily sclerotized and consisting of two parts; anterior (labial) part basket-like, 21-22 μm wide and 9-10.5 μm high and consisting of six curved plates (ribs in lateral view) with small teeth at the base and numerous denticles on the walls; postlabial part 11-12 \times 7-7.5 μm and formed by six smaller plates. Guiding ring simple but distinct. Odontostyle dorylaimid, 0.6-0.7 times the lip region diameter long; its aperture somewhat more than half of the total length. Odontophore rod-like, 1.3-1.5 times the odontostyle but its junction with the pharyngeal lining often inconspicuous. Pharynx with the

typical two parts separated by a constriction. Anterior portion slender but muscular and with two swellings: one at level of the junction between the odontophore and the pharyngeal lining, the other immediately before the basal bulb; its lumen relatively wide. Pharyngeal bulb cylindrical, very muscular and occupying three-fifths of the total neck length; lumen very narrow but inner lining wider than in the anterior part. Pharyngeal gland nuclei and outlets generally distinct (n = 2): DO = 44.9, 47.9; S1N1 = ?, 74.5; S2N = 85.4, 83.9; DN = 49.8, 51.1; S1N2 = 77.8, 76.6; S2O = 85.4, 83.9; DO-DN = 5.1, 3.2. Cardia rounded conoid, almost as long as wide and partially involved by the intestine. Subdorsal rows of a variable number of cells visible in the cardia region of several specimens examined. Nerve ring situated at 25-30% of the total neck length. Genital system didelphic-amphidelphic. Ovaries reflexed, with few oocytes and relatively short, not reaching the level of the sphincter. Oviduct consisting of a slender part with prismatic cells without a visible lumen and a scarcely developed *pars dilatata*. A weakly developed sphincter present at the oviduct-uterus junction. Uterus normally a short tube without special modifications. Vagina cylindrical, extending inwards one-third of the corresponding body width; its wall adjacent to the vulva appearing weakly sclerotized, other part surrounded by musculature. Vulva a longitudinal slit. Sperm absent into the genital tract. Prerectum not distinguishable in the specimens examined. Rectum equal in length to anal body diameter. Tail convex conoid. Caudal pores two pairs at the middle of the tail: one subdorsal, the other lateral.

Male: Unknown.

Juveniles: General morphology similar to adults.

DISTRIBUTION

The species has been found in soil around roots of different types of mediterranean brushwood in two localities in Spain: El Alquíán, province of Almería; and Caniles, province of Granada.

REMARKS

Present description agrees very well with the original one. Only the neck is somewhat shorter (*vs* b = 2.9-4.0) in the Spanish population. The basal shield in the pharyngeal bulb and the existence of prerectum described by Krnjaic and Loof (1975) were not well observed in the material studied.

Observations on the genus *Carcharolaimus* Thorne, 1939

At present twenty species are included under the genus *Carcharolaimus* Thorne, 1939. The genus has never been revised. The Table 2 presents a compendium of the main measurements and diagnostic features of taxonomic interest together with data of the distribution of the species. All species share important morphological

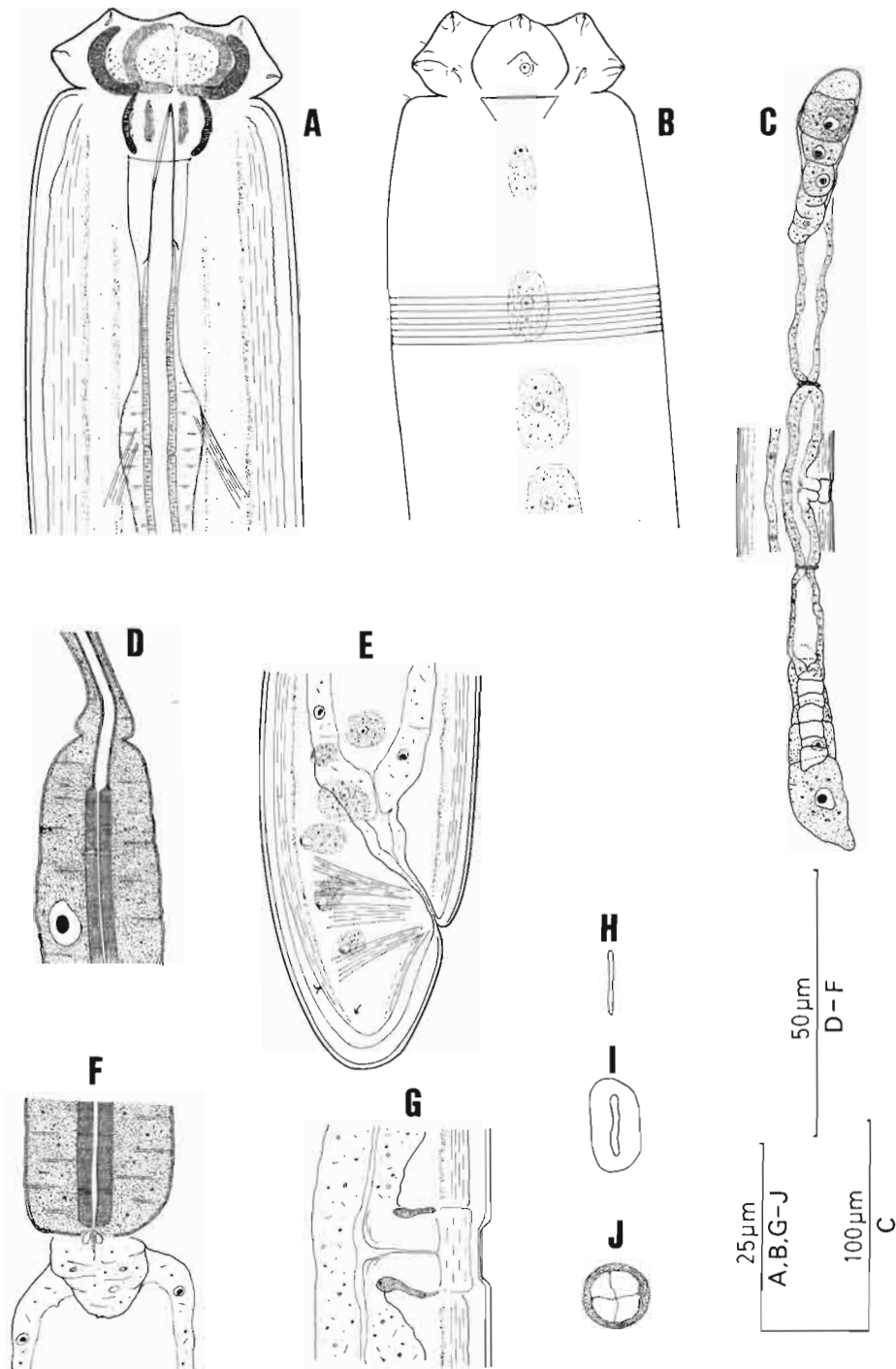


Fig. 3. *Carcharolaimus banaticus* Krnjaic & Loof, 1975, female. **A**: Lip region in median view; **B**: Same in surface view; **C**: Genital system; **D**: Junction between both parts of the pharynx; **E**: Tail; **F**: Cardias region; **G**, **I**, **J**: Vagina; **H**: Vulva.

characters : strongly sclerotized cheilostome with the labial part basket-like, peculiar shape of the inner pharyngeal lining and lumen, presence of numerous glandular bodies along the entire body and female genital system didelphic-amphidelphic. However, an interesting and taxonomically outstanding variability exists in several characters : *i*) the basket-like structure which constitutes the labial portion of the cheilostome can contain different numbers of ribs and presence/absence of teeth or denticles at the base or on the walls respectively, *ii*) the junction between the parts of the pharynx (anterior slender portion and basal bulb) shows separation by a constriction or a short isthmus-like structure, *iii*) the pharyngeal bulb is involved by a distinct sheath in one species, *iv*) a shield of different nature is often present at the base of the pharyngeal bulb and cardia region, *v*) the vulva is frequently transverse but in four species is clearly longitudinal, and *vi*) the tail is almost always rounded-conoid but in two species is conical. While it is probable that the genus includes a natural (monophyletic) species group in order to determine the category of this group with certainty is necessary to undertake further and deeper studies.

The taxonomic position of the genus has been a cause of discussion. Thorne (1939) classified it under the subfamily Actinolaiminae Thorne, 1939 and authors as Goodey (1963), Andrásy (1976) and Jairajpuri and Ahmad (1992) have agreed with this. However, Loof and Coomans (1970), Baqri *et al.* (1975), Coomans and Loof (1978) and Vinciguerra (1988) support the hypothesis that *Carcharolaimus* and other close genera are not directly related to actinolaims but to discolaims. In our opinion, the morphological study of the material found in Spain corroborates the last hypothesis and indicates that the similarity in the cheilostome structure between *Carcharolaimus* and actinolaims could be the result of a process of evolutionary convergence.

Acknowledgement

First author thanks the financial support received of the Project entitled "Fauna Ibérica II" (D.G.I.C.Y.T. PB89-0081).

References

ANDRÁSSY, I. (1963). The zoological results of Gy. Tópal's collectings in South Argentina. 2. Nematoda. *Annal. hist.-nat. Mus. natn. hung.*, 55 : 243-273.

ANDRÁSSY, I. (1976). *Evolution of a basis for the systematization of Nematodes*. London, Pitman Publishing Co., 288 p.

ANDRÁSSY, I. (1982). [Further twenty-five nematode species new to the fauna of Hungary]. *Allat. Közlemén.*, 69 : 139-146.

ANDRÁSSY, I. (1987). The free-living nematode fauna of the Kiskunság National Park. *The Fauna of the Kiskunság National Park*, 15-46.

BAJAJ, H. K. & BHATTI, D. S. (1982). Nematodes associated with cotton in Haryana and Punjab with description of two new leptonchid nematodes. *Indian J. Nematol.*, 12 : 6-13.

BAQRI, Q. H., COOMANS, A. & VAN DER HEIDEN, A. (1975). A taxonomic revision of the nematode species described by S. Stekhoven & Teunissen (1938) and S. Stekhoven (1944) from National Virunga Park, Zaire Republic. II. Actinolaimidae. *Revue Zool. afr.*, 89 : 567-586.

BONGERS, T. (1988). *De Nematoden van Nederland*. Utrecht, KNNV, 408 p.

COOMANS, A. & LOOF, P. A. A. (1978). Observations on the subfamily Aetholaiminae Jairajpuri, 1965 (Nygolaimidae : Nematoda). *Proc. helminth. Soc. Wash.*, 45 : 82-92.

FLEGG, J. J. M. (1967). Extraction of *Xiphinema* and *Longidorus* species from soil by a modification of Coob's decanting and sieving technique. *Ann. appl. Biol.*, 60 : 429-437.

GOODEY, T. (1963). *Soil and freshwater nematodes*. London, Methuen, 544 p.

HEYNS, J. & ARGO, A. D. (1969). Actinolaimoidea of South Africa (Nematoda : Dorylaimida). *Phytophylactica*, 1 : 217-228.

JAIRAJPURI, M. S. (1968). Three new species of Actinolaimidae (Nematoda : Dorylaimoidea) from India. *Proc. helminth. Soc. Wash.*, 35 : 96-103.

JAIRAJPURI, M. S. & AHMAD, W. (1992). *Dorylaimida. Free-living, predaceous and plant-parasitic nematodes*. Leiden, E. J. Brill, 458 p.

KRNJAIC, D. & LOOF, P. A. A. (1975). *Carcharolaimus banaticus* n. sp. (Nematoda : Discolaimidae) and its ecology. *Nematol. medit.*, 3 : 153-161.

LOOF, P. A. A. (1964). Free-living and plant-parasitic nematodes from Venezuela. *Nematologica*, 10 : 201-300.

LOOF, P. A. A. & COOMANS, A. (1970). On the development and location of the oesophageal gland nuclei in the Dorylaimina. *Proc. IX Int. Nematol. Symp., Warsaw, 1967* : 79-161.

LORDELLO, L. G. E. (1953). *Contribuição ao conhecimento dos nematódeos do solo de algumas regiões do Estado de S. Paulo*. Thesis Escola Superior de Agricultura "Luiz de Queiroz", 75 p.

LORDELLO, L. G. E. (1957). Two new nematodes found associated with soy-bean roots. *Nematologica*, 2 : 19-24.

SAUER, M. R. (1967). Three new species of *Carcharolaimus* (Nematoda : Dorylaimidae). *Nematologica*, 13 : 311-317.

SEINHORST, J. W. (1959). A rapid method for the transfer of nematodes from fixative to anhydrous glycerin. *Nematologica*, 4 : 67-69.

SEINHORST, J. W. (1962). On the killing, fixation and transferring to glycerin of nematodes. *Nematologica*, 8 : 29-32.

SIDDIQI, M. R. (1964). Studies on *Discolaimus* spp. (Nematoda : Dorylaimidae) from India. *Z. zool. Syst. Evolut.-Forsch.*, 2 : 174-184.

- SULTAN, M. S. & SINGH, I. (1981). Two new species of *Carcharolaimus* Thorne, 1939 (Nematoda : Dorylaimida). *Revue Nématol.*, 4 : 199-202.
- THORNE, G. (1939). A monograph of the nematodes of the superfamily Dorylaimoidea. *Capita zool.*, 8 : 1-261.
- THORNE, G. (1967). Nematodes of Puerto Rico : Actinolaimoidea, new superfamily with a revision of its genera and species with addenda to Belonidiroidea (Nematoda, Adenophorea, Dorylaimida). *Univ. Puerto Rico agric. exp. Stn. techn. Paper No. 43*, 1-48.
- VINCIGUERRA, M. T. (1987). A new classification of Actinolaimoidea Thorne, 1939 using a cladistic approach. *Nematologica*, 33 (1987) : 251-277.
- VINCIGUERRA, M. T. & ZULLINI, A. (1980). New or rare species of nematodes from Italian sand dunes. *Animalia*, 7 : 29-44.
- ZULLINI, A. (1973). Some soil and freshwater nematodes from Chiapas (Mexico). *Quad. Acad. naz. Lincei*, 171 : 55-96.