

A REVIEW OF THE GORDIACEA (NEMATOMORPHA) IN THE COLLECTION OF THE CALIFORNIA ACADEMY OF SCIENCES WITH THE DESCRIPTION OF A NEW SPECIES

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ABSTRACT

The Gordiacea of the California Academy of Sciences collection are studied. The specimens are included in the known species *Gordius robustus* Leidy, *Pseudochordodes bedriagae* (Camerano) and a new species, *Neochordodes californensis* n. sp. is proposed. Morphological, morphometric and geographical data are provided for these species.

Key words: Collection, California, Gordiacea, Nematomorpha

RESUMEN

Revisión de los Gordiacea (Nematomorpha) de la colección de la Academia de Ciencias de California con descripción de una nueva especie

En este trabajo se estudian los Gordiacea de la colección de la California Academy of Sciences. Los ejemplares se incluyen en dos especies conocidas, *Gordius robustus* Leidy y *Pseudochordodes bedriagae* (Camerano), y una especie nueva: *Neochordodes californensis* n. sp. Se proporcionan datos morfológicos, morfométricos y geográficos para cada una de las especies.

Palabras clave: Colección, California, Gordiacea, Nematomorpha

Introduction

Study of gordiaceans began with Linnaeus (1776), who introduced the genus *Gordius*. Creplin (1847), Leidy (1856), Villot (1874), Janda (1893) and Camerano (1897) supplied important diagnostic, taxonomic and geographic data for several genera. Montgomery (1898 to 1907) carried out most of the research on North American gordiaceans. A few years later

Carvalho (1942) studied material from both North and South America. Sciachittamo (1958) proposed upgrading Heinze's (1935) families to the orders Gordiiformes and Chorodiiformes. The biology of the group was studied by May (1919) and Dorier (1930). Recent work on American gordiaceans include those by Faust and Botero Ramos (1960) in Colombia, Chandler (1985) in the USA and Miralles (1969, 1973, 1976) in Argentina.

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The material studied in this paper belongs to the collection of the California Academy of Science assembled after the 1906 earthquake. It includes new material from different localities in California, Mexico and Canada. The specimens (so far unidentified) examined for this study belong in the following species: *Gordius robustus* Leidy, *Pseudochordodes bedriagae* (Camerano) and *Neochordodes californensis* n. sp. Data on morphological and meristic features are provided as well as data on the geographical range of the species.

The material was examined through a Leitz Wetzlar binocular and the drawings were made using a camera lucida. To analyze the cuticle, the central zone of the body was thin sectioned and the muscles and internal organs were separated by means of dissection needles. The cuticle was mounted on Chloralactophenol. All measurements are in millimeters.

Systematics

Family **Gordiidae** May, 1919

Genus **Gordius** Linnaeus, 1767

1767. *Gordius* Linnaeus, *Syst. Nat.*, ed. XII, pars II, p. 1075

Posterior ends of male bifurcated beyond cloacal aperture, with lobes deeply separated and a cutaneous fold in the manner of a curved postcloacal fold. Posterior end of female not bifurcated with a median-terminal cloacal aperture.

Gordius robustus Leidy, 1856

(Figs. 1-6)

1856. *Gordius robustus* Leidy, *Proc. Acad. Nat. Sci. Philad.*, p. 204

Material: CAT 016903 QUAD Y 101162, a male specimen collected by E. Humm (1-28-81) at 800 meters a.s.l. in Tenejapa, 9 miles away from San Cristobal de las Casas, Chiapas state, Mexico. Group 22 CAT 075619 ACC 15474, 23 males and 24 females collected by E.L. Kessel (8-15-63) in Fork Lake, Alberta, Canada. Group 22 CAT 06180, a female collected by A. Blake (1-25-87) in ditches along the highway in Tamales, Marin county, California.

Males: A specimen measuring 337 mm long and 2.196 mm wide. Twenty three specimens, with a length between a maximum of 330 mm and a mini-

um of 160 mm, and an average of .535 mm wide. Anterior end attenuated (fig. 1), distal edge semicircular. Mouth terminal and central (fig. 2); in one of the specimens the head was retracted within the body. In other specimens the head is not colored and is separated from the rest of the body by a dark neck ring. Body color yellow brownish; shape cylindrical, with dorsal and ventral very shallow and narrow longitudinal furrows poorly developed. Posterior end slightly thinner than central region and developed into two inwardly curved lobes (figs. 3 and 4). Lobular sizes ranging from .406 to .648 mm long and .192 to .321 mm wide. Postcloacal ridge conspicuous and semicircular. Cloacal aperture rounded and placed in front of the ridge, with a diameter ranging between .032 and .094 mm. Cuticle smooth devoid of areolae with underlying net-like muscular lines that can be seen by transparency.

Females: Twenty five specimens with a length between a maximum of 371 mm and a minimum of 156 mm, and an average width of .625 mm.

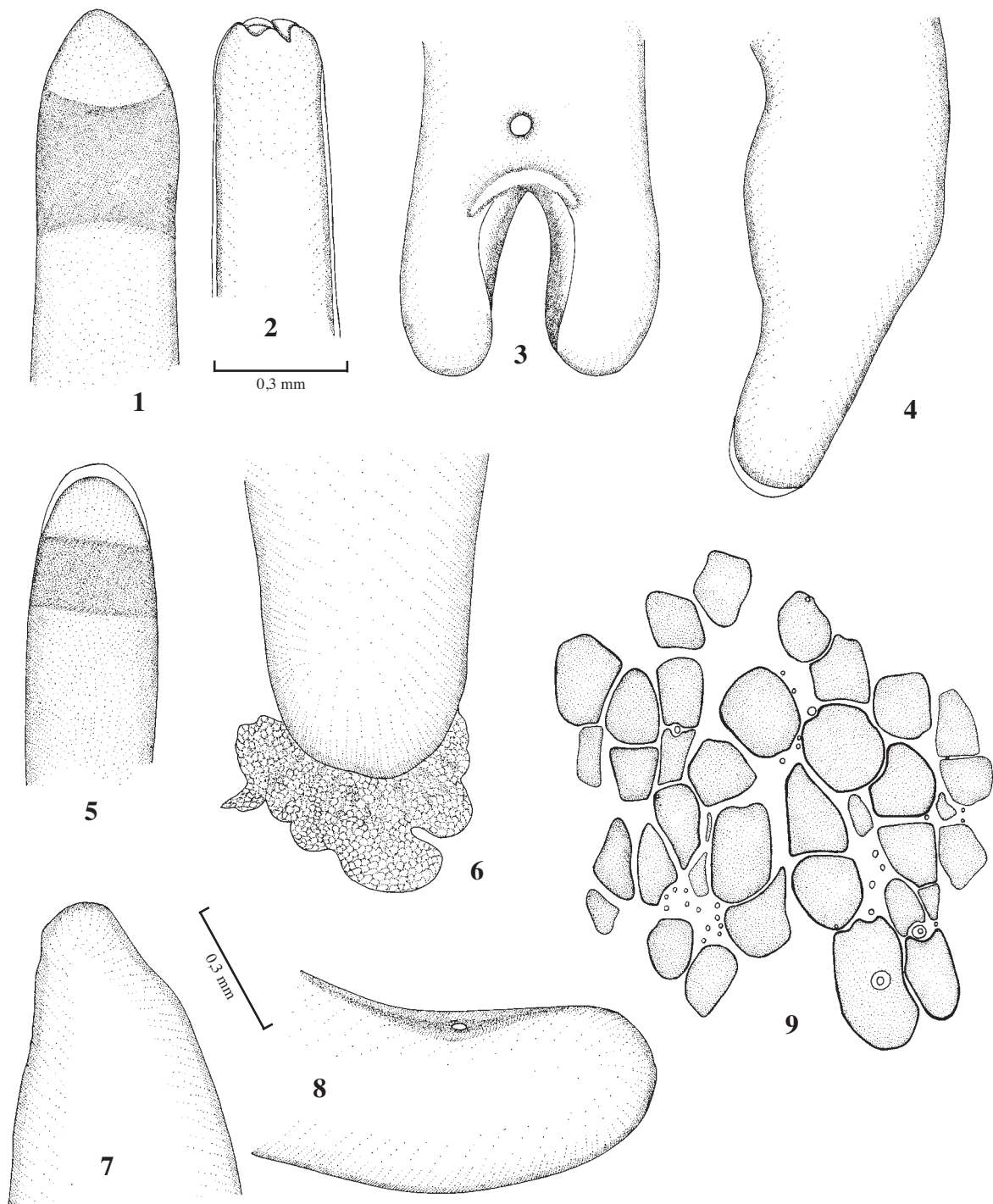
Anterior end semicircular (fig. 5). Head poorly colored and, as in males, separated from the rest of body by a dark ring. Diameter of anterior region, measured at the ring, ranging from .288 to .695 mm. Mouth terminal and central, placed at the very tip of the anterior end. General color is light brown. Dorsal and ventral longitudinal furrows poorly developed. Posterior end claviform, wider than the average width, which ranges between .481 and .845 mm. Most females observed show a flaccid body, possibly due to having been captured immediately after oviposition. Many of them still show eggs clustered to the posterior end (fig. 6). The cuticle is smooth, devoid of any kind of ornamentation.

Family **Chordodidae** May, 1919

Genus **Pseudochordodes** Carvalho, 1942

1942. *Pseudochordodes* Carvalho, *J. Parasitol.* 28(3):213 (*Chordodes* Creplin *pro parte*)

Tropical gordiaceans, medium sized, with pointed anterior end. Very weak posterior mid-ventral groove in males. Cloacal aperture at not more than .5 mm from distal end. Cuticle with two characteristic types of areolae.



Figs 1-9.— 1-6: *Gordius robustus* Leidy. 1: Male anterior region. 2: Retracted anterior end of the male. 3 and 4: Male posterior region. 5: Female anterior region. 6: Female posterior region with eggs adhered to the end. 7-9: *Pseudochordodes bedriagae* (Camerano). 7: Male anterior region. 8: Male posterior region. 9: General view of the cuticle.

Figs 1-9.— 1-6: *Gordius robustus* Leidy. 1: Región anterior del macho. 2: Extremo anterior retraído del macho. 3 y 4: Región posterior del macho. 5: Región anterior de la hembra. 6: Región posterior de la hembra con huevos adheridos en su extremo. 7-9: *Pseudochordodes bedriagae* (Camerano). 7: Región anterior del macho. 8: Región posterior del macho. 9: Vista general de la cutícula.

Pseudochordodes bedriagae (Camerano)

(Figs. 7-9)

1896. *Chordodes bedriagae* Camerano, *Ann. Mus. Zool. St. Petersb.* 213 (???)

Material: Group 22 IZ CAT 013641 ACC 1165 QUAD M 121482, 9 males and 3 females collected by J.L. Kavanagh (3-10-80) in ditches along the highway, 3 miles NE of Petaluma, Sonoma county, California. Group 22 CAT 075618 ACC 15472, male specimen collected by H.B. Leach (4-22-63) in Santo Domingo river, Baja California, Mexico. IZ CAT 075589 ACC 15469, 36 males and 6 females collected by J.W. Carlson (7-23-10) in ponds near Avalon, Catalina Island, California.

Males: Nine specimens with a length between a maximum of 396 mm and a minimum of 133 mm, and an average width of .820 mm.

Anterior end of examined males pointed with an average diameter of .332 mm. (fig. 7). Body brown, head light yellowish. Dark neck ring absent. Body cylindrical with depressions on different areas. Ventral longitudinal groove conspicuously developed. Posterior end rounded (fig. 8), spiral shaped in an apically tapering spoon-like prolongation, average diameter of .450 mm. Cloacal aperture ovate, subterminal, placed within a slight ventral depression. Largest diameter of .09 mm. Younger specimens colored light brown, like females. Cuticle (fig. 9) with two types of areolae: a) high and dark, generally polygonal, paired or in groups of three, sometimes isolated; these are usually separated by a porous canal with sessile bristles and b) low variable in shape and color and ranging over most of the cuticle; interareolar furrows free of tubercles, bristles or other formations.

Females: Three specimens with a length between a maximum of 296 mm and a minimum of 281 mm, and an average width of 1.350 mm.

The sharply tapering anterior tip ends in a cream-colored hemisphere surrounded posteriorly by a dark zone; average diameter of anterior end about .532. The rest of the body is light brown, flattened and with numerous longitudinal folds due to recent oviposition. Dorsal and ventral longitudinal lines poorly defined. In some specimens the posterior end is retracted, in others it appears turgid, claviform and wider than the rest of the body; average diameter is .641 mm. Several females show eggs

adhered to the distal edge. The cuticle is as in the males.

Genus *Neochordodes* Carvalho, 1942

1942. *Pseudochordodes* Carvalho, *J. Parasitol.* 28(3):213 (*Chordodes* Creplin *pro parte*)

Type species: *Neochordodes talensis* (Camerano, 1987)

Remarks: Species belonging in *Neochordodes* show only one kind of areolae, usually polygonal or ovoidal and low. The interareolar furrows may or may not have bristles, hyaline processes or other structures.

Large tropical gordiaceans; thin anterior end; body cylindrical; posterior end attenuated; slightly flattened dorsally in males; males with a shallow mid-ventral cloacal groove; cuticle with only one kind of areolae, generally ovoid and low compared to the ones in *Chordodes*; interareolar furrows with or without hyaline processes, bristles or other structures.

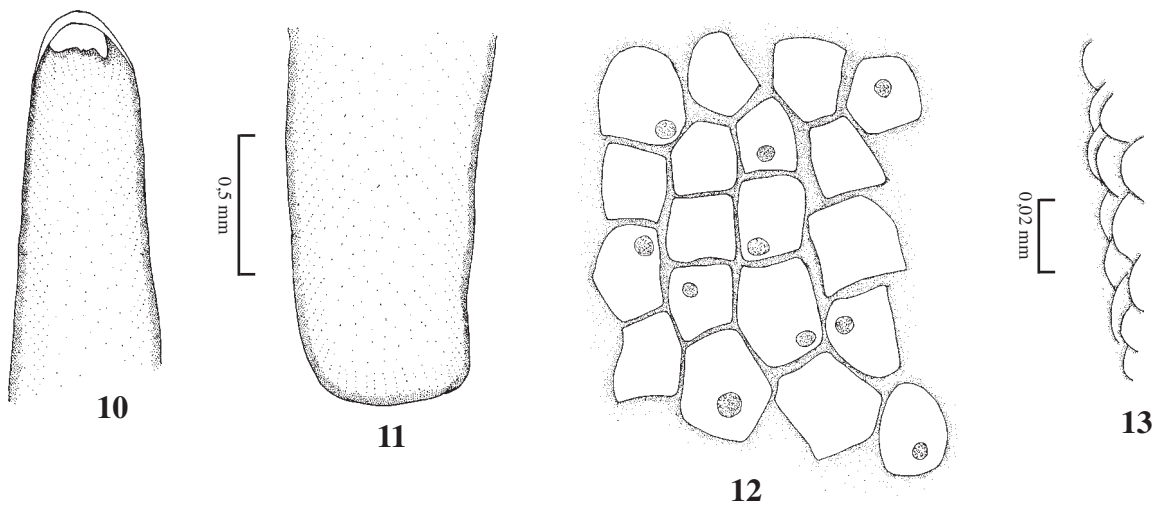
Neochordodes californensis n. sp.

(Figs. 10-13)

Material: The holotype, Group 22 CAT 057620 ACC 15475, a female collected by H.B. Leach (9-2-60) at Soap Cr. Ridge, N of Ft. Jones, Sisikyow County, California (type locality).

Female: Holotype, a specimen 89 mm long and .568 mm wide (diameter?). Cylindrical. Anterior end pointed (fig. 10). Head retracted within body; diameter of .366 mm behind retraction. Cloaca terminal and central (fig. 11). Color light brown, except for head, which is not pigmented. Mid-ventral groove well developed. The cuticle shows only one kind of areolae, which are irregularly quadrangular or polygonal, with rounded corners. On most areolae there is a circle of small protuberances placed near the areolar edge. The interareolar spaces are very narrow and devoid of hyaline processes, bristles or other structures (figs. 12 and 13).

Remarks: After a comparative analysis of the cuticular features of *N. californensis* with other species of the genus, we can conclude that it differs from *N. colombianus* Faust and Ramos in that the areoles are quadrangular or polygonal and that the suprareolar structures are excentric. From *N. talen-*



Figs. 10-13.— *Neochordodes californensis* n. sp.

10. Female anterior region. 11. Female posterior region. 12. General view of the cuticle. 13. Lateral view of the cuticle.

Figs. 10-13.— *Neochordodes californensis* n. sp.

10. Región anterior de la hembra. 11. Región posterior de la hembra. 12. Vista general de la cutícula. 13. Vista lateral de la cutícula.

sis (Camerano) it differs by the low areoles, lacking granulations and by the narrow interareolar furrow and the lack of hialine processes. From *N. nietoi* it can be distinguished because of the uniform areole distribution. The areoles have a rounded surface with irregular contours. It can be separated from *N. senearolatus* Carvalho by the narrower interareolar spaces and the semicircular areolar contours, the absence of tubercles, bristles or other cuticler structures. All this suggests that the specimen studied shows distinctive features that warrant its inclusion in a new species.

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References

- CAMERANO, L., 1896. Descrizione de una nuova specie di gordio del Basso Beni (Bolivia) raccolta dal prof. L. Balzan. *Ann. Mus. Civ. Genova (Ser. 2^a)*, 16: 2.
- CAMERANO, L., 1897a. Viaggio del Dott. Alfredo Borelli nel Chaco boliviano e nella Repubblica Argentina. *Bol. Mus. Zool. Anat. Comp. R. Univ. Torino*, 12(294).
- CAMERANO, L., 1897b. Monografía dei Gordii. *Mem. R. Accad. Sci. Torino (ser. 2)*, 47(2): 375.
- CARVALHO, J.C.M., 1942. Studies on some Gordioidea of North and South America. *J. Parasitol.*, 28(3): 213-222.
- CHANDLER, C.M., 1985. Horsehair worms (Nematomorpha Gordiacea) from Tennessee, with a review of taxonomy and distribution in the United States. *J. Tennessee Acad. Sci.*, 60: 59-62.
- CREPLIN, F.C., 1847. Chordodes parasitus, ein Schmarotzerwurm aus einer hauschrecke. *Froriep's Notiz.*, 3(3): 161.
- DORIER, A., 1930. Recherches biologiques et sistematiques sur les gordiaces. *Ann. Univ. Grenoble (N.S.)*, 7(1): 1-183.
- FAUST, E.C. & BOTERO RAMOS, D., 1960. Extraordinario hallazgo de una nueva especie de *Neochordodes* (Gordiacea) en Colombia. In: *Libro de Homenaje al Dr. E. Caballero y C.*

- Jubileo 1930-1060*. Instituto Politécnico Nacional. México: 523-527.
- HEINZE, K., 1935. Über Gordiiden (species in quereudar und Neubeschreibungen). *Zool. Anz.*, 3: 23-34.
- JANDA, J., 1893. Beitrage zur Systematik der Gordiiden. *Zool. Jahrb. Syst.*, 7: 595-612.
- LEIDY, J., 1856. A synopsis od Entozoa and some of their ectocongeners observed by the author. *Proc. Acad. Nat. Sci. Philadelphia*, 8.
- LINAEUS, C. von, 1767. *Systema Naturae*, ed. XII, pars II, p. 1075.
- MAY, G.H., 1919. Contributions to the life histories of *Gordius robustus* Leidy and *Paragordius varius* (Leidy). *Illinois Biol. Monogr.*, 5(2): 1-118.
- MIRALLES, Delma A.B. de, 1969. Lista preliminar de gordiáceos de Argentina y datos biológicos sobre *Neochordodes uniareolatus* Carv. *Acta Zool. Lilloana*, 24: 183-192.
- MIRALLES, Delma A.B. de, 1973. Sobre la presencia de *Pseudochordodes bedriagae* (Camerano) en Argentina (Gordioidea Chordodidae). *Neotropica*, 19(59): 101.
- MIRALLES, Delma A.B. de, 1976. Notas sobre gordiáceos argentinos. *Neotropica*, 22(68): 77.
- MONTGOMERY, T., 1898. The Gordioidea of certain American collections with particular reference to the North American fauna. *Bull. Mus. Comp. Zool. Harvard*, 32: 23-88.
- MONTGOMERY, T., 1907. The distribution of North American Gordiacea, with description of a new species. *Proc. Acad. Nat. Sci. Philadelphia*, 59: 270-272.
- SCIACCHITANO, I., 1958. Gordioidea del Congo Belga. *Ann. Mus. R. Congo Belga, Serie 8, Sci. Zool.*, 67: 1-111.
- VILLOT, A., 1874. Monographie des dragonneaux (genre *Gordius* Dujardin). *Arch. Zool. Exp. Gén.*, 3: 181-238.

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