

MORPHOLOGY OF *ELAPHOIDELLA GRANDIDIERI* (GUERNE & RICHARD, 1893) (COPEPODA, HARPACTICOIDA) FROM MEXICO WITH NOTES ON FECUNDITY IN CULTURE CONDITIONS

BY

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ABSTRACT

Samples collected from ponds in central Mexico contained male and female specimens of the harpacticoid copepod *Elaphoidella grandidieri* (Guerne & Richard, 1893). Field-collected ovigerous females were transported to the laboratory where several isofemale lines were established. Cultures were established from a single female and maintained on a mono-algal diet in moderately hard water. Specimens of both sexes, particularly the less known males, were analysed morphologically and compared with records from different geographical regions. Differences among these populations are subtle and not geographically consistent. Variations were found in the relative length of setal elements and ornamentations of swimming legs 1, 2, and 4, the proportions and armature of the exopod of the female leg (P) 5, among other characters. The specimens from Mexico have 1-2 long spines near the posteroventral margin of the anal somite; this character has been described only from a North African population. Our analysis supports the notion that this widespread pantropical species shows a considerable degree of variability in various characters. Since a clonal population of this parthenogenetic species could be established, molecular techniques are recommended to evaluate this variability and determine if *E. grandidieri* represents a species complex with morphologically similar taxa. The finding of *E. grandidieri* as an harpacticoid with high reproductive rates suggests that this copepod has an outstanding potential in aquaculture.

RÉSUMÉ

Des échantillons collectés dans des mares du centre du Mexique contenaient des spécimens mâles et femelles du copépode harpacticoïde *Elaphoidella grandidieri* (Guerne & Richard,

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1893). Des femelles ovigères collectées sur le terrain ont été transportées au laboratoire où plusieurs lignées isofemelles ont été établies. Les élevages ont été réalisés à partir d'une femelle unique et maintenus dans de l'eau moyennement dure avec un régime alimentaire mono-algue. Des spécimens des deux sexes, en particulier les mâles, moins connus, ont été analysés quant à leur morphologie et comparés avec les données de différentes régions géographiques. Les différences entre ces populations sont subtiles et ne sont pas cohérentes géographiquement. Des variations ont été trouvées dans la longueur relative des soies et des ornements des pattes nataoires P1, P2 et P4, dans les proportions et l'armature de l'exopodite de la P5 femelle, parmi d'autres caractères. Les spécimens du Mexique ont 1-2 longues épines près du bord postéro-ventral du somite anal ; ce caractère a été décrit seulement d'une population nord-africaine. Notre analyse soutient la notion que cette espèce pantropicale largement répartie présente un degré considérable de variabilité pour différents caractères. Étant donné qu'une population clonale de cette espèce parthénogénétique pourrait être obtenue, des techniques moléculaires sont recommandées pour évaluer cette variabilité et déterminer si *E. grandidieri* représente un complexe d'espèces avec des taxons morphologiquement similaires. Le fait que *E. grandidieri* présente un taux de reproduction élevé suggère un potentiel remarquable pour l'aquaculture chez cette espèce.

RESUMEN

Muestras recolectadas en cuerpos de agua del centro de México contenían especímenes machos y hembras del copépodo harpacticoide *Elaphoidella grandidieri* (Guerne & Richard, 1893). Las hembras ovígeras recolectadas en el campo fueron transportadas al laboratorio, donde se establecieron líneas isofemeninas. Los especímenes de ambos sexos, particularmente los machos casi desconocidos, se analizaron morfológicamente y se compararon con registros de distintas regiones geográficas. Las diferencias entre estas poblaciones son sutiles pero no consistentes geográficamente. Se encontraron variaciones en la longitud relativa de elementos setales y ornamentación de las patas 1, 2 y 4, en la proporción y armadura del exópodo de la quinta pata de la hembra, entre otros caracteres. Los especímenes de México tienen 1-2 espinas largas cerca del margen posteroventral del somita anal; este carácter sólo se ha descrito en una población del norte de África. Nuestro análisis apoya la idea de que esta especie pantropical ampliamente distribuida muestra un grado de variación considerable en diferentes caracteres. Esta variabilidad debe ser evaluada para determinar si *E. grandidieri* podría representar un complejo de especies con taxa morfológicamente similares. El hallazgo de *E. grandidieri* como un harpacticoide partenogénico con elevadas tasas reproductivas sugiere que este copépodo tiene un gran potencial en la acuicultura.

INTRODUCTION

Among the diverse family Canthocamptidae, the genus *Elaphoidella* Chapuis, 1928 is one of the most common; it contains more than 200 nominal species (Pesce & de Laurentiis, 1996; Boxshall & Halsey, 2004). In some regions, the diversity of the genus is very high; for instance, in Europe the number of species of *Elaphoidella* is over 70 (Mori & Brancelj, 2008); in North

America (United States and Canada), the figure is 12 (Wilson, 1975; Reid & Ishida, 1993; Williamson & Reid, 2001). In contrast, in Mexico, Central America, and the Caribbean, the number of records of the genus is relatively low (Dussart, 1982; Reid, 1990a, b). Cuba is the best known country in the Middle America region after the works by Petkovski (1980, 1982), who described several new species from the island; in Mexico only two species and one subspecies of *Elaphoidella* have been recorded (Suárez-Morales & Reid, 1998; Suárez-Morales et al., 2000).

There are several widely distributed species within the genus; one of them is *Elaphoidella grandidieri* (Guerne & Richard, 1893), regarded as a pantropical form (Reid, 1998). Because of its putative broad geographical distribution, it is assumed that this taxon has a detectable range of morphological variation, as suggested by the observations of Dussart (1982) from Caribbean specimens, but comprehensive comparative data are not available. The information about the morphology of the male of this species is limited (Kikuchi, 1985). Overall, the taxonomy of canthocamptid harpacticoids is problematic because the oldest descriptions were incomplete according to modern descriptive standards (Hamond, 1987). Therefore, it is necessary to make detailed comparative efforts based on accurate descriptions of regional or local forms of these widely distributed species.

Based on cultured specimens of *E. grandidieri* collected during a biological survey of freshwater habitats in central Mexico, we provide a full morphological description of both the adult males and females of the Mexican population and compare them with previous taxonomic reports of the species from other geographical regions. The morphology of specimens of *E. grandidieri* from Mexico was explored by standard methods and also by SEM in order to provide a complete overview of its morphology and a working frame for further comparisons among different populations from other geographical areas. Furthermore, the reproductive rates and life span of this harpacticoid remain unknown. Based on our results from rearing this population in the laboratory we provide information on the maintenance techniques, and quantitative data about the peak population densities reached under laboratory conditions.

METHODS

Zooplankton samples were collected from a small fish farm in Cuautla in the State of Morelos (18°49'28"N 98°56'23"W) in the central region of Mexico. Biological samples were obtained using a standard plankton net with a 40 μm

mesh in the fish ponds with muddy bottom. Copepods were sorted from the original samples.

Laboratory culture

Scenedesmus acutus (Meyen, 1828) was used to rear the culture of *Elaphoidella grandidieri*. The alga was mass cultured in 2l transparent bottles using distilled water containing Bold's basal nutrients (Borowizka & Borowizka, 1988). Algae, in the log phase of their growth, were harvested, centrifuged for 5 min at 3000 rpm and resuspended in moderately hard water (EPA medium). The EPA medium was prepared by dissolving 96 mg NaHCO_3 , 60 mg CaSO_4 , 60 mg MgSO_4 and 4 mg KCl in one liter of distilled water (Anonymous, 1985). The density of the algal concentrate was estimated using a Neubauer haemocytometer. From the stock algae, we obtained 2.0×10^6 cells ml^{-1} of *S. acutus* by diluting the stock with EPA medium.

In order to establish the culture we selected 10 egg-bearing females from the field-collected sample. They were set in 250 ml glass beakers with 200 ml of EPA medium and an appropriate quantity of *S. acutus* so as to obtain a concentration of 2.0×10^6 cells ml^{-1} . The cultures were changed twice a week. We did not observe cannibalism and therefore we did not separate the adults from the nauplii using screens. The conditions used for mass cultures and for experiments were similar: temperature 25°C, pH 7.5-8.0, and continuous but diffuse illumination.

To perform the morphological examination of adult females and males, several (at least 30) specimens were fixed and preserved in 70% ethanol and then dissected. The appendages were mounted in glycerine on semi-permanent slides for taxonomic analysis. Cephalic appendages, swimming legs, and other taxonomically important structures were illustrated with the aid of a camera lucida. Additionally, specimens were prepared for SEM (Scanning Electron Microscopy). Observations were performed using a JEOL LV-5900 microscope at the facility of El Colegio de la Frontera Sur (ECOSUR) in Tapachula, Chiapas.

Adult male and female specimens were deposited in the Collection of Zooplankton of El Colegio de la Frontera Sur, Chetumal, Mexico (ECO-CHZ). Nomenclature and descriptive terminology follow Lang (1948); the abbreviated terminology of the structures mentioned in the descriptive section is as follows: A1, antennule; P1–P4, first to fourth swimming legs; benp, basoendopod; exp, exopod; enp, endopod; ae, aesthetasc; s, seta(e).

RESULTS

SYSTEMATICS

Order HARPACTICOIDA

Family CANTHOCAMPTIDAE Sars, 1906; sensu Lang, 1948

Genus *Elaphoidella* Chappuis, 1928; sensu Apostolov, 1985***Elaphoidella grandidieri*** (Guerne & Richard, 1893)

(figs. 1-5)

Material examined. — Samples from a private fish farm in Cuautla, State of Morelos, central Mexico (18°49'28"N 98°56'23"W), collected in August 2006 by S. Nandini and S. S. S. Sarma in a shallow, mud-bottom fish pond; specimens dissected, slides sealed with Entellan (ECO-CHZ-04084, one adult female; ECO-CHZ-04085, one adult male). Twenty adult females and 5 adult males from culture, preserved in 70% ethanol with a drop of glycerine, specimens undissected, vial at ECOSUR in Chetumal (ECO-CHZ-03665). Five adult females, two adult males, and one young male prepared for SEM at ECOSUR facilities in Tapachula. Original samples and cultured specimens at FES-Iztacala, Tlalnepantla, Mexico City.

Description of female. — Body cylindrical, measuring 925-940 μm from the anterior end of the cephalosome to the posterior margin of the anal somite (fig. 3A). First cephalic somite without spines, with abundant sensorial, short hair-like elements scattered on dorsal and lateral surfaces. Nuchal organ (= integumental window) evident with SEM, on dorsal surface of cephalic somite, elongate, sinuous, relatively narrow (fig. 3A). Anterior margin of cephalosome rounded in dorsal view. Rostrum short, subtriangular (fig. 3B).

Second to fourth thoracic somites with parallel transverse rows of tiny spinules on dorsal and lateral surfaces (fig. 3A, E). Similar ornamentation on urosomal somites on dorsal and ventral surfaces (figs. 3A, F, 4A, B). Genital double somite and succeeding urosomites with serrate hyaline fringe, somites ornamented with distal row of strong spinules on lateral and part of ventral margins (figs. 3F, 4A, B). Genital field reaching beyond midlength of somite; transverse rows of spinules at each side of genital pore (fig. 1I). Ventral surface of anal somite not strongly ornamented; with lateral rows of tiny spines, and 1-2 long spinules on posterior margin (fig. 4C). Dorsal surface with rows of short spines; anal plate strongly convex, rounded, pectinate, reaching about half length of caudal rami (fig. 4D).

Caudal rami (fig. 4B, C) subrectangular, about 1.5 times as long as wide, with dorsal, terminally truncate longitudinal keel (arrowed in fig. 4D); rami with transverse row of 3 strong spinules at insertion of distal lateral seta. Inner margin of rami naked. Ramus with basally articulate dorsal seta inserted on

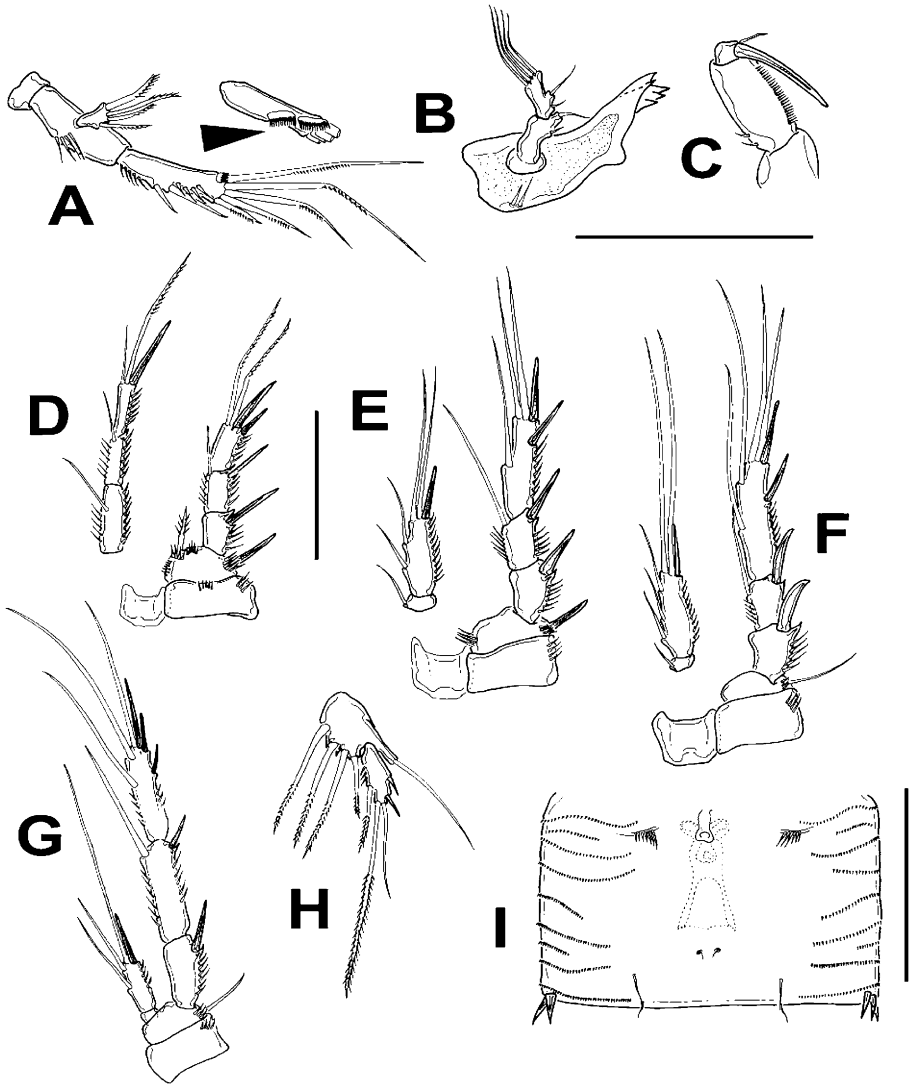


Fig. 1. *Elaphoidella grandidieri* (Guerne & Richard, 1893) from central Mexico, adult female. A, A2 showing detail of ornamentation of terminal segment; B, mandible with palp; C, maxilliped; D, P1; E, P2; F, P3; G, P4; H, P5; I, genital double somite, ventral view showing genital field. Scale bars = 50 μm .

middle surface of ramus (fig. 4D), median terminal seta longest, about 0.6 times as long as body.

Antennule projected from cephalic depression (fig. 3B), 8-segmented (fig. 3C, D). Armament per segment as follows: 1s, 9s, 5s, 1s + 1ae, 1s, 2s,

2s, 6s + 1ae. Fourth segment with long ae, reaching about half length of distal segment. Last segment with shorter, slender ae (fig. 3D).

Antenna (fig. 1A) with allobasis, bisegmented; both segments almost equally long. Enp with 5 terminal setae plus 2 lateral spines, outer margin armed with strong spinules. Inner surface with two rounded pectinate processes (arrowed in fig. 1A). Exp represented by a single segment arising from middle of benp, armed with 4 setae; row of 4-5 long spinules close to insertion of exp.

Mouthparts, including mandibles (fig. 1B), maxillulae, maxillae, and prehensile maxillipeds (fig. 1C) as in Kikuchi (1985) except for two slender spinules on gnathobasis and lower process on outer margin of mandible, shorter distal seta on first segment of mandibular palp and subequal terminal setae on second segment vs. one seta clearly smaller in Kikuchi (1985). Also, lack of rows of spinules on proximal half of maxillipedal basis and lack of longitudinal row of spinules on first endopodal segment.

Couplers of all swimming legs naked. Exopods of P1–P4 all 3-segmented. First leg with 3-segmented enp; P2–P4 with 2-segmented enps. All swimming leg exps longer than enps. Basis of P1 with 1 long inner bipinnate seta and one strong, outer spine (fig. 1D). Basis of P2 with outer spine (fig. 1E); P3 and P4 with outer setae (fig. 1F, G). Major lateral spines of first and second exps of P3 relatively large, distally curved. Setal formula of P1–P4 as in table I (figs. 1D–G, 4E, F).

Leg 5 represented by subrectangular benp reaching less than 1/3 of length of exp, inner lobe armed with four stout distally bipinnate setae, innermost seta shortest. Outer lobe of benp with naked slender seta about twice as long as exopodal segment. Exopod ovoid, armed with row of inner spinules, 3 long terminal setae, and 2 short setae on outer margin (fig. 1H).

Description of male. — Body cylindrical, 830-870 μm (figs. 2A, 5A). Anterior margin of cephalic region truncate. Cuticular ornamentation of cephalosome and body as in females. Nuchal organ as in females but more elongate, almost reaching posterior margin of cephalosome (fig. 5B). Anal somite and operculum as in female (fig. 2I).

Antennule 8-segmented, geniculate (fig. 5D–F); armament per segment as follows: 1s, 4s + 3ae, 3s + 1ae, 5s, 1ae, 1s, 0, 0, 6s + 2ae. Aesthetasc on fourth antennal segment very long, divided proximally (fig. 5F, arrowed). Fourth segment broad, strongly projected (fig. 5D, E); 6th and 7th segments with inner flat processes (fig. 5F).

Antenna as in female (fig. 2C), mouthparts as in female. Three-segmented exps on P1–P4 (fig. 2D–G), enp longer than exp, only on P1. Endopods of P1

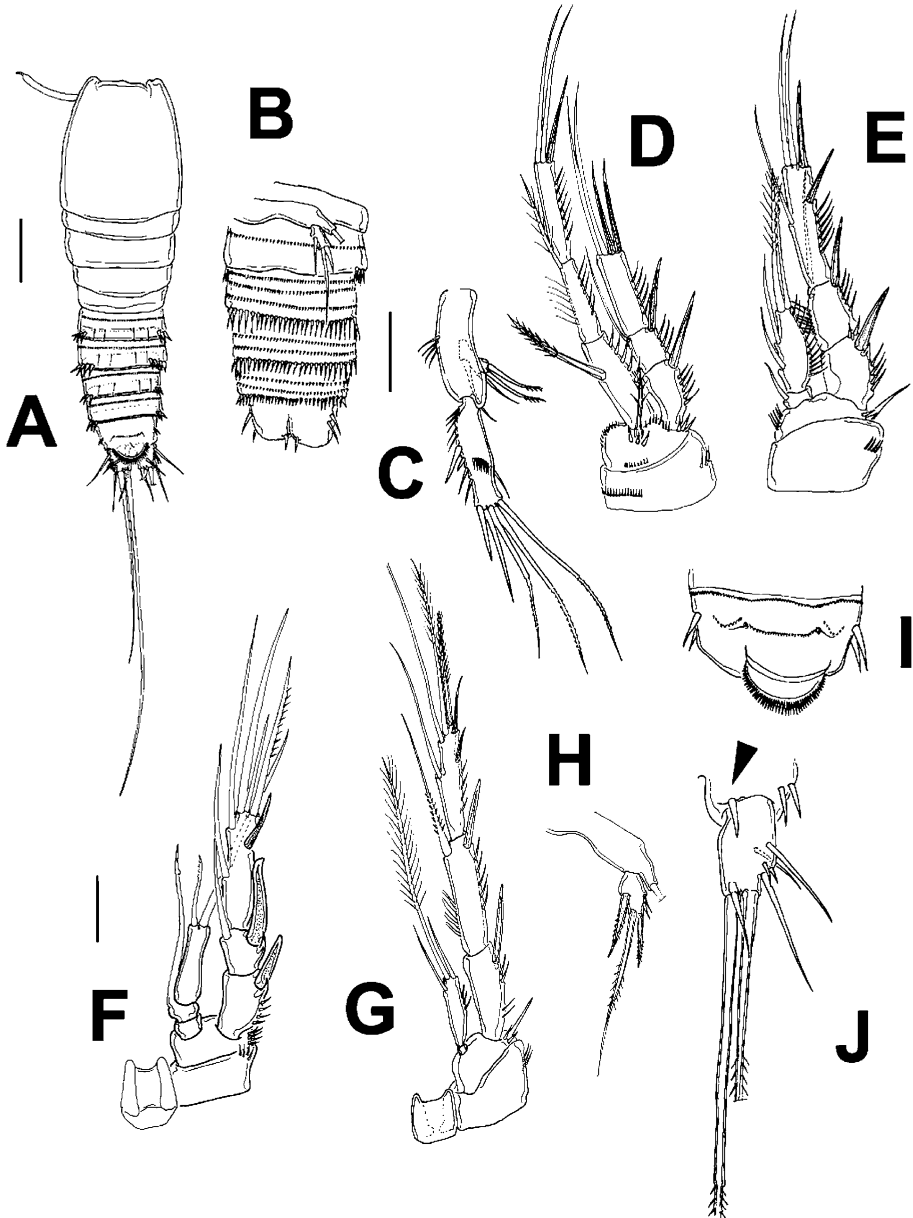


Fig. 2. *Elaphoidella grandidieri* (Guerne & Richard, 1893) from central Mexico, adult male. A, habitus, dorsal view; B, urosome, ventral view; C, antenna; D, P1; E, P2; F, P3; G, P4; H, P5; I, anal somite, dorsal view showing operculum; J, caudal ramus, ventral view. Scale bars: A = 130 μm ; B = 110 μm ; C–J = 50 μm .

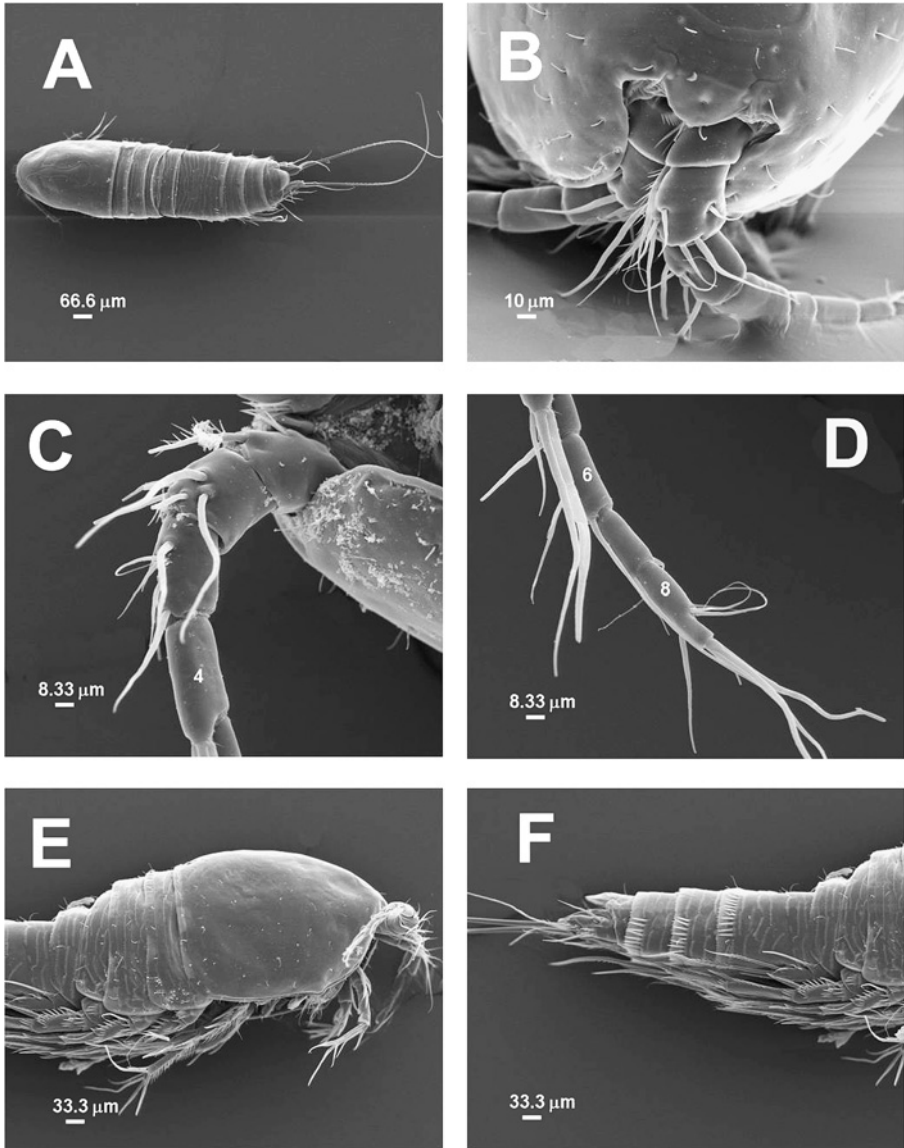


Fig. 3. *Elaphoidella grandidieri* (Guerne & Richard, 1893) from central Mexico, adult female, SEM micrographs. A, habitus, dorsal view; B, detail of rostrum and insertion of antennules, dorsal view; C, first segments (1-4) of the A1; D, antennular segments 5-8; E, cephalosoma, lateral view; F, urosome, lateral view.

and P3, 3-segmented (fig. 2D, F); enps of P2 and P4, 2-segmented (fig. 2E, G). P3 exp with large outer spines on first and second segments (fig. 2F). Setal formula of P1–P4 as in table I.

TABLE I

Setation formula for major armament of *Elaphoidella grandidieri* (Guerne & Richard) (swimming legs). Roman numerals indicate spines, Arabic numbers are setae

	Exp	Enp
Females		
P1	I-0; I-1; II-2	0-1; 0-1; I-2
P2	I-0; I-1; II-2-1	0-1; 0-1-2-2
P3	I-0; I-1; II-2-2	0-1; I-2-3
P4	I-0; I-1; II-2-2	0-0; 0-1-1-2
Males		
P1	I-0; I-1; II-2	0-1; 0-1; I-2
P2	I-0; I-1; II-2-1	0-1; 0-2-2
P3	I-0; I-1; I-3-2	0-0; 0-1; 0-2-0
P4	I-0; I-1; II-2-2	0-0; 0-2-1

Inner lobe of P5 benp flat, naked, inner lobe with usual seta, exp with 3 bipinnate setae, middle seta 2.3 times as long as inner and outer (fig. 2H). Anal somite and caudal rami as in female, including ventral spine on posterior margin of anal somite (fig. 2I, J).

Culture. — Absolute density average (females ml^{-1}) in the laboratory-reared specimens of *E. grandidieri* was followed around 60 days from an initial density of 0.04 females ml^{-1} . The log-phase of population growth in the culture was reached after 35-40 days; the phase where densities approached the carrying capacity occurred after 50 days, with an average of 8-10 adult females ml^{-1} (fig. 6).

Our observations on the cultured developmental stages of *E. grandidieri* showed that the naupliar stage lasted for 12 days and the copepodid stage also for 12 days. After this period adult females with eggs were observed in each of the test recipients and these eggs hatched into nauplii. At low densities, almost all the females were egg-bearing but after around 35 days after initiating the experiment, the egg ratio declined as the population density increased. In this study we did not follow the second generation to confirm the fertility of the offspring but we did observe that probably the species, unlike most copepods, is parthenogenetic. This is an issue that is not under discussion or part of the objectives of this work, but some comments are added in the Discussion. Males were scarce in the culture vessels.

Remarks

General morphology. — The species was identified as *E. grandidieri* as the diagnostic characters described by Lang (1948) and Kikuchi (1985) were

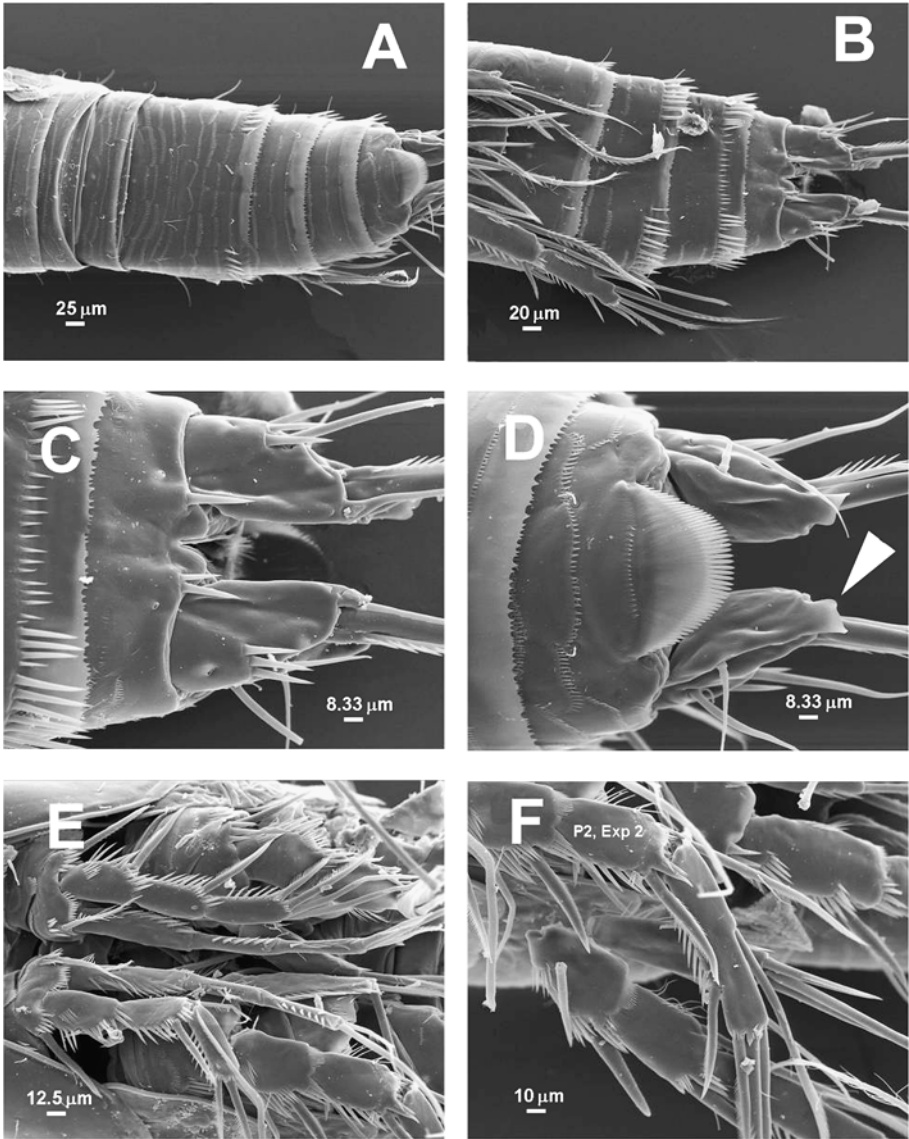


Fig. 4. *Elaphoidella grandidieri* (Guerne & Richard, 1893) from central Mexico, adult female, SEM micrographs. A, urosome, dorsal view, with detail of ornamentation; B, same, ventral view; C, anal somite and caudal rami, anal posteroventral spines arrowed; D, same, dorsal, caudal rami keel arrowed; E, P1, frontal view; F, P2, frontal view.

present. This species belongs to the *Elaphoidella* species Group II proposed by Lang (1948) and Petkovski & Brancelj (1988) by possessing a 3-segmented enp of P1, inner lobe of benp of female P5 with 4 setae and exp with 5 setal

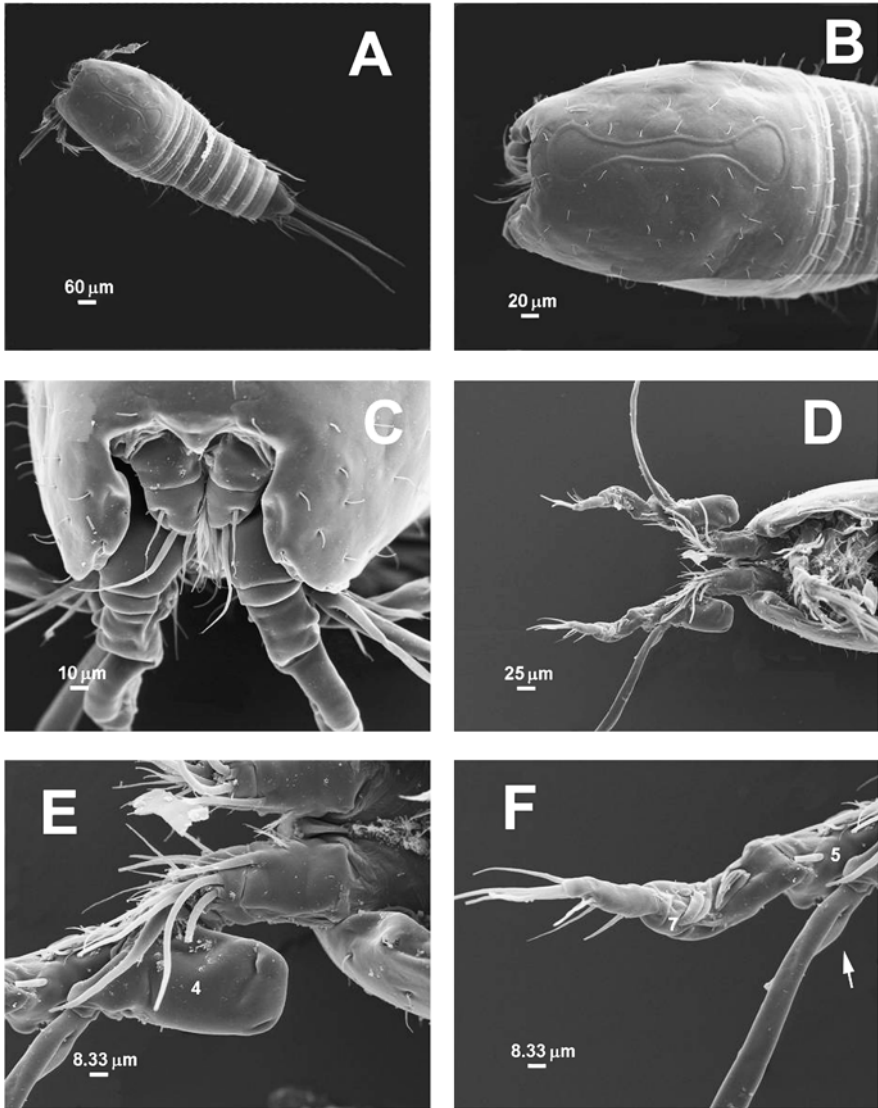


Fig. 5. *Elaphoidella grandidieri* (Guerne & Richard, 1893) from central Mexico, A–B, young male, SEM micrographs. A, habitus, dorsal view; B, cephalosome showing ornamentation and nuchal organ, dorsal view; C–F, adult male; C, rostrum and proximal antennular segments; D, cephalosome and geniculate A1, ventral view; E, right geniculate A1, detail of segments 1–4, ventral view; F, same, segments 5–8.

elements, distal segment of exp of P3 and P4 with 2 inner setae. In the male the distal enp segment of P4 has 3 setae, and that of P2 bears 4 setae plus 1 inner seta on the first segment. In this group, Lang (1948) included 12 more species,

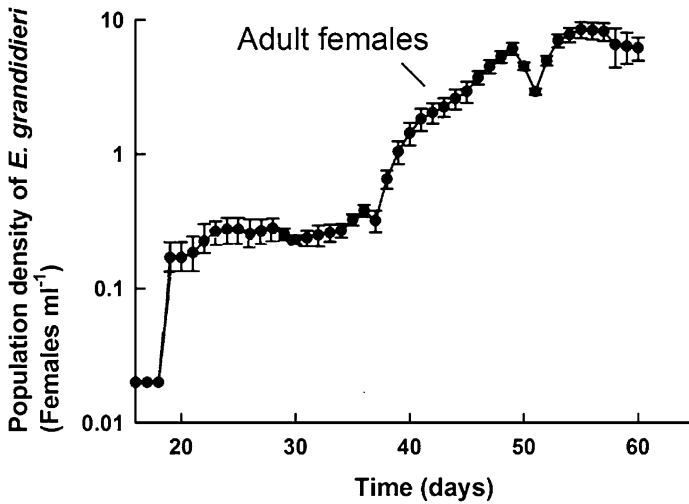


Fig. 6. Population growth curve of *Elaphoidella grandidieri* (Guerne & Richard, 1893) and changes of absolute density average (specimens ml^{-1}) of adult females. Each point represents the mean \pm SE of 4 replicate observations.

among which there are other widespread species such as *E. bidens coronata* (Sars, 1904), *E. gracilis* (Sars, 1863), and *E. intermedia* Chappuis, 1931. The Middle American forms *E. neotropica* Petkovski, 1973 and *E. parvifurcata* Petkovski, 1980 are also included in this group.

Elaphoidella grandidieri is similar to *E. bidens* (Schmeil, 1894) but also to the American species *E. amabilis* Ishida, 1993 and *E. carterae* Reid, 1993. Our specimens key down to the latter species when following Reid & Ishida's (1993) key to the North American species because both species share:

- 1) P2 enp 2 with 4 setae,
- 2) naked exp 1 of P3, and
- 3) four elements on the inner margin of the benp of the female fifth legs, among other characters.

Elaphoidella grandidieri cannot be confused with *E. carterae* because of:

- 1) the distinct structure and armature of the P5,
- 2) the shape of the keel on the caudal rami, hook-like in *E. carterae* (Reid & Ishida, 1993), subrectangular in *E. grandidieri*,
- 3) the strongly convex anal operculum, which is poorly developed in *E. carterae*,
- 4) the shape and size of the nuchal organ, reduced in *E. carterae* and large, well developed in *E. grandidieri*, and

TABLE II

Comparative analysis of variation of selected characters in females of *Elaphoidella grandidieri* (Guerne & Richard) from different geographical regions including the Mexican material. A1 = antennule, enp = endopod, exp = exopod, seg = segment, benp = baseopod, L/W = length/width. Data from Guerne & Richard (1893) (Madagascar = Madag.); Defaye (1988) (Ethiopia); Kikuchi (1985) (Japan 1); Ishida (1990) (Japan 2); Dussart (1982) (Guadeloupe = Guad.); Sars (1904) (Hawaii); this survey (Mexico); (/) indicates ratio. *Dussart (1982) reported 10-segmented A1 in a female specimen from Guadeloupe

	Madag.	Ethiopia	Japan 1	Japan 2	Guad.	Hawaii	Mexico
Outer spine of P1 exp 3/seg	1.08	–	1.0	0.75	0.5	–	0.7
Terminal setae of P2 enp/seg	4.0	–	3.5	2.6	3.0	–	2.5
Spinulation of P2 exp	Light	–	Strong	Strong	Light	–	Light
Inner seta on P4, enp1	Absent	–	Absent	Present	Absent	Present	Absent
L/W P5 exp	1.6	1.3	1.6	1.4	2.3	1.6	2.6
Inner seta of P5 benp/exp	1.5	1.6	1.0	1.4	2.2	1.6	1.0
P5 benp outer lobe seta/exp	0.9	1.3	2.2	0.9	3.1	1.6	1.4
Aes A1 seg 4	Distal end of seg 8	–	Distal end of seg 7	Beyond seg 8	Distal end of seg 10*	–	Halfway of seg 8

5) the armature of the caudal rami, with bulbous setae in *E. carterae* vs. normal setae in *E. grandidieri*.

In table II we provide a comparison of several morphological features that show differences based on other taxonomic accounts of this species from distinct geographical regions. In general, there are variations in the relative length of several setal elements, particularly on P1 and P2, the length of the ae on antennular segment 4, and the proportions of the exp segment of the female P5. The shortest outer spine of P1 terminal exp segment, the longest inner seta of the outer benp lobe, and the longest seta of the inner baseopodal lobe of the female P5 were reported by Dussart (1982) from Guadeloupe, in the Caribbean (see table II). The shortest ae on antennular segment 4 was reported by Kikuchi (1985). The Mexican specimens have a spine on the posteroventral margin of the anal somite; this character has not

been reported in the other accounts analysed herein, except for Monard (1937) from specimens collected in Angola, Southwest Africa. Another variable character in this comparison is the presence or absence of an outer seta on the first enp segment of P4. Kikuchi (1985) noted that this seta was absent from specimens collected in Itako, Japan; however it is present in another Japanese population surveyed by Ishida (1990) from southwestern Japan. In the original description Guerne & Richard (1893) did not report the presence of this seta. This element has been reported from populations in Hawaii (Sars, 1904) and Angola (Monard, 1937), but it is absent in the Mexican specimens examined herein and also in the other taxonomic reports including the original description (table II). Additional differences between the two Japanese reports compared herein are: the length of the seta on the outer lobe of the benp of the P5 and the relative length of the aesthetasc (see table II).

Dussart (1982) recorded a single female (specimen) that he determined as *E. cf. grandidieri*; it has the highest degree of variation from the general *E. grandidieri* pattern (see table II), including also a 10-segmented antennule and asymmetry of the right and left P5. These differences as well as the others noted in this comparative analysis support the notion that this widespread pantropical species shows a considerable degree of variability in various characters. This could be the result of intraspecific variation as suggested by Apostolov (1985) for the highly variable *E. bidens*, or this species could represent distinct subspecific taxa and should be studied further (Janetzky et al., 1996).

DISCUSSION

Elaphoidella grandidieri was originally described from Madagascar (Guerne & Richard, 1893) and has also been recorded from different localities in America, Europe, Africa, and Asia (Kikuchi, 1985; Defaye, 1988; Ishida, 1990; Reid, 1993; Reid & Ishida, 1993). Most of the known records are from the Old World. In the Americas this species has an irregular but wide distribution; it has not hitherto been recorded from North America (United States and Canada) (Wilson, 1975; Williamson & Reid, 2001). The northernmost record of this species is from the central sector of Nuevo Leon, northern Mexico; this record was published by Suárez-Morales & Reid (1998) based on the identification of specimens from that area deposited in the National Museum of Natural History (USNM-267427). Hence, the finding of this species in central Mexico is the second record from Mexico and the second northernmost in the Americas. The species has also been reported from the insular Caribbean, in-

cluding Cuba and Guadeloupe (Dussart, 1982; Reid, 1990a). In South America it was reported from Brazil (Reid, 1998) and Colombia (Gaviria & Aranguren, 2007). Overall, it appears that the species range on the continent is largely restricted to tropical areas. It has been redescribed by Kikuchi (1985) based on Japanese specimens; he noted that the information on the male of this species is limited.

The genus *Elaphoidella* has a very wide range of habitats, from surface sediment layers of rivers and lakes to karstic springs; species of the genus have also been recorded in moss and bromeliads (Mori & Brancelj, 2008). *Elaphoidella grandidieri* has been regarded as being mainly benthic, common in ponds (Gaviria & Aranguren, 2007); the specimens studied here were collected from a shallow (1 m depth) fish pond with a mud bottom.

Several marine harpacticoids are a valuable source of food for marine fish larvae due to their low ash and high protein levels (Watanabe et al., 1983). In freshwater aquaculture, cladocerans and rotifers are traditionally used as live food, principally due to their high nutritional quality (Watanabe et al., 1983) and their high growth rates that can be attributed to their parthenogenetic mode of reproduction (Sarvala, 1979). Parthenogenesis has been confirmed in a few species of harpacticoids of the family Canthocamptidae such as *Elaphoidella bidens*, *Epactophanes richardii* Mrázek, 1894, and *Canthocamptus staphylinus* (Jurine, 1820) (cf. Sarvala, 1979; Dole-Olivier et al., 2000). Since males are rarely found in some of these canthocamptid species, it is suspected that other species such as *Elaphoidella leruthi* Chappuis, 1937, *E. elaphoides* (Chappuis, 1923), and, as assumed from our data, also *E. grandidieri*, are parthenogenetic. This interesting aspect will be treated in more detail in a future contribution. With the available data, any interpretative comments or ideas about why the males are scarce in the culture vessels, would be speculative. The finding of *E. grandidieri* as an harpacticoid that rapidly reaches population densities as high as 30-40 ind. ml⁻¹ (all stages combined), has a large proportion of egg-bearing females, and is consumed locally in high numbers by predators such as *Ameca splendens* Miller & Fitzsimons, 1971 (Pisces) and *Ambystoma mexicanum* Shaw, 1789 (Amphibia) in central Mexico (N. Sarma and S. S. S. Sarma, 2009, pers. comm.), indicates that this harpacticoid has an outstanding potential in aquaculture.

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