NEW PUDICINAE (TRICHOSTRONGYLINA, HELIGMOSOMOIDEA) COPARASITES OF *PROECHIMYS LONGICAUDATUS* (CAVIOMORPHA) FROM BOLIVIA. I - DESCRIPTION OF *PUDICA GINSBURGI* N. SP. AND *HELIGMOSTRONGYLUS CHIARAE* N. SP.

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Summary :

Two new Pudicinae (Trichostrongylina, Heligmosomoidea, Heligmonellidae) coparasites of *Proechimys longicaudatus* (Caviomorph rodent) from Bolivia are described: *Pudica ginsburgi* n.sp. is differentiated from all the other species of the genus by the great length of the spicules and of the vestibule and by a different ratio of the length of the spicules on the length of the body. *Heligmostrongylus chiarae* n.sp. has very developed rays 4, strongly divergent from rays 5 as occurs in three other species, *H. almeidai* (Durette-Desset & Tcheprakoff, 1969), a parasite of *Trichomys apereoides* (= *Cercomys cunicularius*) from Brazil, *H. squamastrongylus* (Travassos, 1937), a parasite of *Proechimys oris* from Brazil and *H. proechimysi* Durette-Desset, 1970, a parasite of *Proechimys semispinosus* from Columbia. The specimens from Bolivia are differentiated from the three species by the division of the dorsal ray (anterior half versus posterior half) and by a different ratio of the length of the spicules on the length of the body.

KEY WORDS : *Pudica ginsburgi* n. sp., *Heligmostrongylus chiarae* n. sp., Nematoda, Trichostrongylina, Pudicinae, Caviomorph rodents, Bolivia.

Résumé : DESCRIPTION DE DEUX NOUVEAUX PUDICINAE (TRICHOSTRONGYLINA, HELIGMOSOMOIDEA, HELIGMONELLIDAE) COPARASITES DE *PROECHIMYS LONGICAUDATUS* (CAVIOMORPHES) EN BOLIVIE

Pudica ginsburgi n.sp. se différencie de toutes les autres espèces du genre par des spicules et un vestibule très longs et par un rapport différent de la longueur des spicules sur la longueur du corps. Heligmostrongylus chiarae *n.sp. possède des côtes 4 dont les extrémités divergent fortement de celles des côtes 5 comme c'est le cas de trois autres espèces,* H. almeidai *(Durette-Desset & Tcheprakoff, 1969), parasite de* Trichomys apereoides *(=* Cercomys cunicularius*), au Brésil,* H. squamastrongylus *(Travassos, 1937), parasite de* Proechimys oris *au Brésil et* H. proechimysi *Durette-Desset, 1970, parasite de* Proechimys semispinosus *en Colombie. Les spécimens de Bolivie se différencient de ces trois espèces par la division de la côte dorsale dans sa moitié antérieure et par un rapport différent de la longueur des spicules sur la longueur du corps.*

MOTS CLÉS : *Pudica ginsburgi n. sp., Heligmostrongylus chiarae n. sp., Nematoda, Trichostrongylina, Pudicinae, Rongeurs caviomorphes, Bolivie.*

INTRODUCTION

The Trichostrongylina have a huge evolutionary capacity. They diversified during the whole of the Tertiary in all the terrestrial vertebrates. Even today, they are still evolving rapidly in some families. For example, the domestic mouse is parasitised in Europe by one species, *Heligmosomoides polygyrus polygyrus* (Dujardin, 1845). Today, two sub-species of *H. polygyrus* are present in USA, *H. polygyrus bakeri* Durette-Desset, Kinsella & Forrester, 1972, also a parasite of the domestic mouse and *H. p. americanus* Durette-Desset, Kinsella & Forrester, 1972 a parasite of Arvicolinae. The two sub speciations occurred after the introduction of the domestic mouse from Europe into America, during the 15th century (Durette-Desset, Kinsella & Forrester, 1972).

Evolutionary radiation is marked in rodents from the Neotropical region, the neo-endemic Muridae (Sigmodontinae). With the paleo-endemic Caviomorpha, a vast number of ecological niches were available for the Trichostrongylina. Therefore, the co-existence of numerous congeneric species in a single individual host is predictable, particularly in the Caviomorpha since the host-parasite association occurred long before that of the neo-endemic Muridae (Chabaud & Durette-Desset, 1978).

The Amboro Park of Santa Cruz de la Sierra Department (Bolivia) is the meeting point of four extremely different geographic areas, the mosaic of ecosystems, a place of intense intermingling and rich biodiversity: the Southern border of the Amazon basin (humid tropical forest), the Western limit of the Brazilian shield (subtropical deciduous woodland), the Northern edge of the temperate forest of the Chaco and the subtropical and temperate forests of the Andes.

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The aim of this work is to describe the first two new species found in one *Proechimys longicaudatus*. General conclusions will be presented when the full complement of the trichostrongylid fauna of this rodent is analysed.

MATERIAL AND METHODS

Rodent hosts were collected in April 1998 in the frame of a collaboration between the Institut de Recherche pour le Développement (France) and the Museo de Historia Natural Noel Kempff Mercado (Bolivia) aiming to study the parasitic fauna of small wild rodents. The study area (2,000 m of altitude) was located in the Southwestern of the Amboro Park of Santa Cruz de la Sierra Department. Rodents were dissected in the field. Gastrointestinal tracts were preserved in 5 % formalin solution and transported to the Laboratoire de Biologie parasitaire and dissected. Nematodes were removed and transferred into 70 % ethanol for storage. To know the precise location of the parasite, the small intestines were divided into four equivalent parts, numbered Si 1 to Si 4 from the duodenum to the caecum. The nomenclature of parasite taxa higher than the family-group is that of Durette-Desset & Chabaud (1993). The synlophe was studied according to the method of Durette-Desset (1985), and the nomenclature used for the components of the caudal bursa is that of Durette-Desset & Chabaud (1981). The measurements are given in micrometres except where otherwise stated. Type specimens were deposited in the Helminthological Collections of the Muséum National d'Histoire Naturelle, Paris, France (MNHN). The nomenclature concerning the hosts follows Wilson & Reeder (1993).

PUDICA GINSBURGI N. SP (FIGS 1-3)

Type material: holotype male, allotype female MNHN 20 XKa, six male, three female paratypes, MNHN 20 XKb.
Host: *Proechimys longicaudatus* (Rengger, 1830) (Echimyidae), MNHN 11 XK.
Site: small intestine (Si 1 with four males, two females; Si 2 with one male, two females; Si 3 with two males).
Geographical origin: Amboro Park, Southern, Samaipata (130 kms from Santa Cruz de la Sierra), Bolivia; altitude: 2,000 m; date: 6 April 1998.
Voucher material: two males, two females MNHN 21 XK, parasites of the small intestine (Si 1) of *Proechimys longicaudatus* MNHN 10 XK, same locality, same date.

DESCRIPTION

Small nematodes with body irregularly coiled. Nerve ring observed only five times. Excretory pore situated within third median posterior part of oesophagus. Round deirids at level of excretory pore, generally slightly anterior (Fig. 3B'). Genital branch present above level of oesophago-intestinal junction. Spicules longer than half of body. Infundibulum difficult to measure since often twisted. Vestibule very long, almost same length as uterus.

Synlophe: (studied in one male and one female from voucher material and one paratype female). In both sexes, cuticle bears longitudinally uninterrupted ridges. Ridges appearing posterior to cephalic vesicle and disappearing at about 100 anterior to caudal bursa in male and at level of anus in female.
In male (Fig. 1), 10 ridges all along body (carene, five dorsal and three ventral ridges of which median comarete); size of ridges varying all along body: in third anterior part, dorsal ridge of carene poorly developed and medio ventral ridge most developed (Fig. 1A-C). In third median part, carene as developed as comarete (Fig. 1D); in third posterior part, size of ridges progressively decreasing except carene (Fig. 1E); at about 900 from caudal bursa, all ridges of equivalent size (Fig. 1F).
In female (Fig. 2), at level of excretory pore, presence of nine ridges (carene, four dorsal, three ventral ridges of which the two nearer left lateral field, comaretes) (Fig. 2A); at end of third part of body (1 mm from head), arising of new ridge in front of right lateral field. Same pattern at mid-body with 10 ridges (carene, five dorsal, three ventral ridges) (Fig. 2C). In third anterior part of body, ventral and dorsal ridges of carene poorly developed (Figs 2A, B); at mid-body, carene most developed. At level of infundibulum, pattern of ridges greatly modified (Fig. 2D); at level of sphincter, one ventral ala appearing (joining of ridges) (Fig. 2E); at level of vestibule, all ridges disappearing except three alae, one ventral and two lateral (Fig. 2F).
In both sexes, absence of ridges in right ventral side. Axis of orientation from right to left except in posterior part of female where ridges orientated perpendicularly to body surface (Figs 1, 2).

Head: (Fig. 3A). Cephalic vesicle present. Oesophageal dorsal gland well developed. In apical view, rounded triangular buccal aperture surrounded by two amphids, four externo lateral papillae and four cephalic papillae.

Holotype male: 2.6 mm long and 90 wide at mid-body; cephalic vesicle 40 long by 28 wide; nerve ring, deirids and excretory pore situated at 150, 220 and 225 from apex, respectively; oesophagus 310 long (Fig. 3B). Slightly asymmetrical caudal bursa with right lateral lobe more developed. Left lobe: pattern of type 2-2-1. Right lobe: pattern of type 2-3 since right ray 6 separated distally from right ray 5. Rays 4 and 5 thick and joined on all length. Rays 4 slightly shorter than rays 5. Rays 8 arising from root of dorsal ray. Long dorsal ray divided at its distal third into two branches, each branch giving rise distally and at same level to rays 9

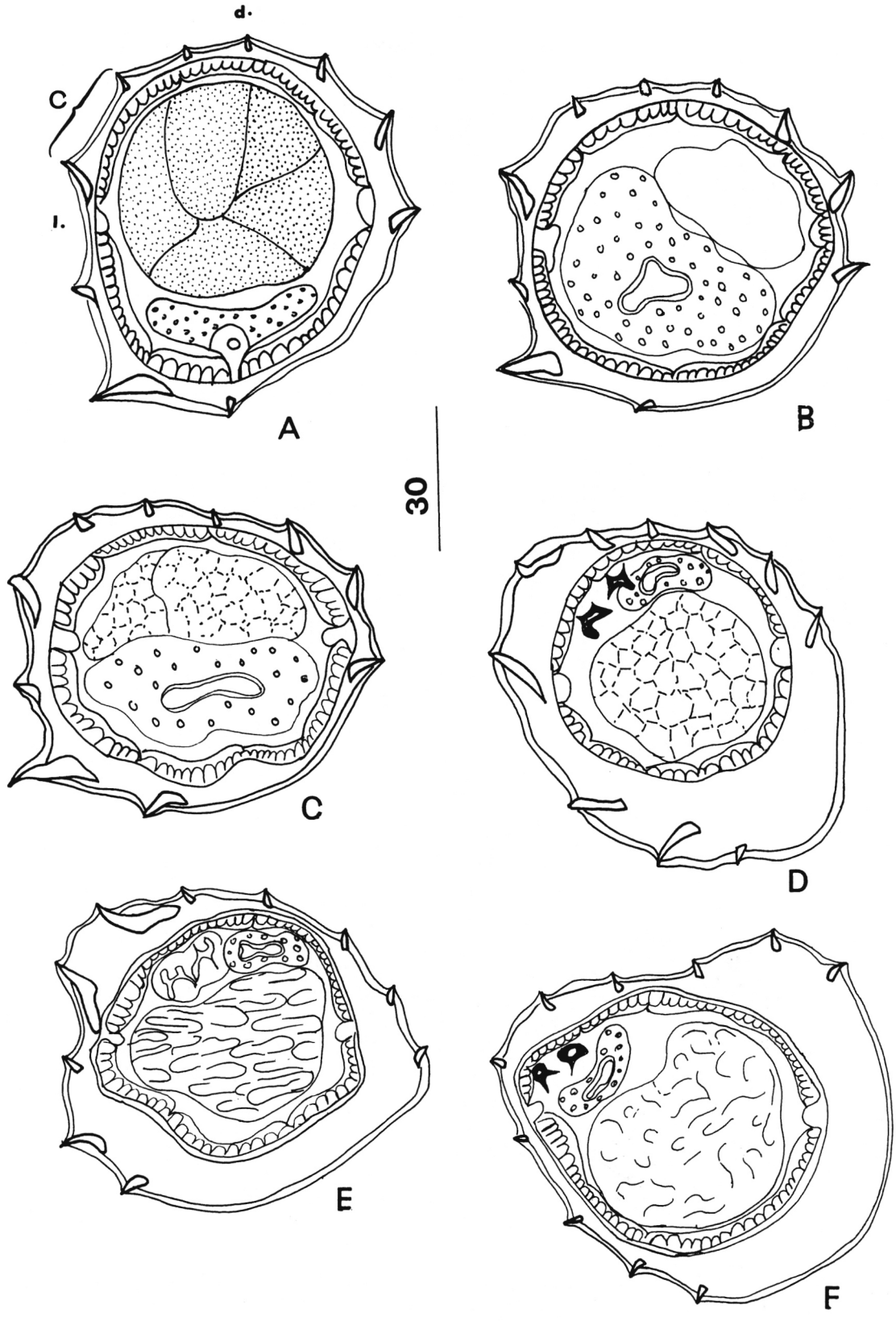

Fig. 1. – *Pudica ginsburgi* n. sp. Male from voucher material, 2.65 mm long, transverse sections of the body. A, at level of the excretory pore. B, at the beginning of the oesophagus. C, at 770 µm from head. D, at mid-body. E, at 940 µm from the caudal bursa. F, at 880 µm from the caudal bursa. All the sections are orientated as A.
Abbreviations: c: carene, l: left side, d: dorsal side.

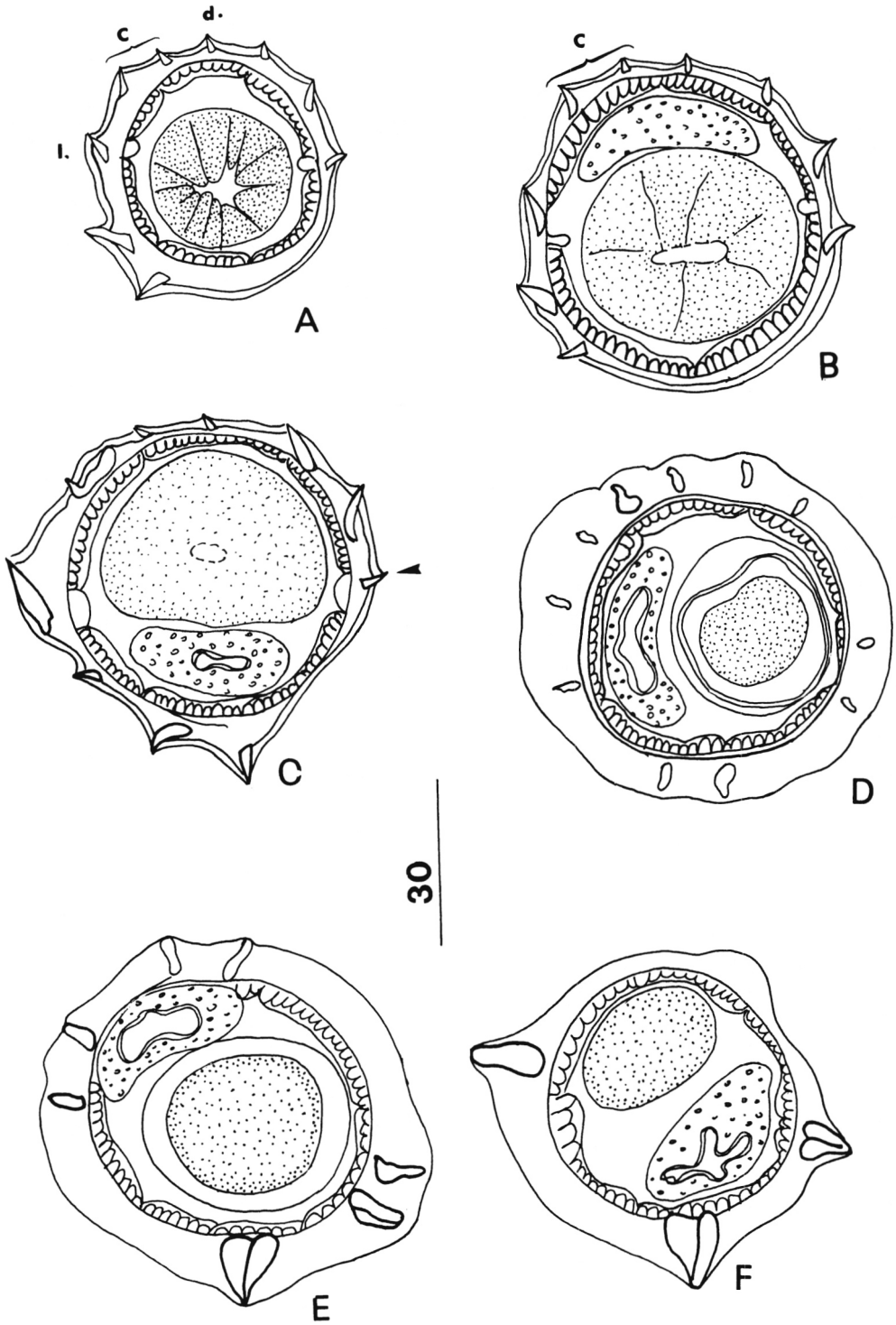

Fig. 2. – *Pudica ginsburgi* n. sp. paratype female, 3.1 mm long, transverse sections of the body. A, section between the level of the excretory pore and the end of the oesophagus. B, at 300 µm from the oesophago-intestinal junction. C, at mid-body. D, at level of the infundibulum. E, at level of the spincter. F, at level of the vestibule. All the sections are orientated as A.
Abbreviations: c: carene, l: left side, d: dorsal side. Arrow: arising of a new ridge.

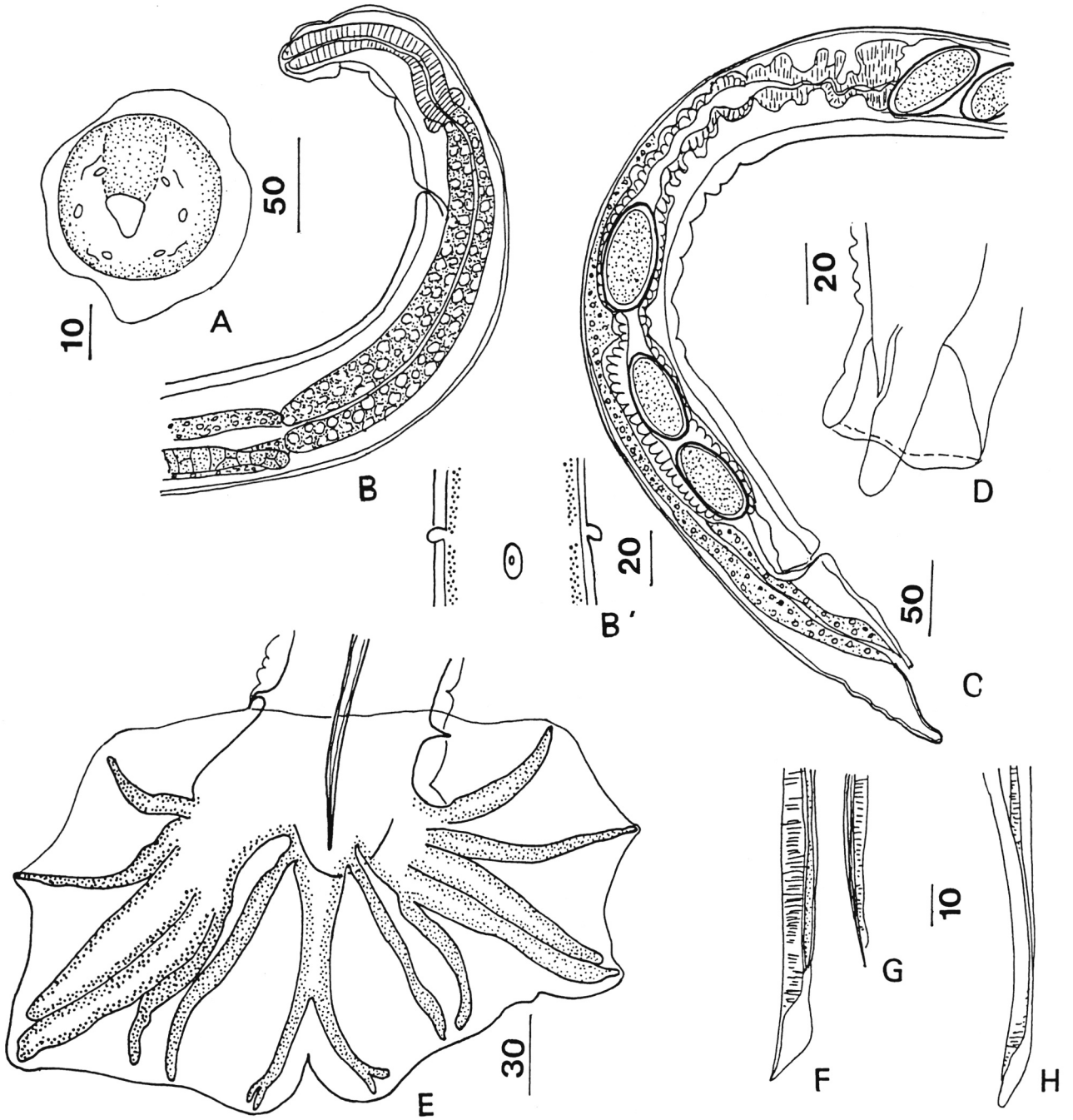

Fig. 3. – *Pudica ginsburgi* n. sp. A, male, head, apical view. B, male, anterior extremity, left lateral view. B', male, detail of the excretory pore and the deirids, ventral view. C, female, ovejector and tail, right lateral view. D, female, invaginated tail, left lateral view. E, male, caudal bursa, ventral view. F-H, male, tips of the spicules. F, left spicule with the two alae forming a groove. G, right spicule. H, the two spicules *in situ*.

(external branches) and rays 10 (internal branches) (Fig. 3E).
Filiform alate spicules, very long (1.65 mm) with asymmetric tips. Right spicule with sharp extremity (Fig. 3G), left spicule with spatulate extremity, (Fig. 3F) made up of two alae which form a groove in which right spicule lodged (Fig. 3H). Ratio of length of spicules on length of body: 63.5 %. Genital cone rounded. Papilla zero and papillae 7 not observed. Gubernaculum absent.
Averages, minima and maxima of main measurements of the six paratypes: body: 2.5 (2.2-2.7) mm; excretory pore situated at 205 (190-225) from apex; oesophagus: 350 (310-400) long; spicules: 1.5 (1.4-1.7) long; ratio of length of spicules on length of body: 61 (56-66) %.

Allotype female: 2.9 mm long and 90 wide at mid-body. Cephalic vesicle 40 long by 30 wide; nerve ring, deirids and excretory pore situated at 165, 285, 280 from apex, respectively; oesophagus 340 long.
Monodelphic: vulva at 140 from caudal extremity; *vagina vera*: 35 long; vestibule 380, sphincter 25 long by 25 wide and infundibulum 170 long; uterus 440 long with seven eggs at morula stage, 60 long by 30 wide (Fig. 3C); tail, 32 long with rounded extremity, invaginated (Fig. 3D).
Averages, minima, maxima of main measurements of the three paratypes: body: 2.6 (2.3-3.1) mm long; excretory pore situated at 210 (185-235) from apex; oesophagus: 370 (320-400) long; vulvar opening in relation to caudal extremity: 136 (130-140); *vagina vera*: 43 (40-45) long; vestibule: 373 (360-380) long; sphincter: 30 (30-30) long by 29 (25-33) wide; uterus: 373 (360-390) long; number of eggs: nine (7-14) ; size of eggs: 72 (65-80) long by 35 (30-40) wide; tail: 44 (40-50).

Discussion

The parasites described above belong to the genus *Pudica* Travassos & Darriba, 1929 (Heligmosomoidea, Heligmonellidae, Pudicinae) according to the following features: ridges continuous, presence of the carene and ventral comaretes, caudal bursa pattern of type 2-2-1. The genus *Pudica* is a parasite of Caviomorph rodents of the families Echimyidae (six species), Myocastoridae (two species) and Dasyproctidae (two species). All the species have the dorsal ray divided in its anterior part except *P. gonosoma* Cassone & Durette-Desset, 1991, a parasite of *Dasyprocta azarae* from Paraguay and the specimens described above. Therefore, these specimens are differentiated from all the other species by the great length of the spicules (1,500 versus 180 to 780 µm) and the ratio of the length of the spicules on the length of the body (61 % versus 4.7 % to 31.6 %). They are also differentiated by the great length of the vestibule in the female, co-adapted to the length of the spicules.
We consider that the specimens from *Proechimys* belong to a new species that we name *Pudica ginsburgi* n. sp. in honour of Pr. H. Ginsburg from the Hebrew University of Jerusalem, Israel.

Heligmostrongylus chiarae n. sp (Fig. 4)

Studied material: holotype male, allotype female MNHN 22 XKa, five males, 16 females, a posterior part female, paratypes, MNHN 22 XKb.
Host: *Proechimys longicaudatus* (Rengger, 1830), (Echimyidae), MNHN 11XK.
Site: small intestine (Si 1 with one female, Si 2 with one female, Si 4 with six males and 15 females).
Geographical origin: Amboro Park, Southern, Samaipata (130 kms from Santa Cruz de la Sierra), Bolivia; altitude: 2,000 m; date: 6 April 1998.

Description

Very small nematodes with body coiled with irregular and loose turns. Nerve ring observed only twice. Rounded deirids situated above excretory pore.

Synlophe: (studied in one male and one female paratypes). In both sexes, cuticle bears longitudinally interrupted ridges, arranged in linear series (Fig. 4C). Ridges appearing posterior to cephalic vesicle and disappearing just anterior to caudal bursa in male and at level of vulva in female. In male, number of ridges constant along length of body: 13 (carene, six dorsal, five ventral ridges) (Fig. 4H). In female, 14 ridges at mid-body (carene, six dorsal, six ventral ridges) (Fig. 4F). Only 11 ridges in posterior third of body with loss of one dorsal and two ventral ridges (Fig. 4G). In both sexes, carene well developed and other ridges of equivalent size. Axis of orientation sub-frontal, directed from right to left (Figs 4F-H).

Head: Very small cephalic vesicle present. In apical view, rounded triangular buccal aperture surrounded by two amphids, four externo lateral papillae and four cephalic papillae (Fig. 4B).

Holotype male: 2.8 mm long and 90 wide at mid-body, including carene 45 long; cephalic vesicle 30 long by 27 wide; nerve ring, deirids and excretory pore situated at 150, 200 and 220 from apex, respectively; oesophagus 270 long (Fig. 4A).
Symmetrical caudal bursa with pattern of type 2-2-1 (Fig. 4E). Rays 4 thick, as long as rays 5. Right ray 6 slightly longer than rays 5. Rays 2 to 6 reaching edge of caudal bursa. Very thick common trunk to rays 8 and dorsal ray. Rays 8 parallel to latter and smaller. Dorsal ray deeply divided at its proximal third into two branches, according to an angle of 70°. Each branch giving rise distally and at same level to rays 9 (external branches) and rays 10 (internal branches). Rays 9 and 10 well individualised, thick and of same length. Filiform spicules, poorly cheratinized, 240 long with sharp tips (Fig. 4E). Ratio of length of spicules on length of

body: 8.6 %. Genital cone rounded. Papilla zero and papillae 7 not observed. Gubernaculum absent.

Averages, minima, maxima of main measurements of the five paratypes: body: 2.9 (2.7-3.0) mm long; excretory pore (three specimens) situated at 215 (205-220) from apex; oesophagus: 260 (250-280) long; spicules: 226 (200-240) long; ratio of length of spicules on length of body: 7.8 (6.9-8.9) %.

Allotype female: 3.45 mm long and 90 wide at mid-body, including carene 40 long. Cephalic vesicle 30 long by 27 wide; nerve ring, deirids and excretory pore situated at 140, 205 and 200 from apex, respectively; oesophagus 265 long.

Monodelphic. Vulva at 80 from caudal extremity; *Vagina vera:* 20 long; Vestibule 52, sphincter 22 long by 28 wide and infundibulum 110 long. Uterus 410 long with five eggs at morula stage, 65 long by 40 wide (Fig. 4D); ratio of length of uterus on length of body: 14.8 %; very narrow tail, rectangular-shaped, 40 long with rounded extremity (Fig. 4D).

Averages, minima, maxima of main measurements of 10 paratypes: body: 3.9 (3.6-4.3) mm and 77.5 (70-90)

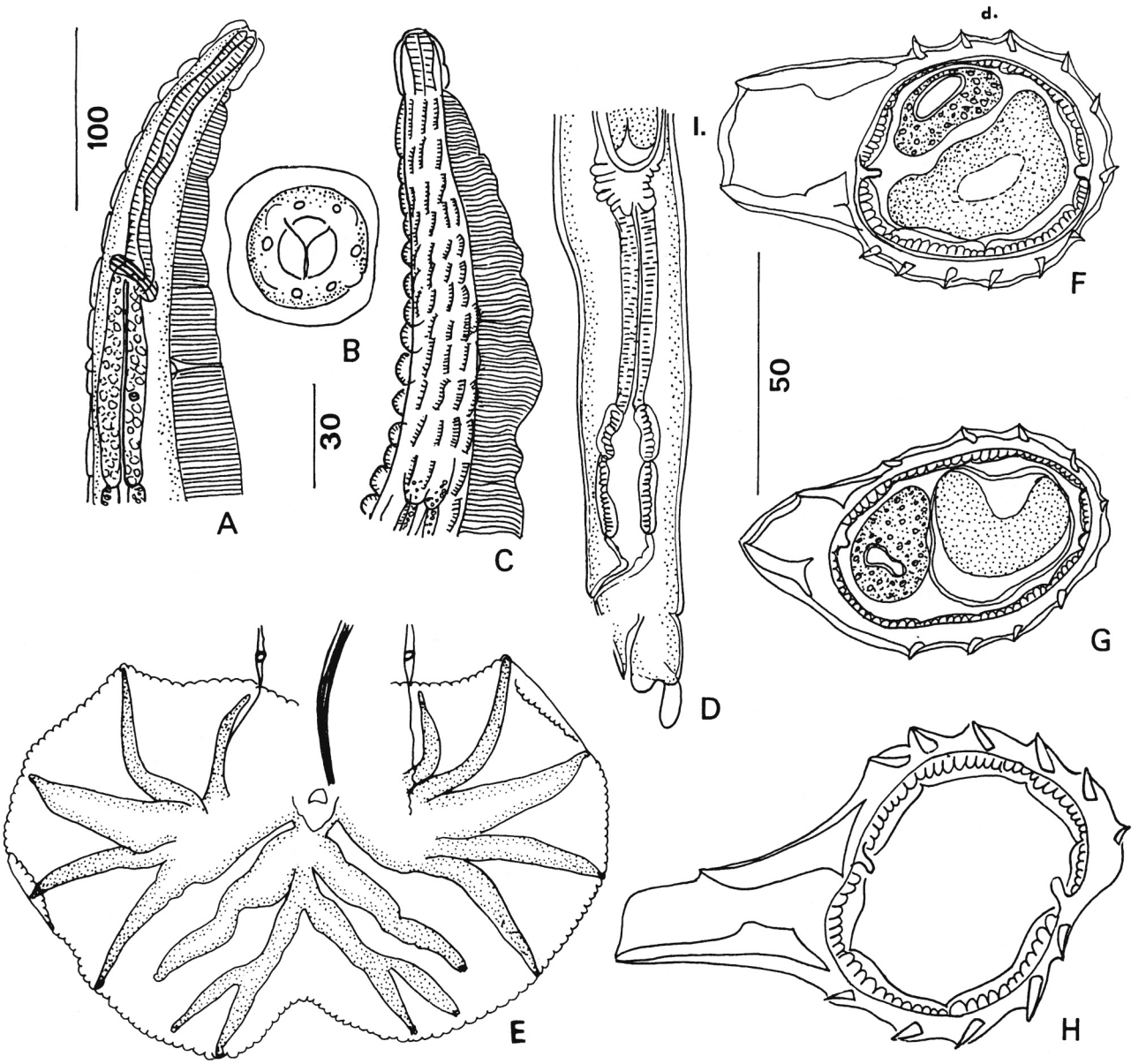

Fig. 4. – *Heligmostrongylus chiarae* n. sp. A, male, anterior extremity, ventral view. B, male, head, apical view. C, male, anterior extremity with cuticular ridges interrupted and arranged in linear series, ventral view. D, female, ovejector and tail, left lateral view. E, male, caudal bursa, ventral view. F-H, transverse sections of the body. F, G, female. F, at mid-body. G, at level of the uterus. H, male, at mid-body. All the sections are orientated as F.
Abbreviations: l: left side, d: dorsal side. Scale: A, C, D: 100 µm; B, E: 30 µm; F-H: 50 µm.

wide; excretory pore situated at 196 (170-225) from apex; oesophagus: 260 (240-290) long; vulvar opening in relation to caudal extremity: 73.5 (55-90); *vagina vera:* 25 (20-30) long; vestibule: 45 (40-55) long; sphincter: 19 (18-22) long by 25.5 (20-30) wide; infundibulum: 100 (80-130) long; uterus: 560 (410-760) long; number of eggs: seven (5-11) ; size of eggs: 68 (50-80) long by 35 (20-40) wide; tail: 38 (35-40) long.

Discussion

The parasites described above belong to the genus *Heligmostrongylus* Travassos, 1917 (Heligmosomoidea, Heligmonellidae, Pudicinae) according to the following features: ridges discontinuous and arranged in linear series; carene well developed, number of other ridges less than 13; caudal bursa pattern of type 2-2-1. The genus *Heligmostrongylus* is parasitic in Caviomorph rodents of the families Echimyidae (five species), Erethizonthidae (two species) and Dasyproctidae (one species). Amongst these species, three have very well developed rays 4, strongly divergent from rays 5 like the Bolivian parasites: *H. almeidai* (Durette-Desset & Tcheprakoff, 1969), a parasite of *Trichomys apereoides* (= *Cercomys cunicularius*), from Brazil (Exu), *H. squamastrongylus* (Travassos, 1937) a parasite of *Proechimys oris* from Brazil (Para) and *H. proechimysi* Durette-Desset, 1970, a parasite of *Proechimys semispinosus* from Columbia (Depto Valle del Cauca). The specimens from Bolivia are differentiated from the three species by the division of the dorsal ray (anterior half versus posterior half) and by a different ratio of the length of the spicules on the length of the body: 7.8 % versus 18.7 % in *H. almeidai*, 10 % in *H. squamastrongylus* and 9.8 % in *H. proechimysi*. They are also distinguished from *H. squamastrongylus* by the clear separation of rays 9 and 10 and from *H. almeidai* and *H. proechimysi* by rays 8 shorter than the dorsal ray and by the absence of vulvar alae.

We consider that the specimens from *Proechimys* belong to a new species which we name *Heligmostrongylus* n. sp. in honour of Chiara Deharo who helped us in the field.

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REFERENCES

Cassone J. & Durette-Desset M.C. Cinq espèces (dont trois nouvelles) de Nématodes Trichostrongyloïdes coparasites de *Dasyprocta azarae* au Paraguay. *Revue Suisse de Zoologie,* 1991, *98*, 229-242.

Chabaud A.G. & Durette-Desset M.C. Parasitisme par plusieurs espèces congénères. *Bulletin de la Société Zoologique de France*, 1978, *103*, 459-464.

Dujardin F. Histoire naturelle des Helminthes ou vers intestinaux. Paris, 1845, *16*, 1-654.

Durette-Desset M.C. Nématodes Héligmosomes d'Amérique du Sud. VII. Description de trois espèces nouvelles, parasites de *Proechimys semispinosus* (Rongeurs Echimyidés). *Bulletin du Muséum National d'Histoire Naturelle,* 2ème série, 1970, *42*, 601-608.

Durette-Desset M.C. Trichostrongyloid nematodes and their vertebrate hosts: reconstruction of the phylogeny of a parasitic group. *Advances in Parasitology,* 1985, *24*, 239-306.

Durette-Desset M.C. & Chabaud A.G. Nouvel essai de classification des Nématodes Trichostrongyloidea. *Annales de Parasitologie Humaine et Comparée*, 1981, *56*, 297-312.

Durette-Desset M.C. & Chabaud A.G. Note sur la nomenclature supra-familiale des Strongylida. *Annales de Parasitologie Humaine et Comparée,* 1993, *68*, 111-112.

Durette-Desset M.C., Kinsella J. M. & Forrester D.J. Arguments en faveur de la double origine des Nématodes néarctiques du genre *Heligmosomoides* Hall, 1916. *Annales de Parasitologie Humaine et Comparée,* 1972, *47*, 365-382.

Durette-Desset M.C. & Tcheprakoff R. Nématodes Héligmosomes d'Amérique du Sud. V. Description de trois nouvelles espèces parasites du *Cercomys cunicularius* Cuvier, 1829. *Bulletin du Muséum National d'Histoire Naturelle,* 2ème série, 1969, *41*, 584-597.

Travassos L. Nematodes parasitos de roedores. *Brazil Medico,* 1917, *31*, 35.

Travassos L. Revisao da familia Trichostrongylidae Leiper, 1912. *Monographias do Instituto Oswaldo Cruz*, 1937, *1*, 1-512.

Travassos L. & Darriba A.R. Notas sobre Heligmosominae. *Sciencias Medico,* 1929, *7*, 432-438.

Wilson E. & Reeder D.M. Mammal Species of the World. A taxonomic and geographic reference. Smithsonian Institution Press, Washington, London, 1993, 1207 p.

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