



DESCRIPTION OF *ELAPHOIDELLA PARAMUNA* N. SP.
(CANTHOCAMPTIDAE), A NEW HARPACTICOID
COPEPOD FROM COLOMBIA

BY

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ABSTRACT

A new species of harpacticoid copepod was discovered on submerged mosses of a high Andean lake in Colombia. The diagnostic characters of the male and female canthocamptid *Elaphoidella paramuna* n. sp. are based on the chaetotaxy of legs 1 to 4, morphology of leg 5, armature of anal urosomite, size and armature of anal operculum and morphology, armature and ornamentation of caudal rami. It belongs to the group X of Lang (1948); its relationships with *Elaphoidella pectinata*, *E. armata* and *E. brevifurcata* are discussed. The 35 species and subspecies of *Elaphoidella* known in the Neotropical region are assigned to groups I, II, VII, VIII and X of Lang's system (1948). Identification keys to Colombian *Elaphoidella* species are provided.

Key words. — Systematics, Neotropical region, Andean lakes, biodiversity, meiofauna

RESUMEN

Una nueva especie de copépodo harpacticóideo fue descubierta en musgos sumergidos de una laguna altoandina de Colombia. Los caracteres diagnósticos del macho y la hembra del cantocámptido *Elaphoidella paramuna* n. sp. se basan en la quetotaxia de las patas 1 a 4, la morfología de la pata 5, la armadura del urosomito anal, el tamaño y la armadura del opérculo anal, y la morfología, armadura y ornamentación de la rama caudal. La nueva especie pertenece al grupo X de Lang (1948); se discute su relación con *Elaphoidella pectinata*, *E. armata* y *E. brevifurcata*. Las 35 especies y subespecies del género *Elaphoidella* conocidas en el Neotrópico fueron asignadas a los grupos I, II, VII, VIII y X del sistema de Lang (1948). Se suministran claves de identificación de las especies Colombianas del género *Elaphoidella*.

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INTRODUCTION

Copepods of the family Canthocamptidae (about 980 species) (Defaye & Dussart, 2011; Gaviria-Melo et al., 2015) constitute the most species-rich family of harpacticoid copepods inhabiting continental water-bodies. Canthocamptids also include some marine representatives (i.e., *Mesochra* Boeck, 1865, *Cletocamptus* Schmankevitsch, 1875).

Within the family, the genus *Elaphoidella* includes about 230 species and subspecies, followed by *Attheyella* (about 100 species and subspecies) (Defaye & Dussart, 2011; Gaviria-Melo et al., 2015), and constitutes the most speciose genus of the family. Representatives of the genus inhabit all types of water-bodies, from surface- to groundwaters, as well as semiterrestrial environments. As most freshwater harpacticoid copepods, they show a benthic mode of life in streams and lakes, also inhabiting hyporheic, phreatic and groundwaters. Species living in terrestrial and semi-terrestrial environments inhabit mosses, leaf-litter, humid soils and phytotelmata. Brancelj (2009) showed that the number of species of *Elaphoidella* in most countries varies between 0 and 5, exceeding 10 in 5 European countries (Bulgaria, France, Italy, Romania and Slovenia). Mori & Brancelj (2008) highlighted that one-third of the known species of *Elaphoidella* has been recorded from Europe. These high numbers in Europe are related to the presence of groundwater species and the large extension of karstic systems, in connection with the number of taxonomic experts in the region. Recently, efforts to study the groundwater species of the genus outside Europe have been made: Brancelj et al. (2010) described *Elaphoidella namnaoensis* Brancelj, Watiroyram & Sanoamuang, 2010 from a cave in Thailand, and Watiroyram et al. (2015) described two species, *Elaphoidella jaesornensis* Watiroyram, Brancelj & Sanoamuang, 2015 and *Elaphoidella thailandensis* Watiroyram, Brancelj & Sanoamuang, 2015, from caves in the same country.

Several attempts have been made to find morphological affinities and to establish phylogenetically related groups of species of this very species-rich genus. Lang (1948) established 10 groups that are still valid. Petkovski & Brancelj (1988) added an 11th group in the description of *Elaphoidella serbica* Petkovski & Brancelj, 1988, and Gaviria (1993) suggested an additional group to accommodate *Elaphoidella colombiana* Gaviria, 1993. Apostolov (1985) split *Elaphoidella* into four genera based on the number of articles of the swimming legs and on the structure of the fifth leg. Later he created a new genus, *Praelaphoidella* Apostolov, 1991. These genera have not been accepted yet because no natural groups were considered and because important morphological characters such as the structures used for reproduction were disregarded. Moreover, some species were not taken into consideration (Reid, 1990; Defaye & Dussart, 2011). Nonetheless, the compilation of the species and elaboration of a species list was very valuable at that time

(Reid, 1990; Wells, 2007). The genera cannot be accepted before a revision of the genus is done (see also Defaye & Dussart, 2011).

In the Neotropical region, 35 species and subspecies of *Elaphoidella* are known, belonging to five different groups of Lang defined mainly by the size of the basoendopod and the chaetotaxy of the fifth pair of legs of the female, the number of segments of the endopod of the first leg in both male and female, and the structure of the armament of the last segment of the endopod of the fourth pair of legs in the male.

Group I: *Elaphoidella cabezasi* Petkovski, 1982, *Elaphoidella jojoi* Petkovski, 1982, *Elaphoidella quemadoi* Petkovski, 1982 and *Elaphoidella sabanillae* Petkovski, 1982.

Group II: *Elaphoidella bidens bidens* (Schmeil, 1894), *Elaphoidella bidens subterranea* Nogueira M. H., 1959, *Elaphoidella grandidieri* (Guerne & Richard, 1893), *Elaphoidella neotropica* Petkovski, 1973, *Elaphoidella parvifurcata* Petkovski, 1980 and *Elaphoidella laciniata* (Van Douwe, 1911) (female only).

Group VII: *Elaphoidella schubarti* Chappuis, 1936, *Elaphoidella humboldtii* Löffler, 1963, *Elaphoidella botosaneanui* Petkovski, 1973, *Elaphoidella crenobia* Petkovski, 1973, *Elaphoidella einslei* Petkovski, 1973, *Elaphoidella subcrenobia* Petkovski, 1980, *Elaphoidella turgisetosa* Petkovski, 1980, and possibly *Elaphoidella negroensis* Kiefer, 1967 and *Elaphoidella prohumboldti* Petkovski, 1980, both latter species with undescribed males.

Group VIII: *Elaphoidella surinamensis* (Delachaux, 1924), *Elaphoidella malayica* Chappuis, 1928, *Elaphoidella seweli americana* (Chappuis, 1933), *Elaphoidella bispina* Dussart, 1984, *Elaphoidella radkei* Reid, 1987, *Elaphoidella paraplesia* Kiefer, 1967 and *Elaphoidella suarezi* Reid, 1987. *Elaphoidella malayica* originally described from Java, was reported from Martinique (Dussart, 1982).

Group X: *Elaphoidella armata* (Delachaux, 1917), *Elaphoidella pectinata* (Delachaux, 1924), *Elaphoidella brevifurcata* Chappuis, 1936, *Elaphoidella jakobii* Nogueira M. H., 1959, *Elaphoidella neoarmata* Petkovski, 1973, *Elaphoidella karllangi* Petkovski, 1973, *Elaphoidella synjakobi* Petkovski, 1980 and *Elaphoidella parajakobii* Reid & José, 1987 (female only).

According to Reid & José (1987), *Elaphoidella pintoae* Reid & Jose, 1987, described only from a female, shows the most similarities with group II. Nevertheless, due to the differences in chaetotaxy of the swimming legs, it should be placed in a subgroup of group II until the male is discovered and described.

Elaphoidella colombiana belongs to an additional group that can be named group XII, as already proposed by Gaviria (1993). Groups I, II, VII, VIII, and X also include species that are distributed outside the Neotropical region (Karanovic, 2001; Dussart & Defaye, 2011). Within the listed species only two, *E. bidens bidens* and *E. grandidieri*, show a wide distribution in the world, while all others

are endemic to their region. Group XI, created in 1988, includes *Elaphoidella serbica* Petkovski & Brancelj, 1988 currently only known from Serbia.

The first record of the genus *Elaphoidella* in Colombia was provided by Löffler (1972). He reported the presence of a taxon in northern Colombia that he named *Elaphoidella schubarti*-group (Löffler, 1972, fig. 5). Unfortunately, the species was not described and, therefore, no exact definition of the species can be considered. Years later, Reid (1987) described *E. radkei* and *E. suarezi*, collected in outdoor tanks at the Magdalena Valley in central Colombia. Six years later, a third species, *E. colombiana*, was described from a high mountain lake from the Eastern Andean Cordillera (Gaviria, 1993). During a study on the biodiversity of microcrustaceans in northwest Colombia (1999-2000), the first author found *E. bidens bidens* at Palmitos, Antioquia, in Laguna Cerro del Padre Amaya, and *E. grandidieri* at the university campus of the Universidad de Antioquia in Medellín (Gaviria & Aranguren, 2007). Recently, Fuentes-Reines & Zoppi de Roa (2013) reported *E. grandidieri* in Ciénaga Grande de Santa Marta, a Caribbean coastal lagoon. Thus, five species are known from Colombia, all inhabiting surfacewater bodies, either in cold waters (*E. colombiana*) or in warm waters (*E. radkei*, *E. suarezi*, *E. bidens bidens* and *E. grandidieri*). The present record includes the description of a new species from a cold, high mountain lake of the Eastern Andean Cordillera.

MATERIAL AND METHODS

The sample containing harpacticoid copepods was collected at Laguna de Buitrago, Colombia (for details of the lake, see type locality of the species), using a handnet of 100 μm mesh size near the banks of the lake. The sample was fixed with 5% formaldehyde (approx. final concentration).

Specimens were later transferred to lactic acid, measured, dissected in glycerine and mounted on slides with gelatine-glycerine. Mouthparts of the animals were dissected using tungsten needles sharpened in an electrolytic bath constituted of a NaCl solution and a 9 V battery (Camacho & Puch, 1990); “minutiae needles” were used to dissect appendages. The animals were examined under a Leica DMLB compound microscope. Illustrations were done using a drawing tube mounted on the microscope; final plates were elaborated with the Adobe Photoshop CS3 program after scanning the drawings.

The descriptive terminology follows Huys & Boxshall (1991). However, we used the term “intercoxal plate” (Dussart & Defaye, 2001) to describe the structure connecting the legs.

Specimens were deposited at the Instituto de Ciencias Naturales, Museo de Historia Natural, Universidad Nacional de Colombia (ICN-MHN), the Muséum national d’Histoire naturelle, Paris (MNHN) and the Naturhistorisches Museum Wien, Vienna (NHMW).

SYSTEMATIC PART

Order HARPACTICOIDA Sars, 1903

Family CANTHOCAMPTIDAE Brady, 1880

Genus *Elaphoidella* Chappuis, 1928***Elaphoidella paramuna* n. sp.**

(figs. 1-8)

Material examined.— Holotype, female ICN-MHN-CR 2716, dissected on 3 slides, collected on 13.vi.1989 on submerged *Sphagnum* moss at Laguna de Buitrago (4°45'15"N 73°49'44"W), 3560 m altitude, 0.81 ha surface area, 3 m mean depth, Chingaza Region, Cundinamarca, Colombia, leg. S. Gaviria.

The following animals are paratypes, with same locality, date and collector as the holotype: allotype, male ICN-MHN-CR 2717, dissected on 2 slides; 1 female NHMW 25495, dissected on 3 slides; 1 male NHMW 25496, dissected on 2 slides; 1 female NHMW 25498, dissected on one slide; 1 female NHMW 25527 undissected on one slide; 1 female and 2 males ICN-MHN-CR 2718, undissected, in ethanol; 1 female and 2 males NHMW 25497, undissected, in ethanol; and 1 female MNHN-IU-2013-8002 and 1 male MNHN-IU-2013-8003 dissected, each on one slide.

Etymology.— The species name *paramuna* is derived from “páramo”, the wet climate zone above the Andean forest, where the lake inhabited by the species is located. This region may be the main ecosystem inhabited by the species. The name is to be treated as an adjective agreeing in gender with the (feminine) generic name.

Diagnosis.— *Elaphoidella* of rather small size, less than 450 μm . Body squat. Somites with dorsal posterior edges smooth in most of their length and only long setules on sides. Anal urosomite without posterolateral spinules. Anal operculum well developed, with 9 to 13 (female) and 8 to 10 (male) long spinules reaching middle of caudal rami. Male and female caudal rami subquadrate, without dorsal carina and with characteristic row of long and curved spinules on mid-dorsal and inner lateral surface forming a half-crown. Furcal setae: setae II and III slender and longer than ramus, seta II inserted on distal quarter of ramus, seta III inserted apically. Legs 1, 2, 4 and exopod of leg 3 similar on male and female, dimorphism present in number of armature elements of distal segment of endopod of leg 4 (3 in female, 2 in male), size of inner seta of apical segment of endopod leg 2 (longer in female) and size of third segment of exopod of legs 2 and 3 (longer than corresponding second segment in female, same size in male).

Female characterized by leg 5 with exopod and basoendopod (inner edge) with 3 and 4 armaments, respectively, basoendopod with inner edge extended, as long as exopod, with wide gap between basoendopod extension and exopod. Somites with posterior edges smooth, row of spinules near posterior edges of genital-double somite (dorsally on each side and laterally) and on urosomite 2 and 3 (dorsally on

each side, laterally and ventrally); urosomite 4 with 7-8 spinules near basis of each caudal ramus ventrally.

Male leg 5 with fused basoendopods and without armaments on inner edge, exopod with 3 armaments. Leg 3 endopod second segment with articulated process on outer margin, apophysis 2 times as long as third segment, ending in 1 barb, third segment with 2 setae.

Description of female (figs. 1-4, except 3f).— Length of holotype 443 μm (excluding caudal setae). Habitus cylindrical with cephalosome slightly wider than thorax and abdomen, cephalosome with small rostrum and rounded integumentary window (fig. 1a) located just in the middle. Cephalosome, thorax and genital double-somite with scarce long sensilla distributed as shown in fig. 1a and 1b. Somites with posterior edges smooth. Thorax somites without spinules. Genital double-somite as long as the following two somites, copulatory tube long, opening of copulatory pore at third quarter of somite (fig. 2c), this somite bearing at each side of dorsal surface a row of long spinules inserted laterodorsally (fig. 1a, b); third and fourth urosomites with row of spinules dorsally and laterally distributed, as in genital double-somite but prolonged ventrally (figs. 1b and 2c). Anal urosomite with 6 spinules inserted near inner base of each caudal ramus ventrally; anal operculum well developed, slightly convex, with 9 long spinules reaching half of caudal rami (fig. 1d).

Caudal ramus (figs. 1d) subquadrate, almost as wide as long (ventrally), without dorsal carina, seta I absent, seta II and III slender, with similar size, longer than caudal ramus; seta II inserted at last quarter of caudal ramus, with 4 spinules near its base (fig. 2d); setae III (outermost seta), IV, V and VI inserted apically; setae IV and VI about of same length as ramus, short and very thin, the latter longer than the former; seta V strong and very long (fig. 1c), as long as cephalothorax and urosomites I to IV together; seta VII (dorsal seta) inserted in third quarter of caudal ramus, its proximal section compound, composed of two small segments. A row of 3-4 long-arched spinules inserted on dorsolateral inner surface forming a semi-crown on ramus, dorsal spinules of crown inserted anterior to dorsal seta, dorsal surface of caudal ramus with 2 additional spinules (shorter and broader than crown spinules) inserted near beginning of crown.

Antennule (fig. 3a): 8-segmented, with setation formula (setae and setules) 1, 8, 5, 1 + aesthetasc (seta and aesthetasc with conjoined bases), 1, 3, 2, 6 and 1 + aesthetasc (seta and aesthetasc with conjoined bases); both aesthetascs as long as four distal segments of antennule together.

Antenna (fig. 3b) with allobasis. Exopod 1-segmented, with 2 lateral smooth setae and 2 apical setae, outer apical seta smooth, ornamentation of inner apical not observed seta (broken seta). Endopod 1-segmented, outer margin with 5 spines,

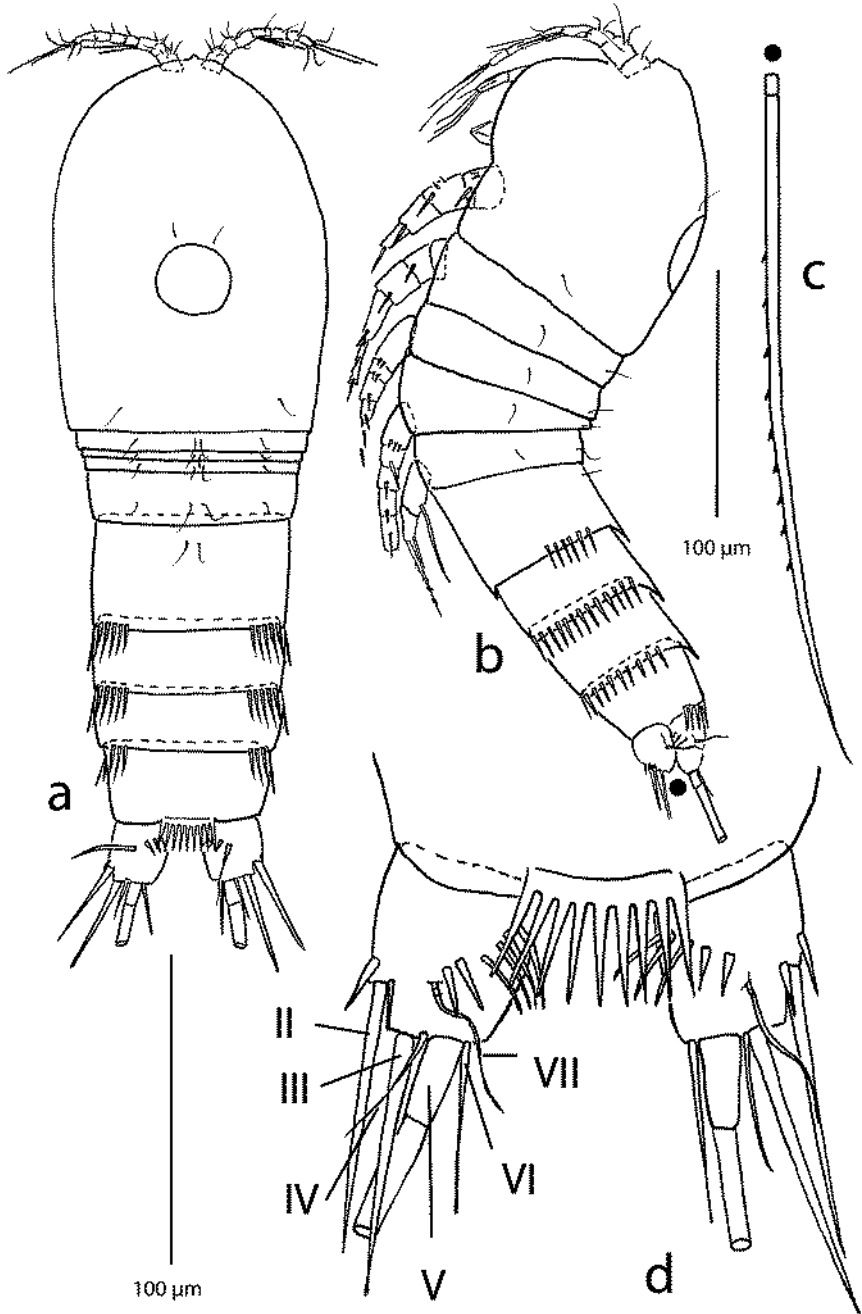


Fig. 1. *Elaphoidella paramuna* n. sp. Female. a, Habitus, dorsal; b, habitus, lateral; c, caudal ramus, seta V; d, caudal rami, dorsal (for Roman numbers, see text).

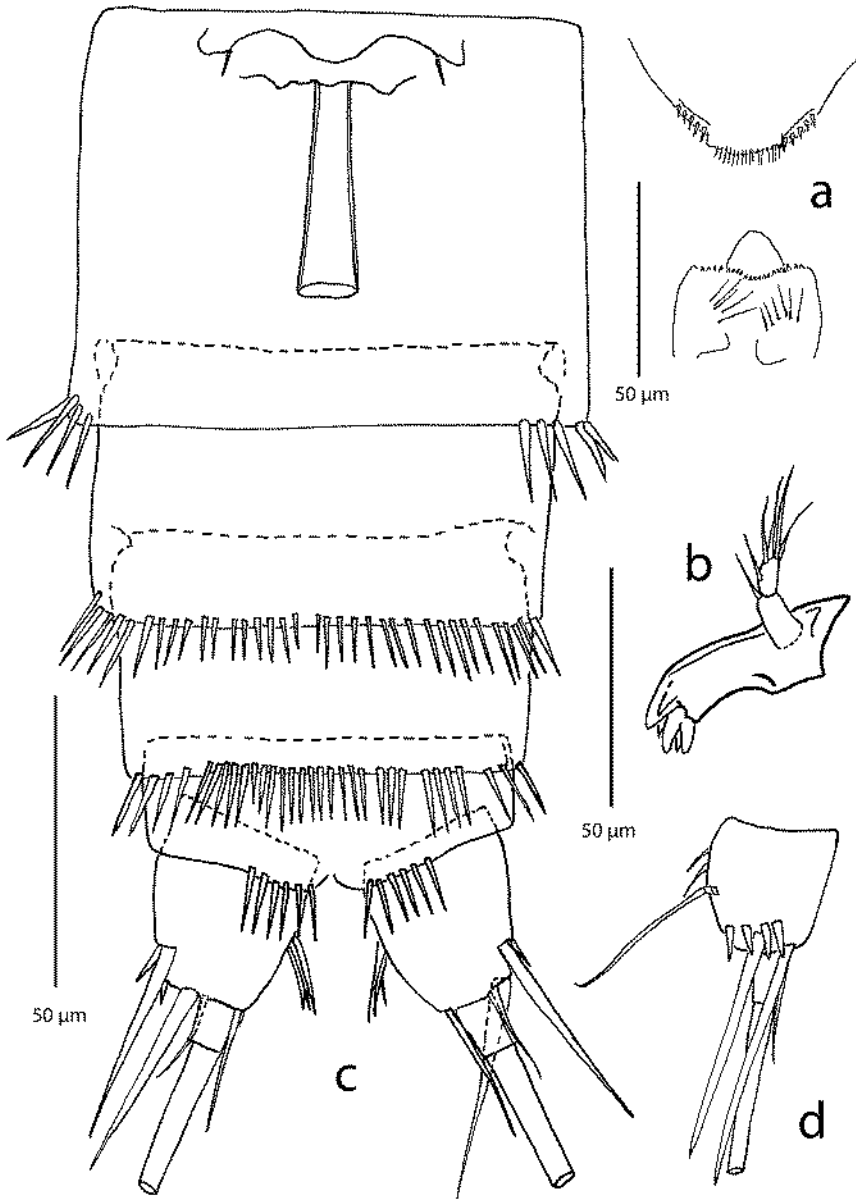


Fig. 2. *Elaphoidella paramuna* n. sp. Female. a, Labrum and paragnath; b, mandible; c, abdomen, ventral; d, caudal ramus, lateral.

2 apicalmost short, inner margin with 1 short spine, apical margin with 1 spine, 1 naked normal seta and 3 geniculated setae of unequal length.

Labrum (fig. 2a) armed with a central row of thin teeth and 1 lateral row at each side of 5 stronger teeth.

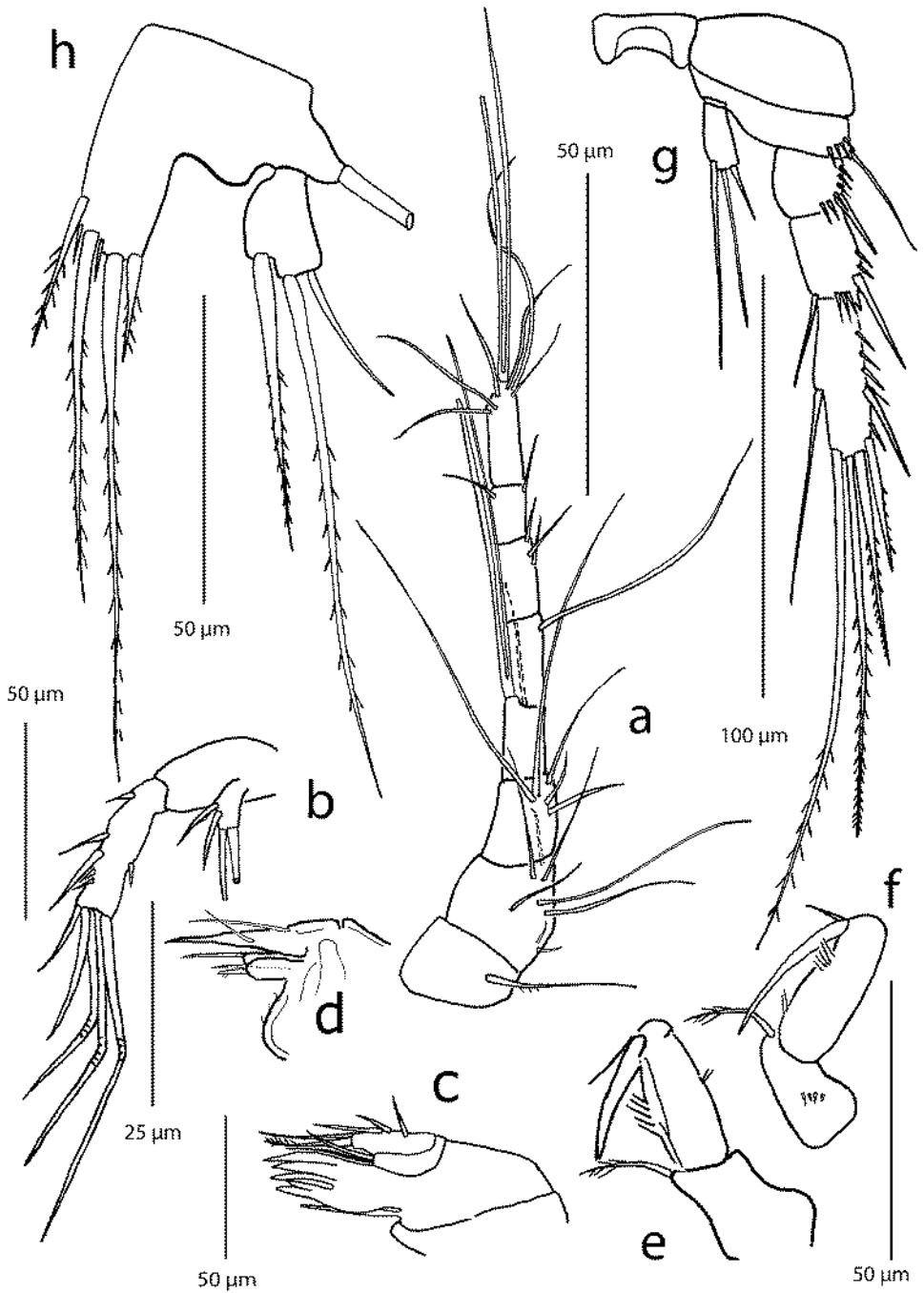


Fig. 3. *Elaphoidella paramuna* n. sp. Female (a-e, g-h), male (f; paratype NHMW 25498). a, Antennule; b, antenna; c, maxillule; d, maxilla; e, maxilliped; f, maxilliped (male); g, leg 4; h, leg 5.

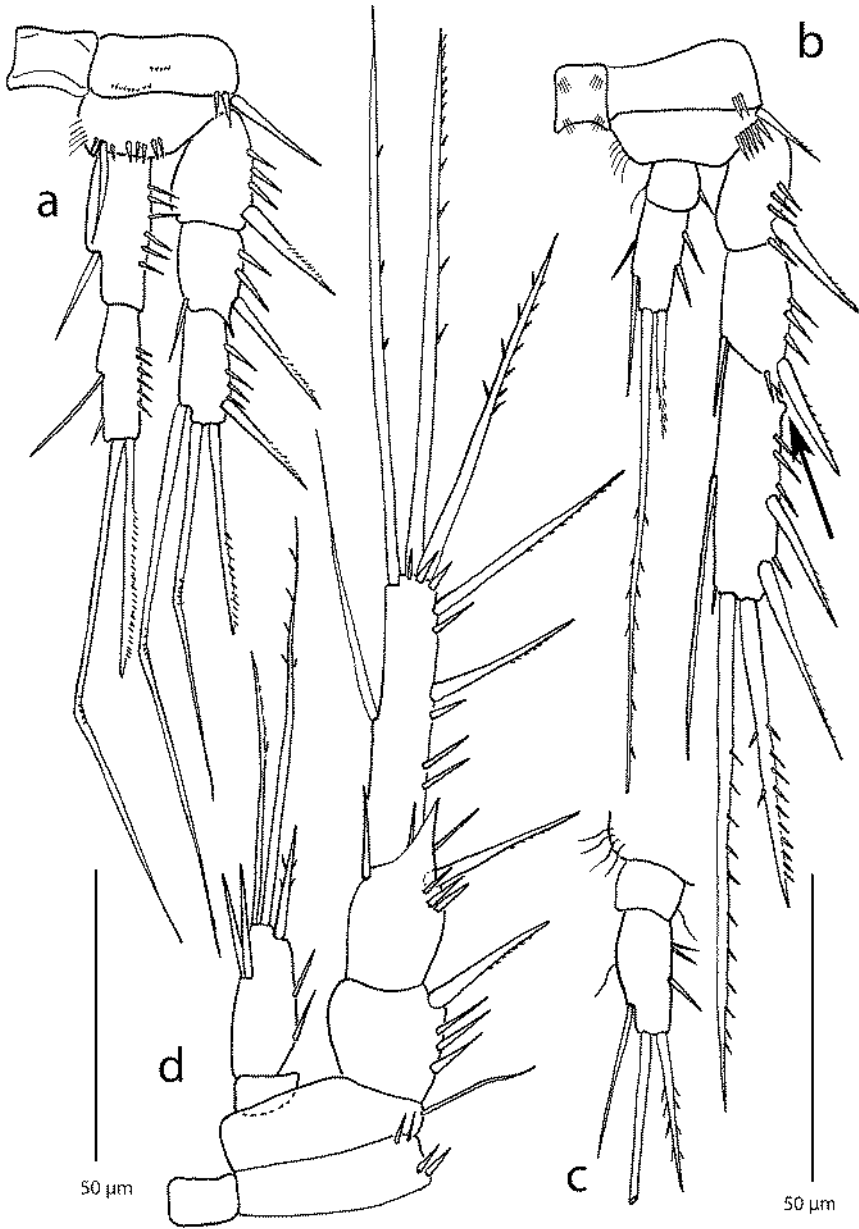


Fig. 4. *Elaphoidella paramuna* n. sp. Female. a, Leg 1, anterior; b, leg 2 (arrow indicates bulge on outer margin); c, leg 2, endopod (paratype NHHM 25495); d, leg 3.

Paragnath (fig. 2a) rectangular, its anterior margin ornamented with small teeth, with round half-plate. Ventral surface with 1 diagonal row of long setae at each side.

Mandible (fig. 2b), gnathobase with 6 strong, chitinized teeth. Mandibular palp long, 2-segmented. Basal segment (basis) with 1 seta, distal segment (endopod) with 1 lateral seta and 4 apical setae.

Maxillule (fig. 3c) with broad precoxa bearing 1 inner smooth seta inserted near base of arthrite, arthrite proximally narrow, apically with 5 large spines, spines strongly chitinized. Coxa with 2 smooth subequal setae. Basis with 3 lateral smooth elements (spines ?), apical margin with 1 smooth outer seta and 1 large inner seta, inner seta distally bipinnate.

Maxilla (fig. 3d) with 2 endites, proximal endite with 2 short terminal setae, first seta unipinnate, second seta smooth; distal endite with 1 seta; basis with claw and 2 setae.

Maxilliped (fig. 3e) (paratype NHMW 25498) prehensile, with strong, unarmed and unornamented syncoxa, inner margin with distal seta, long basis more than 2 times as long as broad, with 5 spinules on outer margin, 2 tiny spinules on inner margin and naked apical seta inserted near insertion of claw. Endopod consisting of slightly curved claw. Seta of syncoxa of maxilliped of holotype lost during dissection.

Legs 1 and 2 (without terminal setae) distinctly shorter than legs 3 and 4.

Leg 1 (fig. 4a): intercoxal plate unarmed. Coxa with 2 rows of minute spinules on anterior surface distributed as shown in fig. 4a, and 2 spinules near outer distal corner. Basis with 1 naked spine on outer margin, 1 naked seta inserted near base of endopod, row of 3 spinules near base of seta and row of 5 spinules near distal margin of segment. Exopod 3-segmented; first segment with 1 unipinnate spine and spinules on outer margin; second segment with expanded distal outer corner, outer margin with 1 unipinnate spine and spinules, inner margin with 1 naked seta; third segment with 1 unipinnate spine and spinules on outer margin, apical margin with 1 unipinnate spine and 1 geniculate seta, inner margin with 1 long geniculate seta inserted subapically. Endopod 2-segmented, a little longer than exopod; first segment with 1 naked seta on inner margin and a row of spinules on outer margin; second segment with a long and a short (spinule ?) naked seta on inner margin, apical margin with 1 geniculate long seta and 1 unipinnate spine, outer margin with a row of spinules.

Leg 2 (fig. 4b): intercoxal plate with 4 rows of tiny spinules on anterior surface, 2 of them inserted proximally and 2 of them inserted distally; coxa ornamented with 2 spinules near distal outer corner. Basis with outer unipinnate spine and row of 5 spinules near base of exopod and hairs at inner corner. Exopod 3-segmented; first segment with 1 unipinnate spine and spinules on outer margin and 1 spinule near apical margin beside outer spine; second segment with expanded distal outer corner, outer margin armed like first segment and inner margin with 1 naked seta; third segment 2 times as long as second segment, with 1 seta inserted

medially and 1 subapical spinule on inner margin, apical margin with 1 inner long unipinnate seta and 1 outer bipinnate spine (inner margin of spine with few secondary spinules), outer margin of segment with 1 proximal bulge, 2 unipinnate spines and spinules. Endopod 2-segmented (hairs not described); first segment with 1 spinule on outer margin (spinule absent in paratype NHMW 25495); second segment with 2 spinules on outer margin (3 in paratype NHHM 25495), 2 bipinnate setae on apical margin (innermost seta exceeds by far tip of inner seta of inner margin of exopod), inner margin with 1 naked seta and 1 spinule (spinule absent in paratype NHHM 25495). Hairs on inner and outer margin of first segment of endopod variable in number.

Leg 3 (fig. 4d): intercoxal plate unarmed. Coxa with 2 spinules near outer margin and 2 spinules near distal outer corner of segment. Basis with thin naked seta on outer margin. Exopod 3-segmented; first segment broader than other segments, with unipinnate spine and spinules on outer margin, second segment with distal outer corner strongly expanded, 1 unipinnate spine and spinules on outer and near distal margins, inner margin with 1 naked seta; third segment (excluding expanded corner) 2 times as long as second segment, with 2 unipinnate spines and spinules on outer margin, apical margin with 1 outer bipinnate spine, 1 apical unipinnate seta and 1 inner unipinnate seta and inner margin with 1 naked seta, anterior surface of segment with spinules near apical margin. Endopod 2-segmented; first segment unarmed, very short; second segment with 2 spinules and a bipinnate seta on outer margin, apical margin with 1 unipinnate inner seta and 1 bipinnate outer seta (latter with only 1 secondary setula on outer margin), inner margin with 2 naked spinules, both spinules of same size and inserted at the same distance from the first segment. Right leg 3: second segment of endopod with second spinule of outer margin difficult to see because it is inserted behind first spinule.

Leg 4 (fig. 3g): intercoxal plate and coxa unarmed. Basis with 1 thin naked seta on outer margin and 4 spinules on anterior surface near apical outer corner. Exopod 3-segmented; first segment with naked spine and spinules on outer margin, anterior surface with spinules near apical outer corner; second segment armed as first segment, additionally with 1 naked seta on inner margin; third segment 2 times as long as second segment with 1 naked spine, 1 unipinnate spine and spinules on outer margin, apical margin with 1 bipinnate spine and 1 bipinnate seta, inner margin with 1 bipinnate seta inserted subapically and a naked median seta. Endopod bisegmented; first segment very short, second segment ending with two apical naked setae and one subapical inner naked seta.

Leg 5 (fig. 3h): right and left basoendopods separated, expansion of basoendopod as long as exopod, broad gap between basoendopod and exopod, basoendopod medial margin with protuberance, basoendopod with 4 major bipinnate armaments,

setae I (innermost) and IV short, setae II and III long, the latter longer than the former, anterior surface with 2 spinules near insertion of seta II, outer margin of basoendopod with lateral naked seta. Exopod 2 times as long as broad, with narrow base, innermost seta bipinnate and inserted subapically, medial and outer seta inserted apically, medial seta long and bipinnate, outer seta short and naked.

Legs 1-4 with following formula of major spines (Roman numerals) and setae (Arabic numerals).

	Coxa	Basis	Exopod	Endopod
Leg 1	0-0	I-1	I-0, I-1, I-II-I	0-1, 0-I+1-2
Leg 2	0-0	I-0	I-0, I-1, II-II-1	0-0, 0-2-1
Leg 3	0-0	1-0	I-0, I-1, II-I+1-2	0-0, II-2-1
Leg 4	0-0	1-0	I-0, I-1, II-I+1-2	0-0, 0-2-1

Leg 6 (fig. 2c) represented by a small plate with 1 spinule (difficult to see) located anterior to genital field.

Male (figs. 5-8): length of allotype 335 μm (excluding caudal setae), habitus (fig. 5a, b) cylindrical, with broadest section at midlength of cephalosome. Cephalosome with rounded integumentary window, located more anteriorly than female. Cephalosome and thorax with scarce median and lateral sensilla. Somites with posterior edges smooth. Thorax somites without spinules. First urosomite on each side of dorsal surface with a small row of spinules inserted near posterior edge; second, third and fourth urosomites dorsally with row of spinules inserted as in first urosomite, this row of spinules prolonged laterally and ventrally; anal somite with ventrally group of 6 spinules near base of each caudal rami (fig. 6c). Anal operculum as in female but with 10 long spinules instead of 9.

Caudal ramus (figs. 5c, 6a-c) as in female, except size of setae II and III, insertion position of spinules of half-crown and additional dorsal spinules; setae II and III 1.5 to 2 times as long as caudal ramus (ventrally), dorsal spinules of half-crown inserted more apically than in female (insertion of first spinule of half-crown more posterior than insertion of dorsal seta), additional short spinules dorsally near spinule half-crown absent (2 spinules in female) (fig. 6b).

Antennules (fig. 7a-e): 8-segmented, geniculated between third and fourth segment and between fifth and sixth segment, fourth segment expanded, antennules with setation formula (observed on paratype NHMW 25496) (fig. 7b-e) 1, 5, 2, 1 + aesthetasc (seta and aesthetasc with conjoined bases), 0, 0, 0, 5 and 1 + aesthetasc (seta and aesthetasc with conjoined bases).

Antenna as in female. Mandible, maxillule and maxilla not studied. Maxilliped (fig. 3f) similar to that of female (fig. 3e) except ornamentation. Syncoxa, outer margin with bipinnate seta inserted near basis (seta probably broken during dissection), ventral surface with row of tiny spinules (absent in female), basis outer

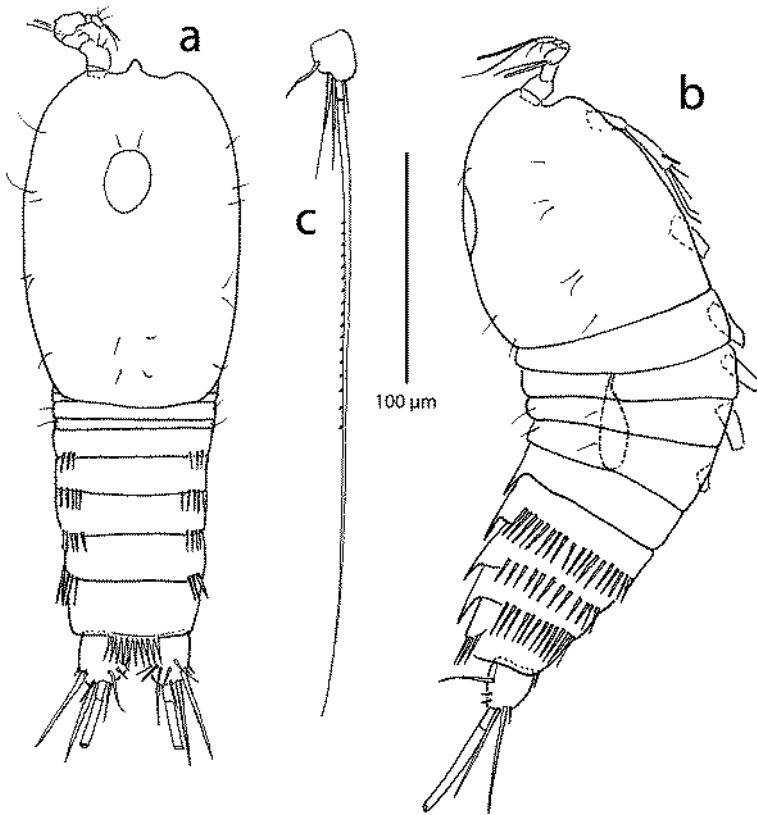


Fig. 5. *Elaphoidella paramuna* n. sp. Male. a, Habitus, dorsal; b, habitus, lateral; c, caudal ramus, lateral.

margin with 2 groups of spinules (1 group in female), inner margin unornamented (with 2 spinules on female).

Leg 1 and 2 (without terminal setae) distinctly shorter than leg 4.

Leg 1 (fig. 8a, b): intercoxal plate armed with 1 small row of spinules at each side of anterior surface distally. Coxa with 1 spinule on outer margin. Basis with 2 rows of minute spinules on anterior surface inserted near proximal margin, 1 unipinnate spine on outer margin, 1 naked seta inserted on anterior surface near base of endopod, 3 rows of spinules inserted near distal margin as shown in fig. 8a and hairs on inner margin. Exopod 3-segmented, first segment the widest, as long as endopod; segments armed as in female. Endopod 2-segmented; first segment armed as in female; second segment as in female but both naked setae on inner margin small and equally sized, apical section of geniculate seta broken (in allotype ICN-MHN-CR2717 and paratype NHMW 25496).

Leg 2 (fig. 8c): intercoxal plate unarmed. Coxa with 2 spinules on outer margin. Basis with naked spine on outer margin. Exopod 3-segmented, third segment

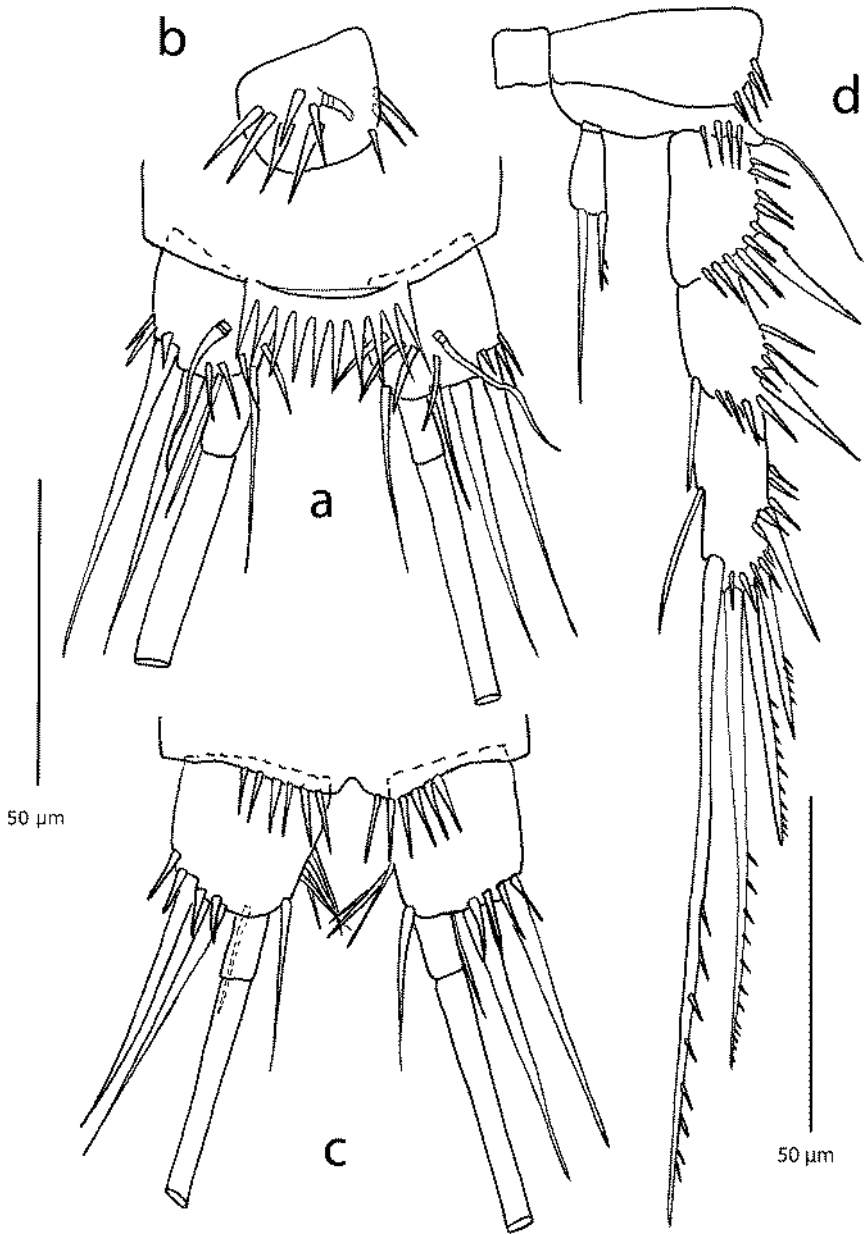


Fig. 6. *Elaphoidella paramuna* n. sp. Male. a, Caudal rami, dorsal; b, caudal ramus, lateral (except proximal section of dorsal seta, setae not shown); c, caudal rami, ventral; d, leg 4.

longer than second segment. First segment armed as in female but spine naked; second segment with strong expansion of apical outer corner (stronger than in female), armature as in female but spine naked; third segment with 1 naked

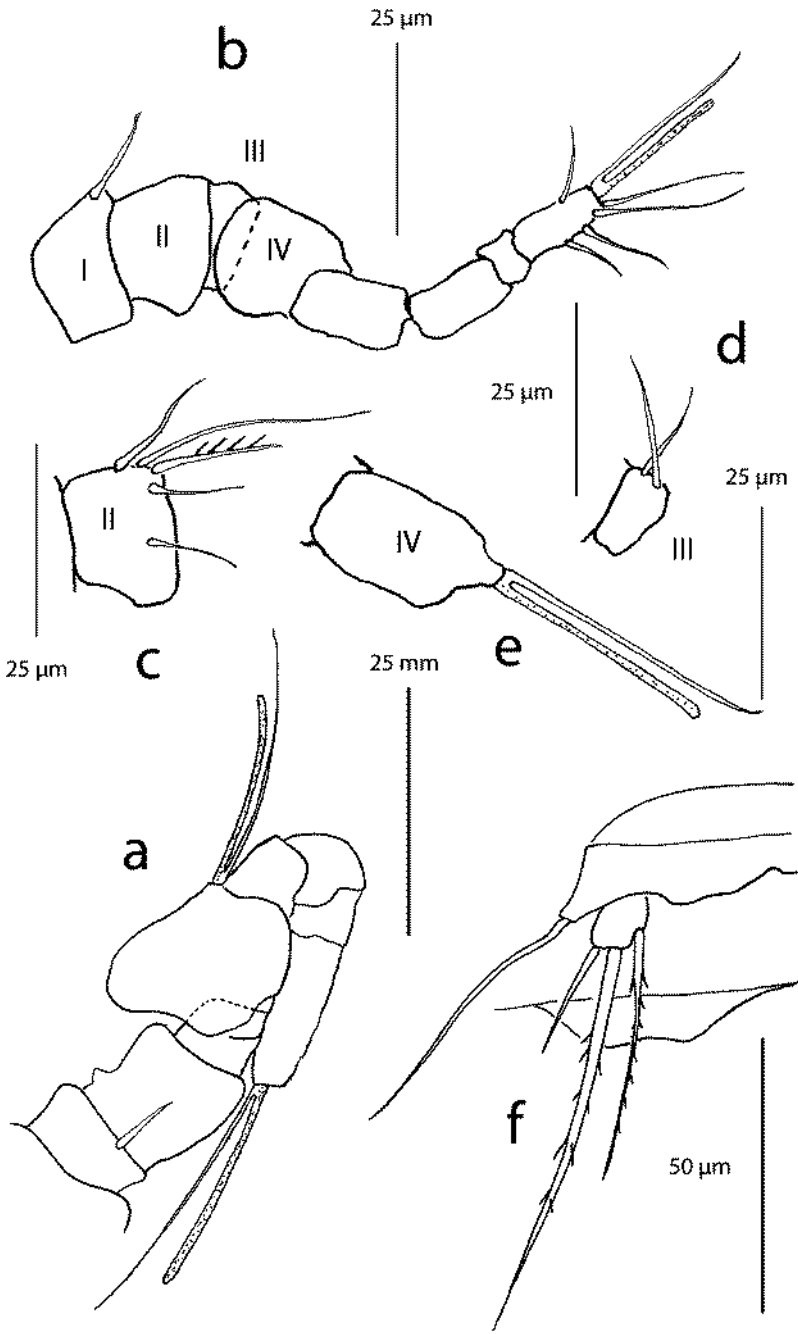


Fig. 7. *Elaphoidella paramuna* n. sp. Male. a, Antennula (setation not shown, except at segment I, and aesthetascs with conjoined setae of segment VIII); b, antennula of paratype NHMW 25496 (geniculations lost during slide preparation); c, d and e, antennular segments II, III and IV; f, legs 5 and 6.

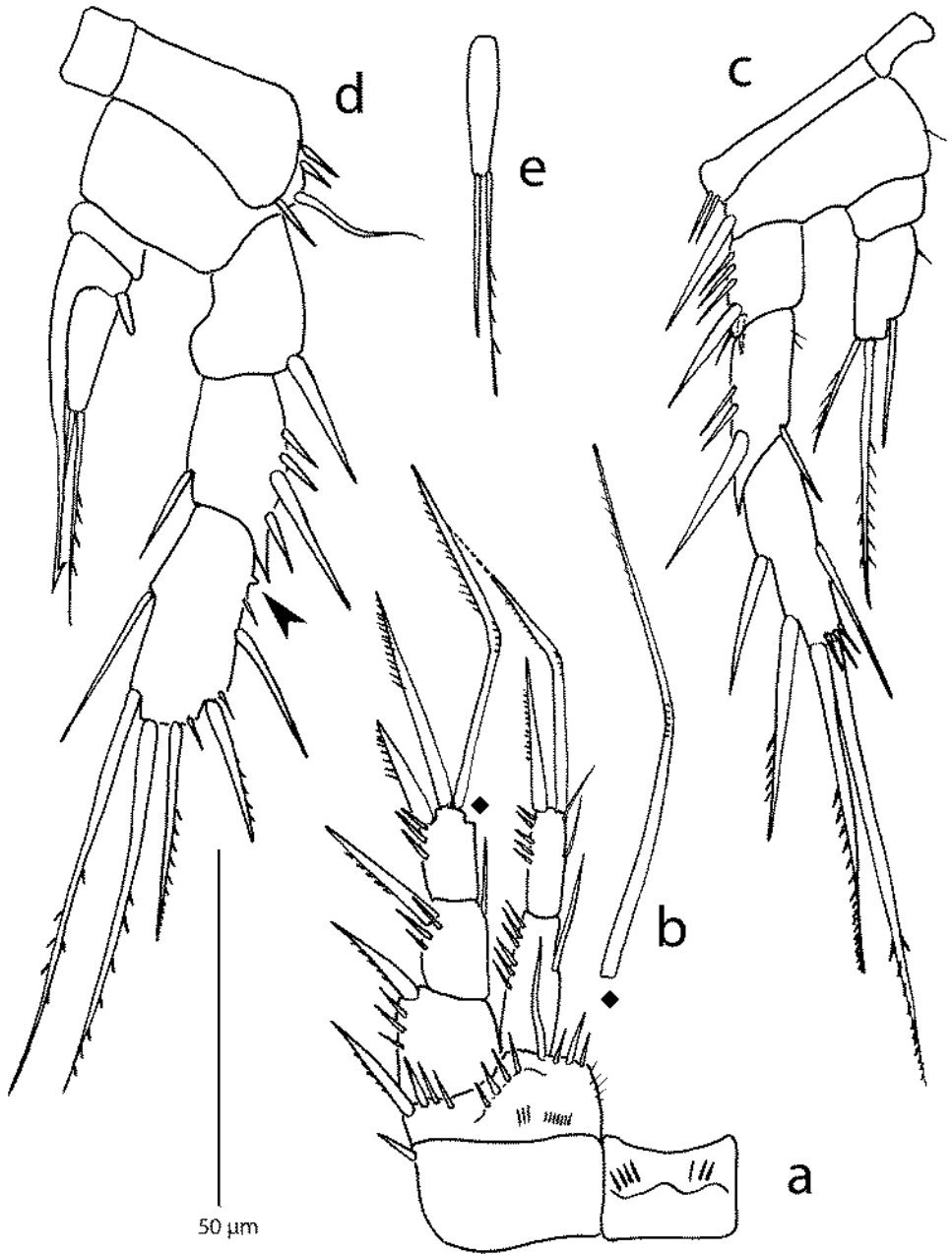


Fig. 8. *Elaphoidella paramuna* n. sp. Male. a, Leg 1; b, leg 1, exopod, seta inner margin; c, leg 2; d, leg 3 (arrow indicates bulge on outer margin); e, leg 3, endopod, third segment.

median seta and 1 unipinnate subapical seta on outer margin, apical margin with 1 outer unipinnate spine and 1 inner bipinnate longer seta (inner margin of setae

represented only by 1 element), anterior surface of segment with 1 row of spinules near apical margin, inner margin with 1 median naked seta much shorter than corresponding seta of female. Endopod 2-segmented; first segment broad and unarmed; second segment with 1 subapical naked seta and 1 tiny spinule on inner margin, apical margin with 1 unipinnate outer setae and 1 bipinnate inner seta, inner seta longer than outer seta, not reaching apical margin of exopod, the latter seta distinctly shorter than corresponding seta of female.

Leg 3 (fig. 8d, e): intercoxal plate as in female. Coxa with 1 spinule on outer margin. Basis with 1 naked thin seta and 2 spinules on outer margin. Exopod 3-segmented; first segment with naked spine on outer margin and a distal rounded prominence on inner margin; second segment with distal outer corner strongly expanded, 1 naked spine and spinules on outer margin, inner margin with 1 naked seta; third segment 1.5 times as long as second segment (not considering expanded corner), outer margin with 1 naked median spine, 1 unipinnate subapical spine and 1 single spinule near insertion of each spine, proximal margin of segment with small bulge near expanded corner of second segment, apical margin with 1 spinule, an unipinnate outer spine and 1 unipinnate inner seta, the latter considerably shorter than in female (being only as long as second and third segments together), inner margin with 1 naked median seta and 1 subapical bipinnate seta, subapical seta considerably shorter than in female (being as long as first, second, and half third segments together). Endopod 3-segmented; first segment very short, unarmed; second segment with apophysis on inner margin reaching median section of third segment of exopod, ending in a barb, inner margin with a thumb-like process articulated with segment; third segment with 1 short naked seta and 1 unipinnate seta on apical margin.

Leg 4 (fig. 6d): intercoxal plate quadrate, unarmed. Coxa with spinules on outer margin. Basis armed as in female. Exopod 3-segmented; first and second segment armed as in female, second segment with outer distal corner expanded in contrast to female; third segment 1.5 times as long as second segment (not considering expanded corner of second segment) with 1 naked outer median spine, 1 unipinnate subapical spine and spinules on outer margin, apical margin with 1 unipinnate spine and 1 unipinnate long seta, inner margin with 1 subapical long unipinnate seta and a naked median seta. Endopod two-segmented as in female but second segment ending only in an outer short unipinnate seta and a long inner naked seta.

Leg 5 (fig. 7f): right and left basoendopods fused, inner margin unarmed, outer margin with 1 naked long seta. Exopod as long as broad, inner margin with bipinnate seta, apical margin with central long bipinnate seta and outer short naked seta.

Legs 1-4 with following formula of major spines (Roman numerals) and setae (Arabic numerals). Leg 3, P means process, A means apophysis.

	Coxa	Base	Exopod	Endopod
Leg 1	0-0	I-1	I-0, I-1, I-I+1-1	0-1, 0-I+1, 2
Leg 2	0-0	I-0	I-0, I-1, II-I+1-1	0-0, 0-2-1
Leg 3	0-0	1-0	I-0, I-1, II-I+1-2	0-0, P-A, 0-2-0
Leg 4	0-0	1-0	I-0, I-1, II-I+1-2	0-0, 0-2-0

Leg 6 (fig. 7f) represented by small plate.

Morphological and meristic variability of males and females.— Females, length (without caudal setae) 336-443 μm ($n = 7$). Males, length (without caudal setae) 294-357 μm ($n = 6$).

Female: Meristic variability was observed in the number of ventral spinules of the anal segment, varying from 6 (holotype) to 8 (paratype NHMW 25495), in the number of spinules of the anal operculum varying from 8 (paratype NHMW 25527), 9 (holotype) to 13 (paratype NHMW 25495), and in the number of spinules of first and second segment of endopod of leg 2: holotype, first segment, outer margin with 1 spinule; second segment, outer margin with 2 spinules, inner margin with 1 spinule; paratype NHMW 25495, first segment unarmed, second segment with 3 spinules on outer margin and without spinules on inner margin (fig. 4c).

Male: Variability was observed in the number of ventral spinules of the anal somite near base of each caudal ramus, varying from 6 (allotype) to 7 at each side (paratype NHMW 25496), the number of spinules of the anal operculum, varying from 8 (paratype NHMW 25496) to 10 (allotype) and the extension of row of spinules on urosomite 1: paratype NHMW 25496 bears spinules dorsally (at each side of segment) and laterally, allotype only dorsally.

Remarks.— *Elaphoidella paramuna* n. sp. fits into the genus *Elaphoidella* Chappuis, 1929 particularly by the 8-segmented female antennule, antenna with 1-segmented exopodite, mandible with endopodite, natatory legs with 2-segmented endopods in female and structure of leg 5.

Elaphoidella paramuna n. sp. belongs to the *Elaphoidella* group X of Lang (1948). Together with the new one, 12 species of *Elaphoidella* have been recognized (Petkovski, 1980; Petkovski & Brancelj, 1988; Defaye & Dussart, 2011) as belonging to this group. Within them, 8 species show a Neotropical distribution.

Species of group X share the following morphological traits. Female: leg 1 with 2-segmented endopod; leg 2 endopod, first segment without (major) armature elements, second segment with 3 or 4 setae (3 in *E. paramuna*); leg 3, endopod, first segment unarmed, second segment with 3, 4 or 5 (major) armaments (3 in *E. paramuna*); leg 4, endopod, first segment unarmed, second segment with 1, 2 or 3 setae (3 in *E. paramuna*); leg 5 with basoendopod expanded at least until half of exopod segment and armed with 4 (major) armaments, exopod with 3 or 4 (major)

setae (3 in *E. paramuna*). Male: leg 2 endopod, second segment with 2 or 3 setae (3 in *E. paramuna*); leg 2 and 4 endopods, first segment without setae on inner margin, leg 4 endopod, second segment with 1, 2 or 3 setae (2 in *E. paramuna*).

The only difference of the new species to the group diagnosis is the absence of a dorsal carina on the caudal rami. However, 2 other species of the group, *E. pectinata* and *E. brevifurcata*, also lack such a dorsal carina. Apparently, Lang (1948) overlooked this character in both taxa during the diagnosis of the group.

Species of *Elaphoidella*-group X living in the Neotropical region constitute a phylogenetic group, already recognized by Chappuis (1931), clearly different from the species of the "Old World". The former group is characterized by female leg 5 with basoendopod strongly extended, exceeding the exopod segment, anal operculum with teeth and caudal rami strongly spinose. At the time of Chappuis, *E. armata* and *E. pectinata* were the only representatives of the group in South America. Further new descriptions and/or supplementary species records extended the distribution of the group to Central America and the Caribbean Islands.

Within the Neotropical species of group X, the new species shows the strongest affinities with *E. pectinata* (from Costa Rica, French Guyana and Surinam) and with the Brazilian *E. brevifurcata*, then with the Peruvian *E. armata*.

Males and females of *E. pectinata*, *E. armata* and *E. paramuna* share the following characters: (1) similar segmentation of legs 1, of exopods of legs 2, 3 and 4, as well as of endopods of leg 2; (2) same number of major armaments on last segment of exopod of leg 2 and (3) same number of setae on exopod of antenna. Chaetotaxy of exopods of leg 3 and 4 is unknown in *E. armata* and *E. pectinata*. Female of *E. brevifurcata* is unknown.

Differences between females are shown in table I. The main differences between *E. pectinata* and *E. armata* is the absence of posterolateral spinules on the anal segment of *E. paramuna*, the length of the copulatory tube (longer in *E. pectinata*, shorter in *E. armata*), the number of major armaments on exopod of leg 5 (3 in *E. paramuna*, 2 in *E. pectinata*, 4 in *E. armata*), and form and armature of the caudal rami (table II).

Differences between males are shown in table III. The main differences of the new species to *E. pectinata*, *E. brevifurcata* and *E. armata* are the number of major armaments of leg 5 exopod (2 in *E. pectinata* and *E. brevifurcata*, 3 in *E. paramuna* and *E. armata*), length of the apophysis of leg 3 (long in *E. brevifurcata* and *E. pectinata*, short in *E. paramuna* and *E. armata*) and the existence or lack of an articulation of the inner process with the second segment of exopod leg 3 (articulated in *E. paramuna* and *E. pectinata*, fused in *E. brevifurcata*, unknown in *E. armata*). The number of armaments of endopod leg 3 is the same (2) in *E. paramuna*, *E. pectinata* and *E. brevifurcata* and only 1 in *E. armata*. Some differences exist in the ornamentation of the somites: *E. paramuna* and *E.*

TABLE I
Differences between selected females of neotropical species of *Elaphoidella*-group X

	<i>paramuna</i> n. sp.	<i>armata</i>	<i>pectinata</i>
Genital-double segment			
Dorsal spinules, each side	Yes	No	No
Lateral spinules	Yes	Yes	Yes
Position of copulatory pore	Third quarter	In the middle	Last quarter
Anal segment			
Posterolateral spinules	No	Yes	Yes
Anal operculum			
Size	Long	Short	Long
Edge ornamentation	Long spines	Cilia	Long spines
Number of spines	10	–	14
Legs 2, 3 and 4, endopod, last segment			
Number of setae	3 : 4 : 3	3 : ? : ?	3 : 4 : 3
Leg 4, endopod			
Number of segments	2	2	1 ^{a)}
Leg 5, exopod			
Number of major armaments	3	4	2
Gap between extension of basoendopod and exopod	Broad	Broad	Narrow
Basoendopod extension : exopod length ratio	1 : 1	1.5 : 1	2.5 : 1

Female of *Elaphoidella brevifurcata* not known.

^{a)} First segment very small, probably overlooked in the description.

brevifurcata share the absence of posterolateral spinules on the anal urosomite (present in *E. pectinata* and *E. armata*) and the presence of dorsal spinules on each side of the first urosomite (as prolongation of the lateral spinule rows); these

TABLE II
Differences between caudal rami of males and females of selected neotropical species of *Elaphoidella*-group X

	<i>paramuna</i> n. sp.	<i>armata</i>	<i>pectinata</i>	<i>brevifurcata</i>
Sex	Male and female	Male and female	Male and female	Male ¹⁾
Form	Subquadrate	Barrel-like	Bulb-like	Conical
Length : width ratio (ventral)	1 : 1	1.75 : 1	1.4 : 1	0.8 : 1
Seta II and III, form	Slender	Strong	Slender	Slender
Seta II and III : ramus length ratio	>	<	>	>
Seta II, insertion	Last quarter	Third quarter	Middle	Middle
Seta III, insertion	Apical	Third quarter	Middle	Apical
Seta IV, position on apical edge	Adaxial	Central	Central	Adaxial
Dorsal carina	No	Yes	No	No
Dorsal subapical teeth	No	No	Yes	No
Spinules crown, spinules size	Long	Short	Long	Long

¹⁾ Female of *Elaphoidella brevifurcata* not known.

TABLE III
Differences between males of selected neotropical species of *Elaphoidella*-group X

	<i>paramuna</i> n. sp.	<i>armata</i>	<i>pectinata</i>	<i>brevifurcata</i>
Countries found	Colombia	Peru, Brazil, Argentina, Paraguay	Costa Rica, Surinam, French Guyana	Brazil
Thorax, last segment				
Dorsal spinules, each side	No	No	No	Yes
Lateral spinules	No	No	No	Yes
Abdomen, first urosomite				
Dorsal spinules, each side	Yes	No	No	Yes
Lateral spinules	Yes, dorsal	Yes	Yes	Yes, ventral
Anal segment				
Posterolateral spinules	No	Yes	Yes	No
Anal operculum				
Form	Long	Short	Long	Long
Edge ornamentation	Long spines	Short cilia	Long spines	Long spines
Number of teeth	9	–	14	10
Leg 2, endopod				
Seta inner margin size	Long	Long	Long	Short
Leg 3, endopod				
Second segment, inner process	Not fused	–	Not fused	Fused
Apophysis/third segment length ratio	2 : 1	2 : 1	4 : 1	3.25 : 1
Third segment, number of armaments	2	1	2	2
Leg 4, endopod				
Number of segments	2	2	1 ^{a)}	1 ^{a)}
Leg 5, exopod				
Number of major armaments	3	3	2	2

^{a)} First segment very small, probably overlooked in the description.

dorsal spinules are lacking in *E. armata* and *E. pectinata*. The last thoracic somite lacks spinules in the new species, *E. armata* and *E. pectinata*, but they are present laterally and at each side of the dorsal surface in *E. brevifurcata*.

The morphology of the anal operculum (except the number of spinules) is not dimorphic. *E. paramuna* and *E. pectinata* show a well-developed anal operculum with long spines, although *E. paramuna* has fewer spinules (male 8-10, female 8-13) than *E. pectinata* (male and female 14 each). Male of *E. brevifurcata* shows a well-developed anal operculum with 10 spines, female of this species is unknown. In contrast, *E. armata* shows a small operculum with margin ornamented with cilia.

Form, armature and ornamentation of the caudal rami are important traits that differentiate the new species from *E. pectinata*, *E. brevifurcata* and *E. armata*

(table II), both male and female. The caudal ramus is subquadrate in *E. paramuna* (male and female), barrel-like in *E. armata* (male and female), bulb-like in *E. pectinata* (male and female) and conical in *E. brevifurcata* (male, female is unknown). In *E. paramuna* it is shorter than in *E. armata* and *E. pectinata* and longer than in *E. brevifurcata*. Particular characters of the caudal rami are the dorsal carina in *E. armata* and the dorsal subapical surface tooth in *E. pectinata*, both structures absent in the new species.

The lateral setae (seta II and III) are short and strong in *E. armata*, but long and slender in *E. pectinata*, *E. brevifurcata* and *E. paramuna*. Their insertion point on the ramus is different in each species: seta II is inserted more distally in *E. paramuna* than in the other 3 species; seta III is inserted on the apical margin of the ramus (as in *E. brevifurcata*), in contrast to *E. pectinata* (median insertion on the ramus) and to *E. armata* (on the third quarter of the ramus). The long terminal seta (seta V) is inserted on the central section of the apical margin in *E. armata* and *E. pectinata*, in contrast to an adaxial insertion (proximal to sagittal body axe) in the new species and in *E. brevifurcata*.

The half-crown of spinules on the dorsal and inner lateral surface of the caudal ramus is composed by long curved spinules in the new species, *E. pectinata* and *E. brevifurcata*. In *E. armata* the spinules are short and straight.

The morphology of the anal operculum, the form and length of the lateral setae, and the spinule size on the spinules half-crown of the caudal rami define two subgroups within the neotropical members of group X: a first subgroup: *armata* sub-group characterized by strong lateral setae much shorter than caudal rami, anal operculum with margin ornamented by short teeth termed cilia by Delachaux (1917), and half-crown with short spinules; this subgroup includes the Peruvian *E. armata*, the Brazilian *E. jakobii* and the Cuban *E. neoarmata* and *E. synjakobii*. Although the Cuban species *E. karllangi* shows a female with some setae (II, III and V) of the caudal rami strongly reduced, other characters such as the presence of a dorsal carina on the rami of male and female and the ornamentation of the male caudal rami argue for arranging that species within the *armata*-subgroup. A second subgroup with slender setae II and III, longer than caudal rami, and spinule crown with long curved spinules would include *E. pectinata*, *E. brevifurcata* and *E. paramuna*. An additional character of this subgroup is the absence of a dorsal carina on the caudal ramus; this carina is present in the *armata*-subgroup and part of the diagnosis of group X; therefore, this character should be amended in the general diagnosis of the group. The *armata*-subgroup was created by Petkovski (1980) during the description of the Cuban species. We propose here to designate the second subgroup defined as above as the *pectinata*-subgroup.

CONCLUSIONS

With the actual discovery, the presently known harpacticoid fauna of Colombian inland waters (Gaviria & Defaye, 2012) consists of 16 species (11 Canthocamptidae, 3 Parastenocarididae, 1 Phyllognathopodidae and 1 Ameiridae).

Diversity of *Elaphoidella* in Colombia (5 species) is lower than in Cuba (10) and Brazil (9), but higher than in Surinam (2) and Argentina (2). Only one species is known from each of the following Neotropical countries: Mexico, Costa Rica, Venezuela, French Guyana, Ecuador, Peru and Paraguay. The French islands Bonaire and Martinique are also inhabited by one species each.

Groundwater, benthic habitats of high Andean lakes in Colombia and aquatic environments of the Magdalena Valley, the eastern Llanos belonging to the Orinoco Basin, and the Amazonas are potential habitats for harpacticoid copepods and particularly for *Elaphoidella*. Other biotopes still poorly investigated are phytotelmata and semiterrestrial habitats. Thus, their study would no doubt yield new species of copepods in the country.

IDENTIFICATION KEY FOR COLOMBIAN SPECIES OF THE GENUS *ELAPHOIDELELLA*

Males

(male of *Elaphoidella suarezi* unknown, male of *Elaphoidella bidens* not known (Wells, 2007))

- 1. Anal operculum triangular, posterior margin with 4 strong teeth. Leg 4 exopod, segment 3 outer margin, with proximal short, tooth-like spine *Elaphoidella grandidieri*
 – Anal operculum convex, posterior edge with at least 8 teeth or spines. Leg 4 exopod, segment 3 outer margin, with proximal spine large, modified or not 2
- 2. Anal operculum short, not reaching posterior edge of anal somite, with 18 to 20 spinules. Leg 4 exopod segment 3, outer margin, both spines modified with strong accessory teeth (fused to spine), giving the spine a “deer antler-like” appearance *Elaphoidella colombiana*
 – Anal operculum large, exceeding posterior margin of anal somite, with less than 11 spines. Leg 4 exopod, segment 3 outer margin, with both spines (except size of distal spine being larger than proximal one) not modified 3
- 3. Anal operculum not reaching midlength of caudal rami, posterior margin with 8 teeth, outermost teeth at each side smaller than inner teeth. Leg 4 exopod segment 3 short, apical margin with outer spine short, modified into stout spine with several claw-like teeth on outer margin *Elaphoidella radkei*
 – Anal operculum exceeding 3/4 length of caudal rami, posterior edge with 8-10 teeth, all teeth with same length. Leg 4 exopod 3 with normal size, apical margin with outer spine long, not modified *Elaphoidella paramuna* n. sp.

Females

(female of *Elaphoidella radkei* unknown)

- 1. Anal operculum with edge smooth *Elaphoidella suarezi*
 – Anal operculum with edge ornamented 2
- 2. Anal operculum not reaching posterior edge of anal somite 3

- Anal operculum extending behind 1/3 of length of caudal rami 4
- 3. Copulatory tube with conical neck. Anal somite without ventral spines above each caudal ramus. Leg 5, basoendopod slightly protruded, not reaching midlength of exopod *Elaphoidella bidens*
- Copulatory tube with straight slender neck. Anal somite with 1 ventral spine above each caudal ramus. Leg 5, basoendopod strongly protruded, exceeding midlength of exopod. *Elaphoidella colombiana*
- 4. Anal operculum strongly convex, margin with dense row of short spinules (>30). Caudal ramus with seta III inserted on lateral margin *Elaphoidella grandidieri*
- Anal operculum slightly convex, margin with large spinules (<10). Caudal ramus with seta III inserted on apical margin *Elaphoidella paramuna* n. sp.

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