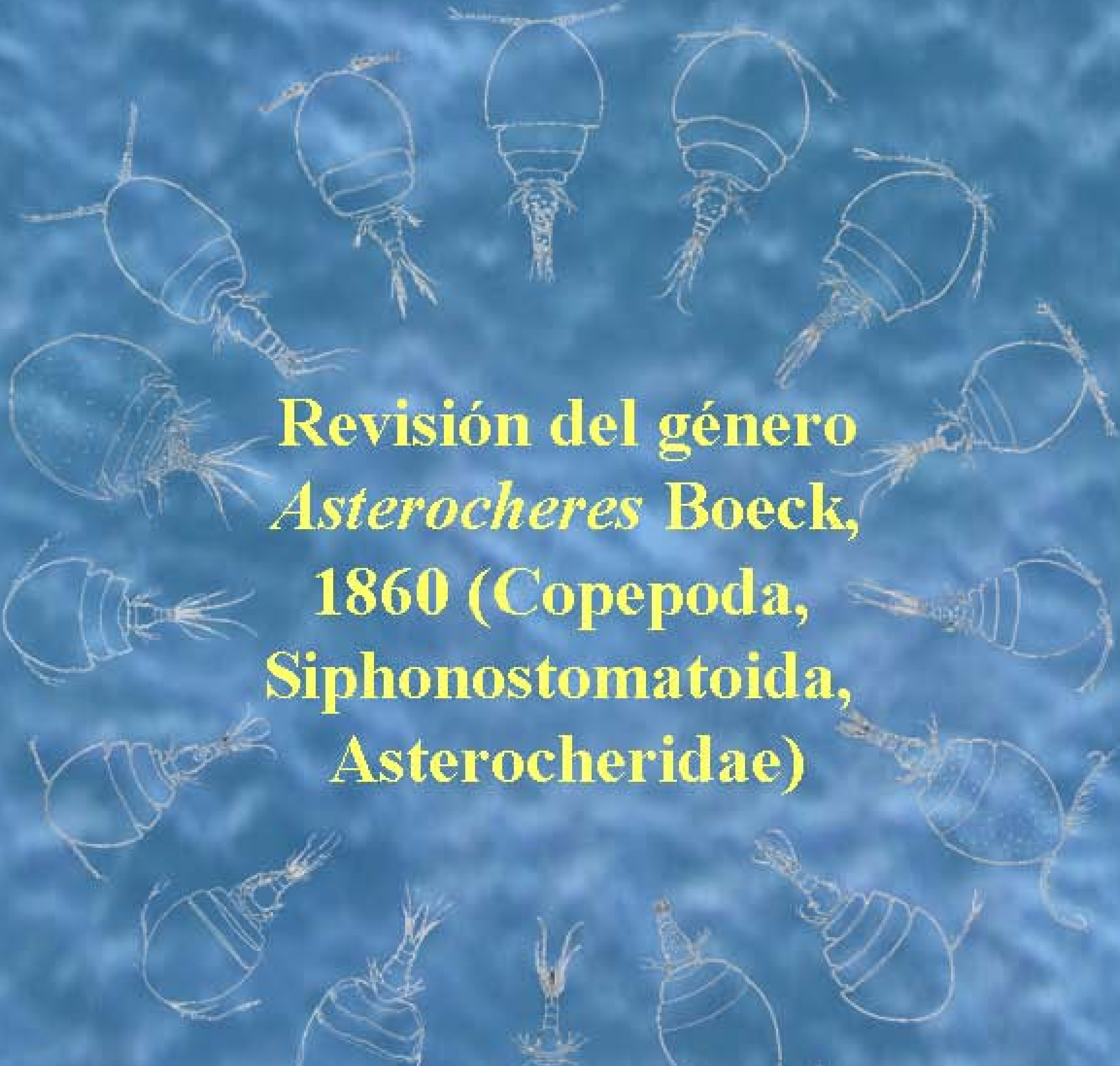

Revisión del género *Asterocheres* Boeck, 1860 (Copepoda, Siphonostomatoida, Asterocheridae)

M.E Bandera García

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REVISIÓN DEL GÉNERO *ASTEROCHERES* BOECK 1860 (COPEPODA, SIPHONOSTOMATOIDA, ASTEROCHERIDAE)

Memoria presentada para optar al título de Doctora Biología por la Universidad de Sevilla

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SEVILLA 2015

DÑA MERCEDES CONRADI BARRENA, PROFESORA TITULAR DEL DEPARTAMENTO DE ZOOLOGÍA DE LA UNIVERSIDAD DE SEVILLA

HACE CONSTAR:

Que esta memoria, titulada "Revisión del género *Asterocheres* Boeck, 1860 (Copepoda, Siphonostomatoida, Asterocheridae)", presentada por Dña. María Eugenia Bandera García, resume su trabajo de Tesis Doctoral y, considerando que reúne todos los requisitos legales y las condiciones de originalidad y rigor científico, autoriza su presentación y defensa para optar al grado de Doctora en Biología por la Universidad de Sevilla.

Sevilla, Abril, 2015

La directora

Fdo Mercedes Conradi Barrena

A la memoria de mi padre,

A mi madre

"…..Allí donde me he equivocado, o donde mi trabajo ha resultado
imperfecto, y cuando he sido ardientemente criticado, incluso
cuando me han adulado, todo lo cual me mortifica,
mi mayor consuelo ha sido decirme a mí mismo miles de veces
que-he trabajado tan duramente y tan bien como he sido capaz,
y nadie puede hacer más que eso-….."
Charles Darwin (Autobiografía, 1876)

AGRADECIMIENTOS

Desde que terminé la carrera y tenía muy claro que quería hacer la tesis, hasta llegar a este momento, he recorrido un camino muy largo, a veces cuesta arriba, a veces cuesta abajo, la mayoría de las veces disfrutando de estos animalitos diminutos, otras veces con mucho esfuerzo, con paciencia, con desesperación….Sin embargo, el esfuerzo y la paciencia, no han sido solo míos sino también de otras personas a las que tengo que agradecer que yo hoy esté escribiendo la última página de esta memoria.

En primer lugar, mi más profundo y sincero agradecimiento es para Mercedes, mi directora, a la que yo nunca he visto como una jefa sino como una amiga. Sin su ayuda, su esfuerzo y su infinita paciencia conmigo, yo nunca hubiera terminado esta tesis. Sentir tu apoyo "a pesar de todo" ha sido fundamental para llegar hasta el final. Contigo, Mer, espero seguir compartiendo esta pasión por los mini-crustáceos y disfrutar, sin prisas, de las charlas taxonómicas, las disecciones y del relajante mundo de pasar a tinta…

Nada de esto hubiera sido posible sin el apoyo y la compresión de mi familia. Quiero agradecer a mis padres que me apoyaran cuando les dije que quería hacer la tesis. Aunque mi padre no haya visto el proceso, el pensar que pueda sentirse orgulloso de mi trabajo es lo que más me ha animado en los momentos de mayor desanimo. Los que más han padecido esta tesis han sido mi madre y Sergio, mi marido. Ellos han compartido conmigo mis momentos de euforia y mis alegrías, y han soportado mis momentos de desánimo, mi desesperación y mis lágrimas … y a pesar de todo han seguido apoyándome. Me siento muy afortunada de teneros en mi vida. A mi hijo, Alejandro, que en estos últimos meses ha perdido la paciencia y que no comprende porque algo que me gusta tanto me pone de tan mal humor. A mi hermano que soportaba mis charlas, siempre sobre el mismo tema, en los inicios. A mis tíos y primos que siempre me preguntan cuándo voy a terminar, porque no es la primera tesis en la familia, pero si la que ha durado más años. A los que se fueron con la duda de si esto llegaría a su fin algún día, y que seguramente me estarán ayudando desde donde estén.

A Fani por estar siempre ahí, apoyándome y animándome y por ser una de las pocas personas en el mundo que comprende lo que siento, ¿por qué será?

En este largo camino, me he cruzado con muchas personas, y a todas tengo algo que agradecerle. Principalmente a José Carlos que me permitió entrar en su grupo de investigación, con overbooking, cuando terminé la carrera, gracias por haberme abierto las puertas en aquel momento y gracias por haberme vuelto a acoger en esta parte final. Seguramente tus clases de Biología Marina hayan tenido mucha culpa de que yo quisiera dedicarme a esto. A Isabel Alfonso, con quien compartí mis inicios en este mundo, compañera de muestreos de esas otras tesis que vinieron antes que ésta, le agradezco su apoyo y compresión en aquellos primeros años. A Carlos María, siempre dispuesto a ayudar en cualquier cosa que haga falta, le agradezco sus consejos para que la redacción en español fuera lo más correcta posible. A Emilio su ayuda en la edición, a Isa esa claridad de ideas que tiene. A José "guerrita", tu apellido no te hace justicia, ¡con lo pacífico que tú eres! Gracias por tu interés en mi trabajo durante todos estos años, siempre preguntado qué tal va y animándome. Al final, ya ves, ¡te ha tocado ser secretario!

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A mis amigos, que no entienden muy bien de que va el asunto, pero que siempre preguntan cuándo voy a terminar. Especialmente a Úrsula, siempre mostrándome su cariño y su apoyo en cualquier cosa que yo decida hacer en la vida.

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Y finalmente, ¿por qué no?, a los cientos de copépodos anónimos que donaron sus cuerpos para que yo pudiera realizar esta memoria.

Creo que en la vida las cosas pasan cuando tienen que pasar, todo tiene su momento y su lugar. Seguro que hay algún motivo para que yo haya tardado tanto tiempo en leer la tesis. Quizás necesitaba recorrer este camino tan largo y aprender no sólo sobre los copépodos, sino también aprender de la vida, de la gente y sobretodo de mi misma. Ahora que parece que las piezas encajan… será que ha llegado el momento ♪♫♪ when all the parts of the puzzle start to look like they fit, then I must remember there´ll be days like this ♪♫♪ (Van Morrison, 1995).

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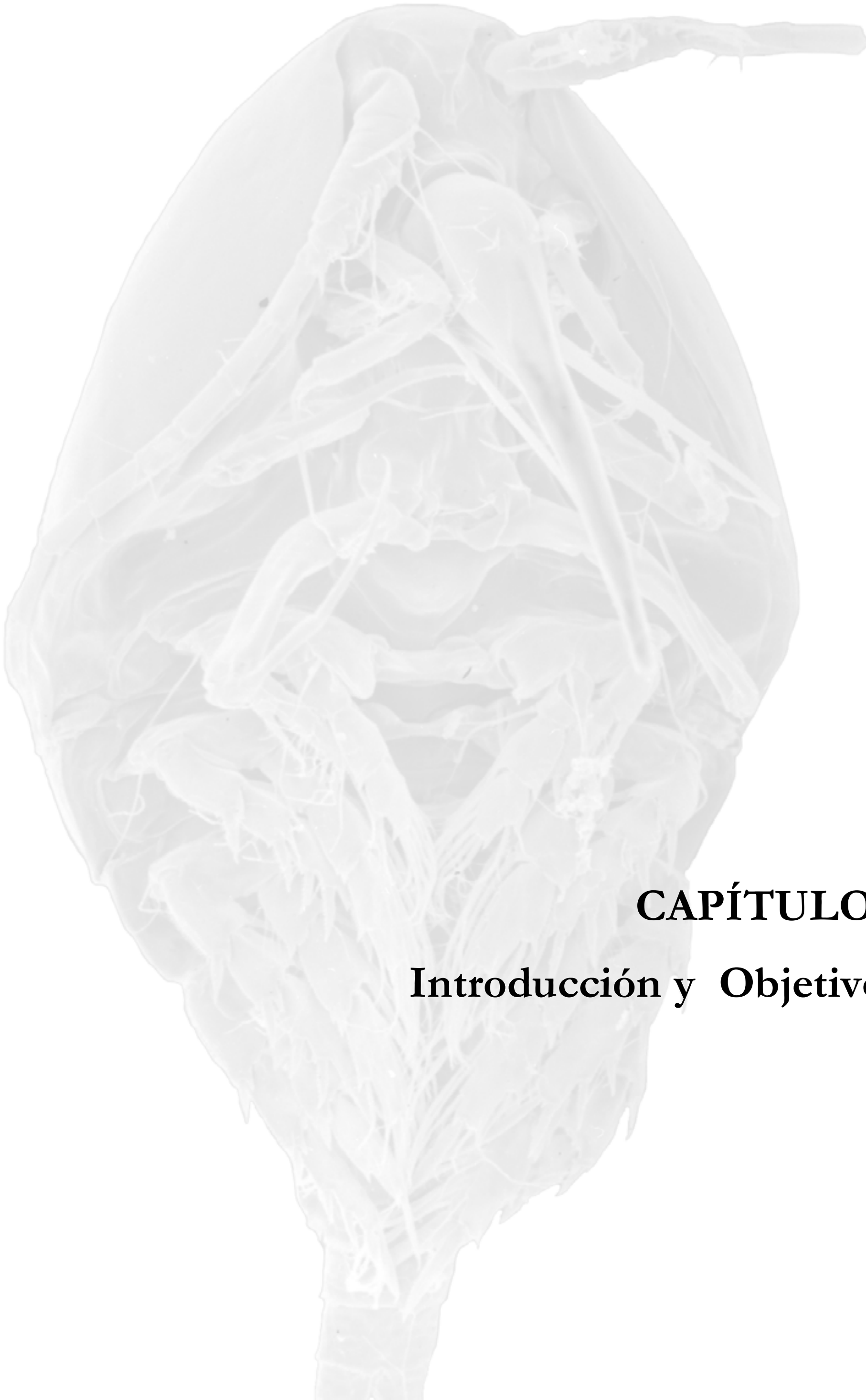
RESUMEN

Los copépodos son un grupo de diminutos crustáceos acuáticos con una amplia diversidad de estructuras y hábitos así como una gran capacidad de adaptación. Aunque estos pequeños crustáceos son conocidos como miembros abundantes del plancton y del bentos, también han tenido un gran éxito ecológico formando distintos grados de asociación con los diversos filos de Metazoos. El orden Siphonostomatoida es uno de los nueve órdenes de la subclase Copepoda, y el único que incluye especies exclusivamente asociadas o parásitas de otros metazoos. La autapomorfía que define a este orden es la presencia de una mandíbula con estilete típicamente contenido en un cono oral o sifón. La familia con mayor número de géneros es Asterocheridae, que es además una de las más plesiomórficas. Esta familia es muy heterogénea y sus representantes pueden vivir como asociados internos o externos de una amplia variedad de filos de invertebrados marinos aunque los hospedadores de varios géneros y muchas especies son aún desconocidos. El género que presenta un mayor número de especies es *Asterocheres*; si bien muchas descripciones están incompletas o son erróneas, lo que hace muy difícil compararlas con sus congéneres. En la mayoría de los casos, estas especies no han vuelto a ser recogidas desde su descripción original, por tanto para estudiarlas hay que recurrir al material depositado en los museos. En la presente memoria se revisa el género *Asterocheres* a partir de material recogido por personal del grupo de investigación y material depositado en distintos museos europeos: (1) el género *Asterocheres* se compone de 100 especies nominales; (2) se describen ocho especies nuevas; (3) se redescriben 21 especies; (4) se nombran dos géneros nuevos; (5) se le devuelve el status de "especie válida" a tres especies consideradas previamente como sinónimas; (6) se considera una especie como taxón indeterminado, dos especies como "incompletamente descritas" y tres especies como *inquirendae*; (7) se relega *Asterocheres violaceus* a sinónimo de *Asterocheres echinicola*; (8) se nombra lectotipo para la especie *Asterocheres stimulans*; (9) se confirma la clasificación *inquirendae* para *Asterocheres longisetosus* y se cataloga su descripción como errónea; y (10) se rehabilitan las grafías originales de los epítetos específicos *boeckii* y *lilljeborgii* de acuerdo con el Código Internacional de Nomenclatura Zoológica.

ABSTRACT

Copepods are diminutive aquatic crustaceans with a wide variety of structures and habits as well as a great capacity for adaptation. Although these small crustaceans are known to be abundant members of marine benthic and plankton, copepods also have an amazing ecological success living in symbiotic relationships with diverse metazoan phyla. Siphonostomatoida is one of the nine orders belonging to subclass Copepoda and the only one that includes exclusively associates or parasites of other metazoan species. The presence of a mandible with a stylet which tipically lies within the lumen of an oral cone is an autapomorphy defining this order. Most of the genera of this order belong to the Asterocheridae which is the most plesiomorphic family within Siphonostomatoida. This family is very heterogenous with members living both as internal or external associated of a very wide variety of marine invertebrates phyla but host are unknown for many species and several genera. *Asterocheres* is the largest and most speciose genus within the Asterocheridae, although several species are poorly or incompletely described that are hardly comparable with other congeners. Most of these poorly known species have not been recorded since their original descriptions and their studies are to be based on type material deposited in museums. In the present revision of the genus *Asterocheres*, material collected by members of this research team and type material deposited in museums are studied: (1) *Asterocheres* is composed by 100 nominal species; (2) eight new species are described; (3) twenty one species are redescribed; (4) two new genus are erected; (5) three species considered as junior synonyms are reinstated as valid species; (6) one species has been classified as "undetermined taxon", two species as "incompletely described" and three species as *inquirendae*; (7) *Asterocheres violaceus* is relegated to a synonym of *Asterocheres echinicola*; (8) the lectotype of *Asterocheres stimulans* is designated; (9) the classification of *inquirendae* for *Asterocheres longisetosus* is confirmed; y (10) the original spelling of the specific epithet *boeckii* and *lilljeborgii* are reinstated according to the International Code of Zoological Nomenclature.



CAPÍTULO 1

Introducción y Objetivos

1.- INTRODUCCIÓN Y OBJETIVOS

1.1- Los Copépodos y su gran diversidad

Los copépodos son crustáceos acuáticos que se encuentran englobados dentro de la clase Maxillopoda Dahl, 1956 (Martin & Davis, 2001). Estos pequeños animales destacan por su gran diversidad en formas corporales y de hábitos de vida (Bosxhall & Hasley, 2004). El extraño nombre "copépodo" proviene del griego y significa "patas como remos" haciendo referencia a sus patas anchas y en forma de palas, y data de 1830 (Damkaer, 2002). Normalmente, alcanzan un rango de tamaño entre 200 μm y 5mm y tienen formas muy variadas, algunos son luminiscentes y otros exhiben llamativos colores y son de una belleza impresionante. En términos de diversidad y abundancia pueden ser vistos como "los insectos del mar", es más algunos autores han señalado que probablemente sean más abundantes que los insectos (Boxshall, 1998). Los copépodos tienen una gran capacidad de adaptación puesto que han colonizado con éxito hábitats con salinidad muy distinta desde hipersalinos, salinos hasta dulceacuícolas, con un amplio rango de temperatura desde las aguas polares hasta las zonas hidrotermales y una distribución vertical asombrosa puesto que se encuentran desde los 10.000 metros de profundidad en las fosas marinas hasta los 5.540 metros de altitud del Himalaya (Huys & Boxshall, 1991), incluso han sido encontrados en "micropiscinas" formadas en las grandes hojas de plantas tropicales (Damkaer, 2002). Los copépodos, como ya se ha mencionado anteriormente, son acuáticos: sin agua, no hay copépodos; sin embargo, se conocen unas pocas especies propias del mantillo de bosques húmedos (Jaume, Conradi & López-González, 2004).

Aunque los copépodos son conocidos como miembros abundantes del plancton y del bentos, también han tenido un gran éxito ecológico formando distintos grados de asociación con los diversos filos de Metazoos (Gotto, 1979). Alrededor del mundo podemos encontrar más de 12.500 especies de copépodos conocidos, de las que aproximadamente la mitad viven en asociaciones simbióticas. La mayoría de éstas son probablemente de parasitismo pero la naturaleza precisa de las relaciones con los hospedadores aún no ha sido determinada en la mayoría de los casos. A causa de este desconocimiento, en la presente memoria utilizaremos el término parásitos, cuando la relación es conocida y el término "asociados" para nombrar a estas relaciones simbióticas que en la mayoría de los casos son de comensalismo. Los copépodos parásitos utilizan un amplio rango de hospedadores encontrándose virtualmente en cada filo animal disponible en el ambiente marino como Porifera, Cnidaria, Platyhelminthes, Nemertea, Sipunculida, Echiura, Annelida, Mollusca, Arthropoda, Phoronida, Brachiopoda, Echinodermata, Hemichordata, Urochordata y Vertebrata (Chondrichthyes, Osteichthyes, Reptilia y Mammalia); incluso se han econtrado asociados a algas (Huys & Boxshall, 1991). Gracias a los fósiles encontrados, se tiene constancia de que esta asociación entre los copépodos y otros animales ocurre desde el Cretácico inferior (Cressey & Boxshall, 1989; Huys & Boxshall, 1991). Dentro de sus hospedadores, ocupan un amplio rango de microhábitats y pueden ser ectoparásitos y endoparásitos. Dado que la mayoría de los peces y otros animales acuáticos, incluyendo a las grandes ballenas, se alimentan fundamentalmente de copépodos y a que estos pequeños crustáceos muestran una variedad y abundancia de relaciones simbióticas, no encontrada en ningún otro grupo de crustáceos (Calman, 1911), se consideran que juegan un papel clave en "la economía de la naturaleza", puesto que los efectos de estos parásitos en la industria pesquera son a menudo severos (Calman, 1911; Kabata, 1979). Debido a esta circunstancia, la mayoría de las investigaciones se han llevado a cabo en los parásitos de peces y la biología de los parásitos de invertebrados marinos es menos conocida, con la excepción de unas pocas especies encontradas en invertebrados comercialmente importantes como los mejillones y las vieiras (Elston et al., 1985; Ho, 2001).

Dentro de la Subclase Copepoda Milne-Edwards, 1840 podemos encontrar a la Infraclase Progymnoplea Lang, 1948 y a la Infraclase Neocopepoda Huys & Boxshall, 1991; y ésta última se divide a su vez en Superorden Gymnoplea

Giesbrecht, 1882 y Superorden Podoplea Giesbrecht, 1882. Huys y Boxshall (1991) reconocieron diez órdenes basándose en sus caracteres morfológicos: Platycopioida Fosshagen, 1985, Calanoida Sars, 1903, Misophrioida Gurney, 1933, Harpacticoida Sars, 1903, Monstrilloida Sars, 1901, Mormonilloida Boxshall, 1979, Gelyelloida Huys, 1988, Cyclopoida Burmeister, 1834, Siphonostomatoida Burmeister, 1835 y Poecilostomatoida Thorell, 1859. La infraclase Progymnoplea incluye al orden Platycopioida, el superorden Gymnoplea al orden Calanoida y el superorden Podoplea a los restantes ocho órdenes. Sin embargo, esta clasificación basada en los diez órdenes reconocidos por Huys y Boxshall (*op.cit.*) no fue adoptada por Boxshall y Halsey (2004), ya que, según estos autores el descubrimiento de una nueva familia, Fratiidae Ho, Conradi & López-González, 1998, tuvo un profundo impacto en el conjunto de la clasificación de los copépodos. Esta familia parece ser el nexo de unión entre los órdenes Cyclopoida y Poecilostomatoida y su inclusión en la clasificación de los copépodos ha provocado la visión de estos dos órdenes como grupo monofilético en contraposición al concepto tradicional de taxón parafilético del orden Cyclopoida. Boxshall y Halsey (2004) en su monografía "Copepod Diversity" aglutinan a todas las familias previamente atribuidas a los órdenes Cyclopoida y Poecilostomatoida bajo un mismo orden, Cyclopoida. Esta reagrupación también ha sido confirmada por los estudios moleculares realizados por Huys y colaboradores (Huys et al., 2007).

De entre los nueve órdenes reconocidos dentro de los copépodos, sólo cinco: Calanoida, Harpacticoida, Cyclopoida, Siphonostomatoida y Mostrilloida se encuentran asociados a otros animales (Tabla 1) si bien estos cinco órdenes engloban casi el 99% de las especies conocidas de Copépodos (Ho, 2001). Los Calanoides son principalmente planctónicos marinos y raramente se encuentran en asociación con otros animales; excepcionalmente se han encontrado asociados a Cnidarios. La mayoría de los Harpacticoides son organismos bentónicos y en pocos casos se

Tabla 1.- Copépodos asociados a los filos de Metazoos (modificado de Huys & Boxshall, 1991)

	Calanoida	Harpacticoida	Monstrilloida	Cyclopoida	Siphonostomatoida
Porifera	-	+	-	+	+
Cnidaria	+	+	-	+	+
Platelmintos	-	+	-	+	-
Nemertinos	-	-	-	+	-
Policheta					
Sipunculidea	-	-	-	+	-
Vestimentifera	-	-	-	-	+
Equiuridea	-	-	-	+	-
Anelida	-	+	+	+	+
Mollusca	-	+	+	+	+
Artropoda	-	+	-	+	+
Foronifera	-	-	-	+	-
Bryozoa	-	+	-	-	-
Brachiopoda	-	-	-	+	-
Echinodermata	-	+	-	+	+
Hemichordata	-	-	-	+	-
Chordata					
Urochordata	-	+	-	+	+
Vertebrata					
Condrictios	-	-	-	+	+
Osteictios	-	+	-	+	+
Anfibios	-	-	-	+	-
Mammalia	-	+	-	-	+

encuentran asociados a animales tan variados como ballenas, isópodos, cangrejos ermitaños y moluscos cefalópodos. Los Montrilloides son un grupo reducido de copépodos en donde sólo los estadíos larvarios son endoparásitos de poliquetos o moluscos, mientras que los Ciclopoides- antes considerados como dos órdenes Cyclopoida y Poecilostomatoida- poseen tanto representantes libres como asociados a otros animales siendo los parásitos de peces, sobre todo de peces marinos, muy diversos. Sólo los representantes del Orden Siphonostomatoida son exclusivamente asociados o parásitos de otros Metazoos (Boxshall & Hasley, 2004). Entre los órdenes restantes, Platycopioida, Misophrioida, Mormonilloida y Gelyelloida, no se han encontrado asociaciones con otros animales. Los Platicopioides son copépodos de vida libre que forman parte de la comunidad hiperbéntica de los mares relativamente poco profundos y un par de géneros que habitan en cuevas anquihalinas. Los

Misofrioides pueden vivir en aguas costeras, hiperbentos de mares profundos, plancton de aguas profundas y cuevas anquihalinas de islas volcánicas y son oportunistas que se alimentan de una variedad de animales que incluyen cnidarios y copépodos. Los Mormonilloides están ampliamente distribuidos por los océanos de todo el mundo, entre profundidades de 400 a 1500 metros, y son suspensívoros. Y, por último, los Gelielloides que viven en aguas subterráneas de sistemas kársticos (Huys & Boxshall, 1991).

Los copépodos simbiontes han debido de evolucionar a partir de copépodos libres de forma que en el curso de su evolución, diferentes grupos de copépodos asociados han adoptado el mismo modo de vida con diferentes adaptaciones (Ho, 2001). Hay numerosos linajes que han pasado al modo de vida parásito de manera independiente por tanto el viejo concepto "Copepoda Parasitica" como taxón ya no tiene validez (Kabata, 1979).

1. 2.- El Orden exclusivamente simbiótico: los Siphonostomatoida.

Todos los integrantes del orden Siphonostomatoida son parásitos o viven asociados a otros animales y utilizan un amplio rango de hospedadores, tanto invertebrados como vertebrados (Figura 1). Se conocen más de 1.980 especies distintas de sifonostomatoides, repartidas en aproximadamente 39 familias y 340 géneros, de las cuales al menos 1.375 especies son parásitas de peces, muy pocas de mamíferos, y alrededor de 590 especies están asociadas a invertebrados marinos. El orden es principalmente marino, aunque existen algunas especies parásitas de peces dulceacuícolas (Huys & Boxshall, 1991). Los sifonostomatoides no son sólo copépodos abundantes, sino que también presentan una gran diversidad morfológica y de formas de vida, por ejemplo, algunos miembros de la familia Nicothoidae han perdido todos sus apéndices, reduciéndose a un cuerpo esférico anclado a su hospedador por medio de "raicillas absorbentes" derivadas del cono oral (Lincoln & Boxshall, 1983).

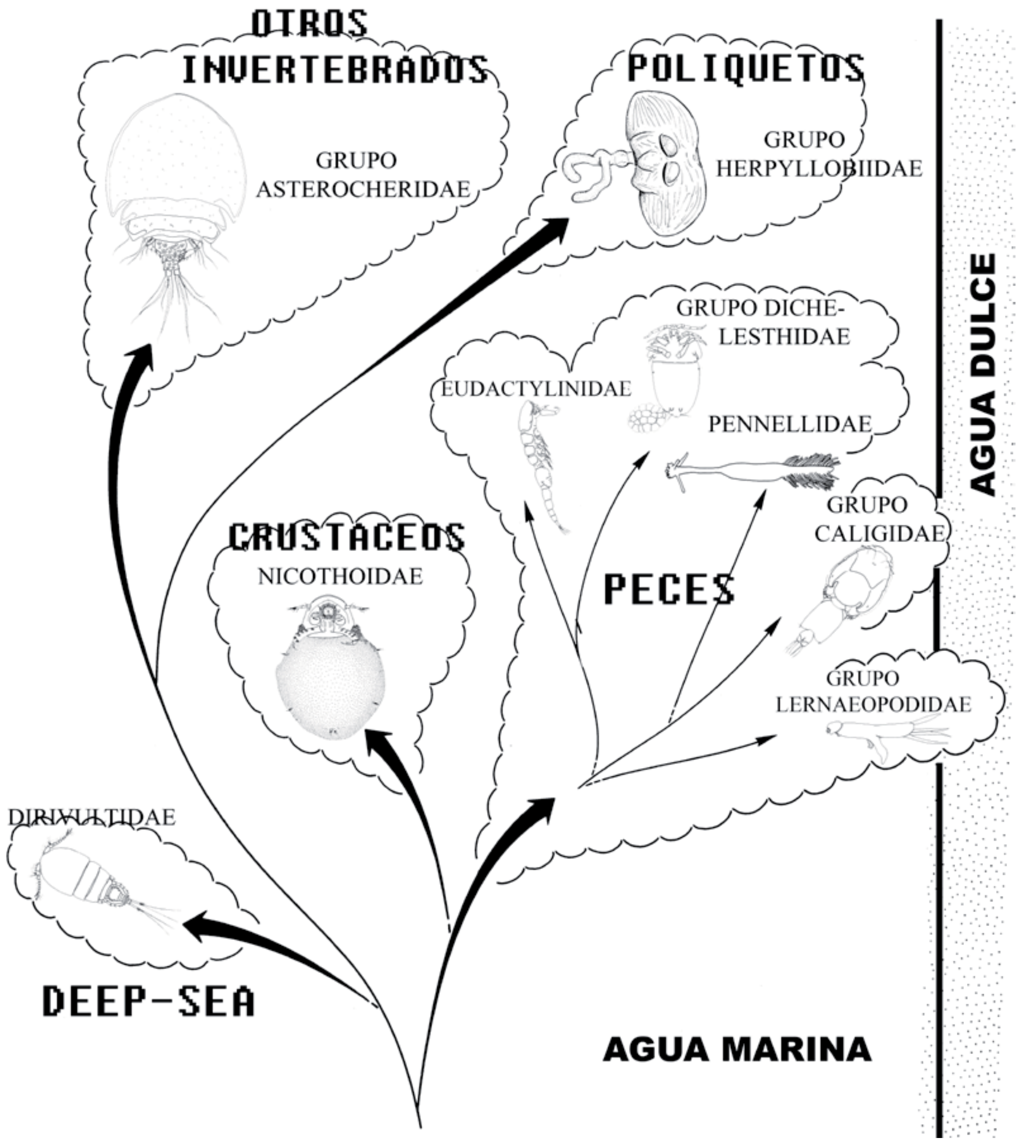


Figura 1.- Distintos filos de animales que los Siphonostomatoida utilizan como hospedador (modificado de Huys & Boxshall, 1991)

La mayoría de estos copépodos asociados viven en la superficie externa de los hospedadores, si bien muchos de ellos pueden refugiarse en microhábitats más internos como son las branquias, las fosas nasales, boca y la línea lateral de los peces, la cavidad paleal de muchos moluscos, las puestas o las branquias de otros crustáceos, la bursa de las ofiuras, las barbas de las ballenas y los sistemas de canales internos de las esponjas y cnidarios. Algunos de ellos son endoparásitos internándose dentro de la musculatura de sus huéspedes, o dentro de su cavidad interna o sistema digestivo. No sólo la mayoría de los órdenes de copépodos presentan formas asociadas sino que además, estos copépodos asociados pueden ser muy abundantes en sus hospedadores (Ho, 2001). Así, por ejemplo Humes (1973) encontró 24146 copépodos de dos especies distintas en la estrella de mar *Astroboa nuda* (Lyman, 1874) de aproximadamente 20 cm de diámetro en Madagascar. Estudiando la alta tasa de mortalidad del bivalvo *Meretriz meretix* (L., 1758) cultivado en china, Ho & Zheng (1994) encontraron una media de 30 individuos de *Ostrincola koe* Tanaka 1961 (Myicolidae, Ciclopoida) en la cavidad branquial de cada bivalvo examinado. Esta alta abundancia en sus hospedadores no sólo ocurre en invertebrados sino también en peces así por ejemplo se han encontrado unos 5431 ejemplares del copépodo *Ergasilus sieboldi* Nordmann, 1832 (Ergasilidae, Ciclopoida) en las branquias de un único pez (Ho, 2001).

La autoría del nombre ordinal Siphonostomatoida ha sido tradicionalmente atribuida a Thorell (1860). Sin embargo, Ivanenko, Ferrari y Smurov (2001) señalaron que Burmeister (1835) incluyó y proporcionó la diagnosis de cinco familias de parásitos dentro del taxón Siphonostoma y citó a Latreille, sin especificar la fecha de publicación, como autor de ese nombre. De hecho Latreille (1829) reunió bajo el nombre Siphonostoma, a título de familia, a un grupo de copépodos. Más tarde, en una publicación sobre crustáceos anfípodos, Milne Edwards (1830) nombró el Orden Siphonostomatoida en una tabla que aunque es la siguiente a la página 356 de la publicación, no fue numerada, y en donde no se especifica qué familias, géneros o especies pertenecen a este orden. Ivanenko, Ferrari y Smurov (*op. cit.*) creen, por lo tanto, que la autoría de Siphonostomatoida debe ser atribuida a Burmeister (1835) ya que "*él aparentemente tuvo la intención de crear un taxón con categoría superior a familia y proporcionó la diagnosis de este taxón y de las familias que lo constituían*".

La presencia de una mandíbula con estilete típicamente contenido en un cono oral o sifón, es una autapomorfía diagnóstica para los sifonostomatoides (Boxshall, 1986; Huys & Boxshall, 1991). El cono oral comprende un labio anterior, el *labrum*, y un labio posterior, el *labium*, que se unen en una estructura tubular que se va estrechando hasta abrirse en la parte distal. El *labrum* normalmente es robusto y tiene músculos poderosos que producen la succión necesaria para atraer el alimento hacia el esófago. El *labium* deriva de la fusión de los paragnatos (Boxshall, 1986b) y lleva un músculo medio y un par de músculos laterales. En las formas primitivas, el *labrum* y el *labium* están libremente asociados y se separan fácilmente para permitir el movimiento del estilete mandibular entre ellos, como ocurre en la familia Dirivultidae Humes & Dojiri, 1981. En las formas más avanzadas, el *labrum* y el *labium* están unidos a lo largo de toda su longitud mediante una estructura compleja de crestas y surcos entrelazados, y el estilete mandibular se encuentra dentro de la cavidad central del cono. El estilete mandibular está desprovisto de musculatura. El cono oral difiere considerablemente en longitud en las distintas especies. La mandíbula presenta un palpo con dos segmentos y un estilete fino que penetra en el cono oral lateralmente a través de una hendidura entre el *labrum* y el *labium*. El palpo se dirige hacia el lado externo del cono y puede tener un papel sensorial (Boxshall, 1990). Sin embargo, el uso del cono oral en taxonomía para diferenciar los distintos órdenes de copépodos está sujeto a dos condiciones: (1) el valor diagnóstico del cono oral como un atributo de los sifonostomatoides no es absoluto ya que varias familias de Harpacticoida exhiben un cono oral bien desarrollado con *labrum*, *labium* y mandíbulas con un estilete que se extiende a lo largo del cono (Huys, 1988; Huys & Conroy-Dalton, 1996; Huys & Iliffe, 1998). La morfología del cono oral de estos harpacticoides y de algunas familias primitivas de sifonostomatoides, como Asterocheridae Giesbrecht, 1899 y Dirivultidae, es muy similar y es el claro resultado de la convergencia indicando un modo de alimentarse parecido; (2) un labio posterior impar no indica necesariamente un *labium* genuino derivado de la fusión media del par de paragnatos. En algunas familias de harpactidoides y ciclopoides los paragnatos han alcanzado una reducción extrema y han perdido su apariencia lobulada dejando sólo un pliegue indiferenciado alrededor del margen posterior de la boca. Esta estructura impar que se deriva de una reducción bilateral y no de una fusión media, claramente no es homóloga del *labium* que definó Boxshall en 1986 y 1990 (Huys *et al*, 2006).

En 2004, Boxshall y Halsey listaron las 38 familias que conformaban el Orden Siphonostomatoida e incluyeron también el género monoespecífico *Pectenophilus* Nagasawa, Bresciani & Lützen, 1988. Estos autores explicaron que la decisión de incluir este género, que no se podía incluir en ninguna familia existente porque presentaba una bolsa de incubación interna, en el orden Siphonostomatoida se debía exclusivamente a que el macho enano adulto tenía una "boca tubular". Esta sugerencia por parte de Boxshall y Halsey de asignar provisionalmente el género *Pectenophilus* al orden Siphonostomatoida fue rechazada por Huys y colaboradores en el año 2006. Según estos autores el género *Pectenophilus* pertenece inequívocamente al orden Cyclopoida, concretamente se encontraría dentro del "complejo poecilostomatoida". A esta conclusión llegaron tanto por un análisis molecular que además proporcionó un respaldo estadístico contundente para establecer la relación, como grupos hermanos, entre *Pectenophilus ornatus* y dos mitilicólidos, *Mytilicola intestinalis* Steuer, 1902 y *Trochicola entericus* Dollfus 1914, como por las nuevas evidencias morfológicas derivadas del estudio del macho enano que demuestran que *Pectenophilus* es un miembro muy modificado de Mytilicolidae Bocquet & Stock, 1957 (Orden Cyclopoida). Ya en 1986, Gee y Davey demostraron que los mitilicólidos no desarrollan la mandíbula en los estadíos post-naupliar lo que concuerdan con la ausencia de mandíbula de *Pectenophilus* confirmada por el estudio con el microscopio electrónico de barrido (SEM) de Huys y colaboradores (2006). Este estudio además demostró que la rudimentaria maxílula, situada en posición preoral desplazada hacia la parte anterior, realizaba las funciones características de las mandíbulas, con las alobases dirigidas hacia la cavidad oral. Este reemplazamiento funcional de la gnatobase mandibular por la alobase maxilular, es una sinapomorfía de la familia

Mytilicolidae y demuestra manifiestamente que *Pectenophilus* debe ser incluido en esta familia.

Entre las 38 familias incluidas por Boxshall y Halsey (2004) en el orden Siphonostomatoida, no se encuentran Coralliomyzontidae Humes & Stock, 1991 y Scottomyzontidae Ivanenko, Ferrari & Smurov, 2001. La familia Coralliomyzontidae fue propuesta por Humes y Stock para acomodar a su nuevo género *Coralliomyzon* Humes & Stock, 1991 y se basó en la presencia de un maxilípedo con cuatro segmentos (dos segmentos basales y dos distales formando una garra) en contraposición con la condición de cinco segmentos presentes en el resto de géneros descritos, la ausencia de una seta interna en el primer y segundo segmento del exópodo de la primera pata, la reducción de la cuarta pata a un lóbulo setoso y a la reducción de la quinta pata (Humes & Stock, 1991). Como todas estas características eran compartidas, además, por el género *Cholomyzon* Stock & Humes, 1969, situado dentro de la familia Asterocheridae, estos mismos autores incluyeron a *Cholomyzon* en su nueva familia (Humes & Stock, 1991), que posteriormente fue ampliada con la descripción de dos nuevos géneros: *Temanus* Humes, 1997 y *Tondua* Humes, 1997 (Humes, 1997). Sin embargo, según Boxshall y Halsey (2004) los caracteres en los que se basó el establecimiento de esta nueva familia son altamente apomórficos e indican que estos cuatro géneros podrían representar una rama terminal especializada dentro de Asterocheridae.

Ivanenko, Ferrari y Smurov (2001) propusieron la familia Scottomyzontidae para incluir al género monotípico *Scottomyzon* (Scott & Scott, 1894) y se basaron en las siguientes características que lo diferenciaban del resto de géneros de Asterocheridae: abdomen compuesto por tres segmentos en ambos sexos, un par de gonoporos dorso-laterales situados cerca del margen posterior del somito, un par de poros copulatorios ventrales situados cerca de la mitad del somito y un sifón oral sexualmente dimórfico. Boxshall y Halsey (2004) no adoptaron esta propuesta aludiendo a que la nueva familia parecía estar basada en un carácter plesiomórfico y tres caracteres derivados y ninguno de estos caracteres derivados podía ser visto con valor significativo a nivel de familia sin un análisis filogenético exhaustivo dado que *Scottomyzon* comparte la pérdida de la seta del endópodo de la quinta pata y la reducción sinapomórfica de la setación de los exópodos de las patas tercera y cuarta con la mayoría de los otros géneros de Asterocheridae. Sin embargo, en la actualidad, estas dos familias están ampliamente aceptadas (concretamente desde mediados del año 2008) como puede comprobarse en el "World Register of Marine Species" (Walter & Boxshall, 2015).

En el orden Siphonostomatoida se incluye también la familia Pseudohatschekiidae Tang *et al*, 2010 de reciente descripción que se caracteriza por presentar las siguientes autapomorfías: (a) dos somitos pedígeros libres entre el cefalotórax y el complejo genital; (b) una antena quelada que lleva dos procesos digitiformes y una cubierta cuticular delgada; (c) una maxílula unilobulada, con el palpo completamente fusionado con el endito y representado por una seta superficial; (d) un proceso redondeado adornado con membranas pectinadas en el ápice del basis de la maxila; (e) ramas con dos segmentos en la patas primera a tercera; y (f) la ausencia de cuarta pata (Tang *et al*, 2010).

Otra de las modificaciones a considerar en el listado de familias integrantes del orden Siphonostomatoida realizada por Boxshall y Halsey (2004) es la inclusión de la familia Cecropidae Dana, 1849, que recientemente ha sido sinonimizada con la familia Pandaridae Milne Edwards, 1840. Kabata ya apuntaba en el año 1979 que la validez de Cecropidae era débil y que cecrópidos y pandáridos compartían muchas características morfológicas; en cambio, la única característica que los distinguía era la estructura del maxilípedo de la hembra. Este autor señaló que distinguir cecrópidos de pandáridos era una tarea problemática debido a su dificultad y desde entonces no se hizo ningún progreso en esta materia. Recientemente, Tang y colaboradores (2012) describieron el macho de *Prosaetes rhinodontis* (Wright, 1876), una especie que en ese momento pertenecía a la familia Cecropidae. Esta descripción contribuyó de manera significativa a diluir los límites entre las familias Cecropidae y Pandaridae ya que el macho de esta especie: (a) carece de placas postero-dorsales en el cuarto somito pedígero, una condición exhibida por la mayoría de los machos de pandáridos (Cressey, 1967); (b) comparte la modificación apomórfica del segmento terminal del endópodo de la tercera pata con machos de cecrópidos y machos de pandáridos del "*Dinemoura*-group" (*sensu* Kabata, 1979); (c) los somitos pedígeros segundo y tercero están fusionados en la hembra de *P. rhinodontis* así como en la hembra de algunos pandáridos del "*Dinemoura*-group" y de la mayoría de cecrópidos; (d) la hembra de *P. rhinodontis* presenta el tercer somito pedígero estrecho sin placas dorsales, como ocurre en las hembras del "*Dinemoura*-group" y casi todos los cecrópidos; (e) la hembra de *P. rhinodontis* tiene el maxilípedo esbelto, similar al del pandárido *Dinemoura discrepans* Cressey, 1967 y todas las hembras de cecrópidos. Por todas estas razones, estos autores consideraron la familia Cecropidae como sinónima de Pandaridae (Tang *et al*, 2012).

Por tanto, el orden Siphonostomatoida actualmente incluye un total de 39 familias, 17 de las cuales son parásitas de peces, 18 se encuentran asociadas a invertebrados marinos y cuatro familias cuyos hospedadores son desconocidos. La familia que tiene el mayor número de géneros es Asterocheridae, con 60 géneros, y 13 de estas familias son monotípicas. Sin embargo, la que tiene el mayor número de especies es Caligidae Burmeister, 1835, con más de 470 especies y Lernaeopodidae Milne-Edwards, 1840 con más dev270 especies y 18 familias tienen un número de especies igual inferior a cinco. Curiosamente, las familias parásitas de peces son las que presenta mayor número de especies (Boxshall & Halsey, 2004; WORMS, 2015). Curiosamente, las familias parásitas de peces como Caligidae y Lernaeopodidae son las que presentan un mayor número de especies, lo que probablemente se deba a un mayor esfuerzo investigador en estas familias dados los efectos negativos que suponen para la acuicultura.

La monofilia del orden Siphonostomatoida fue muy cuestionada por Marcotte (1982) que consideraba al orden polifilético de forma que hipotetizaba dos orígenes distintos: las familias parásitas de peces procederían de un stock de copépodos ancestral distintos a los que darían lugar a los asociados a invertebrados marinos. Este polifiletismo fue rechazado por Boxshall (1990) en su estudio comparado de la morfología del cono oral en sifonostomatoides parásitos de peces y aquéllos asociados a invertebrados que reveló que la disposición y trayectoria de los músculos del *labrum* eran tan similares que un posible origen polifilético del orden estaba completamente descartado. Sin embargo, posteriormente Boxshall y Hasley (2004) reconocían que era imposible confirmar un estatus monofilético de cualquiera de los grupos de siphonostomatoides que se consideraran sin un análisis filogenético exhaustivo de todo el orden. Dado el desconocimiento de las relaciones filogenéticas dentro del orden Siphonostomatoida y con la información que se tiene actualmente, según Boxshall y Halsey (*op. cit.*), los copépodos sifonostomatoides podrían agruparse de la siguiente manera: (1) un primer grupo integrado por las familias parásitas de peces que poseen una forma particular de mandíbula, desprovista de palpo y con una colección de dientes en el margen subdistal del estilete de la mandíbula. Este grupo estaría formado por 17 familias (véase Grupo 1; Tabla 2); (2) un segundo grupo formado por las familias asociadas a invertebrados que a su vez se podría subdividir en dos subgrupos según la morfología del cuerpo. El primer subgrupo se caracterizaría por poseer la forma básica del cuerpo ciclopiforme, con el límite prosoma-urosoma bien definido y la segmentación propia del prosoma y del urosoma. Este subgrupo estaría formado por nueve familias y parte de otras dos familias. En este grupo también se incluyen las familias cuyos hospedadores son desconocidos (véase subgrupo 2A; Tabla 2); (3) el segundo subgrupo se caracteriza por presentar una forma del cuerpo modificada que puede ir desde el cuerpo dorso-ventralmente aplanado (Artotrogidae Brady, 1880 (parte), Asterocheridae (parte) y Entomolepidae Brady, 1899) a cuerpos más o menos hinchados o globulares con una segmentación del cuerpo en el prosoma, urosoma, o ambos, mal definida. Este subgrupo estaría formado por 11 familias y la parte restante de las otras dos familias que se incluyen en el subgrupo 2A (véase subgrupo 2B; Tabla 2).

Con respecto a la relación filogenética del orden Siphonostomatoida con otros órdenes de la subclase Copepoda, Boxshall y Huys (1991) propusieron un esquema basado en datos morfológicos, o mejor dicho, en unos listados que incluían

Tabla 2: Familias consideradas dentro del orden Sifonostomatoida parásitos de peces y asociadas a invertebrados marinos. El grupo A de las familias asociadas a invertebrados marinos son las poco transformadas y el B, las transformadas (modificada de Boxshall & Hasley, 2004).

PECES (Grupo 1)	**INVERTEBRADOS (Grupo 2)**	
Archidactylinidae Izawa, 1996	Artotrogidae (parte) Brady, 1880	
Caligidae Burmeister, 1834	Asterocheridae (parte) Giesbrecht, 1899	
	Brychiopontiidae Humes, 1974	
	Coralliomyzontidae Humes & Stock, 1991	
Dichelesthiidae Milne Edwards, 1840	Dinopontiidae Murnane, 1967	
Dissonidae Yamaguti, 1963	Dirivultidae Murnane, 1967	**A**
Eudactylinidae Wilson, 1922	Ecbathyriontidae Humes 1987	
Hatschekiidae Kabata, 1979	Megapontiidae Heptner, 1968	
Hyponeoidae Heegaard, 1962	Pontoeciellidae Giesbrecht, 1895	
Kroyeriidae Kabata, 1979	Rataniidae Giesbrecht, 1897	
	Scottomyzontidae Ivanenko *et al*, 2001	
Lernaepodidae Milne Edwads, 1840		
Lernanthropidae Kabata, 1979	Artotrogidae (parte) Brady, 1880	
	Asterocheridae (parte) Giesbrecht, 1899	
Pandaridae Milne Edwards, 1840	Calverocheridae Stock, 1968	
Pennellidae Burmeister, 1834	Cancerillidae Giesbrecht, 1897	
Pseudocycnidae Wilson, 1922	Codobidae Boxshall & Ohtsuka, 2001	
Pseudohatschekiidae Tang, *et al*, 2010		
Sphyriidae Wilson, 1919	Dichelinidae Boxshall & Ohtsuka, 2001	
Tanypleuridae Kabata, 1969	Entomolepididae Brady, 1899	**B**
Trebiidae Wilson, 1905	Micropontiidae Gooding, 1957	
	Nanaspididae Humes & Cressey, 1959	
	Nicothoidae Dana, 1849	
	Sponginticolidae Topsent, 1928	
	Spongiocnizontidae Stock& Kleeton, 1964	
	Stellicomitidae Humes & Cressey, 1958	

el estado más plesiomórfico que cada carácter puede exhibir en cada orden de copépodos. Cada lista ordinal estaba referida al conjunto de caracteres ancestrales y para construir este conjunto se buscó el máximo número de segmentos en cada orden, para cada apéndice y el número máximo de setación por segmento de cada apéndice. (Figura 2). En este nuevo esquema filogenético propuesto por Huys y Boxshall (*op. cit.*), el orden Platycopioida es el primer grupo que diverge desde el linaje principal de copépodos, y el segundo son los calanoides. Los ocho órdenes restantes forman dos clados: (a) el primero comprende a los órdenes Misophrioida, Cyclopoida y Gelyelloida. Misophrioida es el primer grupo que diverge formando los Cyclopoida y Gelyelloida un grupo hermano terminal; (b) el segundo grupo está formado por los restantes cinco órdenes, con los Mormonilloida como grupo hermano plesiomórfico de los otros cuatro órdenes. Después se separan los Harpacticoida, seguidos de los Poecilostomatoida (este esquema filogenético data de 1991, y los Poecilostomatoida aún tenían categoría de orden a diferencia de la actualidad en que se considera un "complejo poecilostomatoida" dentro del orden Cyclopoida),, y finalmente por el grupo hermano terminal de este clado que lo formarían los Siphonostomatoida y los Monstrilloida. Estos dos grupos tendrían, según estos autores, las siguientes sinapomorfías: (a) fusión del cefalosoma y primer somito pedígero para formar el cefalotórax; (b) ausencia de esclerito intercoxal entre las quintas patas de la hembra; (c) la fusión del endópodo con el basis para formar un basi-endópodo en las quintas patas de la hembra; y (d) la ausencia de esclerito intercoxal entre las quintas patas del macho. Sin embargo, años más tarde, Huys y colaboradores (2007) señalaron que la mayoría de estas sinapomorfías de los órdenes Monstrilloida y Siphonostomatoida, habían evolucionado de manera convergente en otros órdenes de copépodos y, por tanto, no debían ser consideradas una base segura para hipotetizar una ascendencia común. El problema se agrava con la naturaleza de las autapomorfias usadas para definir el orden Siphonostomatoida ya que, de momento, la monofilia del grupo descansa exclusivamente en los caracteres derivados que muestran los apéndices cefálicos, apéndices que desafortunadamente, están ausentes en su grupo hermano,

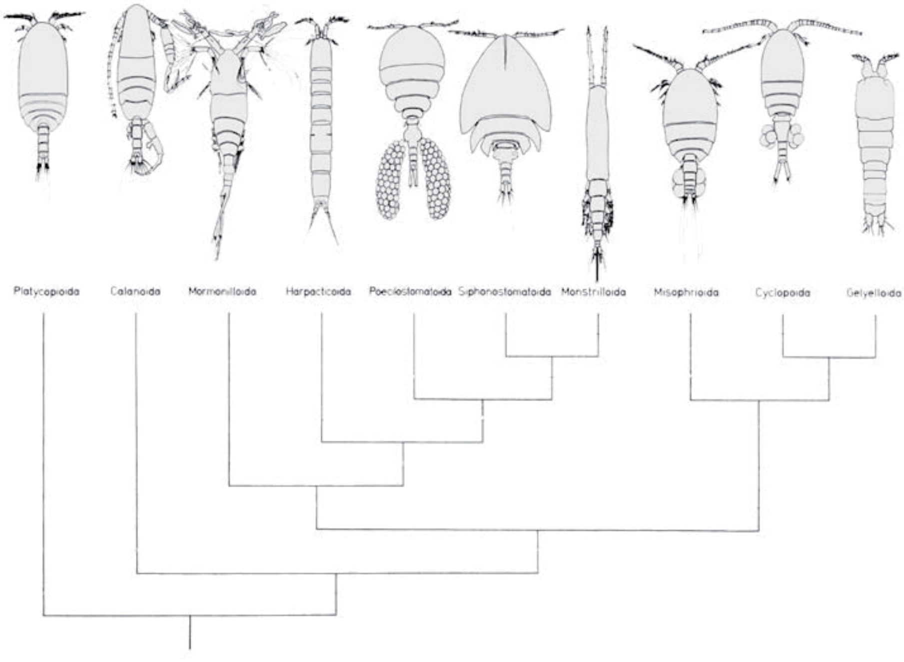


Figura 2: Propuesta de las relaciones filogenéticos de los distintos órdenes de Copépodos realizada por Huys y Boxshall en 1991.

el orden Monstrilloida (Huys & Boxshall, 1991) y, como consecuencia, las anténulas y las ramas caudales son los únicos apéndices que potencialmente pueden proporcionar información (Huys *et al*, 2007). De hecho, Huys y colaboradores (2007) estudiando las secuencias de genes de ADN ribosómico de los diferentes ordenes de copépodos hipotetizaron que el orden Monstrilloida sería el grupo hermano de las familias caligiformes (representadas en el estudio por Pandaridae, Dissonidae Yamaguti, 1963 y Caligidae Burmeister, 1835) lo que convertiría al orden Siphonostomatoida en parafilético. Este parafiletismo además, estaría respaldado por la morfología de sus anténulas y la ontogenia de las ramas caudales de ambos órdenes.

Para el estudio de la morfología de las anténulas tomaron como punto de referencia la geniculación de la anténula del macho que se corresponde con el límite entre los segmentos ancestrales XX y XXI (Huys & Boxshall, 1991). La setación del segmento compuesto (XXI-XXVIII), distal a esta articulación, está muy conservada en la ontogenia y filogenia de los copépodos, lo que se interpreta como evidencia de un sistema mecano-sensorial que alerta del acercamiento de depredadores (Boxshall & Huys, 1998). Los machos de Monstrilloida muestran cuatro tipos de anténulas, las más plesiomórficas (*Monstrilla longicornis* Sars; Huys & Boxshall, 1991: Fig. 2.5.5A) muestran que la disposición de las setas del segmento apical compuesto consiste en 12 elementos (Figura 3)(Huys *et al*, 2007). Esta disposición de setas sólo ha sido encontrada en la familia Caligidae (Orden Siphonostomatoida) que en la fase de copepodito, que es la infectiva, muestra una disposición similar de elementos en el segmento distal. La homología de estos dos segmentos apicales queda inequívocamente autentificada por el modelo de desarrollo antenular de Boxshall y Huys (1998) que demuestra que la articulación que separa los segmentos ancestrales XX y XXI es el primer límite o articulación que se expresa en el desarrollo (en la fase naupliar) (Huys *et al,* 2007).

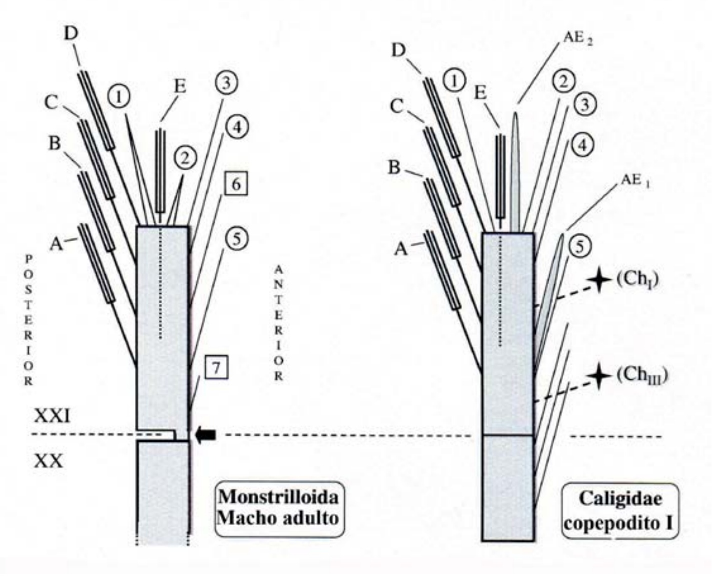


Figura 3.- Esquema comparativo de las setas del elemento apical de las anténulas del macho adulto de Monstrilloida y del copepodito I de Caligidae (vista ventral). La flecha indica la posición de la geniculación pleisiomórfica entre los segmentos ancestrales XX y XXI (A-E: setas modificadas; 1-7: setas no modificadas; AE_{1-2}: aestetascos; $Ch_{I,III}$: estadios *Chalimus* I y III)(Huys *et al.*, 2007).

Con respecto a la ontogenia de las ramas caudales, cuyo potencial filogenético nunca se había analizado anteriormente, Huys y colaboradores (2007) analizaron los patrones de setación de cinco órdenes de Podoplea y los compararon con el patrón básico de los copépodos pleisomórficos definido por Boxshall y Huys (1991): poseer siete setas en las ramas caudales. Entre los copépodos analizados, sólo los sifonostomatoides se desvíaban del modelo básico de forma que en las familias Asterocheridae, Scottomyzontidae y Dirivultidae la seta IV está modificada en una espina hialina aplanada en los estadíos tempranos del desarrollo y sólo alcanza su naturaleza setiforme en copepodito II. Esta modificación se considera una autapomorfía del orden Siphonostomatoida. En cambio, en Caligidae el patrón es completamente distinto debido a su abreviada fase naupliar, con sólo dos estadíos, y las etapas de calimus intercaladas en la fase de copepodito. En este último caso, Caligidae, la mayor divergencia del modelo común en Podoplea es que la seta VII dorsal nunca se expresa durante los diez estadíos completos del ciclo de vida, lo que origina adultos con sólo seis setas en las ramas caudales. Los adultos del orden Monstrilloida muestran una variación considerable en el número de setas caudales que van de tres a seis. El examen de *Monstrilla grandis* Giesbrecht, 1891 y *M. minuta* Isaac, 1975 reveló que la seta VII dorsal está ausente, lo que concuerda con el patrón de Caligidae (Figura 4) (Huys *et al*, 2007).

Por tanto Huys y colaboradores (2007) hipotetizaron que los caligidae y los monstrilloida derivaban de un ancestro común ectoparásito de vertebrados y que posteriormente los monstrilloida divergieron con una gran alteración en la utilización de los hospedadores (vertebrados *vs* invertebrados), en la forma corporal (nauplios transformados y adultos sin alimentarse) y en el ciclo de vida (ectoparásito juvenil *vs* endoparásito, adultos parásitos *vs* adultos libre). Las repercusiones, caso de que esta hipótesis fuera cierta, son importantes puesto que, los monstrilloida ya no se considerarían como orden y estarían incluídos dentro del orden Siphonostomatoida reduciéndose el número de ordenes de copépodos a ocho. Además, este estudio también apoya la monofilia de Cyclopoida (incluyendo taxones de poecilostomatoida) y considera que el filamento frontal de la familia Nicothoidae- la única familia de sifonostomatoida asociada a invertebrados que presenta este carácter (Huys & Boxshall, 1991) -, y aquellos presentes en las familias parásitas de peces, Caligidae, Pandaridae, Dissonidae, Lernaeopodidae Milne-Edwards, 1840,

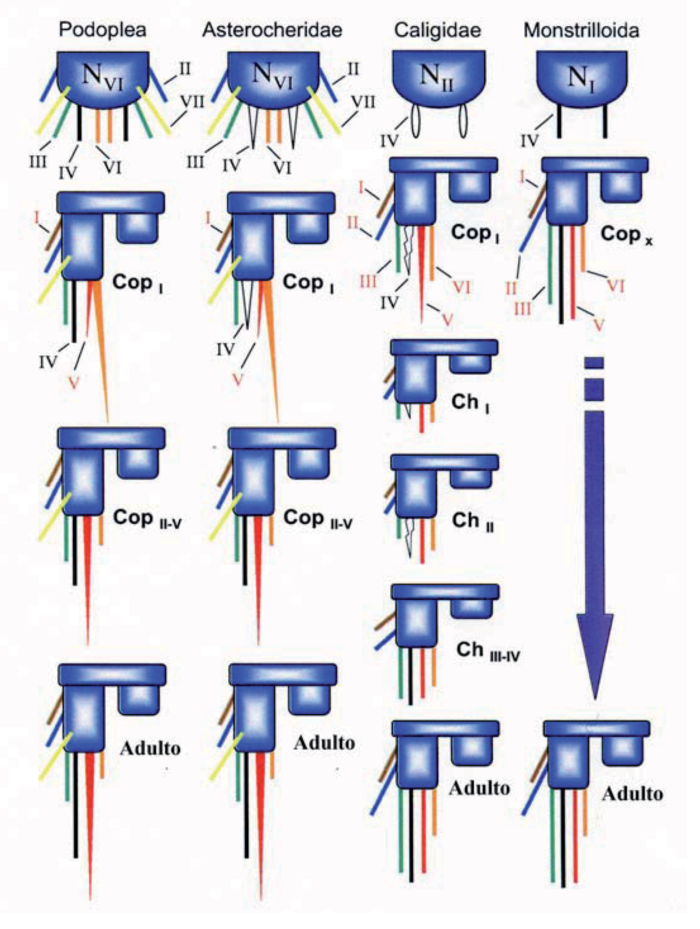


Figura 4.- Esquema con las trayectorias ontogénicas de cada elemento de la setación de las ramas caudales de Podoplea, de dos familias del orden Siphonostomatoida (Asterocheridae, Caligidae) y de Monstrilloida. Los números romanos en rojo indican los nuevos elementos. Los colores señalan a los elementos homólogos en los distintos estados de desarrollo ($N_{I,II,IV}$: estadios naupliares; Cop_{I-V}: copepoditos; Ch_{I-IV}: estadios *Chalimus* (Huys *et al*., 2007).

Pennelidae Burmeister, 1835, Sphyriidae C.B. Wilson, 1919 y Hatschekiidae Kabata, 1979, son homoplásicos, y por tanto los Nicothoidae no son la familia más cercana a los sifonostomatoides parásitos de peces como se creía anteriormente (Huys & Boxshall, 1991).

1. 3.- La familia Asterocheridae

La familia Asterocheridae fue propuesta por Giesbrecht en 1899 para reemplazar a Ascomyzontidae Thorell, 1859, ya que este autor había concluido que *Ascomyzon* Thorell, 1859 era sinónimo de *Asterocheres* Boeck, 1860 (en aquella época *Asterocheres* Boeck, 1859; ver más abajo). Los asteroquéridos viven asociados bien interna o externamente a invertebrados marinos de una amplia variedad de filos: Porifera, Mollusca, Cnidaria, Echinodermata, Urochordata y Bryozoa; si bien, los hospedadores de varios géneros y muchas especies son aún desconocidos.

Durante más de un siglo, la familia Asterocheridae ha servido como depósito para incluir en ella géneros y especies que no se podían acomodar en otras familias de Siphonostomatoida (Boxshall & Halsey, 2004) lo que ha hecho que esta familia sea muy heterogénea (Nair & Pillai, 1984; Boxshall & Hasley, 2004; Johnsson & Neves, 2004) y muy amplia, con 60 géneros y aproximadamente 260 especies, de hecho tal como se ha comentado anteriormente, es la que posee el mayor número de géneros de todo el orden Siphonostomatida. De estos 60 géneros, 38 son monotípicos, sólo nueve géneros tienen un número de especies igual o superior a cinco y el género más diverso es *Asterocheres*. La mayoría de estos géneros habitan en aguas superficiales, pero hay al menos cinco géneros de aguas profundas (Ivanenko & Defaye, 2005).

Debido a la heterogeneidad de esta familia hay algunos géneros que no cumplen totalmente las características diagnósticas de la familia Asterocheridae (Tabla 3)(Boxshall & Halsey, 2004; Ivanenko, 1999; Stock, 1987): así por ejemplo (a) *Scottocheres* Giesbrecht, 1897, *Collocherides* Stock, 1971, *Glyptocheres* Humes, 1987 y algunas especies de *Collocheres* Canu, 1893 carecen de palpo mandibular); (b) *Onychocheres* Stock & Gooding, 1986, *Asterocheroides* Malt, 1991, *Siphonopontius* Malt, 1991 y *Cephalocheres* Kim, 2010; tienen estetasco proximal en el segmento distal de la anténula de la hembra; (c) *Cystomyzon* Stock, 1981 no presenta la característica anténula con un segmento corto que porta de seis a ocho setas; (d) *Acontiophorus* Brady, 1880 no tiene el primer segmento del endópodo de la antena mucho más largo que el segundo (Boxshall & Halsey, 2004; Ivanenko, Ferrari & Smurov, 2001). Según Ivanenko y colaboradores (*op. cit.*) las características (a), (b), (c) y (e) no son autapomorfías de la familia Asterocheridae, ya que pueden encontrarse también en muchas especies de Entomolepididae Brady, 1889.

Tabla 3: Características diagnósticas de la familia Asterocheridae Giesbrecht, 1899 según Boxshall y Halsey, 2004.

Características
1-cuerpo ciclopiforme, prosoma a veces más o menos inflado
2-prosoma: cefalotórax + primer somito pedígero, y 3 somitos pedígeros libres
3-urosoma: 4-5 segmentos en la hembra: somito genital y primer somito pedígero , 2-3 segmentos abdominales libres. Macho con 5-6 segmentos
4-aperturas genitales en la hembra con un par de poros copuladores ventrales y un par de gonoporos dorso-laterales. Macho con aperturas ventrales
5-ramas caudales con 6 setas
6-anténulas con 6-21 segmentos en la hembra con estetasco largo en el segmento homólogo del segmento ancestral XXI (puede ser el preantepenúltimo, antepenúltimo, penúltimo, o muy raramente, en el último segmento);
7-cuatro primeras patas birrameas con 3 segmentos en cada rama, a veces la cuarta sin endópodo o vestigial. Primera pata con seta interna en el basis
8-quinta pata con segmento libre con un máximo de 5 setas, parte protopodal, bien incorporado al somito o representado como un segmento separado con una seta externa
9-sexta pata representada por 1-2 setas en el opérculo genital de la hembra. Macho con 2-3 setas en el opérculo genital
10-sacos ovígeros multiseriados.
Género tipo: *Asterocheres* Boeck, 1860.

La familia Asterocheridae, junto con Artotrogidae, son las más plesiomórficas dentro del orden Siphonostomatoida, y ciertos géneros, en especial aquellos que retienen numerosos caracteres plesiomórficos, como *Myzopontius* Giesbrecht, 1895, parecen ser intermedios entre las dos familias (Boxshall & Halsey, 2004). Además, estas dos familias están tan íntimamente relacionadas que algunos autores han apuntado la posibilidad de que Artotrogidae surgiera de Asterocheridae (Boxshall & Halsey, 2004) y por tanto, ésta última, puede ser parafilética (Boxshall & Halsey, 2004; Johnsson & Neves, 2004). Estas familias necesitan un análisis filogenético exhaustivo ya que han tenido una evolución convergente considerable que tiende a oscurecer los límites entre ellas (Boxshall & Halsey, 2004). Para realizar este estudio, primero se debería revisar los diferentes géneros de ambas familias. Si bien algunos autores han intentado revisar los géneros de la familia Asterocheridae (Sewell, 1949; Stock, 1965, 1975; Ummerkutty, 1966), todavía no se ha realizado una revisión completa ni ningún estudio filogenético que englobe la totalidad de los géneros de esta familia plesiomórfica.

1.4.- El género *Asterochereres*

Sinónimos: *Ascomyzon* Thorell, 1859
Cyclopicera Brady, 1872
Isopodius Kritchagin, 1873
Echinocheres Claus, 1889 (no *Echinocheres* Hansen, 1902= *Calverocheres* CB Wilson, 1932)
Madacheres Humes, 1996

El género *Asterocheres* fue descrito por Boeck en 1860. Más tarde, en 1880, Brady describió la familia Artotrogidae, donde incluyó a los géneros *Cyclopicera* (Brady, 1872), *Acontiophorus* (que describe como nuevo en este trabajo e incluye en él a *Solenostoma scutatum* Brady & Robertson y *Ascomyzon ornatus* Brady & Robertson), *Dyspontius* Thorell, 1859 y *Artotrogus* (donde sinonimiza a tres géneros *Artotrogus* Boeck, *Asterocheres* Boeck y *Ascomyzon* Thorell). Brady (1880) descarta el nombre *Ascomyzon* debido a que, aunque está publicado en el mismo año que *Artotrogus*, el primero parece haber sido posterior ya que el trabajo de Boeck es nombrado en la monografía de Thorell. Igualmente descarta el nombre *Asterocheres* porque, según él, *Artotrogus* es menos problemático ("*less objectionable term*"). Canu (1892) destacó que

Asterocheres no era sinónima de otros géneros de Ascomyzontidae, tal y como propuso Brady y había aceptado Claus (1889), por lo que enumeró las características que, según él, diferenciaban *Asterocheres* de *Artotrogus*, y las que distinguían a *Ascomyzon* de *Cyclopicera*. Sin embargo, *Cyclopicera* fue sinonimizada de nuevo con *Asterocheres* por Giesbrecht en 1897 y *Echinocheres* fue sinonimizada primero con *Cyclopicera* por Giesbrecht en 1895 y más tarde con *Asterocheres* por Giesbrecht en 1897. Aunque Sars (1915) aceptó la sinonimia de *Asterocheres* y *Ascomyzon* y la prioridad del primer nombre, alteró arbitrariamente varios nombres específicos de este género (Hamond, 1968) y favoreció la nomenclatura de *Ascomyzon* sobre la de *Asterocheres* porque "*las especies de este género no son, de ninguna manera, exclusivamente parásitas de astéridos, ya que son encontrados infestando otros muchos animales invertebrados*". Por la misma razón no admitía a la familia Asterocheridae Giesbrecht y prefería el término Ascomyzontidae acuñado por Thorell, si bien no admitía la inclusión del género *Dyspontius* en ésta. En realidad, Sars hacía lo correcto priorizando el nombre *Ascomyzon* sobre *Asterocheres*, pero no por la razón a que él aludía. La autoría de *Asterocheres* debe ser Boeck 1860- que es la que se ha utilizado en la discusión de esta memoria- y no Boeck 1859 que es la que la mayoría de los autores usan. La revista "*The Forhandlinger i Videnskabs-Selskabet i Kristiania*" publicaba las aportaciones científicas realizadas por la Scientific Society of Kristiania (ahora Oslo) cada año, como en el caso del año 1859, sin embargo, estas actas eran publicadas al final de cada año natural, es decir en el año siguiente, 1860. Ahora bien, como la mayoría de los autores utilizaban Boeck, 1859, y como, se ha mencionado anteriormente, el trabajo de Boeck es nombrado en la monografía de Thorell se concedió la prioridad a *Asterocheres* Boeck, 1859 en vez de *Ascomyzon* Thorell, 1859. Sin embargo, hay que destacar que *Ascomyzon* (publicada el 14 de Septiembre de 1859) tiene la prioridad sobre *Asterocheres* Boeck, 1860 (ya que según el ICZN artículo 21.3.2, si sólo se específica o se demuestra el año de la publicación, se toma como fecha de publicación el 31 de Diciembre), aunque el género sea tradicionalmente conocido como *Asterocheres* Boeck, 1859 y lo mismo se aplicaría a la familia por lo que Asterocheridae Giesbrecht, 1899, debería ser en realidad Ascomyzontidae Thorell, 1859.

La última sinonimia fue realizada por Ivanenko en 1999 que sinonimizó el género monotípico *Madacheres* descrito por Humes en 1996 con *Asterocheres*. Cuando Humes erigió el género *Madacheres* para acomodar a esta especie, no había ninguna característica en su descripción que no correspondiera a las características diagnósticas de *Asterocheres*. En la discusión, Humes destaca que solo dos géneros de la familia Asterocheridae poseen dos segmentos en el palpo de la mandíbula como ocurría en su especimen, *Monocheres* Stock, 1966 y *Psilomyzon* Stock, 1965; en los otros géneros el palpo solo posee un segmento (Humes, 1996). Sin embargo, la mandíbula en el género *Asterocheres* puede presentar típicamente uno o dos segmentos, por lo que no existe ninguna razón para que *Madacheres* no pueda ser sinonimizado con *Asterocheres*.

Dentro de la familia Asterocheridae, el género *Asterocheres* es el que tiene el mayor número de especies, 100 especies nominales, lo que supone aproximadamente el 40% de las especies conocidas. Sin embargo, las descripciones de muchas de estas especies están incompletas o son erróneas, lo que hace muy difícil compararlas con sus congéneres (Stock, 1966; Ho, 1984; Humes, 1996; Ivanenko & Smurov, 1997; Kim, 2004, 2005). En la mayoría de los casos, estas especies no han vuelto a ser recogidas desde su descripción original, por tanto para estudiarlas hay que recurrir al material depositado en los museos que algunas veces no está en condiciones óptimas dada la antigüedad de la muestra o por problemas de conservación. Las características diagnósticas más reciente del género es la realizada por Kim en el año 2010 (Tabla 4), a partir de la cual algunas especies fueron consideradas no válidas (ver discusión)- La especie tipo del género es *Asterocheres lilljeborgii* Thorell, 1859 pero la especie que ha sido seleccionada como el sifonostomatoide típico, y por tanto también el asteroquérido típico - dado el alto número de caracteres plesiomórficos que retiene - es *Asterocheres reginae* Boxshall & Huys, 1994 (Huys & Boxshall,1991) Estos caracteres plesiomórficos son:(a) anténula de la hembra con 21 segmentos; (b) antena con tres segmentos en el endópodo y un segmento en el exópodo; (c) palpo mandibular con dos segmentos; (d) maxilípedo con tres segmentos en el endópodo, al menos en el macho (Boxshall & Huys, 1994).

Tabla 4: Características diagnósticas del género *Asterocheres* Boeck, 1960 según Kim, 2010.

Características
1-asterocheridae: prosoma ovoide o en forma de disco, urosoma con 4 segmentos en la hembra y 5 en el macho.
2-anténula de la hembra típicamente con 21 segmentos y un estetasco en el segmento 18; los tres segmentos distales frecuentemente fusionados para formar uno o dos segmentos.
3-antena con 1 segmento en el exópodo y 3 en el endópodo, con espina o garra distal.
4-cono oral en forma de sifón.
5-mandíbula con estilete puntiagudo y palpo con 1-2 segmentos con 2 setas distales.
6-maxílula bilobulada, con 5 setas en el lóbulo interno y 4 en el externo básicamente.
7-maxila con 3 segmentos; segmento distal en forma de garra.
8-maxilípedo con 6 segmentos, con la armadura 1,1(0),2,1,1,1+garra terminal.
9-cuatro primeras patas con 3 segmentos en cada rama. Basis de la primera pata con una seta interna y otra externa (1-1). Seta interna de la cuarta pata ausente o vestigial, raramente prominente y plumosa. Tercer segmento del exópodo de la hembra con la armadura (III,2,2) en la primera pata y (III,I,4) en las patas segunda a cuarta. Tercer segmento del endópodo de la hembra con la armadura (1,2,3) en las patas primera y segunda; (1,1+I,3) en la tercera pata y (1,1+I,2) en la cuarta pata. Segundo segmento del endópodo de las patas primera a tercera con dos setas internas; en la cuarta pata con una o dos setas.
10-segmento libre de la quinta pata con 3 setas, una de las cuales puede ser pequeña u obsoleta.
11-dimorfismo sexual en las patas primera a tercera o en ninguna.

Las especies de este género viven asociadas a varios filos de invertebrados siendo las asociaciones más comunes con esponjas (aproximadamente el 57% de las especies válidas), con antozoos (16%) y equinodermos (12%). Las asociaciones con ascidias son escasas (alrededor del 4%) y sólo se conoce un caso de asociación con una especie de briozoo. Del total de especies válidas, en sólo seis especies el hospedador es desconocido.

1.5.- Objetivos

El objetivo de la presente memoria es revisar el material del género *Asterocheres* depositado en los distintos museos y compararlos con sus descripciones originales para redescribir aquéllas especies poco o mal descritas. Determinar y describir el material recolectado por el equipo de investigación del Departamento de Zoología de la universidad de Sevilla para finalmente establecer el número de especies que componen el género *Asterocheres*.

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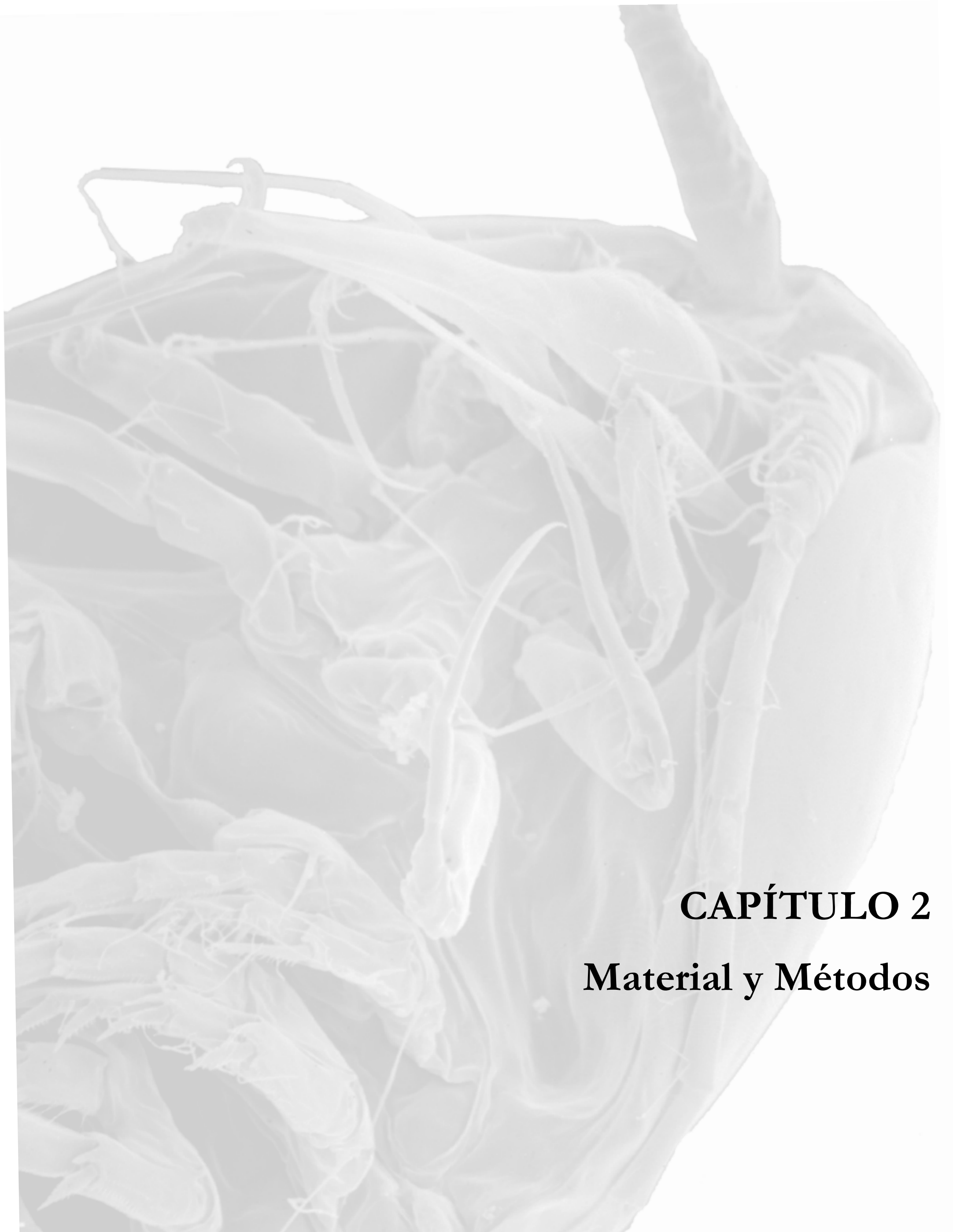


CAPÍTULO 2

Material y Métodos

MATERIAL Y MÉTODOS

En la presente memoria se ha estudiado material de diversa procedencia por lo que los métodos de extracción han sido varios. En el caso de las muestras antárticas, el material se recogió usando una draga Agassiz y fue clasificado, fijado y etiquetado a bordo (R/V Polarstern). Cuando las muestras se recogieron directamente del mar, por buceo con escafandra autónoma, las colonias de hospedadores fueron recogidas individualmente, aisladas en bolsas de plástico e inmediatamente fijadas en formaldehido al 8-10% en agua de mar. La fauna simbiótica se obtuvo filtrando el agua a través de una malla de 100 μm y los copépodos finalmente se recuperaron del sedimento retenido en la malla para posteriormente conservarse en etanol al 70%.

El material procedente de los distintos museos era más variado puesto que a veces sólo se disponía de preparaciones para microscopio óptico y otras, el museo nos prestaba viales con los especímenes conservados en etanol al 70%.

Las disecciones de los ejemplares se han llevado a cabo en un estereomicroscopio (Leica MZ 12). Antes de la disección, los especímenes seleccionados se limpiaron y aclararon con ácido láctico y fueron posteriormente teñidos con Negro Clorazol E (Sigma® C-1144). Las disecciones se realizaron en ácido láctico con minucias entomológicas de 0,10, 0,15 y 0,20 mm. Cada pieza diseccionada fue preparada, para su examen temporal, en lactofenol, usando un portaobjeto para cada pieza y cubriendo la muestra con un cubreobjeto apoyando uno de sus lados sobre otro cubreobjeto, de manera que el espécimen se pueda apretar justo hasta que mantenga la posición deseada sin llegar a aplastarlo y que se deforme. La presión que el cubreobjeto produce sobre la pieza se puede regular deslizando un cubreobjeto sobre el otro o añadiendo o sustrayendo lactofenol. De esta forma se consigue mover la pieza sin dañarla y poder observarla y dibujarla desde distintos ángulos. Una vez terminado el estudio temporal, las muestras se prepararon para el montaje permanente deslizando el cubreobjeto que funcionaba de soporte y sellando la preparación con Entellan (Merck® 1.07961-UN 1866). Todas las figuras fueron dibujadas con la ayuda de una cámara clara en un microscopio de contraste de interferencia diferencial (Leica DMLB).

Para el estudio detallado de estructuras muy pequeñas, algunos especímenes se prepararon para ser observados y fotografiados con un microscopio electrónico de barrido (Philips XL30 SEM). Para ello, las muestras se volvieron a fijar en una solución tampón al 2.5% glutaraldehido en 0.2M cacodilato a pH 7,3 y posteriormente en la misma solución tampón con OsO_4 1%. A continuación los especímenes se deshidrataron en un gradiente de alcoholes (30%, 50%, 70%, 80%, 95% y 100%), se sometieron al punto crítico de secado, se montaron en los soportes para microscopia electrónica y se cubrieron con una aleación de oro y paladio.

Todos los segmentos de los apéndices y los elementos de setación han sido nombrados y numerados usando la terminología introducida por Huys y Boxshall (1991). La longitud del cuerpo de los copépodos se midió desde el margen anterior del rostro hasta el margen posterior de las ramas caudales.

Se ha estudiado material prestado por los siguientes museos: Museo de Historia Natural de Londres (NHM), Museo de Historia Natural de la Universidad de Oslo (ZMO), Museo Zoológico de Amsterdam (Universidad de Amsterdam) (ZMA) y Museo Zoológico de la Universidad de Copenague (ZMUC).

El material recogido por los miembros del Departamento de Zoología de la Universidad de Sevilla se ha depositado en museos: el material antártico en el Instituto de Zoología y Museo de Zoología de Hamburgo (ZMH), el material procedente de las costas de Cádiz en el Museo Nacional de Ciencias Naturales de Madrid (MNCN), así como en la colección de dicho Departamento (BEIM).

Todo este material estudiado se detalla en la tabla 5, expuesta a continuación.

Tabla 5.- Material prestado por distintos museos y recogido por el Departamento de Zoología de la Universidad de Sevilla que se ha estudiado en la presente memoria.

Especie	Etiquetada como	Institución	Nº Registro	Tipo	Hospedador	Localidad	Recolector
***A. abyssi* (Hansen, 1923)**	*A. abyssi* (Hansen, 1923)	ZMUC	CRU-5026	Holotipo		Danish Ingolf Exped. Sta. 36	
***A. astroidicola* Conradi et al, 2006**		MNCN	20.04/7578	Holotipo	*Astroides calycularis* (Pallas, 1766)	Tarifa (SP)	
***A. astroidicola* Conradi et al, 2006**		MNCN	20.04/7579	Alotipo	*Astroides calycularis* (Pallas, 1766)	Tarifa (SP)	
***A. astroidicola* Conradi et al, 2006**		USE	BEIM.COP.501	Holotipo	*Astroides calycularis* (Pallas, 1766)	Tarifa (SP)	
***A. boeckii* (Brady, 1880)**	*A. boeckii*	NHM	1911.11.8.47282-286	No		Devon (GB)	Norman
***A. boeckii* (Brady, 1880)**	*A. boeckii*	NHM	1911.11.8.M.2634	No			
***A. boeckii* (Brady, 1880)**	*A. boeckii*	ZMO	F21599	No		Ranø (NO)	Sars
***A. boeckii* (Brady, 1880)**	*A. boeckii*	NHM	1951.8.10.74	No			
***A. boeckii* (Brady, 1880)**	*A. boeckii*	NHM	1951.8.10.75	No			
***A. boeckii* (Brady, 1880)**	*A. boeckii*	NHM	1951.8.10.76	No			
***A. boeckii* (Brady, 1880)**	*A. boeckii*	NHM	1911.11.8.47291-300	No			
***A. boeckii* (Brady, 1880)**	*A. boeckii*	NHM	1986.381	No		Scotland (GB)	
***A. boeckii* (Brady, 1880)**	*A. boeckii*	ZMUC	CRU-4936	No		Talsnafiord Island (NO)	
***A. bulbosus* Malt, 1991**	*A. bulbosus* Malt, 1991	NHM	1989.200	Holotipo	Esponja	Hong Kong	
***A. bulbosus* Malt, 1991**	*A. bulbosus* Malt, 1991	NHM	1989.201	Alotipo	Esponja	Hong Kong	
***A. bulbosus* Malt, 1991**	*A. bulbosus* Malt, 1991	NHM	1989.202	Paratipo	Esponja	Hong Kong	
***A. bulbosus* Malt, 1991**	*A. bulbosus* Malt, 1991	NHM	1989.203-210	Paratipo	Esponja	Hong Kong	
***A. bulbosus* Malt, 1991**	*A. bulbosus* Malt, 1991	NHM	1989.211	Paratipo	Esponja	Hong Kong	
***A. bulbosus* Malt, 1991**	*A. bulbosus* Malt, 1991	NHM	1989.212-218	Paratipo	Esponja	Hong Kong	
***A. complexus* Stock, 1960**	*A. complexus* Stock, 1960	ZMA	Co. 100.571b	Holotipo	*Dysidea fragilis* (Montagu, 1814)	Cap Béar (FR)	J.H. Stock

Tabla 5 (continuación)

Especie	Etiquetada como	Institución	Nº Registro	Tipo	Hospedador	Localidad	Recolector
***A. complexus* Stock, 1960**	*A. complexus* Stock, 1960	ZMA	Co. 100.571	Paratipo	*Dysidea fragilis* (Montagu, 1814)	Cap Béar (FR)	J.H. Stock
***A. echinicola* (Norman, 1868)**	*A. echinicola* Giesbrecht	NHM	1911.11.8.M.2589	Sintipo		Shetland (GB)	Norman
***A. echinicola* (Norman, 1868)**		USE	BEIM.COP.542	No	*Paracentrotus lividus* (Lamarck, 1816)	Tarifa (SP)	
***A. echinicola* (Norman, 1868)**	*Asc. violaceus* Giesbrecht	ZMO	F21606	No		Skjerjehaun (NO)	Sars
***A. echinicola* (Norman, 1868)**	*Asc. violaceus* Giesbrecht	ZMO	F21604	No		Skjerjehaun (NO)	Sars
***A. echinicola* (Norman, 1868)**	*Asc. violaceus* Giesbrecht	ZMO	F21605	No	*Echinus elegans* Düben & Koren, 1846		Sars
***A. corneliae* Schirl, 1973**	*A. cf. corneliae* Schirl, 1973	NHM	1986.385	No	Esponja	Banyuls (FR)	
***A. ellisi* Hamond, 1968**	*A. ellisi* Hamond, 1968	NHM	1967.10.2.3	Holotipo		Norfolk (GB)	
***A. ellisi* Hamond, 1968**	*A. ellisi* Hamond, 1968	NHM	1967.10.2.3	Alotipo		Norfolk (GB)	
***A. ellisi* Hamond, 1968**	*A. ellisi* Hamond, 1968	NHM	1967.10.2.3A	Paratipo		Norfolk (GB)	
***A. eugenioi* Bandera & Conradi, 2014**	*A.suberitis* Giesbrecht, 1897	NHM	1911.11.8.47277-281A	Holotipo	*Suberites domuncula* (Olivi, 1792)	Devon (GB)	Norman
***A. eugenioi* Bandera & Conradi, 2014**	*A.suberitis* Giesbrecht, 1897	NHM	1911.11.8.47277-281A	Alotipo	*Suberites domuncula* (Olivi, 1792)	Devon (GB)	Norman
***A. eugenioi* Bandera & Conradi, 2014**	*A.suberitis* Giesbrecht, 1897	NHM	1911.11.8.47277-281	Paratipos	*Suberites domuncula* (Olivi, 1792)	Devon (GB)	Norman
***A. genodon* Stock, 1966**	*A. genodon* Stock, 1966	ZMA	Co.100.956	Holotipo	*Haliclona* Grant, 1836	Mauricio	J.H. Stock
***A. genodon* Stock, 1966**	*A. genodon* Stock, 1966	ZMA	Co.100.956b	Paratipo	*Haliclona* Grant, 1836	Mauricio	J.H. Stock
***A. halichondriae* Stock, 1966**	*A. halichondriae* Stock, 1966	ZMA	Co. 100.951c	Holotipo	*Halichondria symbiotica* Lévi, 1961	Mauricio	J.H. Stock
***A. halichondriae* Stock, 1966**	*A. halichondriae* Stock, 1966	ZMA	Co. 100.951a	Alotipo	*Halichondria symbiotica* Lévi, 1961	Mauricio	J.H. Stock

Tabla 5 (continuación)

Especie	Etiquetada como	Institución	Nº Registro	Tipo	Hospedador	Localidad	Recolector
***A. halichondriae* Stock, 1966**	*A. halichondriae* Stock, 1966	ZMA	Co. 100.951b	Paratipo	*Halichondria symbiotica* Lévi, 1961	Mauricio	J.H. Stock
***A. halichondriae* Stock, 1966**	*A. halichondriae* Stock, 1966	ZMA	Co. 100.952	No	*Halichondria symbiotica* Lévi, 1961	Mauricio	J.H. Stock
***A. halichondriae* Stock, 1966**	*A. halichondriae* Stock, 1966	ZMA	Co. 100.953	No	*Halichondria symbiotica* Lévi, 1961	Mauricio	J.H. Stock
***A. hirsutus* Bandera et al, 2005**		ZMH	K 40872	Holotipo	*Rossella* Carter, 1872	South Shetland (Antártida)	Polarstern
***A. hirsutus* Bandera et al, 2005**		ZMH	K 40873	Alotipo	*Rossella* Carter, 1872	South Shetland (Antártida)	Polarstern
***A. hirsutus* Bandera et al, 2005**		ZMH	K 40874	Paratipo	*Rossella* Carter, 1872	South Shetland (Antártida)	Polarstern
***A. hirsutus* Bandera et al, 2005**		USE	BEIM.COP.504	No	*Rossella* Carter, 1872	South Shetland (Antártida)	Polarstern
***A. hoi* Bandera & Conradi, 2013**	*A. cf. simulans* (Th. Scott, 1898)	ZMA	Co. 201.521a	Holotipo	*Lytechinus variegatus* (Lamarck, 1816)	Curaçao (BR)	J.H. Stock
***A. hoi* Bandera & Conradi, 2013**	*A. cf. simulans* (Th. Scott, 1898)	ZMA	Co. 201.521b	Paratipo	*Lytechinus variegatus* (Lamarck, 1816)	Curaçao (BR)	J.H. Stock
***A. hongkongensis* Malt, 1991**	*A. hongkongensis* Malt, 1991	NHM	1989.199	Holotipo	Esponja	Hong Kong	
***A. indicus* Sewell, 1949**	*A. indicus* Sewell, 1949	NHM	1963.6.28.435	Holotipo	Alcionáceos	J.Murray Exped. Sta. 25	
***A. intermedius* (Hansen, 1923)**	*A. intermedius* (Hansen, 1923)	ZMUC	CRU-6873/8357	Holotipo		Danish Ingolf Exped. Sta. 25	
***A. kervillei* Canu, 1898**		NHM	2007.940-941	No	*Pseudodistoma lyrnusense* Pérès, 1952	Tarifa (SP)	
***A.kervillei* Canu, 1898**	*A. echinicola* Giesbrecht	NHM	1996.747-754 (parte)	No		Norflok (GB)	Hamond
***A.kervillei* Canu, 1898**	*Asc. parvum* Sars	NHM	1968.1.30.11 (parte)	No		Scilly Isles (GB)	SubAqua
***A. kervillei* Canu, 1898**		USE	BEIM.COP.549	No	*Pseudodistoma lyrnusense* Pérès, 1952	Tarifa (SP)	
***A. latus* (Brady, 1872)**	*A. echinicola* Giesbrecht	NHM	1951.8.10.73	No			
***A. latus* (Brady, 1872)**	*A. echinicola* Giesbrecht	NHM	1911.11.8.M.2635	No			

Tabla 5 (continuación)

Especie	Etiquetada como	Institución	Nº Registro	Tipo	Hospedador	Localidad	Recolector
A. latus **(Brady, 1872)**	*A. echinicola* Giesbrecht	NHM	1976.697	No			
A. latus **(Brady, 1872)**	*A. echinicola* Giesbrecht	NHM	1996.747-754 (parte)	No		Norfolk (GB)	Hamond
A. latus **(Brady, 1872)**	*A. echinicola* Giesbrecht	NHM	1911.11.8.47269-273	No		Scotland (GB)	Norman
A. latus **(Brady, 1872)**	*Asc. parvum* Sars	NHM	1968.1.30.11 (parte)	No		Scilly Isles (GB)	SubAqua
A. latus **(Brady, 1872)**	*A. echinicola* Giesbrecht	NHM	1911.11.8.47267-268	No		Scotland (GB)	Norman
A. latus **(Brady, 1872)**	*A. echinicola* Giesbrecht	NHM	1967.10.31.84	No		Scilly Isles (GB)	SubAqua
A. latus **(Brady, 1872)**	*A. echinicola* Giesbrecht	NHM	1911.11.8.47262-266	No		Scotland (GB)	Norman
A. latus **(Brady, 1872)**	*A. echinicola* Giesbrecht	NHM	1911.11.8.47261	No			
A. latus **(Brady, 1872)**	*A. echinicola* Giesbrecht	ZMA	Co. 100.565	No	*Cliona* sp	Banyuls (FR)	
A. lilljeborgii **Boeck, 1859**	*Asc. asterocheres* Boeck	ZMO	F21598	No			Sars
A. lilljeborgii **Boeck, 1859**	*A. lilljeborgii* Boeck	ZMO	F21609	No		Kristiansand (NO)	Sars
A. lilljeborgii **Boeck, 1859**	*Asc. asterocheres* Boeck	ZMO	F7644	No			Sars
A. lilljeborgii **Boeck, 1859**	*A. lilljeborgii* Boeck	ZMO	F21610	No	Estrella de mar		
A. lilljeborgii **Boeck, 1859**	*A. lilljeborgii*	NHM	1984.265	No	*Henricia sanguinolenta* (Müller, 1776)	Scotland (GB)	
A. lilljeborgii **Boeck, 1859**	*A. lilljeborgii*	NHM	1911.11.8.47306-309	No		Scotland (GB)	Norman
A. lilljeborgii **Boeck, 1859**	*Asterocheres sp*	ZMUC	No numerado	No	*Henricia sanguinolenta* (Müller, 1776)	Ryopiden	Tromso Museum Asterias St. 4689
A. lilljeborgii **Boeck, 1859**	*Asterocheres sp*	ZMUC	No numerado	No	*Henricia sanguinolenta* (Müller, 1776)	Langanes Islands	Hallas

Tabla 5 (continuación)

Especie	Etiquetada como	Institución	Nº Registro	Tipo	Hospedador	Localidad	Recolector
A. lilljeborgii **Boeck, 1859**	*Asterocheres sp*	ZMUC	No numerado	No	*Henricia oculata* (Pennant, 1777)	Irish Sea	
A. lilljeborgii **Boeck, 1859**	*Asterocheres sp*	ZMUC	No numerado	No	*Henricia sanguinolenta* (Müller, 1776)	Ellingøy (NO)	Trondheim Biol. Stat.
A. lilljeborgii **Boeck, 1859**	*Asterocheres sp*	ZMUC	No numerado	No	*Henricia sanguinolenta* (Müller, 1776)	Gaulfjorden (NO)	Tromso Museum Asterias St. 312
A. madeirensis **Bandera et al, 2007**		MNCN	20.04/7785	Holotipo	*Petrosia ficiformis* (Poiret, 1789)	Madeira (PT)	
A. madeirensis **Bandera et al, 2007**		MNCN	20.04/7786	Alotipo	*Petrosia ficiformis* (Poiret, 1789)	Madeira (PT)	
A. madeirensis **Bandera et al, 2007**		MNCN	20.04/7787	Paratipo	*Petrosia ficiformis* (Poiret, 1789)	Madeira (PT)	
A. madeirensis **Bandera et al, 2007**		USE	BEIM.COP.506	No	*Petrosia ficiformis* (Poiret, 1789)	Madeira (PT)	
A. maxillatus **Stock, 1987**	*A. maxillatus* Stock, 1987	ZMA	Co. 102.745c	Holotipo	*Manicina areolata* (Linnaeus, 1758)	Curaçao (BR)	J.H. Stock
A. maxillatus **Stock, 1987**	*A. maxillatus* Stock, 1987	ZMA	Co. 102.745a+b	Paratipo	*Manicina areolata* (Linnaeus, 1758)	Curaçao (BR)	J.H. Stock
A. minutus **(Claus, 1889)**		USE	BEIM.COP.562	No	*Paracentrotus lividus* (Lamarck)	Tarifa (SP)	
A. ovalis **Sewell, 1949**	*A. ovalis* Sewell, 1949	NHM	1963.6.28.436	Holotipo	Ascidias	J.Murray Exped. Sta. 10	
A. proboscideus **Stock, 1966**	*A. proboscideus* Stock, 1966	ZMA	Co. 100.957a	Holotipo	*Pericharax heteroraphis* Poléjaef, 1883	Mauricio	J.H. Stcok
A. proboscideus **Stock, 1966**	*A. proboscideus* Stock, 1966	ZMA	Co. 100.957a	Paratipo	*Pericharax heteroraphis* Poléjaef, 1883	Mauricio	J.H. Stock
A. proboscideus **Stock, 1966**	*A. proboscideus* Stock, 1966	ZMA	Co. 199.957b	Paratipo	*Pericharax heteroraphis* Poléjaef, 1883	Mauricio	J.H. Stock
A. rotundus **Malt, 1991**	*A. rotundus* Malt, 1991	NHM	1989.219	Holotipo	Esponja	Hong Kong	
A. rotundus **Malt, 1991**	*A. rotundus* Malt, 1991	NHM	1989.220	Alotipo	Esponja	Hong Kong	
A. rotundus **Malt, 1991**	*A. rotundus* Malt, 1991	NHM	1989.221	Paratipo	Esponja	Hong Kong	
A. rotundus **Malt, 1991**	*A. rotundus* Malt, 1991	NHM	1989.222	Paratipo	Esponja	Hong Kong	
A. rotundus **Malt, 1991**	*A. rotundus* Malt, 1991	NHM	1989.223	Paratipo	Esponja	Hong Kong	
A. rotundus **Malt, 1991**	*A. rotundus* Malt, 1991	NHM	1989.224	Paratipo	*Ricinia* sp	Hong Kong	

Tabla 5 (continuación)

Especie	Etiquetada como	Institución	Nº Registro	Tipo	Hospedador	Localidad	Recolector
***A. rotundus* Malt, 1991**	*A. rotundus* Malt, 1991	NHM	1989.225	Paratipo	*Ricinia* sp	Hong Kong	
***A. sarsi* Bandera & Conradi, 2009**	*Asc. latum* Sars, 1915	ZMUC	CRU-4937	No		Kapt. Ørssad	
***A. sarsi* Bandera & Conradi, 2009**	*Asc. latum* Sars, 1915	ZMO	F21600a	Holotipo	Invertebrados	RauØ (NO)	Sars
***A. sarsi* Bandera & Conradi, 2009**	*Asc. latum* Sars, 1915	ZMO	F21600b	Paratipo	Invertebrados	RauØ (NO)	Sars
***A. simulans* (Scott, 1898)**	*A. robustia*	NHM	1996.1010-1019	No	*Suberites domuncula* (Olivi, 1792)	White Sea	Ivanenko
***A. simulans* (Scott, 1898)**	*Asc. simulans* Scott	ZMO	F21602	No		Ranø (NO)	Sars
***A. siphonatus* Giesbrecht, 1897**	*Asc. lilljeborgi* Thorell	ZMO	F7645	No		Noruega	Sars
***A. siphonatus* Giesbrecht, 1897**	*Asc. lilljeborgi* Thorell	ZMO	F7646	No		Noruega	Sars
***A. siphonatus* Giesbrecht, 1897**	*Asc. lilljeborgi* Thorell	ZMO	F21603	No	*Corella parallelograma* (Müller)	Risør	Sars
***A. siphonatus* Giesbrecht, 1897**		USE	BEIM.COP.548	No	*Synoicum argus* (Milne Edwards)	Algeciras (SP)	
***A. siphonatus* Giesbrecht, 1897**	*A. lilljeborgii*	NHM	1928.4.2.12	No			
***A. scutatus* Stock, 1966**	*A. scutatus* Stock, 1966	ZMA	Co. 100.974a	Holotipo	*Rhodactis rhodostoma* (Ehrenberg, 1834)	Eilat (Israel)	J.H. Stock
***A. scutatus* Stock, 1966**	*A. scutatus* Stock, 1966	ZMA	Co. 100.974b	Paratipo	*Rhodactis rhodostoma* (Ehrenberg, 1834)	Eilat (Israel)	J.H. Stock
***A. suberitis* Giesbrecht, 1897**	*A. suberitis* Giesbrecht, 1897	ZMUC	CRU-8298	Cotipos	*Suberites domuncula* (Olivi, 1792)	Golfo Nápoles (IT)	
***A. tarifensis* Conradi & Bandera, 2011**		MNCN	20.04/8570	Holotipo	*Astroides calycularis* (Pallas)	Tarifa (SP)	
***A. tarifensis* Conradi & Bandera, 2011**		MNCN	20.04/8571	Paratipo	*Astroides calycularis* (Pallas)	Tarifa (SP)	
***A. tarifensis* Conradi & Bandera, 2011**		USE	BEIM.COP.513	No	*Astroides calycularis* (Pallas)	Tarifa (SP)	
***A. tenerus* (Hansen, 1923)**	*A. tenerus* (Hansen, 1923)	ZMUC	CRU-8357	Holotipo		Danish Ingolf Exped. Sta. 25	

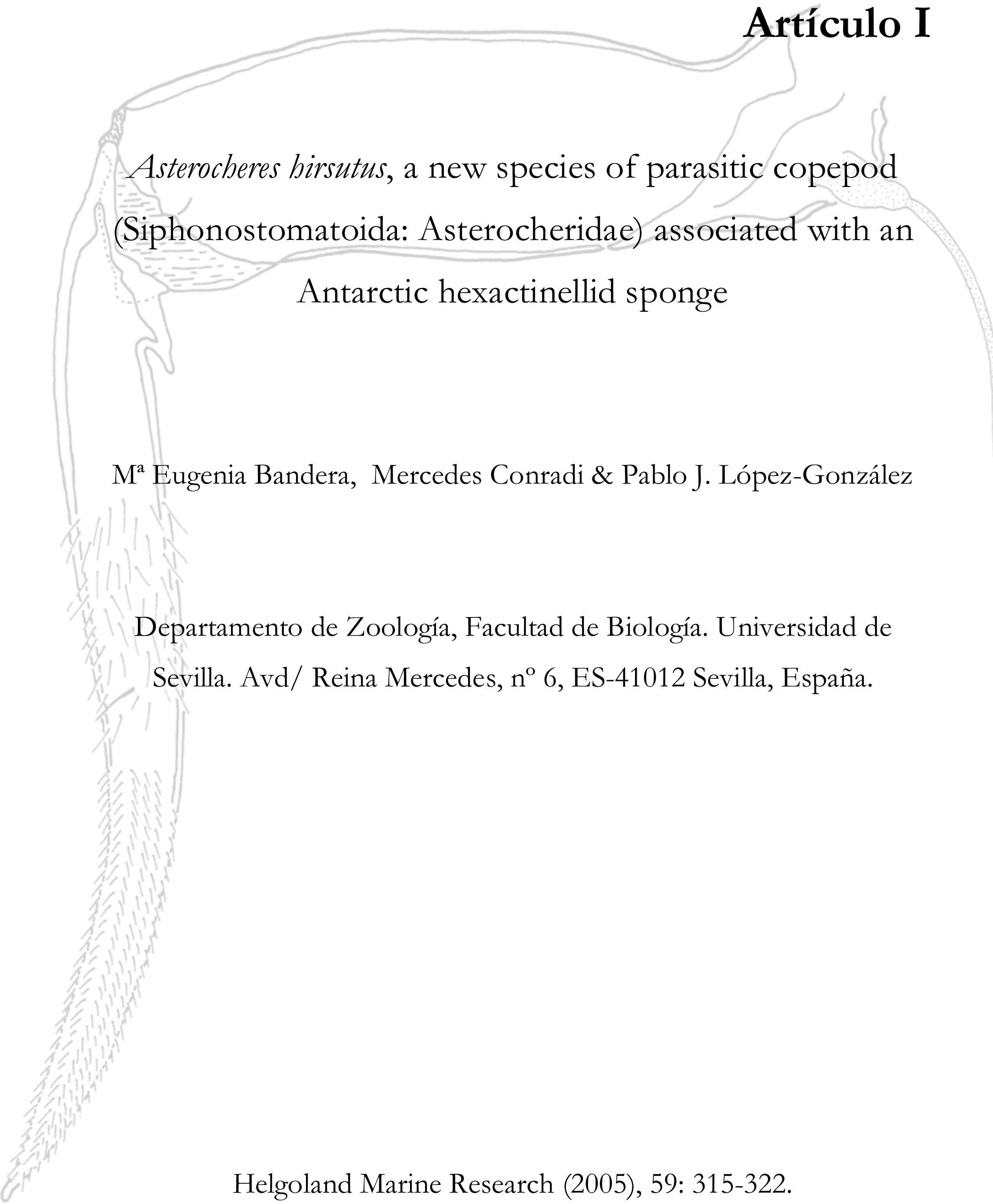
Tabla 5 (continuación)

Especie	Etiquetada como	Institución	Nº Registro	Tipo	Hospedador	Localidad	Recolector
***A. tenerus* (Hansen, 1923)**	*A. tenerus* (Hansen, 1923)	ZMUC	CRU-6873/8357	Paratipo		Danish Ingolf Exped. Sta. 25	
***Dermatomyzon nigripes* (Brady & Robertson, 1875)**	*Asc. Thorelli* G.O. Sars	ZMO	F21897	Sintipo	Algas	Spitsbergen (NO)	
Harpacticoide	*A. micheli* Gurney, 1927	NHM	1928.4.2.13	Holotipo		Kabret (Canal Suez)	
No *Asterocheres*	*A. boeckii* Brady	NHM	1951.8.10.74	No		Belfast Bay (GB)	
***S. mucronipes* (Stock, 1960)**	*A. mucronipes* Stock, 1960	ZMA		Holotipo	*Eunicella singularis* (Esper, 1794)	Roussillon (FR)	J.H. Stock
***S. mucronipes* (Stock, 1960)**	*A. mucronipes* Stock, 1960	ZMA		Paratipo	*Eunicella singularis* (Esper, 1794)	Roussillon (FR)	J.H. Stock
***S. mucronipes* (Stock, 1960)**	*A. mucronipes* Stock, 1960	ZMA		No	*Astroides calycularis* (Pallas)	Tarifa (SP)	
***S. mucronipes* (Stock, 1960)**	*A. mucronipes* Stock, 1960	USE	BEIM.COP.	No	*Astroides calycularis* (Pallas)	Tarifa (SP)	
***S. crassus* Bandera & Huys, 2008**	*A. mucronipes* Stock, 1960	ZMA	Co. 100.955	Holotipo	*Oscarella* sp	Mauricio	J.H. Stock
***S. crassus* Bandera & Huys, 2008**	*A. mucronipes* Stock, 1960	ZMA	Co. 100.955A	Paratipo	*Oscarella* sp	Mauricio	J.H. Stock
-------------	*A. globosus*	NHM	1934.2.21.1	No			

MNCN= Museo Nacional de Ciencias Naturales (Madrid); NHM= Museo de Historia Natural (Londres); ZMUC= Museo Zoológico de la Universidad de Copenague; ZMA= Museo Zoológico de Amsterdam (Universidad de Amsterdam); ZMO= Museo de Historia Natural de la Universidad de Oslo; ZMH= Instituto de Zoología y Museo de Zoología de Hamburgo; USE= Universidad de Sevilla; (SP)= España; (GB)= Reino Unido; (NO)= Noruega; (FR)= Francia; (PT)= Portugal; (BR)= Brasil y (IT)= Italia.

CAPÍTULO 3

Resultados



Artículo I

Asterocheres hirsutus, a new species of parasitic copepod (Siphonostomatoida: Asterocheridae) associated with an Antarctic hexactinellid sponge

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ORIGINAL ARTICLE

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Pablo J. López-González

Asterocheres hirsutus, a new species of parasitic copepod (Siphonostomatoida: Asterocheridae) associated with an Antarctic hexactinellid sponge

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Abstract The asterocherid siphonostomatoid copepod *Asterocheres hirsutus*, a new species, is described from a hexactinellid sponge of the genus *Rossella* Carter collected during the *Polastern* cruise ANT XVII/3, off South Shetland Islands. The distinctive features of this new species are: a female with 21-segmented and a male with 17-segmented antennules, praecoxal endite of maxillule more than four times longer than palp and the ornamentation of the posterior surface of legs 1–4. A detailed description of both sexes is presented.

Keywords Asterocherid siphonostomatoid · Hexactinellid sponge · Symbiosis · Antarctica

Introduction

The Asterocheridae Giesbrecht, 1899 is the largest family of the siphonostomatoid copepods with about 200 species. This family exploits the potential diversity that exists among invertebrate organisms as hosts and can be found associated with molluscs, bryozoans, corals, echinoderms, polychaetes, sponges and ascidians (Ivanenko and Smurov 1997; Johnsson and Bustamante 1997).

Among copepods of the family Asterocheridae, the type-genus *Asterocheres* Boeck, 1859 is the most speciose with about 33% of the known species, 56% of which have been found associated with sponges. Despite the fact that the sponges are one of the groups that dominate many of the Antarctic shelf benthic communities (Galéron et al. 1992), only one species of *Asterocheres* associated with sponges is known in this area.

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Research on the biodiversity in the Southern Ocean has increased greatly in recent decades (Arntz 1997). Nevertheless, the research effort directed at the different taxonomic groups has not been uniform. Some surveys have been carried out within the framework of international programs, such as EASIZ (Ecology of the Antarctic Sea Ice Zone), in order to improve the understanding of certain, as yet poorly known, groups in the Southern Ocean. These expeditions gave the authors the opportunity to study some fauna associated to Antarctic invertebrates. In the present work we describe a new species of *Asterocheres* found associated with a hexactinellid sponge of the genus *Rossella* Carter.

Methods

Sponges infected with parasitic copepods were collected on the R/V *Polarstern* cruise ANT XVII/3 (EASIZ III) sponsored by the Alfred Wegener Institut für Polar- und Meeresforschung, Bremerhaven, during the austral summer of 2000. The material was collected with the aid of Agassiz trawl, sorted, labelled and fixed on board. Symbiotic fauna was obtained by pouring the wash water through a 100 μm mesh net. The copepods were finally recovered from the sediment retained and preserved in 70% ethanol.

Selected specimens were stained with Chlorazole black E (Sigma® C-1144), dissected in lactic acid and examined as temporary mounts in lactophenol. All figures were drawn with the aid of a camera lucida on a Leica DMLB differential interference microscope. In order to detect minute details, some specimens were prepared and photographed using a PHILIPS XL30 SEM. All appendage segments and setation elements are named and numbered using the system established by Huys and Boxshall (1991).

Material examined in the present paper is deposited in the Zoologisches Institut und Zoologisches

Museum in Hamburg (ZMH) and in the collection of Biodiversidad y Ecología de Invertebrados Marinos research group of the University of Seville (BEIM).

Results

Asterocheres hirsutus sp. nov (Figs. 1, 2, 3, 4, 5)

Material examined

Sixty-three females and nine males associated with the hexactinellid sponge *Rossella* sp. collected from the *Polarstern* cruise ANT-XVII/3 (EASIZ-III), off South Shetland (Antarctica), stn. 178.2, 61°58.50'S 60°19.70'W, 804–930 m depth, 2 May 2000. The holotype, 1 adult female (K 40872), allotype, 1 adult male (K 40873), paratypes, 20 females and 4 males (K 40874) have been deposited in the ZMH. The rest of the material is deposited in the collection of BEIM (COP-504).

Adult female

Body cyclopiform (Figs. 1, 2), slender with cephalothorax oval and cyclindrical urosome (Figs. 1a, b.). Mean

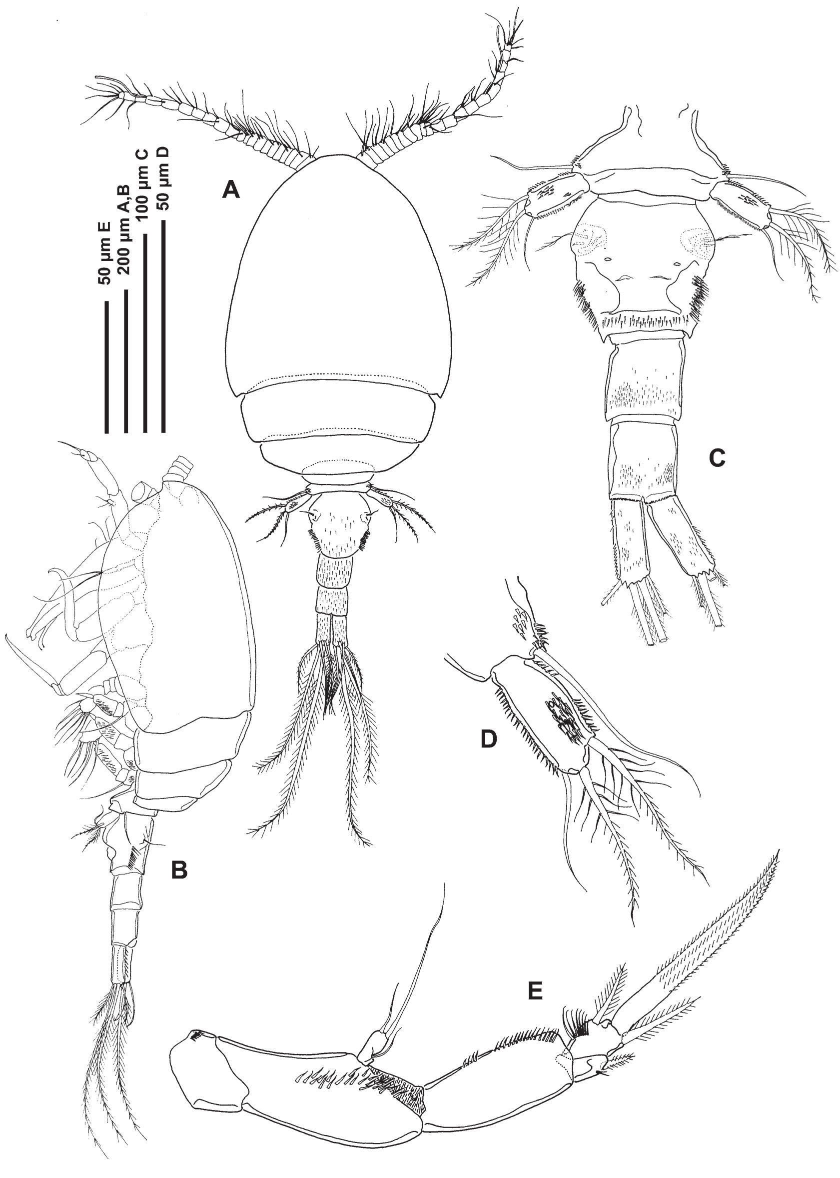
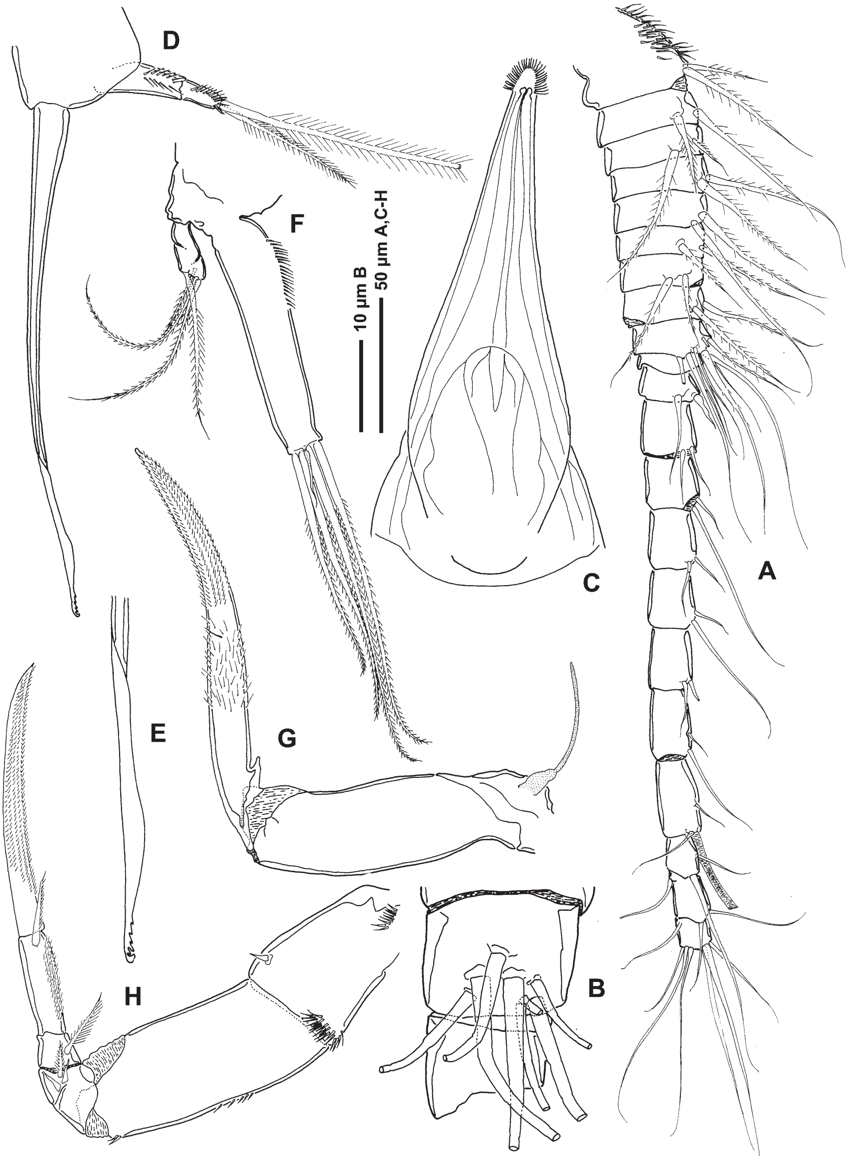


Fig. 1 *Asterocheres hirsutus* sp. nov. Female, **a**, habitus, dorsal; **b**, habitus, lateral; **c**, urosome, ventral; **d**, fifth leg, dorsal; **e**, second antenna

Fig. 2 *Asterocheres hirsutus* sp. nov. Female, **a**, antennule; **b**, detail of the compound segment 9 (IX–XII) of the antennule; **c**, oral cone; **d**, mandible; **e**, tip of mandibular stylet; **f**, maxillule; **g**, maxilla; **h**, maxilliped



body length 820 μm; with range of 759–875 μm (based on three specimens). Ratio of length to width of prosome 1.44: 1. Ratio of length of prosome to that of urosome, 2:1. Prosome comprising the cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Somite bearing leg 4 is much smaller and narrower than preceding ones.

Urosome 4-segmented comprising leg 5-bearing somite, genital double-somite and two free abdominal somites. Somite bearing leg 5 (Fig. 1c) wider than long, 40×80 μm with some spinules on dorsal surface. Genital double-somite as long as wide, bearing genital apertures, paired gonopores located laterally. Lateral margin of double-somite ornamented with fringe of long spinules located about midway along double-somite, posterior to gonopores level (Fig. 1a, b, c; 4 e, g). Each genital area armed with one plumose seta and one spiniform element. Two postgenital somites subquadrate (Fig. 1c). Dorsal surface of free abdominal somites and posterior part of double-somite ornamented with tiny spinules.

Caudal rami 2.5 times longer than wide (Figs. 1c, 4e), armed with six setae. Two medial dorsal naked setae, outer 100 μm long and inner 96 μm. Four terminal setae: outermost terminal setae, 90 μm; innermost, 94 μm, both

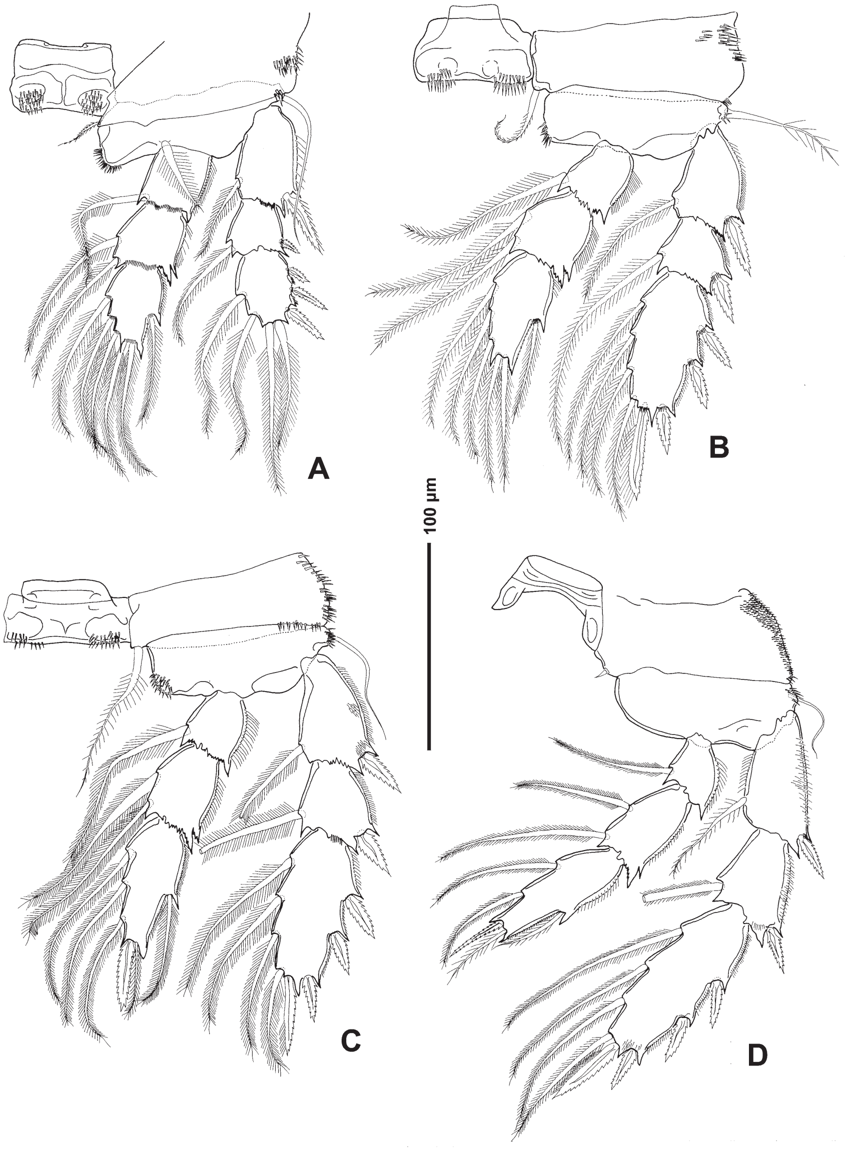


Fig. 3 *Asterocheres hirsutus* sp. nov. Female, **a**, leg 1; **b**, leg 2; **c**, leg 3; **d**, leg 4

with setules on inner side; and two median terminal plumose setae, 210 µm (outer) and 300 µm (inner). Surface of caudal ramus ornamented with minute spinules.

Antennule 369 µm long and consist of 21 articulating segments (Fig. 2a). Segmental fusion pattern as ollows: 1(I), 2(II), 3(III), 4(IV), 5(V), 6(VI), 7(VII), 8(VIII), 9(IX–XII), 10(XIII), 11(XIV), 12(XV), 13(XVI), 14(XVII), 15(XVIII), 16(XIX), 17(XX), 18(XXI), 19(XXII–XXIII), 20(XXIV–XXV), 21(XXVI–XXVIII). Lengths (µm) of its segments are as follows (measured along their posterior margin), 21 (30 along anterior margin), 14, 12, 10, 14, 10, 12, 14, 12, 7, 10, 21.8, 23.6, 18.7, 23.4, 23.4, 23.4, 26.5, 29.6, 15.6, 17, 10. Segments 1–8 each with 2 setae; segment 9 with 8 setae; segment 10–17 each with 2 setae; segment 18 with 2 setae plus an aesthetasc; segment 19 with 2 setae; segment 20 with 3 setae; segment 21 with 7 setae. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX-XII) (Fig. 2b).

Antenna biramous and 180 µm long excluding terminal claw (Fig. 1e). Small unarmed coxa with tuft of spinules. Elongated unarmed basis ornamented with fine spinule row and bearing 1-segmented exopodite and long 3-segmented endopodite. Exopod small, longer than wide armed with one lateral and two unequal apical setae, the longer three times longer than the small one. First segment of endopodite elongate, 61×26.5 μm, unarmed but ornamented with rows of spinules; second segment produced distally on medial side but articulating with third segment proximally on lateral side and armed with one plumose short seta and two setules at base. Third segment armed with two plumose setae and large distal claw, 93 μm long, and also ornamented with rows of fine spinules shortened in length.

Mandible with 2-segmented palp and stylet-like gnathobase (Fig. 2D). Stylet 192 μm long, with subapical denticulate margin (Fig. 2e). First segment of palp slender, unarmed but ornamented with a row of spinules laterally; second segment half length of first one, with 2 terminal unequal plumose setae. Stylet located in oral cone. Oral cone (Fig. 2c, 4a,b) formed by labrum and labium joined laterally, 195 μm long, reaching intercoxal sclerite of leg 1. Cone broad proximally and tapering distally. Labrum almost completely covers labium. Tip of labrum curved posteriorly, with ribbed surface and dense hair-like ornamentation.

Maxillule bilobed (Figs. 2f, 4b); praecoxal endite more than four times longer than palp, armed with five distal setae, four plumose and one naked and shorter, and ornamented with a row of spinules laterally. Palp armed with three terminal and one subterminal setae, all plumose.

Maxilla 3-segmented (Figs. 2g, 4d). Praecoxa bearing long flaccid element medially, possibly an aesthetasc; coxa unarmed and claw-like basis bearing small hyaline process proximally in axil. Claw surface with minute spinules arranged irregularly in medial part, armed with 1 very small seta at about one half length laterally and with rows of minute spinules distally.

Maxilliped 5-segmented (Fig. 2h). First segment with small inner distal seta and patch of fine spinules. Second segment elongate and slender with spinules distally and laterally. Third segment short, with three setae, two of them naked. Fourth segment armed with one plumose seta. Fifth segment ornamented with patches of small spinules on inner margin and armed with one subapical setae plumose only on outer edge. Terminal claw nearly three times longer than the fifth segment, 107 μm long, ornamented with rows of minute spinules.

Swimming legs 1–4 biramous (Figs. 3a-d), with 3-segmented rami. Intercoxal sclerite present in legs 1–4 and except in leg 4, ornamented with patches of spinules. Spine and seta formula.

Table 1

	Coxa	Basis	Exopod segments	Endopod segments
Leg 1	0-1	1-1	I-1;I-1;III,4	0-1;0-2;1,2,3
Leg 2	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,2,3
Leg 3	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,1 + I,3
Leg 4	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,1 + I,2

Coxae of all legs ornamented with spinules rows laterally, as figured, and in leg 3 also with spinules in the margin. Inner coxal seta is plumose in legs 1–3 and reduced and naked in leg 4. Except in leg 2, basal seta of all legs long and naked. Posterior surface of legs 1–4 with minute spinules (Fig. 4d).

Most of the outer spines of all exopodal segments bilaterally serrate, terminal exopodal element setiform in leg 1, spiniform in legs 2–4 serrate laterally and with setules medially or distally. Outer margins of exopodal and endopodal segments with setules.

Leg 5 (Fig. 1d) with protopodal segment incorporated into somite, with outer seta located dorsally ornamented with spines at base, exopod slender, more than two times longer than wide, ornamented with spinules and armed with two plumose setae and one naked seta.

Adult male

Body cyclopiriform with broad prosome as for female (Fig. 5a). Total length, excluding caudal setae, 660 μm (645–675 μm); (all measurements based on three specimens). Ratio of length of prosome to that of urosome 1.93:1. Ratio of lenth to width prosome 1.5:1. Urosome (Figs. 4f, 5b) consisting of five articulating units: leg 5-bearing somite, genital somite and three free abdominal somites. Posterior margins of all somites ornamented with hyaline frills with serrated free margins. Surface of urosomal somites ornamented with fine spinules. Some spinules present also on dorsal surface of fifth pedigerous somite. Genital somite about 1.5 times wider than long, bearing genital apertures postero-laterally on ventral surface (Fig. 5b). Three postgenital somites from anterior to posterior 29.5×66 μm, 25×61.3 μm, and 41×52 μm. Caudal ramus 1.7 times longer than wide, armed as in female.

Appendages as for female except antennules, maxillipeds and fifth and sixth legs. Antennule (Fig. 5c) 17-segmented, geniculate; segmental fusion pattern as follow: 1(I), 2(II), 3(III), 4(IV), 5(V), 6(VI), 7(VII), 8(VIII), 9(IX–XII), 10(XIII), 11(XIV), 12(XV–XVI), 13(XVII), 14(XVIII), 15(XIX-XX), 16(XXI–XXIII), 17(XXIV–XXVIII). Geniculation located between segments 15 (XIX–XX) and 16 (XXI–XXIII). Segments 1–8 each with 2 setae; segment 9 with 8 setae; segments 10,11,13,14 each with 2 setae, segments 12 and 15 with 4 setae; segment 16 with 4 setae plus one aesthetasc, segment 17 with 11 setae. Segment 10(XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX–XII).

Maxilliped (Fig. 5d) 5-segmented; comprising short syncoxa, long basis and distal subchela consisting of three free endopodal segments armed with distal claw-like element. Syncoxa with patch of fine spinules at proximal angle and one medial seta; basis with one minute seta, one small tooth-like process in proximal half of medial margin and some patches of fine spinules in medial and distal half of external margin. First endopodal segment bearing three setae, two of them

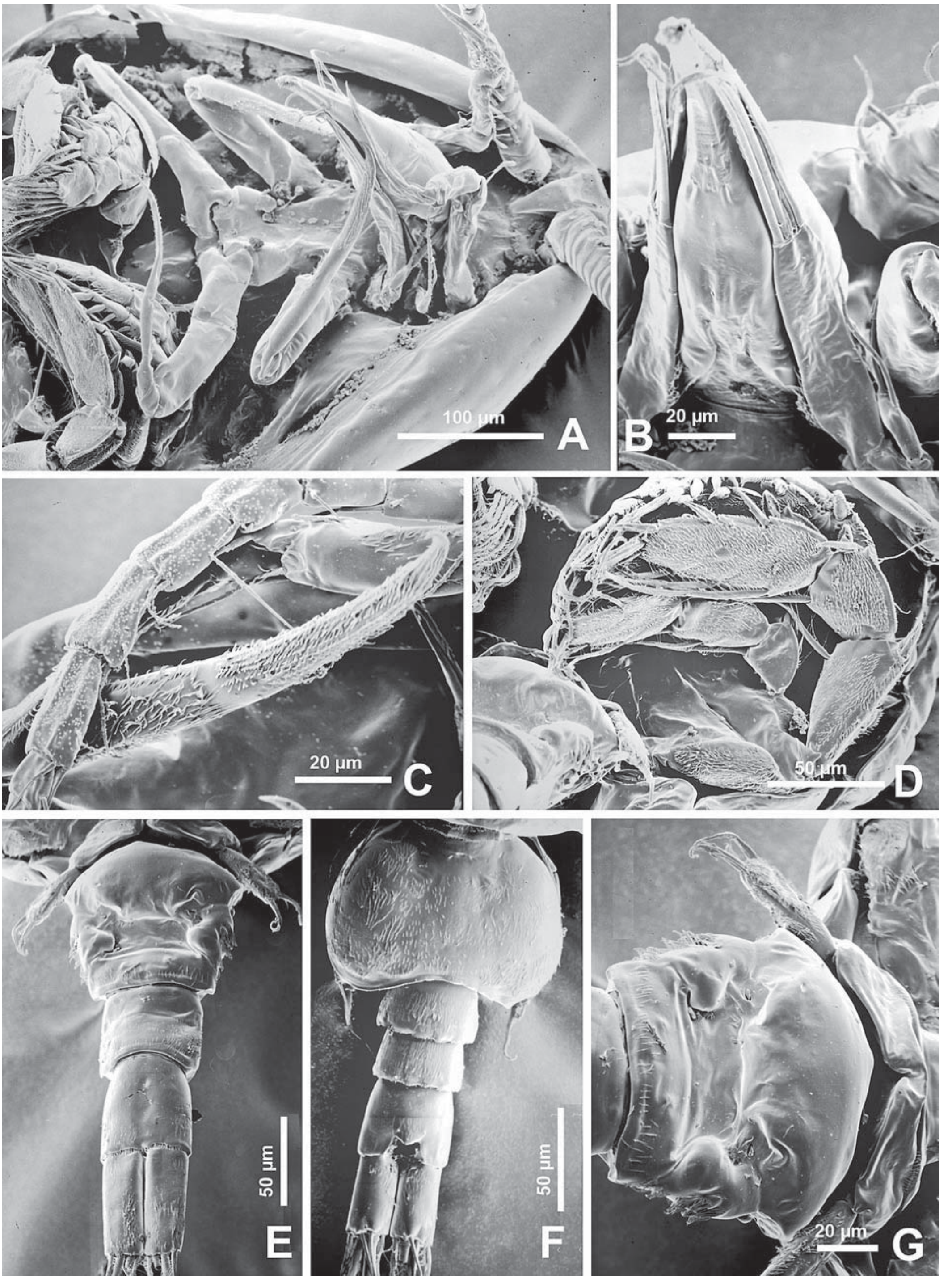


Fig. 4 *Asterocheres hirsutus* sp. nov. Female: **a**, general view of the oral appendages; **b**, oral cone and maxillule; **d**, posterior surface of leg 4; **e**, ventral view of urosome; **g**, ventral view of the genital double-somite. Male: **c**, detail of the distal segment of the maxilla and last antennular segment; **f**, dorsal view of urosome

naked. Second endopodal segment armed with one plumose seta. Third endopodal segment bearing long terminal claw plus additional apical plumose seta. Claw-like element with rows of minute spinules.

Leg 6 (Fig. 5b) postero-ventral flap on genital somite bearing two subequal seta, the outer naked and ornamented with rows of fine spinules.

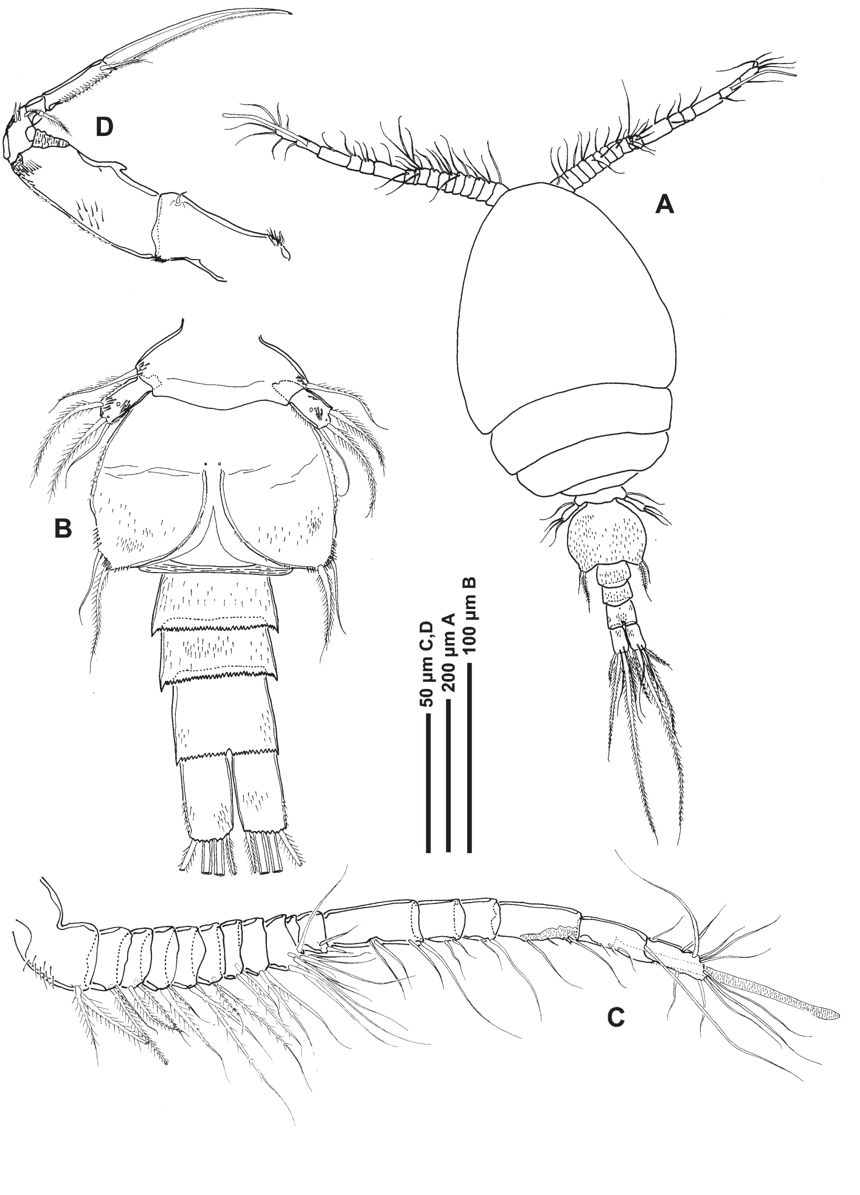
Etymology

The species is named from the Latin *hirsutus* (= hirsute, hairly), alludes to the numerous spinules and setules present on the surface of this species.

Discussion

The genus *Asterocheres* contains a large number of species which can be divided into two groups (Boxshall and Huys 1994). The smaller group, to which the new species belongs, is characterised by females with a 21-segmented antennule and the larger group is characterised by females having an 18- to 20-segmented antennule. According to Kim (2004), a total of ten valid species are included in the first group: *A. bulbosus* Malt, 1991; *A. flustrae* Ivanenko and Smurov, 1997; *A. jeanyeatmanae* Yeatman, 1970; *A. lunatus* Johnsson, 1998; *A. minutus* (Claus, 1889); *A. reginae* Boxshall and

Fig. 5 *Asterocheres hirsutus* sp. nov. Male, **a**, habitus, dorsal; **b**, urosome, dorsal; **c**, antennule; **d**, maxilliped



Huys, 1994; *A. suberitis* Giesbrecht, 1899; *A. tenuicornis* Brady; *A. violaceous* (Claus, 1889) and *A. urabensis* Kim, 2004. Ivanenko and Smurov (1997) pointed out that *A. aesthetes* Ho, 1984 was described in the text as having a 19-segmented antennule in the female which is discordant with the presence of 21 segments on the figure. However, Ho (personal communication 2003) has established that the antennule of *A. aesthetes* has 19 segments with the terminal segment indistinctly divided into two segments.

Among these species only three, *A. aesthetes, A. flustrae* and *A. reginae*, have an aesthetasc on the proximal part of the syncoxa of the maxilla, as found in *A. hirsutus*. Boxshall and Huys (1994) considered this character as unusual in the genus since only two species, *A. aesthetes* and *A. reginae* possessed this character (see Ho 1984, Boxshall and Huys 1994). The discovery of this aesthetasc in a new species of *Asterocheres*, *A. flustrae*, and in other three genera of Asterocheridae, *Chelacheres* Humes, 1989, *Sinopontius* Boxshall, 1990 and *Inermocheres* Boxshall, 1990, strongly suggested that this characteristic is probably more common within this family, as was pointed out by Boxshall and Huys (1994), but it has been overlooked (Ivanenko and Smurov 1997). This is the main reason for not using this characteristic to distinguish the new species from its congeners in the present paper.

Asterocheres hirsutus sp. nov. may be separated from all congeners with 21-segmented antennule by the shape of its maxillule, with the endite being nearly five times longer than the palp and the caudal rami 2.5 times longer than wide. Furthermore, *A. bulbosus*, *A. violaceus* and *A. minutus* differ from *A. hirsutus* in their possession of 1-segmented mandibular palp. *A. suberitis* has a 2-segmented endopod in the antenna, instead of the 3-segmented endopod present in the antenna of *A. hirsutus*. *A. tenuicornis* is also readily distinguished from the new species, and all its congeners, by its very elongate caudal rami. *A. jeanyeatmanae* possesses only two setae in the free segment of leg 5, instead of the three setae of *A. hirsutus*. *A. lunatus* has four setae in the inner lobe of maxillule and the formula (1-0) in the basis of leg 1, by contrast, *A. hirsutus* has five distal setae in the endite of maxillule and the formula (1-1) in the basis of leg 1. The extremely flattened prosome of *A. reginae* serves to separate it from the new species. The maxilliped is 6-segmented in *A. flustrae* and 5-segmented in *A. hirsutus*. The claws of the antenna, maxilla and maxilliped of *A. urabensis* are smooth; however, in *A. hirsutus* they are densely hairy.

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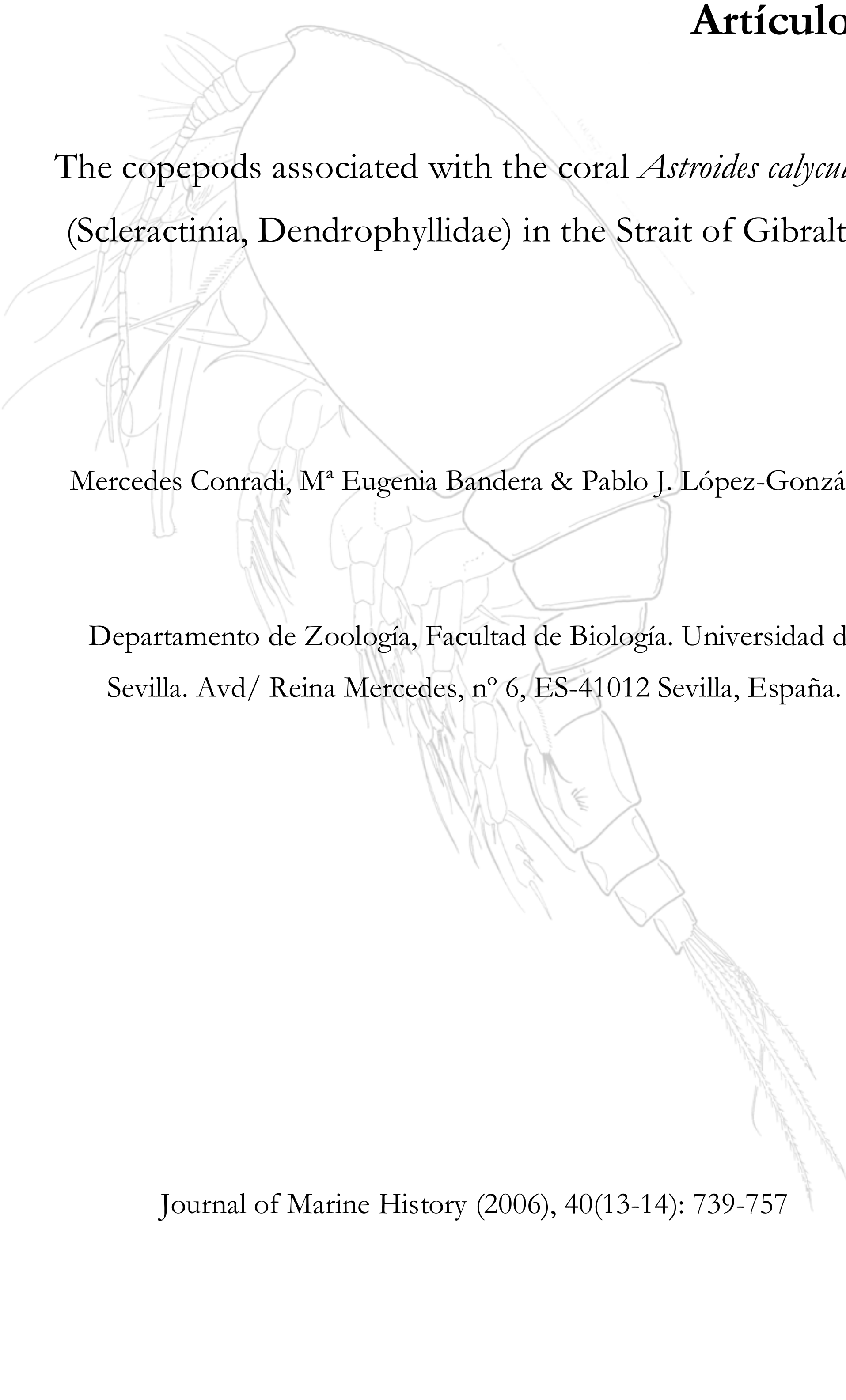
Artículo II



The copepods associated with the coral *Astroides calycularis* (Scleractinia, Dendrophylliidae) in the Strait of Gibraltar.

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The copepods associated with the coral *Astroides calycularis* (Scleractinia, Dendrophyllidae) in the Strait of Gibraltar

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Abstract
This paper describes and provides new records of the copepods hosted by the ahermatypic scleractinian *Astroides calycularis* (Pallas, 1766). This coral species is endemic to the Mediterranean Sea and protected by the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). The coral colonies were collected at both sides of the Strait of Gibraltar. Two new species, the poecilostomatoid *Doridicola helmuti* and the siphonostomatoid, *Asterocheres astroidicola*, are described and compared with their congeners. Furthermore, this paper represents the first record of the genus *Doridicola* associated with a scleractinian coral, the first time that *Acontiophorus scutatus* is found associated with Cnidaria, and the first report of an *Asterocheres* species living on scleractinian corals from the European coasts.

Keywords: Astroides*, scleractinian, Copepoda, Poecilostomatoida, Siphonostomatoida, symbionts*

Introduction

Copepoda have been extremely successful in developing associations with Cnidaria and they can be found in association with three classes, the Hydrozoa, the Scyphozoa, and the Anthozoa. In doing so, the copepods have undergone considerable morphological modification and adaptation, although they range from relatively unmodified copepods such as *Acanthomolgus* Humes and Stock, 1972 (associated with gorgonians) to highly modified forms such as *Lamippe* Bruzelius, 1858 (soft corals), *Magnippe* Stock, 1978 from gorgonians or *Mesoglicola* Quidor, 1906 (corallimorpharians).

The Anthozoa have a large number of copepod associates, resulting from: (1) the fact that the larger colonies of the hosts provide more space for copepods; (2) the existence of relatively large gastrovascular cavities offering a protected environment; and (3) the greater

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opportunity for the evolution of host specificity in these very diverse cnidarians (Humes 1985). Both soft corals, within the octocorals, and scleractinian, or hard corals, among the Hexacorallia, serve as hosts for many more copepods than any other groups (Stock 1987; Humes 1995, 1996; Huys and Boxshall 2001). Among scleractinians, copepods are the most abundant in shallow-water reef-building hermatypic corals, which are the most conspicuous animals in tropical waters, while they are much less abundant in ahermatypic corals (Stock 1985).

Of the various orders of symbiotic Copepoda, the Poecilostomatoida contains by far the greatest number of species associated with cnidarians. The remaining orders are much less frequent, and they are represented by relatively small numbers although Siphonostomatoida and Harpacticoida are probably much more frequent associates than presently recorded.

The scleractinian coral *Astroides calycularis* (Pallas, 1766) is endemic to the southwest Mediterranean Sea and can be found from the Strait of Gibraltar to the Gulf of Naples including the Maltese Islands in European waters, and from the Strait of Gibraltar to Cape Bon (Tunisia) in North Africa (Zibrowius 1980, 1995). Currently this species is protected by CITES and recently the Spanish Government has included this ahermatypic coral as "vulnerable" in the National Catalogue of Endangered Species. In a recent survey on the biology of *A. calycularis* from the Strait of Gibraltar, a variety of species of copepods belonging not only to the order Poecilostomatoida, but also to Siphonostomatoida, have been found associated with this orange coral. The purpose of this work is to describe some of these copepods.

Materials and methods

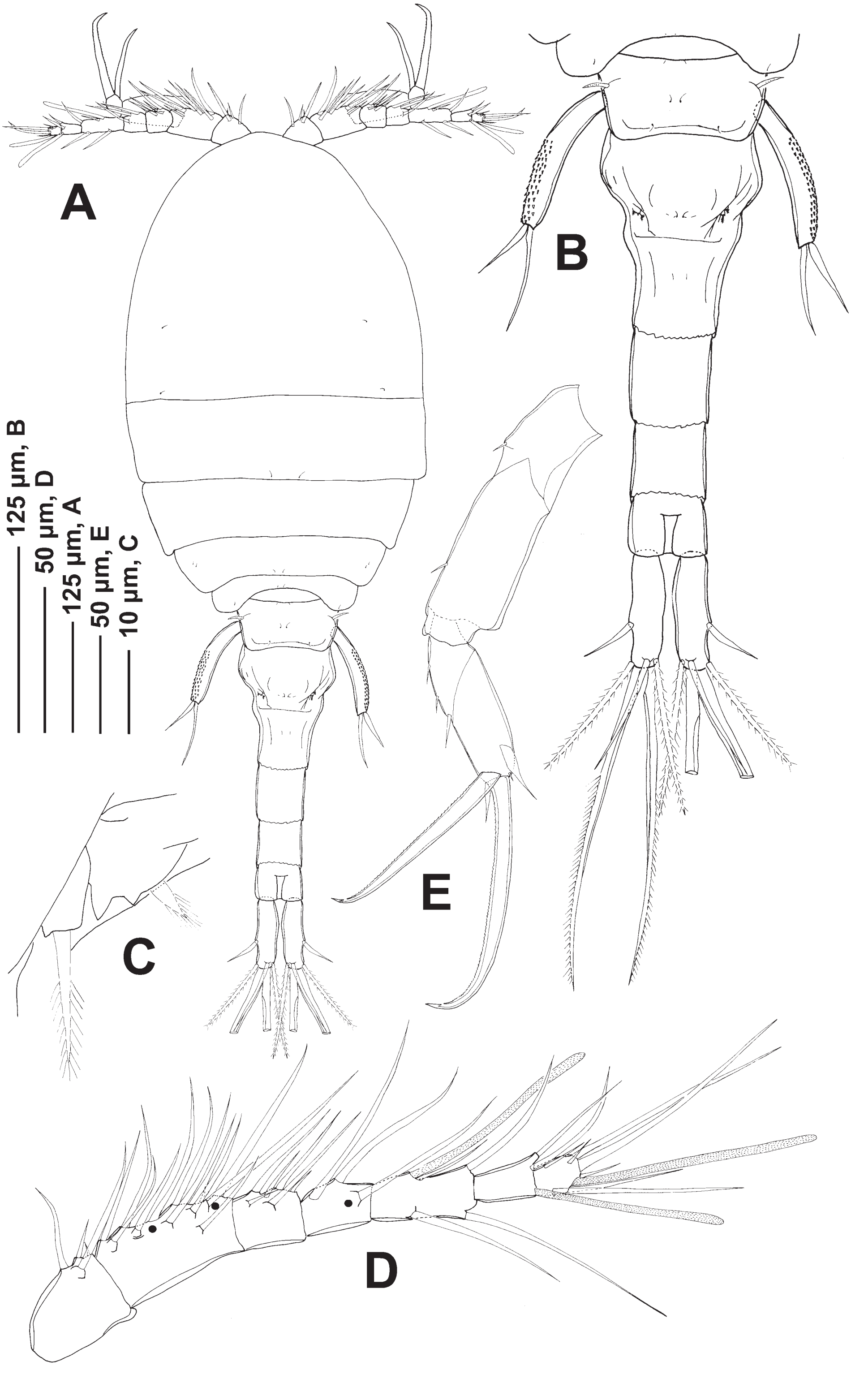
The colonies of the host scleractinian were individually collected, each one being isolated in a plastic bag, by scuba diving at both sides of the Strait of Gibraltar and immediately fixed in formaldehyde (8–10%) in seawater. Symbiotic fauna was obtained by pouring the wash water through a 100 µm net. The copepods were finally recovered from the sediment retained and preserved in 70% ethanol.

Selected specimens were dissected in lactic acid and examined as temporary mounts in lactophenol. All figures were drawn with the aid of a camera lucida on a Leica DMLB differential interference microscope. In order to detect minute details, two selected specimens of each species were prepared for scanning electron microscopy (SEM) studies: they were post-fixed in 2.5% glutaraldehyde in 0.2 M cacodylate buffer at pH 7.3 and in 1% OsO_4 in the same buffer and subsequently critical-point dried, mounted on stubs, coated with gold–palladium and observed and photographed using a Philips XL 30 SEM. All appendage segments and setation elements are named and numbered using the terminology introduced by Huys and Boxshall (1991).

Material examined in the present paper is deposited in the Museo Nacional de Ciencias Naturales in Madrid (MNCN) and in the collection of the research team Biodiversidad y Ecología de Invertebrados Marinos of the University of Seville (BEIM).

Results

Order POECILOSTOMATOIDA Thorell, 1859
Family RHYNCHOMOLGIDAE Humes and Stock, 1972
Doridicola Leydig, 1853
Doridicola helmuti sp. nov.
(Figures 1–5)


A
B
C
D
E
125 µm, B
50 µm, D
125 µm, A
50 µm, E
10 µm, C

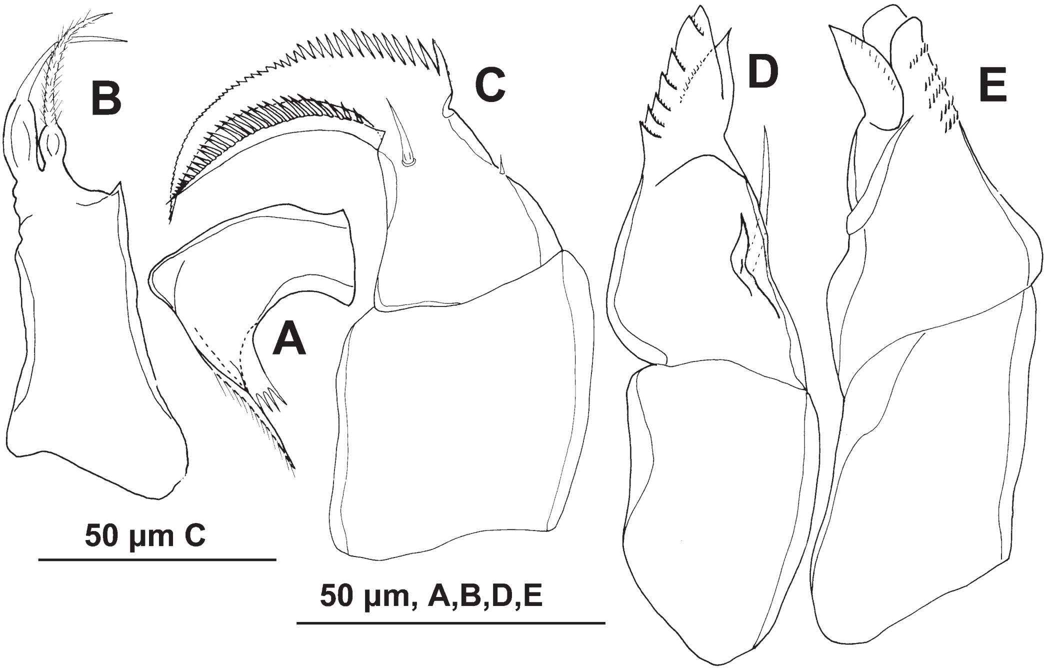


Figure 2. *Doridicola helmuti*, female. (A) Mandible; (B) maxillule; (C) maxilla; (D) maxilliped, latero-posterior view; (E) maxilliped, latero-anterior view.

Material examined

MNCN 20.04/7575 holotype, one adult female, associated with the scleractinian *Astroides calycularis*, Tarifa Island, 36°01′N, 5°37′W, 25–30 m depth, July 1999; MNCN 20.04/7576 allotype, adult male, with the same sampling data as the holotype; MNCN 20.04/7577 paratypes, 10 females and seven males, with the same sampling data as the holotype; BEIM (COP 215), 10 adult females, six adult males and 12 copepodids, with the same sampling data as the type material; BEIM (COP 216), three adult females, and four copepodids, associated with the scleractinian *Astroides calycularis*, Punta Desnarigado, Ceuta, North Africa, 35°53′N, 5°18′W, 40 m depth, August 1998; BEIM (COP 217), three adult females and five adult males, associated with the scleractinian *Astroides calycularis*, Tarifa Island, 36°01′N, 5°37′W, 25 m depth, October 1999.

Description

Female. Body (Figure 1A) 985 µm long (920–1008 µm) (excluding setae on caudal rami) and 362 µm wide (340–400 µm) (greatest width of cephalothorax) based on six females in lactic acid. First pediger separated from cephalosome by distinct dorsal furrow. Ratio of length to width of prosome 1.7:1. Ratio of length of prosome to that of urosome 1.62:1. Segment bearing leg 5 subquadrate, 57.7 × 92.9 µm. Genital double somite (Figure 1A, B) 1.23 times longer than wide, 134.6 × 109 µm, with prominent anterodorsal bulge

Figure 1. *Doridicola helmuti*, female. (A) Dorsal view; (B) urosome, dorsal view; (C) genital area; (D) antennule; (E) antenna.

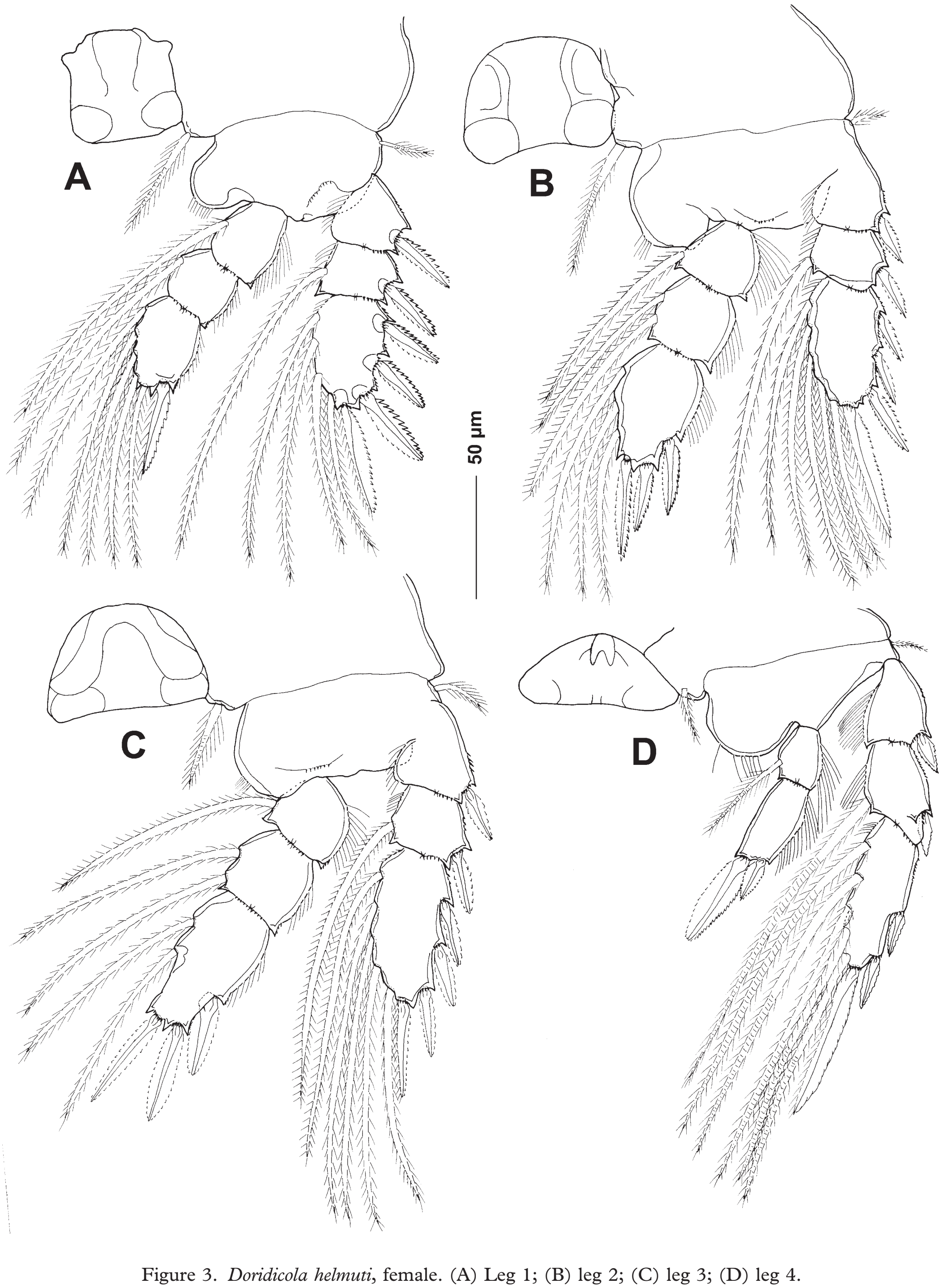


Figure 3. *Doridicola helmuti*, female. (A) Leg 1; (B) leg 2; (C) leg 3; (D) leg 4.

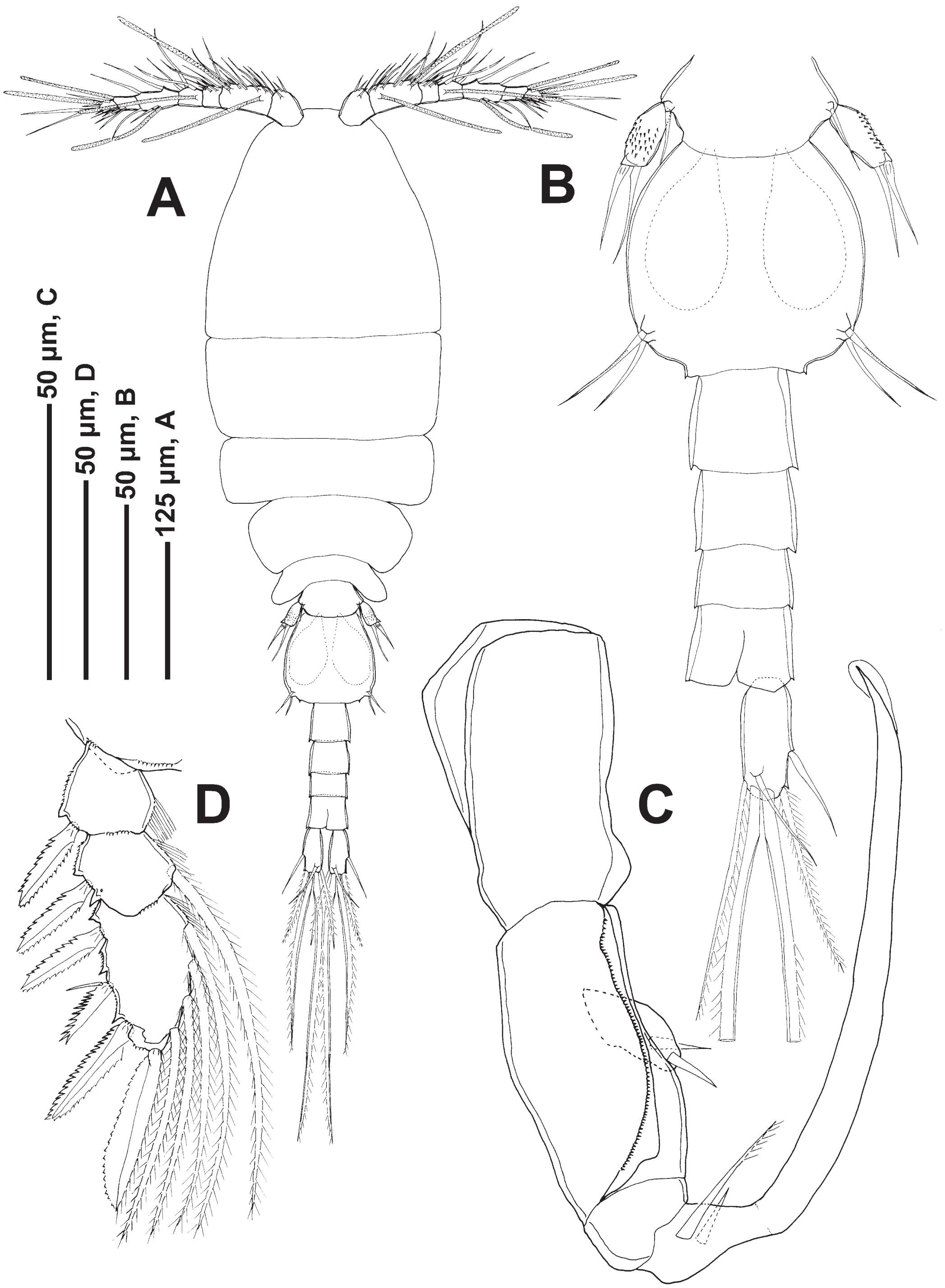


Figure 4. *Doridicola helmuti*, male. (A) Dorsal view; (B) urosome, dorsal view; (C) maxilliped; (D) endopod of leg 1.

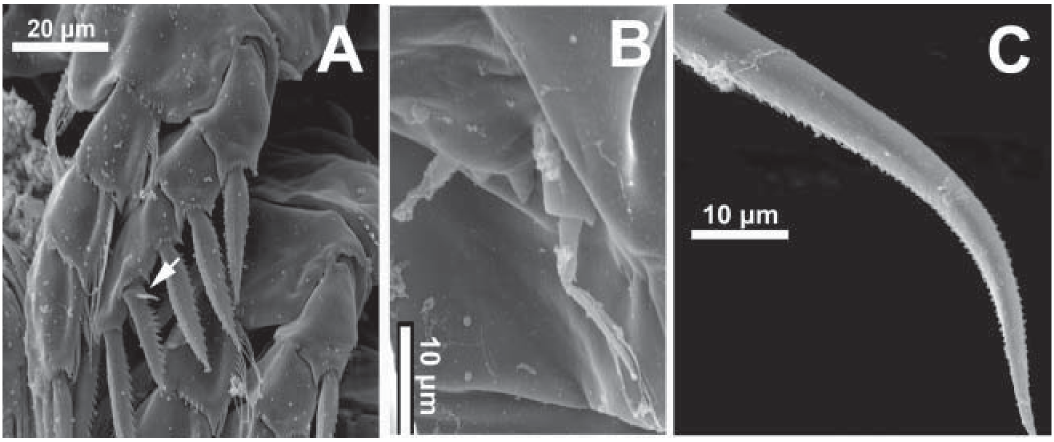


Figure 5. *Doridicola helmuti*. (A) Male, detail showing (arrow) additional spinule on the second lateral spine of endopod dorsal view; (B) female, genital area; (C) female, detail of terminal claw of antenna.

expanding laterally to egg sac attachment area and overhanging narrow posterior part of somite proper (Figure 1A, B). Genital areas composed of two parts, the first one rounded with short plumose seta and two spiniform processes. Second part subquadrate bearing a longer plumose seta and a small spiniform process (Figures 1C, 5B).Three free abdominal somites 60×57.7, 43.3×48, and 57×52.9 µm, respectively (Figure 1A, B). Posterodorsal border of genital segment and of the two first postgenital segments irregular. Caudal ramus (Figure 1A, B) 3.4 times longer than wide, measuring 81.7×24 µm and bearing six setae in terminal area. Outer lateral seta 38.4 µm, dorsal seta 80 µm, both smooth. Outermost terminal seta 89.7 µm, innermost terminal seta 102. 5 µm, both with lateral setules widely spaced. The two median terminal fringed setae 221 µm (outer), 214 µm (inner) with setules on their outer margin. Egg sac elongate, oval. Dorsal surface of body lacking visible ornamentation, except for minute setules as shown in Figure 1A.

Rostrum broadly rounded posteroventrally. Antennule (Figure 1D) seven-segmented, with armature formula: 4, 13, 6, 3, 4+1 aesthete, 2+1 aesthetasc, and 7+1 aesthetasc. Antenna (Figure 1E) four-segmented; with formula of armature: 1, 1, 3, and 3+2 subequal claws slightly dentate (Figure 5C). Claws 2.5 times longer than the last segment. Labrum with two large, divergent posteroventral lobes. Mandible (Figure 2A) minute, with shallow proximal notch followed by a short terminal lash setulose on its outer side. A small lobe bearing three to four teeth between the proximal notch and the lash. Convex margin with a naked outer scale. Maxillule (Figure 2B) armed with two terminal subequal setae, the inner plumose, and one spiniform process. Maxilla (Figure 2C) two-segmented; proximal segment (syncoxa) unarmed; distal segment (basis) ornamented with three typical setae: a tiny outer setula (seta III) at base, naked seta (seta II) on anterior surface, and seta armed with strong spinules (seta I) proximal to the base of the main lash and as long as it. Terminal lash armed along one side with large strong spinules. Maxilliped (Figure 2D, E) two-segmented; proximal segment unarmed; distal segment long with just one naked long seta which usually is around the segment, terminating in various barbed pointed processes and carrying a spiniform process with setules at its inner margin.

Legs 1–4 (Figure 3A–D) biramous, with three-segmented rami except the endopod of leg 4, which is two-segmented. Intercoxal sclerite present in legs 1–4. Formula of spines (in Roman numerals) and setae (in Arabic numerals) as follows:

	Coxa	Basis	Exopod segments	Endopod segments
Leg 1	0-1	1-0	I-0; I-1; III,I,4	0-1; 0-1; I,5
Leg 2	0-1	1-0	I-0; I-1; III,I,5	0-1; 0-2; I,II,3
Leg 3	0-1	1-0	I-0; I-1; III,I,5	0-1; 0-2; I,II,2
Leg 4	0-1	1-0	I-0; I-1; II,I,5	0-1; II

Inner coxal seta plumose in all legs on inner margin of basis of all legs ornamented with setules and basal seta of all legs plumose.

Leg 5 (Figure 1A, B) long, reaching more than half the length of the double genital segment and armed with small spinules; without proximal inner expansion. Two terminal smooth setae, subequal in length.

Male. Body (Figure 4A) 800 µm long (760–830 µm) (excluding setae on caudal rami) based on four males in lactic acid, with six-segmented urosome. Genital somite (Figure 4A, B) slightly wider than long. Four postgenital segments. Caudal ramus 2.3 times longer than wide with the usual six setae in terminal area as described for the female. Rostrum as in female. First antenna similar to that of female but with three aesthetascs at locations indicated by dots in Figure 1D. Second antenna slightly different from female in having spinules on the surface of the first and second segments. Labrum, mandible, maxillule, and maxilla resembling those of female. Maxilliped (Figure 4C) four-segmented; first segment (syncoxa) large but unarmed; second segment (basis) armed with a row of spinules and two inner setae, one of them inserted in a protuberance; third segment (endopod) smallest and unarmed; terminal claw as long as the preceding segments. The claw with terminal lamellae, one long barbed seta and a smaller naked seta at the basal region. Armature on rami of legs 1–4 are as in female, except for the armature of the endopod of leg 1 (Figures 4D, 5A) since the second lateral spine of the last segment has an additional spinule at its base. The free segment of leg 5 (Figure 4A, B) small, 21.7×8.6 µm, tipped with two subequal setae. Leg 6 (Figure 4B) composed of two ventral subequal setae located at posterolateral corner of genital somite.

Etymology

The specific name *helmuti* is after Dr Helmut Zibrowius (Station Marine d'Endoume, Marseille) for his important contribution to our knowledge of the biodiversity and distribution of European scleractinians.

Remarks

Among the 46 species currently recognized in the genus *Doridicola*, 25 species have the two terminal claws of the antenna subequal in size like *D. helmuti* (Ho and Kim 2001), although none of them has the claw 2.5 times longer than the fourth segment. Furthermore, among these 25 species, only *D. antheliae* (Humes and Stock, 1973), associated with an actiniarian from Madagascar, and *D. rostripes* Humes, 1990, living in an octocoral from the Moluccas, have a naked outer scale of the mandible. However, *D. antheliae* can be easily separated from the new species by: (1) the shape of the mandible; (2) the armature of the maxillule; (3) the seta I and II of the maxilla; and (4) the armature of the maxilliped and leg 5. The mandible of *D. anthelinae* has the concave margin deeply indented and, in general appearance, is stronger than in the new species. The maxillule has four elements in *D. anthelinae* and three in *D. helmuti*. The seta I of the maxilla is short, not reaching the terminal lash, and has spinules on both sides in *D. anthelinae*, while the new species has a long spined internal seta I. The seta II of this appendage is barbed in *D. anthelinae* and smooth in *D. helmuti*. The maxilliped has a very different armature in both species and *D. anthelinae* has an inner expansion on leg 5 which lacks spinules (Humes and Stock 1973).

Doridicola rostripes differs from the new species by its broad flattened prosome, the robust second antenna, the three terminal seta of the maxillule, the slender maxilla, the armature of the maxilliped and the prominint beak-like process of leg 5 (Humes 1990).

Therefore, the new species is easily separated from its congeners by the combination of the following features: (1) ratio of length of claw to that of the last segment of the second antenna; (2) armature of the inner margin of the mandible; (3) armature of the maxillule and the maxilliped; (4) the seta II of the maxilla; and (5) basal swelling of leg 5. Furthermore, the description of this new *Doridicola* species is the first record of this genus associated with a scleractinian coral.

Order SIPHONOSTOMATIDA Thorell, 1859
Family ASTEROCHERIDAE Giesbrecht, 1899
Asterocheres Boeck, 1859
Asterocheres astroidicola n. sp.
(Figures 6–10)

Material examined

MNCN 20.04/7578 holotype, one adult female associated with the scleractinian *Astroides calycularis*, Tarifa Island, 36°01′N, 5°37′W, 10–20 m depth, July 1999; MNCN 20.04/7579 allotype, one adult male, with the same sampling data as the holotype; BEIM (COP 501), three adult females, with the same sampling data as the type material.

Description

Female. Body cyclopiform, slender with cephalothorax oval and cylindrical urosome (Figure 6A, B). Body length 750 µm (650–790 µm) and width 420 µm (390–450 µm), based on four specimens. Ratio of length to width of prosome 1.19:1. Ratio of length of prosome to that of urosome 2.1:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Urosome four-segmented comprising leg 5-bearing somite, genital double somite and two free abdominal subquadrate somites. Somite bearing leg 5 (Figure 6D) wider than long, with some spinules on its lateral surface. Dorsal surface of free abdominal somites and posterior part of double somite ornamented with large, flattened epicuticular scales, arranged in irregular, overlapping rows (Figures 6D, 10C). Posterior margins of all somites ornamented with hyaline frills with more or less serrated margins. Genital double somite about 1.25 times wider than long, bearing genital apertures, paired gonopores located laterally. Lateral margin of double somite ornamented with fringe of long spinules located about midway along double somite, posterior to gonopores level (Figure 6C). Each genital area armed with one plumose seta. Integumental pores and sensilla present on urosomal somites (Figure 6C). Caudal rami slightly longer than wide, ornamented dorsally with epicuticular scales; armed with six setae.

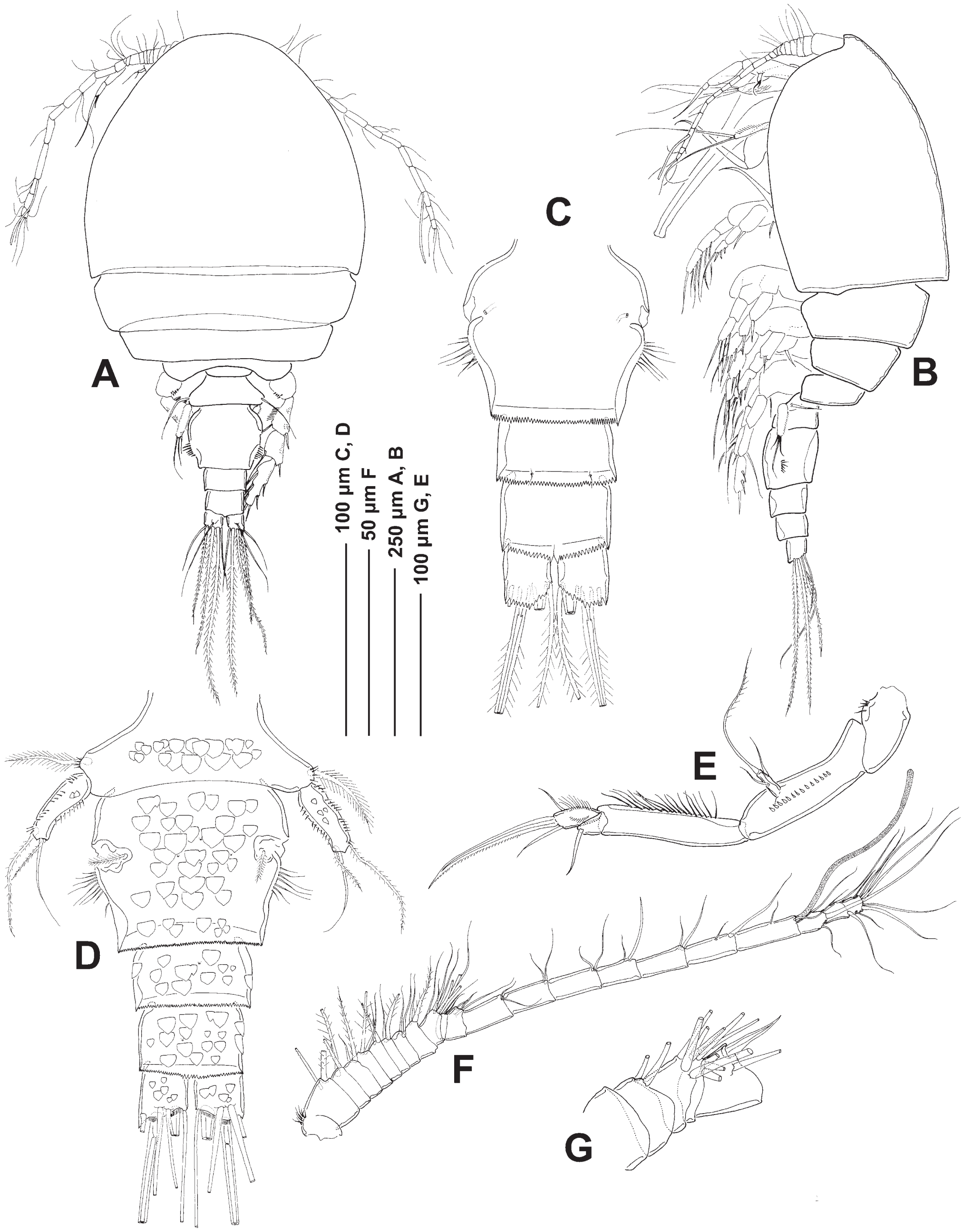


Figure 6. *Asterocheres astroidicola*, female. (A) Dorsal view; (B) lateral view; (C) urosome, ventral view; (D) urosome, dorsal view; (E) antenna; (F) antennule; (G) same, detail of compound segment IX–XII.

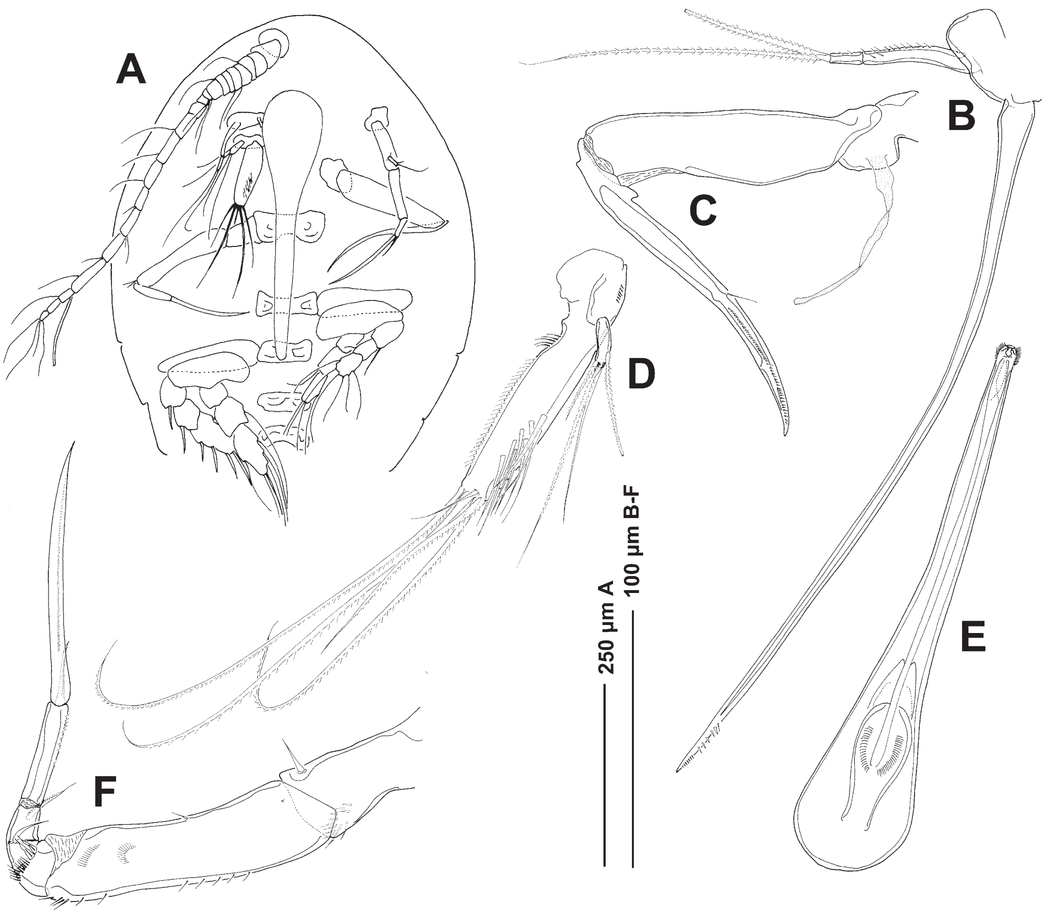


Figure 7. *Asterocheres astroidicola*, female. (A) Prosome, ventral; (B) mandible; (C) maxilla; (D) maxillule; (E) oral cone; (F) maxilliped.

Antennule 21-segmented (Figures 6F, 6G); segmental fusion pattern as follows: 1(I), 2(II), 3(III), 4(IV), 5(V), 6(VI), 7(VII), 8(VIII), 9(IX–XII), 10(XIII), 11(XIV), 12(XV), 13(XVI), 14(XVII), 15(XVIII), 16(XIX), 17(XX), 18(XXI), 19(XXII–XXIII), 20(XXIV–XXV), 21(XXVI–XXVIII). Segments 1–8 each with two setae; segment 9 with eight setae; segment 10–17 each with two setae; segment 18 with two setae plus an aesthetasc; segment 19 with two setae; segment 20 with three setae; segment 21 with seven setae. Segment 10 (XIII) (Figure 6G) reduced, partly overlapped by distal expansion of compound segment 9 (IX–XII). Antenna (Figure 6E) biramous, 380 µm long with a small unarmed coxa ornamented with tuft of spinules and a large unarmed basis with fine spinule row. Exopod small, one-segmented, bearing two lateral and one apical setae. Endopod three-segmented; first segment elongated, ornamented with a row of long spinules; second segment produced distally on medial side but articulating with third segment proximally on lateral side and armed with one smooth seta, third segment armed with two short naked setae, and large terminal claw also ornamented with rows of fine spinules. Mandible (Figure 7B) with two-segmented palp and stylet-like gnathobase. Stylet with denticulate margin subapically and located in oral cone. First segment of palp slender, unarmed but ornamented with a row of

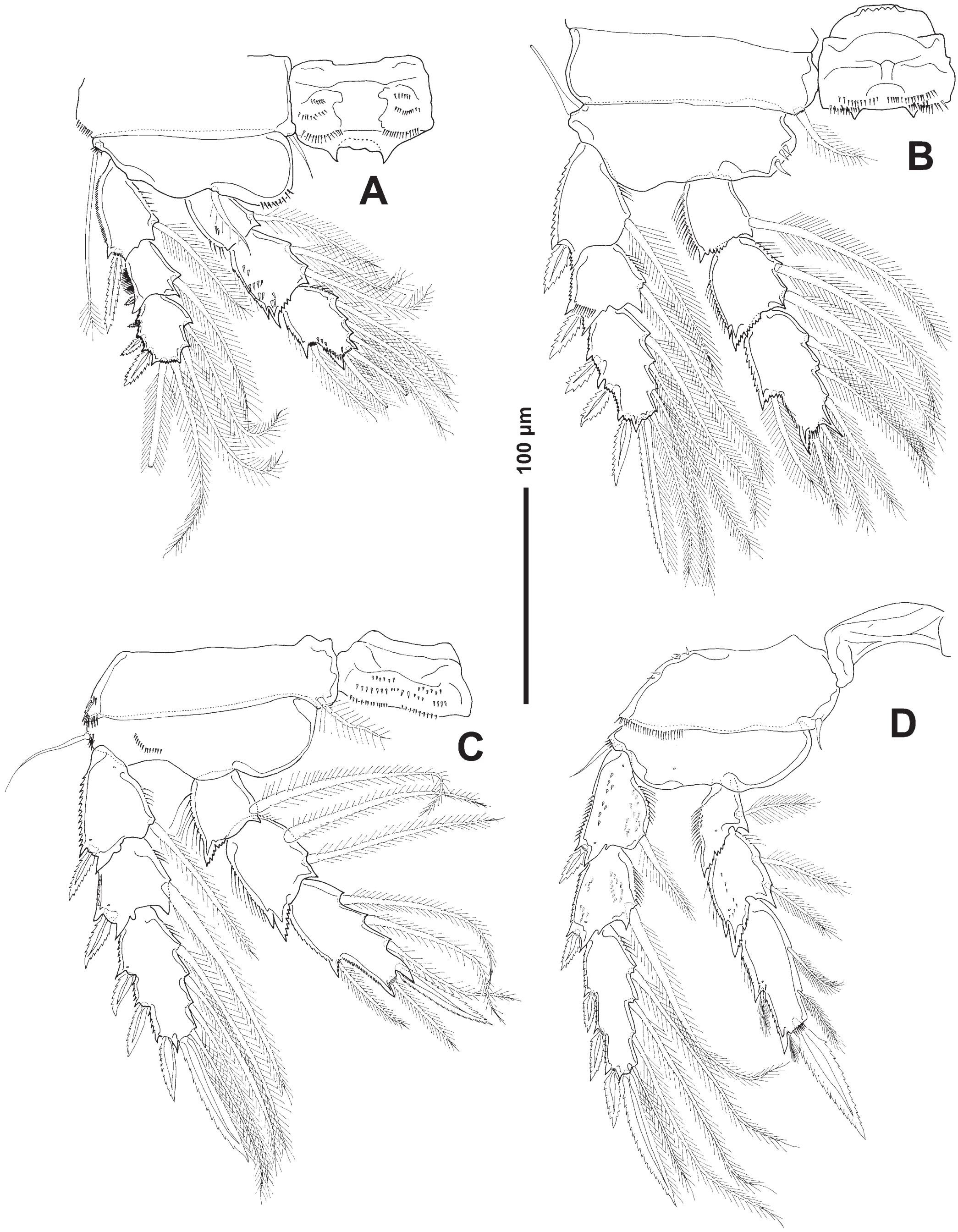


Figure 8. *Asterocheres astroidicola*, female. (A) Leg 1; (B) leg 2; (C) leg 3; (D) leg 4.

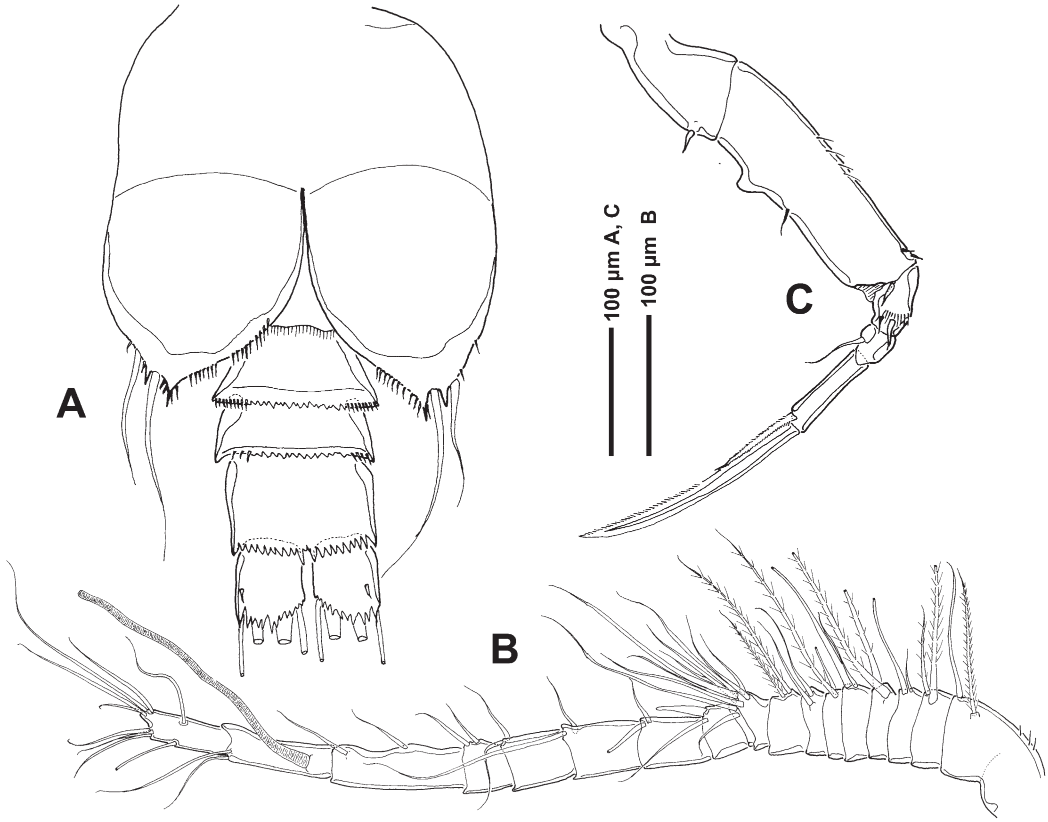


Figure 9. *Asterocheres astroidicola*, male. (A) Urosome, ventral view; (B) antennule; (C) maxilliped.

spinules laterally; second segment with two terminal plumose setae. Oral cone long and slender, 293 µm long, formed by labrum and labium joined laterally, reaching nearly to the posterior margin of intercoxal plate of leg 2 (Figure 7A, E). Maxillule bilobed (Figure 7D); praecoxal endite more than four times longer than palp and more than three times wider than palp. Praecoxal endite armed with five distal setae (one of them smooth and short), ornamented with patch of long spinules distally and row of shorter spinules laterally. Palp armed with three terminal and one subterminal setae. Maxilla three-segmented (Figure 7C). Praecoxa bearing long flaccid element medially (Figure 10B), possibly an aesthetasc; coxa unarmed and claw-like basis bearing small hyaline process proximally in axil; armed with one very small seta at about one-half its length laterally; claw margins with row of minute spinules distally. Maxilliped five-segmented (Figure 7F), first segment with small inner distal seta and patch of spinules. Second segment elongate and slender, with minute hyaline seta at midway of inner margin and rows of fine spinules distally. Third segment short, ornamented with two minute smooth setae and a patch of fine spinules medially. Fourth segment armed with two short setae, one of them smooth. Fifth segment with one terminal plumose seta and one claw-like seta, 105 µm long, ornamented with a lateral row of minute spinules.

Legs 1–4 biramous (Figure 8A–D), with three-segmented protopods and three-segmented rami. Intercoxal sclerite present on legs 1–4, ornamented with patches

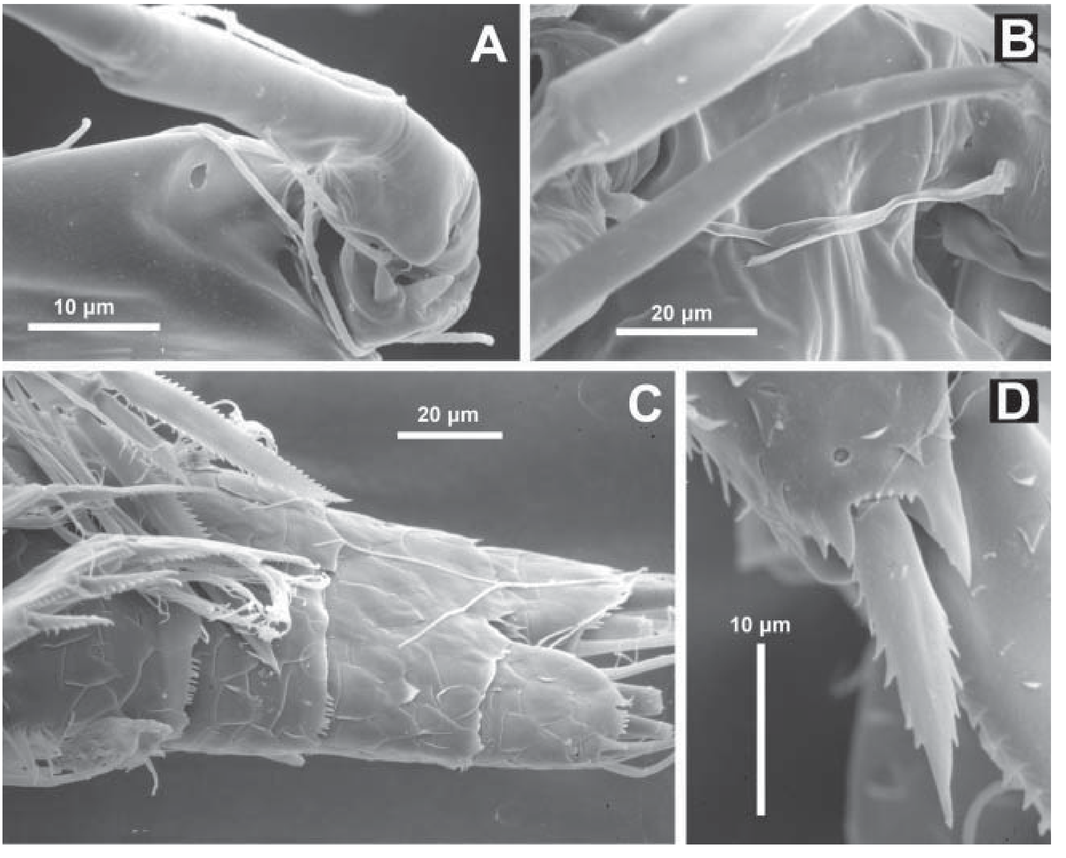


Figure 10. *Asterocheres astroidicola*, female. (A) Maxilliped, detail showing two setae of third segment; (B) maxilla, detail showing the flaccid element of praecoxa; (C) urosome, ventral view; (D) detail of the pore of leg 4.

of spinules on legs 1–3 and pair of processes on legs 1 and 2. Formula for armature as follows:

	Coxa	Basis	Exopod segments	Endopod segments
Leg 1	0-1	1-1	I-1; I-1; III,1,3	0-1; 0-2; 1,2,3
Leg 2	0-1	1-0	I-1; I-1; III,I,4	0-1; 0-2; 1,2,3
Leg 3	0-1	1-0	I-1; I-1; III,I,4	0-1; 0-2; 1,1+I,3
Leg 4	0-1	1-0	I-1; I-1; III,I,4	0-1; 0-2; 1,1+I,2

Coxae of all legs ornamented with spinule rows laterally as figured. Inner coxal seta plumose in legs 1–3 and reduced and naked in leg 4. Except on leg 2, basal seta of all legs long and naked. Posterior surface of legs 1–4 ornamented with flattened epicuticular scales, arranged in irregular, overlapping rows (Figure 10D). Lateral margins of exopodal segments with minute serrations; lateral margins of endopodal segment with row of setules.

Leg 5 (Figure 6D) with elongated free segment. Three terminal setae, two of them plumose. Few minute spinules on both sides of free segment. Adjacent seta on body somite plumose. Leg 6 (Figure 6D) represented by seta on genital area.

Male. Only one adult male specimen but seriously damaged. Body cyclopiform, slightly more slender than in female, with oval-shaped cephalothorax and cylindrical urosome. Urosome five-segmented, comprising pedigerous somite 5, genital somite and three free abdominal somites. Posterior margins of all somites ornamented with hyaline frills with more or less serrated free margins. Genital somite slightly longer than wide; bearing genital apertures postero-laterally on ventral surface (Figure 9A). Appendages as in female except antennule, maxilliped and leg 6. Leg 5 expected to be different to that of the female but in this specimen it has not been observed due to the fact that it was not complete.

Antennule (Figure 9B) 18-segmented, geniculate; segmental fusion pattern as follows: 1(I), 2(II), 3(III), 4(IV), 5(V), 6(VI), 7(VII), 8(VIII), 9(IX–XII), 10(XIII), 11(XIV), 12(XV), 13(XVI), 14(XVII), 15(XVIII), 16(XIX–XX), 17(XXI–XXIII), 18(XXIV–XXVIII). Geniculation located between segments 16(XIX–XX) and 17(XXI–XXIII). Segments 1–8 each with two setae; segment 9 with eight setae; segment 10–16 each with two setae; segment 17 with two setae plus an aesthetasc; segment 18 with nine setae. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX–XII). Maxilliped (Figure 9C) five-segmented, similar to that of female but second segment with medial proximally directed thorn-like process.

Leg 6 (Figure 9A) forming large opercular plates closing off genital apertures, armed with two smooth setae, ornamented with rows of fine spinules.

Etymology

The name of the species, *astroidicola*, is a combination of *Astroides*, the host name, and -*icola* from the Latin meaning "inhabiting", alluding to the relationship between the copepod and the coral.

Remarks

Eleven valid species of *Asterocheres* Boeck, 1859 have been reported as possessing a 21-segmented antennule in the female. Three of them, *A. suberitis* Giesbrecht, 1897, *A. violaceus* Claus, 1889, and *A. minutus* Claus, 1889, were collected from NE Atlantic and Mediterranean coasts and another eight from other areas, namely *A. bulbosus* Malt, 1991 from Hong Kong, *A. jeanyeatmanae* Yeatman, 1970 from Chesapeake Bay, *A. tenuicornis* Brady, 1910 from Antarctica, *A. reginae* Boxshall and Huys, 1994 from Belize, *A. flustrae* Ivanenko and Smurnov, 1997 from the White Sea, *A. lunatus* Johnsson, 1998 from Brazil, *A. urabensis* Kim, 2004 from the Pacific Coast of Panama, and *A. hirsutus* Bandera et al., 2005 from Antarctica. Except for *A. urabensis* and *A. hirsutus*, all of these species are characterized by having a relatively short siphon which does not extend beyond the insertion of the maxillipeds (Boxshall and Huys 1994). *Asterocheres urabensis*, *A. hirsutus*, and the new species, *A. astroidicola*, possess a longer oral cone. In the first two species it reaches to the insertion of leg 1 and in the latter species the oral cone enlarges nearly to the intercoxal plate of leg 2. However, in a detailed comparison of *A. astroidicola* and the remaining species with a 21-segmented antennule, a number of additional differences can be discussed. Firstly, *A. bulbosus*, *A. violaceus*, and *A. minutus* have a one-segmented mandibular palp in contrast to the two-segmented mandibular palp present in the new species. As for *A. tenuicornis*, it differs from *A. astroidicola* by its very elongated caudal rami which is almost six times longer than wide.

From the point of view of body shape, *A. reginae* and *A. jeanyeatmanae* differ from the new species by their dorso-ventrally flattened prosome. Moreover, *A. astroidicola* can be distinguished from *A. reginae* by having one additional seta on the inner lobe of the maxillule and from *A. jeanyeatmanae* by having one distal additional seta on the free segment of the fifth leg. The extremely large inner lobe of the maxillule, at least four times longer than outer lobe, of *A. astroidicola* and *A. hirsutus* serves to separate them from the remaining four species, *A. flustrae*, *A. suberitis*, *A. lunatus*, and *A. urabensis*, which have a much smaller endite in the maxillule. *Asterocheres suberitis* and *A. lunatus* possess four terminal setae on the inner lobe of the maxillule in contrast with the five setae present in *A. astroidicola*. *Asterocheres flustrae* has a six-segmented maxilliped instead of the five-segmented maxilliped present in *A. astroidicola*. The caudal rami is 2.5 times longer than wide in *A. hirsutus*, whereas in *A. astroidicola* it is only slightly longer than wide.

Concerning hosts, except for *A. suberitis* and *A. tenuicornis* whose hosts are unknown, *A. flustrae* lives in association with the bryozoan *Flustra foliacea* L. and *A. minutus* and *A. violaceus* live in association with an echinoderm. The remaining species of this group, except for *A. urabensis*, are symbionts on sponges. *Asterocheres urabensis* and *A. astroidicola* are associated with scleractinian coral, *Pocillopora damicornis* (L.) and *Astroides calycularis* (Pallas, 1766), respectively. These two species are very similar but they can be distinguished by the following features: (1) the endopodal claw of the antenna; (2) the length of the oral cone; (3) the shape of the inner lobe of the maxillule; (4) the armature of the free segment of leg 5. The claw of the antenna is longer than the entire endopod in *A. urabensis*, while in the new species it is smaller and the oral cone is longer in *A. astroidicola*. The inner lobe of the maxillule is less than three times longer than the palp in *A. urabensis*, while that of *A. astroidicola* is more than four times longer and more than three times wider than the palp. The free segment of leg 5 has three smooth setae in *A. urabensis* and adjacent small seta on body somite 5 whereas *A. astroidicola* possesses two plumose setae and one smooth seta on leg 5 and a long adjacent seta on body somite 5 which reaches to the end of the free segment.

Acontiophorus (Brady, 1880)
Acontiophorus scutatus (Brady and Robertson, 1873)
(Figure 11)

Solenostoma scutatum Brady and Robertson, 1973.
Acontiophorus scutatus Brady, 1880; Thompson, 1883; Claus, 1889; Canu, 1891, 1892, 1894; Thompson, 1883?, 1887; Giesbrecht, 1895, 1897, 1899; Norman and Scott, 1906; Sars, 1915, 1918; Hansen, 1923; Gotto, 1993.
Acontiophorus angulatus Thompson, 1888.

Material examined

BEIM (COP 518), five females and two copepodids, associated with the scleractinian *Astroides calycularis*, Tarifa Island, 36°01′N, 5°37′W, 10–20 m depth, 8 November 1996; BEIM (COP 535), six females, three males and two copepodids, associated with the scleractinian *Astroides calycularis*, Tarifa Island, 36°01′N, 5°37′W, 10–20 m depth, 14 July 1999; BEIM (COP 525), one female, associated with the scleractinian *Astroides calycularis*, Tarifa Island, 36°01′N, 5°37′W, 10–20 m depth, 22 September 1999.

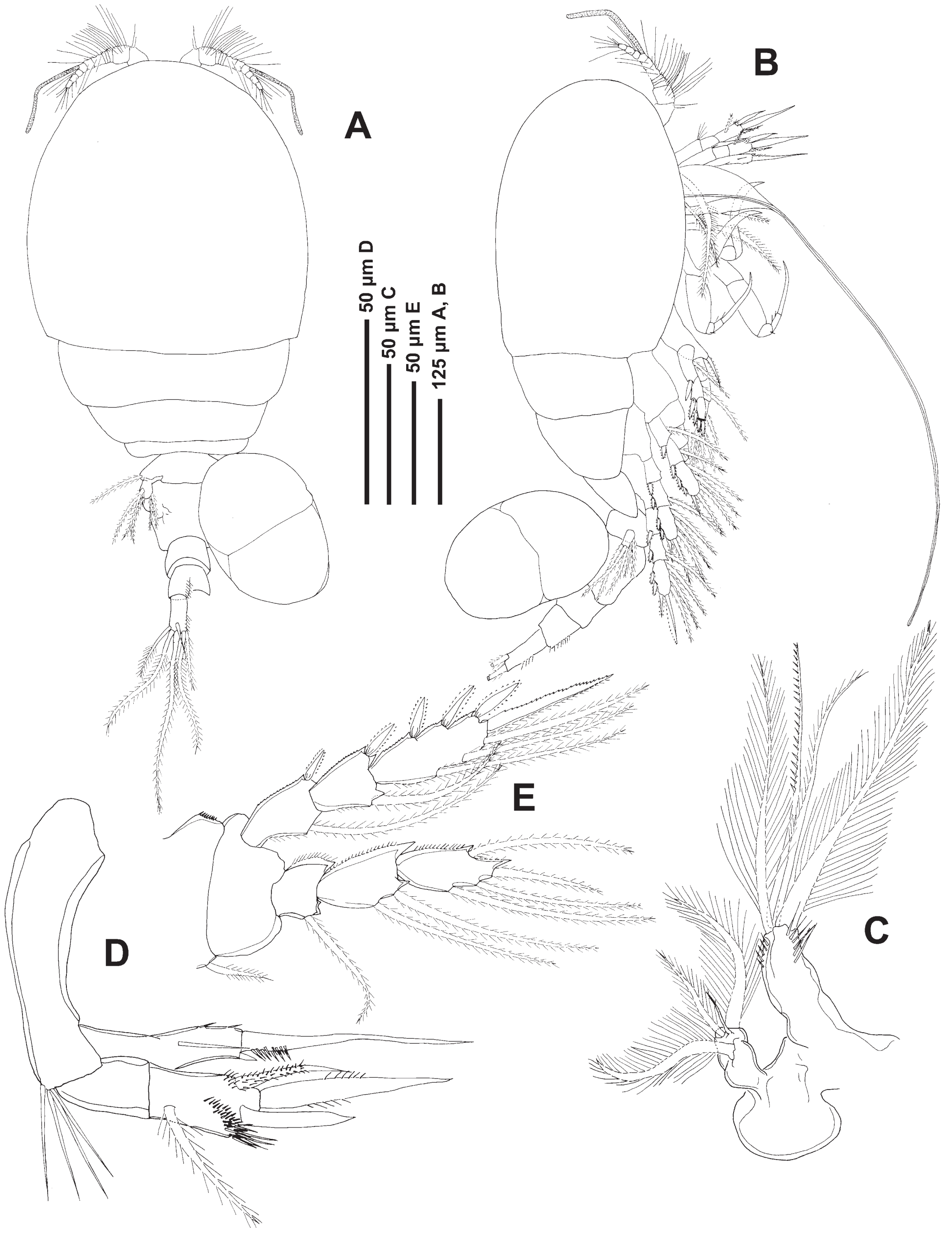


Figure 11. *Acontiophorus scutatus* (Brady and Robertson, 1873), female. (A) Dorsal view; (B) lateral view; (C) maxillule; (D) antenna; (E) leg 4.

Remarks

The specimens from Tarifa differ slightly from those drawn by Giesbrecht (1899) in the second antenna, the maxillule, and the fourth leg. The setae ornamentation of the last endopodal segment of the second antenna is slightly dissimilar since the medial seta is shorter and has setules and the innermost seta is stronger than Giesbrecht's specimens. On the maxillule of our specimens the four setae of the endite are ornamented: the two outermost setae are densely plumose and of the two innermost setae, one is barbed and the other plumose laterally only. With respect to the legs, the only difference is in the length of the basis seta of leg 4 which is shorter in the specimens found in Tarifa.

Host

This species has been found free and caught either by surface-net at night (Brady 1880), or by dredging (Brady 1880; Thompson 1883). It was also discovered among seaweeds such as *Laminaria saccharina* and *Sargassum* (Sars 1915; Gotto 1993). The only invertebrate host known is the sponge, *Spongelia fragilis* var. *ramosa*. However, according to Canu (1892), this siphonostomatoid is unusually associated with sponges and ascidians. This is the first time that this species has been found associated with Cnidaria.

General distribution

Species widely distributed in the North Atlanthic Ocean: Faroes (Hansen 1923), Norway (Sars 1915, 1918), UK (Brady 1880; Brady and Robertson 1873; Norman and Scott 1906), France (Canu 1892), and Strait of Gibraltar (present paper). Thompson's record (1887) of this species in Madeira is dubious (Giesbrecht 1899; Hansen 1923). It is also present in the Mediterranean Sea: Adriatic Sea (Claus 1989) and Tyrrhenian Sea (Giesbrecht 1899), but the record from New Zealand is probably wrong (Hansen 1923).

Acknowledgements

We wish to thank Isabel Alfonso for assistance in collecting colonies of *Astroides calycularis* at Tarifa (Spain). Support for this work was provided by The Natural History Museum (London) under the EC-funded TMR Bioresource Large-scale Facility Programme.

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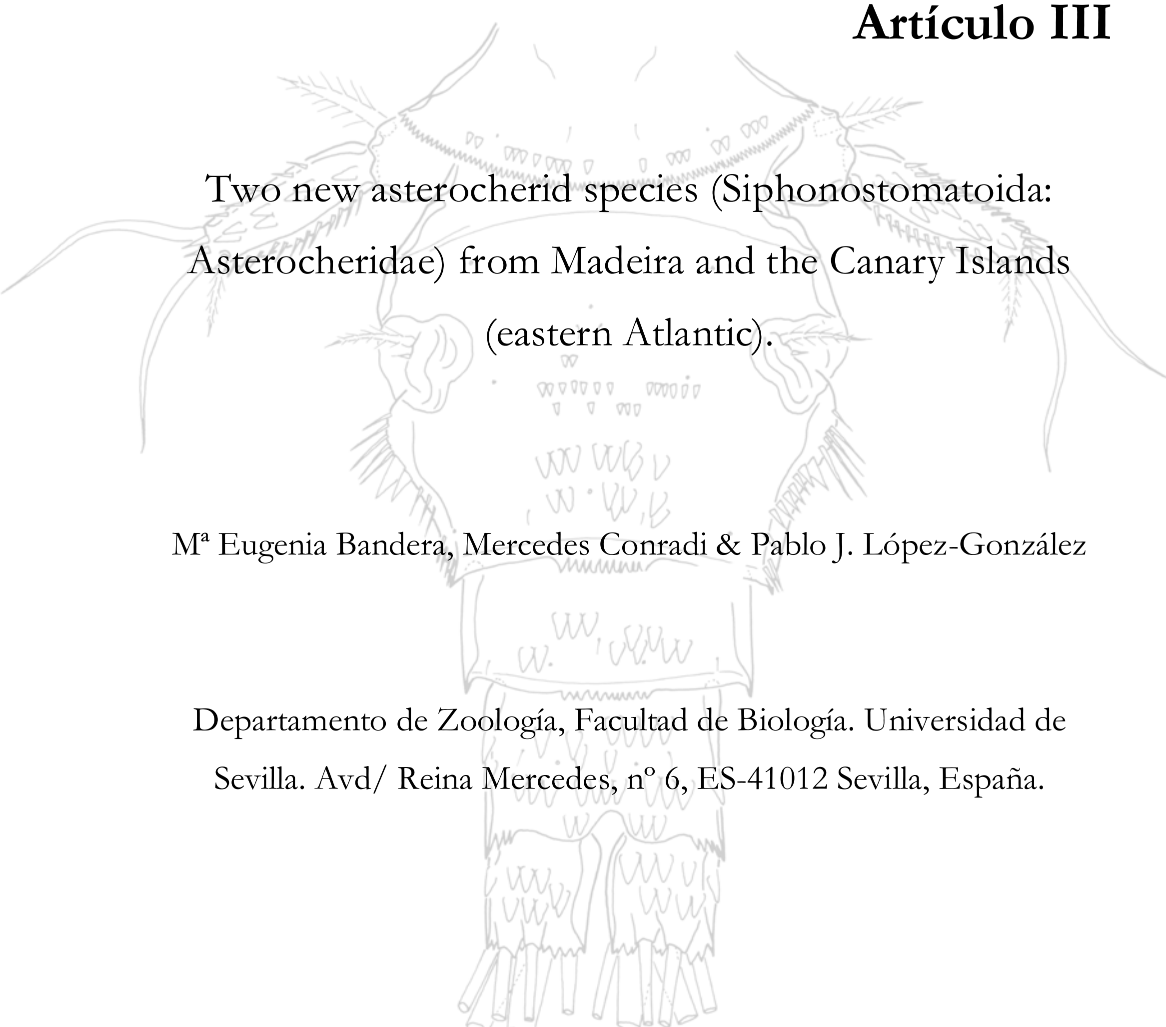
Artículo III



Two new asterocherid species (Siphonostomatoida: Asterocheridae) from Madeira and the Canary Islands (eastern Atlantic).

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ORIGINAL ARTICLE

Two new asterocherid species (Siphonostomatoida: Asterocheridae) from Madeira and the Canary Islands (eastern Atlantic)

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Abstract

The siphonostomatoid family Asterocheridae Giesbrecht, 1899 uses a wide range of host phyla, mainly due to the host diversity of two genera – *Asterocheres* Boeck, 1859 and *Orecturus* Humes, 1992. In the present paper, two new asterocherid species from the eastern Atlantic are described and compared with their congeners. One of these species belongs to the genus *Asterocheres*, *A. madeirensis*, and was found associated with the sponge *Petrosia ficiformis* (Poiret, 1789) in Madeira Island. This sponge occurs both in the Mediterranean and on nearby Atlantic coasts, although currently there are no records of the presence of symbiotic asterocherids for its Mediterranean populations. The second new species, *Orecturus canariensis*, is the first record of the genus on the eastern Atlantic coasts and was found in association with the gorgonian *Villogorgia bebrycoides* (Koch, 1887) in the Canary Islands. The diagnosis of the genus *Orecturus* is slightly modified to include some features shown by this new species and some of its plesimorphic and derived characteristics compared with the remaining asterocherid genera. Although the gorgonian *Paramuricea grayi* (Johnson, 1861) occurs in the same ecological assemblages as the infested colonies of *V. bebrycoides*, no specimens of asterocherid copepods were found on *Paramuricea* colonies. Therefore, *O. canariensis* may be a monoxenous symbiont.

Key words: *Asterocheres, Asterocheridae, Canary Islands, Orecturus, Madeira*

Introduction

Siphonostomatoid copepods live in association with many marine invertebrates all around the world (Gotto 1979). The siphonostomatoidan family Asterocheridae Giesbrecht, 1899 uses a wide range of host phyla, including sponges, cnidarians, molluscs, bryozoans, polychaetes, echinoderms and ascidians (Ivanenko & Smurov 1997; Johnsson & Bustamante 1997). This is mainly due to the host diversity of two genera: *Asterocheres* Boeck, 1859 and *Orecturus* Humes, 1992 (Boxshall & Halsey 2004). The genus *Asterocheres* is also the most specious asterocherid genera, as it contains approximately 70 species, although only 16 of them have been reported for the eastern Atlantic. On the contrary, none of the 10 known *Orecturus* species has been reported in this area. In fact, the Asterocheridae fauna from the eastern Atlantic, and specifically that from Madeira and the Canary Islands, is poorly known. Thompson (1888) reported a list of 64 copepods species collected in Madeira and the Canary Islands during a cruise. However, out of this number, only two siphonostomatoid were found, the asterocherid *Acontiophorus scutatus* (Brady & Robertson 1875) and the artotrogid *Artotrogus normani* (Brady & Robertson 1875), both of them taken from Funchal Bay, Madeira. More than a century later, Johnsson (2001) described two copepods belonging to the family Artotrogidae – *Cryptopontius madeirensis* and *Dyspontius gerardius* – taken, respectively, from Reis Magos Beach and Porto Novo, Madeira.

In this paper, two new asterocherid species from Madeira and the Canary Islands, one belonging to *Asterocheres* and the other to the genus *Orecturus*, are described and compared with their respective congeners. The new species of *Asterocheres* was found associated with the sponge *Petrosia ficiformis* (Poiret, 1789) in Madeira and the new species of *Orecturus*

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was collected from the gorgonian *Villogorgia bebrycoides* (Koch, 1887) in the Canary Islands.

Material and methods

The colonies of *Villogorgia bebrycoides* were individually collected, each one being isolated in a plastic bag, by SCUBA diving at Guadamojete Point (Radazul, southeast coast of Tenerife, Canary Islands, Spain) (Figure 1) and immediately kept in cooled seawater (10°C) for several hours. Samples were then gently anaesthetized with MgCl. The sponge *Petrosia ficiformis* was individually collected by SCUBA diving at Porto da Cruz (Madeira Island, Portugal) (Figure 1) and immediately isolated in a plastic bag containing formalin 8–10% and seawater. In both cases, the symbiotic fauna were fixed with a 10% buffered formalin/seawater solution for 48 h and later sieved through a 100 µm net. The copepods were recovered from the sediment retained and preserved in 70% ethanol.

Selected specimens were stained with Chlorazol Black E, dissected in lactic acid, and examined as temporary mounts in lactophenol. All figures were drawn with the aid of a camera lucida on a Leica DMLB differential interference microscope. In order to detect minute details, a specimen of each species was dehydrated in a graded series of ethanol, critical-point dried, mounted on stubs, coated with gold palladium and observed and photographed using a Philips XL30 scanning electron microscope. All appendage segments and setation elements were named and numbered using the system established by Huys & Boxshall (1991).

Material examined in the present paper is deposited in the Museo Nacional de Ciencias Naturales in Madrid (MNCN) and in the collection of Biodiversidad y Ecología de Invertebrados Marinos research group of the University of Seville (BEIM).

Results

Order Siphonostomatida Thorell 1859
Family Asterocheridae Giesbrecht, 1899
Asterocheres Boeck, 1859
Asterocheres madeirensis, n. sp.
(Figures 2–6A–C)

Material examined

Holotype female (MNCN 20.04/7785), allotype male (MNCN 20.04/7786) and paratypes, two females and one male (MNCN 20.04/7787), associated with the sponge *Petrosia ficiformis* (Poiret, 1789) at Porto da Cruz, Madeira, Portugal, at about 3–5 m depth, September 1998. BEIM (COP–506) paratypes, eight females and five males, with the same sampling data as the holotype.

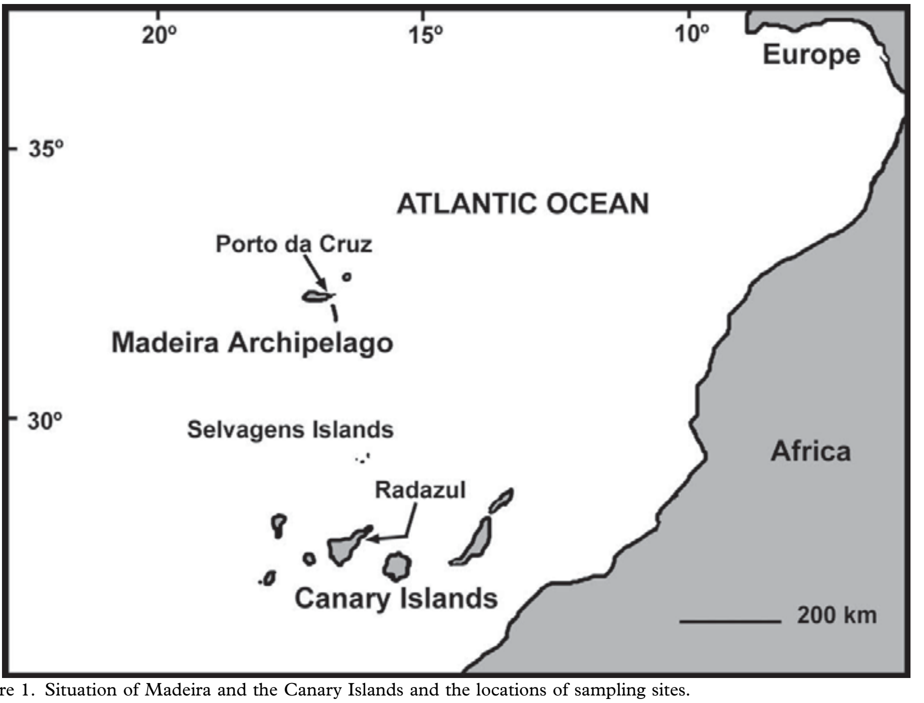

Figure 1. Situation of Madeira and the Canary Islands and the locations of sampling sites.

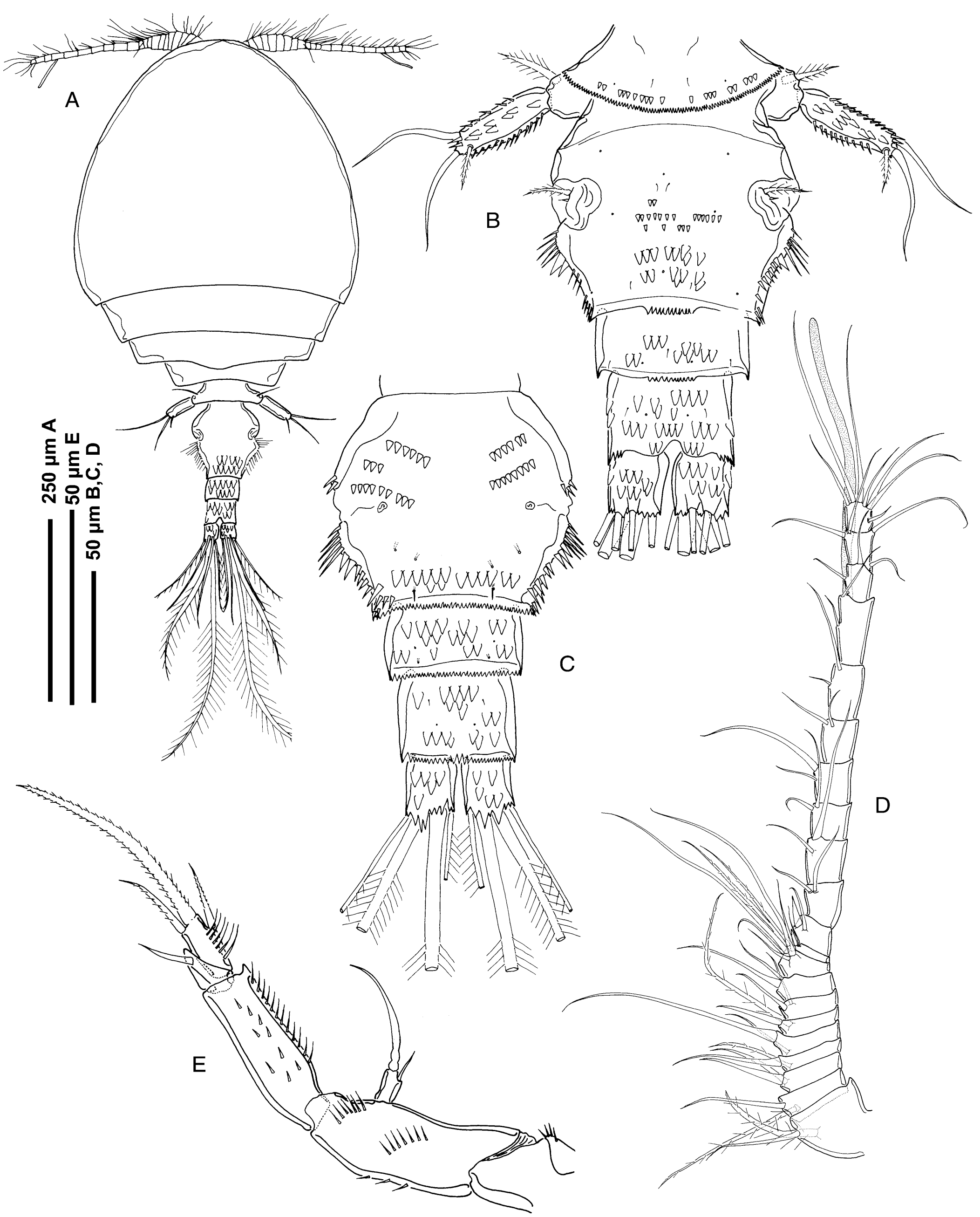

Figure 2. *Asterocheres madeirensis*, female. (A) Dorsal view. (B) Urosome, dorsal view. (C) Urosome, ventral view. (D) Antennule. (E) Antenna.

Description

Adult female. Body cyclopiform, slender with oval cephalothorax and cylindrical urosome (Figure 2A). Mean body length from rostral margin to posterior margin of caudal rami (without caudal setae) 560 µm (510–590 µm) and maximum width 330 µm (260–370 µm), based on three specimens. Ratio of length to width of prosome 1.2:1. Ratio of length of prosome to that of urosome 1.4:1. Prosome

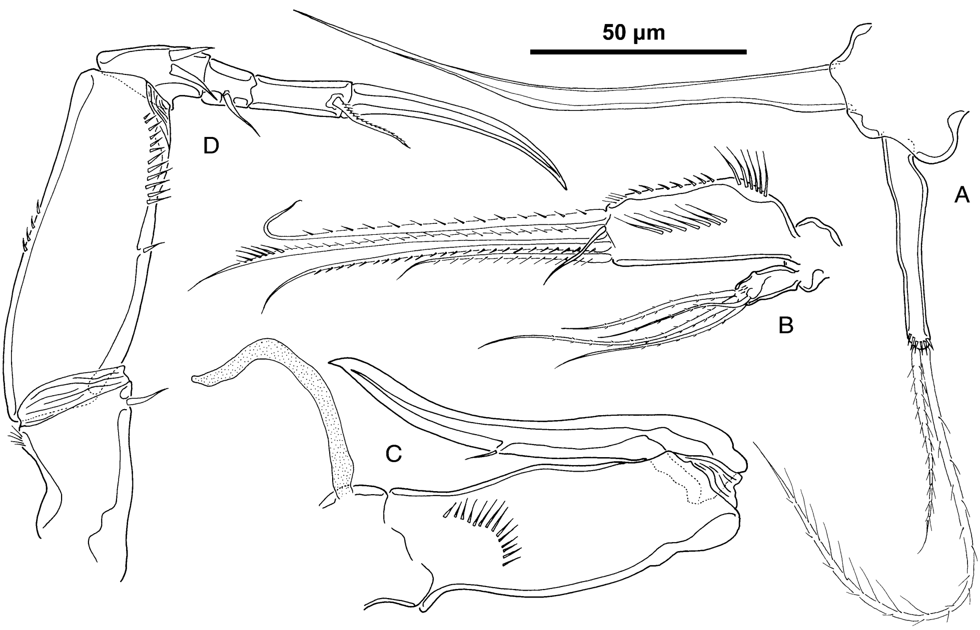

Figure 3. *Asterocheres madeirensis*, female. (A) Mandible. (B) Maxillule. (C) Maxilla. (D) Maxilliped.

comprising cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Somite bearing leg 4 much smaller than preceding ones. Dorsal cephalothoracic shield and free pedigerous somites ornamented with integumental pores and sensilla. Urosome four-segmented comprising leg 5-bearing somite, genital double somite and two free abdominal somites. Somite bearing leg 5 (Figure 2B) wider than long, with some spinules on its dorsal surface and a narrow membrane along posterodorsal margin. Genital double somite approximately 1.15 times wider than long, bearing genital apertures, paired gonopores located laterally. Lateral margin of double somite ornamented with fringe of long spinules located about midway along double somite, posterior to gonopore level (Figure 2B, C). Each genital area armed with one plumose seta and one minute spinule. Genital double somite and following somites provided with large epicuticular scales arranged in overlapping pattern all around (Figure 6A). Posterior margin of urosomites ornamented with hyaline frills with serrated free margins. Integumental pores and sensilla present on urosomal somites (Figure 2C). Caudal rami about as long as wide, ornamented dorsally with epicuticular scales; armed with six setae, seta I absent and setae II and VII slightly offset on to dorsal surface.

Antennule 21-segmented (Figure 2D); segmental fusion pattern as follows: 1(I), 2(II), 3(III), 4(IV), 5(V), 6(VI), 7(VII), 8(VIII), 9(IX–XII), 10(XIII), 11(XIV), 12(XV), 13(XVI), 14(XVII), 15(XVIII), 16(XIX), 17(XX), 18(XXI), 19(XXII–XXIII), 20(XXIV–XXV), 21(XXVI–XXVIII). Segments 1–8 each with two setae; segment 9 with seven setae; segments 10–17 each with two setae; segment 18 with two setae plus an aesthetasc; segment 19 with two setae; segment 20 with four setae; segment 21 with seven setae. Segment 10(XIII) reduced, partly overlapped by distal expansion of compound segment 9(IX–XII).

Antenna biramous (Figure 2E), 180 µm long, with small unarmed coxa ornamented with tuft of spinules and large unarmed basis with fine spinule rows. Exopod small, one-segmented, bearing one subapical and one apical seta. Endopod three-segmented; first segment elongated, unarmed but ornamented with spinules and lateral row of fine spinules; second segment produced distally on medial side but articulating with third segment proximally on lateral side and armed with one smooth seta; third segment armed with two short pinnate setae and large distal claw also ornamented with lateral rows of fine spinules.

Mandible with one-segmented palp and stylet-like gnathobase (Figure 3A). Stylet located in oral cone. Palp slender, ornamented with crown of fine spinules apically and armed with two terminal plumose setae. Oral cone long and slender, 126 µm long, reaching the insertion of maxillipeds.

Maxillule bilobed (Figure 3B); praecoxal endite (inner lobe) nearly three times longer than palp

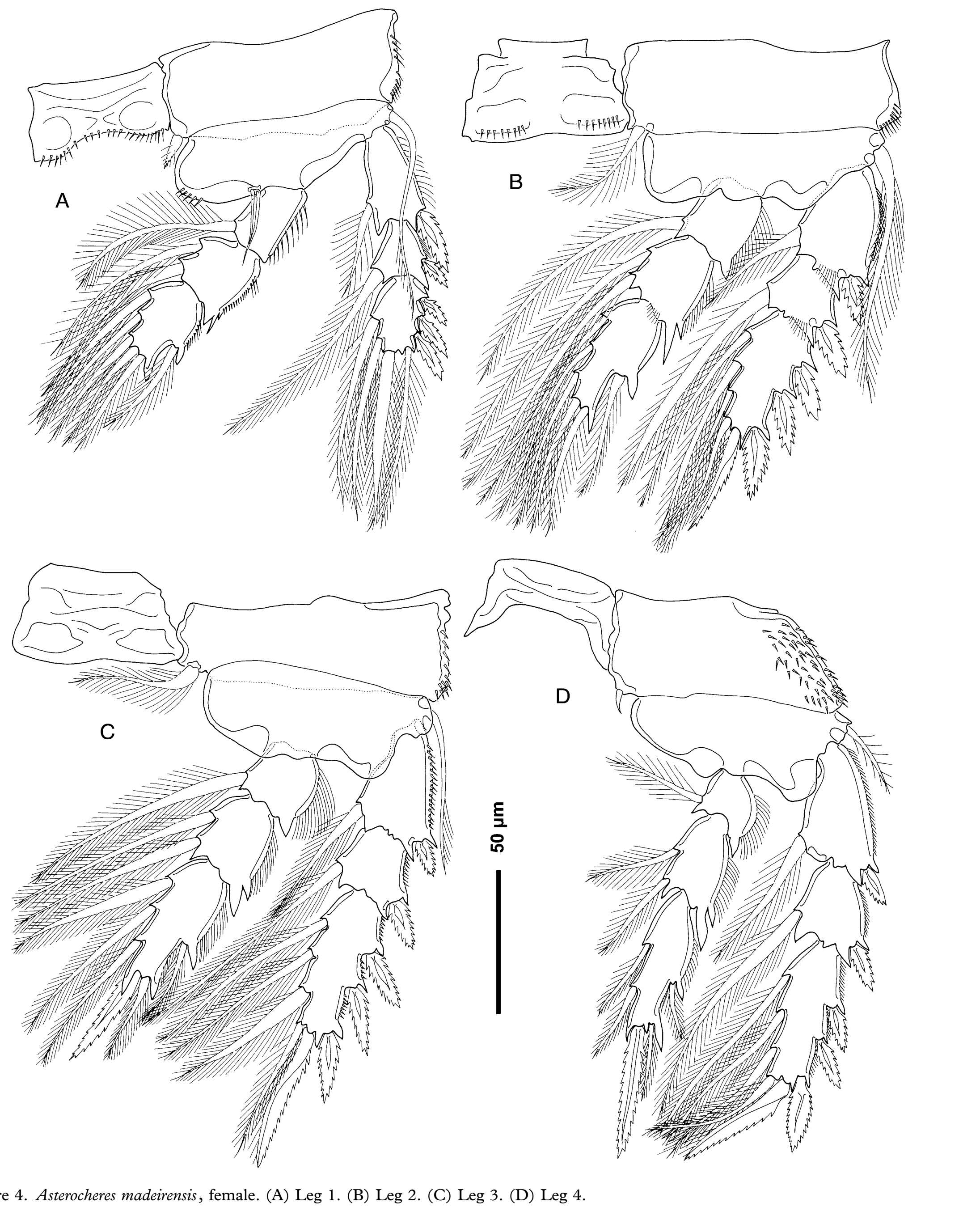

Figure 4. *Asterocheres madeirensis*, female. (A) Leg 1. (B) Leg 2. (C) Leg 3. (D) Leg 4.

(outer lobe). Endite ornamented with long setules proximally and spinules distally on the lateral margin and row of long setules medially; armed with five distal setae, four of them ornamented with spinules and one short and smooth. Palp armed with four barbed terminal setae.

Maxilla two-segmented (Figure 3C) but with partial transverse suture on syncoxa (proximal segment) possibly marking plane of praecoxa–coxa fusion; praecoxal part bearing long flaccid element medially (Figure 6C), representing tubular extension over the opening of the maxillary gland; coxal part

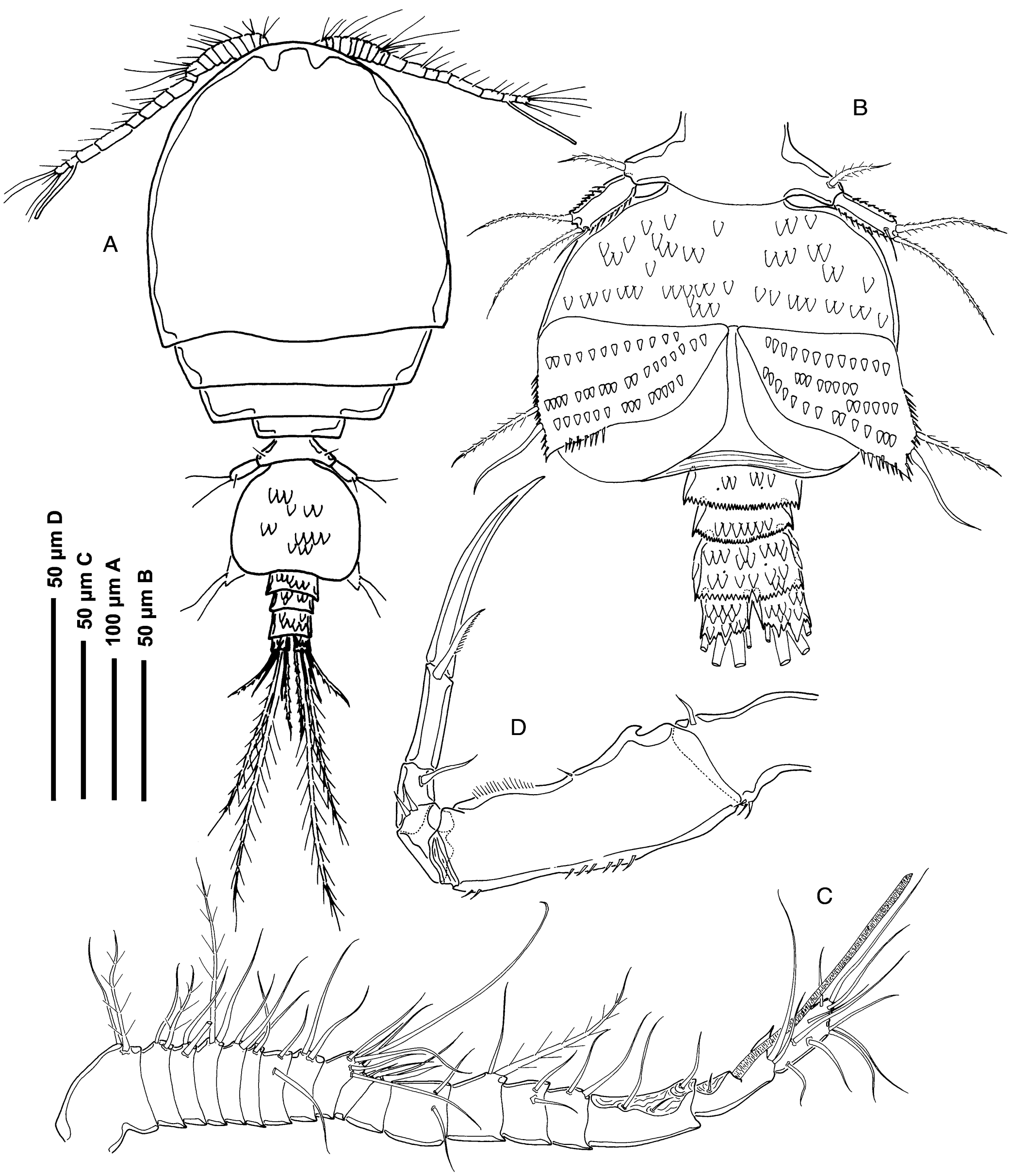

Figure 5. *Asterocheres madeirensis*, male. (A) Dorsal view. (B) Urosome, dorsal view. (C) Antennule. (D) Maxilliped.

unarmed but ornamented with a row of spinules proximally. Claw-like basis more or less straight; armed with one very small lateral seta at approximately half its length.

Maxilliped five-segmented (Figure 3D) comprising short syncoxa, long basis and distal subchela consisting of three free endopodal segments armed with distal claw-like element. Syncoxa with short seta distally; basis elongated and slender with minute hyaline seta approximately half its length on inner edge and row of spinules on lateral distal margin. First endopodal segment bearing two short setae and second with smooth short seta. Third endopodal segment with terminal claw, 57 µm long with no ornamentation, and additional apical plumose seta.

Swimming legs 1–4 biramous (Figure 4A–D), with three-segmented protopods and three-segmented rami. Intercoxal sclerite present in legs 1–4,

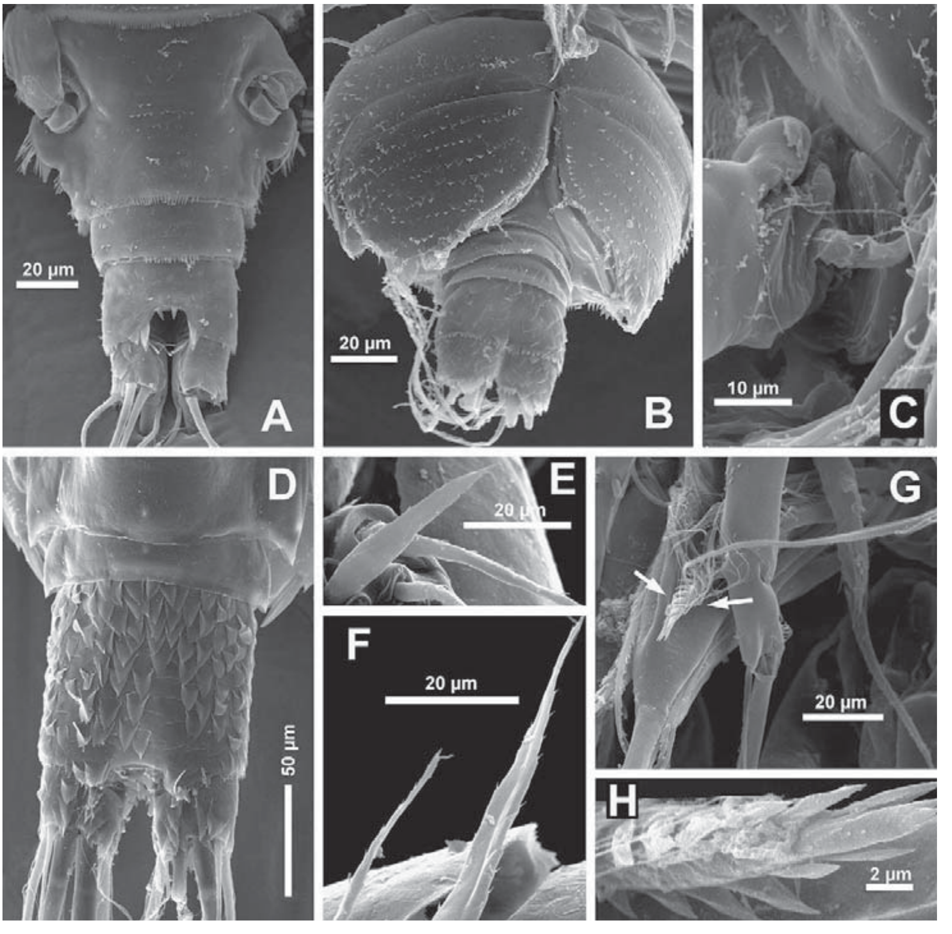

Figure 6. *Asterocheres madeirensis*: detail of the epicuticular scales in the urosome, dorsal view in (A) female and (B) male. (C) Maxilla, detail showing the flaccid element of the praecoxa. *Orecturus canariensis*, female: (D) detail of the epicuticular scales in the urosome, dorsal view; (E–F) antennule, detail of the spinous seta (E), and the seta with an apical setule that has an apical hollow (F) from the first to third segments; (G–H) maxillule, detail of the armature of one seta of the endite.

ornamented with rows of spinules in legs 1 and 2. Table I shows the formula for armature.

Coxae of all legs ornamented with spinule rows laterally, as figured. Inner coxal seta plumose in legs 1–3 and reduced and naked in leg 4. Outer spines of exopodal segments in legs 1–4 bilaterally serrated. Lateral margins of exopodal segments in legs 2–4 with minute serrations; lateral margins of endopodal segments in legs 1–4 with rows of setules. Second and third endopodal segments in legs 2–4 with beak-like spiniform process distally. Leg 5 with protopodal segment incorporated into somite (Figure 2B). Elongated free segment armed with two smooth terminal setae and subterminal plumose seta; ornamented with large epicuticular scales and fine spinules laterally. Leg 6 represented by seta on genital area (Figure 2B).

Table I. *Asterocheres madeirensis*, female, formula for armature of legs 1–4.

	Coxa	Basis	Exopodal segments	Endopodal segments
Leg 1	0–1	1–I	I–1;I–1;III,2,2	0–1;0–2;1,2,3
Leg 2	0–1	1–0	I–1;I–1;III,I,4	0–1;0–2;1,2,3
Leg 3	0–1	1–0	I–1;I–1;III,I,4	0–1;0–2;1,1+I,3
Leg 4	0–1	1–0	I–1;I–1;III,I,4	0–1;0–2;1,1+I,2

Adult male. Body cyclopiform, slightly more slender than female, with cephalothorax oval and cylindrical urosome (Figure 5A). Mean body length 450 µm (410–490 µm) and greatest width 240 µm (220–260 µm), based on three specimens. Ratio of length to width of prosome 1.2:1. Ratio of length of prosome to that of urosome 1.4:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Somite bearing leg 4 much smaller than preceding ones. Dorsal cephalothoracic shield and free pedigerous somites ornamented with integumental pores and sensilla. Urosome five-segmented, comprising fifth pedigerous somite, genital somite and three free abdominal somites. Dorsal and ventral surfaces of genital and free abdominal somites ornamented with large epicuticular scales arranged in overlapping pattern (Figure 6B). Posterior margin of urosomites ornamented with hyaline frills with more or less serrated free margins. Genital somite slightly wider than long, bearing genital apertures posterolaterally on ventral surface (Figure 5B). Caudal rami approximately as long as wide; armed with six setae as in female. Appendages as in female except for antennules, maxillipeds, and fifth and sixth legs.

Antennule 18-segmented (Figure 5C), geniculate; segmental fusion pattern as follows: 1(I), 2(II), 3(III), 4(IV), 5(V), 6(VI), 7(VII), 8(VIII), 9(IX–XII), 10(XIII), 11(XIV), 12(XV), 13(XVI), 14 (XVII), 15(XVIII), 16(XIX–XX), 17(XXI–XXIII), 18(XXIV–XXVIII). Geniculation located between segments 16(XIX–XX) and 17(XXI–XXIII). Segments 1–8 each with two setae; segment 9 with seven setae; segments 10–15 each with two setae; segment 16 with three setae; segment 17 with two setae plus an aesthetasc; segment 18 with nine setae. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9(IX–XII). Maxilliped five-segmented (Figure 5D), similar to that of female but second segment with medial proximally directed thorn-like process. Leg 5 with protopodal segment incorporated into somite (Figure 5B), armed with smooth seta. Free segment bearing two barbed terminal setae and smooth subterminal seta; ornamented with rows of fine spinules.

Leg 6 forming large opercular plates closing off genital apertures (Figure 5B), armed with two setae, one plumose and one smooth, and ornamented with rows of fine spinules.

Etymology

The specific name *madeirensis* refers to Madeira Island where the species was collected.

Discussion

Although the precise antennule segmentation of some *Asterocheres* species is unknown due to its original description being either incomplete or based only on the male with the female unknown, *Asterocheres* is characterized as a genus with females possessing 18- to 21-segmented antennules. Boxshall & Huys (1994) considered seven *Asterocheres* species with 21-segmented antennules, including their new species *A. reginae* Boxshall & Huys, 1994. These species were: *A. suberitis* Giesbrecht, 1899, *A. violaceus* (Claus, 1889), *A. minutus* (Claus, 1889), *A. bulbosus* Malt, 1991, *A. jeanyeatmanae* Yeatman, 1970 and *A. tenuicornis* Brady, 1910 (according to Eiselt 1965). However, these authors overlooked *A. simulans* (T. Scott, 1898), which also has a 21-segmented antenule according to both Scott's (1898) illustrations and the redescription of this species made by Ivanenko (1997).

Since 1994, a further five species have been described with this antennule segmentation: *A. flustrae* Ivanenko & Smurov, 1997, the only *Asterocheres* found associated with a bryozoan (Ivanenko & Smurov 1997), *A. lunatus* Johnsson, 1998, associated with Brazilian sponges (Johnsson 1998a), *A. urabensis* Kim, 2004 hosted by a coral from the Pacific coast of Panama (Kim 2004), *A. hirsutus* Bandera et al., 2005, which lives in association with an Antarctic hexactinellid sponge (Bandera et al. 2005) and *A. astroidicola* Conradi et al., 2006 associated with a Mediterranean coral (Conradi et al. 2006). Two more species, *A. echinicola* (Norman, 1868) and *A. lilljeborgi* Boeck, 1859, are also included in the 21-segmented antennule group, as further studies of these species (see Boxshall & Huys 1998; Ivanenko & Ferrari 2003) found that they have one segment more than appeared in their original descriptions. Therefore, there are 15 *Asterocheres* species having a 21-segmented antennule in the female.

Asterocheres madeirensis differs from 12 of these 15 species (*A. astroidicola, A. echinicola, A. flustrae, A. hirsutus, A. jeanyeatmanae, A. lilljeborgi, A. lunatus, A. reginae, A. simulans, A. suberitis, A. tenuicornis, A. urabensis*) in the possession of a two-segmented mandibular palp, in contrast to the one-segmented mandibular palp present in the new species.

The setation formula of the maxillule separates *A. madeirensis* from *A. bulbosus*, as the new species possesses five setae in the endite and four setae in the palp, but *A. bulbosus* presents four setae in the endite and three setae in the palp.

Among the species with a 21-segmented antennule in the female group, *A. violaceus* and *A. minutus*, two sibling species, are the closest to the new species. However, a detailed comparison among these three species reveals a number of significant differences. Thus, compared with these two species, *A. madeirensis* has an additional seta in the third segment of the antennary endopod and one seta less in the exopod. The inner lobe of the maxillule is almost three times longer than the outer lobe in *A. madeirensis*, whereas it is about as long as the outer lobe in both *A. violaceus* and *A. minutus*. Furthermore, the longest seta of the outer lobe is three times longer than the others in *A. violaceus* and *A. minutus*, but is as long as the remaining setae in the new species.

Host

Although the genus *Asterocheres* has been found associated with many marine invertebrate phyla, nearly 56% of the known species have been found associated with sponges (Bandera et al. 2005). This is also the host phylum of the new species, as *A. madeirensis* was found in *Petrosia ficiformis*, a sponge with an Atlantic–Mediterranean distribution. Although there are no records of the presence of symbiotic *A. madeirensis* for the Mediterranean populations of *P. ficiformis*, the presence of symbionts is also possible. One of the sponges collected was the host of two males of *Acontiophorus* sp. as well as the new *Asterocheres* species described above.

Genus *Orecturus* Humes, 1992
Orecturus canariensis n. sp.
(Figure 6D–H, 7–10)

Material examined

Holotype female (MNCN 20.04/7788), allotype male (MNCN 20.04/7789), and paratypes, two females, (MNCN 20.04/7790) associated with the gorgonian *Villogorgia bebrycoides* (Koch, 1887), at Guadamojete Point, Tenerife, Canary Islands, 85 m depth, January 1997. BEIM (COP–508) paratypes, seven females and two males, with the same sampling data as the holotype.

Emended diagnosis of the genus

Asterocheridae. Prosome dorsoventrally flattened, expanded laterally. Anal somite elongated, longer than preceding somite. Antennule 16- to 20-segmented in female, 12- to 17-segmented in male. Antennary exopod one-segmented, bearing one very long seta, one short setule apically, and one lateral seta. Oral cone long, reaching from level of third pair of legs to genital somite. Mandible with slender needle-shaped masticatory blade and one-segmented palp bearing terminal setulose seta. Maxillule with one stout and setulose seta on inner lobe. Maxilla two-segmented; claw armed with one seta. Maxilliped sexually dimorphic. Formula of third endopodal segment of legs 1–4 as (1,2,3); (1,1+I,3); (1,I,3) and (1,I,2). Leg 5 placed ventrally, free segment bearing five elements.

Description

Adult female. Body cyclopiform, slender with oval cephalothorax and cylindrical urosome (Figure 7A, B). Mean body length 1043 μm (900–1114 μm) and greatest width 526 μm (450–600 μm), based on six specimens. Ratio of length to width of prosome 1.21:1. Ratio of length of prosome to that of urosome 2.4:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Epimeral areas of somites bearing legs 1–3 pointed (Figure 7A). Somite bearing leg 4 rounded laterally and much smaller than preceding somite. Dorsal cephalothoracic shield and tergites of free pedigerous somites ornamented with few integumental pores and sensilla. Urosome four-segmented comprising leg fifth pedigerous somite, genital double somite and two free abdominal somites. Somite bearing leg 5 (Figure 7C) wider than long, with some spinules on its lateral surface. Posterior margins of anal somite and caudal rami ornamented with hyaline frills with more or less serrated margins. Genital double somite approximately 1.8 times wider than long (width measured at small anterior rounded expansions), bearing genital apertures, paired gonopores located laterally (Figure 7C). Each genital area armed with one smooth seta. First postgenital somite wider than long, with no ornamentation. Elongated anal somite, more than four times as long as preceding somite, ornamented all round with large, flattened epicuticular scales, arranged in irregular, overlapping rows. Integumental pores and sensilla present on urosomal somites (Figure 6D, 7C).

Caudal rami slightly wider than long, ornamented with epicuticular scales, arranged in irregular overlapping rows. Armed with six setae; seta I absent, setae II and VII offset on to dorsal surface, placed near lateral margins of rami.

Antennule 20-segmented (Figure 7E, F); segmental fusion pattern as follows: 1(I), 2(II), 3(III–IV) 4(V), 5(VI), 6(VII), 7(VIII), 8(IX–XII), 9(XIII), 10(XIV), 11(XV), 12(XVI), 13(XVII), 14(XVIII), 15(XIX), 16(XX), 17(XXI), 18(XXII), 19(XXIII–XXIV), 20 (XXV–XXVIII). Segments 1 and 2 each with two setae; segment 3 with three setae; segments 4–7 each with two setae; segment 8 with eight setae; segments 9–16 each with two setae; segment 17 with two setae plus an aesthetasc; segment 18 with two setae; segment 19 with four setae and segment 20 with eight setae. Certain setae on segments 1 and 3 spinous, and some other setae with lateral setules that have an apical hollow (Figure 6E–F). Segment 9 (XIII) reduced, partly overlapped by distal expansion of compound segment 8 (IX–XII).

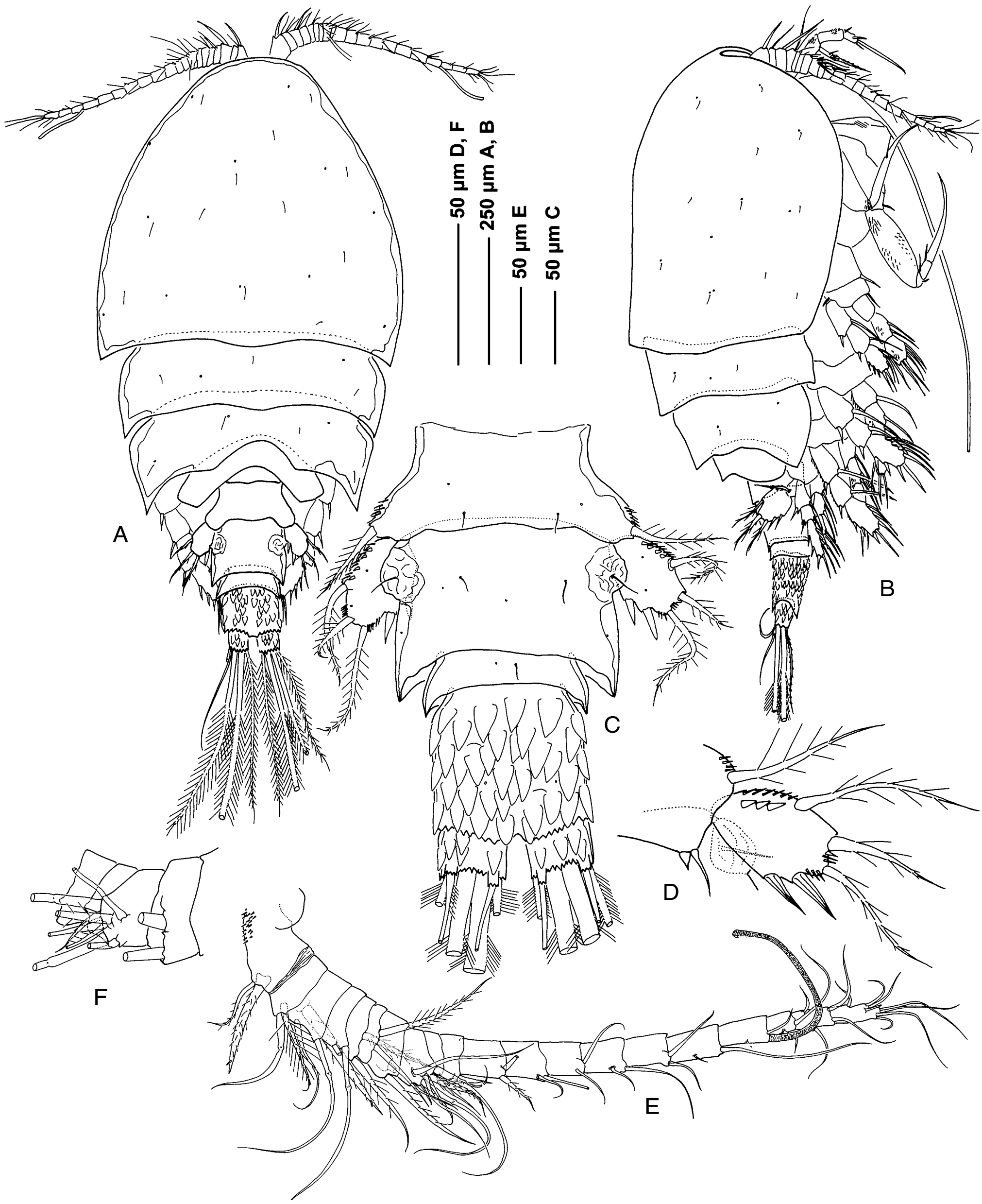

Figure 7. *Orecturus canariensis*, female. (A) Dorsal view. (B) Lateral view. (C) Urosome, dorsal view. (D) Leg 5. (E) Antennule. (F) Same, detail of compound segment IX–XII.

Antenna biramous (Figure 8A); 300 µm long, protopodal part comprising short unarmed coxa and elongated basis with patch of fine spinules on outer margin. Exopod one-segmented, slender, bearing small inner smooth seta and long terminal barbed seta, and having spinules along outer side and tuft of fine setules apically. Endopod two-segmented; first segment elongated, unarmed but ornamented with lateral and terminal rows of fine spinules; second segment ornamented with row of fine setules laterally and a row of fine spinules on terminal part, and bearing one smooth seta proximally, one plumose seta near midregion and one smooth seta distally. Large terminal claw.

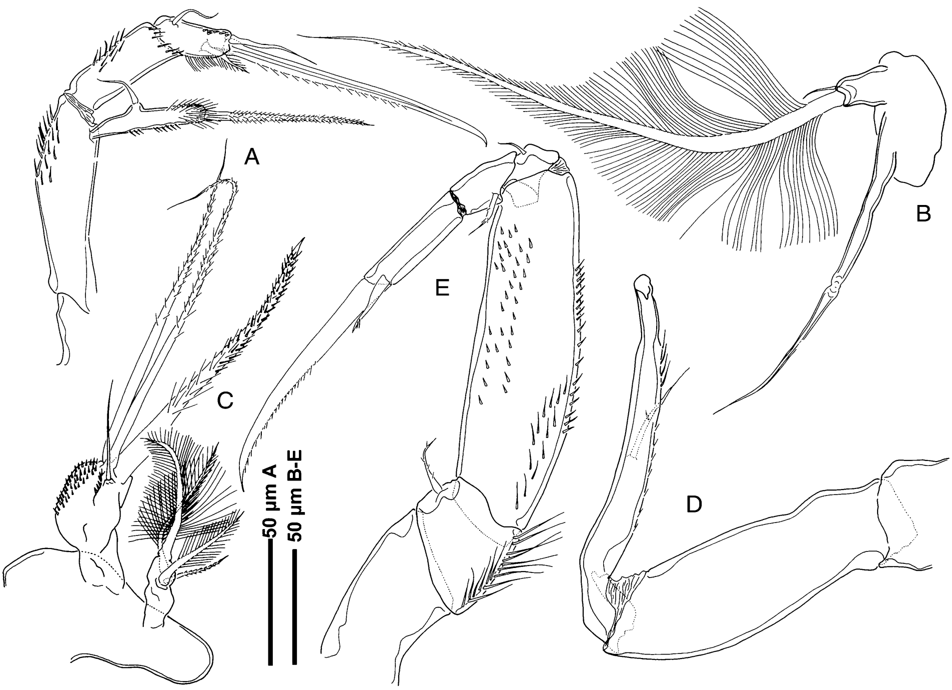

Figure 8. *Orecturus canariensis*, female. (A) Antenna. (B) Mandible. (C) Maxillule. (D) Maxilla. (E) Maxilliped.

Mandible comprising stylet-like gnathobase and short one-segmented palp (Figure 8B). Stylet slightly compressed approximately half its length. Palp bearing small smooth terminal seta and very long feathered apical seta. Oral cone long and slender, 750 µm long, reaching nearly anterior edge of genital segment (Figure 7B).

Maxillule bilobed (Figure 8C); praecoxal endite larger than palp. Endite ornamented with patch of spinules laterally and row of spinules medially and armed with four distal setae: three very long – two barbed (Figure 6G–H) and one with spinules terminally and setules proximally – and one smooth and short. Palp armed with four setae on distal part, three long and plumose, one of them densely plumose, and one shorter and barbed.

Maxilla two-segmented (Figure 8D); with unarmed praecoxa and coxa. Claw-like basis with recurved tip and armed with smooth seta at half its length; distal margin of claw provided with row of minute spinules and few setules distally.

Maxilliped five-segmented with unarmed pedestal arising from the ventral body wall (Figure 8E). First segment, short with minute plumose inner seta and rows of long setules on outer margin. Second segment elongated and unarmed but ornamented with rows of minute setules on outer margin and rows of small spinules on surface close to the inner margin. Segments 3, 4 and 5 forming part of distal subchela. Third segment armed with small smooth outer seta; fourth segment with slightly plumose inner seta, and fifth segment with apical seta with two minute spinules distally. Long terminal claw with minute setules on inner margin.

Swimming legs 1–4 biramous (Figure 9A–D), with three-segmented rami. Intercoxal sclerite present in legs 1–4, ornamented with pair of processes only in leg 1. Table II shows the spine and seta formulae of all legs.

Coxae ornamented with spinule rows laterally in legs 1 and 2. Outer spines of exopodal segments bilaterally serrated in leg 1 and smooth in legs 2–4, except for those of first segment in legs 2 and 3. Fringed spines on first exopodal segment of legs 1 and 2, on exopodal segments of leg 3 and on terminal segments of endopod and exopod of leg 4. Apical elements of legs 3 and 4 rounded at their base. Endopodal segments of legs 1 and 2 with minute spinules. Lateral margins of exopodal segments with minute serrations; lateral margins of endopodal segments, except for leg 4 which is serrated, with row of setules.

Leg 5 with protopodal segment incorporated into somite (Figure 7D), ornamented with rows of fine

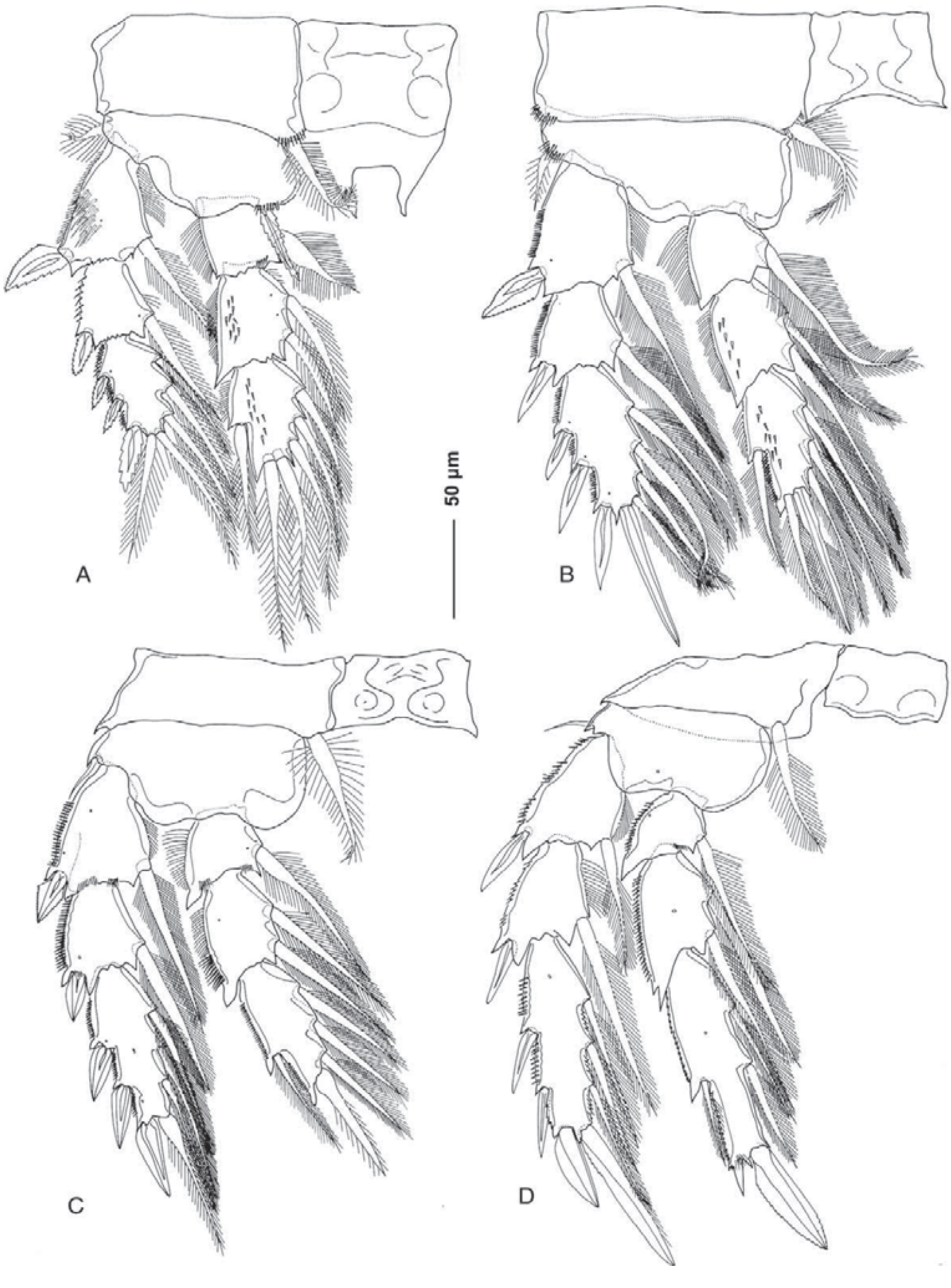

Figure 9. *Orecturus canariensis*, female. (A) Leg 1. (B) Leg 2. (C) Leg 3. (D) Leg 4.

setules laterally and armed with plumose seta located dorsally and two triangular inner lobes each armed with smooth seta and spine. Exopod oval, placed ventrally, ornamented with spinules and fine setules dorsally and armed with three outer plumose setae and two inner spines.

Leg 6 represented by paired opercular plates closing off gonopores on genital double somite; armed with smooth seta (Figure 7A, C).

Adult male. Body cyclopiform, slender with cephalothorax oval and cylindrical urosome (Figure 10A).

Table II. *Orecturus canariensis*, female, formula for armature of legs 1–4.

	Coxa	Basis	Exopodal segments	Endopodal segments
Leg 1	0–1	1–I	I–1; I–1; III,2,3	0–1; 0–2; 1,2,3
Leg 2	0–1	1–0	I–1; I–1; III,I,4	0–1; 0,2; 1,1+I,3
Leg 3	0–1	1–0	I–1; I–1; II,I,4	0–1; 0–2; 1,1,3
Leg 4	0–1	1–0	I–1; I–1; II,II,3	0–1; 0–2; 1,I,2

Mean body length 695 μm (690–700 μm) and greatest width 350 μm (345–355 μm), based on two specimens. Ratio of length to width of prosome 1.44:1. Ratio of length of prosome to that of urosome 2.78:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Epimeral areas of somites bearing legs 1–4 pointed. Somite bearing leg 4 much smaller than preceding somite. Dorsal surface without visible sensilla.

Urosome five-segmented comprising leg fifth pedigerous somite, genital somite and three free abdominal somites. Somite bearing leg 5 wider than long, with some spinules on its lateral surface (Figure 10B). Posterior margins of anal somite and caudal rami ornamented with hyaline frills with more or less serrated margins. First and second postgenital somites wider than long, with no ornamentation. Elongated anal somite, ornamented with large, flattened epicuticular scales, arranged in irregular, overlapping rows.

Caudal rami slightly wider than long, ornamented dorsally with epicuticular scales, arranged in irregular, overlapping rows. Armed with six setae; seta I absent, setae II and VII offset on to dorsal surface, placed near lateral margins of rami. Appendages as for female except antennules, maxillipeds and fourth, fifth and sixth legs.

Antennule 17-segmented (Figure 10C), geniculate; segmental fusion pattern as follows: 1(I), 2(II), 3(III–IV), 4(V), 5(VI), 6(VII), 7(VIII), 8(IX–XII), 9(XIII), 10(XIV), 11(XV), 12(XVI–XVII), 13(XVIII–XIX),

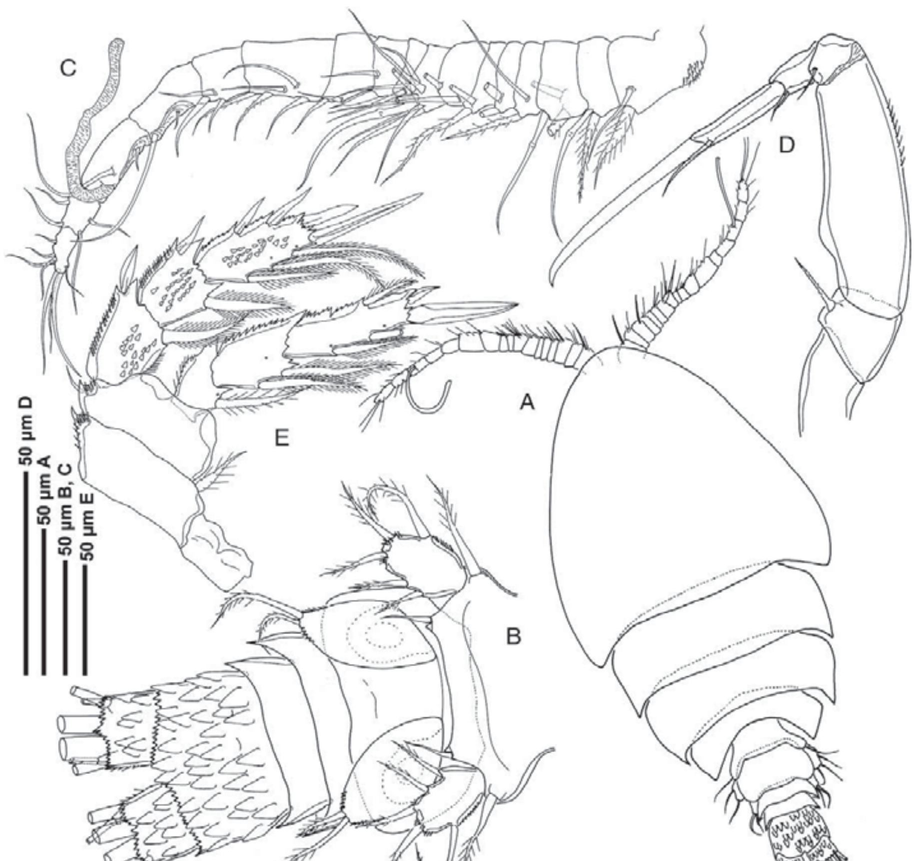

Figure 10. *Orecturus canariensis*, male. (A) Dorsal view. (B) Urosome, dorsal view. (C) Antennule. (D) Maxilliped. (E) Leg 1.

14(XX), 15(XXI–XXIII), 16(XXIV–XXV), 17 (XXVI–XXVIII). Geniculation located between segments 14(XX) and 15(XXI–XXIII). Segments 1 and 2 each with two setae; segment 3 with three setae; segments 4–7 each with two setae; segment 8 with eight setae; segments 9–11 each with two setae; segment 12 with five setae; segment 13 with three setae; segment 14 with two setae; segment 15 with two setae plus one aesthetasc; segment 16 with four setae; segment 17 with eight setae. Segment 9(XIII) reduced, partly overlapped by distal expansion of compound segment 8(IX–XII).

Maxilliped five-segmented with unarmed pedestal arising from the ventral body wall (Figure 10D). First segment, short with plumose inner seta. Second segment showing sexual dimorphism in having pronounced lobe on inner side; elongated and unarmed but ornamented with row of minute setules on outer margin. Segments 3, 4 and 5 forming part of distal subchela. Third segment armed with small smooth inner seta; fourth segment with smooth inner seta, and fifth segment with one apical smooth seta. Long terminal claw.

Leg 4 biramous (Figure 10E), with three-segmented rami. Intercoxal sclerite present. Coxa armed with plumose inner seta and ornamented with setule rows laterally. Basis unarmed but ornamented with few setules. Exopodal segments ornamented with minute flattened, epicuticular scales, arranged in irregular rows. Lateral margins of endopodal and exopodal segments with minute serrations. Spine and seta formula as follows: exopodal segments with I–1;I–1;II,II,3 and endopodal segments with 0–1;0–2;1,II,2.

Leg 5 with protopodal segment incorporated into somite (Figure 10B), with outer plumose seta located ventrally and two triangular inner lobes each armed with smooth seta and spine; exopod oval, placed ventrally, ornamented with fine setules and armed with five plumose setae.

Leg 6 forming large opercular plates closing off genital apertures (Figure 10B), armed with two plumose unequal setae and ornamented with fine setules.

Etymology

The specific name *canariensis* refers to the Canary Islands where the species was collected.

Discussion

Since Humes erected the genus *Orecturus* in 1992, 10 new species have been described. In order to accommodate some of these new species, the original diagnosis of the genus has been slightly modified. Thus, the segmentation of the antennule in the *Orecturus* females was enlarged to 16 or 17 segments to include *O. bahiensis* Johnsson, 1998 (Johnsson 1998b). The variability of this appendage has to be enlarged again to include the new species here described, *O. canariensis*, which has a 20-segmented antennule. The length of the oral cone within the genus is also variable. Although most species have a siphon that extends up to the intercoxal plate of leg 3, there are some exceptions, such as *O. forticulus* Humes, 1993, which possesses the shortest siphon of the genus (it only reaches to leg 1), and *O. finitimus* Humes, 1993, which has a much longer siphon, reaching to leg 5 (Humes 1993). However, *O. canariensis* becomes the *Orecturus* species with the longest siphon, as it extends beyond leg 5, reaching to the genital segment.

Most species of the genus *Orecturus*, like many asterocherid genera, have the protopod of leg 5 fully incorporated into the somite and represented by a single outer seta (Huys & Boxshall 1991; Boxshall & Halsey 2004). However, the new species together with three previously described species: *O. bahiensis*, *O. grandisetiger* Humes, 1992, and *O. sakalavicus* Humes, 1994 present an expansion, commonly triangular, in the protopod as a reminiscence of the fusion between the protopod and the somite. Among these four species, *O. bahiensis* and *O. canariensis* have a small inner seta on the protopod as a vestigial endopod. This endopod is not represented, as in the majority of siphonostomatoids, in other *Orecturus* species. This plesiomorphic characteristic, although unusual in *Orecturus* species, is not unique among the asterocherid genera, as some of them, such as *Acontiophorus* Brady, 1880, *Dermatomyzon* Claus, 1889, *Paracontiophorus* Eiselt, 1961 and *Scottocheres* Giesbrecht, 1897, have a small inner seta on the protopod representing the endopod (Huys & Boxshall 1991). The genus *Laperocheres* Ivanenko, 1998 has the protopod partially fused with the somite (Ivanenko 1998) and some asterocherid genera, such as *Collocheres* Canu, 1893, *Collocherides* Stock, 1971, *Cheramomyzon* Humes, 1989, *Dermatomyzon* and *Glyptocheres* Humes, 1987 have a clearly differentiated protopod (Claus 1889; Canu 1893; Stock 1971; Humes 1987, 1989). Therefore, there is a tendency towards fusion of the protopod of leg 5 and the somite bearing this in different asterocherid genera, which may imply convergent evolution.

The distinctive features of the new species, *O. canariensis*, are: 20-segmented antennule; oral cone reaching nearly the anterior edge of the genital segment; basis of legs 2–4 unarmed; protopodal segment of leg 5 with one inner seta and spine.

Host

The gorgonian *Villogorgia bebrycoides* is known to occur in both the Mediterranean and the eastern Atlantic coasts, between 63 and 700 m (Grasshoff 1977). In the Canary Islands, *V. bebrycoides* colonizes hard bottoms with corals, the axes of other gorgonians, rocks, shell masses and, less frequently, unstable detritic bottoms. It is particularly common in the orange coral, *Dendrophyllia ramea* (Linné, 1758) assemblage (Arístegui et al. 1987). The gorgonian *Paramuricea grayi* (Johnson, 1861) also occurs in the same assemblages as the infested colonies of *V. bebrycoides* (Martin et al. 2002). However, no specimens of asterocherid copepods were found on these colonies. Thus, *O. canariensis* may be a monoxenous symbiont. The colonies of *V. bebrycoides* harboured an abundant associated epifauna, including both mobile and sedentary species. Among them are the bivalve *Pteria hirundo* (Linné, 1758), the syllids *Grubeosyllis limbata* (Claparède, 1868), *Eusyllis lamelligera* Marion & Bobretzki, 1875, *Haplosyllis villogorgicola* Martin, Nuñez, Riera & Gil, 2002, the amphipod *Caprella aequilibra* Say, 1818 and several harpacticoid copepods (Martin et al. 2002). There are no records of the presence of *Orecturus* for the Mediterranean populations of *V. bebrycoides*, although the presence of this symbiont is also possible.

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Artículo IV

Proposal of new genus for *Asterocheres mucronipes* Stock, 1960 (Copepoda, Siphonostomatoida, Asterocheridae), an associate of the scleractinian coral *Astroides calycularis* (Pallas, 1766) in the Strait of Gibraltar.

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Proposal of new genus for *Asterocheres mucronipes* Stock, 1960 (Copepoda, Siphonostomatoida, Asterocheridae), an associate of the scleractinian coral *Astroides calycularis* (Pallas, 1766) in the Strait of Gibraltar

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A new genus of Asterocheridae (Copepoda: Siphonostomatoida) ***Stockmyzon*** **gen. nov.** is proposed for *Asterocheres mucronipes* Stock, 1960, and a new, previously misidentified, species ***Stockmyzon crassus*** **sp. nov.** from sponge washings in Mauritius. ***Stockmyzon*** **gen. nov.** can be differentiated from other asterocherid genera by the annulated mandibular stylet, the atrophied maxillulary palp with large modified lateral seta, the presence of beak-shaped processes on the endopods of legs 1, and the transformation of the outer spine on the first exopodal segment of leg 4 into a seta. ***Stockmyzon mucronipes*** **comb. nov.** is the fourth copepod known to utilize the hermatypic coral *Astroides calycularis* (Pallas, 1766) as its host in the Strait of Gibraltar. A reinterpretation of the original description of *Asterocheres stimulans* Giesbrecht, 1897 from Naples revealed that it was based on an amalgam of two diffent species, the male being conspecific with *S. mucronipes*; the illustrated female is formally designated here as the lectotype of *A. stimulans*. The current symbiotic relationship between *S. mucronipes* and the gorgonian *Eunicella singularis* (Esper, 1794) along the French mediterranean coast is reviewed in the light of potential host switching, following the extinction of *A. calycularis* in the north-western Mediterranean, north of 40°N, during the late Sicilian regression (Rissian age), about 238 000–225 000 years ago.

ADDITIONAL KEYWORDS: glaciation – scanning electron microscopy – Scleractinia – symbiosis – taxonomy.

INTRODUCTION

Siphonostomatoid copepods are almost exclusively symbiotic, and utilize a wide range of invertebrate and vertebrate hosts all around the world (Gotto, 1979; Ho, 1982; Humes, 1993; Humes, 1996; Ivanenko & Smurov, 1997; Kim, 1998; Boxshall & Halsey, 2004). Those that live as external or internal symbionts of marine invertebrates primarily utilize sponges, cnidarians, echinoderms, bryozoans, molluscs, and ascidians, but for many members of the families Asterocheridae and Artotrogidae the hosts are still unknown. Substantial gaps remain in our knowledge of symbiotic copepods, even in areas where marine invertebrates have been the subject of comprehensive investigation. For example, in European waters siphonostomatoids are most commonly reported from sponges, but documented associations with scleractinian corals are scarce. This conceivably reflects sampling bias rather than host-phylum preference. Five years ago, an ongoing programme on the biology of the hermatypic scleractinian *Astroides calycularis* (Pallas, 1766) was initiated around Tarifa Island (Strait of Gibraltar), where it represents the most important macrobenthic organism in shallow waters. Although there were no previous records of

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copepods inhabiting *A. calycularis*, this coral species turned out to be the host of a variety of symbiotic copepods, reinforcing Humes's (1994) hypothesis that virtually any marine macroinvertebrate is a potential host to copepods. Recently, Conradi, Bandera & López-González (2006) described two new species, *Doridicola helmuti* (Rhynchomolgidae) and *Asterocheres astroidicola* (Asterocheridae), and listed the first record of *Acontiophorus scutatus* (Brady & Robertson, 1873) from this coral host. Here, we describe another new asterocherid that exhibits similarities with members of the genus *Asterocheres*, but also displays some important differences. Comparison of the nearly 70 species currently assigned to the genus revealed that one species, *Asterocheres mucronipes* Stock, 1960, was morphologically very similar to the specimens recovered from the *Astroides* colonies. Stock's (1960) description was based on four females obtained from washings of the gorgonian *Eunicella verrucosa* (Pallas, 1766), found at a depth of 30 m near Cap Béar along the French mediterranean coast (Roussillon). In a later paper, Stock (1966) emended the description based on 19 females in washings of an orange sponge, possibly a species of *Oscarella* Vosmaer, 1884, from Mauritius. Stock (1966) also corrected the identification of the Roussillon host to *Eunicella stricta* (Bertoloni, 1810), but the latter is now generally regarded as a junior synonym of the white seafan *Eunicella singularis* (Esper, 1794) (cf. Weinberg, 1976, 1978). A re-examination of Stock's (1960) type material of *Asterocheres mucronipes* in the Zoological Museum of Amsterdam proved that the specimens from Tarifa were conspecific with the Roussillon population. Contrary to Stock's (1966) opinion, the material from Mauritius differed significantly from both Mediterranean populations, justifying the proposal of a new species. In this paper we establish a new genus, ***Stockmyzon***, to accommodate the type species *Stockmyzon mucronipes* (Stock, 1960) comb. nov., and a new species *Stockmyzon crassus* sp. nov. is proposed for Stock's (1966) specimens from Mauritius; detailed descriptions of both species are presented.

MATERIAL AND METHODS

Colonies of *A. calycularis* were individually collected by SCUBA diving at Tarifa Island, and were immediately isolated in separate plastic bags containing a solution of 8–10% formaldehyde in seawater. Symbiotic fauna was obtained by pouring the wash water through a 100-μm net. Copepods were extracted from the filtrate and preserved in 70% ethanol.

Selected specimens were dissected in lactic acid and examined as temporary mounts in lactophenol. For scanning electron microscopy, a specimen of each species was dehydrated in a graded series of ethanol, critical-point dried, mounted on stubs, coated with a gold–palladium alloy, and examined in a Phillips XL30 SEM. All figures were drawn with the aid of a camera lucida mounted on a Zeiss Axioskop differential interference contrast microscope. All appendage segments and setation elements are named and numbered using the terminology introduced by Huys & Boxshall (1991).

Material from Tarifa was deposited in the Zoological Museum of Amsterdam (ZMA), and in the collection of the research team Biodiversidad y Ecología de Invertebrados Marinos of the University of Seville (BEIM).

SYSTEMATICS

ORDER SIPHONOSTOMATOIDA BURMEISTER, 1835
FAMILY ASTEROCHERIDAE GIESBRECHT, 1899
GENUS ***STOCKMYZON*** GEN. NOV.

Diagnosis: Asterocheridae. Body: cyclopiform, comprising dorsoventrally flattened prosome and cylindrical urosome. Siphon of medium size, reaching to or slightly beyond rear margin of cephalothorax. Sexual dimorphism present in prosome width, urosomal segmentation, antennules, maxillipeds, and leg 6.

Urosome: four-segmented in female; five-segmented in male. Antennule: 20-segmented in female, with large aesthetasc on segment 18; 18-segmented in male, with large aesthetasc on segment 17 and geniculation located between segments 16 and 17. Antenna: with large one-segmented exopod and three-segmented endopod with terminal claw. Mandibular palp: two-segmented, second segment with two plumose setae; stylet with annulation in middle part and denticulate margin subapically. Maxillule: bilobed, with a rectangular praecoxal endite, and atrophied palp bearing large characteristically plumose seta and two or three accessory setae. Maxilla: two-segmented, with aesthetasc-like tubular extension on praecoxal portion of syncoxa, and a claw-like basis recurved towards the apex. Maxilliped: comprising short syncoxa, long basis, and three-segmented endopod; male basis with spinous process close to syncoxa–basis joint. Legs 1–4: biramous with three-segmented rami; middle and distal endopodal segments with beak-shaped spiniform processes. Outer element on proximal exopodal segment of leg 4: setiform. Leg 5: with protopod incorporated into somite (represented by dorsal surface seta) and one-segmented exopod bearing three setae.

Etymology: The genus is named in honour of the late Prof. Jan Hendrik Stock (Zoölogisch Museum, Amsterdam) who described its type species. The

Greek suffix -*myzon* (μυζώ), meaning to suck, is commonly used in the formation of siphonostomatoid generic names, and refers to the sucking oral cone or siphon. Gender: male.

Type species: Asterocheres mucronipes Stock, 1960 = *Stockmyzon mucronipes* (Stock, 1960) comb. nov.

Other species: Stockmyzon crassus sp. nov.

Remarks
Stock (1960) placed his new species *A. mucronipes* in *Asterocheres*, but expressed some reservations about his generic assignment. Although he recognized a superficial similarity in the enlarged prosome with some other *Asterocheres* species, such as *Asterocheres lilljeborgi* Boeck, 1859 and *Asterocheres ovalis* Sewell, 1949, certain other characters exhibited by *A. mucronipes* were considered more significant and potentially of 'valeur générique'. In particular, Stock (1960) mentioned the characteristic endopodal spinous processes on legs 1–4, the unusual armature of leg 4 (proximal exopod segment with outer seta), the 'biarticulated' mandibular stylet, and the presence of only two setae (instead of four) on the maxillulary palp, one of which being enlarged ('aspect gonflé'). Stock also noted that the male of *Asterocheres stimulans* Giesbrecht, 1897 has similar spinous processes on legs 1–4 (Giesbrecht, 1899: plate 3). He also claimed that the maxillulary palp of *Asterocheres canui* Giesbrecht, 1897 [= *A. lilljeborgi sensu* Canu (1892); cf. Giesbrecht (1897): 11)] displays a transitionary state, between the typical *Asterocheres* condition and that in *A. mucronipes*, having retained the typical number of four terminal setae, with one of them being gonflate. Based on these observations, Stock (1960) maintained a tentative assignment of *A. mucronipes* to *Asterocheres* was warranted. However, our reinterpretation of Giesbrecht's (1899) illustrations of male *A. stimulans* revealed that it is conspecific with *A. mucronipes* (see the Discussion), and comparison of Canu's (1892) figure of the maxillule showed it to be quite different from the *A. mucronipes* condition, but remarkably similar to that of other typical *Asterocheres* species, such as *Asterocheres reginae* Boxshall & Huys, 1994 (Boxshall & Huys, 1994: fig. 3F). The palp in *A. canui* is not atrophied, and the lateral seta is not enlarged, excessively plumose, or typically recurved and concealed under the gnathobasal endite, as it is in *A. mucronipes*.

Although *A. mucronipes* resembles species of *Asterocheres* in several aspects, such as the long, multisegmented antennule, the antenna with one-segmented exopod and three-segmented endopod, the segmentation of the maxilla and maxilliped, and the one-segmented leg 5 bearing three setae, it differs in a number of characters, warranting the proposal of a new genus.

The mandible of *Stockmyzon* has a two-segmented palp, which is shared by over two-thirds of the species of *Asterocheres*; however, none of these exhibits the distinctly annulated stylet. This character is regarded here as an autapomorphy of the new genus. In some asterocherids the mandibular stylet shows a thinning of the cuticle halfway along its length, but never a strong annulation. Johnsson (1998) illustrated a long 'segmented' stylet in his description of *Asterocheres crenulatus* Johnsson, 1998, but a re-examination of a female paratype (NHM reg. no. 1997.185) revealed this to be an observational error, possibly as a result of excessive squashing during the mounting process.

The bilobate maxillule of *Stockmyzon* is unique in its marked size disparity between the outer (palp) and the inner lobe (gnathobase). The palp is atrophied and has two or three small setae, in addition to a large, densely plumose lateral seta. Furthermore, within the Asterocheridae a somewhat similar condition is only found in *Acontiophorus* Brady, 1880 (e.g. Kim & Je, 2000), but this genus represents a completely different lineage in the family, deviating from all others in the morphology of the antennule, antenna, and mandible. The primitive leg 5 and swimming leg armature formula also indicate a very basal position in the Asterocheridae.

The spine and seta formula of the swimming legs in the new genus is similar to that of *Asterocheres*, except for leg 4, which has an outer seta on the first exopodal segment in *Stockmyzon*, instead of an outer spine. The transformation of this element into a seta is a unique apomorphy within the Asterocheridae. A similar transformation on the basis of leg 1 (seta replaced by spine) in *A. crenulatus* and *Asterocheres spinopaulos* Johnsson, 1998 [and three other species described by Johnsson (1998)] was recently considered potential justification for their removal to a distinct genus (Kim, 2004b).

Perhaps the most conspicuous feature of *Stockmyzon* is the presence of large beak-shaped spiniform processes on the endopodal segments of legs 1–4. This character has been recorded in some genera previously allocated to the Coralliomyzontidae (e.g. Humes & Stock, 1991; Humes, 1997), which coincidently also utilize scleractinian corals as hosts. Within the speciose genus *Asterocheres*, currently encompassing 67 valid species (Kim, 2004a, b, 2005; Bandera, Conradi & López-González, 2005; Bispo, Johnsson & Neves, 2006; Conradi *et al*., 2006), only *Asterocheres tubiporae* Kim, 2004 exhibits similar modifications on leg 1. In every other aspect this species is a typical representative of the genus *Asterocheres*, and consequently the spinous processes on the leg-1 endopod are likely to have resulted from convergence. Also note that Kim (2004b) erroneously described and illustrated the female antennule of *A. tubiporae* as 22-segmented; no other extant siphonostomatoid has more than 21 segments. Comparison with *A. reginae* (Boxshall & Huys, 1994: fig. 3A–E) suggests Kim (2004b) had inadvertently intercalated a supernumerary segment between the spine-bearing segment XIV and the aesthetasc-bearing segment XXI.

Stockmyzon is related to a group of genera that exhibit a tubular extension of the opening of the maxillary gland. Although some reports have suggested that this character may be widely distributed within the Asterocheridae (Boxshall & Huys, 1994), it has thus far been found only in *Asterocheres* (e.g. Ho, 1984; Boxshall & Huys, 1994; Ivanenko & Smurov, 1997; Ivanenko, 1997; Kim, 2004a, b), *Inermocheres* Boxshall, 1990 and *Sinopontius* Boxshall, 1990 (Boxshall, 1990), *Dermatomyzon* Claus, 1889 (Ivanenko & Ferrari, 2003), and, to a lesser extent, *Laperocheres* Ivanenko, 1998.

STOCKMYZON MUCRONIPES (STOCK, 1960) **COMB. NOV.**

Synonyms: Asterocheres mucronipes Stock, 1960; *Asterocheres stimulans* Giesbrecht, 1897 (♂ only; see the Discussion).

Original description: Stock (1960: 224–228, figs 4, 5).

Type locality: France, Roussillon; off Cap Béar (near Banyuls-sur-Mer); washings of *E. singularis* collected at a depth of 30 m.

Material examined: (a) Holotype female and one paratype female (deposited in ZMA) from type locality; collected by J.H. Stock, 17 June 1959; (b) five females and nine males (deposited in ZMA) associated with *A. calycularis* off Tarifa Island (southern Spain) at a depth of 10–20 m; collected September 1999, by SCUBA diving; (c) additional specimens from Tarifa Island deposited in BEIM.

Description

Female: Body (Fig. 1A–B): cyclopiform, consisting of dorsoventrally flattened prosome and cylindrical urosome. Total length from anterior margin of rostrum to posterior margin of caudal rami, 603 μm; maximum width, 465 μm measured at 4/5 length of cephalothorax. Prosome: comprising cephalothorax (fully incorporating first pedigerous somite) and three free pedigerous somites. Cephalothorax (Fig. 1B) with posterolateral angles produced into backwardly directed processes. Rostrum completely fused to cephalothorax, forming triangular ventrally deflected lobe. Somites bearing legs 2–3, broad; epimeral areas with posterolateral angles rounded (leg 2) or pointed (leg 3) (Fig. 1B). Somite bearing leg 4: much smaller and narrower than preceding ones. Dorsal cephalothoracic shield and free pedigerous somites ornamented with numerous integumental pores and sensilla.

Urosome: four-segmented, comprising leg-5-bearing somite, genital double somite, and two free abdominal somites. Except for leg-5-bearing somite, all other urosomites ornamented with large, flattened epicuticular scales, arranged in irregular overlapping pattern dorsally (Fig. 1D) and ventrally (not shown in Fig. 1C); scales occasionally with incised distal margin. Posterior hyaline frills of urosomites with serrate free margins (Fig. 1C). Leg-5-bearing somite: narrow, largely concealed under pleurotergite of leg-4-bearing somite. Genital double somite (Fig. 1C–D): laterally produced; about 1.65 times wider than long; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore (oviduct opening); lateral margins with setular tufts in distal third (posterior to genital apertures).

Caudal rami (Fig. 1C–D): about as long as wide (measured along outer margin); trapezoid with inner margin much shorter than outer one; entirely covered by overlapping epicuticular scales; armed with six setae; seta I absent, setae II–VII all arranged around posterior margin, with setae II and VII slightly displaced onto dorsal surface.

Antennule (Fig. 1E–G): 20-segmented, about 250-μm long, lengths of segments (measured along posterior nonsetiferous margin) 16 (30-μm along anterior margin), 7, 8, 8, 7, 7, 6, 11, 11, 1, 7, 13, 16, 14, 14, 13, 13, 13, 8, and 14 μm, respectively. Segmental fusion pattern as follows (Roman numerals indicating ancestral segments): 1(I), 2(II), 3(III), 4(IV), 5(V), 6(VI), 7(VII), 8(VIII), 9(IX–XII), 10(XIII), 11(XIV), 12(XV), 13(XVI), 14(XVII), 15(XVIII), 16(XIX), 17(XX), 18(XXI), 19(XXII–XXIII), 20(XXIV–XXVIII). Segments 1–8, each with two setae, one of which is plumose; segment 9, with seven setae and a small spine; segments 10–11, each with one seta and one small spine at anterodistal corner; segments 12–17, each with two setae; segment 18, with two setae plus an aesthetasc; segment 19, with one anterior, one ventral, and one posterior seta; segment 20, with ten setae (Fig. 1G). Segment 10(XIII): reduced, forming incomplete sclerite, partly overlapped by distal expansion of compound segment 9(IX–XII) (Fig. 1F).

Antenna (Fig. 2A–B): biramous. Coxa unarmed, with few spinules. Basis unarmed, with fine spinule rows as shown in Figure 2A. Exopod: one-segmented, slender, about 2/5 length of proximal endopod segment; with one small lateral seta and two terminal setae. Endopod: three-segmented; proximal segment

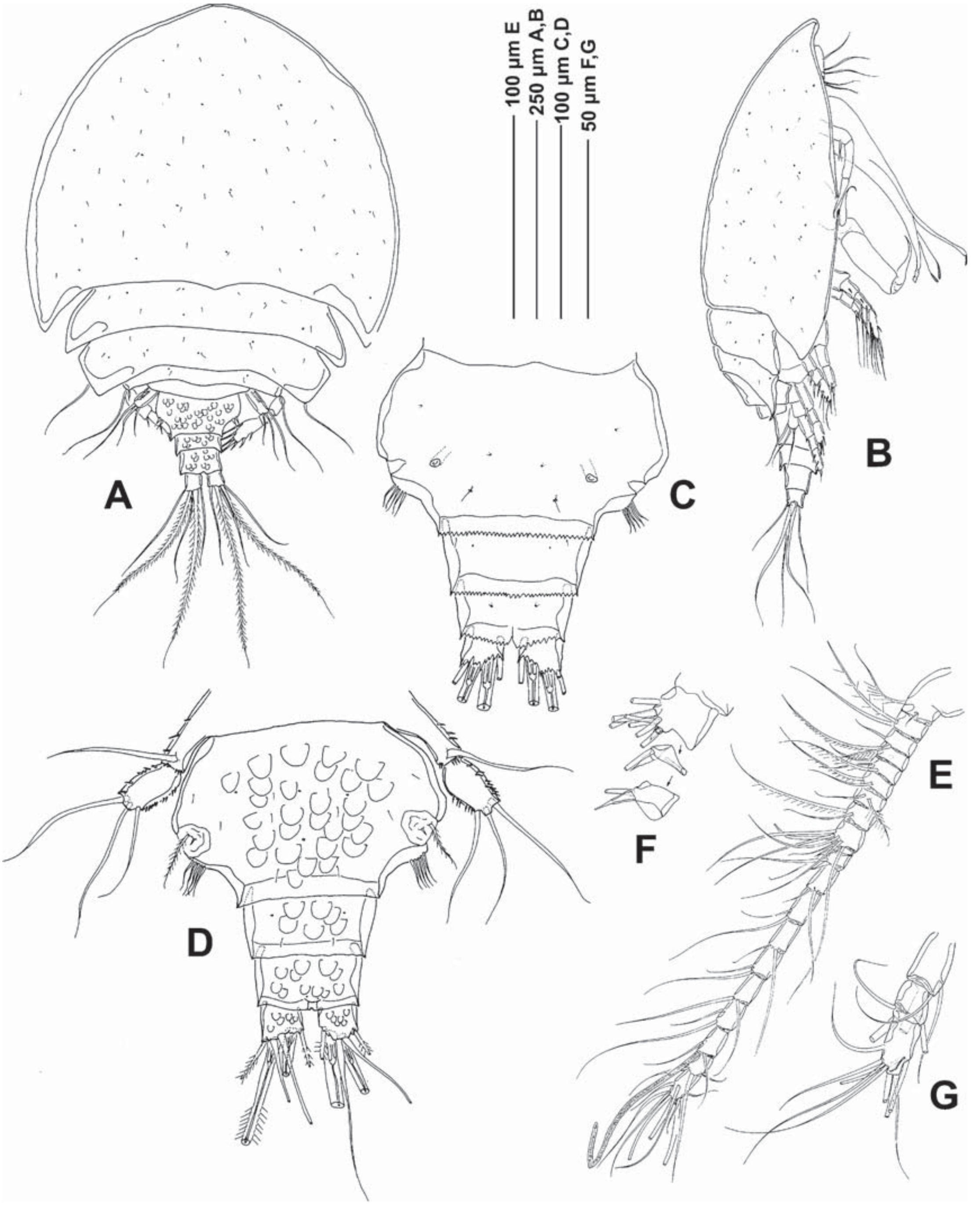

Figure 1. ***Stockmyzon mucronipes*** (Stock, 1960) **comb. nov.** (female). A, habitus, dorsal; B, habitus, lateral; C, urosome (excluding leg-5-bearing somite), ventral; D, urosome, dorsal; E, antennule, ventral; F, detail of antennulary segments IX–XII, XIII, and XIV; G, detail of antennulary segments XXI, XXII–XXIII, and XXIV–XXVIII.

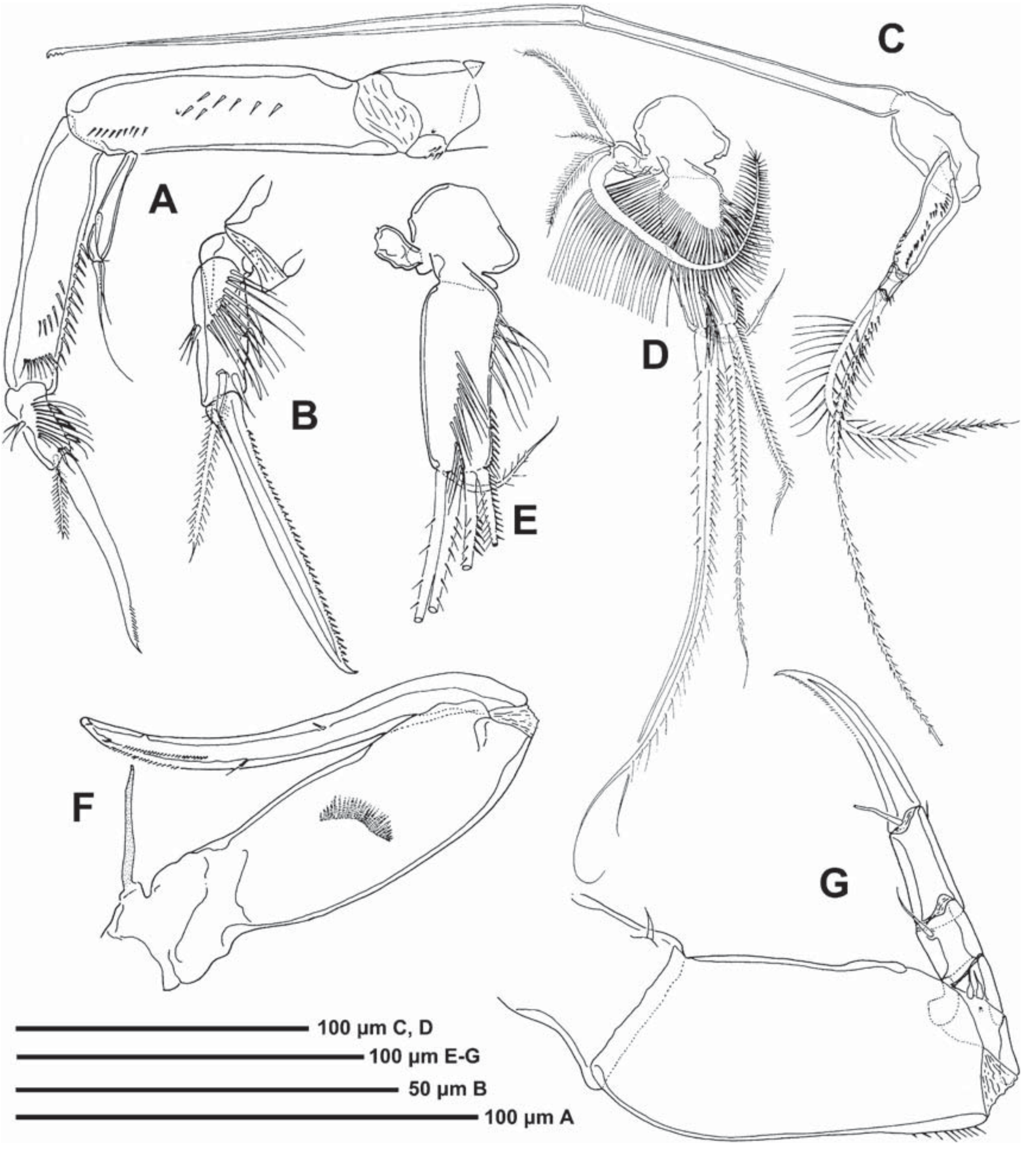

Figure 2. ***Stockmyzon mucronipes*** (Stock, 1960) **comb. nov.** (female). A, antenna; B, detail of second and third endopodal segments of antenna; C, mandible; D, maxillule, dorsal (posterior); E, detail of praecoxal gnathobase of maxillule, dorsal (posterior); F, maxilla; G, maxilliped.

elongated, ornamented with lateral and distal rows of fine spinules, as illustrated; middle segment produced distally on medial side, but articulating with distal segment proximally on lateral side (Fig. 2B), bearing one distal seta; distal segment with large distal claw, one well-developed pinnate seta, and two short, smooth setae; outer margin of distal segment with few coarse spinules and surface with long setules.

Siphon (Figs 3B, D): long and slender, reaching nearly to the posterior margin of the intercoxal sclerite of leg 2 (Fig. 1B).

Mandible (Fig. 2C): comprising stylet-like gnathobase and slender two-segmented palp. Proximal segment of palp: longest, ornamented with rows of spinules; distal segment minute, with two plumose, unequal apical setae. Stylet located in oral cone, formed by anterior labrum and posterior labium (Fig. 3D). Stylet: with annulation (not a genuine articulation) at about halfway along its length; basal part relatively more chitinized, distal part flexible with denticulate margin subapically (Fig. 3D).

Maxillule (Figs 2D–E, 3E): bilobed; praecoxal gnathobase (inner lobe) distinctly larger than palp (outer lobe). Praecoxal endite: rectangular, ornamented with long setules proximally and spinules distally on the lateral margin, and with a row of long setules medially (Fig. 2E); armed with one short and four long but unequal setae, latter ornamented with short spinules proximally and setules distally. Palp strongly reduced, atrophied, with one elongate strongly plumose (Fig. 3E) and three shorter pinnate setae.

Maxilla (Fig. 2F): two-segmented, but with partial transverse surface suture on syncoxa (proximal segment), possibly marking the plane of the praecoxa–coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland; coxal portion unarmed, but ornamented with a row of spinules medially. Basis: claw-like, more or less straight, but recurved towards the apex; armed with two vestigial setae in middle third; distal inner margin of claw provided with a double row of minute spinules.

Maxilliped (Figs 2G, 4C): five-segmented, comprising short syncoxa, long basis, and three-segmented endopod. Syncoxa: with one short seta distally. Basis: with a row of spinules on distal outer margin. First endopodal segment: bearing two short distal setae; second endopodal segment compound, partial suture marking original separation of two ancestral segments, with (0,1) armature formula; third endopodal segment bearing recurved terminal claw plus additional apical seta. Distal margin of claw provided with rows of minute spinules; apex with pore (Fig. 4C).

Swimming legs 1–4 (Fig. 5A–D): biramous, with three-segmented protopods (praecoxa not shown in Fig. 5A–D, but see Fig. 4A for complete protopod) and three-segmented rami. Intercoxal sclerite present in legs 1–4, ornamented with patches of spinules in legs 1–2.

See Table 1 for the spine and seta formula.

Coxae ornamented with spinule rows around outer margin; inner coxal seta short and bare in leg 1, long and plumose in legs 2–3, and absent in leg 4. Bases of P1–P3: with spinules around inner margin; outer seta

Table 1. Spine and seta formula of *Stockmyzon mucronipes* (Stock, 1960) **comb. nov.**

	Coxa	Basis	Exopod	Endopod
Leg 1	0–1	1–1	I-1; I-1; III,2,2	0–1; 0–2; 1,2,3
Leg 2	0–1	1–0	I-1; I-1; III,I+1,3	0–1; 0–2; 1,2,3
Leg 3	0–1	1–0	I-1; I-1; III,I+1,3	0–1; 0–2; 1,1+I,3
Leg 4	0–0	1–0	1–1; I-1; III,I+1,3	0–1; 0–2; 1,1+I,2

plumose in leg 2, but smooth in other legs, and extremely long in leg 1. Outer spines of exopodal segments in legs 2–4 bilaterally serrate; in leg 1, smooth with subapical tubular extension. Lateral margins of exopodal segments: with minute serrations or spinular rows; those of endopodal segments with rows of setules. Middle and distal endopodal segments in legs 1–4: with a beak-shaped spiniform process distally (Fig. 4B). Outer element on proximal exopodal segment of leg 4: setiform instead of spiniform (as in legs 1–3).

Fifth leg (Fig. 1D): with protopod incorporated into somite; outer basal seta displaced to laterodorsal surface. Free segment (exopod): elongate-oval, with three smooth setae distally; outer and inner margins with spinules.

Sixth leg represented by paired opercular plates closing off gonopores on genital double somite; each armed with one plumose seta and one spiniform element.

Male: Mean body length, 463 µm (450–480 µm), and greatest width, 323 µm (320–430 µm) ($N = 3$). Sexual dimorphism present in prosome width, urosomal segmentation, antennules, maxillipeds, and leg 6. Prosome (Fig. 6A): broader than in female, about 1.05 times wider than long. Urosome (Fig. 6B): five-segmented, comprising leg-5-bearing somite, genital somite, and three free abdominal somites. Dorsal surface of genital somite, and dorsal and ventral surfaces of free abdominal somites, ornamented with large, epicuticular scales arranged in an irregular overlapping pattern; scales occasionally with serrate distal margin. Posterior margin of urosomites: ornamented with hyaline frills with serrate free margins. Genital somite about 1.4 times wider than long.

Antennule (Figs 3C, 6D–F): 18-segmented, geniculate with geniculation positioned between segments 16(XIX–XX) and 17(XXI–XXIII). Segmental fusion pattern as follows (Roman numerals indicating ancestral segments): 1(I), 2(II), 3(III), 4(IV), 5(V), 6(VI), 7(VII), 8(VIII), 9(IX–XII), 10(XIII), 11(XIV), 12(XV), 13(XVI), 14(XVII), 15(XVIII), 16(XIX–XX), 17(XXI–XXIII), 18(XXIV–XXVIII). Segments 1–8, each with two setae; segment 9, with eight setae; segment 10,

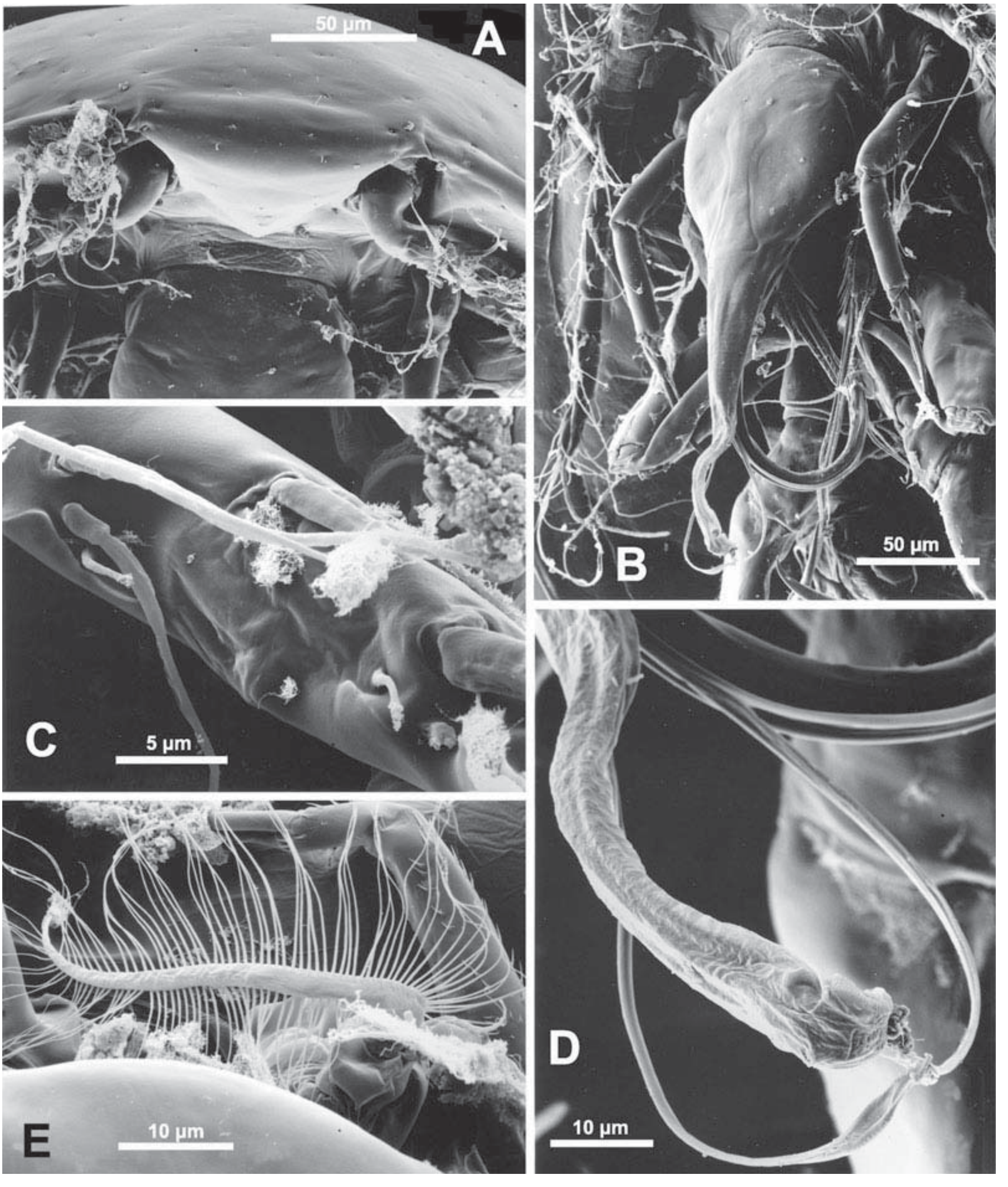

Figure 3. ***Stockmyzon mucronipes*** (Stock, 1960) **comb. nov.** SEM micrographs. A, rostral area (female); B, oral cone (female); C, antennulary segments XVIII and XIX–XX (male); D, apical part of labrum and stylet-like gnathobases of mandibles (female); E, large plumose seta on maxillulary palp (female).

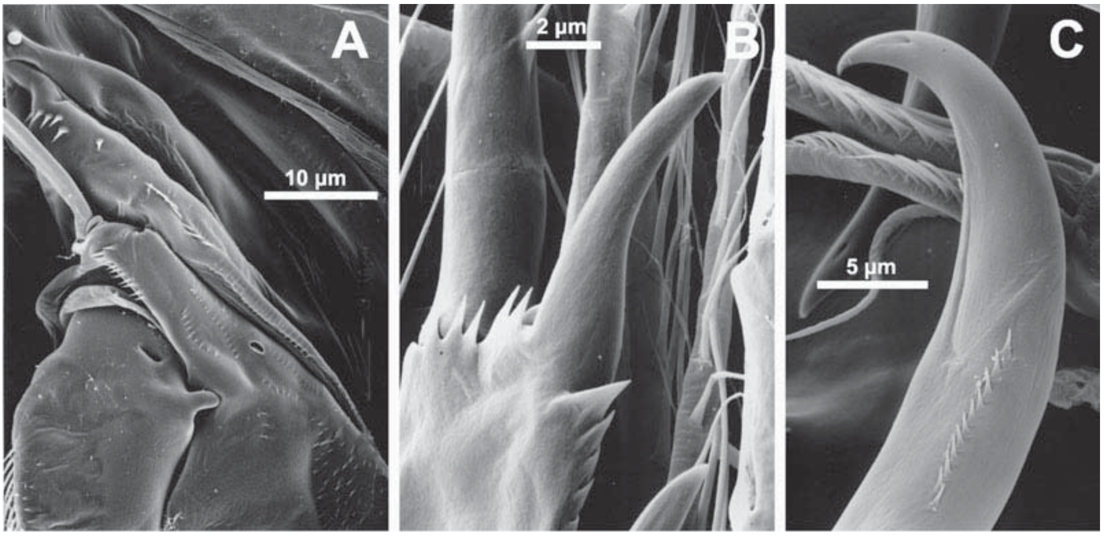

Figure 4. ***Stockmyzon mucronipes*** (Stock, 1960) **comb. nov.** SEM micrographs (female). A, protopodal segmentation of leg 1, anterior; B, spinous process on proximal endopod segment of leg 4; C, tip of maxillipedal claw.

with one seta and one small spine; segments 11–15, each with two setae; segment 16, with four setae; segment 17, with three setae plus an aesthetasc; segment 18 with nine setae. Segment 10 reduced, partly covered by distal expansion of compound segment 9 (Fig. 6E). Proximal seta on ancestral segments XVIII–XX: rudimentary (Figs 3C, 6D).

Maxilliped (Fig. 6C): indistinctly six-segmented; comprising short syncoxa, long basis, and indistinctly four-segmented endopod. Syncoxa with one short seta distally, incompletely separated from basis. Basis: with one small tooth-like process along medial margin near syncoxa–basis joint; with spinules along outer margin. First endopodal segment not completely separated from basis; with two setae and a few spinules near the distal margin. Second endopodal segment: with one terminal seta. Third endopodal segment: compound, showing membranous insert marking plane of fusion between ancestral segments 3–4; with recurved terminal claw plus short accessory apical seta.

Fifth legs (Fig. 6B): not markedly different from those of female.

Sixth legs (Fig. 6B): represented by opercula closing off genital apertures; each with two smooth setae.

Remarks

Comparison with Stock's (1960) text and illustrations revealed a number of discrepancies, which may be attributed to imperfect dissection and/or observation: (1) Stock (1960) described the female antennule as 19-segmented and stated that segments 18–19 were indistinctly separated; re-examination showed that the minute tenth segment (XIII) was overlooked by Stock, and that the terminal segments are divided by a clear articulation; (2) the antennary exopod has not two, but three elements; Stock missed the lateral exopodal seta, as well as the two smaller setae on the distal endopod segment; (3) the mandibular palp is not indistinctly two-segmented, as stated by Stock; (4) Stock's illustration of the maxillule shows four terminal setae on the praecoxal endite (the shorter one was overlooked), and only two instead of four on the palp; (5) the maxilla has an aesthetasc-like extension on the proximal part of the syncoxa, which was not illustrated by Stock [nor in any other asterocherid descriptions prior to Ho (1984); cf. *Asterocheres aesthetes* Ho, 1984); (6) Stock described and illustrated the maxillipedal endopod as distinctly three-segmented, but his segment boundaries do not coincide with the pattern we observed – his proximal segment is a composite of the genuine first segment and the proximal half of the middle segment (compare Fig. 2G), whereas his middle segment corresponds to only the distal half of that segment – this reinterpretation explains the difference between our endopodal setal formula [2, (0,1), 1+claw] and Stock's [1, 1, 1+claw]; (7) Stock overlooked the inner basal seta on P1, and erroneously illustrated the outer basal seta as plumose; (8) the epicuticular scales on the urosomited were not illustrated in Stock's description.

Slight morphological variations occur between the Tarifa specimens and the Roussillon population. In

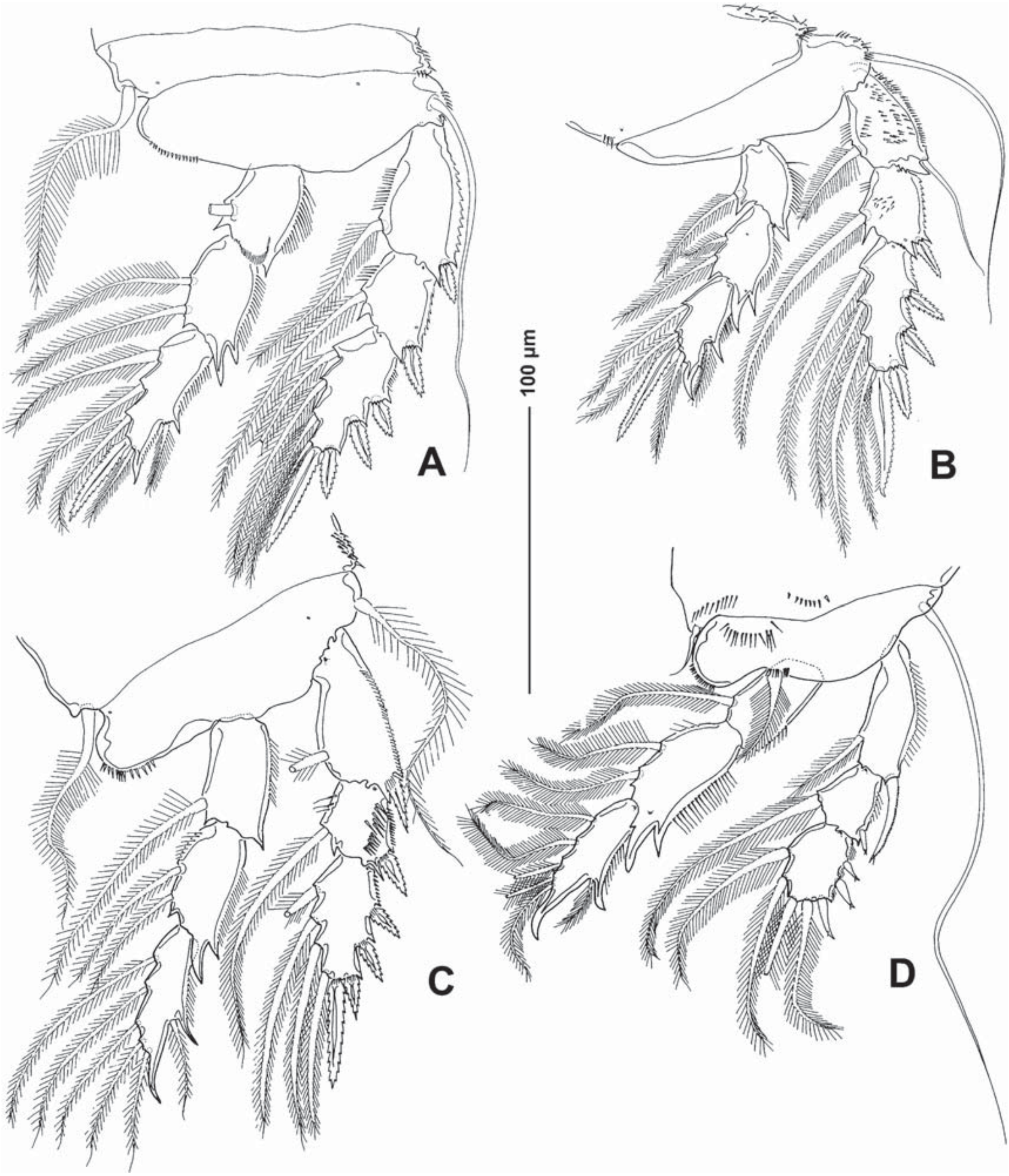

Figure 5. ***Stockmyzon mucronipes*** (Stock, 1960) **comb. nov.** (female). A, leg 3, anterior; B, leg 4, anterior; C, leg 2, anterior; D, leg 1, anterior.

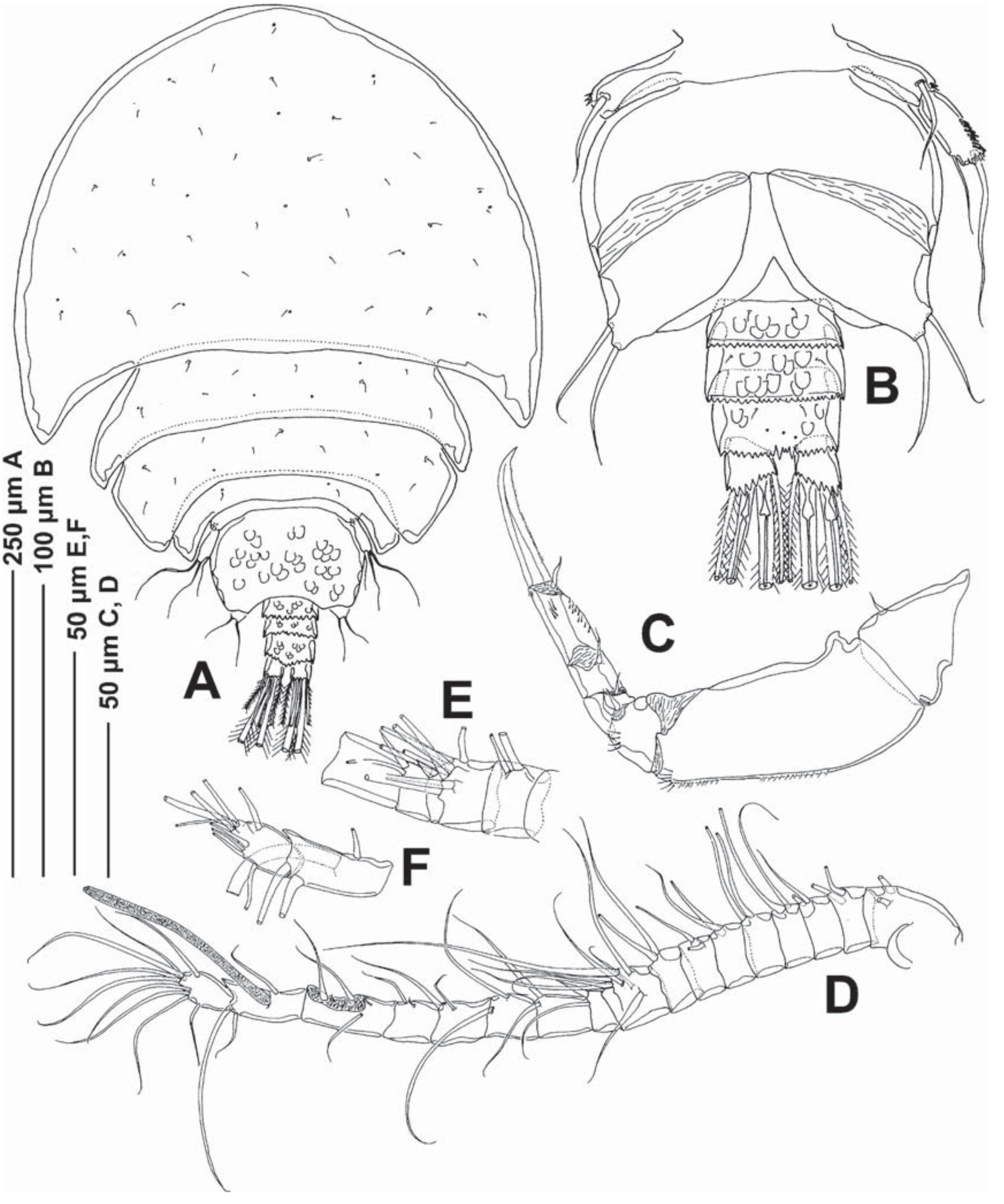

Figure 6. ***Stockmyzon mucronipes*** (Stock, 1960) **comb. nov.** (male). A, habitus, dorsal; B, urosome, ventral; C, maxilliped; D, antennule; E, detail of antennulary segments VIII, IX–XII, XIII, XIV, and XV; F, detail of antennulary segments XX–XXII and XXIII–XXVIII.

the Roussillon population: (1) the oral cone is slightly shorter, reaching only as far as the bases of leg 1; (2) the proximal outer process on the middle endopod segment of leg 1 is markedly shorter, whereas the apical process and outer seta on the distal endopod segment are distinctly longer; (3) the apical spine and seta on the distal endopod segment of leg 3 are longer than the segment (but shorter in the Tarifa population); (4) the caudal rami are slightly longer; and (5) the body length is smaller (551–589 µm).

Stockmyzon crassus sp. nov.

Synonym: Asterocheres mucronipes Stock, 1960 *sensu* Stock (1966).

Original description: Stock (1966: 146–147, fig. 1a–c).

Type locality: Mauritius, Chenal du Trou d'Eau Douce; associated with "small flabby orange sponges", without skeleton (*Oscarella* sp.), in small "grottos" in the reef at 6–10 m depth'.

Material examined: Holotype female and 16 paratype females (originally identified as *A. mucronipes*) (ZMA Co. 100.955) from type locality; collected by J.H. Stock, 7 February 1964.

Description: Restricted to differences with the type species.

Female: Body (Fig. 7A): cyclopiform, consisting of dorsoventrally flattened prosome and cylindrical urosome. Total length measured from rostral margin to posterior margin of caudal rami, 652 µm [564–664, $N = 6$ according to Stock (1966)]; maximum width, 440 µm measured at 4/5 length of cephalothorax. Ratio of length to width of prosome: 1.08 : 1. Ratio of length of prosome to that of urosome: 2.5 : 1. Genital double somite and free abdominal somites: covered with large epicuticular scales arranged in an overlapping pattern (Fig. 8E); scales larger than in *S. mucronipes*. Somite bearing leg 5 (Fig. 7B): wider than long, with some spinules around bases of outer basal setae. Genital double somite (Fig. 7B–C): narrower and less laterally produced than in *S. mucronipes*, about 1.2 times wider than long; with lateral postgenital setular tufts.

Caudal rami (Figs 7B–C, 8E): slightly longer than wide (measured along outer margin), ornamented with epicuticular scales all over. Caudal setae IV–V: distinctly swollen in proximal half.

Antennule (Fig. 7D): 20-segmented, about 312-µm long; segmental fusion pattern as in *S. mucronipes*. Segments 1–8, each with two setae; segment 9, with six setae and a small spine; segment 10, with two setae; segment 11, with one seta and one small spine; segments 12–17, each with two setae; segment 18, with two setae plus an aesthetasc; segment 19, with three setae; segment 20, with nine setae. Segment 10(XIII), reduced, forming incomplete sclerite partly overlapped by distal expansion of compound segment 9(IX–XII). All setae smooth.

Antenna (Fig. 7E): biramous, 186-µm long. Coxa and basis: without spinule rows. Exopod: as in *S. mucronipes*. Endopod: three-segmented; proximal segment with spinular ornamentation as illustrated; middle segment with one smooth seta; distal segment with one naked seta and one distal claw, and with few spinules along margin and long setules on anterior surface.

Siphon (Fig. 8A): long and slender, reaching to intercoxal sclerite of leg 1.

Mandible (Fig. 9A): comprising stylet-like gnathobase and slender two-segmented palp. Proximal segment of palp unarmed; distal segment with two plumose, unequally long, apical setae. Stylet: as in *S. mucronipes*.

Maxillule (Figs 8C, 9B): bilobed. Praecoxal gnathobase four times longer than palp; ornamented with a row of long spinules distally, and a row of shorter spinules laterally; armed with five distal setae (one of them smooth and short). Palp strongly reduced; with one elongate, strongly plumose seta, and two short pinnate setae.

Maxilla (Figs 8B, 9C): essentially as in *S. mucronipes*, but coxal part of syncoxa without surface spinule row. Vestigial element on claw-like basis: not discernible.

Maxilliped (Fig. 9D): as in *S. mucronipes*, but basis and endopod relatively more slender; endopod segments 1–2 separated by suture on anterior side only.

Swimming legs 1–4 (Figs 8D, 10A–D): intercoxal sclerite present in legs 1–4, ornamented with patches of spinules in legs 1–3. Spine and seta formula: as for *S. mucronipes*. Coxae ornamented with spinule rows laterally, as illustrated. Middle and distal endopodal segments in legs 1–4: with a beak-shaped spiniform process distally (e.g. Fig. 8D). Leg 1 differs from that of *S. mucronipes* in the following characteristics: outer basal seta shorter; inner coxal seta pinnate instead of bare; proximal outer spinous process on middle endopod segment shorter; outer seta of distal endopod segment extending just beyond distal spinous process. Legs-2–3 inner coxal seta and outer basal seta: much shorter than in *S. mucronipes*. Proximal inner seta of middle endopod segment of leg 4: much longer than in *S. mucronipes* and approaching the length of the distal inner seta.

Fifth leg (Fig. 7B): as in *S. mucronipes* except for lateral exopodal seta being distinctly shorter. Sixth legs (Fig. 7B): represented by paired opercular plates

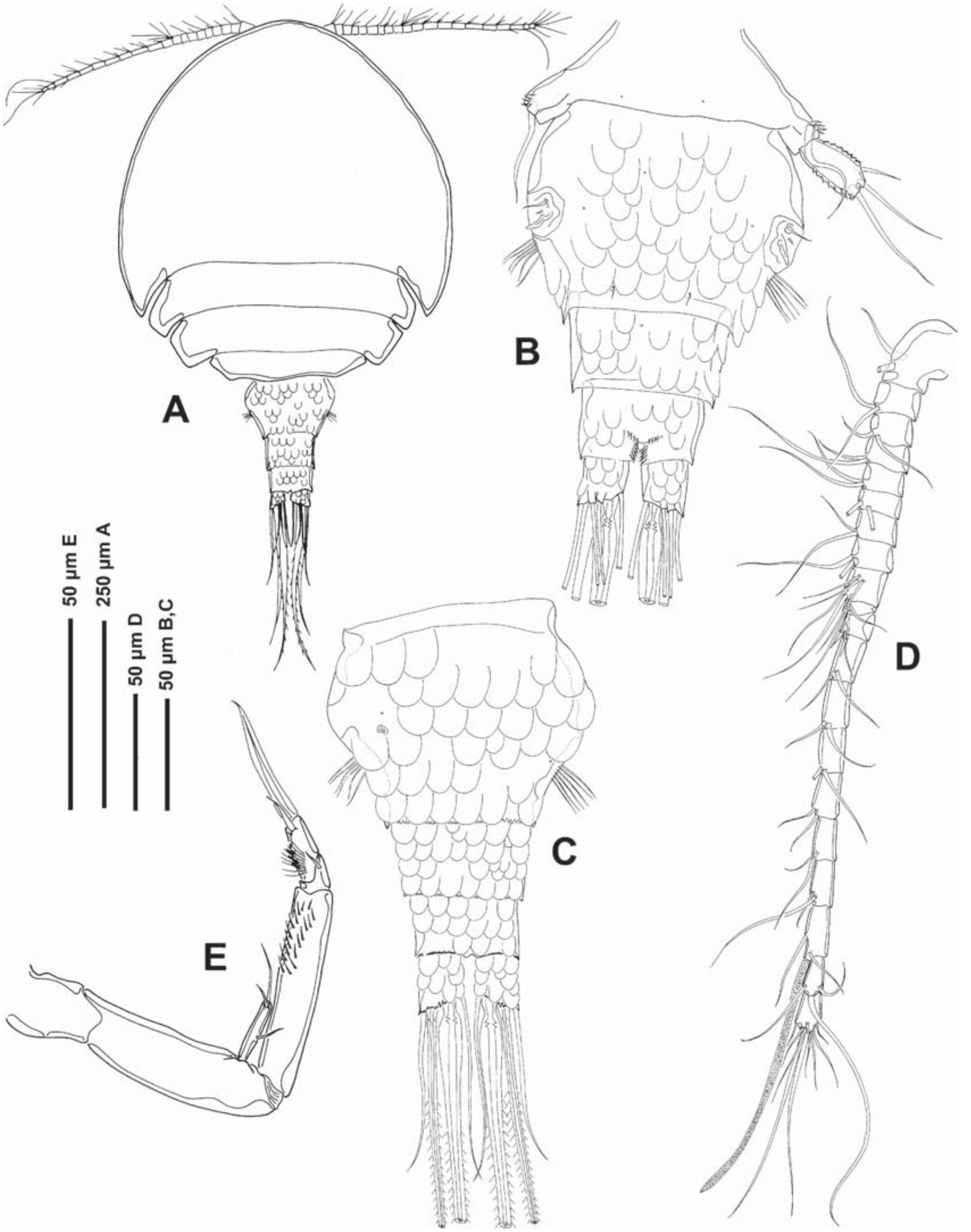

Figure 7. ***Stockmyzon crassus*** (Stock, 1966) **sp. nov.** (female). A, habitus, dorsal; B, urosome, dorsal; C, urosome (excluding leg-5-bearing somite), ventral; D, antennule, ventral; E, antenna.

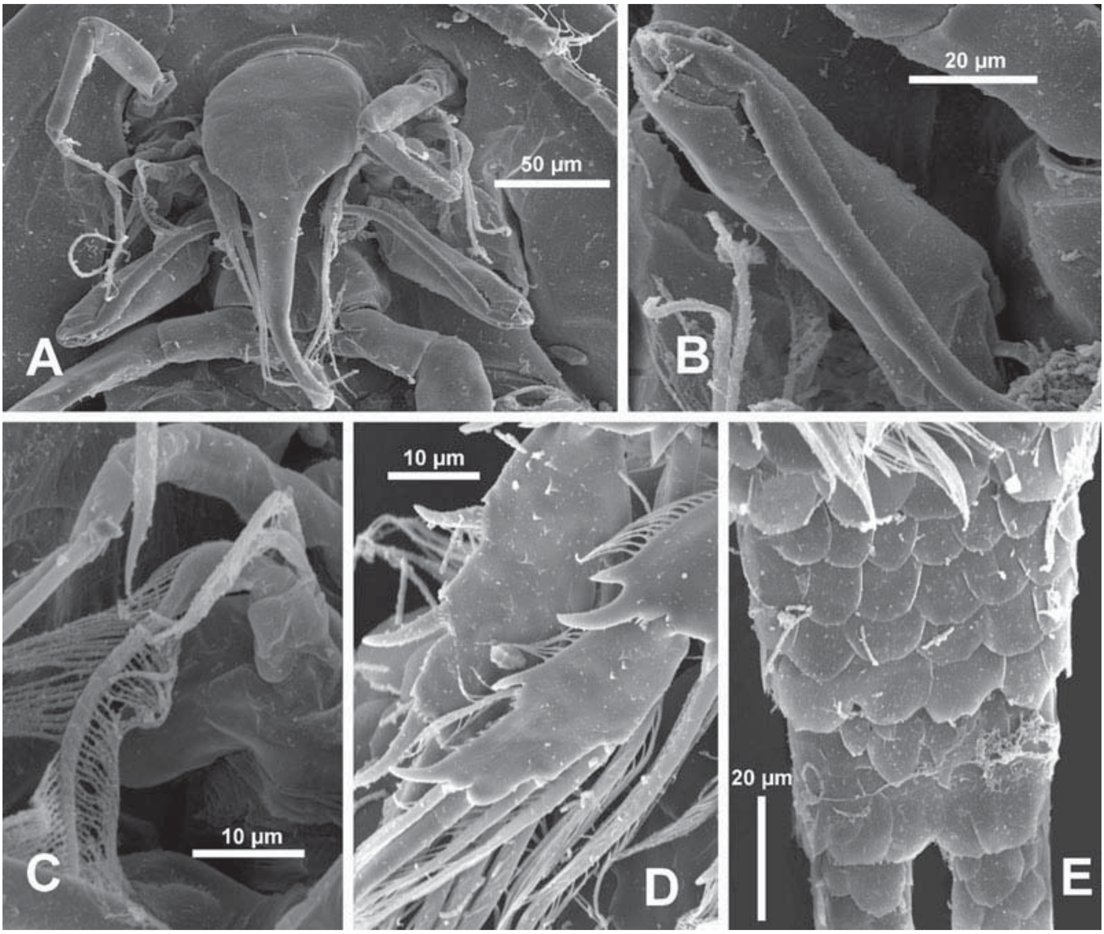

Figure 8. ***Stockmyzon crassus*** (Stock, 1966) **sp. nov.** SEM micrographs (female). A, oral cone; B, maxilla; C, maxillulary palp; D, P4 endopod, anterior; E, surface scales on urosomites, ventral.

closing off gonopores on genital double somite; armed with one short, smooth seta, and one spiniform element.

Male: Unknown.

Etymology: The specific name is derived from the Latin *crassus*, meaning thick, and refers to the swollen caudal setae.

Remarks

Stock's (1966) redescription of *A. mucronipes* from Mauritian sponges is concise and limited to illustrations of the urosome, leg 4, and the maxillule. Stock confirmed several similarities with the Mediterranean type population, such as the annulated structure of the mandibular stylet and the presence of beak-shaped processes on the swimming legs; however, he also claimed that the maxillule differed slightly in the shape of the 'outer ramus' or palp, being gonflate basally, and distinctly narrower distally (Stock (1966: fig. 1b). This could not be confirmed in the Mauritian material or in the types of *S. mucronipes* (Stock doubted his original observation) (Figs 2D, 9B); instead, our re-examination revealed that Stock (1966) had overlooked a seta on both the maxillulary endite and palp. His illustration of leg 4 also shows minor discrepancies with our Figure 10D, such as proportional length differences in the outer seta of the proximal exopodal segment and the inner proximal seta of the middle endopodal segment, and the apparent slenderness of the outer

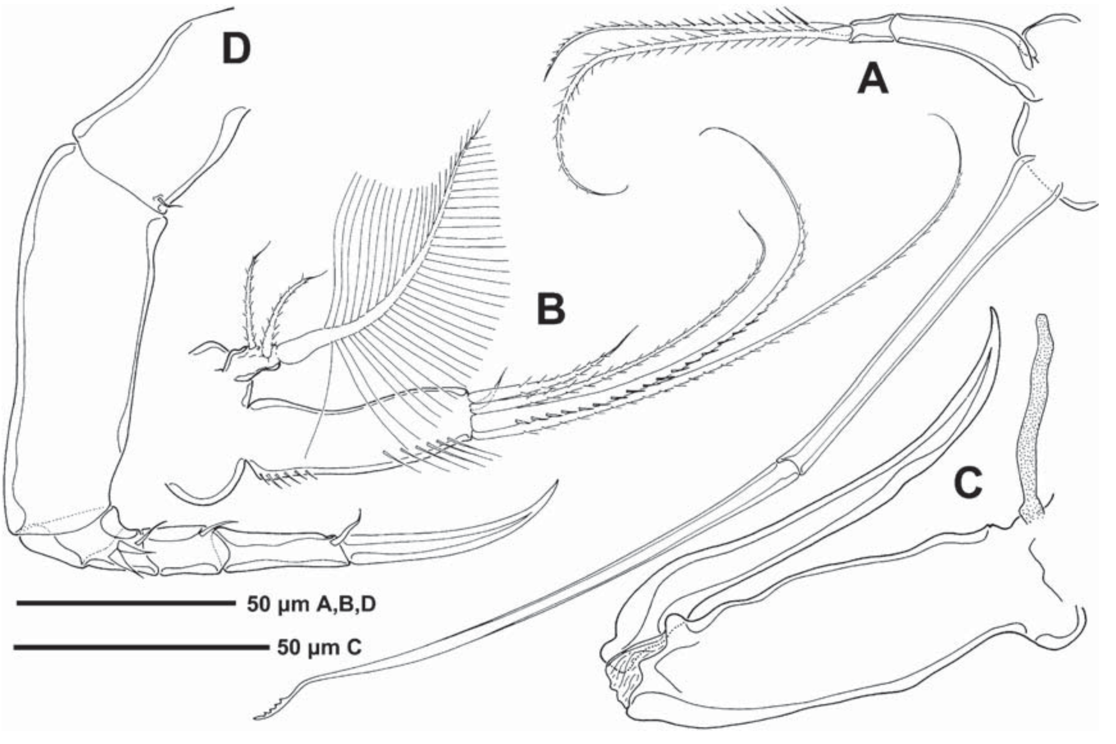

Figure 9. ***Stockmyzon crassus*** (Stock, 1966) **sp. nov.** (female). A, mandible; B, maxillule; C, maxilla; D, maxilliped, posterior.

exopodal spines (as a result of omitting the membranous flanges). Stock (1966) illustrated the swollen caudal ramus setae IV–V, but did not remark on this character in the text.

DISCUSSION

Species discrimination

Stockmyzon mucronipes and *S. crassus* are morphologically very similar in most aspects, but the latter can be distinguished from the former by the following suite of characters: (1) epicuticular scales on genital double somite and free abdominal somites, larger; (2) genital double somite, narrower and less laterally produced (width : length ratio 1.2 vs. 1.7 in *S. mucronipes*); (3) caudal ramus setae IV–V distinctly swollen in proximal half; (4) all antennulary setae smooth; (5) siphon slightly shorter, reaching to intercoxal sclerite of leg 1; (6) maxillulary palp with one elongate, strongly plumose seta, and only two short pinnate setae; (7) coxal part of maxillary syncoxa without surface spinule row; (8) maxilliped basis and endopod relatively more slender; (9) leg-1 outer basal seta shorter, and inner coxal seta pinnate instead of bare; proximal outer spinous process on middle endopod segment, shorter; outer seta of distal endopod segment extending just beyond distal spinous process; (10) legs-2–3 inner coxal seta and outer basal seta, much shorter; (11) proximal inner seta of middle endopod segment of leg 4, much longer, approaching the length of the distal inner seta; and (12) leg-5 lateral exopodal seta, distinctly shorter.

Taxonomic position of *Asterocheres stimulans* Giesbrecht, 1897

Giesbrecht (1897) named three new species of *Asterocheres*, all of which were collected in the Gulf of Naples: *Asterocheres dentatus*, *Asterocheres parvus*, and *A. stimulans*. Although no illustrations or formal diagnoses were given, Giesbrecht did cite the new species in his identification key. Such a citation can be considered the equivalent of a differential diagnosis, and is sufficient to make the new species names available. Illustrated descriptions were given in a subsequent report on the Asterocheridae of the Gulf of Naples (Giesbrecht, 1899). Stock (1960) recognized the similarity in swimming leg morphology between

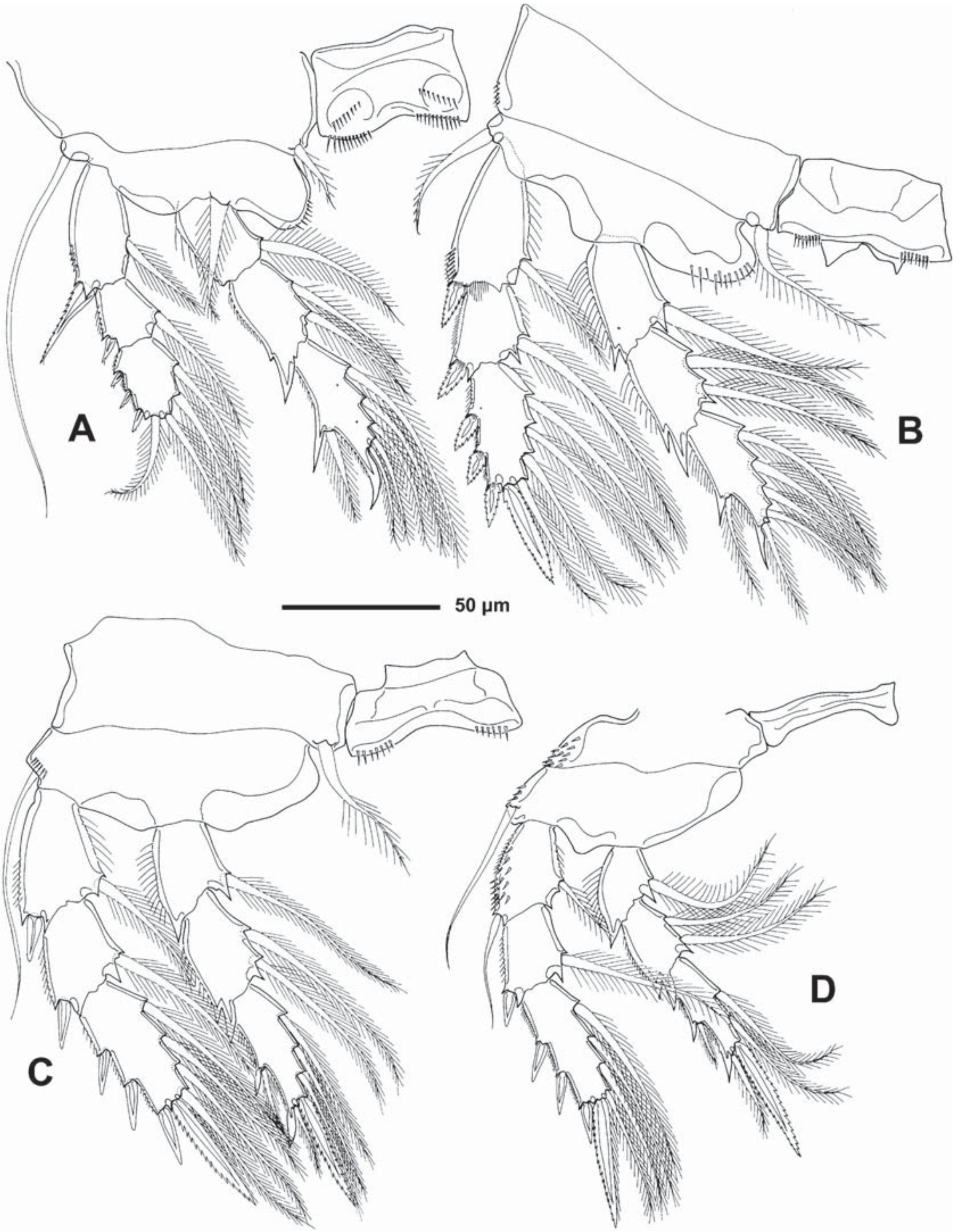

Figure 10. ***Stockmyzon crassus*** (Stock, 1966) **sp. nov.** (female). A, leg 1, anterior; B, leg 2, anterior; C, leg 3, anterior; D, leg 4, anterior.

A. mucronipes and the male of *A. stimulans*, in particular the beak-shaped processes on the endopods. Examination of Giesbrecht's detailed illustrations of both sexes of *A. stimulans* casts severe doubts on their conspecificity. His figures of the male include the habitus, antennule, maxilliped (note the position of the spinous process on the basis), leg 1, and endopods of legs 2–4 (note the short proximal inner seta on the middle endopod segment of leg 4), all of which conform exactly to *S. mucronipes*. The only exception is the illustration of the mouth cone area, which shows a slightly longer siphon (extending to the intercoxal sclerite of leg 3), and only three small setae on the maxillulary palp. The first difference is probably caused by excessive squashing of the specimen, which results in a slightly posterior displacement of the siphon in the foreshortened *in situ* view (also note the distorted position of the mandibular palp). The significant aspect in the second difference is the absence of the large, gonflate seta. This seta is typically medially directed, and could easily be concealed by the praecoxal gnathobase and oral cone in a squashed preparation (compare Figs 2D and 3E). The palp (even though Giesbrecht's illustration is small) shows the atrophied facies that is characteristic for *Stockmyzon*. The description of the female of *A. stimulans* is concise, and includes figures of the habitus, antennule, maxillule, maxilliped, and urosome. The antennule is 20-segmented, as in *S. mucronipes*, but the segmental homologies are different. In female *A. stimulans* there are three segments distal to the aesthetasc-bearing segment XXI, and the vestigial segment XIII represents the ninth segment; in *S. mucronipes* only two segments are expressed distal to the ancestral segment XXI, and segment XIII is homologous with the tenth segment. The maxillule bears no resemblance to that in *S. mucronipes*, being similar to the typical *Asterocheres* condition. The female maxilliped is atypical in that it differs significantly from the male in its general slenderness and the length of the endopodal claw; such sexual dimorphism is extremely rare among asterocherids and makes the conspecificity of the two sexes highly questionable. We strongly believe that Giesbrecht (1899) based his description of *A. stimulans* on an amalgam of two different species. No holotype was designated by Giesbrecht and the original type series no longer exists (Kölmel, 1980; confirmed during a visit to the Stazione Zoologica in Naples by RH, October 2003). In order to preserve the stability of nomenclature, we designate the female specimen illustrated by Giesbrecht (1899: plate 3; figs 1, 3, 6, 7, 12, 14) (as the lectotype of *A. stimulans* (ICZN Art. 74.4). The male illustrated in Giesbrecht (1899: figs 2, 4, 5, 8–11, 13) is considered here as conspecific with *S. mucronipes*. Although its host was unknown to Giesbrecht (1897, 1899), we suspect that it was *A. calycularis*; Giesbrecht's material was collected in the vicinity of Naples, which virtually coincides with the northernmost limit of distribution of this host in Italy (Zibrowius, 1995). The identity of Canu's (1898) record of *A. stimulans* from algal washings in Maisy (Normandy coast) requires confirmation. The only female collected shows a 21-segmented antennule, but the similarity in siphon size, shape of the genital double somite, and length of the caudal ramus indicates that conspecificity cannot be ruled out.

Host switching in the north-western Mediterranean?

Astroides calycularis is an azooxanthellate dendrophylliid colonial coral, typically inhabiting shallow waters down to a depth of about 30 m, and preferring shaded places and strong water movement (Zibrowius, 1980, 1995). It is protected by the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and since 1999 has been listed by the Spanish Government as a vulnerable species in the National Catalogue of Endangered Species (Catálogo Nacional de Especies Amenazadas) (Anonymous, 1999). *Astroides calycularis* is essentially endemic to the south-western Mediterranean, with a few outliers beyond the Straits of Gibraltar in the west and the Straits of Sicily in the east. Its distribution is presently limited at 37°38′N (Cape Palos) on the coast of Spain and 40°48′N (Gulf of Gaeta) on the coast of Italy (Zibrowius, 1980, 1983). More recent research based on fossil evidence has demonstrated that *A. calycularis* lived on the mediterranean coast of France at 43°42′–43°44′N during part of the Pleistocene, taking advantage of the slightly higher surface water temperatures than those prevailing now in the northern Mediterranean (Zibrowius, 1995). Field experiments with colonies transplanted from Italy showed that present-day temperatures allow short-term survival, but fail to sustain successful reproduction. Stock (1960) found *S. mucronipes* in washings of the gorgonian *E. singularis* in the Banyuls-sur-Mer area, which is south of the northernmost limit of distribution of *A. calycularis* during the Upper Sicilian and Upper Tyrrhenian (interstages of the Riss and Würm glaciations). We postulate that the symbiotic association between *A. calycularis* and *S. mucronipes* was already established before the Pleistocene and in the entire former distribution range of the host, i.e. the western mediterranean basin. When climatic conditions changed during the late Sicilian regression (Rissian age), about 238 000–225 000 years ago, the drop in temperature caused the extinction of *A. calycularis* along the French Mediterranean coast, and the northern coastal waters of Spain and Italy, but did not necessarily wipe out the symbionts that depended on it. Switching to suitable hosts that reside in deeper waters, and are less susceptible to ambient temperature changes, offers a solution for symbionts that are at the risk of extinction. It appears that *S. mucronipes* maintained its presence in the north-western Mediterranean by switching to alternative hosts, such as the gorgonian *E. singularis*; however, the authenticity of Stock's (1960) record requires confirmation by additional sampling over a wider geographical scale before this hypothesis can be supported. Stock (1966) himself failed to collect additional *S. mucronipes* specimens from *E. singularis* in subsequent years, and therefore suggested the real host may well be a sponge, as in the case of *S. crassus*.

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Artículo V

Some poorly known *Asterocheres* species (Siphonostomatoida: Asterocheridae) deposited in the Natural History Museum of London.

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Some poorly known *Asterocheres* species (Siphonostomatoida: Asterocheridae) deposited in the Natural History Museum of London

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A total of seven poorly known species of the genus Asterocheres*, the largest genus of the family Asterocheridae, are redescribed based on material deposited in the Natural History Museum of London. Among the material available, there were specimens of both sexes of* A. bulbosus, A. ellisi *and* A. rotundus*; the dissected holotypes for* A. hongkongensis, A. indicus *and* A. ovalis *which have no other specimens; and only cotype of* A. micheli*, turned out to be lost. Some taxonomically important appendages of these species are described and illustrated for the first time. Furthermore, discrepancies have been observed in: (1) the general shape of the body; (2) the antennule segmentation; (3) the omission of some elements in various oral appendages; and (4) the segmentation of the mandibular palp. These redescribed species were then compared with their closest congeners.*

Keywords: Siphonostomatoida, *Asterocheres*, Hong Kong, Great Britain, John Murray Expedition

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INTRODUCTION

The Asterocheridae and Artotrogidae, the most plesiomorphic families of the order Siphonostomatoida, are so closely related that some authors have pointed out the possibility that the Artotrogidae arose within the Asterocheridae (Boxshall & Hasley, 2004) and therefore the latter may be paraphyletic (Boxshall & Hasley, 2004; Johnsson & Neves, 2004). There is not only a need for a comprehensive phylogenetic analysis of these families, but it is also necessary to revise the different asterocherid genera, since for more than a century Asterocheridae has been serving as a repository for genera and species which did not fit into other siphonostomatoidan families (Boxshall & Hasley, 2004). This has enlarged the heterogeneity of this family (Nair & Pillai, 1984; Boxshall & Hasley, 2004; Johnsson & Neves, 2004). Although several attempts have been made to study the family as a whole (Sewell, 1949; Stock, 1965, 1975; Ummerkutty, 1966), a thorough revision of the family is still to be undertaken. *Asterocheres* is the largest genus within Asterocheridae since it contains nearly 30% of the known species; however, many of these are poorly or incompletely described for reliable comparisons to be made (Stock, 1966a; Ho, 1984; Humes, 1996a; Ivanenko & Smurov, 1997; Kim, 2004, 2005). Most of these poorly known species have not been recorded since their original descriptions and future studies may be based on type material deposited in different museums in order to clarify the rather confused state of the systematics of *Asterocheres* and, therefore, the family.

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In this paper, we redescribe some of these poorly known or incompletely described *Asterocheres* species deposited in the Natural History Museum of London (NHM).

MATERIALS AND METHODS

The condition of the type material deposited in the NHM differs according to the *Asterocheres* species studied. Thus, for three species—*A. hongkongensis* Malt, 1991; *A. indicus* Sewell, 1949; and *A. ovalis* Sewell, 1949—there is only the dissected holotype, a female in case of the two first species, and a male for the latter. Some of these slides are currently in such bad condition and/or contain the entire copepod—as in the case of *A. indicus*—that some details of the copepod's oral appendages are difficult to observe. On the contrary, there was enough material of both sexes for *A. ellisi* Hamond, 1968, A. *bulbosus* Malt, 1991 and *A. rotundus* Malt, 1991. When the dissected specimens of these three species were not enough to make detailed descriptions of some appendages, a specimen was dissected in lactic acid, stained with Chlorazol black E (Sigma® C-1144) examined as a temporary mount in lactophenol and finally sealed with Entellan as a permanent mount.

With regards to *A. micheli*, Gurney did not mention where he deposited its type material, but the Museum considered a specimen in alcohol as Gurney's type material. However, this specimen did not correspond to a siphonostomatoid but to a harpacticoid copepod and, therefore the holotype of *A. micheli* should be considered lost. All figures were drawn with the aid of a camera lucida on a Leica DMLB differential interference microscope. All appendage segments and setation elements were named and numbered using the system established by Huys & Boxshall (1991). Mean body length of the copepod was measured from anterior margin of rostrum to posterior margin of caudal rami.

SYSTEMATICS

Order SIPHONOSTOMATIDA Thorell 1859
Family ASTEROCHERIDAE Giesbrecht, 1899
Genus *Asterocheres* Boeck, 1859
Asterocheres bulbosus Malt, 1991
(Figure 1)

TYPE MATERIAL

Holotype (NHM 1989.200; 1 slide), allotype (NHM 1989.201; 1 slide) plus one female paratype (NHM 1989.202; 11 slides), 8 female paratypes (NHM 1989.203–210; in alcohol), one male paratype (NHM 1989.211; 1 slide) and 7 male paratypes (NHM 1989.212–218; in alcohol) associated with a purplish sponge collected at 10 m depth at Gau Tau (Hong Kong) on 18 April 1986.

DIAGNOSIS

Description of adult female

Body cyclopiform (Figure 1A), slender, with cephalothorax oval and cylindrical urosome. Mean body length 486 μm (470–510 μm) and maximum width 206 μm (190–220 μm), based on 3 specimens. Ratio of length to width of prosome 2.2:1. Ratio of length of prosome to that of urosome 1.7:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites. Epimeral areas of pedigerous somites 2, 3 and 4 with rounded posterolateral angles (Figure 1A).

Urosome 4-segmented comprising pedigerous somite 5, genital double-somite and 2 free abdominal somites. All urosomites ornamented with flattened epicuticular scales (not shown in the Figure 1B). Pedigerous somite 5 wider than long. Genital double-somite slightly longer than wide, bearing genital apertures, paired gonopores located dorsolaterally; lateral margins with rows of setules in distal third, posterior to genital apertures (Figure 1B). Each genital area armed with 2 small setae. Integumental pores and sensilla present on urosomites (Figure 1B).

Caudal rami wider than long, armed with 6 setae; seta I absent, setae II–VII all arranged around posterior margin with setae II and VII slightly offset onto dorsal surface. Caudal setae IV and V bulbous, all setae plumose.

Antennule 20-segmented (Figure 1C); about 190 μm long, segmental homologies and setation as follows: I-1; II-2; III-2; IV-0; V-1; VI-1; VII-2; VIII-2; IX–XII-7; XIII-1; XIV-spine; XV-1; XVI-1; XVII-1; XVIII-1; XIX-1; XX-0; XXI-1 + ae; XXII–XXIII-2; XXIV–XXVIII-9. All setae smooth.

Antenna, siphon, mandible and maxilla as in original description (Figure 5D–G; see Malt, 1991).

Maxilla 2-segmented (Figure 1D); with unarmed coxa. Claw-like basis recurved at its end; ornamented with row of spinules distally on lateral margin.

Maxilliped 5-segmented (Figure 1E), comprising short syncoxa, long basis and 3-segmented endopod with distal claw-like element. Syncoxa with short seta distally and basis without ornamentation. First endopodal segment bearing 3 short

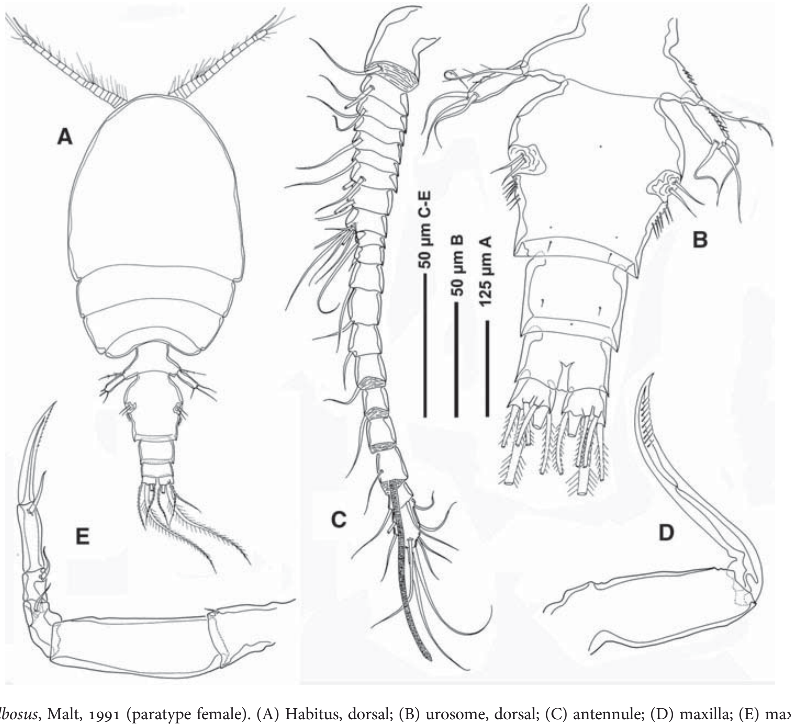

Fig. 1. *Asterocheres bulbosus*, Malt, 1991 (paratype female). (A) Habitus, dorsal; (B) urosome, dorsal; (C) antennule; (D) maxilla; (E) maxilliped.

smooth setae and second segment with subdistal seta. Third endopodal segment bearing curved terminal claw plus additional distal smooth seta. Claw surface ornamented with row of spinules.

Swimming legs as in original description (Figure 5H–K; see Malt, 1991).

Fifth leg (Figure 1B) with protopod incorporated into somite; outer basal seta displaced to laterodorsal surface. Free segment elongated, more than twice longer than wide, with 3 smooth terminal setae. Outer lateral margin with spinules.

Sixth leg (Figure 1B) represented by paired opercular plates closing off gonopores on genital double-somite; each armed with 2 smooth setae.

Description of adult male

Body cyclopiform (Figure 6A; Malt, 1991) with mean body length 385 μm (360–410 μm) and maximum width 150 μm (140–160 μm), based on 2 specimens. Sexual dimorphism in urosomal segmentation, antennules and leg 6 but not in the maxilliped which lacks hook-like process usually present on the basis. Except for plumose setae of the caudal rami, urosome and caudal rami as in original description (Figure 6B; Malt, 1991).

Antennule (Figure 6C; Malt, 1991) 17-segmented, about 167 μm long, with geniculation between segments 15 (XIX–XX) and 16 (XXI–XXII). Anteroventral margin of the penultimate segment enlarged in a pointed process (not a hook).

Remaining appendages as in Malt's illustrations.

REMARKS

Malt (1991) described *Asterocheres bulbosus* omitting some taxonomically important appendages, such as the maxilla and the maxilliped which are drawn and described here for the first time. Comparison with Malt's text and illustration revealed some differences such as the body shape is not dorso-ventrally flattened, but rather cyclopiform and slender with oval cephalothorax and cylindrical urosome. The genital area drawn by Malt has one seta instead of 2 present in the holotype. The epicuticular scales on the urosomite and the spinulose ornamentation of the external margin of leg 5 were not observed by Malt. Furthermore, Malt's illustration of the female antennule shows 21 segments, instead of 20. This last difference is indeed very important since *A. bulbosus* has always been compared with the group of *Asterocheres* species with a 21-segmented antennule in females defined by Boxshall & Huys (1994) to which this species no longer belongs. Contrarily, *A. bulbosus* should be compared with the group of *Asterocheres* having a 20-segmented antennule, which is the group with the highest number of incompletely described species. The 20-segmented antennule group is composed of about 23 species. However, among all these species, only three, *A. longisetosus* Nair & Pillai, 1984, *A. stocki* Nair & Pillai, 1984 and *A. tetrasetosus* Johnsson, 1998, possess a 1-segmented mandibular palp like *A. bulbosus*. Nevertheless, there are also four species—*A. dentatus* Giesbrecht, 1897, *A. minor* Thompson & Scott, 1903, *A. intermedius* (Hansen, 1923) and *A. ventricosus* (Brian, 1927)—with no information about this appendage (Giesbrecht, 1897; Thompson & Scott, 1903; Hansen, 1923; Brian, 1927; Nair & Pillai, 1984; Johnsson, 1998) and therefore they should be distinguished from *A. bulbosus* by other characteristics. *Asterocheres dentatus* and *A. ventricosus* have the ratio of the genital double-somite wider than long (Brian, 1927) while *A. bulbosus* has a slightly longer than wide genital double-somite. The oral cone in *A. bulbosus* reaches only as far as the base of the maxilliped, being significantly shorter than that of *A. intermedius* which extends beyond the insertion of first leg (Hansen, 1923). *Asterocheres minor* can be separated from *A. bulbosus* based on the body shape. Thompson & Scott's (1903) illustration of the habitus of *A. minor* shows a nearly circular body in outline with second abdominal somite longer than wide and only slightly shorter than genital somite. In contrast, *A. bulbosus* presents a cephalothorax oval and the second abdominal somite wider than long.

Asterocheres stocki can be easily distinguished from *A. bulbosus* by the extremely long siphon, which extends to the hind border of the fifth leg (Nair & Pillai, 1984). *Asterocheres longisetosus* possesses 3 striking features which are unique among *Asterocheres* species: the long aesthetasc on distal segment of the antennule, 3 terminal setae on mandibular palp, and ornamentation of leg 5 with the free segment armed with 2 long setae and 2 very short spines, together with the unusual long seta of pedigerous somite 5 (see figure 32 in Nair & Pillai, 1984).

Asterocheres tetrasetosus presents 4 setae on the free segment of the fifth leg therefore differentiating it from all other known species of the genus (Johnsson, 1998).

Asterocheres ellisi Hamond, 1968
(Figures 2–3)

TYPE MATERIAL

Holotype female (NHM 1967.10.2.3, 1 slide), allotype male (NHM 1967.10.2.3, 1 slide) and 6 female paratypes (NHM 1967.10.2.3A; in alcohol) at West Runton, Norfolk (Great Britain). Host unknown.

DIAGNOSIS

Description of adult female

Body cyclopiform, with dorso-ventrally flattened prosome and cilindrical urosome (Figure 7; Hamond, 1968). Mean body length 736 μm (700–760 μm) and maximum width 490 μm (450–540 μm), based on 3 specimens. Ratio of length to width of prosome 1.17:1. Prosome comprising cephalothorax and 3 free pedigerous somites. Cephalothorax fully incorporating first pedigerous somite; with posterolateral angles incurved and slightly overhanging. Pedigerous somite 4 much smaller and narrower than preceding ones.

Urosome 4-segmented, comprising pedigerous somite 5, genital double-somite and 2 free abdominal somites. Pedigerous somite 5 wider than long. Genital double-somite (Figure 3B; figure 8 in Hamond, 1968) slightly wider than long; paired genital apertures bipartite, each comprising latero-ventral copulatory pore and dorsolateral gonopore; lateral margins with rows of setules on distal third, posterior to genital apertures. Each genital area armed with 2 small setae (Figure 3B).

Caudal rami (figures 7–8 in Hamond, 1968) slightly longer than wide; armed with 6 setae. Seta I absent, setae III–VI

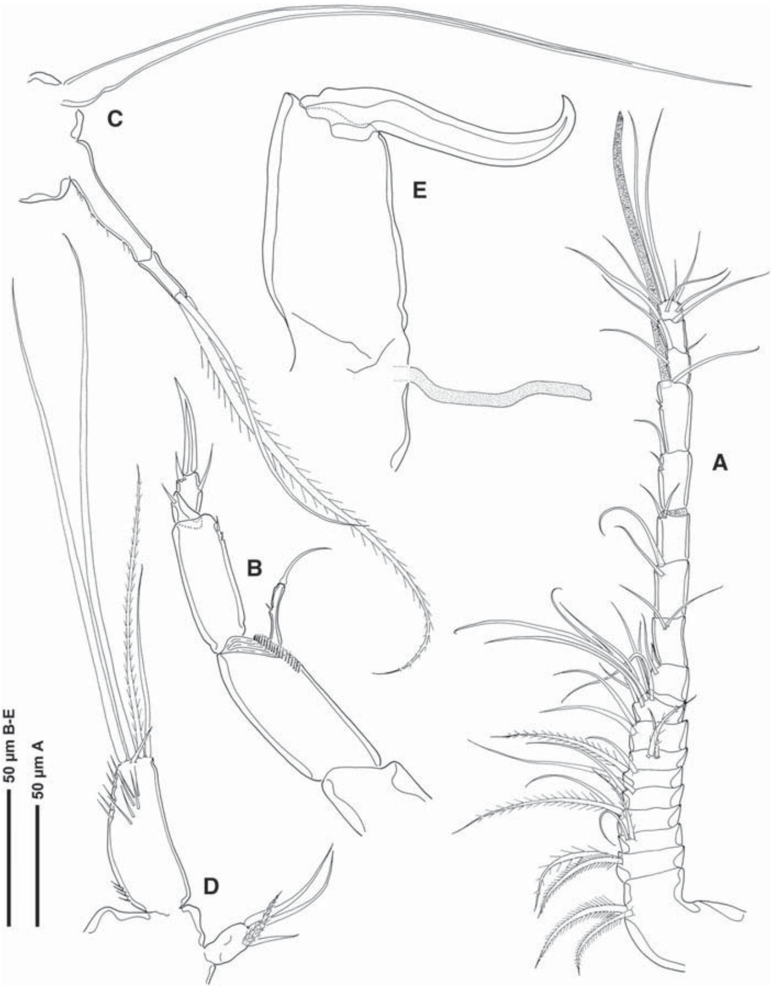

Fig. 2. *Asterocheres ellisi* Hamond, 1968 (holotype female except for A). (A) Antennule (paratype female); (B) antenna; (C) mandible; (D) maxillule; (E) maxilla.

arranged around posterior margin and setae II and VII slightly displaced onto dorsal surface.

Antennule (Figure 2A) 21-segmented, about 321 µm long, segmental homologies and setation as follows: I-1; II-2; III-2; IV-2; V-2; VI-2; VII-2; VIII-2; IX–XII-7; XIII-2; XIV-1 + spine; XV-2; XVI-2; XVII-2; XVIII-2; XIX-2; XX-2; XXI-2 + ae; XXII–XXIII-2; XXIV–XXV-3; XXVI–XXVIII-7. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX–XII).

Antenna biramous (Figure 2B), about 188 µm long. Coxa unarmed, basis unarmed but ornamented with row of spinules on distal third. Exopod 1-segmented, very long, about 6 times longer than wide; with small lateral seta and long terminal seta. Endopod 3-segmented; proximal segment elongated, ornamented with 2 spinules on lateral margin; middle segment produced distally on medial side but articulating with distal segment proximally on lateral side, bearing smooth subterminal seta; distal segment with lateral and terminal smooth setae, both smooth, and distal claw.

Siphon slender (figure 13 in Hamond, 1968), about 301 µm long, reaching between bases of legs 1 and 2.

Mandible (Figure 2C) comprising stylet-like gnathobase and slender 2-segmented palp. Proximal segment ornamented with spinules on lateral margin and longer than distal segment. Distal segment armed with one plumose and one smooth terminal setae. Stylet located in oral cone, formed by labrum and labium.

Maxillule bilobed (Figure 2D); praecoxal endite (inner lobe) 3 times longer than palp (outer lobe). Inner lobe armed with 5 distal setae, one of them minute, ornamented with rows of spinules on lateral margin proximally and distally, and patch of long spinules subdistally. Outer lobe armed with 2 terminal and 2 subterminal setae, one subterminal seta stout and densely plumose.

Maxilla (Figure 2E) 2-segmented but with partial transverse surface suture on syncoxa marking plane of fusion between praecoxa and coxa. Praecoxa bearing flaccid element medially, representing tubular extension of external opening of maxillary gland, and coxa unarmed. Claw-like basis stout and short recurved at its end.

Maxilliped 5-segmented (Figure 3A), comprising short syncoxa, long basis and 3-segmented endopod. Syncoxa with

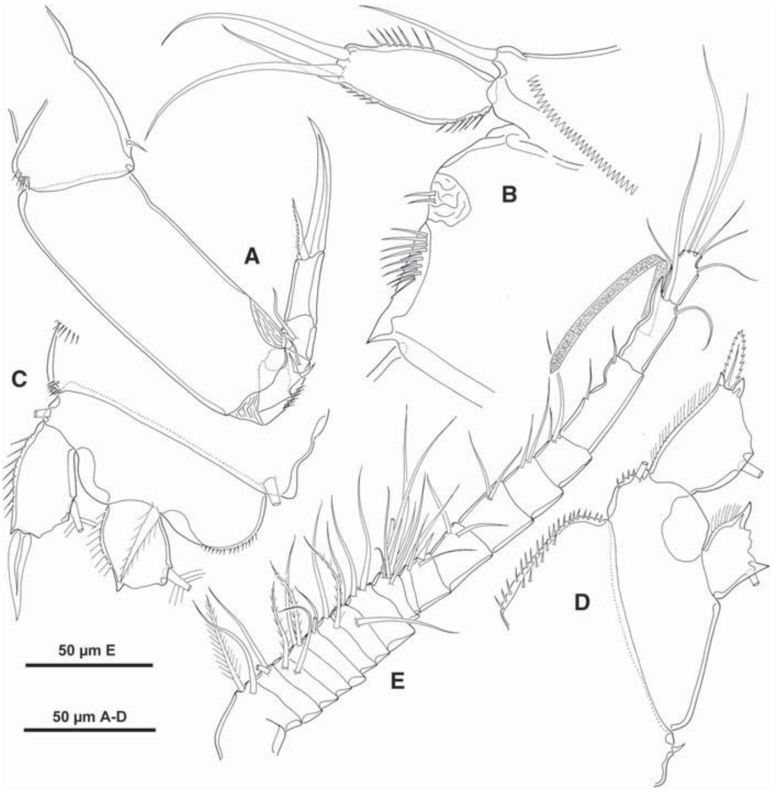

Fig. 3. *Asterocheres ellisi* Hamond, 1968 (holotype female). (A) Maxilliped; (B) detail of genital double somite and leg 5; (C) leg 1; (D) leg 4. *Asterocheres ellisi* Hamond, 1968 (allotype male); (E) antennule.

short seta on inner margin and patch of spinules distally on outer margin. Basis unarmed, without ornamentation. First endopodal segment bearing 3 smooth setae and ornamented with rows of spinules on outer margin; second endopodal segment with smooth seta; and third endopodal segment bearing terminal claw close to pinnated seta.

Swimming legs 1–4 biramous (Figure 3C & D; figures 16–19 in Hamond, 1968). Intercoxal sclerite present in legs 1–4. Spine and seta formula:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-1	I-1; I-1; III,4	0-1; 0-2; 1,5
Leg 2	0-1	1-0	I-1; I-1; III,I,4	0-1; 0-2; 1,2,3
Leg 3	0-1	1-0	I-1; I-1; III,I,4	0-1; 0-2; 1,1 + I,3
Leg 4	0-1	1-0	I-1; I-1; III,I,4	0-1; 0-2; 1,1 + I,2

The inner coxal seta short in leg 1, large in legs 2 and 3, and reduced in leg 4; being always pinnate (except for leg 4) whereas outer basal seta always smooth.

Fifth leg (Figure 3B) with protopod incorporated into somite; outer basal seta smooth, displaced to lateral surface. Free segment (exopod) elongated, oval, with truncated distal end and bearing 3 smooth terminal setae. Both outer and inner margins with spinules.

Sixth leg represented by paired opercular plates closing off gonopores on genital double-somite; armed with 2 short smooth setae.

Description of adult male

Body cyclopiform, with dorsoventrally flattened prosome and cylindrical urosome (figure 20 in Hamond, 1968). Smaller than female, and much less broad; body length 580 µm. Sexual dimorphism in urosomal segmentation, antennules, maxillipeds and leg 6. Urosome 5-segmented, comprising pedigerous somite 5, genital somite and 3 free abdominal somites (figure 21 in Hamond, 1968). Genital somite about 1.2 times wider than long.

Antennule (Figure 3E) 18-segmented, about 272 µm long, geniculation located between segments 16 (XIX–XX) and 17 (XXI–XXII). Segmental fusion pattern as follows: I-2; II-2; III-2; IV-2; V-2; VI-2; VII-2; VIII-2; IX–XII-7; XIII-2; XIV-1 + spine; XV-2; XVI-2; XVII-2; XVIII-2; XIX–XX-2; XXI–XXII-2 + ae; XXIII–XXVIII-6.

REMARKS

Comparison with Hamond's text and illustrations revealed a number of discrepancies: (1) Hamond (1968) described the female antennule as 20-segmented; re-examination showed that the minute tenth segment (XIII) was overlooked by Hamond and thus, the antennule is 21-segmented; (2) the antennary exopod has 2 elements, alateral setule and a terminal seta instead of a single element, and the 3-segmented antennary endopod has a different articulation from that shown by the original illustration; (3) the mandibular palp is clearly 2-segmented; (4) the inner maxillular lobe has 5 terminal setae instead of 4 as stated by Hamond; (5) the maxilla has an aesthetasc-like extension on the proximal part of the syncoxa which was not illustrated by Hamond; (6) the maxilliped is 5-segmented with the setal formula: (1, 0, 3, 1, 1 + claw) and not 4-segmented as claimed by Hamond; (7) the 2 short-setae of the genital areas were omitted; and (8) the basal setae of the first and fourth legs were also overlooked by Hamond.

Asterochres ellisi was originally included in a group of species that shows 20-segmented antennule in females. However, after this redescription it should be relocated to the group of 21-segmented antennule. According to Bandera *et al.* (2007), this latter group is composed of fifteeen species (excluding *A. bulbosus*; see above). However, these authors disregarded 2 species which also have this characteristic: (1) *Asterocheres uncinatus* (Kritchagin, 1873) described from Yalta; and (2) *Asterocheres bacescui* (Marcus, 1965) from the Black Sea.

From these seventeen species, only 7 have been described or illustrated as dorso-ventrally flattened prosome: *A. jeanyeatmanae* Yeatman, 1970, *A. tenuicornis* Brady, 1910 (redescribed by Eiselt, 1965), *A. simulans* (Scott, 1898) (redescribed by Sars in 1915 and Ivanenko in 1997), *A. reginae* Boxshall & Huys, 1994, *A. lunatus* Johnsson, 1998, *A. lilljeborgi* Boeck, 1859 and *A. bacescui*. Furthermore, we also have to consider *A. uncinatus* whose body shape was omitted in the description. This last species can be separated easily from *A. ellisi* by the number of terminal setae on the exopod of leg 5, *A. uncinatus* has 2 (Kritchagin, 1873) and *A. ellisi* shows 3 setae. Among the 7 species with dorso-ventrally flattened prosome, *A. bacescui* is the only one with 1-segmented mandibular palp (see Figure 6C; Marcus, 1965), in contrast with the 2-segmented mandibular palp of *A. ellisi*.

According to Yeatman's description (see figure 35 in Yeatman, 1970), *A. jeanyeatmanae* possesses 2 terminal setae in the exopod of leg 5, although, as mentioned above, *A. ellisi* bears 3 terminal setae on this leg.

The caudal rami, slightly longer than wide in *A. ellisi*, separates it from *A. tenuicornis*, that has an extremely long caudal rami (about 6 times longer than wide; see Figure 2A; Eiselt, 1965); and *A. simulans* which shows a very short caudal rami (about twice wider than long; see Figure 1B; Ivanenko, 1997).

As for the cephalosome shape, *A. ellisi* presents a cephalosome moderately broad, about 1.3 wider than long and epimeral areas of cephalosome and somites bearing legs 2–4 with posterolateral angles rounded. Contrarily *A. reginae* shows a broad and short cephalosome, about 1.8 times wider than long (see Figure 1A; Boxshall & Huys, 1994) and *A. lilljeborgi* and *A. lunatus* have the epimeral areas of cephalothorax with posterolateral angles pointed (Johnsson, 1998; Ivanenko & Ferrari, 2003).

Asterocheres hongkongensis Malt, 1991
(Figure 4)

TYPE MATERIAL

Holotype female (NHM 1989.199; 1 slide) associated with an orange sponge collected at Chek Chau (Hong Kong), 8 m depth, in April 1986.

DIAGNOSIS

Description of adult female

As this species was described based on a single female, the only available material was the slide made by Malt (1991) and therefore, the habitus of this copepod has been impossible to observe. Total length measured 500 µm (according to Malt, 1991). Prosome 1.8 times as the length of urosome.

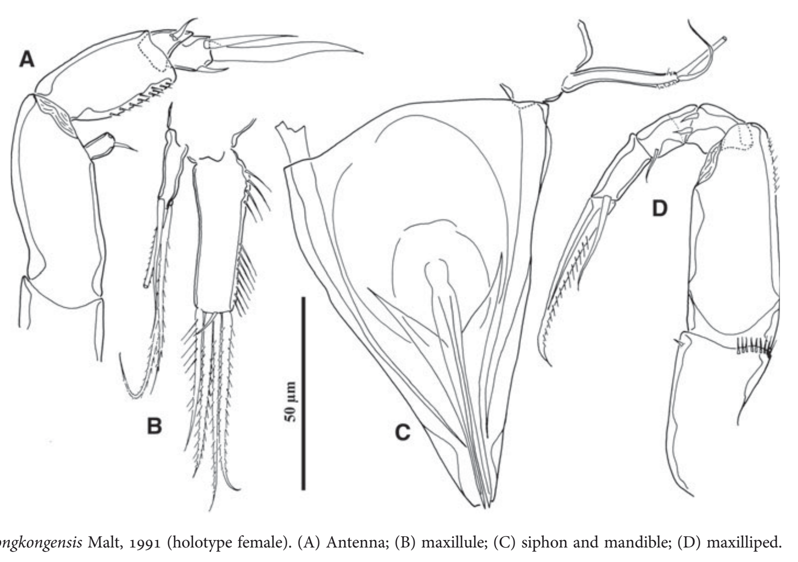

Fig. 4. *Asterocheres hongkongensis* Malt, 1991 (holotype female). (A) Antenna; (B) maxillule; (C) siphon and mandible; (D) maxilliped.

Urosome 4-segmented, comprising pedigerous somite 5, genital double-somite and 2 free abdominal somites. Pedigerous somite 5 wider than long. Genital double-somite (Figure 4B; Malt, 1991) as long as wide; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore; lateral margins with some setules posterior to genital apertures.

Caudal rami (Figure 4B; Malt, 1991) slightly longer than wide (measured along outer margin); armed with 6 short setae; seta I absent; setae III–VI arranged around posterior margin and setae II and VII on dorsal surface.

Antennule as in original description (Figure 4C; Malt, 1991).

Antenna biramous (Figure 4A), stout and 152 μm long. Coxa and basis unarmed. Exopod 1-segmented, short, about 1.5 times longer than wide; with a short and smooth seta and a hole where might be another seta that has been lost in dissection. Endopod 3-segmented; first segment elongated, unarmed but ornamented with row of spinules on lateral margin. Second segment produced distally on medial side but articulating with distal segment proximally on lateral side; bearing subterminal smooth seta. Third segment with distal claw, and 2 setae, one lateral and short and other subterminal and long, both of them smooth.

Siphon short, about 105 μm long, pyriform, not reaching maxilliped base (Figure 4C).

Mandible (Figure 4C) comprising stylet-like gnathobase and slender 1-segmented palp. Stylet located in oral cone formed by labrum and labium. Palp ornamented with spinules distally; armed with 2 unequal apical setae.

Maxillule bilobed (Figure 4B); praecoxal endite (inner lobe) more than twice longer than palp (outer lobe) and ornamented with row of setules on proximal and distal margins; armed with 5 distal setae, four of them plumose and one short and smooth. Palp armed with subterminal smooth seta and 3 distal plumose setae.

Maxilla 2-segmented (Figure 4F; Malt, 1991), with unarmed syncoxa and claw-like basis terminally recurved with minute seta (overlooked by Malt, 1991) and rows of spinule distally.

Maxilliped 5-segmented (Figure 4D), comprising short syncoxa, long basis and distal subchela consisting of 3 free endopodal segments armed with distal claw-like element. Syncoxa with one short seta on inner margin and row of setule distally. Basis elongated with spinules laterally. First endopodal segment bearing 2 setae and second armed with one smooth seta. Third endopodal segment bearing apical seta and curved terminal claw with distal margin with row of long spinules. All endopodal setae smooth.

Legs 1 to 5 as in original description (Figure 4B & 4H–K; Malt, 1991).

Sixth leg represented by paired opercular plates closing off gonopores on genital double-somite; each armed with 2 setae.

Adult male unknown.

REMARKS

Although Malt (1991) described the body of this asterocherid species as dorso-ventrally flattened, rounded cyclopoid, her illustration (page 171, figure 5A, Malt, 1991) is more similar to a rounded shape than to a dorso-ventrally flattened prosome as stated. Unfortunately, this feature has not been verified because the single female available was dissected.

A detailed re-examination of *Astrerocheres hongkongensis* holotype has revealed a number of significant differences: (1) the antennary endopod is 3-segmented instead of 2-segmented. Furthermore the formula of its armature is 0, 1, 2 + claw with first endopodal segment ornamented with row of spinules on lateral margin; (2) as Kim (2005) pointed out Malt (1991) described this species omitting the mandible. Nevertheless, the palp is 1-segmented with 2 terminal setae, a short seta and another probably longer although its length is impossible to ascertain since it is broken; and (3) Malt also overlooked some elements in the maxillule and maxilliped: the maxillule possesses 5 and 4 setae in inner and outer lobes respectively and the 5-segmented maxilliped has the formula: 1, 0, 2, 1, 1 + claw.

Asterocheres hongkongensis belongs to the species group with 19-segmented antennules in females and 1-segmented mandibular palp which includes: *Asterocheres scutatus* Stock, 1966, *Asterocheres proboscideus* Stock, 1966, *Asterocheres aesthetes* Ho, 1984, *Asterocheres aplysinus* Johnsson, 2002 and *Asterocheres brevisurculus* Kim, 2005.

The length of the oral cone separates *A. hongkongensis*, characterized by a short siphon not reaching the maxilliped base, from 2 species: *Asterocheres proboscideus*, which according to Stock (1966a) has a very long oral siphon, extending beyond the caudal rami and *A. aplysinus* with siphon extending beyond the insertion of leg 1 (Johnsson, 2002). Furthermore, the exopod of leg 5 of *A. aplysinus* bears only 2 setae instead of the 3 as in *A. hongkongensis*.

In *A. scutatus* the genital double-somite is much wider than long (about as wide as the last metasome segment; see figure 1A, B in Stock, 1966b) while in *A. hongkongensis* it is about as long as wide.

The 2 remaining species can be separated from *A. hongkongensis* by the length of the caudal setae. According to the illustration made by Ho (figure 17A in Ho, 1984), *A. aesthetes* presents the caudal setae longer than the entire urosome; and in the description of *A. brevisurculus* made by Kim in 2005 (Figure 4A; Kim, 2005) the caudal setae are as long as the entire urosome. In contrast, *A. hongkongensis* possesses the caudal setae scarcely longer than the caudal rami, being a unique characteristic among the *Asterocheres* species.

Asterocheres indicus Sewell, 1949
(Figure 5)

TYPE MATERIAL

Holotype female (NHM 1963.628.435; 1 slide) found in washings from alcyonarians at the John Murray Expedition Station 45.

DIAGNOSIS

Description of adult female

Body cyclopiform (figure 10A in Sewell, 1949), slender with oval cephalothorax and cylindrical urosome. Total length 740 μm and maximum width 380 μm. Ratio of length to width of prosome 1.3:1. Ratio of length of prosome to that of urosome 1:1. Epimeral areas of cephalothorax and pedigerous somites 2–4 with posterolateral angles rounded. Pedigerous somite 4 much smaller and narrower than preceding ones.

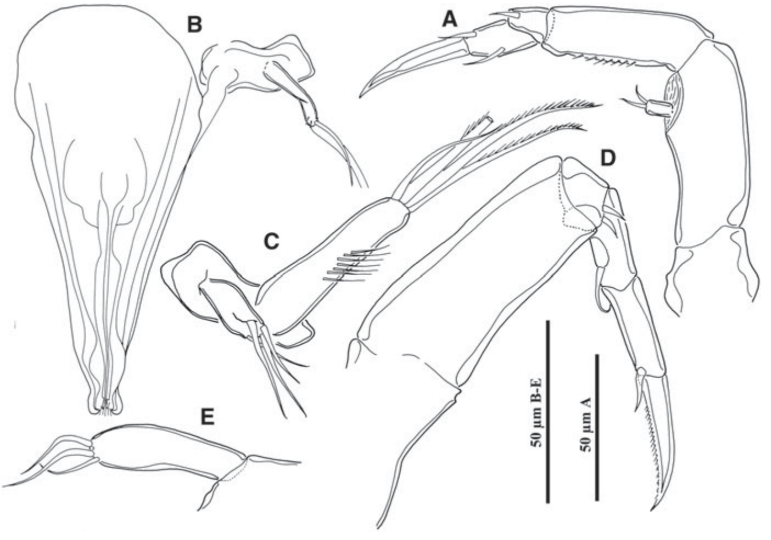

Fig. 5. *Asterocheres indicus* Sewell, 1949 (holotype female). (A) Antenna; (B) siphon and mandible; (C) maxillule; (D) maxilliped; (E) free segment of leg 5.

Urosome 4-segmented, comprising pedigerous somite 5, genital double-somite and 2 free abdominal somites. Pedigerous somite 5 wider than long. Genital double-somite about 1.1 times wider than long; genital apertures bipartite, comprising ventrolaterally located copulatory pore and dorsolaterally located gonopore.

Caudal rami (figure 10A, B in Sewell, 1949) slightly longer than wide and armed with 6 setae; seta I absent, setae II–VII arranged around posterior margin.

Antennule (figure 10C in Sewell, 1949) 20-segmented, about 218 µm long. Segment 18 armed with an aesthetasc.

Antenna biramous (Figure 5A); about 166 µm long. Coxa and basis unarmed. Exopod short, twice longer than wide; 1-segmented, bearing 2 short smooth setae. Endopod 3-segmented; first segment elongated, unarmed but ornamented with row of spinules on lateral margin. Second segment produced distally on medial side but articulating with third segment proximally on lateral side and armed with distal smooth seta. Third segment with distal claw, and 2 smooth subterminal setae.

Siphon short (Figure 5B), about 140 µm long, reaching posterior margin of insertion of maxillipeds.

Mandible (Figure 5B) comprising stylet-like gnathobase and slender 1-segmented palp. Stylet located in oral cone formed by labrum and labium. Palp ornamented with distal rows of spinules and armed with 2 unequal apical setae.

Maxillule bilobed (Figure 5C); praecoxal endite (inner lobe) 2.3 times longer than palp (outer lobe). Endite ornamented with row of setules medially; armed with 4 distal setae, 3 of them plumose, ornamented with short spinules distally, plus short and smooth seta. Palp armed with 2 subterminal and 2 terminal setae; all setae seemingly smooth.

Maxilla as in original description (figure 10E in Sewell, 1949).

Maxilliped 5-segmented (Figure 5D), comprising short syncoxa, long basis and distal subchela consisting of 3 free endopodal segments with distal claw-like element. The small inner distal seta usually present in syncoxa has not been observed although there is a notch where this seta is commonly found. Basis elongated, without ornamentation and unarmed. First endopodal segment bearing 2 naked setae and second segment with smooth seta. Third endopodal segment bearing recurved terminal claw plus additional apical smooth seta. Distal margin of claw with row of minute setules.

Swimming legs as in original description (figure 10G in Sewell, 1949).

Fifth leg (Figure 5E) with protopodal segment incorporated into somite; exopod slender, more than 3 times longer than wide, armed with 3 smooth terminal setae.

Sixth leg represented by paired opercular plates closing off gonopores on genital double-somite; each armed with a seta.

Adult male unknown.

REMARKS

Sewell (1949) described *Asterocheres indicus* with omission of the mandible which is drawn and described for the first time here. Furthermore, a re-examination of the holotype revealed some differences with the original description: (1) Sewell described this species as possessing a 19-segmented antennule and illustrated it with segments 9 (IX–XII) and 10 (XIII) only incompletely separated (see figure 10C in Sewell, 1949). Although the specimen has been mounted in ventral side with antennules lying on the rest of the body, it can be observed that segments 9 and 10 are completely separated and, therefore the antennule has one more segment; (2) Sewell drew the antennal endopod with 2 segments, the latter with a suture. However, this structure is clearly 3-segmented. The ornamentation of the first endopodal segment, a row of lateral spinules, is also missing in the original illustration; (3) the original description only mentioned that the 2 maxillulary lobes are markedly unequal not specifying their armature or ornamentation. However, as the specimen is whole mounted, it is impossible to ascertain whether the setae of the outer lobe are plumose; (4) the maxilliped is 5-segmented with setal formula 0, 0, 2, 1, 1 + claw instead of 0, 0, 0, 1, 1 + claw illustrated by Sewell.

Nevertheless it is probable that the seta usually present in the first segment was lost during the mounting since there is a notch in that place; and (5) the free segment of leg 5 bears 3 terminal setae instead of 2 as described by Sewell.

Some of these observations have already been made by Ummerkutty (1966), who found this species in the Gulf of Manaar from weed washings. He observed that his specimens have the antennule segments 9 (IX–XII) and 10 (XIII) fully separated and also that the free segment of leg 5 bears 3 terminal setae. These two characteristics are present in the holotype. However, the third difference stated by Ummerkutty (1966), 'a pair of rather strong setae is present on the ventral side of the genital somite, guarding the genital apertures', has been impossible to observe due to the rather deteriorated state of the genital area in the holotype.

From now on, *A. indicus* belongs to the group of species with 20-segmented antennule in females and 1-segmented mandibular palp. As commented above (see remarks on *A. bulbosus*), there are 4 *Asterocheres* species which share these 2 characteristics (*A. longisetosus*, *A. stocki*, *A. tetrasetosus* and *A. bulbosus*) and another 4 species which have to be included since there is no available information about the mandibular palp (*A. dentatus*, *A. minor*, *A. intermedius* and *A. ventricosus*).

Among the species poorly described, *A. minor* can be separated from *A. indicus* by body shape, which is nearly circular in outline in the former and has an oval cephalothorax in the latter. According to Brian (1927), *A. ventricosus* possesses a genital somite laterally expanded, about 1.8 times wider than long. However, the genital somite of *A. indicus* is as long as wide. The length of the siphon reaching the posterior margin of the insertion of maxillipeds in *A. indicus* separates it from *A. intermedius* whose siphon, reaches beyond the base of leg 1 and from the 2 species described by Nair & Pillai (1984)—*A. longisetosus* and *A. stocki*—that have an extremely long siphon (see remarks on *A. bulbosus*). The characteristic 4 setae on the free segment of the fifth leg of *A. tetrasetosus* distinguish this species from *A. indicus*.

Information about *A. dentatus* is really scarce. However, this species has a genital somite with tooth-like process on lateral margin, posteriorly to genital area, which is absent in *A. indicus*. *Asterocheres bulbosus* is the most similar species to *A. indicus* in this group; however we can find some differences between them. According to Malt's illustration (see Figure 5D; Malt, 1991), the exopod of the antenna bears 2 terminal long setae instead of the 2 short setae present in *A. indicus*. The caudal rami are longer in *A. indicus* and the genital somite is longer in *A. bulbosus*.

Asterocheres micheli Gurney, 1927
(figures 110G–H in Gurney, 1927)

TYPE MATERIAL

The material deposited in the Natural History Museum of London as *Ascomyzon micheli* (NHM 1928.4.2.13; cotype), collected at Kabret (Cambridge Suez Canal Expedition) in 1924, is a harpacticoid copepod.

REMARKS

This species was collected during the Cambridge Expedition to the Suez Canal and described by Gurney in 1927. The description is poor, the author only drew the dorsal habitus of the male (figure 110G in Gurney, 1927) and a ventral view showing the mouth parts (figure 110H in Gurney, 1927), not mentioning the number of specimens collected nor the host where the copepods were found. Nevertheless the original text description provides enough information to distinguish it from the remaining species of the genus. According to Gurney's description the antennule is 18-segmented in the female and there are only 2 species more which share this characteristic, *A. unicus* Johnsson, 2001 and *A. spongus* Johnsson, 2002. These 2 species can be separated from *A. micheli* by the mandibular palp and length of the oral cone. *Ascomyzon micheli* possesses a 2-segmented mandibular palp and siphon reaching the insertion of leg 1. However, *A. unicus* shows 1-segmented mandibular palp and siphon between the insertion of maxilliped and leg 1; *A. spongus* has 1-segmented mandibular palp and the oral cone reaches beyond the insertion of the maxilliped (Johnsson, 2001, 2002). Moreover, the 2 species decribed by Johnsson possess 2 setae on the free segment of the leg 5 while *A. micheli* has 3 terminal setae.

In the original description, Gurney pointed out that the basipodite of leg 1 presents a very large spine. However, there is no illustration of this appendage and it is not possible to know its exact position or length.

Another uncommon feature is the length of the male antennule. Gurney describes it as rather longer than the female antennule.

This species (a single male) has also been recorded by Sewell 1949, who collected it at Nicobar Island (Bay of Bengal, India). However he expressed some reservations about its specific assignment and did not provide any information about the host.

Asterocheres ovalis Sewell, 1949
(Figure 6)

TYPE MATERIAL

Holotype male (NHM 1963.6.28.436; 1 slide) found in washings from an ascidian host at the John Murray Expedition Station 10.

DIAGNOSIS

Description of adult male

Body cyclopiform (figure 11A in Sewell, 1949), with dorsoventrally flattened prosome and cylindrical urosome. Total body length 500 μm and maximum width 360 μm. Ratio of length to width of prosome 1.1:1. Ratio of length of prosome to that of urosome 2.2:1. Prosome very broad, comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites with well-developed epimeral margins. Genital somite about 1.4 times wider than long; bearing genital apertures postero-laterally on ventral surface.

Caudal rami (figure 11A in Sewell, 1949) as long as wide and armed with 6 setae; seta I absent, setae II–VII arranged around posterior margin. Antennule, maxillule and maxilla as in original description (figure 11B, D, F in Sewell, 1949).

Antenna (Figure 6A) biramous, 178 μm long, with small unarmed coxa and long unarmed basis. Exopod more than

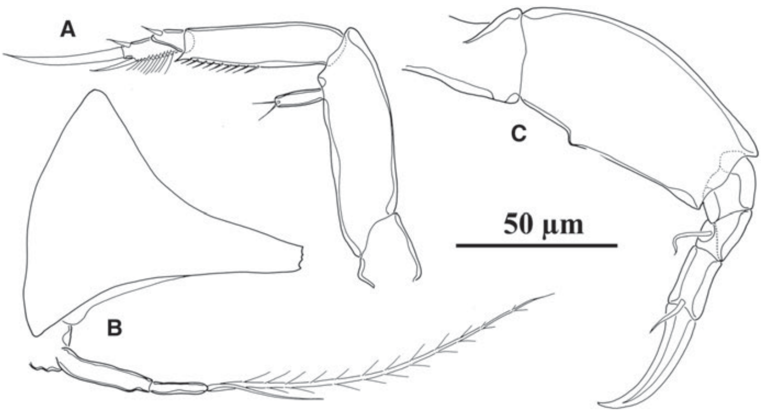

Fig. 6. *Asterocheres ovalis* Sewell, 1949 (holotype male). (A) Antenna; (B) siphon and mandible; (C) maxilliped.

3 times longer than wide, 1-segmented, bearing 2 terminal setae. Endopod 3-segmented; first segment elongated, unarmed but ornamented with lateral row of spinules. Second segment produced distally on medial side but articulating with third segment proximally on lateral side and armed with smooth seta. Third segment armed with 2 subterminal smooth setae and distal claw; inner margin ornamented with lateral rows of fine setules.

Mandible (Figure 6B) with 2-segmented slender palp and stylet-like gnathobase. Stylet located in oral cone. Both segments of palp without ornamentation; second segment armed with 2 terminal setae, the shorter one smooth.

Siphon (Figure 6B) short, about 86 µm long, formed by labrum and labium joined laterally, reaching between the insertions of maxilla and maxilliped.

Maxilliped 5-segmented (Figure 6C), robust, comprising short syncoxa, long basis and distal subchela consisting of 3 free endopodal segments armed with distal claw-like element. Syncoxa without usual small inner distal seta. Basis with small tooth-like process in proximal half of medial margin. First endopodal segment unarmed; second armed with smooth seta and third endopodal segment with recurved terminal claw plus additional apical smooth seta. Distal claw stout.

Legs as in original description (figure 11I–H in Sewell, 1949).

Female unknown.

REMARKS

Sewell (1949) described *Asterocheres ovalis* based on a single male. Except for three species: *A. abyssi* (Hansen, 1923), *A. ovalis* Sewell, 1949 and *A. alter* Eiselt, 1965, the descriptions of the *Asterocheres* species are based on females of which in more than 30% of cases the male is unknown, so it is difficult to make comparisons among them.

After comparing the specimen deposited in the NHM and the original description, a number of differences have been found: (1) the antenna possesses a 3-segmented endopod with setal formula: 0, 1, 2 + claw instead of 1, 0, 2 + claw illustrated by Sewell; (2) the mandibular palp is 2-segmented; and (3) the armature of the maxilliped is 0, 0, 0, 1, 1 + claw and not unarmed as in the original illustration. The setae usually present in segments 1 and 3 have not been observed in this specimen.

The most conspicuous feature of *A. ovalis* is the number of antennule segments since there is no previous record of an *Asterocheres* with only 14 segments.

The prosome of *A. ovalis* is dorsoventrally flattened, which is shared by about 30% of the 71 *Asterocheres* species known. In 16 of these 20 species, the male is known and the antennules are always 17- or 18-segmented. From the remaining 4 species whose males are still unknown, 3 of them can be separated from *A. ovalis* with respect to: (1) the mandibular palp, which is 1-segmented in *A. scutatus* Stock, 1966 in contrast with the 2-segmented palp present in *A. ovalis*; (2) the siphon length, reaching the insertion of leg 1 in *A. serrulatus* (Humes, 1996b); and (3) the armature of the outer lobe of the maxillule, which consists of only 2 setae in *A. crenulatus* Johnsson, 1998 and 4 setae in *A. ovalis*.

The closest *Asterocheres* species to *A. ovalis*, with regard to the characteristics mentioned above, is *A. maxillatus* Stock, 1987. Nevertheless, this latter species has only a female known which was collected in Curaçao (Netherlands Antilles) associated with the scleractinian coral *Manicina areolata* (Linnaeus, 1758), and the females present a 20-segmented antennule. The male antennule will probably be 17- or 18-segmented as in the remaining species of the group with 20-segmented antennule in the female. According to Stock (1987), the shield-shaped anterior part of the body of this species hides the posterior metasomites in dorsal view while there are no hidden metasomites in *A. ovalis*.

Asterocheres rotundus Malt, 1991
(Figure 7)

TYPE MATERIAL

Holotype female (NHM 1989.219; 1 slide) plus 1 female paratype (NHM 1989.225; in alcohol) associated with a purplish sponge, at Gau Tau (Hong Kong), 5–10 m depth, 18 April 1986. 1 female paratype (NHM 1989.224; 1 slide) and 1 male paratype (NHM 1989.225; 1 slide) associated with *Ricinia* sp. at Chek Chau (Hong Kong), 15 m depth, 6 April 1986. 1 male allotype (NHM 1989.220; 1 slide) associated with a reddish-purple sponge at Peng Chau (Hong Kong), 2 m depth, 15 April 1986 plus 2 female paratypes (NHM 1989.222–223; 2 slides) and 1 male paratype (NHM 1989.221; 1 slide).

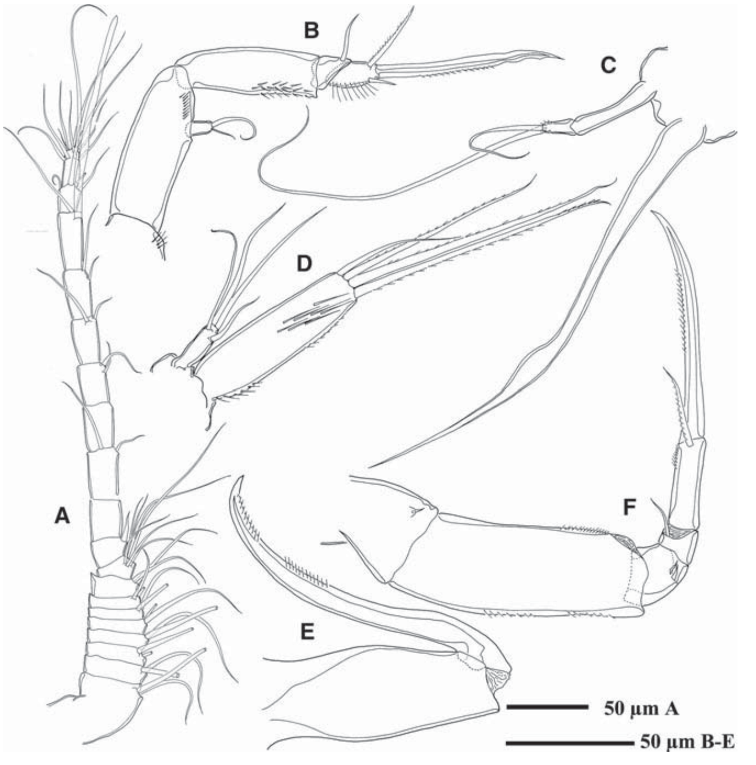

Fig. 7. *Asterocheres rotundus* Malt, 1991 (holotype female). (A) Antennule; (B) antenna; (C) mandible; (D) maxillule; (E) maxilla; (F) maxilliped.

DIAGNOSIS

Description of adult female

Body cyclopiform (Figure 6E; Malt, 1991), with cephalothorax oval and cylindrical urosome. Body length 620 µm (590–660 µm) and maximum width 327 µm. Prosome about 2.2 times as long as urosome. Epimeral areas of pedigerous somites 2 and 3 with posterolateral angles rounded. Pedigerous somite 4 narrower than preceding ones.

All urosomites ornamented with epicuticular scales. Pedigerous somite 5 wider than long. Genital double-somite 1.2 times wider than long; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore; lateral margins with rows of setules in distal third, posterior to genital apertures. Each genital area armed with 2 setae.

Caudal rami (Figure 6F; Malt, 1991) slightly wider than long; armed with 6 setae; seta I absent; setae II–VII arranged around posterior margin.

Antennule 19-segmented (Figure 7A); about 365 µm long, segmental homologies and setation as follows: I-2; II-2; III-2; IV-2; V-2; VI-2; VII-2; VIII-2; IX–XII-7; XIII-spine; XIV-0; XV-2; XVI-0; XVII-2; XVIII-2; XIX-2; XX–XXI-1 + ae; XXII–XXIII-3; XXIV–XXVIII-10. All setae smooth.

Antenna biramous (Figure 7B); 213 µm long. Coxa and basis unarmed. Exopod 1-segmented, with 2 distal setae, one short and the other long. Endopod 3-segmented; first segment elongated, ornamented with patch of spinules on lateral margin. Second segment produced distally on medial side but articulating with distal segment proximally on lateral side; bearing distal seta. Third segment with distal claw plus 2 subterminal setae, one of them plumose and ornamented with long setules on lateral margin.

Siphon pyriform (figure 6I in Malt, 1991), about 170 µm long, reaching between insertion of maxilliped and leg 1.

Mandible (Figure 7C) comprising stylet-like gnathobase and slender 2- segmented palp. Stylet located in oral cone, formed by labrum and labium, with expansion medially. Palp with first segment long and slender; second segment ornamented with fine spinules apically and 2 apical smooth setae.

Maxillule bilobed (Figure 7D); praecoxal endite (inner lobe) 3.2 times longer than palp (outer lobe), ornamented with spinules on lateral margin, long setules medially, with 4 distal setae, three of them long and plumose and remaining seta short and smooth. Palp with 2 subterminal and 2 terminal setae, all smooth.

Maxilla 2-segmented (Figure 7E); with unarmed coxa. Claw-like basis curved at its end; ornamented with distal row of spinules on lateral margin.

Maxilliped 5-segmented (Figure 7F), comprising short syncoxa, long basis and distal subchela consisting of 3 free endopodal segments with distal claw-like element. Syncoxa with short seta distally; basis ornamented with rows of spinules on lateral margins. First endopodal segment bearing 2 short smooth setae; second segment with medial seta; third endopodal segment ornamented with spinules apically bearing curved terminal claw plus plumose seta distally.

Legs as in original description (figures 6F & 7A–D in Malt, 1991).

Description of adult male

Mean body length 490 μm (480 – 500 μm). Sexual dimorphism in urosomal segmentation, antennules, maxillipeds and leg 6 (Figure 7F – H; Malt, 1991). Prosome (Figure 7E; Malt, 1991) with angular head.

REMARKS

This species was described by Malt in 1991 and was collected from Hong Kong together with *Asterocheres hongkongensis* and *Asterocheres bulbosus*. Malt described these three species as having a dorso-ventrally flattened prosome but none of them seem to have it, they possess the usual cyclopoid shape with cephalothorax oval and cylindrical urosome. The re-examination of the holotype and paratypes of *Asterocheres rotundus* also provide some characteristics that are missing in the original description. For example: (1) Malt missed one seta in the 19-segmented antennule; (2) the antennary exopod is shorter than originally drawn and her boundary between the second and third endopodal segments does not correspond with the pattern observed; (3) the mandibular palp is clearly 2-segmented and the stylet has a thicker area at medial region; (4) the maxillule inner lobe presents long setules medially and the outer lobe possesses 4 naked setae; and (5) the maxilliped is 5-segmented with setal formula (1, 0, 2, 1, 1 + claw). In the original description there are some setae missing and the segmentation between the 2 last segments is unclear.

Asterocheres rotundus belongs to the *Asterocheres* species group with 19-segmented antennule in the female and a 2-segmented mandibular palp which includes: *Asterocheres renaudi* Canu, 1892, *A. halichondriae* Stock, 1966, *A. serrulatus* (Humes, 1996), *A. dysideae* Humes, 1996, *A. enewetakensis* Humes, 1997, *A. crenulatus* Johnsson, 1998, *A. spinopaulus* Johnsson, 1998, *A. abrolhensis* Johnsson, 1998, *A. crinoidicola* Humes, 2000, *A. picinguabensis* Johnsson, 2001, *A. pilosus* Kim, 2004 and *A. walteri* Kim, 2004. *Asterocheres renaudi* is particularly distinct because of the cuticle ornamentation of the cephalic appendages (Canu, 1892) which distinguishes it from the remaining *Asterocheres* species.

Asterocheres serrulatus Humes, 1996, *A. dysideae* Humes, 1996, *A. crenulatus* Johnsson, 1998, *A. spinopaulus* Johnsson, 1998 and *A. abrolhensis* Johnsson, 1998 have a dorsoventrally flattened prosome (Humes, 1996; Johnsson, 1998) separating them from *A. rotundus*.

The illustration of the urosome in dorsal view for *A. rotundus* (see Figure 6F; Malt, 1991) shows a relatively short free segment of leg 5 which is 2.6 times longer than wide. The illustrations of urosome for *A. enewetakensis* (see Figure 1B, C; Humes, 1997) and *A. crinoidicola* (see Figure 1A, C; Humes, 2000) show a clearly longer free segment of leg 5 whose ratios are, respectively, 6 and 5 times longer than wide. The ornamentation of this structure differs in *A. rotundus*, with 2 long and 1 very short terminal setae and *A. picinguabensis*, which has only 2 terminal setae (Johnsson, 2001).

Kim described 2 species, *A. pilosus* and *A.walteri*, from Panama in 2004. *Asterocheres pilosus* possesses the largest innermost seta of the maxillular palp with very long hairs on the inner margin. However, *A. rotundus* has 4 setae of usual length and shape for the genus in the maxillular palp. Furthermore, the inner lobe of the maxillule is 3.2 times longer than the outer lobe in *A. pilosus*, while in contrast, *A. walteri* has an outer lobe 1.2 times longer than the inner lobe (Kim, 2004).

The most similar species of this group is *A. halichondriae*. In order to make a detailed comparison between these two species, we have re-examined Stock's material deposited in the Zoological Museum of Amsterdam (ZMA Co. 100.951c). This comparison revealed 2 unique differences between *A. rotundus* and *A. halichondriae*: (1) the body length is about 150 μm longer in *A. rotundus*; and (2) *A. halichondriae* possesses 5 setae in the inner lobe of maxillule, one of them naked and minute (Stock, 1966a); while, the inner lobe of maxillule of *A. rotundus* present only 4 distal setae.

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Artículo VI

Redescription of *Asterocheres suberitis* Giesbrecht, 1897 and *A. tenerus* (Hansen, 1923) (Copepoda: Siphonostomatoida), including notes on *A. abyssi* (Hansen, 1923) and *A. intermedius* (Hansen, 1923).

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Redescription of *Asterocheres suberitis* Giesbrecht, 1897 and *A. tenerus* (Hansen, 1923) (Copepoda: Siphonostomatoida), including notes on *A. abyssi* (Hansen, 1923) and *A. intermedius* (Hansen, 1923)

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Abstract

The present paper reviews the type material of four poorly described species of *Asterocheres* Boeck, 1859 deposited in the Zoologisk Museum of the University of Copenhagen. For *A. abyssi* (Hansen, 1923) and *A. intermedius* (Hansen, 1923), each taxon was represented by only the poorly preserved, dissected holotype. Consequently, neither species could be redescribed in detail. As the original description of *A. abyssi* is not sufficient to differentiate it from its congeners, we propose to regard this species as undetermined. Although only the antennule and antenna of *A. intermedius* were amended, this species is still considered valid based on a combination of characters that include a 21-segmented antennule, oral siphon extending beyond leg 1 insertion, and genital double-somite being longer than wide. The other two species, *A. suberitis* Giesbrecht, 1897 and *A. tenerus* (Hansen, 1923), were redescribed which revealed inaccuracies in the original descriptions. *Asterocheres suberitis* is characterized by having a 21-segmented antennule, oral siphon extending to the maxilliped insertion, 2-segmented mandibular palp, and genital double-somite being wider than long. *Asterocheres tenerus* is distinguished by a combination of characters that include a 21-segmented antennule, oral siphon extending to the intercoxal plate of leg 2, 2-segmented mandibular palp, relatively slimmer and longer claws on the antenna, maxilla and maxilliped, and genital double-somite being about as long as wide.

Key words: Siphonostomatoida, *Asterocheres*, Danish Ingolf expedition, Davis Strait, Naples

Introduction

Asterocheres Boeck, 1859 is the most speciose genus of the siphonostomatoid copepod family Asterocheridae Giesbrecht, 1899, containing approximately 70 species, most of which were poorly or incompletely described (Stock 1966; Ho 1984; Humes 1996; Ivanenko & Smurov 1997; Kim 2004, 2005). As such, these descriptions are unreliable for comparative purposes. Nevertheless, the number of new *Asterocheres* species continues to increase at a fairly rapid rate, with 15 new members being described since 2000 (Humes 2000; Johnsson 2001, 2002; Kim 2004, 2005; Bandera *et al*. 2005, 2007; Bispo *et al*. 2006; Conradi *et al*. 2006). In sharp contrast, only one poorly known species has been recently redescribed within the same time period (Ivanenko & Ferarri 2003). This paper provides morphological information on the type material of four *Asterocheres* species as part of the ongoing taxonomical revision of poorly known species within this symbiotic group (Bandera & Huys 2008; Bandera & Conradi in press).

Material and methods

Type material of *Asterocheres abyssi* (Hansen, 1923), *A. intermedius* (Hansen, 1923), *A. suberitis* Giesbrecht, 1897 and *A. tenerus* (Hansen, 1923) deposited in the Zoologisk Museum of the University of Copenhagen (ZMUC) were examined in this study. Copepod body length was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami. For *A. suberitis* and *A. tenerus*, additional type specimens were cleared in lactic acid, stained with Chlorazol black E (Sigma® C-1144), dissected, and temporarily mounted in lactophenol in order to make detailed observations. All temporary mounts were subsequently sealed with Entellan (Merck® 1.07961-UN 1866) following examinations. Figures were drawn with the aid of a camera lucida attached to a Leica DMLB differential interference microscope. Appendage segmentation and setation were named and numbered using the system established by Huys & Boxshall (1991).

Results

Order Siphonostomatida Thorell, 1859

Family Asterocheridae Giesbrecht, 1899

Asterocheres Boeck, 1859

Asterocheres abyssi (Hansen, 1923)

Ascomyzon abyssi Hansen 1923: 8.
Asterocheres abyssi: Stock 1966a: 209; Johnsson 1998: 96; Kim 2004: 181.

Material examined. Holotype ♂ (ZMUC. CRU-5026) collected during the "Danish Ingolf expedition" in Davis Strait, Station 36 (61º50′N, 56º21′W), at 1,435 fathoms (ca. 2.62 km).

Hosts. Unknown.

Distribution. Atlantic Ocean (Hansen 1923).

Remarks. This species was described by Hansen (1923) based on a damaged male and has not been subsequently recorded. Re-examination of the material deposited in the ZMUC did not yield any useful taxonomic information due to the poor condition of the type specimen. Therefore, the only morphological information regarding this species is that provided by Hansen (1923), who described *A. abyssi* as possessing: 1) a 5-segmented urosome, with the anal somite nearly as long as wide and slightly longer than the two preceding somites combined; 2) a genital somite as long as broad; 3) caudal rami shorter than anal somite; 4) a presumably 17-segmented antennule (however, Hansen could only observe 15 segments in the type specimen); 5) the terminal claw of the antenna as long as the first endopodal segment; 6) a siphon that extends beyond the insertion of the maxillipeds; 7) a maxillulary palp (outer lobe) about one-third as long as the praecoxal endite (inner lobe) and armed with two terminal setae; and 8) a 2-segmented mandibular palp (see Hansen 1923: Plate I, fig. 4b).

Descriptions of *Asterocheres* species are, with the exception of *A. abyssi*, *A. ovalis* Sewell, 1949 and *A. alter* Eiselt, 1965, based on females. Indeed, the male is unknown in more than one-third of these descriptions. Among the known males, *A. jeanyeatmanae* Yeatman, 1970 and *A. major* (Thompson & Scott, 1903) share the eight aforementioned characteristics with *A. abyssi*. As there are no known features to distinguish *A. abyssi* from these congeners, we consider it as an undetermined taxon.

***Asterocheres intermedius* (Hansen, 1923)**

Ascomyzon intermedium Hansen 1923: 6.
Asterocheres intermedius: Stock 1966b: 152; Johnsson 1998: 91.

Material examined. Holotype ♀ (ZMUC. CRU-6873/8357) collected during the "Danish Ingolf Expedition" in Davis Strait, Station 25 (63º30′N, 54º25′W), at 582 fathoms (ca. 1.06 km).

Hosts. Unknown.

Distribution. Atlantic Ocean (Hansen 1923).

Remarks. Hansen (1923) omitted some taxonomically important appendages, such as the mandible and fifth legs (the latter lost in the type specimen), in his description of *A. intermedius*. Unfortunately, this species has not been recorded again, and only the antennule and antenna could be observed in the damaged, dissected holotype. Our observations of the pre-oral appendages differed from the original description as follows: 1) the antennule, despite being cleanly broken in half in the holotype, consists of 21 rather than 20 free segments; and 2) the endopod of the antenna is comprised of 3 instead of 2 segments. Despite these amendations, a detailed redescription of this species is still badly needed.

Contrary to the above species, *A. intermedius* can be easily differentiated from its congeners. For instance, *A. intermedius*, along with the following 19 congeners, possess a 21-segmented antennule in females: *A. astroidicola* Conradi, Bandera & López-González, 2006; *A. bacescui* (Marcus, 1965); *A. echinicola* (Norman, 1868); *A. ellisi* Hamond, 1968; *A. flustrae* Ivanenko & Smurov, 1997; *A. hirsutus* Bandera, Conradi & López-González, 2005; *A. jeanyeatmanae* Yeatman, 1970; *A. lilljeborgi* (Boeck, 1859); *A. lunatus* Johnsson, 1998; *A. madeirensis* Bandera, Conradi & López-González, 2007; *A. minutus* (Claus, 1889); *A. reginae* Boxshall & Huys, 1994; *A. simulans* (T. Scott, 1898); *A. suberitis* Giesbrecht, 1897; *A. tenerus* (Hansen, 1923) (redescribed below as possessing a 21-segmented antennule in female); *A. tenuicornis* Brady, 1910; *A. uncinatus* (Kritchagin, 1873); *A. urabensis* Kim, 2004; and *A. violaceus* (Claus, 1889). Among these species, only *A. ellisi*, *A. urabensis*, *A. hirsutus*, *A. tenerus* and *A. astroidicola* have a siphon extending beyond the insertion of leg 1 as in *A. intermedius*. However, these four species do not have a genital double-somite that is longer than wide as in *A. intermedius.*

***Asterocheres suberitis* Giesbrecht, 1897**
(Fig. 1)

Cyclopicera echinicola (*nec* Norman, 1868): Giesbrecht 1895: 175.
Asterocheres suberitis Giesbrecht 1897: 254; Giesbrecht 1899: 70.
Asterocheres echinicola (*nec* Norman, 1868): T. Scott 1898: 270; T. Scott 1900: 389; Norman & T. Scott 1906: 192.
Asterocheres suberitis antarctica T. Scott 1903: 573.

Material examined. 7 ♀ and 4 ♂ (ZMUC. CRU-8298) cotypes, ex *Suberites domuncula* (Olivi), Gulf of Naples, leg. W. Giesbrecht in 1895.

Redescription of adult female: Body (see Giesbrecht 1899: fig. 1, Taf. 2) cyclopiform, with oval prosome and cylindrical urosome. Total length 840 µm (n = 1); maximum width 420 µm. Ratio of length to width of prosome 1.1:1. Ratio of length of prosome to urosome 1.6:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites. Pedigerous somite 4 much smaller and narrower than preceding somites. Dorsal cephalothoracic shield and free pedigerous somites ornamented with integumental pores and sensillae. Urosome 4-segmented, comprising pedigerous somite 5, genital double-somite and 2 free abdominal somites. Genital double-somite about as long as wide; genital apertures separate, each comprising ventrolateral copulatory pore and dorsolateral gonopore (oviduct opening). Lateral margin of genital double-somite ornamented with setular rows posterior to genital apertures. Each genital area armed with seta. Caudal rami (see Giesbrecht 1899: fig. 7, Taf. 2) slightly more than 1.5 times longer than wide, armed with 6 setae (seta I absent); setae II–VII arranged along posterior margin.

Antennule (see Giesbrecht 1899: fig. 2, Taf. 2) 21-segmented, 360 µm long, with an aesthetasc on segment 18. Antenna (Fig. 1A) biramous, 234 µm long (including claw); coxa and basis unarmed. Exopod 1-segmented, slightly longer than wide, with small medial seta and 2 unequal terminal setae. Endopod 3-segmented; first segment elongated, ornamented with lateral row of fine spinules; second segment asymmetric, distomedially produced, and armed with simple seta; third segment with distal naked claw and two unequal, pinnate setae.

Siphon (see Giesbrecht 1899: fig. 13, Taf. 2) pyriform, about 130 µm long, reaching maxilliped insertions. Mandible (Fig. 1B) comprising stylet-like gnathobase and slender 2-segmented palp. Stylet with denticulate margin subapically. First segment of palp ornamented with lateral row of spinules; second segment ornamented with spinules apically and armed with 2 spinulate setae. Maxillule (Fig. 1C) bilobed. Praecoxal endite (inner lobe) 2.5 times longer than palp (outer lobe), ornamented with small spinules proximally and long setules apically, and armed with 4 distal setae (1 smooth, 2 spinulate, and 1 with apical spinules and spoon-shaped tip). Palp armed with 4 pinnate setae. Maxilla (see Giesbrecht 1899: fig. 14, Taf. 2) 2-segmented, with curved claw-like basis. Maxilliped (see Giesbrecht 1899: fig. 16, Taf. 2) 5-segmented.

Swimming legs 1 and 4 as in original description (see Giesbrecht 1899: figs. 4 and 6, Taf 2). Legs 2 and 3 (Figs 1D–E) biramous and trimerous, with armature formula as follows:

	Coxa	Basis	Exopod	Endopod
Leg 2	0-1	1-0	I-1; I-1; III,I+1,3	0-1; 0-2; 1,2,3
Leg 3	0-1	1-0	I-1; I-1; III,I+1,3	0-1; 0-2; 1,1+I,3

Legs 2 and 3 outer exopodal spines bilaterally serrated. Intercoxal sclerites present in both legs. Leg 3 coxa ornamented with spinules along lateral margin (Fig. 1E).

Fifth leg (see Giesbrecht 1899: fig. 11, Taf. 2) 2-segmented, with protopod incorporated into somite; free segment oval, armed with 3 distal plumose setae, and ornamented with spinules. Sixth leg (see Giesbrecht 1899: fig. 7, Taf. 2) represented by paired opercular plates, each armed with seta, closing off gonopores on genital double-somite.

Adult male: Body (see Giesbrecht 1899: fig. 10, Taf. 2) cyclopiform, more slender than female, with oval cephalothorax and cyclindrical urosome. Total length 590 µm and maximum width 260 µm (n = 1). Prosome comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites. Urosome 5-segmented, comprising pedigerous somite 5, genital somite and 3 free abdominal somites. Caudal ramus as in female.

Appendages similar to those of female except for the following. Antennule (see Giesbrecht 1899: fig. 3, Taf. 2) 17-segmented, 210 µm long, with an aesthetasc on segment 16 and geniculation located between segments 15 and 16. Maxilliped (see Giesbrecht 1899: fig. 12, Taf. 2) with thorn-like process in proximal-half of basis. Sixth leg (see Giesbrecht 1899: fig, 15, Taf. 2) forming large opercular plate closing off genital apertures, armed with 2 setae.

Hosts. The most common host of *Asterocheres suberitis* is the hermit crab sponge *Suberites domuncula* (Olivi) [*domunculus* = "little house"], which is a Mediterranean species that typically grows on an empty snail shell or a shell occupied by a snail or hermit crab and less commonly on other substrates such as bivalve shells or wharf pilings (Riedl 2000). *Suberites domuncula* hosts other siphonostomatoid copepods such as *Spongin-ticola uncife*r Topsent, 1928 and *Asterocheres simulans* (T. Scott, 1898) (Topsent 1928; Ivanenko 1997). Recently, Mariani & Uriz (2001) found *A. suberitis* associated with other sponge species such as the widespread *Cliona viridis* (Schmidt), *Scopalina* sp. and the Mediterranean *Scopalina lophyropoda* Schmidt. However, these authors recognized that their copepod identification must be treated with caution.

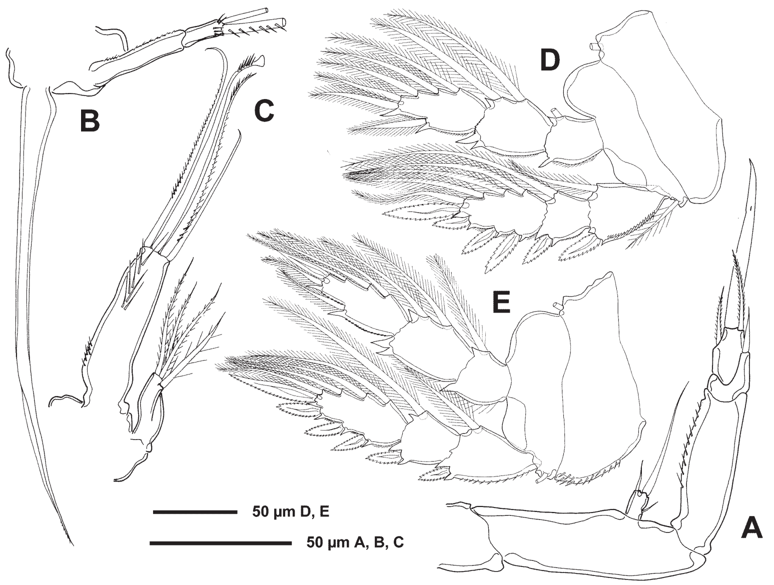

FIGURE 1. *Asterocheres suberitis*, Giesbrecht, 1897, cotype female. A, antenna; B, mandible; C, maxillule; D, leg 2; E, leg 3.

Distribution. Mediterranean (Giesbrecht 1895; Mariani & Uriz 2001), north Atlantic (according to Stock (1967) and Gotto (1993) the form referred to as *A. echinicola* by T. Scott (1898, 1900) and Norman & T. Scott (1906) from the Clyde and Loch Fyne almost certainly belong to *A. suberitis*), and India (Krishnaswamy 1959—this record requires confirmation).

Remarks. Giesbrecht (1895) collected this species from *Suberites domuncula* (Olivi) from Naples, but reported it under the binomen *Cyclopicera echinicola* Norman, 1868. Giesbrecht (1897) subsequently realised that his specimens from *S. domuncula* were not conspecific with *C. echinicola* and renamed it *Asterocheres suberitis*.

Our examination of Giesbrecht´s (1897) cotypes revealed the following errors in his original and subsequent descriptions: 1) the antennal endopod is composed of 3 instead of 2 segments as illustrated by Giesbrecht (1899); 2) the mandibular palp is clearly 2-segmented and not 1-segmented as depicted in the original illustration; 3) the ornamentation of the inner lobe of the maxillule was overlooked by Giesbrecht (1899); and 4) legs 2 and 3 were never illustrated by Giesbrecht (1897, 1899).

This species, like *A. intermedius* discussed above, belongs to the group of congeners with 21-segmented antennules in females. However, *A. suberitis* can be distinguished from other members of this group as follows. *Asterocheres suberitis* can be easily separated from *A. lilljeborgi*, *A. simulans* (see Ivanenko 1997), *A. bacescui*, *A. jeanyeatmanae*, *A. reginae* and *A. lunatus* (see Johnsson 1998) by lacking a dorsoventrally flattened prosome. *Asterocheres suberitis*, like most *Asterocheres* species, possesses a siphon reaching the maxilliped base. In contrast, the siphon of *A. ellisi*, *A. urabensis*, *A. hirsutus*, *A. intermedius*, *A. tenerus* and *A. astroidicola* extends to leg 1 or 2. *Asterocheres suberitis* has caudal rami 1.5 times longer than wide, while in *A. tenuicornis* and *A. echinicola* they are 6 and 2.5 times longer than wide, respectively, and in *A. flustrae* it is about as long as wide. *Asterocheres uncinatus* has a 2-segmented endopod on the antenna (see Marcus & Por 1960 and Marcus 1965), while *A. suberitis* has 3 segments on this appendage. The 2-segmented mandibular palp of *A. suberitis* separates it from *A. minutus, A. violaceus* and *A. madeirensis*, each having a 1-segmented mandibular palp.

In 1903, T. Scott collected some *Asterocheres* specimens from Scotia Bay (South Orkneys) which in his opinion closely resembled *A. suberitis*. Although he reported some differences between them, such as the shape of the siphon, the length of the fifth leg, and the proportional lengths in the antennulary segments and abdominal somites, he considered that these differences were not sufficient enough to establish a new species, and therefore, named the Scotia Bay specimens *Asterocheres suberitis antarctica*. However, comparisons between the illustrations of these two forms revealed another difference: the antennary exopod of the Scotia Bay specimens bears "two or three short terminal bristles" rather than a small medial seta and 2 terminal setae, one of them very long, as in *A. suberitis*. Thus contrary to T. Scott's opinion, we consider that these two forms are not conspecific and that the differences enumerated above are enough to separate them at species level. Nevertheless, as *A. s. antarctica* material is no longer extant, the establishment of a new species must be postponed until more specimens are collected.

***Asterocheres tenerus* (Hansen, 1923)**
(Figs 2–4)

Ascomyzon tenerum Hansen 1923: 7.
Asterocheres tenerus: Stock 1966b: 152; Johnsson 1998: 92.

Material examined. Holotype ♀ and 8 paratypes (5 ♀ and 3 ♂) (ZMUC. CRU-8357) collected during the "Danish Ingolf Expedition" in Davis Strait, Station 25 (63º30′N, 54º25′W), at 582 fathoms depth (ca. 1.06 km).

Redescription of adult female: Body (Fig. 2A) cyclopiform, with oval cephalothorax and cylindrical urosome. Total length 904 µm (n = 1); maximum width 452 µm. Ratio of length to width of prosome 1.5:1. Ratio of length of prosome to urosome 2.6:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites. Pedigerous somite 4 much smaller and narrower than preceding somites. Dorsal cephalothoracic shield and free pedigerous somites ornamented with integumental pores and sensillae (these features not shown in Fig. 2A). Urosome (Fig. 2B) 4-segmented, comprising pedigerous somite 5, genital double-somite and 2 free abdominal somites. Genital double-somite and following somites furnished with large spinules. Pedigerous somite 5 narrow, largely concealed under tergite of pedigerous somite 4, with spinular row on each side of dorsal midline. Genital double-somite about as long as wide, with separate genital apertures, each comprising ventrolateral copulatory pore and dorsolateral gonopore (oviduct opening); lateral margins with rows of setules posterior to genital apertures. Caudal rami longer than wide, armed with 6 setae (seta I absent); setae III–VI arranged along posterior margin; setae II and VII inserted subapically on dorsal surface.

Antennule (Fig. 2C) 21-segmented, 544 µm long. Segmental homologies (expressed segment given first followed by ancestral segment(s) in brackets) and setation pattern as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX–XII)-7, 10(XIII)-2, 11(XIV)-1+spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+ae, 19(XXII–XXIV)-3, 20(XXV)-2, 21(XXVI-XXVIII)-7. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX-XII). One of two setae on segments 1–8 plumose. Antenna (Fig. 2D) biramous, 430 µm long (including claw); coxa small, unarmed; basis elongated, unarmed, and ornamented with row of spinules along inner margin. Exopod 1-segmented, with small medial seta and 2 subequal terminal setae. Endopod 3-segmented; first segment elongated, with few setules along inner margin; second segment distomedially produced, bearing terminal seta; third segment ornamented with coarse spinules and few setules along inner margin and armed apically with long spinulate claw flanked by 2 unequal barbed setae.

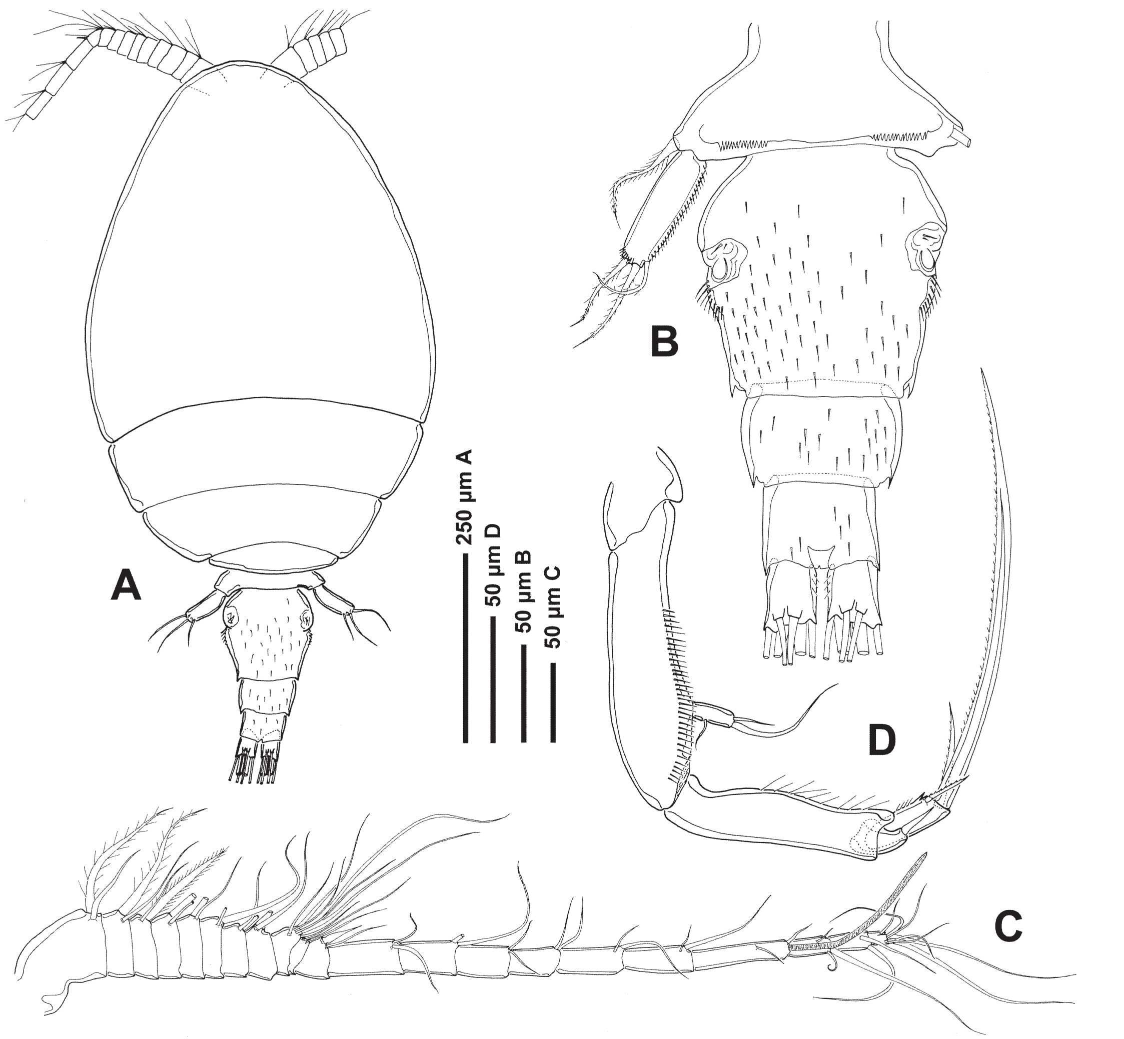

FIGURE 2. *Asterocheres tenerus* (Hansen, 1923), paratype female. A, habitus, dorsal; B, urosome, dorsal; C, antennule; D, antenna.

Siphon long and slender, 370 µm long, reaching the intercoxal plate of leg 2. Mandible (Fig. 3A) composed of stylet-like gnathobase (356 µm long) and 2-segmented palp. First segment of palp ornamented with an incomplete row of spinules; second segment with spinules along distal margin and armed apically with 2 unequal, pinnate setae. Maxillule (Fig. 3B) bilobed, with inner lobe 4 times longer than outer lobe. Outer lobe armed distally with 4 barbed setae. Inner lobe ornamented with spinules laterally and long setules along midline, and armed with 5 distal setae, one of them very short.

Maxilla (Fig. 3C) 2-segmented, with partial transverse suture on syncoxa, possibly marking plane of praecoxa-coxa fusion; praecoxal region bearing long flaccid element medially, representing tubular extension of external opening of maxillary gland; coxal region unarmed, ornamented with row of spinules proximally. Claw-like basis bearing small hyaline process proximally and row of spinules along distal margin. Maxilliped (Fig. 3D) 5-segmented, comprising short syncoxa, long basis and 3 free endopodal segments. Syncoxa with short seta distomedially and few spinules distolaterally; basis with few spinules distolaterally. First endopodal segment with thin distal seta and 2 robust medial setae. Second endopodal segment with medial barbed seta. Third endopodal segment bearing long spinulate claw and apical spinulate seta.

Swimming legs 1–4 (Figs 4A–D) biramous, with only leg 1 complete. Spine and seta formula as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0-1	1-0	I-1; I-1; III,2,2	0-1; 0-2; 1,2,3
Leg 2	0-1	1-0	I-1; I-1; ?	0-1; 0-2; 1,2,3
Leg 3	0-1	1-0	I-1; ?; ?	0-1; 0-2; ?
Leg 4	0-1	1-0	I-1; ?; ?	0-1; 0-2; ?

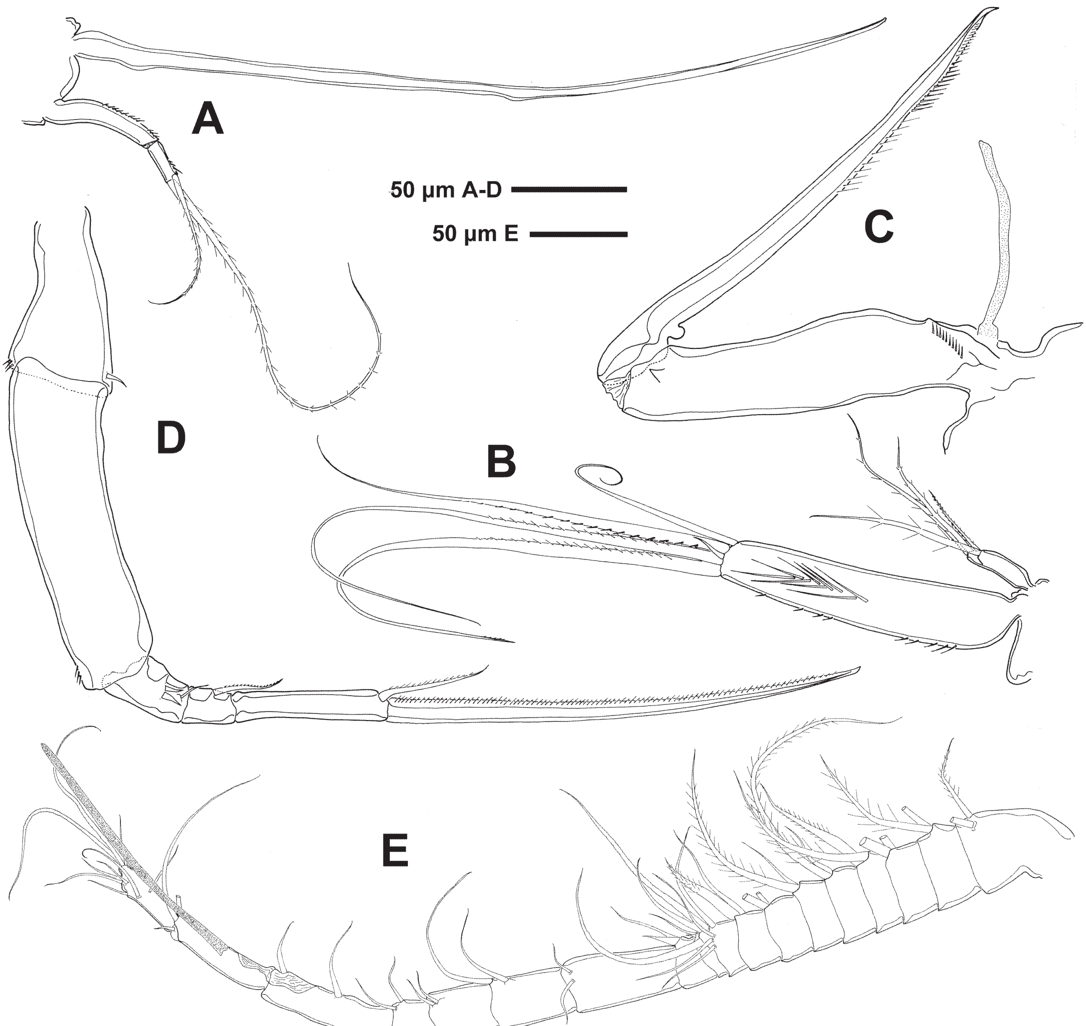

FIGURE 3. *Asterocheres tenerus* (Hansen, 1923), paratype female (A–D) and paratype male (E). A, mandible; B, maxillule; C, maxilla; D, maxilliped; E, antennule.

Intercoxal sclerite of legs 1–3 ornamented with rows of spinules along posterior margin. Coxae of legs 2–4 ornamented with rows of spinules laterally; coxal seta naked in legs 1 and 4, plumose in legs 2 and 3;

outer basal seta of all legs naked. Outer spine of first exopodal segment of leg 3 smooth. Lateral margins of exopodal segments with minute spinules; lateral margins of endopodal segments with row of setules.

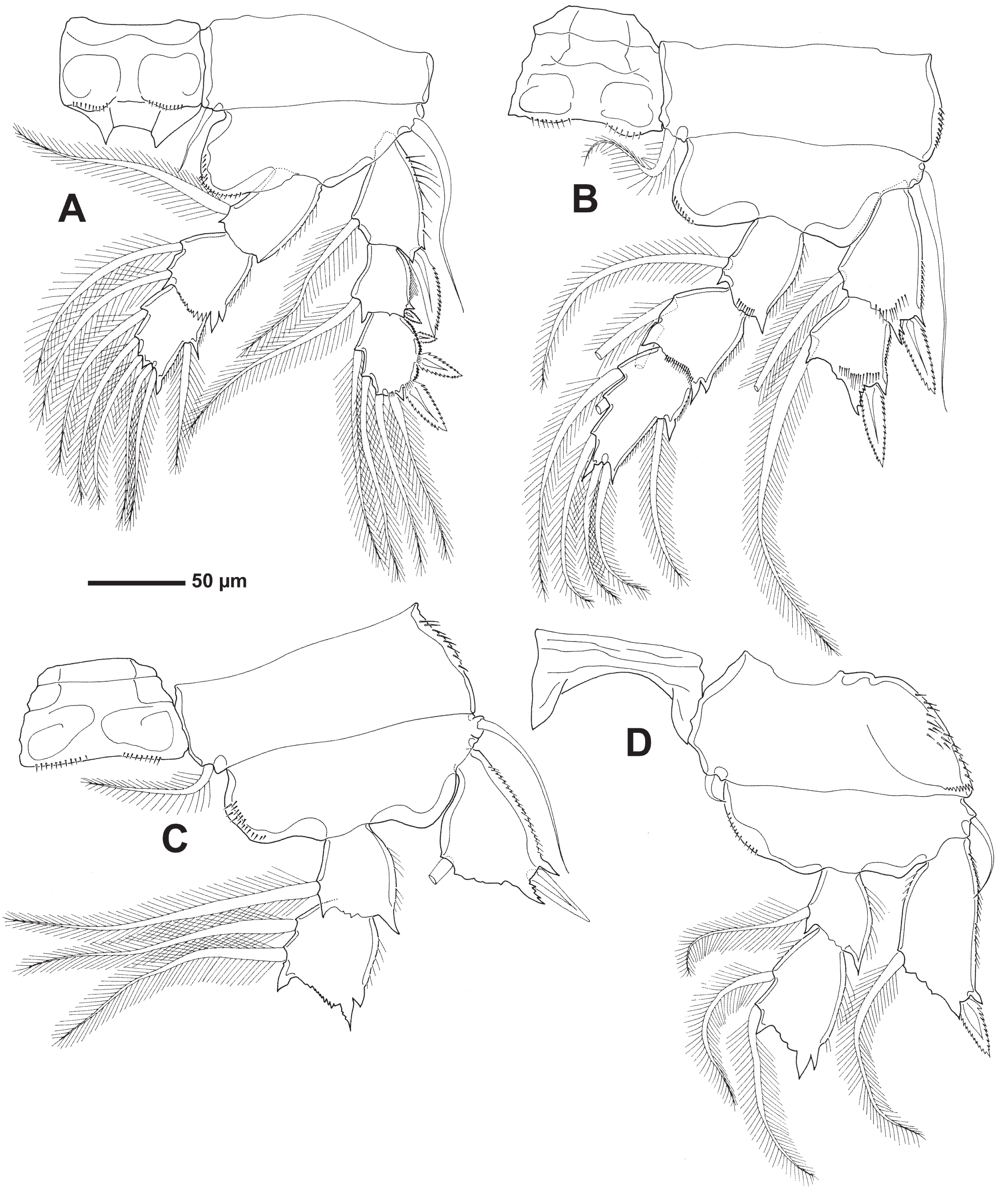

FIGURE 4. *Asterocheres tenerus* (Hansen, 1923), paratype female. A, leg 1; B, leg 2; C, leg 3; D, leg 4.

Leg 5 (Fig. 2B) with protopodal segment incorporated into somite; protopodal seta located laterally; free segment slender, armed with 3 distal plumose setae and ornamented with medial spinular row. Leg 6 (Fig. 2B) represented by paired opercular plates closing off gonopores on genital double-somite; armed with 2 smooth setae, one of them minute.

Adult male: Body cyclopiform, with oval cephalothorax and cylindrical urosome. Total length 890 µm (n = 1); maximum width 460 µm. Prosome comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites. Urosome 5-segmented, comprising pedigerous somite 5, genital somite and 3 free abdominal somites. Caudal ramus armed as in female.

Appendages as in female, except for the following. Antennule (Fig. 3E) 18-segmented, geniculate; segmental homologies (expressed segment given first followed by ancestral segment(s) in brackets) and setation pattern as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-1+spine, 11(XIV)-1+spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX–XX)-2, 17(XXI–XXIII)-3+ae, 18(XXIV–XXVIII)-9. Geniculation located between segments 16 (XIX–XX) and 17 (XXI–XXIII). Segment 10(XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX–XII). Maxilliped with small tooth-like process in proximal-half of basis. Leg 6 forming large opercular plates closing off genital apertures, armed with 2 smooth setae.

Hosts. Unknown.

Distribution. Atlantic Ocean (Hansen, 1923).

Remarks. A detailed re-examination of *Asterocheres tenerus* type material has revealed the following differences between our observations and the original description by Hansen (1923): 1) the highly reduced tenth (XII) antennulary segment of the female was overlooked by Hansen; 2) the antennary exopod bears 3 instead of one element, and the proximal margin of the distal endopodal segment articulates on the lateral side of the preceding segment; 3) the oral siphon extends to the intercoxal plate of leg 2, a feature that is unclear in the original description (according to Hansen, the siphon reaches beyond the insertion of leg 1 or beyond that of leg 2); 4) the inner lobe of the maxillule possesses 5 rather than 4 terminal setae; 5) the aesthetasc-like extension on the proximal part of the maxillary syncoxa was overlooked by Hansen; 6) the maxilliped is composed of 5 instead of 4 segments; 7) the swimming legs, which were not described by Hansen, are indeed present in the type specimens; 8) the free segment of leg 5 bears 3 instead of 2 distal setae; and 9) the male antennule is comprised of 18 rather than 17 segments.

Based on our redescription, *A. tenerus* belongs to the group of *Asterocheres* species having a 21-segmented antennule, which is currently composed of 20 species total as mentioned in the Remarks section of *A. intermedius*. *Asterocheres tenerus* differs from *A. bacescui*, *A. madeirensis*, *A. minutus,* and *A. violaceus* by having a 2-segmented rather than 1-segmented mandibular palp. *Asterocheres tenerus* can be distinguished from *A. lilljeborgi*, *A. echinicola*, *A. uncinatus*, *A. tenuicornis*, *A. simulans*, *A.suberitis*, *A. jeanyeatmanae*, *A. reginae*, *A. flustrae* and *A. lunatus* by having an oral siphon that reaches the insertion of leg 2 rather than only to the insertion of the maxillipeds.

Asterocheres tenerus differs from *A. ellisi* by lacking a dorsoventrally flattened prosome and from *A. intermedius* by having a genital double-somite that is as long as wide rather than longer than wide. The length of caudal rami separates *A. tenerus* from *A. hirsutus*. *Asterocheres tenerus* has caudal rami that are slightly longer than wide, while *A. hirsutus* possesses caudal rami that are 2.5 times longer than wide. *Asterocheres tenerus* can be differentiated from the remaining 2 species, *A. astroidicola* and *A. urabensis*, by having considerably slimmer and longer claws on the antenna, maxilla and maxilliped.

Acknowledgements

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Artículo VII

Two copepod species largely confused: *Asterocheres echinicola* (Norman, 1868) and *A. violaceus* (Claus, 1889). Taxonomical implications.

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ORIGINAL ARTICLE

Two copepod species largely confused: *Asterocheres echinicola* (Norman, 1868) and *A. violaceus* (Claus, 1889). Taxonomical implications

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Abstract Due to its extremely brief description, *Asterocheres echinicola* (Norman, 1868) has been confused with some *Asterocheres* species such as *Asterocheres suberitis* Giesbrecht, 1897, *Asterocheres parvus* Giesbrecht, 1897 and *Asterocheres latus* (Brady, 1872). Furthermore, this species has been considered conspecific with *Cyclopicera lata* (Brady, 1872) and *Asterocheres kervillei* Canu, 1898. The objective of this paper is to study the syntypes of *Asterocheres echinicola* deposited in the Museum of Natural History of London together with abundant material from this and other institutions. Re-examination of these syntypes revealed that *Asterocheres echinicola* was conspecific with the currently known *Asterocheres* species, *A. violaceus*. Therefore, this latter species should be considered as a junior synonym of the former. The specimens described by Brady as *Cyclopicera lata* represent distinctively *Asterocheres echinicola* (=*Asterocheres violaceus*) and are identical to Sars's *Ascomyzom parvum* and to Giesbrecht's *Asterocheres echinicola*. We propose to rename *Cyclopicera lata* as *Asterocheres latus* (Brady, 1872), and raise Sars' *Ascomyzon latus*, a species which is different from *Asterocheres echinicola* (=*Asterocheres violaceus*) and from *Asterocheres latus* (=*Cyclopicera lata*), as a new species. In this paper, we not only redescribe both species *A. echinicola* and *A. latus*, but also compare them with their previous descriptions, with the new material available and with their congeners. The redescription of *Asterocheres latus* revealed new specific differences between this species and *Asterocheres kervillei*, a species considered as synonymous of *Asterocheres latus* for almost 40 years. We strongly recommend that these differences are sufficient to consider these two species different. Finally, we analyzed the implications of all these taxonomical changes with respect to the diversity of the hosts utilized by these copepods and their geographical distribution.

Keywords Siphonostomatoida · *Asterocheres echinicola* · *Asterocheres violaceus* · *Asterocheres kervillei*

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Introduction

Norman (1868) described *Asterocheres echinicola* as *Ascomyzon echinicola*, on the basis of females living in the echinoderm *Echinus esculentus* Linneo, 1758 at Shetland Islands (UK). This description was very concise and devoid of any illustrations and, therefore, the identity of this species was not clear. Four years later, Brady described the species *Cyclopicera lata* which were living among algae in UK (Brady 1872). However, later on, the same author (Brady 1880) after a re-examination of type-specimens of *Ascomyzon echinicola* and studying more specimens of *Cyclopicera lata* collected from dredged material from Ireland, realized that these two species were conspecific. Brady's confusing suggestion of favouring the name of *Cyclopicera lata* to *Ascomyzon echinicola* in spite of the priority of the latter was followed by Thompson (1889, 1893) and Scott (1893, 1898, 1900).

Brady's suggestion was corrected when Giesbrecht (1895) returned to the specific name of *echinicola*, naming his specimens collected from Naples as *Cyclopicera* *echinicola*. However, he misidentified them since, as Giesbrecht himself admitted after the examination of some specimens of *A. echinicola* sent to him by Scott, these specimens belonged to a new *Asterocheres* species: *A. suberitis* (Giesbrecht, 1897). This was not the only incidence when these two species were confused, since according to Stock and Gotto, the form referred to uncertainly as *A. echinicola* by Scott (1898, 1900) from the Clyde and Loch Fyne belongs to *A. suberitis* (Stock, 1967; Gotto, 1993).

Giesbrecht (1897) also stated the almost certain synonym between *A. echinicola* and *Asterocheres kervillei*, a species described by Canu (1898) in association with marine invertebrates in France. Nevertheless, he was not convinced because of the lack of *A. echinicola* males (Giesbrecht 1897). Seventy years later, Stock studying material of both sexes of these two species, concluded that they were conspecific with certain reservations: the length of the caudal rami, the slenderness of the body, and the ornamentation of the urosomal somites (Stock 1967). According to this author, these differences should be considered as intraspecific variability of *A. echinicola*. Surprisingly, Stock in his same work utilized similar characteristics—the length and shape of the siphon, the slenderness of the body, the length of the shortest seta of the mandibular palp and the armature of the fourth leg—to separate *A. echinicola* from *A. parvus* Giesbrecht, 1897.

Asterocheres echinicola has not only been confused with *A. suberitis* and *A. kervillei* but also with *A. parvus* (Sars, 1915, Klie, 1933; Lang, 1949). Thus, Sars, who does not believe in the conspecifity of *Cyclopicera lata* and *Asterocheres echinicola*, named his specimens of *A. echinicola* as *Ascomyzon parvum*. He also named *Cyclopicera lata* as *Ascomyzon latum* and stated that the specimens of *Asterocheres boecki* collected by Giesbrecht belong also to *A. latum*. It was Stock (1967) who demonstrated the conspecifity of *A. echinicola* and *A. parvus* illustrated by Sars (1915) and the validity of the species *Asterocheres parvus* described by Giesbrecht (1897). In fact, up to the present date, the most detailed description and illustrations of *A. echinicola* were performed by Sars under the name of *Ascomyzon parvum*.

Hamond in 1968 added more confusion to the identity of *A. echinicola*. He reported 16 specimens associated with the sponge *Halichondria panicea* (Pallas) collected from Norfolk in 1959 and compared them with *A. echinicola* (as *Ascomyzon parvum* Sars) and *A. latus* (Brady, 1880). Hamond claimed that there were two different forms among the Norfolk specimens: the *latus*-like and the *echinicola*-like with intermediate states. Therefore, and according to Hamond, *A. latus* should also be considered as a synonym of *A. echinicola*.

All of these difficulties in distinguishing *Asterocheres echinicola* from its congeners are due to inadequacies in its original description. Therefore, the study of Norman's species from type specimens is necessary to solve the taxonomic problems in this genus. This paper studies the syntypes of *A. echinicola* deposited in The Natural History Museum of London, together with abundant material from Norman′s collection and others from later expeditions.

Materials and methods

The studied specimens come from both material loaned by various Musea and material collected by the authors. The studied material from The Natural History Museum of London [BM(NH)] included: Norman`s collection, some specimens collected by Hamond in 1988 in Great Britain; and those copepods from this country obtained during The Sub-Aqua Expedition in 1966 sponsored by this institution and the University of London. Furthermore, we have examined material collected by Sars in Norway in 1915 and deposited in The Natural History Museum of the University of Oslo (ZMO) and some specimens collected by Stock in France in 1959 which were deposited in the Zoological Museum of the University of Amsterdam (ZMA).

The material collected by Dr. López-González and one of the authors (MC) was found at Tarifa (Spain) in 1991 associated with marine invertebrates. These invertebrates were individually collected in a plastic bag by SCUBA diving and immediately fixed in formaldehyde 8–10% in seawater. Symbiotic fauna was obtained by pouring the wash water through a 100 μm net. The copepods were finally recovered from the sediment retained and preserved in 70% ethanol.

When the dissected specimens of the asterocherid species from the different musea were not sufficient to make a detailed description of some appendages, we dissected a specimen in lactic acid, prior to staining it with Chlorazol black E (Sigma® C-1144). It was then examined as temporary mounts in lactophenol and later on, sealed with Entellan as permanent mounts. This procedure was also followed with selected specimens obtained by the authors.

All figures were drawn with the aid of a camera lucida on a Leica DMLB differential interference microscope. All appendage segments and setation elements were named and numbered using the system established by Huys and Boxshall (1991). Mean body length of the copepod was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami.

Material from Tarifa was deposited in The Natural History Museum of London (NHM) and in the collection of the research team Biodiversidad y Ecología de Invertebrados Marinos of the University of Seville (BEIM).

Results

Asterocheres echinicola (Norman, 1868)
Echinocheres violaceus Claus, 1889

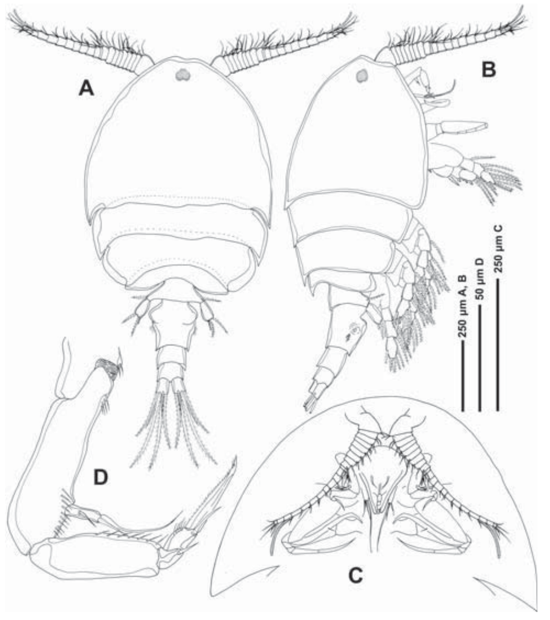


Fig. 1 *Asterocheres echinicola* (Norman, 1868) (female). **a** habitus, dorsal; **b** habitus, lateral; **c** oral appendages; **d** antenna

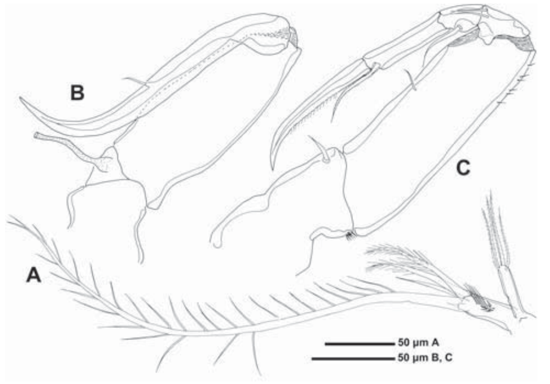


Fig. 2 *Asterocheres echinicola* (Norman, 1868) (female). **a** mandible, **b** maxillule, **c** maxilla

Ascomyzon thompsoni A. Scott, 1896
Asterocheres violaceus Giesbrecht, 1897
(Figures 1, 2, 10a)

Material examined

Three female syntypes (NHM 1911.11.8.M.2589) from Shetland; 5 females plus 4 males (BEIM COP-542), associated with the sea-urchin *Paracentrotus lividus* Lamarck, 1816, Tarifa Island (Southern Iberian Peninsula), 12 m depth, October 1991; 2 females (ZMO F21606), 9 females and 2 males (ZMO F21604) from Skjerjehaun (Norway) collected by Sars; 4 females (ZMO F 21605) associated with *Echinus elegans* Düben and Koren, 1846, collected by Sars.

Description

Adult female

Body cyclopiform (Figs. 1a, b), slender with cephalothorax oval and cylindrical urosome. Mean body length 1,010 µm (980–1,050 µm) and maximum width 540 µm (530–580 µm), based on three specimens. Ratio of length to width of prosome 1.25:1. Ratio of length of prosome to that of urosome 1.6:1.

Prosome, urosome, caudal rami and antennule as in the text and figures of Bocquet et al. (1963) and Giesbrecht (1899).

Antenna biramous (Fig. 1d), about 363 µm long. Coxa unarmed, with few setules on inner margin; basis unarmed but ornamented with fine spinule rows. Exopod 1-segmented, slender, with small lateral seta and two terminal setae, one of them very long. Endopod 3-segmented; proximal segment elongated, ornamented with lateral row of fine spinules. Middle segment produced distally on medial side but articulating with distal segment proximally on lateral side; bearing one distal smooth seta. Third segment with stout distal claw, one smooth terminal seta, and a row of setules on inner margin.

Siphon (Figs. 1c, 10a) very short, reaching posterior margin of insertion of maxilla.

Maxillule bilobed (Fig. 2a); inner lobe (praecoxal endite) approximately as long as outer lobe (palp) but wider than outer lobe. Inner lobe ornamented with long setules and spinules medially; armed with five setae: two plumose, one smooth, one very short and smooth and one longer than the rest—about four and a half times longer—and ornamented with setules. Outer lobe armed with four barbed setae.

Maxilla two-segmented (Fig. 2b) but with transverse suture on syncoxa possibly marking plane of preacoxa-coxa fusion; praecoxal part bearing flaccid element medially, representing tubular extension of external opening of maxillary gland, and coxal part unarmed. Basis claw-like recurved at its end, armed with small seta in the middle of lateral margin.

Maxilliped five-segmented (Fig. 2c), comprising short syncoxa, long basis and three-segmented endopod. Syncoxa with one short seta distally; basis with setule on inner margin. First endopodal segment bearing two smooth distal setae; second endopodal segment with one smooth seta; third endopodal segment bearing terminal recurved claw and one barbed apical seta. Distal margin of claw with row of minute spinules.

Remaining appendages as in the description of Bocquet et al. (1963) and Giesbrecht (1899).

Adult male

As described by Bocquet et al. 1963.

Remarks

Although Norman (1868) did not designate a holotype, the syntypes of *Asterocheres echinicola* are deposited in the NHM as one slide that contains three dissected *Asterocheres* specimens with their oral appendages, legs and urosomes mixed. These specimens belong to the same species, which is clearly recognizable by its short antennule, the extremely short siphon, its characteristic maxillule and the "rounded tip" of the fifth leg. However, this species does not correspond to the diagnostic characteristics that currently defined the species *Asterocheres echinicola* but to another known species described lately by Claus, *Asterocheres violaceus* (Claus, 1889). When Norman (1868) described *A. echinicola*, he provided the following characteristics: body shape similar to that of *Ascomyzon lilljeborgi* (Thorell)—which actually is *Asterocheres siphonatus* Giesbrecht—caudal rami twice as long as broad and the antennule 20-segmented (basal segments excessively short and the remaining somewhat longer but none of them as long as wide). Except for the length of the caudal ramus, which in *A. violaceus* is only one and a half times longer than wide and not twice as long as wide, the information that he provided was closer to *A. violaceus* than to *A. echinicola*. The confusion came later, when Brady considered the type specimens lent by Norman to be identical with *Cyclopicera lata* (Brady, 1880). It is very possible that Norman had mixed these two species since those *Asterocheres* collected later by him and labeled as *A. echinicola* had the diagnostic characteristics that currently defined *A. echinicola*. Nevertheless, since the syntypes of the *A. echinicola* had the diagnostic characteristics of *Asterocheres violaceus*, we have to consider the latter as a junior synonym of the former. Therefore, the specimen described by Brady as *Cyclopicera lata* is in reality a distinct species from *A. echinicola* (=*A. violaceus*). No holotype was designated by Brady, but there is a female of this species recorded by Brady at Roker, a popular collecting locality for Brady, with no collection date deposited in the Hancock Museum (UK) (NEWHM-2.39.04). Unfortunately, we could not examine this unique slide with the entire copepod because the full Brady slide collection is currently in cabinets packed into sealed crates, which are stored in a climate-controlled warehouse while major construction work is carried out on the museum buildings (D. Gordon, personal communication). This collection will be available when the museum re-opens. Nevertheless, the examination of Brady's illustration of the urosome casts no doubts on its conspecificity with Sars' *Ascomyzon parvum* (1915) and with Giesbrecht's *Asterocheres echinicola* (1899). Furthermore, the specimens that Sars (1915) stated to be identical to *Cyclopicera lata* and described as *Ascomyzon latum* (re-examination of Sars' specimens; ZMO reg. no. F21601) are also a different species from *A. echinicola* (=*A. violaceus*) and from *Cyclopicera lata*. This species should therefore be given a new name since *Cyclopicera lata* will be named, by priority and from now on, as *Asterocheres latus* (Brady, 1872). We here redescribed *A. latus* (=Brady's *Cyclopicera lata* and Sars' *Ascomyzon parvum* and Giesbrecht's *Asterocheres echinicola*); and propose also to raise Sars' *Ascomyzon latum* as a new species, naming it as *Asterocheres sarsi* sp. *nov.*, a species which will be fully described in a future work.

Asterocheres echinicola was poorly described and illustrated as *Ascomyzon echinicola* by Norman in 1868 and as *Echinocheres violaceus* by Claus in 1889. Later on, it was described and illustrated by Giesbrecht (1899) and Bocquet et al. (1963) under the name of *Asterocheres violaceus* (Claus, 1889). The population of this species found in Tarifa Island (Southern Spain) shows some discrepancies with the previous descriptions. (1) The antennary exopod has not two but three elements; Bocquet et al. missed one lateral seta; (2) The armature of the third segment of the antennal endopod consists of one apical seta, claw and lateral row of setules, and not two setae and one claw as illustrated by Bocquet et al.; (3) The inner lobe of the maxillule possesses five setae instead of the four setae illustrated by Giesbrecht in 1899. The longest seta is more than four times longer than the median setae and is ornamented with setules. Furthermore, the shortest seta is smooth and shorter than the setules which ornamented the endite of the maxillule. (4) Giesbrecht's illustration of the maxillule shows four smooth setae on the outer lobe and the specimens from Tarifa possess four barbed setae. (5) The maxilla has a flaccid element medially, representing a tubular extension of the external opening of maxillary gland on the proximal part of the syncoxa which was not illustrated or mentioned by previous descriptions. (4) Bocquet et al. in 1963 illustrated the maxilliped of male as possessing six segments with the two median devoid of setae or spines. The specimens from Tarifa have a five-segmented maxilliped with the following armature formula: (1, 1, 2, 1, 1 + claw).

This species belongs to the *Asterocheres* species group characterized by possessing a 21-segmented antennule in females and a 1-segmented mandibular palp. This group is composed of only three species: *A. minutus* (Claus, 1889), *A. bacescui* (Marcus, 1965) and *A. madeirensis* Bandera et al., 2007.

Asterocheres bacescui and *A. madeirensis* can be separated from *A. echinicola* by the length of the siphon and the comparative size of the two lobes of the maxillule (Bandera et al. 2007; Marcus and Por 1960). The inner lobe of the maxillule is longer than the outer lobe for *A. bacescui* and *A. madeirensis,* while, the two lobes of *A. echinicola* are more or less similar in length. As for the siphon, *A. echinicola* possesses an oral cone shorter than the remaining two species.

Asterocheres minutus is the most similar *Asterocheres* species to *A. echinicola*. In fact, these two species are considered sibling species (Bocquet et al. 1963; Bocquet and Stock 1962; Gotto 1979). However, there are a number of differences that separate them, such as (1) the body length, *A. minutus* is much shorter than *A. echinicola*; (2) the exopod of the antenna is slightly longer in *A. minutus*; (3) the shortest seta of the inner lobe of the maxillule which is shorter in *A. echinicola*; (4) the shape of the apical part of the free segment of the fifth leg which is more rounded in *A. echinicola*; (5) *A. minutus* bears three terminal setae equal in length in the exopod of the fifth leg and *A. echinicola* possesses one short seta and two long setae (about twice as long as the shorter one).

Host

For long time, *Asterocheres echinicola* was considered as mainly symbiont with sponges, with its occurrence on *Echinus* being accidental. This reason was even used as argument by Brady in support of the name of *Cyclopicera lata* rather than *Ascomyzon echinicola* in spite of the priority of the latter. The current synonymy between *Asterocheres echinicola* and *A. violaceus* demonstrates that *A. echinicola* is a well-distributed Atlantic-Mediterranean species typically associated with a wide range of both echinoid and asteroid species (Humes 1986). Its occurrence on ophiurids is dubious and needs confirmation (Gotto 1993).

This copepod has been found in four species of asteroids, two belonging to the order Forcipulata, *Marthasterias glacialis* (Linnaeus, 1758) and *Asterias rubens* Linnaeus, 1758, and other two to the order Spinulosida, *Porania pulvillus* (O. F. Müller, 1776) and *Crossaster papposus* (Linnaeus, 1767) (as *Solaster papposus*) (Barel and Kramers 1977; Bresciani and Lützen 1962; Bocquet and Stock 1962; Bocquet et al. 1963). A total of eight echinoids serve as hosts to *A. echinicola*: *Psammechinus miliaris* (Gmelin, 1778), *P. Microtuberculatus*, *Strongylocentrotus droebachiensis* (O. F. Müller, 1776); *Echinus esculentus* Linnaeus, 1758; *E. elegans*; *Paracentrotus lividus*; *Arbacia lixula* (Linnaeus, 1758), and *Sphaerechinus granularis* (Bocquet and Stock 1962; Bocquet et al. 1963; Claus 1889; Giesbrecht 1897, 1899; Graeffe 1902; Norman 1868; Sars 1915; Stock 1960, present record).

Distribution

Norway (Sars 1915), Sweden (Barel and Kramers 1977; Bresciani and Lützen 1962; Lang 1949), Great Britain (Norman 1868; Gooding 1957), France (Bocquet and Stock 1962; Bocquet et al. 1963; Stock 1960), Italy (Claus 1889; Giesbrecht 1897, 1899; Graeffe 1902) and Spain (present record).

***Asterocheres latus* (Brady, 1872)**
Cyclopicera lata Brady 1872, 1880
Asterocheres echinicola Giesbrecht, 1899
Ascomyzon parvum Sars, 1915
(Figures 3, 4, 5, 10)

Material examined

Two females (NHM 1911.11.8.47267-268; in alcohol) collected in Firth of Forth (Scotland) by Norman; eight females (NHM) 1911.11.8.47269-273; in alcohol) collected in Firth of Forth (Scotland) by Norman; 5 females (NHM 1911.11.8. 47262-266; in alcohol) collected in Firth of Forth (Scotland) by Norman; one female (ZMA Co. 100.565; in alcohol) collected among washings of sponges (*Cliona* sp) in Banyuls (France) at 90 m depth in 1959; eight females (NHM 1967.10.31.84; in alcohol) collected in Scilly Isles (England) during SubAqua Expedition in 1966 (The Natural History Museum and The University of London); four females (NHM 1968.1.30.11; slides 1, 2, 5 and 6) collected in Scilly Isles (England) during SubAqua Expedition in 1966 (The Natural History Museum and The University of London).

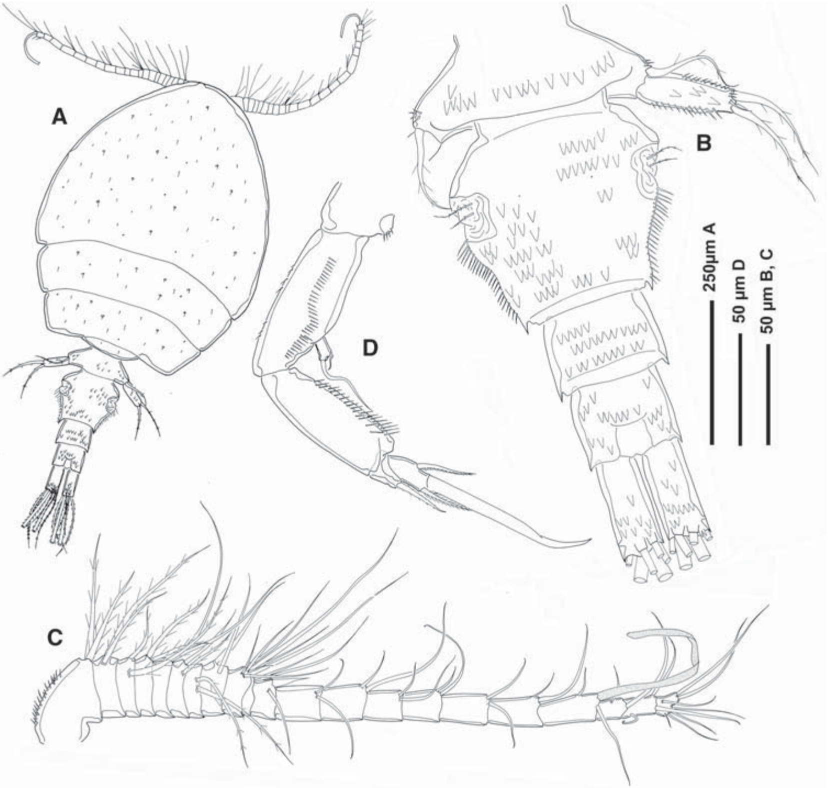
Description

Adult female

Body cyclopiform (Fig. 3a), with cephalothorax oval and cylindrical urosome. Total length 754 µm and maximum width 392 µm. Ratio of length to width of prosome 1.3:1. Ratio of length of prosome to that of urosome 2.2:1 Prosome comprising cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Somites bearing legs 2 and 3 broad; epimeral areas with posterolateral angles rounded (Fig. 3a). Each somite is slightly concealed under the preceding somite except for somite bearing leg 4 which is much smaller and narrower than preceding ones and mostly hidden by anterior segment. Dorsal cephalothoracic surface and free pedigerous somites ornamented with integumental pores and sensilla.

Urosome 4-segmented (Fig. 3b), comprising leg 5-bearing somite, genital double-somite and two free abdominal somites. All urosomites ornamented with flattened epicuticular scales (Fig. 10b, c). Leg 5-bearing somite wider than long. Genital double-somite about as long as wide; genital apertures bipartite, comprising lateroventrally located copulatory pore and dorsolaterally located gonopore. Lateral margin of double somite ornamented with rows of setules on distal third, posterior to genital apertures (Fig. 3b). Each genital area armed with two small setae.

Fig. 3 *Asterocheres latus* (Brady, 1872) (female). **a** habitus, dorsal; **b**, urosome, dorsal; **c** antennule; **d** antenna



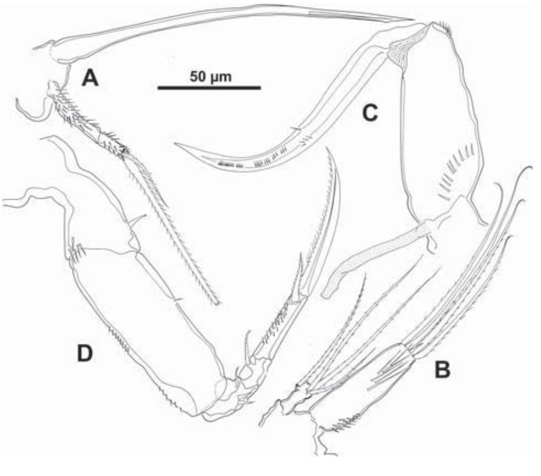


Fig. 4 *Asterocheres latus* (Brady, 1872) (female). **a** mandible, **b** maxillule, **c** maxilla, **d** maxilliped

Caudal rami (Fig. 2b) 2.6 times longer than wide (measured along outer margin); armed with six setae; seta I absent, setae III–VI arranged around posterior margin and setae II and VII slightly displaced onto dorsal surface.

Antennule (Fig. 3c) 21-segmented, about 320 µm long. Segmental fusion pattern as follows: 1 (I), 2 (II), 3 (III), 4 (IV), 5 (V), 6 (VI), 7 (VII), 8 (VIII), 9 (IX–XII), 10 (XIII), 11 (XIV), 12 (XV), 13 (XVI), 14 (XVII), 15 (XVIII), 16 (XIX), 17 (XX), 18 (XXI), 19 (XXII–XIII), 20 (XXIV–XXV), 21 (XXVI–XXVIII). Segments 1–8 with 2 setae each; segment 9 with 8 setae; segment 10 with 2 setae; segment 11 with one seta and one spine; segments 12–17 with 2 setae each; segment 18 with 2 setae plus an aesthetasc; segment 19 with 2 setae; segment 20 with 3 setae; segment 21 with 7 setae. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX–XII).

Antenna biramous (Fig. 3d), about 254 µm long. Coxa unarmed, with few spinules. Basis unarmed but ornamented with spinule row. Exopod 1-segmented, short; with short seta and long terminal seta. Endopod 3-segmented; proximal segment elongated, ornamented with spinule rows on lateral margin; middle segment produced distally on medial side but articulating with distal segment proximally on lateral side, bearing one plumose terminal seta; distal segment with distal claw and 2 pinnated subterminal setae.

Siphon slender, about 185 µm long, reaching between the insertion of maxilliped and leg 1.

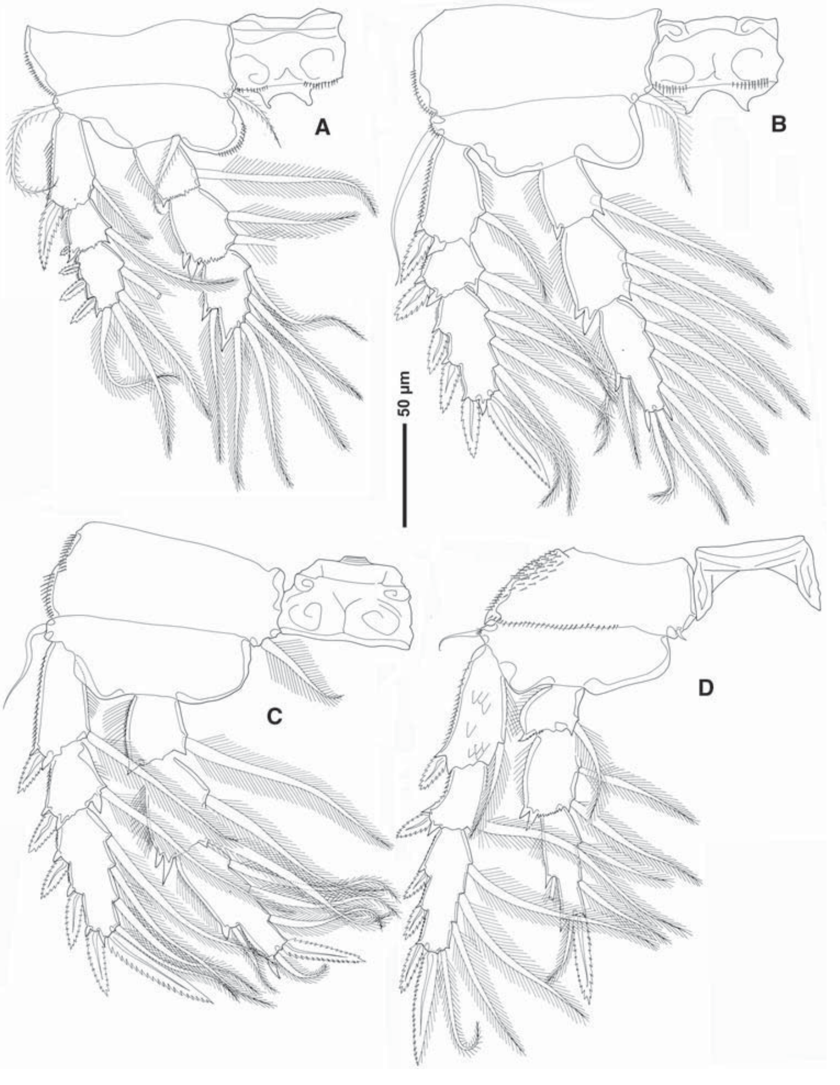


Fig. 5 *Asterocheres latus* (Brady, 1872) (female). **a** leg 1, **b** leg 2, **c** leg 3, **d** leg 4

Mandible (Fig. 4a) comprising stylet-like gnathobase and slender 2-segmented palp. Proximal segment of palp longest, ornamented with spinules; distal segment shorter, ornamented with spinules and armed with 2 plumose unequal apical setae. Stylet located in oral cone, formed by labrum and labium. Stylet with elongated cavity in distal third.

Maxillule bilobed (Fig. 4b); inner lobe 3.2 times longer than outer lobe. Inner lobe ornamented with patch of spinules proximally and long setules medially; armed with five distal setae, one of them is minute and smooth. Outer lobe armed with three terminal setae and subterminal pinnated seta.

Maxilla (Fig. 4c) 2-segmented but with partial transverse surface suture on syncoxa possibly marking plane of praecoxa–coxa fusion; preacoxal part bearing flaccid element medially representing tubular extension of external opening of maxillary gland. Coxal part unarmed but ornamented with spinules rows proximally and distally. Basis claw-like recurved at its end; armed with one minute seta and spinule rows in distal half.

Maxilliped 5-segmented (Fig. 4d), comprising short syncoxa, long basis and 3-segmented endopod. Syncoxa with short seta and patch of spinules distally. Basis with seta on inner margin and setule rows on outer margin. First endopodal segment bearing three smooth setae; second endopodal segment armed with plumose seta; and third endopodal segment bearing terminal claw plus subterminal pinnated seta.

Swimming legs 1–4 biramous (Figs. 5a–d), with 3-segmented rami. Intercoxal sclerites present in legs 1–4, ornamented with spinule rows in legs 1 and 2. Formula for armature as follows:

	Coxa	Basis	Exopod	Endopod
Leg 1	0–1	1–1	I–1; I–1; III, 2, 2	0–1; 0–2; 1, 5
Leg 2	0–1	1–0	I–1; I–1; III, I, 4	0–1; 0–2; 1, 2, 3
Leg 3	0–1	1–0	I–1; I–1; III, I, 4	0–1; 0–2; 1, 1+I, 3
Leg 4	0–1	1–0	1–1; I–1; III, I, 4	0–1; 0–2; 1, 1+I, 2

Fifth leg (Fig. 3b) with protopod incorporated into somite; outer basal seta displaced to laterodorsal surface. Free segment (exopod) elongated with two terminal setae and one hyaline setule (not a genuine seta). Outer and inner margins with spinules.

Sixth leg (Fig. 3b) represented by paired opercular plates closing off gonopores on genital double-somite; armed with two setae.

Adult male

Unknown.

Remarks

Asterocheres latus was poorly described and illustrated as *Cyclopicera lata* by Brady in 1872 with the following characteristics: the somite bearing leg 5 has a very small 1-segmented exopod with one basal (somite) and two terminal setae; the caudal rami are about as long as the anal somite; the antennule in the male possesses 17 segments, in the female 20 segments. His illustrations also show an antenna with a 1-segmented exopod with two terminal setae and a 2-segmented endopod with the setal formula: (2, 1 + claw); and maxillule with the inner lobe twice as long as the outer lobe, both lobes armed with three terminal setae each. Eight years later, the same author erroneously considered this species identical to *Asterocheres echinicola* Norman, 1868 (see above) and under this name it was later described by Giesbrecht in 1899. This latter author, who studied material collected by Scott in the Firth of Forth, added the followings characteristics to the diagnosis of *A. latus*: the caudal rami is longer than the anal somite and 2.5 times longer than wide, the abdominal somites present irregular rows of "spinules", the longest seta of the mandibular palp is plumose, and the shape of the fifth leg is similar to that of *A. boecki*. Although Sars (1915) believed that Giesbrecht's *A. boecki* was identical to *Cyclopicera lata*, Stock (1967) demonstrated that both species were distinct and different also from Brady's original *A. boecki*. This latter author also claimed that Sars' *Ascomyzon parvum* (Sars, 1915) and those records of Klie (1933) and Lang (1949) were in reality a different species from Giesbrecht's original *A. parvum* (Stock, 1967). These records certainly referred to *A. latus* and until now, Sars' description of *A. parvum* provide us with the most detailed description and illustrations of *A. latus*. Giesbrecht was the first author in pointing out the presence of a third seta in the fifth leg (see illustrations of Giesbrecht 1899) which was confirmed by Sars (see illustrations of Sars 1915).

Our study of *A. latus* has revealed some differences with respect to its previous descriptions. For example, this species is commonly described as possessing 20 segments in the antennule of females, but the antennule really shows 21 segments as illustrated by Huys and Boxshall in 1991. We agreed with Sars (1915) that the antennal endopod possesses three segments with the seta formula: 0, 1, 2 + claw instead of the two segments illustrated by Brady (1872). The mandibular palp is 2-segmented as illustrated by Sars, but fully ornamented with spinules. The inner lobe of the maxillule has five setae (one of them minute) in contrast with three setae described by Giesbrecht (1899) and four setae illustrated by Sars. The maxilliped shows five segments as Sars illustrated but he did not show the ornamentation and armature present in this appendage. The genital area of the female presents two small setae. As Sars pointed out, the fifth leg bears three terminal setae, although one of them is "very small, delicate and difficult to see even under an oil-immersion lens" as Hamond (1968) described. The caudal setae are 2.5 times longer than wide as Giesbrecht described. The urosomites are ornamented with flattened epicuticular scales.

Asterocheres latus, which is included into the group of *Asterocheres* species with 21-segmented antennule in females, can be separated from 7 of the 19 species of the group by the body shape. While *A. bacescui*; *A. ellisi* Hamond, 1968, *A. jeanyeatmanae* Yeatman, 1970, *A. lilljeborgi* Boeck, 1859, *A. lunatus* Johnsson, 1998; *A. simulans* (Scott, T., 1898), and *A. reginae* Boxshall and Huys, 1994 possess a dorsoventrally flattened prosome, *A. latus* shows an oval cephalothorax and a cylindrical urosome (Marcus and Por 1965; Hamond 1968; Yeatman 1970; Ivanenko and Ferrari 2003; Johnsson 1998; Ivanenko 1997; Boxshall and Huys 1994).

The 2-segmented mandibular palp present in *A. latus* serves to separate it from *A. minutus*, *A. echinicola* and *A. madeirensis* whose mandibular palp has only one segment (Bandera et al. 2007; Claus 1889). Like the majority of *Asterocheres* species, *A. latus* possesses three terminal setae in the free segment of the fifth leg. However, *A. uncinatus* (Kritchagin, 1873) differs from this species by the possession of only two terminal setae in the exopod of this leg (Marcus and Por 1960 as *Ascomyzon carausi*).

The length of the caudal setae serves to distinguish *A. tenuicornis* Brady, 1910, *A.suberitis*, *A. tenerus*

(Hansen, 1923), *A. flustrae* Ivanenko and Smurov, 1997, *A. urabensis* Kim, 2004, *A. astroidicola* Conradi et al., 2006 and *A. intermedius* (Hansen, 1923) from this species. *A. latus* possesses a caudal setae 2.5 longer than wide, while in contrast the caudal setae is 6 times longer than wide in *A. tenuicornis*, 1.5 times longer than wide in *A. suberitis*, and only slightly longer than wide in *A. tenerus, A. flustrae, A. urabensis, A. astroidicola* and *A. intermedius* (Eiselt, 1965; Hansen, 1923; Ivanenko and Smurov, 1997; Kim, 2004; Conradi et al., 2006). *Asterocheres hirsutus* Bandera et al., 2005 can be separated from *A. latus* from the ornamentation of the claws of the antenna, maxilla and maxilliped. While *A. latus* shows these claws naked or with a small row of spinules (only in that of the maxiliped), *A. hirsutus* presents these claws completely covered by spinules (see Figs. 1e, 2g, h; Bandera et al. 2005).

In 1898, Canu described a new *Asterocheres* species from the Normandy coasts. This species, *Asterocheres kervillei*, was so closely related to *A. latus* that Giesbrecht (1899) pointed out their possible conspecificity. The differences, according to Giesbrecht, were only: the shorter body length, slightly longer siphon and slightly shorter caudal rami of *A. kervillei*. He could not demonstrate that they were identical because of the lack of *A. latus* males in order to verify if the latter species had the same irregularities present in *A. kervillei* males on the first leg, the maxillipeds and on the genital somite. Later on, Stock (1967) studied material from both sexes and species and confirmed that these two species, *A. latus* and *A. kervillei* were identical, although he had certain reservations: the length of caudal rami, the slenderness of the body (above all at insertion of urosome level), and the ornamentation of the urosomal somites.

However and after the redescription of these two species (see below for the redescription of *A. kervillei*), we added the following differences between these species to those mentioned by Giesbrecht and Stock: (1) *A. kervillei* is shorter than *A. latus*; (2) The body of *A. kervillei* is more slender than that of *A. latus*; (3) The ornamentation of the body is different in both species: the urosomites of *A. latus* are covered by flattened epicuticular scales (Fig. 10b, c). However, those of *A. kervillei* are ornamented with spinules arranged in symmetric pattern in ventral view (Fig. 10d, e); (4) The caudal rami are 2.5 times longer than wide in *A. latus* and less than twice as long as wide in *A. kervillei*; (5) The segmental fusion pattern of antennule is also different: while in *A. latus* the last three segments of antennule have the formula 19 (XXII–XXIII), 20 (XXIV–XXV), 21 (XXVI–XXVIII); in *A. kervillei* is 19 (XXII), 20 (XXIII–XXIV), 21 (XXV–XXVIII); (6) The siphon is shorter in *A. kervillei*; (7) The genital area of *A. latus* shows two small plumose setae, whereas that of *A. kervillei* presents a small naked seta plus a spiniform element.

Although these two species have been considered synonymous for almost 40 years, we strongly believe that these differences are enough to consider these species as different.

Hosts

Although Brady found this species among algae in tidal pools or dredged from muddy sand, *A. latus* is found associated mainly with sponge species such as undetermined, *Ciocalypta penicillus* Bowerbank, 1864; *Clathrina primordialis* (Haeckel, 1872); *Cliona* sp.; *Halichondria panicea* (Pallas, 1766), *Haliclona oculata* (Pallas, 1766); *Haliclona cinerea* (Grant, 1826), and *Grantia compressa* (Fabricius, 1780), (Klie, 1933; Lang, 1949; Stock, 1960; Hamond, 1968; Schirl, 1973; Scott, 1893; Thompson, 1889, 1893). The record of Norman on *Echinus* is not valid for this species since it corresponds to *A. echinicola* (=*A. violaceus*).

Distribution

Sweden (Lang 1949), Netherlands (Sars 1915); United Kingdom (Brady 1872; Hamond 1968; Scott 1893, Thompson 1889, 1893, present record), France (Stock 1960; Schirl 1973).

***Asterocheres kervillei* Canu, 1898**
(Figures 6, 7, 8, 9, 10d, e)

Material examined

Five females and three males (NHM 1996.747–754; in alcohol) collected at N. W. of Brancaster, Golf Club, Norfolk (Great Britain) by D. Hamond in 1988; one female and one male (NHM 2007.940–941) associated with the ascidian *Pseudodistoma lyrnusense* Pérès, 1952 at Isla Palomas (Tarifa Island, Southern Iberian Peninsula), 8 m depth, in August of 1991; ten females and three males (BEIM COP-549) with the same sampling data as NHM 2007.940–941.

Description

Adult female

Body cyclopiform (Fig. 6a, b), slender with cephalothorax oval and cylindrical urosome. Mean body length 687 μm (640–730 μm) and greatest width 382 μm (340–410 μm), based on four specimens. Ratio of length to width of prosome 1.2:1. Ratio of length of prosome to that of urosome 1.8:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Epimeral areas of somites slightly pointed and clearly separated from the preceding somite. Segment bearing leg 4 smaller than preceding segment. Dorsal cephalothoracic shield and tergites of free pedigerous somites ornamented with few

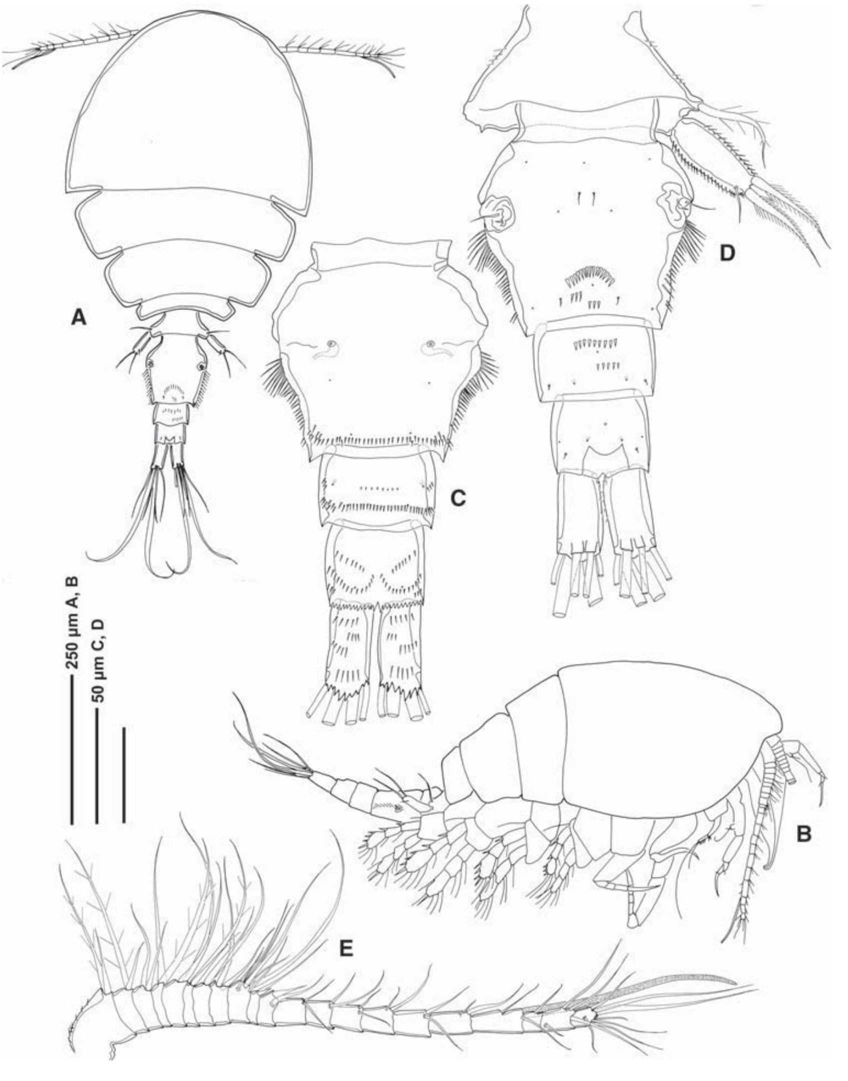


Fig. 6 *Asterocheres kervillei* Canu, 1898 (female). **a** habitus dorsal, **b** habitus lateral, **c** urosome, ventral, **d** urosome dorsal, **e** antennule

integumental pores and sensilla. Chitinous points and spines on the copepod's surface described by Canu, not observed.

Urosome (Fig. 6c, d) 4-segmented comprising leg fifth pedigerous somite, genital double-somite and two free abdominal somites. Somite bearing leg 5 (Fig. 6d) wider than long, with some spinules on its lateral surface. Posterior margins of anal segment and caudal rami ornamented with hyaline frills with more or less serrated margins. Genital double-somite and following somites provided with spinules arranged in regular pattern all around (Figs. 6c, 10d, e). Integumental pores and sensilla present on urosomal somites. Genital double somite about as long as wide (width measured at small anterior rounded expansions), bearing genital apertures, paired gonopores located laterally. Each genital area armed with smooth seta and spiniform element (Fig. 6b). Caudal rami almost twice longer than wide, armed with six setae; seta I absent, setae II–VII all arranged around posterior margin with setae II and VII slightly offset onto dorsal surface.

Antennule 21-segmented (Fig. 6e); segmental fusion pattern as follows: 1 (I), 2 (II), 3 (III), 4 (IV), 5 (V), 6 (VI), 7 (VII), 8 (VIII), 9 (IX–XII), 10 (XIII), 11 (XIV), 12 (XV), 13 (XVI), 14 (XVII), 15 (XVIII), 16 (XIX), 17 (XX), 18 (XXI), 19 (XXII), 20 (XXIII–XXIV), 21 (XXV–XXVIII). Segments 1–8 with 2 setae each; segment 9 with 7 setae; segments 10–11 with 1 seta and 1 small spine each; segments 12–17 with 2 setae each; segment 18 with 2 setae plus an aesthetasc; segment 19 with 1 seta; segment 20 with

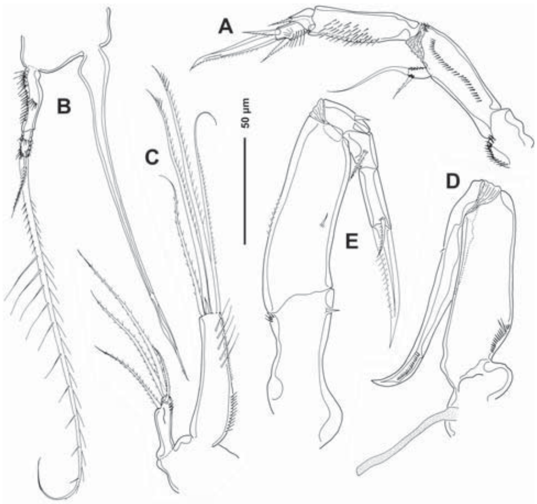


Fig. 7 *Asterocheres kervillei* Canu, 1898 (female). **a** antenna, **b** mandible, **c** maxillule, **d** maxilla, **e** maxilliped

4 setae and segment 21 with 7 setae. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX–XII).

Antenna biramous (Fig. 7a), about 185 µm long; coxa unarmed, with row of setules; basis unarmed, with fine spinule rows. Exopod 1-segmented, ornamented with spinule rows, short, about 2.3 times longer than wide; with short barbed seta and long smooth terminal seta. Endopod 3-segmented; proximal segment elongated, unarmed but ornamented with tuft of setules on distal and medial parts. Middle segment produced distally on medial side but articulating with distal segment proximally on lateral side; bearing distal barbed seta. Third segment with distal claw and two pinnate setae; ornamented with row of fine setules laterally.

Mandible (Fig. 7b) comprising stylet-like gnathobase and slender 2-segmented palp. Stylet 160 µm long, with spinules on distal part; located in oral cone formed by labrum and labium. Palp ornamented with rows of spinules laterally, medially and distally in both segments; armed with two plumose unequal apical setae (the longest is more than six times longer than the shortest). Siphon slender, 162 µm long, reaching nearly to posterior margin of insertion of maxillipeds.

Maxillule bilobed (Fig. 7c); praecoxal endite more than twice as long as palp. Praecoxal endite ornamented with row of spinules laterally and row of long setules distally; armed with five distal setae, four of them long but unequal, ornamented with short spinules distally, and one short and naked seta. Palp armed with two subterminal and two terminal barbed setae and ornamented with several spinules distally.

Maxilla 2-segmented (Fig. 7d) but with partial transverse suture on syncoxa possibly marking plane of praecoxa-coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland. Coxa portion unarmed but ornamented with row of spinules and claw-like basis recurved on its end; bearing minute setule on proximal part and row of fine setules on distal part.

Maxilliped 5-segmented (Fig. 7e), comprising short syncoxa, long basis and distal subchela consisting of 3 free endopodal segments armed with distal claw-like element. Syncoxa with small inner distal seta and patch of fine spinules. Basis elongated with spinules laterally and setule on inner medial region. First endopodal segment bearing two naked setae, and the second with plumose seta. Third endopodal segment bearing recurved terminal claw plus additional apical plumose seta. Distal margin of claw provided with row of minute setules.

Swimming legs 1–4 biramous (Fig. 8a–d), with 3-segmented rami. Intercoxal sclerite present in legs 1–4, ornamented with rows of spinules in leg 1–3. Formula for armature as follows:

	Coxa	Basis	Exopod segments	Endopod segments
Leg 1	0–1	1–1	I–1; I–1; III, 2, 2	0–1; 0–2; 1, 2, 3
Leg 2	0–1	1–0	I–1; I–1; III, I, 4	0–1; 0–2; 1, 2, 3
Leg 3	0–1	1–0	I–1; I–1; III, I, 4	0–1; 0–2; 1, 1 + I, 3
Leg 4	0–0	1–0	I–1; I–1; III, I + 1, 3	0–1; 0–2; 1, 1 + I, 2

Coxae of all legs ornamented with spinule rows laterally, as figured; coxal seta not present in leg 4. Outer spines of exopodal segments in legs 1–4 bilaterally serrated. Lateral margins of exopodal segments with minute serrations; lateral margins of endopodal segments with rows of setules. Second and third endopodal segments in legs 1–4 with small beak-shaped spiniform process distally.

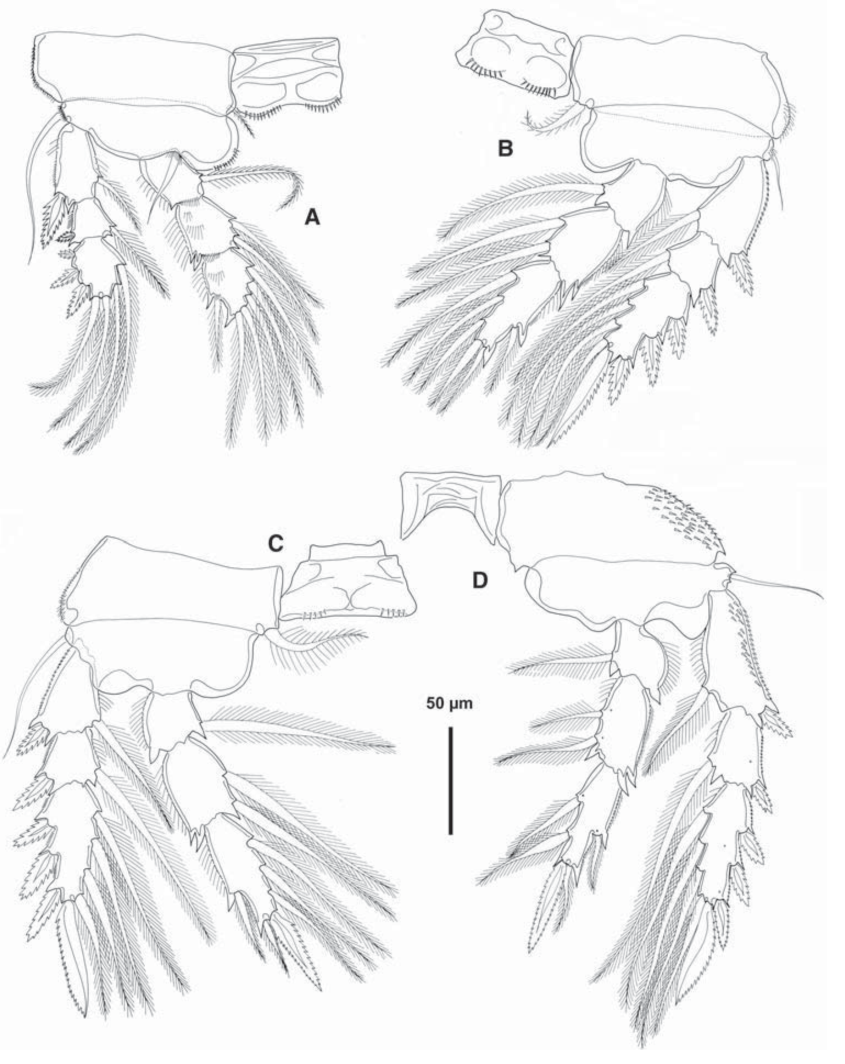
Leg 5 (Fig. 6d) with protopodal segment incorporated into somite with outer seta located laterally; exopod slender, more than twice as long as wide, ornamented with rows of spinules laterally and armed with two plumose terminal setae and shorter naked subterminal seta.

Leg 6 (Fig. 6d) represented by paired opercular plates closing off gonopores on genital double somite; armed with plumose seta and spiniform element.

Adult male

Body cyclopiform, with oval prosome and cylindrical urosome (Fig. 9a). Mean body length 520 µm (490–540 µm) and greatest width 253 µm (238–280 µm), based on 3 specimens. Ratio of length to width of prosome 1.5:1. Ratio of length of prosome to that of urosome 1.9:1. Prosome

Fig. 8 *Asterocheres kervillei* Canu, 1898 (female). **a** leg 1, **b** leg 2, **c** leg 3, **d** leg 4



comprising cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Dorsal cephalothoracic shield and free pedigerous somites ornamented with integumental pores and sensilla. Urosome 5-segmented (Fig. 9b), comprising fifth pedigerous somite, genital somite and three free abdominal somites. Posterior margin of anal segment and caudal ramus ornamented with hyaline frills with serrated free margins. Genital somite about 1.2 times wider than long, bearing genital apertures postero-laterally on ventral surface. Caudal rami 1.5 times longer than wide, armed as in female. Appendages as in female except for antennules, maxillipeds and, fourth and sixth legs.

Antennule (Fig. 9c) 17-segmented; the last segment indistinctly 2 segmented (with 2 and 8 setae), geniculate. Segmental fusion pattern as follows: 1 (I), 2 (II), 3 (III), 4 (IV), 5 (V), 6 (VI), 7 (VII), 8 (VIII), 9 (IX–XII), 10 (XIII), 11 (XIV), 12 (XV–XVI), 13 (XVII), 14 (XVIII), 15 (XIX-XX), 16 (XXI–XXIII), 17 (XXIV–XXVIII). Geniculation located between segments 15 (XIX–XX) and 16 (XXI–XXIII). Segments 1–8 with 2 setae each; segment 9 with 6 setae plus an aesthetasc; segments 10 with 1 seta and 1 small spine; segment 11 with 2 setae; segment 12 with 4 setae; segments 13 and 14 with 2 setae each; segments 15 with 4 setae; segment 16 with 4 setae plus one aesthetasc, segment 17 with 10 setae. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX-XII).

Maxilliped 5-segmented (Fig. 9d), comprising short syncoxa, long basis and distal subchela consisting of

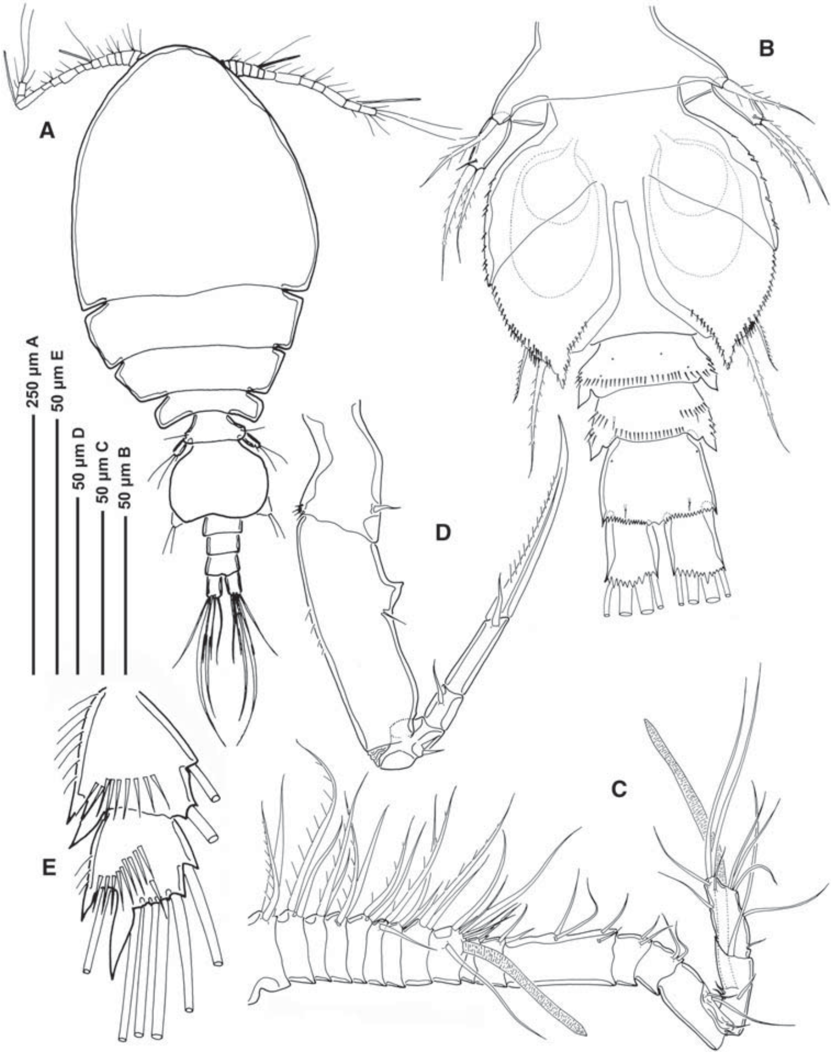


Fig. 9 *Asterocheres kervillei* Canu, 1898 (male). **a** habitus, dorsal; **b** urosome, dorsal; **c** antennule; **d** maxilliped; **e** two last endopodal segments of the fist leg

three free endopodal segments armed with distal claw-like element. Syncoxa with small inner distal seta and patch of fine spinules. Basis elongated with spinules laterally, small tooth-like process in proximal half of medial margin and setule on inner medial region. First endopodal segment bearing two naked setae and second with smooth seta. Third endopodal segment bearing recurved terminal claw plus additional apical smooth seta. Distal margin of claw provided with row of minute setules.

First leg (Fig. 9e) as for female except for the ornamentation of second and third endopodal segments. These two segments have row of spinules on distal part. Third segment with beak-like process.

Sixth leg (Fig. 9b) forming large opercular plates closing off genital apertures, armed with two plumose unequal setae and ornamented with fine spinules.

Remarks

This species was described by Canu in 1898 on the basis of specimens living freely among seaweeds in a mussel bank in Normandy. Although the original description and illustrations are very good, Canu did not make a detailed description of the oral appendages or the swimming legs. Thus, the antenna, mandible, maxillule, maxila and maxilliped were not described, although some of these appendages were showed in the illustration of the male in ventral view.

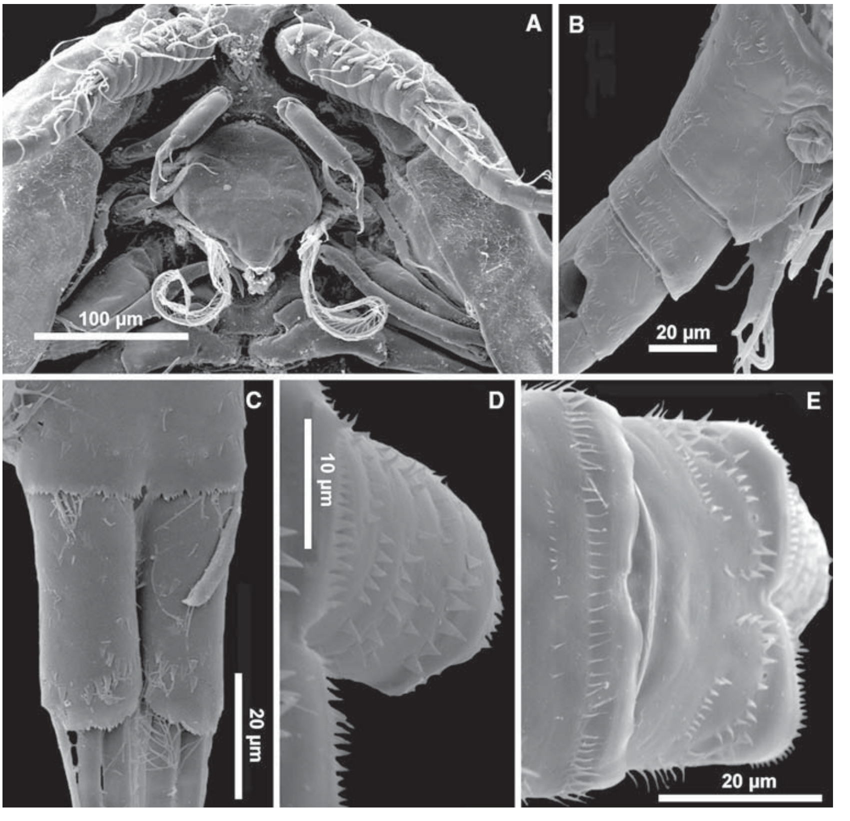


Fig. 10 *Asterocheres echinicola* (Norman, 1868) (female): **a** oral appendages; *Asterocheres latus* (Brady, 1872) (female): **b** urosome, lateral; **c** caudal rami, lateral. *Asterocheres kervillei* Canu, 1898 (female): **d** caudal rami, ventral; **e** urosome, ventral

The antenna was illustrated as possessing a 2-segmented endopod; although in fact, the antenna shows a 3-segmented endopod with the third segment ornamented with setules and armed with two subterminal setae plus an apical claw. The mandibular palp has rows of spinules that did not appear in Canu′s illustration. The maxillule possesses an inner and an outer lobe with five and four setules, respectively; while in the original illustration the inner lobe lacks any ornamentation and only presents four setae. The maxilla was originally described as 2-segmented without ornamentation or armature, while in fact, the maxilla is ornamented with setules and spinules in both segments and a flaccid aesthetasc-like element medially in the praecoxal portion of syncoxa. The maxilliped is 5-segmented as Canu described, but the illustration does not show the armature which is (1, 1, 2, 1, 1 + claw).

The swimming legs for females are described and illustrated for the first time and the fifth leg which was described as bearing two terminal setae, is now redescribed with three terminal setae.

The male antennule was described as possessing 18 segments. However, the re-examination of males specimens has revealed that the antennule shows 17 segments with the last segment partially divided in two segments. The sixth legs show two setae instead of the unique seta described by Canu.

Asterocheres kervillei belongs to the group of *Asterocheres* species possessing a 21-segmented antennule in the female and 2-segmented mandibular palp. This group consists of fourteen species: *A. lilljeborgi*; *A. latus*; *A. uncinatus*; A. t*enuicornis*; *A. simulans*; *A. suberitis*; *A. tenerus*; *A. ellisi*; *A. jeanyeatmanae*; *A. reginae*; *A. flustrae*; *A. lunatus*; *A. urabensis*; *A. hirsutus* and *A. astroidicola*.

As regards the body shape, *A. lilljeborgi*, *A. simulans, A. jeanyeatmanae* and *A. reginae* are characterized by having a dorso-ventrally flattened prosome in contrast with the slender oval cephalothorax present in *A. kervillei* (Ivanenko and Ferrari, 2003; Ivanenko, 1997; Yeatman, 1970 and Boxshall and Huys, 1994).

Johnsson in 1998 described *A. lunatus* as an asterocherid with a very broad prosome and the pedigerous somite 1 and 2 with extended pointed epimera which serve to separate it from *A. kervillei*.

As for the length of the siphon, most of these species possess a siphon that reaches to the insertion of maxillipeds, including *A. kervillei*. However, the siphon of *A. tenerus*, *A. urabensis* and *A. hirsutus* extends up to the intercoxal plate of leg 1 and *A. astroidicola* possess a siphon that reaches up to the leg 2 (Bandera and Conradi 2009; Kim 2004; Bandera et al. 2005).

Asterocheres tenuicornis can be easily distinguished from the rest of *Asterocheres* with 21-segmented antennule and the new species by its very elongated caudal rami (based on Fig. 2a of Eiselt 1965). *A. uncinatus* possesses only two terminal setae on the exopod of the fifth leg (Marcus and Por 1960). However, *A. kervillei* shows three terminal setae on the free segment of the fifth leg.

The length of the caudal rami serves to separate *A. kervillei* from the remaining species of the group, *A. simulans, A. flustrae, A. ellisi, A. suberitis* and *A. latus*. The caudal rami of *A. kervillei* are twice as long as wide. However, those of *A. simulans*, *A. flustrae, A. ellisi, A. suberitis* and *A. latus* are about twice as wide as long, as long as wide, only slightly longer than wide, 1.5 times longer than wide and 2.5 times longer than wide, respectively (Ivanenko 1997; Ivanenko and Smurov 1997; Hamond 1968; Giesbrecht 1899; see above for redescription of *A. latus*). The most similar species of the group is *A. latus,* and in fact, during 40 years these two species have been synonymous. However, the above mentioned differences are enough to separate these two species.

Hosts

Living freely among seaweeds in a mussel bank (Canu 1898) and in association with the ascidian *Pseudodistoma lyrnusense* Pérès, 1952 (present record).

Distribution

Atlantic.

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Artículo VIII

Asterocherids (Copepoda: Siphonostomatoida) associated with marine invertebrates in the Strait of Gibraltar.

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Asterocherids (Copepoda: Siphonostomatoida) associated with marine invertebrates in the Strait of Gibraltar

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Abstract

Six years ago, an ongoing sampling programme to seek symbiont copepods was initiated in the Strait of Gibraltar. Most of the copepod species reported in this area (48%) belonged to the families Notodelphyidae and Botryllophilidae and nearly 30% of them were new to science. This paper describes a new species of *Asterocheres* (Asterocheridae, Siphonostomatoida) and redescribes two poorly known species of this genus. *Asterocheres tarifensis* n. sp. was found living in association with *Astroides calycularis*, a coral that hosts a variety of symbiotic copepods. This new species differs from its congeners by the possession of the following combined characters: body cyclopiform, 21-segmented antennule in female, 2-segmented mandibular palp, siphon reaching the insertion of maxilliped, maxilla without aesthetasc, maxilliped 5-segmented, armature of the antennary exopod consisting of two setae, inner lobe and outer lobe of maxillule each armed with four setae, genital area armed with two setae, fifth leg exopod with three setae, and caudal rami about as long as wide. Furthermore, two poorly known *Asterocheres* species are redescribed revealing some discrepancies with their previous descriptions. *Asterocheres minutus* is characterized by having a 21-segmented antennule, a very short oral siphon, a 1-segmented mandibular palp, and the two lobes of the maxillule with a similar length. The cladistic model of budding hypothesis is proposed for the origin of the two sibling *Asterocheres* species: *A. minutus* and *A. echinicola*. *Asterocheres siphonatus* is distinguished by a combination of characters that include a 21-segmented antennule, an oral siphon extending to the intercoxal plate of leg 4 and the 1-segmented mandibular palp. The controversy concerning the name of this species is also studied.

Key words: symbiosis, Copepoda, Siphonostomatoida, *Asterocheres*, Strait of Gibraltar

Introduction

The Strait of Gibraltar, limited by the meridians of 7ºW and 4ºE, lying between southernmost Spain and northwesternmost Africa, is the only natural channel connecting the Mediterranean Sea with the Atlantic Ocean. This strait, of approximately 300 metres in depth, is 58 km long and narrows to 13 km between Point Marroquí (Spain) and Point Cires (Morocco). The study of the Strait of Gibraltar is of great zoogeographical interest since the faunas of the Mediterranean and the Atlantic, along one axis, and of Europe and Africa along the other overlap (Medel & López-González 1996).

As a result of this great zoogeographical interest, different groups of marine invertebrates from this area were intensively sampled over a period of six years in order to collect symbiotic copepods. Collections were made from intertidal areas to a depth of 30 metres by snorkelling and SCUBA diving. Hitherto, a total of 45 copepod species have been listed from this region, 13 of which were new to science (Bandera & Conradi 2009; Bandera & Huys 2008; Conradi & López-González 1994; 1996; Conradi, *et al*. 1992; 1993; 1994; 2004; 2006; Ho *et al*. 1998; López-González & Conradi 1995; 1996; López-González *et al*. 1992a; 1992b; 1993; 1997; 1998; 1999a; 1999b). Furthermore, three new genera were described, and a new family, Fratiidae Ho, Conradi and López-González 1998, was erected for the new genus *Fratia* Ho, Conradi and López-González 1998 (Bandera & Huys 2008; Ho *et al.* 1998; López-González *et al*. 1998). Since the majority of the marine invertebrates studied to date in search for symbiont copepods were solitary and compound ascidians, most of the copepod species reported in this area (48%)

belonged to the families Notodelphyidae Dana, 1853 and Botryllophilidae Sars, 1921 (order Cyclopoida), both families being typical parasites of this group of invertebrates. Nevertheless, some specimens of the family Asterocheridae Giesbrecht, 1899 (order Siphonostomatoida) from this area have been very helpful to: (1) relocate the species *Asterocheres mucronipes* to a new asterocherid genus (Bandera & Huys 2008), (2) reveal the conspecifity of *Asterocheres echinicola* (Norman, 1868) and *A. violaceus* (Claus, 1889), (3) re-establish the valid species *A. kervillei* Canu, 1898 (Bandera & Conradi 2009), (4) describe a new species *Asterocheres astroidicola* Conradi *et al*., 2006 and (5) enlarge the distribution of *Acontiophorus scuttatus* (Brady & Robertson, 1873) (Conradi *et al*. 2006). The present paper reports three further *Asterocheres* species found in the Strait of Gibraltar: one of these, associated with a scleractinian coral, turned out to be a new species while the other two species, one associated with an ascidian and the other with a sea urchin, serve to redescribe two *Asterocheres* species poorly or incompletely described: *A. minutus* (Claus, 1889) and *A. siphonatus* Giesbrecht, 1897. Furthermore, this study contributes to the ongoing taxonomical revision of the genus *Asterocheres* (family Asterocheridae) in order to clarify the rather confused state of its systematics.

Material and methods

The hosts were individually collected, each one being isolated in a plastic bag, by SCUBA diving at Algeciras Bay and Tarifa Island (Southern Iberian Peninsula). Later, the samples were fixed by adding Formalin progressively to make a concentration of approximately 4% in sea water. The fixative sea water was passed through a 100 m net. The copepods were finally recovered from the sediment retained and preserved in 70% ethanol.

Selected specimens were dissected in lactic acid and examined as temporary mounts in lactophenol. All figures were drawn with the aid of a camera lucida on a Leica DMLB differential interference microscope and photographed in a Phillips XL 30 SEM. All appendage segments and setation elements were named and numbered using the terminology introduced by Huys and Boxshall (1991). Mean body length of the copepod was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami.

Furthermore, we have examined material collected by Sars in Norway in 1915 and deposited in The Natural History Museum of the University of Oslo (ZMO). Material studied in the present paper is deposited in the Museo Nacional de Ciencias Naturales, Madrid (MNCN) and in the collection of Biodiversidad y Ecología de Invertebrados Marinos research group of the University of Seville (BEIM).

Results

Order Siphonostomatida Thorell, 1859

Family Asterocheridae Giesbrecht, 1899

Asterocheres Boeck, 1859

Asterocheres tarifensis, n. sp.
(Figs. 1–4)

Material examined. (a) holotype female (MNCN 20.04/8570) and one paratype female (MNCN 20.04/8571) associated with the scleractinian coral *Astroides calycularis* (Pallas) from Tarifa Island (southern Spain, 36º 01N, 5º 36W) at 12 m depth collected in 1999; (b) 2 females and 2 males with the same sampling data as the holotype deposited in BEIM (COP–513).

Description. Adult female: Body (Fig. 1A) cyclopiform, slender with an oval cephalothorax and a cylindrical urosome. Mean body length 558 µm (510–625 µm) and greatest width 266 µm (240–310 µm), based on 3 specimens. Ratio of length to width of prosome 1.36:1. Ratio of length of prosome to that of urosome 2.18:1. Prosome comprising cephalothorax, fully incorporating first pedigerous somite, and 3 free pedigerous somites. Somite bearing leg 4 with posterolateral angles rounded (Fig. 1A).

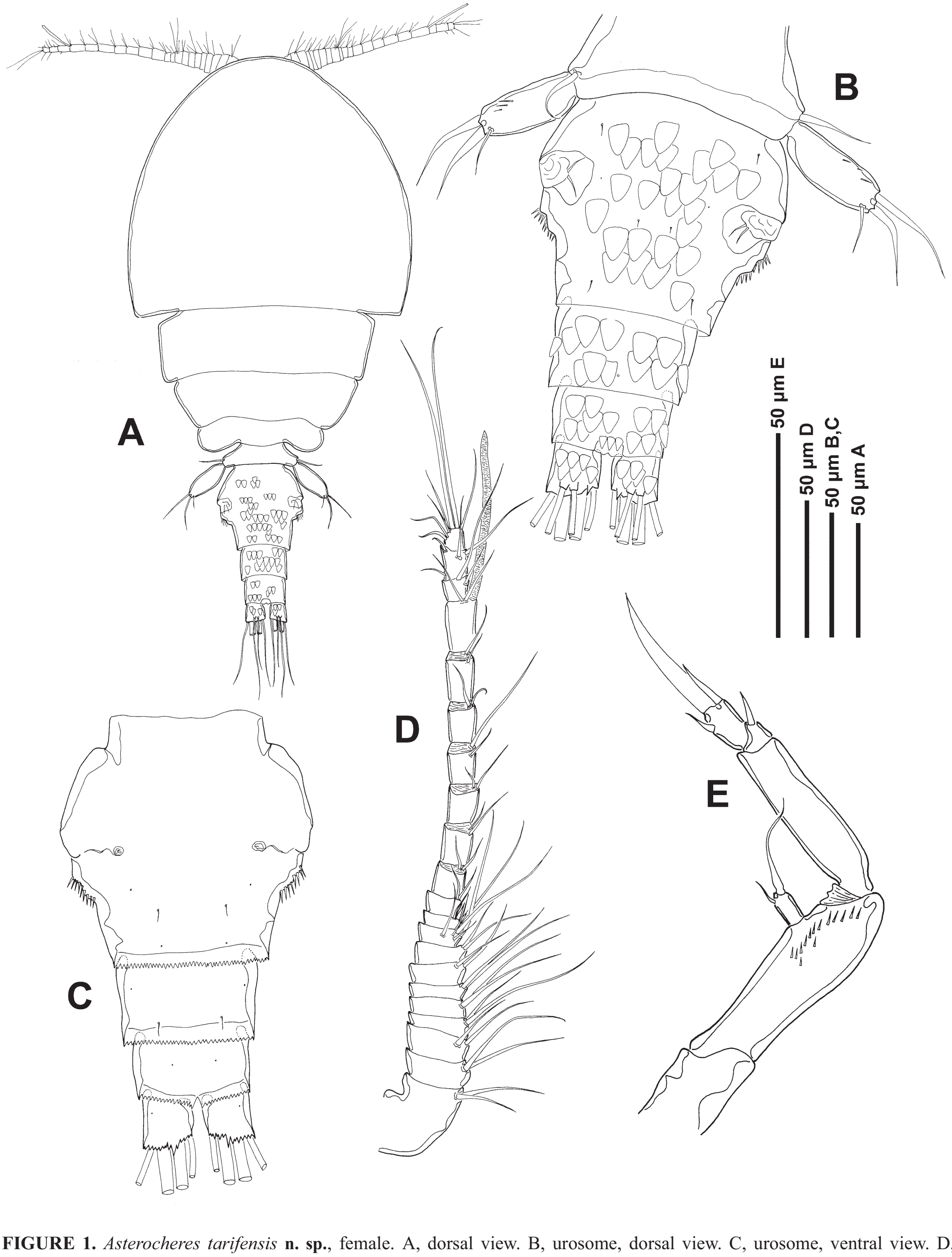

FIGURE 1. *Asterocheres tarifensis* **n. sp.**, female. A, dorsal view. B, urosome, dorsal view. C, urosome, ventral view. D, antenna. E, antennule.

Urosome 4-segmented, comprising leg 5-bearing somite, genital double-somite and 2 free abdominal somites. Genital double-somite and following somites provided with large epicuticular scales arranged in overlapping pattern all around (Figs. 1B, 4A). Posteroventral margins of urosomites ornamented with hyaline frills with more or less serrated margins (Fig. 1C). Genital double-somite (95x98 µm) slightly wider than long; paired genital apertures bipartite, comprising lateroventral copulatory pore and dorsolateral gonopore (oviduct opening); lateral margins with a spinule row (about 9–10 spinules) in distal third (posterior to genital apertures) (Figs. 1B–C, 4A). Genital area armed with two setae (Figs. 1B, 4B). Integumental pores and sensilla present on urosomites.

Caudal rami (Fig. 1B–C) about 25x20 µm (length measured along outer margin); covered by overlapping epicuticular scales; armed with 6 setae, seta I absent, setae II and VII slightly offset onto dorsal surface.

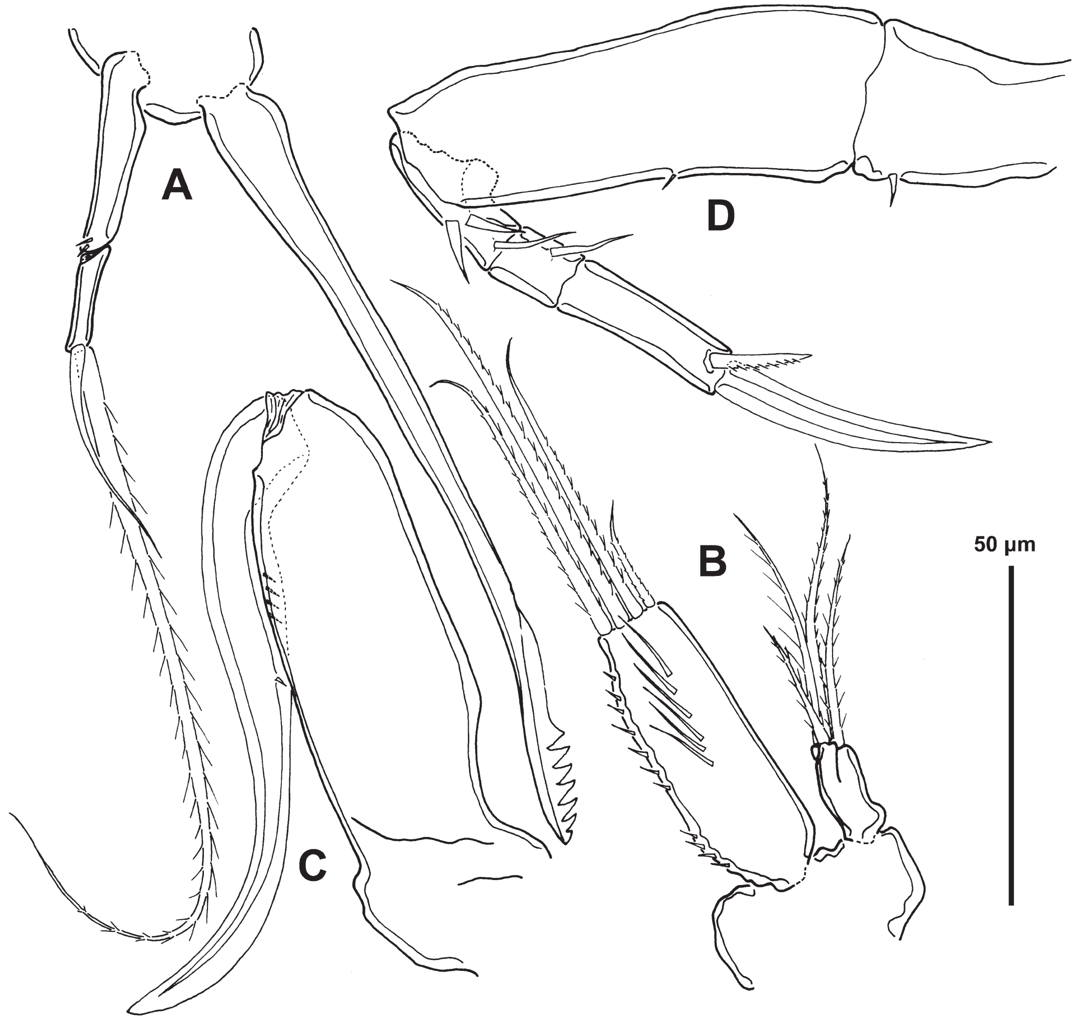

FIGURE 2. *Asterocheres tarifensis* **n. sp.**, female. A, mandible. B, maxillule C, maxilla. D, maxilliped.

Antennule (Fig. 1D) 21-segmented, about 230 µm long. Segmental homologies (expressed segment given first followed by ancestral segments in brackets) and setation pattern as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5 (V)-2, 6(VI)-2, 7(VII)-2, 8 (VIII)-2, 9 (IX-XII)-7, 10 (XIII)-1+spine, 11 (XIV)-2, 12 (XV)-2, 13 (XVI)-2, 14 (XVII)-2, 15 (XIII)-2, 16 (XIX)-2, 17 (XX)-2, 18 (XXI)-2+ae, 19 (XXII)-2, 20 (XXIII-XXIV)-4, 21(XXV-XXVIII)-7. All setae smooth.

Antenna (Fig. 1E) biramous, 170µm long, including terminal claw. Coxa and basis unarmed; basis ornamented with fine spinule rows. Exopod 1-segmented, with one small subterminal seta and one long terminal seta. Endopod 3-segmented; proximal segment elongated; middle segment protruded distally on medial side but articulating with distal segment proximally on lateral side, bearing one distal seta; distal segment with distal claw (35 µm long), one subterminal and one terminal seta, all setae smooth.

Siphon, about 120 µm long, reaching to insertion of maxillipeds.

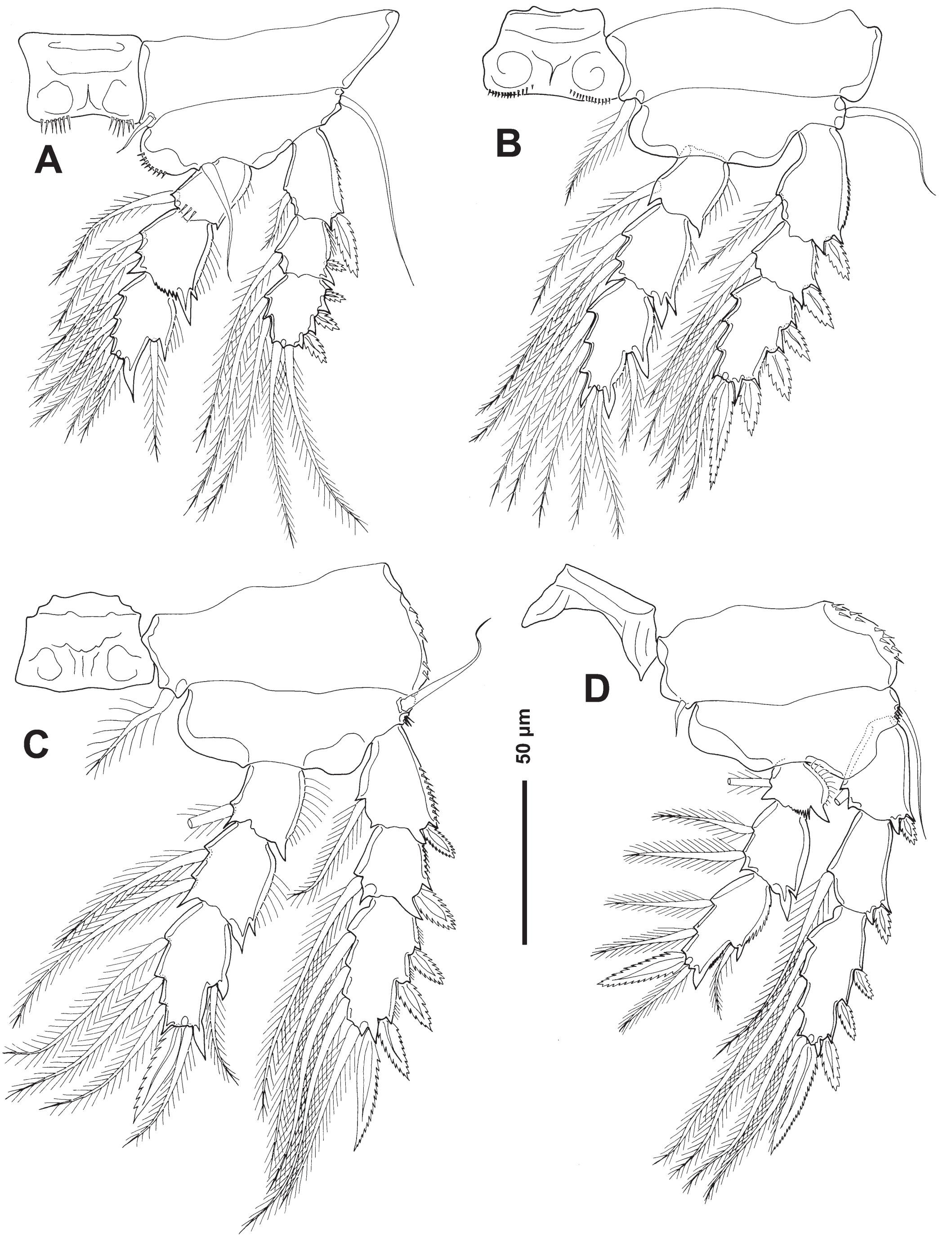

FIGURE 3. *Asterocheres tarifensis* **n. sp.**, female. A, leg 1. B, leg 2. C, leg 3. D, leg 4.

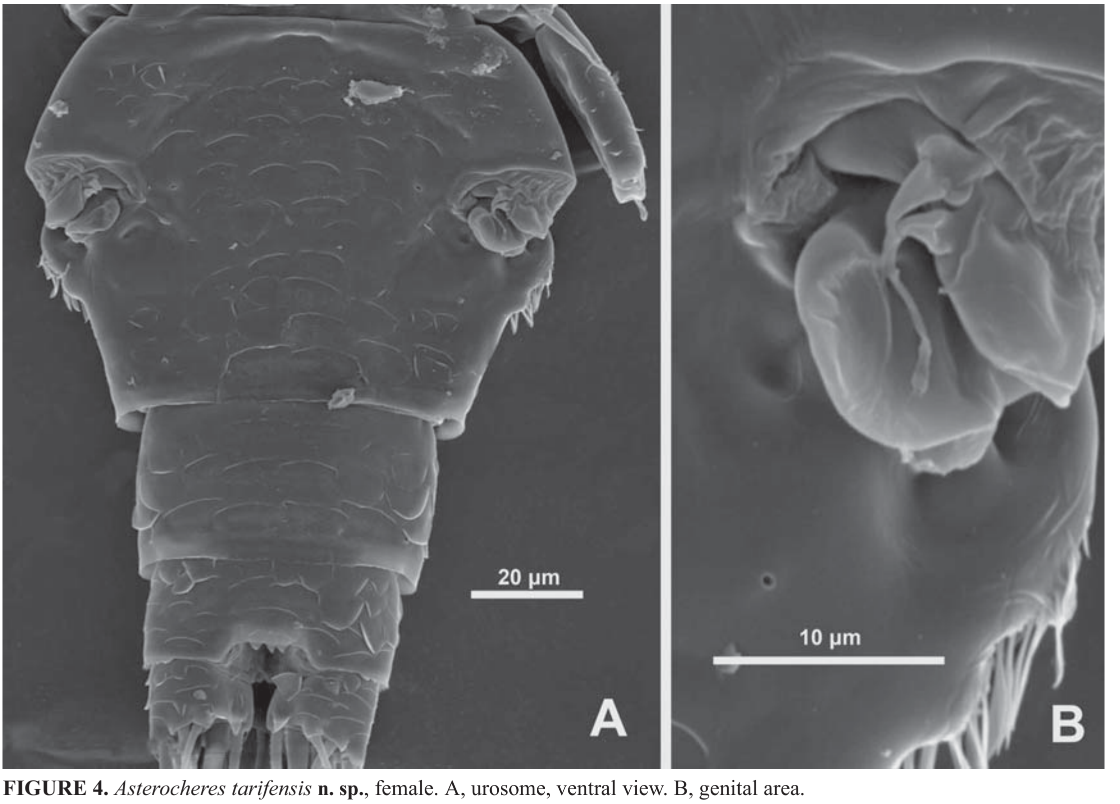

FIGURE 4. *Asterocheres tarifensis* **n. sp.**, female. A, urosome, ventral view. B, genital area.

Mandible (Fig. 2A) comprising stylet-like gnathobase and slender 2-segmented palp. Stylet located in oral cone formed by anterior labrum and posterior labium, with 5 large teeth subapically. First segment of palp ornamented with distal spinules; second segment armed with 2 apical setae, the shorter smooth and the longer pinnate.

Maxillule (Fig. 2B) bilobed; praecoxal endite (inner lobe, 45x15 µm) larger than palp (outer lobe, 16x7 µm). Praecoxal endite armed with 4 barbed distal setae, ornamented with spinules on lateral margin and a row of long setules medially. Palp armed with 4 barbed, distal setae.

Maxilla (Fig. 2C) 2-segmented; with unarmed coxa. Claw-like basis recurved in its end; armed with a few setules on the proximal inner lateral margin.

Maxilliped (Fig. 2D) 5-segmented, comprising short syncoxa, long basis and distal subchela consisting of 3 free endopodal segments armed with distal claw-like element. Syncoxa with one short seta distally. Basis with a spinule on medial inner margin. First endopodal segment bearing two short medial setae and one distal seta; second endopodal segment with one medial seta and third endopodal segment bearing curved terminal claw (45 µm long) plus additional apical barbed seta.

Swimming legs 1–4 (Figs. 3A–D) biramous, with 3-segmented rami. Intercoxal sclerite present in legs 1–4, ornamented with patches of spinules in legs 1 and 2. Spine and seta formula as follows:

	Coxa	Basis	Exopod segments	Endopod segments
Leg 1	0-1	1-1	I-1;I-1;III,2,2	0-1;0-2;1,2,3
Leg 2	0-1	1-0	I-1;I-1;III,I+1,3	0-1;0-2;1,2,3
Leg 3	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,1+I,3
Leg 4	0-1	1-0	I-1;I-1;III,I+1,3	0-1;0-2;1,1+I,2

Coxae ornamented with spinule rows laterally in legs 3 and 4. Outer spines of exopodal segments in legs 1–4 bilaterally serrated. Lateral margins of exopodal segments in legs 1–3 with minute serrations; lateral margins of endopodal segments with rows of setules (Fig. 3A–D). Second and third endopodal segments in legs 1–4 with a small beak-shaped spiniform process distally.

Fifth leg (Fig. 1B) with protopod incorporated into somite and one outer seta displaced to dorsal surface. Free segment slender (50x20 µm), armed with one subterminal and two terminal smooth setae and ornamented with few spinules.

Sixth leg represented by paired opercular plates closing off gonopores on genital double somite; each armed with two smooth setae (Figs. 1B; 4B).

Adult male: Unknown.

Etymology. The specific name *tarifensis* refers to Tarifa Island where the species was collected.

Remarks. With regards to the antennule, the species of the genus *Asterocheres* fall into two groups: females having a 18 to 20-segmented antennule and females with a 21-segmented antennule. The latter group contains a total of 20 species (Bandera & Conradi 2009) and can be subdivided into two subgroups: (1) species with a 1-segmented mandibular palp and (2) species with a 2-segmented mandibular palp. The new species described above belongs to the second subgroup. Together with *Asterocheres tarifensis* **n.sp.**, 16 asterocherid species have a 21-segmented antennule in females and a 2-segmented mandibular palp: *A. astroidicola* Conradi *et al.*, 2006; *A. ellisi* Hamond, 1968; A. *flustrae* Ivanenko & Smurov, 1997; *A. hirsutus* Bandera *et al.*, 2005; *A. jeanyeatmanae* Yeatman, 1970; *A. kervillei* Canu, 1898; *A. latus* (Brady, 1872); *A. lilljeborgi* Boeck, 1859; *A. lunatus* Johnsson, 1998; *A. reginae* Boxshall & Huys, 1994; *A. simulans* (Scott T, 1898); *A. suberitis* Giesbrecht, 1899; *A. tenerus* (Hansen, 1923); *A. tenuicornis* Brady, 1910; *A. uncinatus* (Kritchagin, 1873) and *A. urabensis* Kim, 2004. However, *A. intermedius* (Hansen, 1923) also has to be included since there is no available information about its mandibular palp.
Asterocheres tarifensis **n.sp.** can be separated from *A. ellisi*, *A. jeanyeatmanae*, *A. lilljeborgi*, *A. lunatus*; *A. simulans*, and *A. reginae* by its body shape. While these species have a dorsoventrally flattened prosome (Marcus & Por 1960; Hamond 1968; Yeatman 1970; Ivanenko & Ferrari 2003; Johnsson 1998; Ivanenko 1997; Boxshall & Huys 1994), *A. tarifensis* shows an oval cephalothorax and a cylindrical urosome (Fig. 1A). Like the majority of *Asterocheres* species, the new species possesses three terminal setae in the free segment of the fifth leg (Fig. 1B). However, *A. uncinatus* and *A. latus* differ from this species by the possession of only two terminal setae (for *A. uncinatus*, see Marcus & Por 1960) or two terminal seta and one hyaline setule (not a genuine seta) in the exopod of this leg (for *A. latus*, see Bandera & Conradi 2009b). *Asterocheres tarifensis* **n.sp.** has a siphon which reaches up to the insertion of the maxillipeds, whereas *A. astroidicola*, *A. hirsutus, A. intermedius* and *A. urabensis* possess siphons which exceed this length (Kim 2004; Bandera *et al*. 2005; Conradi *et al*. 2006; Bandera & Conradi 2009a). The new species is easily separated from *A. tenuicornis, A. kervillei, A. suberitis* and *A. tenerus* by the length of the caudal rami which is, almost 6 times longer than wide in *A. tenuicornis*, twice longer than wide in *A. kervillei*, slightly more than 1.5 times longer than wide in *A. suberitis* and only just longer than it is wide in *A. tenerus*, in comparison with that of *A. tarifensis* **n. sp.**, in which the caudal rami is as long as it is wide (Bandera & Conradi 2009a; b).

Although *A. flustrae* also possesses caudal rami as long as its width, some characteristics such as the two setae of the antennary exopod (Fig. 1E), the inner lobe of the maxillule with four setae (Fig. 2B), the absence of an aesthetasc on the maxilla (Fig. 2C), the 5-segmented maxilliped (Fig. 2D) and the two setae of the genital area separate *A. tarifensis* **n.sp.** from *A. flustrae*, since, *A. flustrae* has three setae on the antennary exopod; the inner lobe of the maxillule has five setae; the maxilla bears an aesthetasc on syncoxa; each genital area is armed with two elements, one seta and one spine and the maxilliped is 6-segmented (according to the illustrations of Ivanenko & Smurov 1997).

Host. *Astroides calycularis* is an azooxanthellate dendrophylliid colonial coral, typically inhabiting shallow waters down to a depth of about 30 m, and preferring shaded places and strong water movement (Zibrowius 1980; 1995). This coral, protected by the Convention on International Trade in Endangered species of Wild Fauna and Flora (CITES), is essentially endemic to the south-western Mediterranean, with a few outliers beyond the Strait of Gibraltar in the west and the Straits of Sicily in the east.

The colonies of *A. calycularis* harbour an abundant associated fauna, including both mobile and sedentary species. At least two uncommon gastropods are now known to live and feed on this coral: *Epitonium dendrophylliae* Bouchet and Warén and the coralliophilid *Babelomurex cariniferus* (Sowerby) (Richter & Luque 2004). Various isopod species such as *Carpias stebbingi* (Monod); *Cymodoce emarginata* Leach; *C. truncata* Leach, *Dynamene edwardsi* (Lucas); *Gnathia illepida* (Wagner); *G. inopinata* Monod; *G. venusta* Monod, and *G. vorax* (Lucas) have also been recorded living on this coral (Castellanos *et al*. 2003). Recently two copepod species have been described living in association with *A. calycularis*: the cyclopoid *Doridicola helmuti* Conradi, *et al*., 2006; and the siphonostomatoid *Asterocheres astroidicola* Conradi *et al*., 2006. These species were found together with the siphonostomatoid *Acontiophorus scutatus* (Brady & Robertson, 1873) and an undetermined harpacticoid species (Conradi *et al*. 2006). Furthermore, the collection of some specimens of *Asterocheres mucronipes* in association with this coral serves to redescribe the species and accommodate it into a new genus, *Stockmyzon* Bandera and Huys, 2008 (Bandera & Huys 2008).

Distribution. Known only from the type locality (southern Spain, 36º 01N, 5º 36W).

Asterocheres minutus **(Claus, 1889)**
(Fig. 5)

Echinocheres minutus Claus, 1889
Asterocheres minutus sensu Giesbrecht, 1987

Material examined. 2 females (BEIM (COP-562) associated with the sea urchin *Paracentrotus lividus* (Lamarck) from Tarifa Island (southern Spain) at 12 m depth in 1991.

Description. Adult female: Body (Fig. 5A) cyclopiform, slender with cephalothorax oval and cylindrical urosome. Mean body length 470 µm (460–480 µm) and maximum width 265 µm (260–270 µm), based on 2 specimens. Ratio of length to width of prosome 1.29:1. Ratio of length of prosome to that of urosome 2.2:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites.

Antenna (Fig. 5C) biramous, 125 µm long including terminal claw. Coxa and basis unarmed. Basis ornamented with spinule row medially. Exopod 1-segmented, slightly longer than wide; with one smooth subterminal seta and two pinnate terminal setae. Endopod 3-segmented; proximal segment elongated with row of spinules laterally; middle segment protruded distally on medial side but articulating with distal segment proximally on lateral side, bearing one distal seta; distal segment with smooth distal seta and distal claw (20 µm long) ornamented with minute spinules on lateral margin.

Oral cone very short, about 90 µm long, reaching to the insertion of maxilliped (Fig. 5B), with membranous lateral flanges.

Mandible (Fig. 5D) comprising stylet-like gnathobase and slender 1-segmented palp. Palp ornamented with rows of setules laterally and armed with two unequal distal densely plumose setae, the longer ornamented with three spinules apically.

Maxillule (Fig. 5E) bilobed; inner lobe (25x15 µm) as long as outer lobe (25x5 µm). Inner lobe armed with five distal setae, one setulose very long seta, one shorter smooth seta, two median setae ornamented with setules on distal part and one short smooth seta. Outer lobe armed with three terminal and one subterminal smooth setae.

Maxilla (Fig. 5F) 2-segmented but with partial transverse suture on syncoxa possibly marking plane of praecoxa-coxa fusion; praecoxal part bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland; coxal part unarmed. Basis claw-like recurved, distally armed with one naked, small seta at mid length and minute spinules in distal portion.

Remaining appendages as described by Bocquet *et al*. (1963).

Adult male: As described by Bocquet *et al*. (1963).

Remarks. *Asterocheres minutus* was poorly described and illustrated as *Echinocheres minutus* by Claus in 1889 and as *Asterocheres minutus* by Giesbrecht in 1899. Later on, it was described and illustrated by Bocquet *et al*. (1963) who also made a comparative study of *A. minutus* and *A. echinicola* (=*A. violaceous*, see Bandera & Conradi 2009b). The population of this species found in Tarifa Island (Southern Spain) shows some discrepancies from the previous descriptions. (1) The antennary exopod has not two but three elements (Bocquet *et al*. (1963) missed one lateral seta); (2) The armature of the third segment of the antennal endopod consists of one apical seta, claw and lateral row of setules, and not two setae and one claw as illustrated by Bocquet *et al*. (1963); (3) The palp of the mandible possess two distal setae as illustrated by Bocquet *et al*. (1963) but the longer one is thicker and has three spinules apically in addition to the setules of the distal part. (4) The inner lobe of the maxillule bears 5 distal setae but the length and ornamentation differ from those described by Bocquet *et al*. 1963 (5) The maxilla has a flaccid element medially, representing a tubular extension of the external opening of the maxillary gland on the proximal part of the syncoxa, and the claw-like basis is armed with a small seta and ornamented with setules on the distal part which were not illustrated or mentioned by previous descriptions.

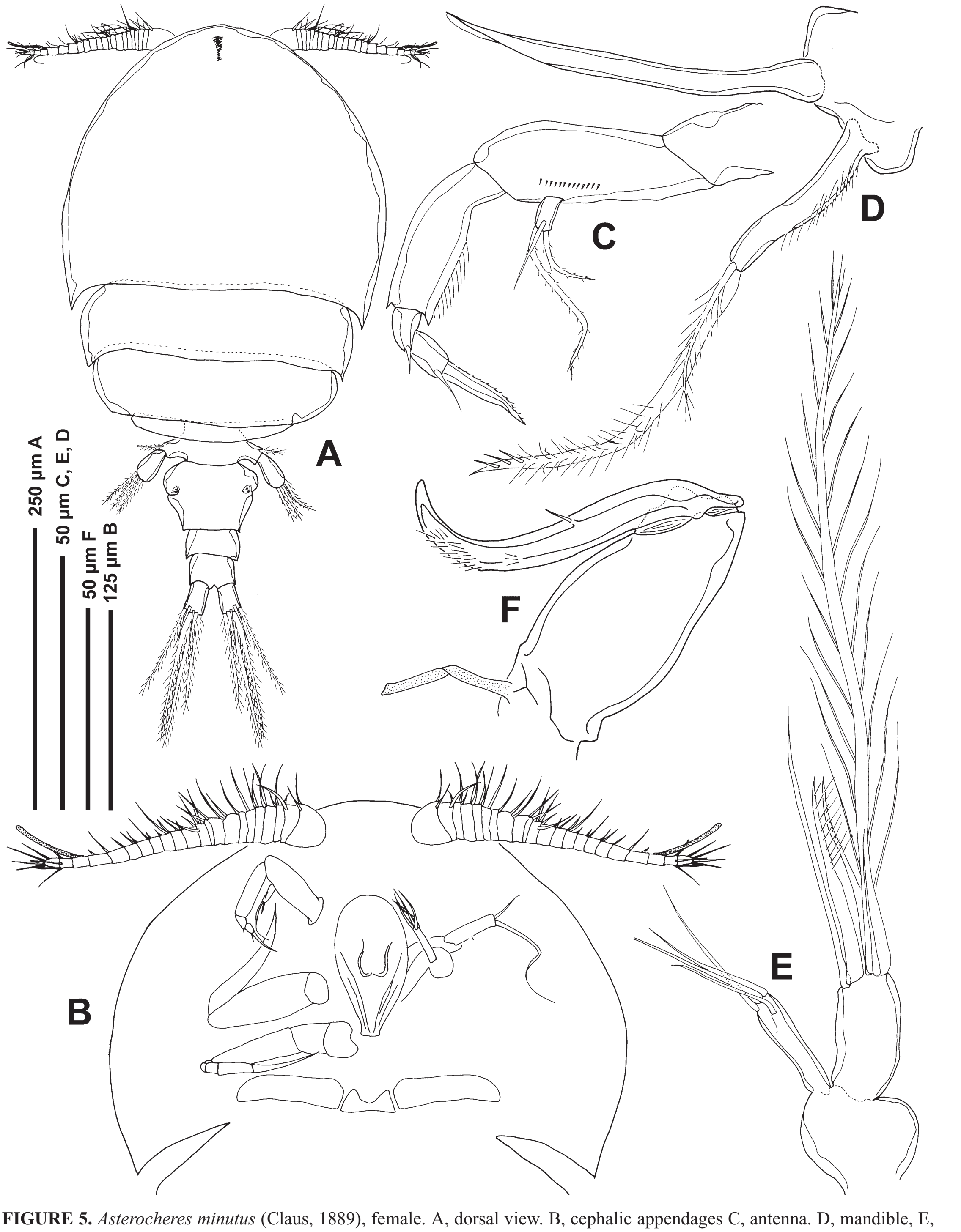

FIGURE 5. *Asterocheres minutus* (Claus, 1889), female. A, dorsal view. B, cephalic appendages C, antenna. D, mandible, E, maxillule. F, maxilla.

This species belongs to a group of *Asterocheres* species characterized by possessing a 21-segmented antennule in females and a 1-segmented mandibular palp. This group is composed of only three species: *A. bacescui* (Marcus, 1965), *A. madeirensis* Bandera *et al*., 2007, and *A. echinicola* (Norman, 1868). As commented above, we also have to include *A. intermedius*, since there is no available information about its mandibular palp. *Asterocheres minutus* can be separated from *A. bacescui, A. intermedius* and *A. madeirensis* by the length of the siphon which is shorter than those of the other three species (Bandera *et al*. 2007; Marcus & Por 1960, Bandera & Conradi 2009a). Furthermore, the inner lobe of the maxillule is longer than the outer lobe in *A. bacescui* and *A. madeirensis,* while the two lobes of *A. minutus* are more or less of equal length.

Asterocheres minutus is most similar to *A. echinicola,* and these two species provide a classic example of sibling species from regular echinoids on the western European coastlines (Bocquet & Stock 1963; Bocquet *et al.* 1963; Gotto 1979; Bandera & Conradi 2009b). The two copepods overlap in their distribution in the Mediterranean and may be found together on the same sea-urchin without displaying any territorial preference. Bocquet *et al* (1963) considered *A. minutus* to be derived from *A. echinicola* and believed that the present situation can be interpreted as a consequence of allopatric speciation. In this case, therefore, a single ancestral species of *Asterocheres* is envisaged, which parasitized sea-urchins over a wide geographical range, but became divided into “western” (Atlantic) and “eastern” (Mediterranean) components by a land barrier. The Atlantic population remained relatively unchanged due to a stable oceanic environment. The Mediterranean group, however, trapped in a relatively small sea subject to considerable fluctuations throughout its history, accumulated sufficient mutations to transform it into the species *A*. *minutus*. By the time the Strait of Gibraltar had opened to re-establish the communication, specific separation was complete. The new sea link allowed the euryplastic *A. echinicola* to recolonize the Mediterranean, but did not permit range-extension westward by *A. minutus*, a species by now stenoplastically adaptated to the conditions peculiar to an island sea (Bocquet & Stock 1963). Therefore, the most likely cladistic model of the origin of these two *Asterocheres* species is the budding hypothesis described by Queiroz (1998) since one of the *Asterocheres* species is the origin of the other, and both species (original and new) coexist in the time, naturally isolated on their respective hosts. Such demonstrations of the important role played by geographical isolation in the speciation of parasitic copepods makes information on the existence of geographic races or subspecies very desirable but such information is very scanty.

Paired species of copepods associated with echinoid hosts have also been recorded in the genera *Paramolgus*, *Plesiomolgus* and *Metaxymolgus* (Humes 1975). It may be presumed that their evolution has followed a similar course to that suggested for *Asterocheres*. Other examples of speciation which occur in the Strait of Gibraltar are the twin species *Astericola clausi* Rosoll, 1889 and *A. asterinae* (Bocquet, 1952), lichomolgid symbionts of asteroids, and *Doridicola botulosus* (Stock & Kleeton, 1963) and *D. comai* Conradi *et al*., 2004 rynchomolgid symbionts of gorgonaceans which are likely to be derived from a common ancestor (Bocquet *et al*. 1970; Conradi *et al*. 1993, 2004).

Host. This tiny copepod is restricted to Echinoidea and it has been recorded in association with three species *Paracentrotus lividus*, *Psammechinus microtuberculatus* (Blainville) and *Sphaerechinus granularis* (Lamarck) (Bocquet *et al*. 1963; Claus 1889; Giesbrecht 1987; present record).

Distribution. Mediterranean endemic: France (Bocquet *et al*. 1963), Italy (Claus 1889; Giesbrecht 1897), and Spain (present record).

Asterocheres siphonatus Giesbrecht, 1897
(Figs. 6–9)

Ascomyzon lilljeborgi Thorell, 1859, Sars, 1915
Artrotogus boeckii Brady, 1880
Asterocheres thorelli Bresciani and Lützen, 1962

Material examined. (a) One female (ZMO-F7645, 1 slide) collected in Norway by G.O. Sars. (b) One female (ZMO-F7646, 1 slide) collected in Norway by G.O. Sars. (c) 97 females (ZMO-F21603, in alcohol) collected in association with *Corella parallelograma* (Müller) in Norway by G.O. Sars. (d) 11 females (BEIM (COP-548) associated with the ascidian *Synoicum argus* (Milne Edwards) from Las Lajas, Algeciras Bay (southern Spain) at 5 m depth in 1991.

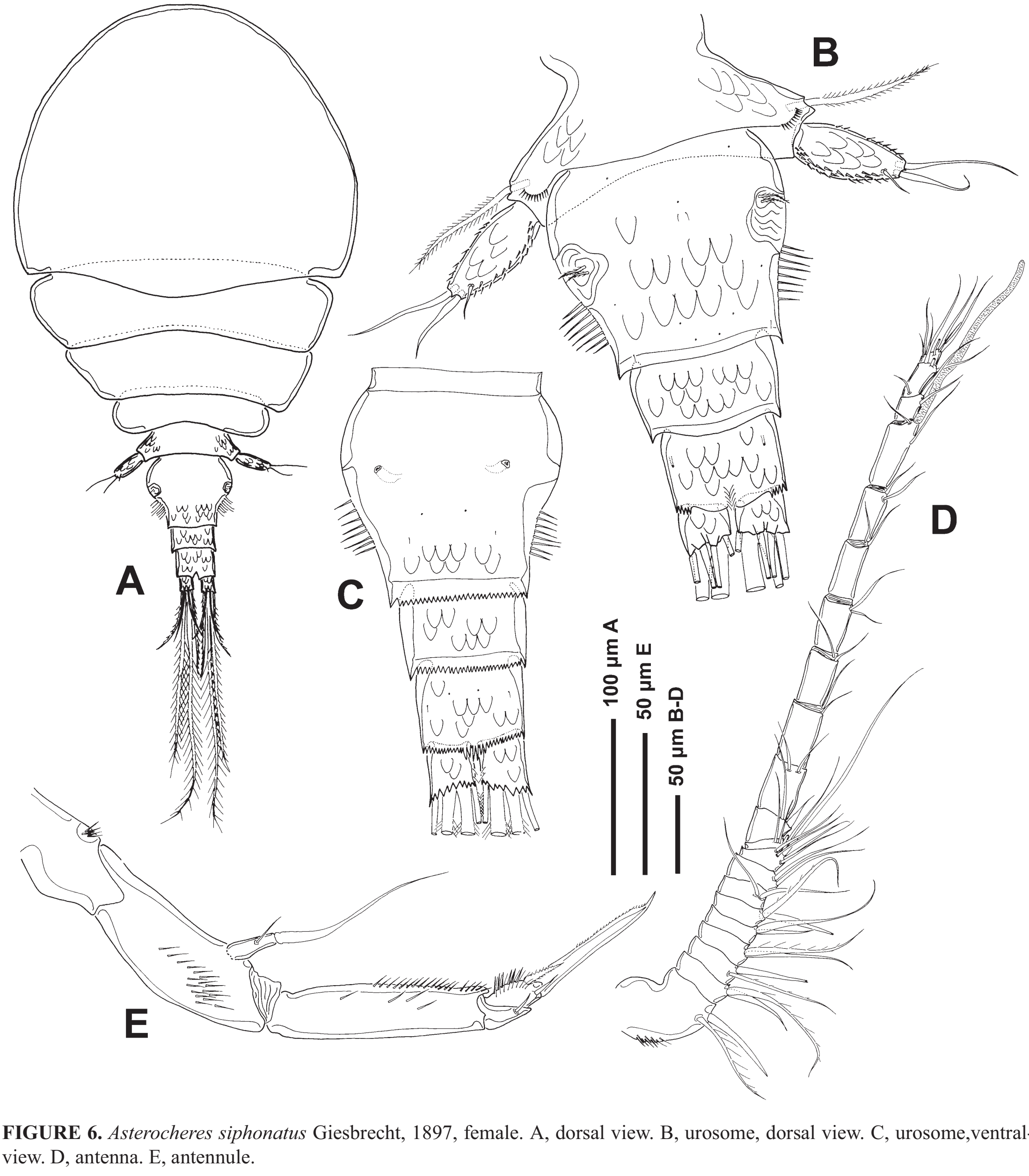

FIGURE 6. *Asterocheres siphonatus* Giesbrecht, 1897, female. A, dorsal view. B, urosome, dorsal view. C, urosome,ventral-view. D, antenna. E, antennule.

Description. Adult female. Body (Fig. 6A) cyclopiform, with moderately broad prosome and cyclindrical urosome. Mean body length 910 µm (880–960 µm) and maximum width 510 µm (450–540 µm), based on 5 specimens. Ratio of length to width of prosome 1.7:1. Ratio of length of prosome to that of urosome 2.45:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites.

Urosome 4-segmented comprising leg 5-bearing somite, genital double-somite and 2 free abdominal somites. Dorsal and ventral surfaces of free abdominal somites and genital double-somite ornamented with large, flattened epicuticular scales arranged in overlapping rows (Fig. 6B, C). Posteroventral margins of abdominal somites ornamented with hyaline frills with serrated margins (Fig. 6C). Integumental pores and sensilla present on urosomal somites. Leg 5-bearing somite wider than long with some epicuticular scales on dorsal surface (Fig 6B, 9A). Genital double-somite slightly wider than long (150x145 µm), bearing paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore; lateral margin with row of long spinules (about 8 spinules) in distal third (posterior to genital apertures) (Fig. 6B, C). Genital area armed with two plumose seta (Fig. 6B).

Caudal rami (Fig. 6B,C) as long as wide (30x30 µm), covered by overlapping epicuticular scales; armed with 6 setae. Seta I absent; setae II and VII smooth, slightly offset onto dorsal surface; setae III, IV, V and VI plumose.

Antennule (Fig. 6D) 21-segmented, about 470 µm long. Segmental homologies (expressed segment given first followed by ancestral segments in brackets) and setation pattern as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-2, 11(XIV)-2, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+ae, 19(XXII)-2, 20(XXIII-XXIV)-4, 21(XXV-XXVIII)-7. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX-XII). Three first segments with one seta with a circlet of cuticular denticles at each tip (Fig. 9C).

Antenna (Fig. 6E) biramous, 215 µm long including terminal claw. Small unarmed coxa with tuft of spinules on inner margin. Elongated unarmed basis ornamented with fine spinule rows. Exopod one-segmented, slender, bearing one medial and one terminal naked setae. Endopod three-segmented; proximal segment elongated, unarmed but ornamented with rows of spinules; middle segment small, protruded distally on medial side but articulating with third segment on lateral side and armed with smooth, distal seta; distal segment with rows of fine setules and spinules laterally, and armed with one smooth and one barbed setae, and distal claw, 55 µm long, with minute spinules on lateral margin.

Oral cone very long and slender, 620 µm long, reaching almost to posterior margin of intercoxal sclerite of leg 4.

Mandible (Fig. 7A) comprising stylet-like gnathobase and slender one-segmented palp. Stylet located in oral cone, very long and slender but expanded at the apex as illustrated. Palp slender, one-segmented with spinules arranged like a fan in middle third and some spinules on lateral margin; armed with 2 equal apical setae, one of them with spinules.

Maxillule (Fig. 7B) bilobed; praecoxal gnathobase 1.7 times longer than palp. Praecoxal endite (70x30 µm) ornamented with tufts of setules at base and distally and a row of spinules on lateral margin; armed with 5 distal setae different in length, one of them very short and naked. Palp (40x10 µm) with spinules on lateral margin; armed with 2 subterminal and 2 terminal barbed setae.

Maxilla (Fig. 7C) 2-segmented but with partial transverse suture on syncoxa (proximal segment) possibly marking plane of praecoxa-coxa fusion; coxal portion unarmed. Basis claw-like armed with small seta in distal third. Claw margins smooth.

Maxilliped (Fig. 7D) 5-segmented, comprising short syncoxa, long basis and three-segmented endopod. Syncoxa with inner seta distally. Basis elongated with short seta on lateral inner margin in middle third. First endopodal segment short, bearing 3 naked setae; second endopodal segment armed with naked seta; third endopodal segment bearing recurved terminal claw plus additional subapical seta. Claw 62 µm long, with minute spinules on lateral margin.

Swimming legs 1–4 (Fig. 8A–D) biramous, with three-segmented rami. Intercoxal sclerite present in legs 1–4, ornamented with rows of spinules in legs 1 and 2. Spine and seta formula as follows:

	Coxa	Basis	Exopod segments	Endopod segments
Leg 1	0-1	1-1	I-1;I-1;III,4	0-1;0-2;1,2,3
Leg 2	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,2,3
Leg 3	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,1+I,3
Leg 4	0-0	1-0	I-1;I-1;III,I,4	0-1;0-2;1,1+I,2

Coxae ornamented with spinule rows laterally, as illustrated. Inner coxal seta pinnate in legs 1–3 and absent in leg 4. Basis ornamented with spinule rows laterally; outer seta naked in all legs; longer than first exopodal segment in legs 1 and 2 and shorter than first exopodal segment in legs 3 and 4. Surface of legs 1–4 ornamented with flattened epicuticular scales arranged in irregular pattern (Fig. 8A–D). Lateral margins of exopodal segments with spinular rows; those of endopodal segments with rows of setules. Outer spines of exopodal segments bilaterally serrated in legs 1 and 4 and serrated only in external side in legs 2 and 3.

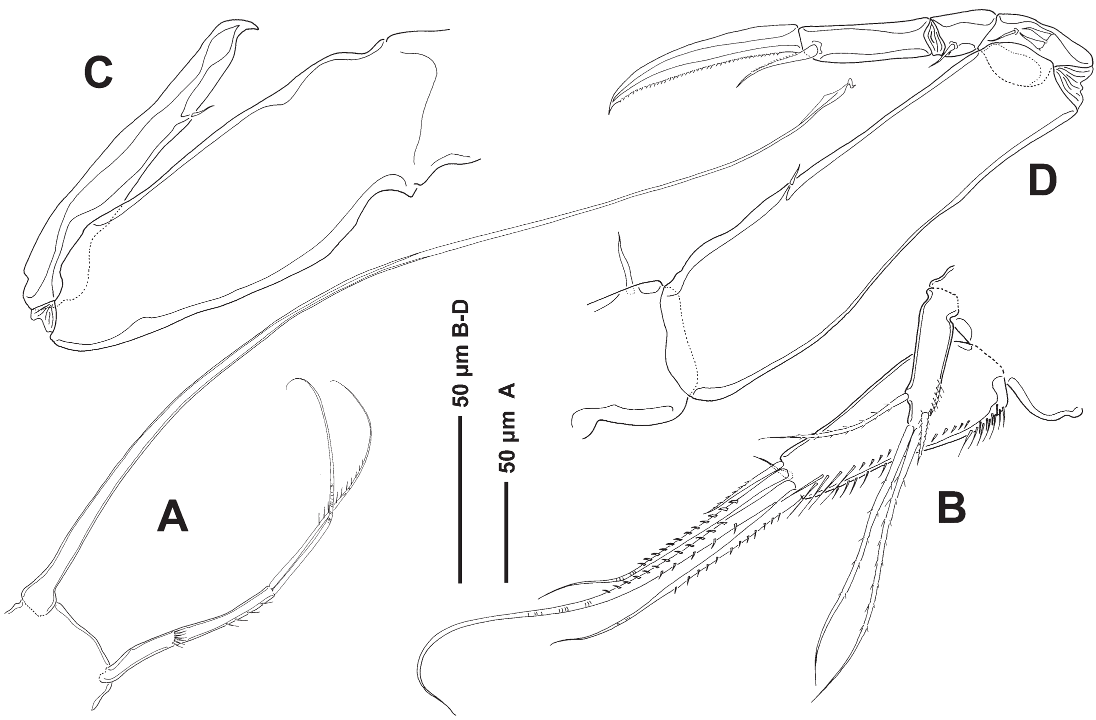

FIGURE 7. *Asterocheres siphonatus* Giesbrecht, 1897, female. A, mandible. B, maxillule C, maxilla. D, maxilliped.

Fifth leg (Fig. 6B) with protopod incorporated into somite; outer seta displaced laterally, with spinule row at base. Free segment (75x33 µm) elongated oval, 2.3 times longer than wide; ornamented with spinules and epicuticular scales and armed with one subterminal and 2 terminal naked setae (Fig. 9B).

Sixth leg (Fig. 6B) represented by paired opercular plates closing off gonopores on genital double somite; armed with two plumose setae.

Colour of living specimens reddish.

Adult male: scarcely described by Thorell (1859) and Sars (1915).

Remarks. Thorell described this species as the type species of his new genus *Ascomyzon, A. lilljeborgi,* in 1859. The specific name *lilljeborgi*, however, had already been preoccupied by *Asterocheres lilljeborgi* Boeck, 1859. This was pointed out by Brady (1880) although he also considered *Artotrogus* Boeck 1859 as synonymous to these genera. While these three genera were described at the same year, there was no doubt about the priority of Boeck's names since Thorell cited Boeck's work in his monograph. Between Boeck's two names, Brady favoured *Artotrogus,* considering it "less objectionable than the term *Asterocheres"*. Therefore, he proposed the name of *Artotrogus boeckii* for Thorell's species and *Artotrogus lilljeborgii* for Boeck's. Brady's suggestion was emended by Giesbrecht (1897) when he pointed out the certain synonymity of *Asterocheres* and *Ascomyzon* (and also *Cyclopicera* Brady, 1872), the validity of the genus *Artotrogus* and the difference between the species described by Thorell as *Ascomyzon lilljeborgi* and that described by Brady as *Artotrogus boeckii*. Hence, Giesbrecht proposed the name of *Asterocheres siphonatus* for Thorell's species (*Ascomyzon lilljeborgi)* since the specific name of *lilljeborgi* was preoccupied by *Asterocheres lilljeborgi* Boeck, 1859, and considered Brady's species as *Asterocheres boecki* (Brady, 1880).

Although Sars (1915) accepted the synonymy of *Asterocheres* and *Ascomyzon* and the priority of the first, he favoured the name of *Ascomyzon* to *Asterocheres* because "*the species of this genus are by no means exclusively parasites of asterids, but are found to infest many other invertebrate animals*". He returned Thorell`s species to the name *Ascomyzon lilljeborgi* , and considered *Asterocheres siphonatus* Giesbrecht, 1897 as a junior synonym of *Ascomyzon lilljeborgi* and changed the specific name of Boeck's to *Ascomyzon asterocheres*. Sars' erroneous suggestion was followed by Gurney (1927), Van Oorde-de lint *et al.* (1936), Bocquet (1952) and Lang (1949). Ten

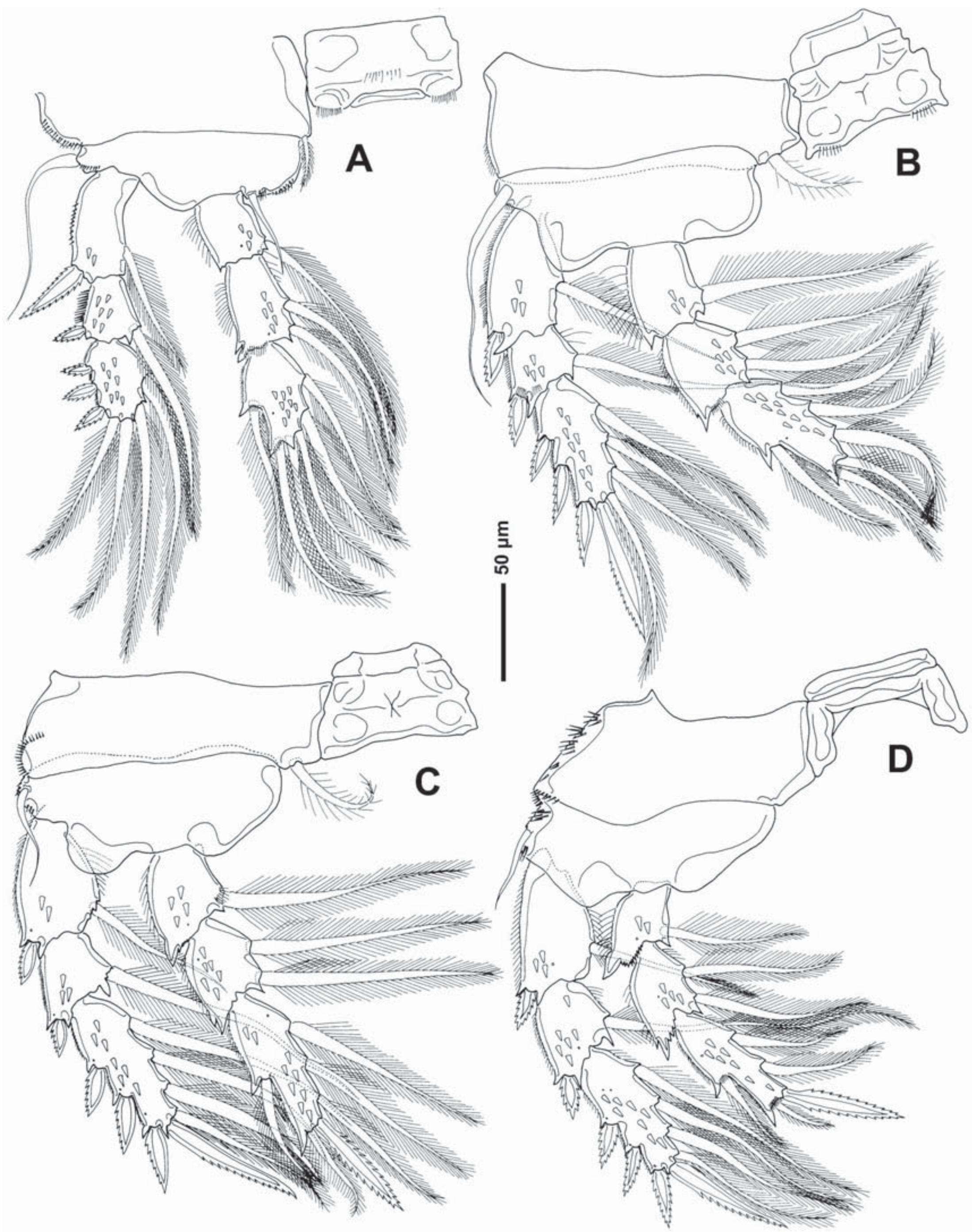

FIGURE 8. *Asterocheres siphonatus* Giesbrecht, 1897, female. A, leg 1. B, leg 2. C, leg 3. D, leg 4.

years later, Bresciani and Lützen (1962) re-established the priority of *Asterocheres* and proposed the specific name of *thorelli* for Thorell's species without considering that this species had already been named by Giesbrecht. Since then, this species has been erroneously named as *A. thorelli* (Sars G.O., 1879) (Brun 1976; Barel & Kramers 1977;

Humes 1986), until Gotto's excellent monograph (1993) where, following the International Code of Zoological (article 60.3), he cited this species as *A. siphonatus* Giesbrecht, 1897. Except for Walter (2009), most authors identify this species as such these days.

This species is easily recognized by its very long siphon and this may be the reason why it has only been illustrated by Thorell in 1859 and Sars in 1915 under the name of *Ascomyzon lilljeborgi*. Our study of *Asterocheres siphonatus* has revealed some important differences with respect to these previous descriptions: (1) For example, this species is commonly described as possessing 19–20 segments in the antennules of females, but in fact the antennule has 21 segments, (2) The antennary exopod has 2 elements, a medial and a terminal setae instead of a single element, and the last segment of the antennary endopod bears a stouter claw and one seta more than those previously illustrated. (3) The mandibular stylet was omitted, and the palp has two terminal setae equal in length as illustrated by Thorell, and not unequal as drawn by Sars. (4) The inner lobe of the maxillule has five setae instead of four, and the outer lobe has four setae, 2 subterminal and 2 terminal, in contrast with the three setae described by Thorell and the 1 subterminal and 3 terminal illustrated by Sars. (6) The basis of the maxilliped has one seta and the first endopodal bears 3 setae which were overlooked in the previous descriptions. (7) The subterminal seta of the free segment of leg 5 and the two plumose setae of leg 6 were also unobserved. (8) The flattened epicuticular scales on the urosomite and legs 1–4 were omitted.

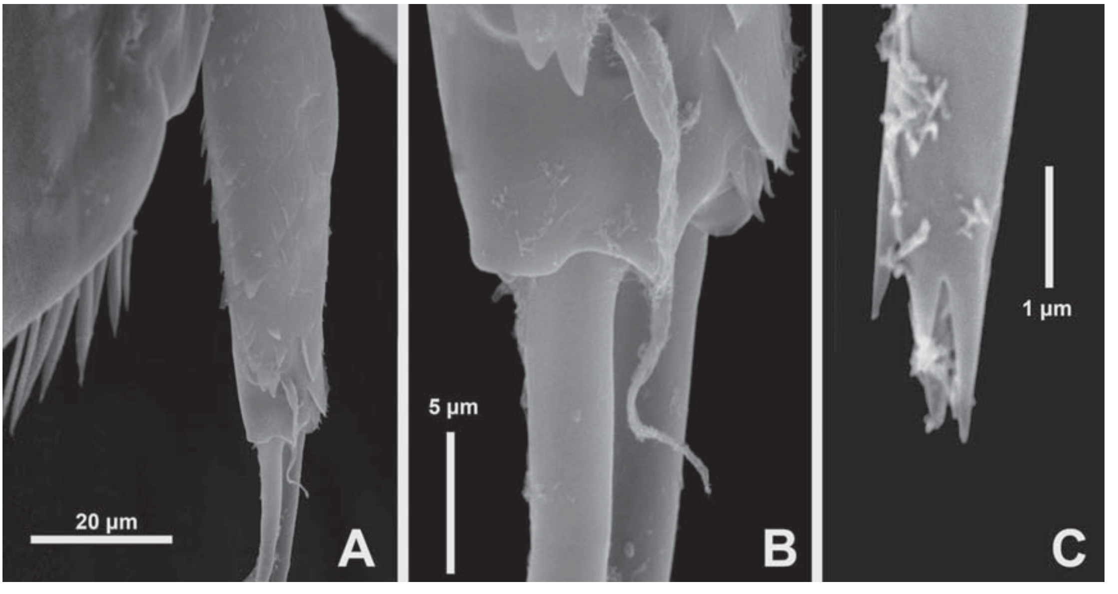

FIGURE 9. *Asterocheres siphonatus* Giesbrecht, 1897, female. A, leg 5. B, leg 5, detail of the subterminal seta. C, antennule, seta with a circlet of cuticular denticles at its tip.

From now on, *A. siphonatus* belongs to the group of species with a 21-segmented antennule in the females and a 1-segmented mandibular palp which includes only four species (*A. bacescui*, *A. madeirensis*, *A. echinicola* and *A. minutus)* together with the additional *A. intermedius* which has an undetermined mandibular palp. The very short siphon and the equal length of both maxillular lobes of *A. echinicola* and *A. minutus* separate them from *A. siphonatus*. The siphons of *A. bacescui* and *A. madeirensis* reach the insertion of the maxillipeds and that of *A. intermedius* extends to the intercoxal plate of leg 1 while that of *A. siphonatus* reaches the intercoxal plate of leg 4 (Bandera *et al*. 2007; Bandera & Conradi 2009a; Marcus & Por 1960).

Host. Although this copepod was initially recorded in association with ascidians, it has also been recorded associated with starfishes, free or among dredged material. The host ascidian species are: *Corella parallelograma* (Müller) (as *Ascidia parallelograma* in Thorell 1859; Sars 1915) and *Ascidia virginia* Müller (as *Phallusia virginia*, Aurivillus 1882).

Our specimens were found associated with the polyclinidae ascidian *Synoicum argus* (Milne Edwards) which has an Atlantic-Mediterranean distribution and generally lives in photophilic communities (Naranjo 1996). However, in Algeciras Bay, this compound ascidian is very common in harbour areas and it has been considered as an indicator of areas which have been subjected to intense stress over a long period (Naranjo *et al*. 1996). Up to now, the only fauna reported to be associated with *S. argus* has been the cyclopoid copepod *Doroixys uncinata* Kershner, 1879 (López-González *et al*. 1997).

Distribution. Sweden (Thorell 1859; Aurivillus 1882), Norway (Sars 1918); France (Van oorde-de Lint *et al*. 1936; Bocquet 1952); Suez Channel (Gurney 1927); Spain (present record).

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Artículo IX

Redescription of five *Asterocheres* species (Copepoda: Siphonostomatoida) and a description of a new species discovered in the collections of the Zoological Museum of Amsterdam.

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Redescription of five *Asterocheres* species (Copepoda: Siphonostomatoida) and a description of a new species discovered in the collections of the Zoological Museum of Amsterdam

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This paper re-examines the type material of five *Asterocheres* Boeck, 1859 species from the collection of Jan Stock deposited in the Zoological Museum of Amsterdam and describes a new species, *Asterocheres hoi*. Some taxonomically important appendages of these species are redescribed and illustrated. The most striking discrepancies with the original descriptions have been observed in: (1) the segmentation of antennule, antenna and mandibular palp; (2) the omission of some elements in various oral appendages such as the antenna, maxillule, maxilla and maxilliped; (3) the presence or not of a flaccid element on the maxilla; (4) the length of the siphon and the shape of the stylet. The redescribed species, *Asterocheres genodon* Stock, 1966, *Asterocheres halichondriae* Stock, 1966, *Asterocheres maxillatus* Stock, 1987, *Asterocheres proboscideus* Stock, 1966 and *Asterocheres scutatus* Stock, 1966, were also compared with their closest congeners.

http://www.zoobank.org/urn:lsid:zoobank.org:pub:1E9F6B4E-ADE0-4A84-91EB-222D391E88D7

Keywords: Copepoda; Siphonostomatoida; symbionts; Jan Stock's collection

Introduction

The Asterocheridae Giesbrecht, 1899 is the largest family of the siphonostomatoid copepods that uses marine invertebrates as hosts, with about 200 species. This family exploits the diversity of marine invertebrate organisms as potential hosts and can be found associated with molluscs, bryozoans, corals, echinoderms, polychaetes, sponges and ascidians (Ivanenko and Smurov 1997; Johnsson and Bustamante 1997). *Asterocheres* Boeck, 1859 is the largest genus within the family as it contains nearly 30% of the known species (approximately 72 nominal species). However, many of these species are poorly or incompletely described (Stock 1966; Ho 1984; Humes 1996a; Ivanenko and Smurov 1997; Boxshall and Halsey 2004; Kim 2004b, 2005, 2010). As such, these descriptions are unreliable for comparative purposes. Most of these poorly known species have not been recorded since their original descriptions and future studies may be based on type material deposited in different museums. The number of *Asterocheres* species has increased at a rapid pace, with about 35 new members described since 2000 (Humes 2000; Johnsson et al. 2001; Johnsson 2002; Kim 2004a, 2004b, 2005, 2010; Bandera et al. 2005, 2007; Bispo et al. 2006; Conradi et al. 2006; Conradi and Bandera 2011). In contrast, only 15 poorly known species have

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been redescribed within the same time period (Ivanenko and Ferrari 2003; Bandera and Conradi 2009a, 2009b, 2009c; Kim 2010).

As Kim (2010) pointed out, it is necessary to consider the validity of the nominal species of *Asterocheres*, so the definition of the genus needs to be strict. He sorted the 72 nominal species into: valid species (45 species), incompletely described species that are hardly comparable with congeners (15 species) and *species inquirendae*, which are hardly considered to belong to *Asterocheres* (12 species). The species belonging to the last two groups need to be re-examined for morphological details before placing them in a particular genus.

A partial revision of the genus *Asterocheres* Boeck, 1859, based on type material deposited in various museums, was recently initiated to clarify the confused systematic and phylogenetic relationships of this genus. The present paper deals with the redescription of some species deposited in the Zoological Museum of Amsterdam by Jan Stock. Although this material belong to the group of valid species, the re-examination of their holotypes showed some discrepancies with their respective original descriptions and, furthermore, one of them turned out to be a new species.

Material and methods

The condition of the type material of the *Asterocheres* deposited in the Zoological Museum of Amsterdam varies according to species. When the dissected specimens were not in good enough condition to make detailed descriptions of some appendages, an additional specimen was dissected in lactic acid, stained with Chlorazol black E (Sigma C-1144), examined as a temporary mount in lactophenol, and finally sealed with Entellan as a permanent mount.

All figures were drawn with the aid of a camera lucida on a Leica DMLB differential interference microscope. All appendage segments and setation elements were named and numbered using the system established by Huys and Boxshall (1991). Mean body length of the copepod was measured from anterior margin of rostrum to posterior margin of caudal rami.

Results

Asterocheres genodon Stock, 1966
(Figure 1)

Material examined

Holotype female (ZMA-Co.100.956) and seven paratype females (ZMA-Co.100.956b) associated with the sponge *Haliclona* sp. at Chenal du Trou d´Eau Douce (Mauritius) at 6–10 m depth collected 7 February 1964, by J.H. Stock.

Description

Female. Body cyclopiform, with oval cephalothorax and cylindrical urosome (fig. 6A; Stock 1966 and fig. 39A; Kim 2010). Mean body length 880 µm (810–940 µm) and maximum width 520 μm (490–550 μm), based on five specimens. All appendages as redescribed by Kim (2010), except for antennule and maxillule.

Antennule 21-segmented (Figure 1A), about 450 μm long. Segmental fusion pattern as follows (roman numerals indicating ancestral segments): 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-1+1 spiniform element, 11(XIV)-1+1 spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+1 aesthetasc, 19(XXII)-2, 20(XXIII-XXIV)-4 and 21(XXV-XXVIII)-7. Segment 10(XIII) reduced and partly overlapped by distal expansion of compound segment 9(IX-XII).

Maxillule bilobed (Figure 1B). Inner lobe three times longer and wider than outer. Inner lobe with tuft of long spinules medially and row of spinules laterally, bearing five terminal setae, one of them short and naked. Outer lobe with two subterminal setae (one of them barbed) and two plumose terminal setae.

Male described by Kim (2010).

Remarks

This species, which lives associated with the sponge *Haliclona* sp. in Chenal du Trou d´Eau Douce (Mauritius), was collected by Jan Stock in 1964 and described and illustrated in 1966. Recently, this species has been thoroughly redescribed by Kim (2010) with material from Madagascar collected by A.G. Humes. Despite this exhaustive redescription, the study of the holotype has revealed two small discrepancies in the oral appendages: (1) the segmental fusion pattern of antennule in female is 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-1+1 spiniform element, 11(XIV)-1+1 spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+1 aesthetasc, 19(XXII)-2, 20(XXIII-XXIV)-4 and 21(XXV-XXVIII)-7 and the setation described by Kim (2010) is different: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-2, 11(XIV)-2, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+1 aesthetasc, 19(XXII-XXIII)-4, 20(XXIV)-2 and 21(XXV-XXVIII)-7; (2) the outer lobe of maxillule shows four plumose distal setae instead of the naked setae illustrated by Kim (2010).

After the redefinition of the genus *Asterocheres* by Kim (2010), only 60 valid species are considered as belonging to this genus. *Asterocheres genodon* belongs to the group of *Asterocheres* species with 21-segmented antennules in females, which comprises 22 species. These species are: *A. astroidicola* Conradi, Bandera and López-González, 2006, *A. echinicola* (Norman, 1868), *A. ellisi* Hamond, 1968, *A. flustrae* Ivanenko and Smurov, 1997, *A. hirsutus* Bandera, Conradi and López-González, 2005, *A. jeanyeatmanae* Yeatman, 1970, *A. kervillei* Canu, 1898, *A. latus* (Brady, 1872), *A. lilljeborgi* Boeck, 1859, *A. madeirensis* Bandera, Conradi and López-González, 2007, *A. minutus* (Claus, 1889), *A. nudicoxus* Kim, 2010, *A. peniculatus* Kim, 2010, *A. reginae* Boxshall and Huys, 1994, *A. simulans* (Scott, 1898), *A. siphonatus* Giesbrecht, 1897, *A. suberitis* Giesbrecht, 1897, *A. tarifensis* Conradi and Bandera, 2011, *A. tenerus* (Hansen, 1923), *A. tenuicornis* Brady, 1910, *A. tubiporae* Kim, 2004 and *A. urabensis* Kim, 2004.

Asterocheres genodon can be easily separated from five of these species, *A. echinicola*, *A. madeirensis*, *A. minutus*, *A. nudicoxus* and *A. siphonatus*, by the number of segments in the mandibular palp. Whereas these species have a one-segmented mandibular palp, *A. genodon* has two segments in the mandibular palp (Bandera et al. 2007; Bandera and Conradi 2009c; Kim 2010; Conradi and Bandera 2011).

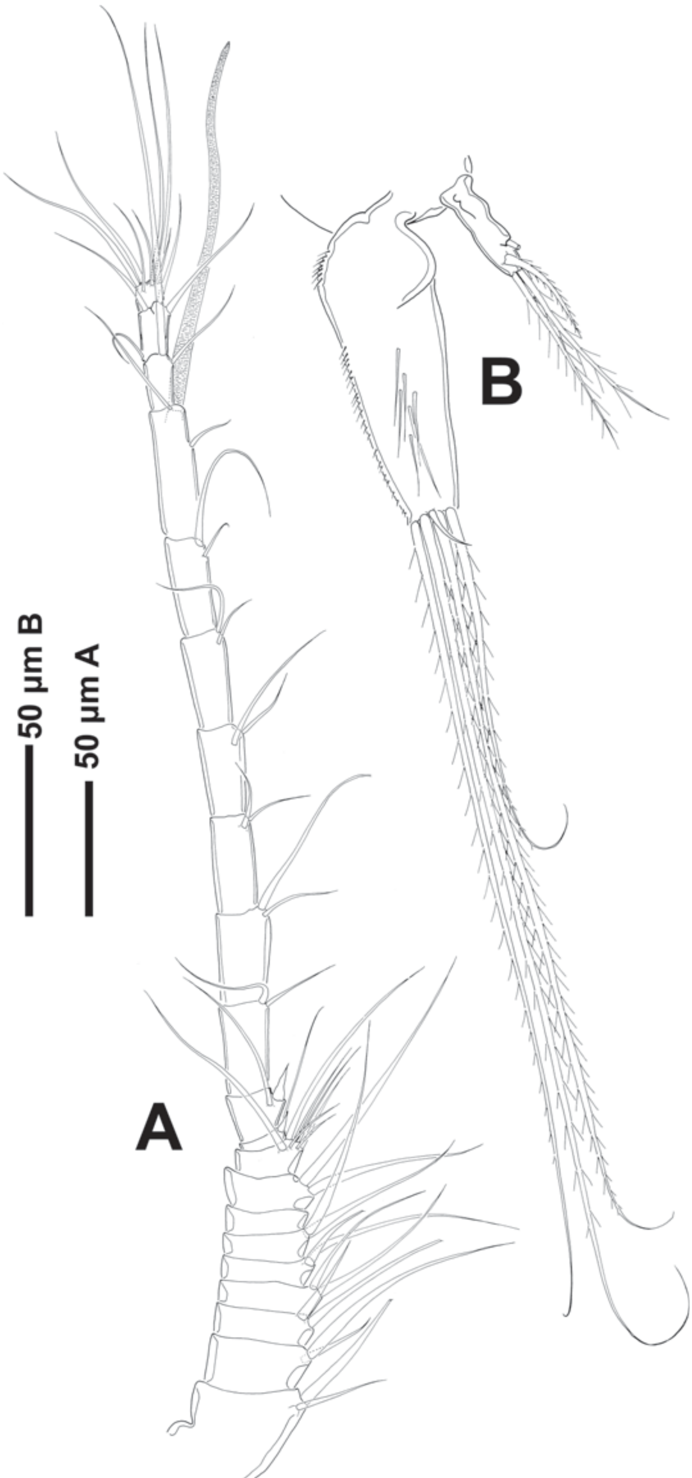

Figure 1. *Asterocheres genodon* Stock, 1966, holotype (female). (A) Antennule; (B) maxillule.

The oral cone of *A. genodon* forms an elongate siphon, reaching slightly beyond the intercoxal plate of leg 2. However, the siphon of *A. peniculatus*, *A. hirsutus*, *A. ellisi*, *A. urabensis* and *A. latus* only reaches to the intercoxal plate of leg 1 (Kim 2004a, 2010; Bandera et al. 2005; Bandera and Conradi 2009b, 2009c); in *A. flustrae*, *A. reginae*, *A. simulans*, *A. suberitis*, *A. jeanyeatmanae*, *A. tarifensis*, *A. kervillei* and *A. tubiporae*, the siphon extends only to the insertion of maxillipeds (Yeatman 1970; Boxshall and Huys 1994; Ivanenko 1997; Ivanenko and Smurov 1997; Kim 2004b; Bandera and Conradi 2009a, 2009c; Conradi and Bandera 2011); and in *A. lilljeborgi* the siphon extends only to the maxilla (according to Ivanenko and Ferrari 2003).

Eiselt's illustration of the habitus of *A. tenuicornis* shows a caudal ramus six times longer than wide (Eiselt 1965). In contrast, *A. genodon* has a caudal ramus slightly longer than wide.

Finally, *A. genodon* can be differentiated from the remaining two species, *A. astroidicola* and *A. tenerus*, by having a ventral seta on the caudal ramus (illustrated and described by Kim 2010). As Kim mentioned, this ventral seta on the caudal ramus is also reported in *A. dysideae* Humes, 1996. This feature is very rare in the genus because it is absent in most species. However, this "seta I" on the caudal ramus was observed by Boxshall and Huys (1994) in *A. reginae*, although in this case this seta was much shorter and lateral.

Asterocheres halichondriae Stock, 1966
(Figure 2)

Material examined

(a) Holotype female (ZMA-Co.100.951c), allotype male (ZMA-Co.100.951a) and 23 females and one male paratype (ZMA-Co.100.951b) associated with the sponge *Halichondria symbiotica* Levi from Flic en Flacq Lagoon (Mauritius) at 1 m depth, collected 13 February 1964 by J.H. Stock; (b) 20 females (ZMA-Co.100.952) associated with *Halichondria symbiotica* Levi from Black River Bay (Mauritius) at 1.5 m depth, collected 24 January 1964 by J.H. Stock; (c) two females (ZMA-Co.100.953) associated with *Halichondria symbiotica* Levi from Pointe aux Sables (Mauritius) at 1.5 m depth, collected 26 January 1964 by J.H. Stock.

Description

Female. Body cyclopiform with oval cephalothorax and cylindrical urosome (fig. 2A; Stock 1966). Mean body length 480 µm (455–510 µm) and maximum width 265 µm (250–285 µm), based on five specimens. Prosome comprising cephalothorax (fully incorporating first pedigerous somite) and three free pedigerous somites. Urosome four-segmented, comprising leg-5 bearing somite, genital double-somite and two free abdominal somites (fig. 3A; Stock 1966). Dorsal surface of free abdominal somites and posterior part of genital double-somite with epicuticular spinules. Genital double-somite about as long as wide; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore; lateral margins with long spinules in distal half, posterior to genital apertures (fig. 3A; Stock 1966). Each genital area with two small naked setae.

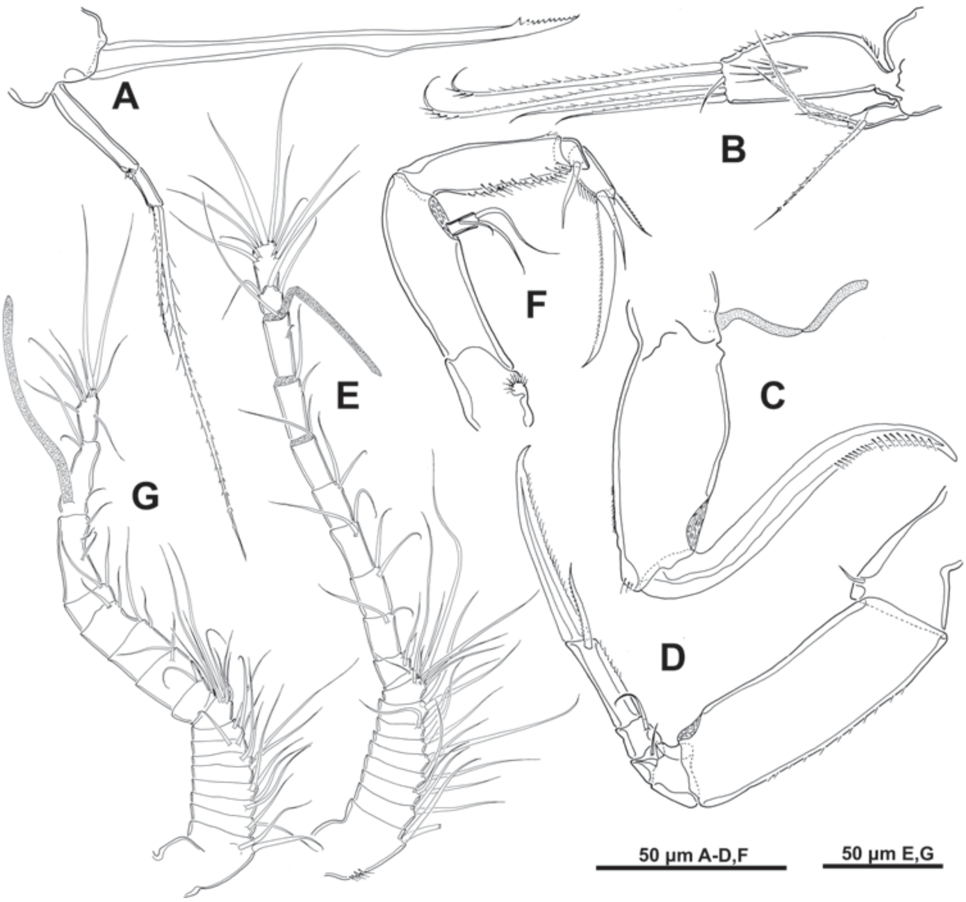

Figure 2. *Asterocheres halichondriae* Stock, 1966, holotype (female). (A) Mandible; (B) maxillule; (C) maxilla; (D) maxilliped; (E) antennule; (F) antenna. *Asterocheres halichondriae*, male. (G) Antennule.

Caudal rami about as long as wide (fig. 3A; Stock 1966), trapezoidal with inner margin shorter than outer; with six setae; seta I absent, setae III–VI plumose (middle setae very stout) and setae II and VII slightly displaced onto dorsal surface and smooth.

Antennule 20-segmented (Figure 2E), about 265 µm long. Segmental fusion pattern as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-1, 11(XIV)-1+1 spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+1 aesthetasc, 19(XXII-XXIII)-3 and 20(XXIV-XXVIII)-9. Segment 10(XIII) reduced and partly overlapped by distal expansion of compound segment 9(IX-XII). All setae smooth.

Antenna biramous (Figure 2F), about 175 µm long. Coxa small with fan-like spinular tuft. Basis elongate, unarmed. Exopod one-segmented, about twice as long as wide, with two long terminal setae and one shorter and lateral seta. Endopod three-segmented; proximal segment elongated with spinules in inner margin; middle segment produced distally on medial side but articulating with distal segment proximally on lateral side, bearing one distal smooth seta (longer than segment); distal segment with two subterminal setae, one of them plumose, and distal claw with minute spinules on inner margin.

Siphon short, about 125 μm long, and conical. Reaching to posterior margin of maxilliped insertion.

Mandible (Figure 2A) comprising stylet-like gnathobase and slender two-segmented palp. Proximal segment of palp longer, with fan-like spinular tuft in distal part; distal segment shorter, with one distal spinule and two slightly plumose, unequal terminal setae. Stylet located in oral cone, with denticulate margin subapically.

Maxillule bilobed (Figure 2B). Inner lobe almost three times longer and wider than outer one. Praecoxal endite with five distal setae, one of them minute and naked, with tuft of long spinules medially and row of shorter spinules laterally. Palp with two terminal and two subterminal setae; all slightly plumose.

Maxilla two-segmented (Figure 2C) but with partial transverse surface suture on syncoxa (proximal segment) possibly marking plane of praecoxa–coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland. Coxal portion ornamented with spinules on outer margin being longer at apical part. Basis claw-like with spinule row in distal half as figured.

Maxilliped five-segmented (Figure 2D). First segment with one short smooth seta on inner distal margin. Second segment elongate, with small spinules on outer margin. Third segment compound, partial suture marking original separation of two ancestral segments, with (2,1) armature formula. Fourth segment short, with one smooth seta on inner medial part. Fifth segment with small spinules on inner margin, one plumose subterminal seta and a terminal claw with spinules on inner margin.

Swimming legs 1–4 biramous (fig. 4A–D; Stock 1966), with three-segmented rami and each with intercoxal sclerite. Legs 1–4 as described and illustrated by Stock (1966). Spine and seta formula as follows (Table 1):

Fifth leg (fig. 3A; Stock 1966) with protopod incorporated into somite. Exopod elongate, ornamented with small spinules on margins and armed with three terminal setae, the two longer plumose. Smooth protopodal seta on somite longer than entire exopod.

Sixth leg represented by two short smooth setae in genital area (fig. 3A; Stock 1966).

Male. Body cyclopiform, with cephalothorax oval and cylindrical urosome. Mean body length 406 μm (380–430 μm), based on three specimens. Urosome five-segmented, comprising leg 5-bearing somite, genital somite, and three free abdominal

Table 1. Spine and seta formula for *Asterocheres halichondriae* Stock, 1966.

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

somites. Genital somite about as long as wide bearing genital apertures posterolaterally on ventral surface (fig. 5A; Stock 1966). Most appendages as for female except for antennules, maxillipeds, and legs 2 and 6.

Antennule 18-segmented (Figure 2G), geniculate with geniculation positioned between segments 16(XIX-XX) and 17(XXI-XXIII). Segmental fusion pattern as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-1, 11(XIV)-1+1 spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX-XX)-3, 17(XXI-XXIII)-3+1 aesthetasc and 18(XXIV-XXVIII)-9. Segment 10(XIII) reduced and partly covered by distal expansion of compound segment 9 (IX-XII). All setae smooth.

Maxilliped five-segmented (fig. 5C; Stock 1966), very similar to that of female but with tooth-like process in proximal half of second segment.

Second leg (fig. 5D; Stock 1966) showing sexual dimorphism in third endopodal segment.

Fifth leg (fig. 5A; Stock 1966) as for female but all exopodal setae smooth.

Sixth leg (fig. 5A; Stock 1966) represented by opercula closing off genital apertures; each with two smooth setae and rows of fine spinules.

Remarks

Asterocheres halichondriae was collected by Stock at Flic en Flacq (Mauritius) in 1964 where it lives associated with the sponge *Halichondria symbiotica* Levi. The re-examination of the holotype and allotype has revealed some differences with the original description. (1) The antennule is 20-segmented in the female and not 19-segmented as Stock described it. (2) The antennary exopod carries one medial seta in addition to the two terminal setae described by Stock. The second endopodal segment has a subterminal seta much longer than the seta illustrated by Stock. (3) The second segment of the mandibular palp has two plumose terminal setae. (4) The inner lobe of maxillule has five terminal setae, all of them plumose except for the shorter seta, and the two longer setae have three or four stout spinules distally. (5) The maxilla bears a flaccid element medially, representing tubular extension of external opening of maxillary gland. (6) The third segment of maxilliped has three elements instead of the two elements described by Stock. (7) The antennule is 18-segmented in the male and not 17-segmented as Stock described it.

Asterocheres halichondriae belongs to the group of *Asterocheres* species with 20-segmented antennules in females, which comprises 21 species. These species are: *A. aesthetes* Ho, 1984, *A. boecki* (Brady, 1880), *A. bulbosus* Malt, 1991, *A. complexus* Stock, 1960, *A. corneliae* Schirl, 1973, *A. crinoidicola* Humes, 2000, *A. dentatus* Giesbrecht, 1897, *A. galeatus* Kim, 2010, *A. indivisus* Kim, 2010, *A. maxillatus* Stock, 1987, *A. neptunei* Johnsson, 2001, *A. oricurvus* Kim, 2010, *A. planus* Kim, 2010, *A. sensilis* Kim, 2010, *A. simplex* Schirl, 1973, *A. stimulans* Giesbrecht, 1897, *A. stocki* Nair and Pillai, 1984, *A. tenuipes* Kim, 2010, *A. tricuspis* Kim, 2010, *A. trisetatus* Kim, 2010 and *A. ventricosus* (Brian, 1927).

Asterocheres halichondriae differs from eight of these 21 species (*A. planus*, *A. sensilis*, *A. indivisus*, *A. bulbosus*, *A. boecki*, *A. corneliae*, *A. aesthetes* and *A. stocki*) in the possession of a one-segmented mandibular palp, in contrast to the two-segmented mandibular palp shown by the present species (Brady 1880; Schirl 1973; Ho 1984; Nair and Pillai 1984; Bandera and Conradi 2009b; Kim 2010).

As for the body shape, *A. halichondriae* has an oval cephalothorax and cylindrical urosome, whereas *A. tenuipes* has a very broad, almost rounded prosome, and a very small urosome and *A. galeatus* has a large, helmet-shaped cephalothorax (Kim 2010). Stock (1987) described the cephalosome of *A. maxillatus* as a rounded shield that covers metasomite 3 and urosomite 1, and *A. neptunei* has a dorsoventrally flattened prosome (Johnsson et al. 2001).

Among the remaining 10 species, *A. oricurvus* and *A. stimulans* can be easily separated from *A. halichondriae* by the length of the oral cone. The siphon reaches leg 4 in *A. oricurvus* and *A. stimulans*, whereas in *A. halichondriae* it extends only to the insertion of maxillipeds (Giesbrecht 1899; Kim 2010).

The shape of the caudal rami serves to separate *A. halichondriae* from *A. complexus* and *A. simplex*. The caudal rami in these two last species are longer than wide, in contrast *A. halichondriae* has caudal rami that are wider than long (Stock 1960; Schirl 1973).

From the point of view of the genital double-somite, *A. halichondriae* shows a regularly rounded contour, whereas *A. dentatus*, *A. ventricosus* and *A. tricuspis* have one- or four-denticulated processes at posterolateral corners of broad anterior part (Giesbrecht 1899; Kim 2010). Although the description made by Brian in 1927 for *A. ventricosus* (as *Ascomyzon ventricosum*) is incomplete, the illustration of the urosome shows a tooth-like process on the genital double-somite (Brian 1927).

Finally, the remaining two species, *A. crinoidicola* and *A. trisetatus* can be differentiated from *A. halichondriae* by the maxillule. In *A. halichondriae*, the inner lobe is almost three times longer and wider than the outer and the lobes are provided with five distal setae and two terminal and two subterminal setae, respectively. However, in *A. crinoidicola*, the inner lobe of maxillule is twice as long as wide; and *A. trisetatus* has only three distal setae on the outer lobe of the maxillule (Kim 2010).

Asterocheres hoi sp. nov.
(Figures 3 and 4)

Material examined

Holotype female (ZMA-Co.201.521) and one paratype female (ZMA-Co.201.521) associated with *Lytechinus variegatus* (Lamarck, 1816) in Piscadera Bay (Curaçao) at 3 m depth collected 17 November 1958 by J.H.Stock.

Description

Female. Body cyclopiform with oval cephalothorax and short, cylindrical urosome (Figure 3A). Mean body length 780 μm (750–810 μm) and maximum width 430 μm (410–450 μm), based on two specimens. Prosome comprising cephalothorax (fully incorporating first pedigerous somite) and three free pedigerous somites. Cephalothorax and free pedigerous somites with rounded posterolateral angles. Rostrum triangular. Dorsal cephalothoracic shield and free pedigerous somites with integumental pores and sensilla. Urosome four-segmented, comprising leg-5 bearing somite, genital double-somite, and two free abdominal somites (Figure 3B). Genital double-somite slightly wider than long; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore; lateral margins with

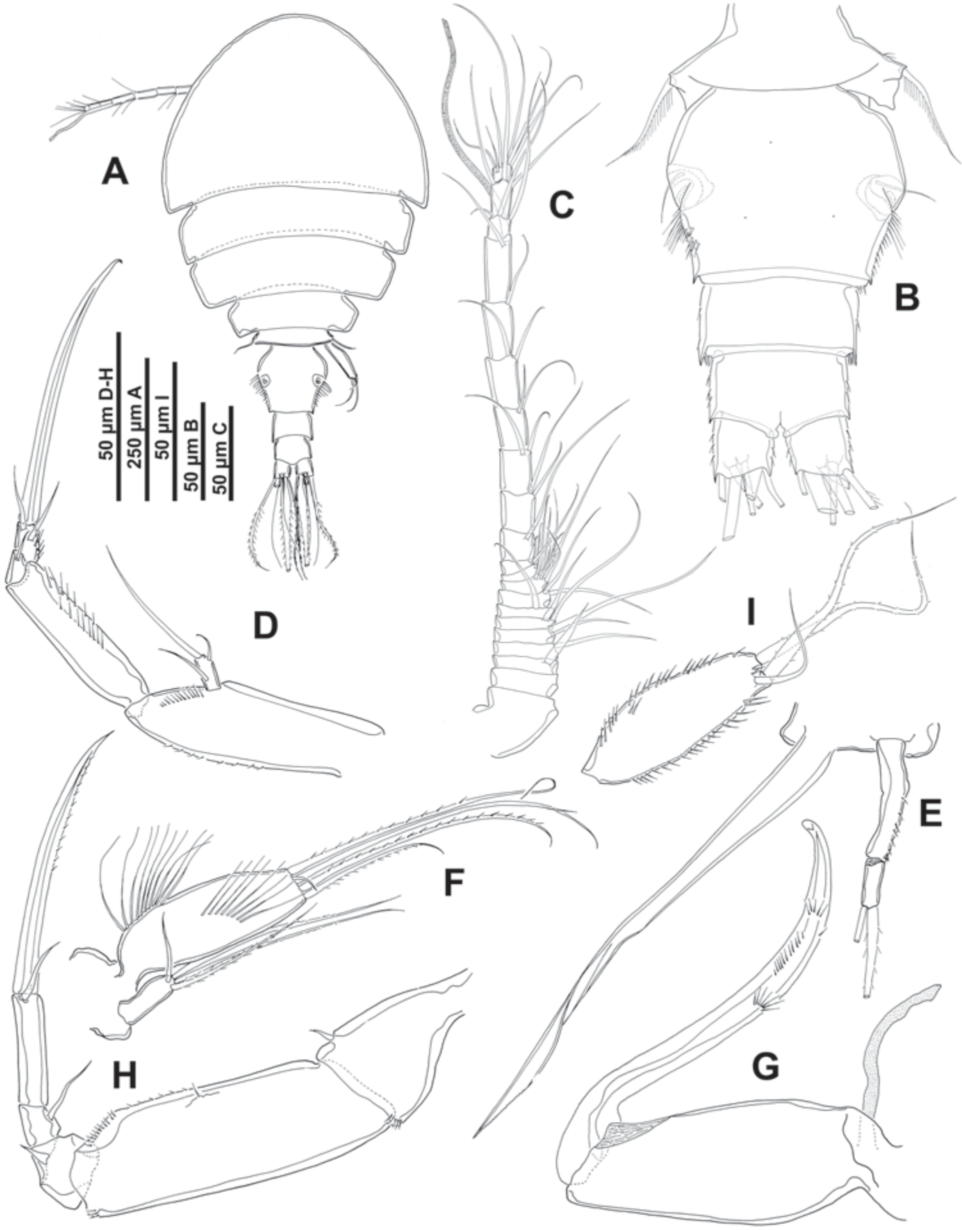

Figure 3. *Asterocheres hoi*, sp. nov. (female). (A) Dorsal view; (B) urosome, dorsal view; (C) antennule; (D) antenna; (E) mandible; (F) maxillule; (G) maxilla; (H) maxilliped; (I) leg 5.

long spinules in middle third, posterior to genital apertures (Figure 3B). Each genital area with smooth seta.

Caudal rami (Figure 3A,B) slightly longer than wide (measured along outer margin), armed with six setae; seta I absent, setae III–VI plumose and setae II and VII slightly displaced onto dorsal surface and smooth.

Antennule 21-segmented (Figure 3C), about 320 μm long. Segmental fusion pattern as follows: 1(I), 2(II), 3(III)-1, 4(IV)-1, 5(V)-2, 6(VI)-2, 7(VII)-1, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-1, 11(XIV)-1+1 spine, 12(XV)-1, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-1, 18(XXI)-1+1 aesthetasc, 19(XXII)-2, 20(XXIII-XXIV)-4 and 21(XXV-XXVIII)-6. Segment 10(XIII) reduced and partly overlapped by distal expansion of compound segment 9(IX-XII).

Antenna biramous (Figure 3D), about 300 μm long (excluding coxa and including terminal claw). Coxa lost in dissection. Basis unarmed, with fine spinule rows on margins. Exopod one-segmented, about twice as long as wide; with one lateral seta, one subterminal seta and one long terminal seta, all naked. Endopod three-segmented; proximal segment elongate with spinular rows as figured; middle segment produced distally on medial side but articulating with distal segment proximally on lateral side, bearing one subterminal smooth seta; distal segment with spinules on inner margin and two smooth subterminal setae, and distal claw.

Siphon slender, about 350 μm long, reaching to intercoxal sclerite of leg 1.

Mandible (Figure 3E) comprising stylet-like gnathobase and two-segmented palp. Proximal segment of palp longer, with row of spinules on lateral margin; distal segment with two unequal apical setae. Stylet located in oral cone, formed by anterior labrum and posterior labium, with denticulate margin subapically.

Maxillule bilobed (Figure 3F); inner lobe 3.5 times longer than outer, with row of very long setules on lateral margin and medially, and with five terminal setae, four of them long and plumose and one minute and naked. Outer lobe with four terminal setae, three of them long and pinnate and one shorter and naked.

Maxilla (Figure 3G) two-segmented but with partial transverse surface suture on syncoxa (proximal segment) possibly marking plane of praecoxa–coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland. Coxal portion unarmed. Basis claw-like with fan-like tufts of spinules medially and distally, and rows of spinules on distal half; recurved tip.

Maxilliped five-segmented (Figure 3H), comprising short syncoxa, long basis and three-segmented endopod. Syncoxa with row of spinules and one short seta distally. Basis with rows of spinules on inner margin and distally and one minute seta medially. First endopodal segment compound, partial suture marking original separation of two ancestral segments, with (1,0) armature formula; second endopodal segment bearing one naked seta; third endopodal segment with recurved terminal claw plus additional apical seta. Inner margin of claw provided with row of minute spinules.

Swimming legs 1–4 biramous (Figure 4A–D), with three-segmented rami and each with intercoxal sclerite. Spine and seta formula (Table 2):

Table 2. Spine and seta formula for *Asterocheres hoi* sp. nov.

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

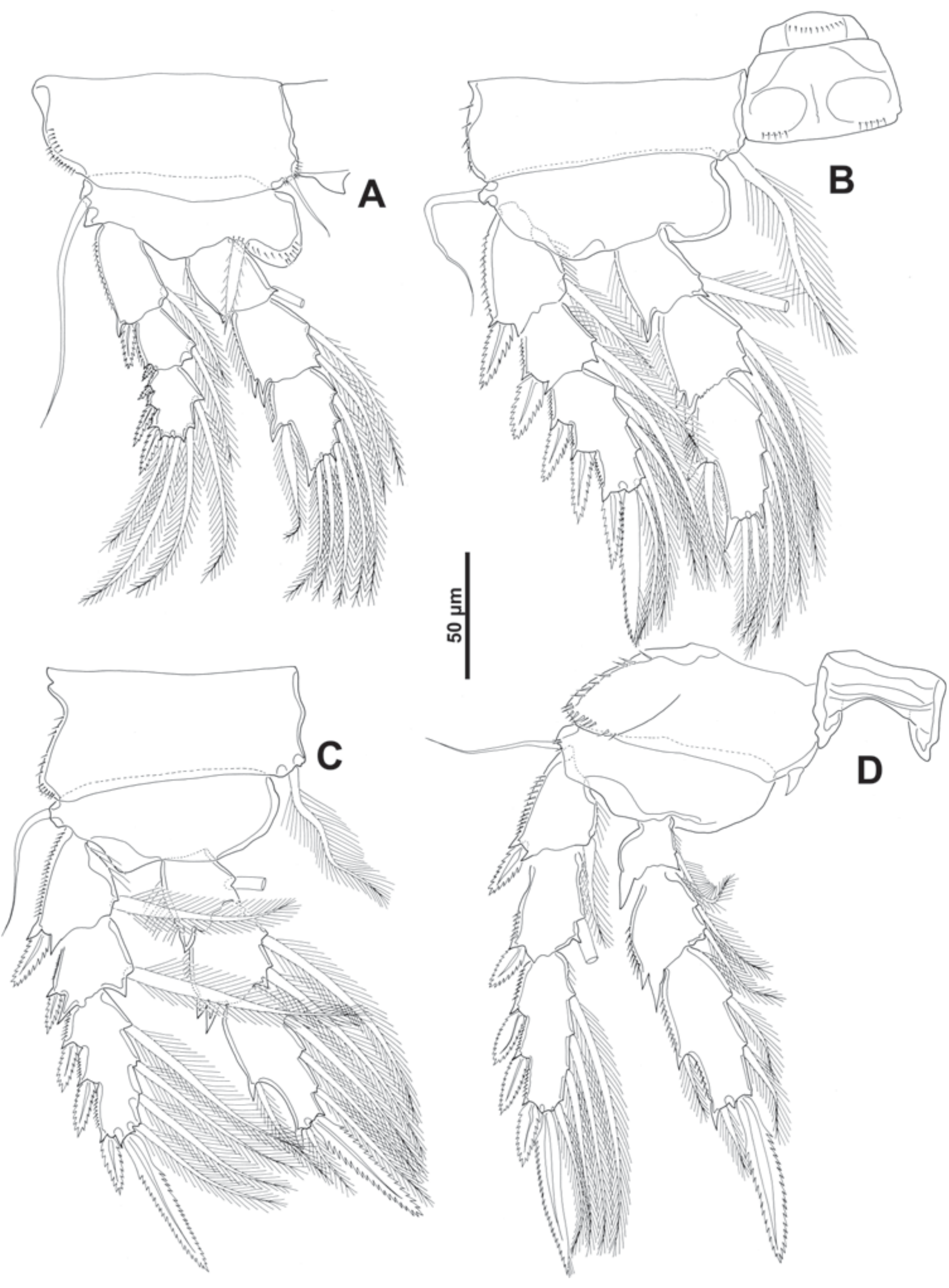

Figure 4. *Asterocheres hoi*, sp. nov. (female). (A) Leg 1; (B) leg 2; (C) leg 3; (D) leg 4.

Coxae ornamented with spinule rows around outer margin; inner coxal seta short and naked in leg 1, long and plumose in legs 2–3, and reduced in leg 4 (Figure 4A–D). Basis of leg 1 with spinules around inner margin; outer seta long and naked in legs 1–4. Outer spines of exopodal segments in legs 1–4 bilaterally serrate. Lateral margins of exopodal segments with minute serrations or spinular rows; those of endopodal segments with rows of setules.

Fifth leg (Figure 3I) with protopod incorporated into somite. Free segment almost three times longer than wide, elongate-oval, with two long pinnate terminal setae and one shorter smooth subterminal seta; outer and inner margins with spinules.

Sixth leg (Figure 3B) represented by paired opercular plates closing off gonopores on genital double-somite; each armed with one smooth seta.

Male. Unknown.

Etymology

The species is named in honour of Prof. Ju-shey Ho.

Remarks

This species was found in a vial labelled as "*Asterocheres cf. simulans* (Th. Scott, 1898)" which turned out to contain a new species. This species was collected by Stock in Curaçao (Piscadera Bay) in 1958 and lives associated with *Lytechinus variegatus* (Lamarck, 1816). The most striking features of this species are: (1) the antennules are 21-segmented; (2) the antenna has a three-segmented endopod and a one-segmented exopod with three setae; (3) the mandible has two-segmented palp with two terminal setae and stylet with denticulate margin subapically; (4) the siphon reaches approximately to the insertion of leg 1; (5) the outer lobe of maxillule has four distal setae and the inner lobe has five distal setae (one minute and naked) and rows of long setules in the lateral margin and medially; (6) the maxilla bears a flaccid element medially, representing tubular extension of external opening of maxillary gland and claw with rows of spinules in the second half; (7) the maxilliped is five-segmented with terminal claw; (8) legs 1–4 biramous, as usual in the genus; (9) the free segment of fifth leg bears three terminal setae; (10) the caudal rami are slightly longer than wide with six terminal setae.

This species belongs to the group of species with a 21-segmented antennule in the female and a two-segmented mandibular palp. This group consists of 18 species named above.

The oral cone of *A. hoi* possesses an elongate siphon reaching to the intercoxal plate of legs 1. In contrast, the siphon of *A. genodon*, *A. astroidicola*, *A. ellisi* and *A. tenerus* reaches to the intercoxal plate of leg 2; in *A. flustrae*, *A. reginae*, *A. simulans*, *A. suberitis*, *A. jeanyeatmanae*, *A. tarifensis*, *A. kervillei* and *A. tubiporae*, the siphon reaches the insertion of maxillipeds; and in *A. lilljeborgi* the siphon extends only to the maxilla (Ivanenko and Ferrari 2003).

The shape of the caudal rami separates *A. hoi* from *A. hirsutus*, *A. tenuicornis*, (according to the illustration in Eiselt 1965) and *A. latus*, as the new species has caudal rami only slightly longer than wide, but in *A. hirsutus* the caudal rami are 2.5 times longer than wide, in *A. latus* 2.6 times longer than wide and in *A. tenuicornis* six times longer than wide.

The ornamentation of the antenna and the maxillule serve to differentiate *A. hoi* from *A. peniculatus*. The new species has the antennal claw longer than the first endopodal segment and a row of very long setules on the lateral margin of the inner lobe of the maxillule. *Asterocheres peniculatus* has an antennal claw shorter than the first endopodal segment and the basis has a longitudinal row of bifurcate or trifurcate spinules or scales near base of the exopod; the inner lobe of the maxillule has a row of short setules, as usual in the genus (Kim 2010).

Finally, the exopod of leg 5 is 2.5 times longer than wide and the two terminal barbed setae are much longer than the entire segment in *A. hoi*. In contrast, in *A. urabensis* the exopod of leg 5 is 3.8 times longer than wide and the two terminal smooth setae are shorter than the free segment (Kim 2004a).

Asterocheres maxillatus Stock, 1987
(Figure 5)

Material examined

Holotype female (ZMA-Co.102.745c) and one paratype female (ZMA-Co.102.745a+b) associated with *Manicina areolata* (L.) f. *mayori*. In Curaçao (500 m west off Piscadera Bay) at 4 m depth, collected 7 January 1974 by J.H. Stock.

Description

Female. Body cyclopiform, consisting of dorsoventrally flattened prosome with rounded cephalothorax, and cylindrical urosome (fig. 1A; Stock 1987). Total length 610 μm and maximum width 420 μm. Prosome comprising cephalothorax (fully incorporating first pedigerous somite) and three free pedigerous somites. Cephalothorax and pedigerous somite 2 and 3 forming a rounded shield covering pedigerous somites 4 and 5 and even half of genital double-somite dorsally (fig. 1A; Stock 1987). Epimeral areas of cephalothorax and somite bearing leg 2 with posterolateral angles pointed backwards. Urosome four-segmented, comprising leg-5 bearing somite, genital double-somite, and two free abdominal somites (fig. 1B; Stock 1987). Genital double-somite wider than long, with paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore. Each genital area with one long seta and one stout spine (fig. 1B; Stock 1987). Prosome and urosome with numerous integumental pores and sensilla.

Caudal rami longer than wide, with six terminal setae. Seta I absent; setae II and VII slightly displaced onto dorsal surface; setae III–VI arranged around posterior margin and plumose (fig. 1B; Stock 1987).

Antennule 20-segmented, as described and illustrated by Stock (fig. 1D; Stock 1987).

Antenna biramous (Figure 5A), about 220 μm long (including terminal claw). Coxa short and basis elongate, both unarmed. Exopod one-segmented, 1.5 times longer than wide, with one proximal short seta and two terminal setae, unequal in length. Endopod three-segmented; first segment elongate, with spinules rows as figured; second segment produced distally on medial side but articulating with distal segment proximally on lateral side, with short barbed seta; and third segment with row of long setules on inner margin, two plumose subterminal setae, and terminal claw with spinule row on inner margin.

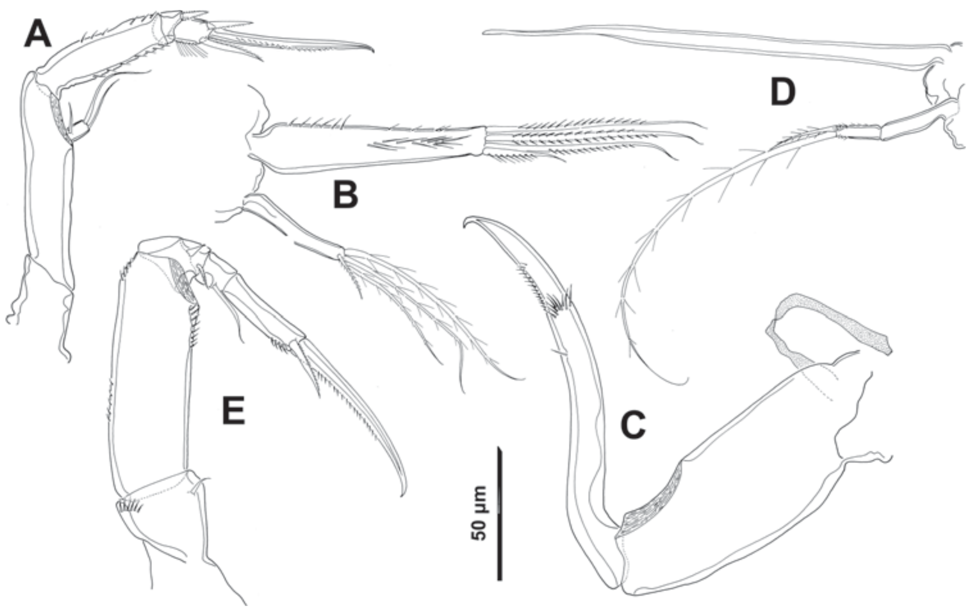

Figure 5. *Asterocheres maxillatus* Stock, 1987, holotype (female). (A) Antenna; (B) maxillule; (C) maxilla; (D) mandible; (E) maxilliped.

Siphon conical about 190 µm long, reaching to maxilliped insertion.

Mandible (Figure 5D) comprising stylet-like gnathobase and two-segmented palp. Stylet located in oral cone, with denticulate margin subapically. First segment of palp elongate, unarmed; second segment short, with spinules in lateral margins and apically, and two plumose setae, one short.

Maxillule bilobed (Figure 5B). Both lobes very long and narrow, but inner lobe twice as long as outer. Inner lobe with spinules row in lateral margin and medially and four plumose terminal setae, unequal in length but all shorter than entire segment. Outer lobe with short barbed subterminal seta and three long plumose terminal setae.

Maxilla two-segmented (Figure 5C) but with partial transverse surface suture on syncoxa (proximal segment) possibly marking plane of praecoxa–coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland. Coxa robust and unarmed and basis claw-like with fan-like tuft of spinules and spinule rows in distal half.

Maxilliped five-segmented (Figure 5E), comprising short syncoxa, long basis and three-segmented endopod. Syncoxa with short distal seta on inner margin and spinule row on outer distal margin. Basis elongate, with spinules on margins. First endopodal segment compound, partial suture marking original separation of two ancestral segments, with (1,1) armature formula. Second endopodal segment short, with one smooth very long seta medially. Third endopodal segment with minute spinules on inner distal margin, one plumose subterminal seta, and terminal claw with spinule row on inner margin.

Swimming legs 1–4 biramous (fig. 2C–F; Stock 1987), with three-segmented rami and each with intercoxal sclerite. Spine and seta formula as follows (Table 3):

Table 3. Spine and seta formula for *Asterocheres maxillatus* Stock, 1987.

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

Fifth leg with protopod incorporated into somite (fig. 1B; Stock 1987). Free segment (exopod) three times longer than wide, with two smooth terminal setae and one subterminal seta. Somite with outer smooth basal seta displaced to laterodorsal surface and longer than entire exopod.

Sixth leg (fig. 1B; Stock 1987) represented by one long smooth seta and one spine on each genital area.

Male. Unknown.

Remarks

This species lives associated with *Manicina areolata* (L.) f. *mayori*. Stock collected it in Curaçao in 1974. Comparison with Stock's text and illustration revealed a number of discrepancies: (1) the antennary exopod has two distal setae and one proximal seta, which was overlooked by Stock; (2) the second segment of the mandibular palp carries rows of spinules; (3) the inner lobe of the maxillule has long spinules medially; (4) the maxilla bears a flaccid element medially, representing tubular extension of external opening of maxillary gland; (5) the setae present on the third and fifth maxilliped segments are plumose.

This species belongs to the group of species with 20-segmented antennules in the female. This group is composed of 21 species, however *A. maxillatus* can be separated from all of them by the shape of the body. In this species the cephalosome and metasomites 1 and 2 form a rounded shield, dorsally covering metasomite 3, urosomite 1 and the anterior half of urosomite 2 (genital double-somite) (Stock 1987). No other species in this group shows this feature.

Asterocheres proboscideus **Stock, 1966**
(Figure 6)

Material examined

Holotype female (ZMA-Co.100.957a) and six paratype females (ZMA-Co.100.957a and ZMA-Co.100.957b) associated with the calcareous sponge *Pericharax heteroraphis* Polejaeffin Mauritius (20°22′S, 57°21′ E) at 10–19 m depth collected 10 February 1964 by J.H. Stock.

Description

Female. Body cyclopiform, with cephalothorax nearly circular in outline and occupying distinctly less than half of entire body length and cylindrical urosome (fig. 9A;

Stock 1966). Mean body length 720 μm (650–810 μm) and maximum width 370 μm (330–400 μm), based on six specimens. Prosome comprising cephalothorax (fully incorporating first pedigerous somite) and three free pedigerous somites. Cephalothorax and free pedigerous somites with rounded posterolateral angles (fig. 9A; Stock 1966). Urosome four-segmented, comprising leg 5-bearing somite, genital double-somite and two free abdominal somites (fig. 9B; Stock 1966). Genital double-somite about as long as wide; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore; lateral margins with rows of long spinules on distal half and posterior part of somite (fig. 9B; Stock 1966). Each genital area with two smooth setae.

Caudal rami slightly wider than long; with rows of spinules on terminal part; and six setae. Seta I absent. Setae II and VII smooth and displaced onto dorsal surface. Setae III–VI plumose, arranged around posterior margin of segment, middle setae very stout.

Antennule 20-segmented (Figure 6B), about 360 μm long. Segmental fusion pattern as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-1, 6(VI)-2, 7(VII)-1, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-1, 11(XIV)-1+1 spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-1, 18(XXI)-2+1 aesthetasc, 19(XXII-XXIII)-3 and 20(XXIV-XXVIII)-9. Segment 10(XIII) reduced and partly overlapped by distal expansion of compound segment 9(IX-XII). All setae smooth.

Antenna biramous (Figure 6E), about 270 μm long (including terminal claw). Coxa small, unarmed. Basis elongate with spinules on inner distal margin. Exopod

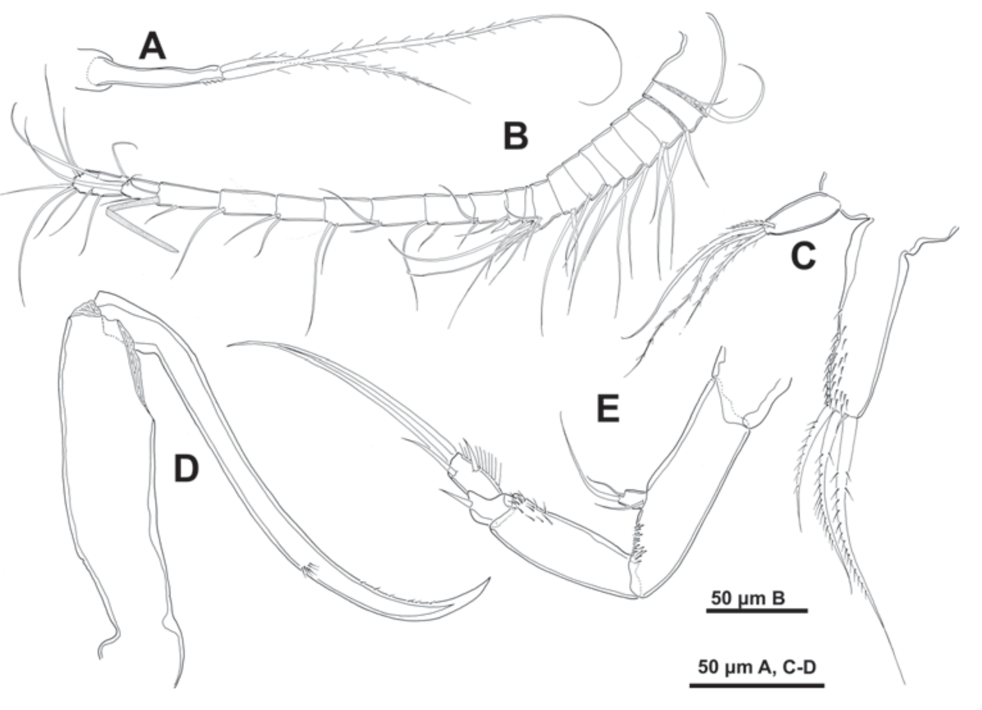

Figure 6. *Asterocheres proboscideus* Stock, 1966, holotype (female). (A) Mandibular palp; (B) antennule; (C) maxillule; (D) maxilla; (E) antenna.

one-segmented, 1.5 times longer than wide, with one proximal seta medially, one subterminal seta laterally, and one distal seta twice as long as other two; all setae smooth. Endopod three-segmented; proximal segment elongate, with spinules on inner part; middle segment produced distally on medial side but articulating with distal segment proximally on lateral side, with one smooth subterminal seta, shorter than entire segment; distal segment with row of long setules on inner margin, one smooth lateral seta, one smooth subterminal seta, and terminal claw slightly longer than entire endopod.

Siphon very long, about 600 μm long, with tubiform distal part usually curled; reaching beyond caudal rami.

Mandible (Figure 6A) comprising stylet-like gnathobase and one-segmented palp. Palp elongate, with spinules on laterodistal margin and two plumose terminal setae unequal in length.

Maxillule bilobed (Figure 6C). Inner lobe 2.5 times longer than outer; with tuft of short spinules on distal half and four distal setae, one of them smooth and short. Outer lobe with one subterminal barbed seta and three plumose terminal setae.

Maxilla (Figure 6D) two-segmented. Coxa unarmed and basis claw-like with row of small spinules on outer margin and fan-like tuft of setules medially as figured.

Maxilliped five-segmented (fig. 10E; Stock 1966) as described and illustrated by Stock (1966).

Swimming legs 1–4 biramous, with three-segmented rami and intercoxal sclerite present in all of them. Swimming legs 1–4, fifth and sixth legs as described and illustrated by Stock (figs 9B, 10F, 11A–C; Stock 1966).

Colour ruddy-yellowish.

Male. Unknown.

Discussion

This species, which lives associated with the sponge *Pericharax heteroraphis* Polejaeff in Mauritius, was collected by Stock in 1964. The discrepancies found in the re-examination of this species are as follows: (1) the antennule has 20 segments in contrast with the 19 segments described by Stock; (2) Stock described the antennary exopod having two terminal setae but this segment has one terminal, one subterminal and one proximal seta; (3) the only segment of the mandibular palp carries two plumose distal setae; (4) the inner lobe of the maxillule (second half) is covered with short and stout spinules; (5) the second segment of the maxilla, the claw, has a fan of spinules at middle length and a row of spinules on the distal margin.

This species belongs to the group of species with a 20-segmented antennule in the female. This group comprises 22 species, however *A. proboscideus* can be separated from all of the remaining species by the length of the oral cone. This is the only species in the group with a siphon that extends beyond the caudal rami (Stock 1966).

Asterocheres scutatus Stock, 1966
(Figure 7)

Material examined

Holotype female (ZMA Co. 100.974a) and one paratype female (ZMA Co. 100.9746) from near Hotel Coral Beach, Eilat (Israel); associated with the anemone

Rhodactis rhodostoma (Ehrenberg, 1834) and collected at 1 m depth by J.H. Stock, April 1962.

Description

Female. Body cyclopiform, almost circular in outline and slightly dorsoventrally flattened (fig. 1A; Stock 1966). Total length of holotype 540 μm and maximum width 430 μm. Prosome comprising cephalothorax (fully incorporating first pedigerous somite) and three free pedigerous somites. Cephalothorax with posterolateral angles slightly pointed, somite bearing leg 2 with posterolateral angles very pointed, somite bearing leg 3 with posterolateral angles rounded and somite bearing leg 4 partly covered by previous somite. Urosome four-segmented, comprising leg 5-bearing somite, genital double-somite, and two free abdominal somites, which are wider than long. Leg 5-bearing somite wider than long, not visible in lateral view as completely concealed by last abdominal somite. Genital double-somite laterally expanded, 1.5 times wider than long, paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore; lateral margins with rows of long spinules in distal half. Each genital area with one smooth seta (fig. 1B; Stock 1966).

Caudal rami slightly wider than long, with six terminal setae, two longest plumose (fig. 1B; Stock 1966).

Antennule 19-segmented, about 260 μm long. All setae plumose. Described and illustrated by Stock (fig. 1C; Stock 1966).

Antenna biramous (Figure 7D), about 200 μm long; coxa small with tuft of spinules; basis elongate. Exopod one-segmented, small, twice as long as wide; with one lateral and two terminal setae, all of them smooth. Endopod three-segmented; first segment elongate with row of long spinules; second segment produced distally on medial side but articulating with distal segment proximally on lateral side, triangular, with

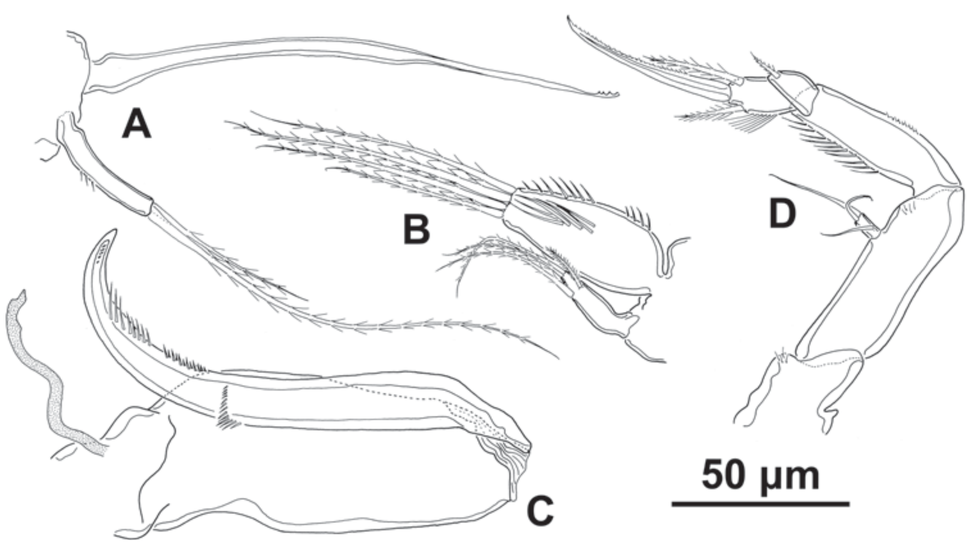

Figure 7. *Asterocheres scutatus* Stock, 1966, holotype (female). (A) Mandible; (B) maxillule; (C) maxilla; (D) antenna.

one plumose seta; third segment with row of setules on inner margin and two plumose subterminal setae plus terminal claw.

Siphon short, about 160 μm long, conical, reaching to maxilliped insertion.

Mandible (Figure 7A) consisting of stylet-like gnathobase with four distal teeth and small one-segmented palp. Palp with few spinules on lateral margin and two plumose terminal setae, unequal in length.

Maxillule bilobed (Figure 7B); inner lobe oval and twice as long as outer one, with tuft of long spinules medially, row of shorter spinules laterally, and four plumose distal setae. Outer lobe with two terminal and two subterminal setae, one of them shorter and barbed.

Maxilla (Figure 7C) two-segmented but with partial transverse surface suture on syncoxa (proximal segment) possibly marking plane of praecoxa–coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland. Coxal portion unarmed. Basis claw-like with rows of spinules on distal half.

Maxilliped (fig. 1I; Stock 1966) five-segmented with armature formula (1,0,2,1,1+claw) as described and illustrated by Stock in 1966.

Swimming legs 1–4 biramous (fig. 2A–E; Stock 1966) with three-segmented rami and intercoxal sclerite present in all of them. Swimming legs as described by Stock (1966).

Fifth and sixth legs as described by Stock (fig. 1B; Stock 1966).

Colour light yellowish.

Male. Unknown.

Remarks

This species was described by Stock from two females collected in Eilat (Israel) in 1962. *Asterocheres scutatus* lives associated with the sea anemone *Rhodactis rhodostoma* (Ehrenberg, 1834). Some oral appendages of this species are slightly different from those described by Stock: (1) the endopod of the antenna has three well-defined segments and the terminal seta of the exopod is approximately twice as long as the seta illustrated by Stock; (2) the stylet of the mandible is illustrated for the first time; (3) the setae of the inner and the outer lobes of the maxillule are plumose and the inner lobe has a patch of long spinules; (4) the maxilla bears a flaccid element medially, representing tubular extension of external opening of maxillary gland.

This species belongs to the group of species with 18- or 19-segmented antennules in females that comprises 13 species. These species are: *A. bahamensis* Kim, 2010, *A. brevisurculus* Kim, 2005, *A. canui* Giesbrecht, 1897, *A. dysideae* Humes, 1996, *A. enewetakensis* Humes, 1997, *A. fastigatus* Kim, 2010, *A. hongkongensis* Malt, 1991, *A. pilosus* Kim, 2004, *A. plumosus* Kim, 2010, *A. rotundus* Malt, 1991, *A. serrulatus* (Humes, 1996), *A. unioviger* Kim, 2010 and *A. walteri* Kim, 2004.

Asterocheres scutatus differs from 11 of these 13 species (*A. bahamensis*, *A. canui*, *A. dysideae*, *A. enewetakensis*, *A. fastigatus*, *A. pilosus*, *A. plumosus*, *A. rotundus*, *A. serrulatus*, *A. unioviger* and *A. walteri*) in the possession of a two-segmented mandibular palp, in contrast to the one-segmented mandibular palp shown by the present species (Giesbrecht 1899; Humes 1996b, 1997; Kim 2004a, 2010; Bandera and Conradi 2009b).

Asterocheres hongkongensis differs from *A. scutatus* in the extremely short caudal setae (described and illustrated by Malt 1991 as about as long as the caudal rami). In contrast, *A. scutatus* has long caudal setae, as usual for the genus.

As for the shape of the urosome, *A. scutatus* has a genital double-somite that is much wider than long, whereas *A. brevisurculus* has a genital double somite that is longer than wide (Kim 2005).

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Artículo X

A new species of *Asterocheres* (Copepoda, Siphonostomatoida) with a redescription of *A. complexus* Stock, 1960 and *A. sarsi* Bandera & Conradi, 2009.

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A new species of *Asterocheres* (Copepoda, Siphonostomatoida) with a redescription of *A. complexus* Stock, 1960 and *A. sarsi* Bandera & Conradi, 2009

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Abstract

The present paper reviews the material of three species of *Asterocheres* Boeck 1859 deposited in four different Zoological European museums as part of the ongoing taxonomical revision of this genus. *Asterocheres sarsi* Bandera & Conradi 2009*,* the species described by Sars in 1915 as *Ascomyzon latum* (Brady 1880) and lately recognized as a distinct species by Bandera and Conradi in 2009 is fully described in this paper from material collected by Sars in Norway in 1915 and deposited in The Natural History Museum of the University of Oslo. *Asterocheres complexus* Stock, 1960 which has been sometimes confused with *A. sarsi* is redescribed from material collected by Stock in France in 1959 and deposited in the Zoological Museum of the University of Amsterdam. Furthermore, a new species, previously misidentified as *A. suberitis* Gieisbrecht 1897, from the Norman`s collection of The Natural History Museum of London, is described as *A. eugenioi*, new species. These three species, *A. complexus, A. eugenioi*, and *A. sarsi* share the general appearance of body thanks to the pointed posterolateral angle of the epimeral area of somite bearing leg 3, sometimes slightly produced into backwardly directed processes, and somite bearing leg 4 largely concealed under somite bearing leg 3.

Key words: *Asterocheres*, Siphonostomatoida, Norman´s Collection, Sars, Stock

Introduction

Some years ago a partial revision of the genus *Asterocheres* Boeck, 1859 was initiated in order to clarify the rather confused systematics and phylogenetic relationships of this symbiotic genus. This ongoing taxonomical revision has been based on both material loaned by various museums and material collected by the authors, and has resulted in: (1)the description of six new species (Bandera et al. 2005, 2007; Conradi et al. 2006; Bandera & Conradi 2009b, 2013; Conradi & Bandera 2011), (2) the redescription of 21 species of *Asterocheres* (Bandera & Conradi 2009a, 2013, in prep.; Conradi & Bandera 2011), (3) the reinstatement of three species previously considered as junior synonyms (Bandera & Conradi 2009b), (4) the ranking of *A. abyssi* (Hansen 1923) as a species *incertae sedis* (Bandera & Conradi 2009a), (5) the reinterpretation of the original description of *A. stimulans* Giesbrecht, 1897 (Bandera & Huys 2008); (6) the removal of *A. mucronipes* Stock 1960 to a new genus, *Stockmyzon* Bandera & Huys 2008 (Bandera & Huys 2008), (7) the relegation of *A. violaceus* (Claus 1889) to a junior synonym of *A. echinicola* (Norman 1868), and (8) the recognition of *Ascomyzon latus* (Brady 1880) *sensu* Sars (1915) as a distinct species (Bandera & Conradi 2009b). Here, we describe this last species as *Asterocheres sarsi* Bandera & Conradi 2009 from material collected by Sars in Norway in 1915 and deposited in The Natural History Museum of the University of Oslo, and redescribe another asterocherid species, *A. complexus* Stock 1960 that exhibit similarities with *A. sarsi* species to which has been sometimes confused (Sars 1915; Stock 1960). The specimens of *A. complexus* are from material collected by Stock in France in 1959 and deposited in the Zoological Museum of the University of Amsterdam. Furthermore a new species, previously identified as *A. suberitis* Gieisbrecht 1897, from the Norman`s collection of The Natural History Museum of London, is described as *A. eugenioi*.

Material and methods

The studied specimens come from material loaned by various museums: some specimens from the Norman's collection from The Natural History Museum of London (NHM), some material collected by Sars in Norway in 1915 and deposited in The Natural History Museum of the University of Oslo (ZMO), a specimen labelled as *Ascomyzon latum* deposited in the Zoologisk Museum of the University of Copenhagen (ZMUC), and some specimens collected by Stock in France in 1959 which were deposited in the Zoological Museum of the University of Amsterdam (ZMA).

When the dissected specimens of the asterocherid species from the different museums were not sufficient to make a detailed description of some appendages, we dissected a specimen in lactic acid, prior to staining it with Chlorazol black E (Sigma® C-1144). Specimens were then examined as temporary mounts in lactophenol and later on, sealed with Entellan as permanent mounts.

All figures were drawn with the aid of a camera lucida on a Leica DMLB differential interference microscope. All appendage segments and setation elements were named and numbered using the terminology established by Huys and Boxshall (1991). Mean body length of the copepod was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami.

Systematics

Order Siphonostomatoida Thorell, 1859

Family Asterocheridae Giesbrecht, 1899

***Asterocheres* Boeck, 1859**

***Asterocheres complexus* Stock, 1960**
(Fig. 1)

Asterocheres boecki Giesbrecht, 1899 (non Brady 1872)

Material examined. holotype female (preserved in ethanol, deposited in ZMA under registration number ZMA-Co.100.571b) and 1 female plus 1 copepodid paratypes (ZMA-Co. 100.571) associated with *Spongelia fragilis* (Schmidt) var. *ramose*; collected in Cap Béar (France), 30 m depth, June 16 1959, coll. by Dr. J.H. Stock.

Description of adult female. Body cyclopiform, slender with cephalothorax oval and cylindrical urosome (see Fig. 2 of Taf. 1 in Giesbrecht 1899). Total length from anterior margin of rostrum to posterior margin of caudal rami 680 µm and maximun width 360 µm. Prosome comprising cephalothorax fully incorporating first pedigerous somite and three free pedigerous somites. Cephalothorax (see Fig. 28 of Taf. 2 in Giesbrecht 1899) with posterolateral angles straight and slightly produced into backwardly directed processes.

Urosome 4-segmented, comprising leg 5-bearing somite, genital double-somite and 2 free abdominal somites (see Fig. 3B in Stock 1960). Leg 5-bearing somite wider than long, with serrate dorsal margin. Posterior hyaline frills of urosomites with serrate free margins. Urosomites ornamented with numerous integumental pores and sensilla and apparently devoid of epicuticular scales. Genital double-somite slightly wider than long; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore (oviduct opening); lateral margins with row of long spinules in middle third, close to gonopore area (see Fig. 3B in Stock 1960). Seta of genital area not observed.

Caudal rami about as long as wide (measured along outer margin); armed with 6 terminal setae (see Fig. 3B in Stock 1960). Seta I absent and setae II and VII slightly displaced onto dorsal surface.

Antennule (Fig. 1D) 21-segmented, about 310 µm long. Segmental fusion pattern as follows (Roman numerals indicating ancestral segments): 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-2, 11(XIV)-1+1espina, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+1 aesthetasc, 19(XXII)-2, 20(XXIII-XXIV)-4 and 21(XXV-XXVIII)-7. Segment 10(XIII) reduced and partly overlapped by distal expansion of compound segment 9(IX-XII).

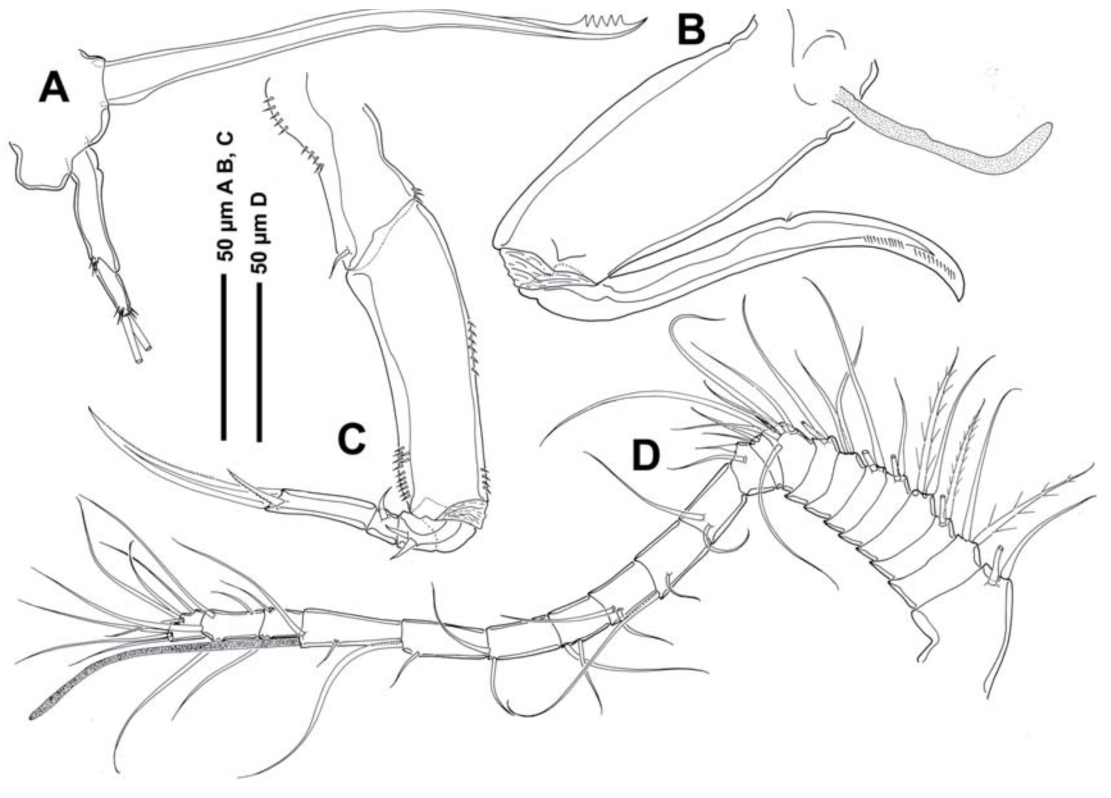

FIGURE 1. *Asterocheres complexus* Stock 1960 (female). A, mandible; B, maxilla; C, maxilliped; D, antennule.

Antenna (see Fig. 3E in Stock 1960) biramous, about 220 µm long (including terminal claw). Coxa small, with a tuft of minute spinules on inner margin. Basis elongated with a row of fine spinules on inner margin . Exopod small, one-segmented with one short subterminal seta and one long terminal seta, both of them smooth. Endopod 3-segmented; proximal segment elongated, ornamented with a row of long spinules on inner margin; middle segment produced distally on medial side but articulating with distal segment proximally on lateral side, bearing one distal seta longer than entire segment; distal segment with 2 subterminal setae, one of them pinnate, and a terminal claw with a row of fine spinules on inner margin. Distal claw as long as proximal segment of endopod.

Siphon about 180 µm long, conical, reaching the insertion of maxillipeds. Mandible (Fig. 1A) comprising slender two-segmented palp and stylet-like gnathobase with 5 large subapical teeth. Proximal segment of palp longest, ornamented with spinules on distal outer margin; distal segment with spinules apically, armed with 2 terminal setae.

Maxillule bilobed (see Fig. 3D in Stock 1960); praecoxal gnathobase (inner lobe) 2.5 times longer than palp (outer lobe). Praecoxal endite ornamented with a tuft of long spinules proximally, a row of short spinules apically on outer margin and a row of long setules medially; armed with 5 distal setae, one of them smooth and short. Palp with 4 barbed terminal setae (illustrated as naked by Stock).

Maxilla (Fig. 1B) 2-segmented but with partial transverse surface suture on syncoxa (proximal segment) possibly marking plane of praecoxa-coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland; coxal portion unarmed. Basis claw-like with a minute seta at middle length and a row of spinules along medial distal part.

Maxilliped (Fig. 1C) 5-segmented, comprising short syncoxa, long basis and 3-segmented endopod. Syncoxa with one short seta distally and a row of spinules along inner proximal margin. Basis elongated, with rows of spinules on both margins. First endopodal segment short, bearing 2 smooth short setae; second endopodal segment with a smooth seta subapically; third endopodal segment bearing recurved terminal claw (65 µm long) plus additional plumose apical seta. Distal margin of claw provided with a row of minute spinules.

Swimming legs 1–4 (see Fig. 3A,C in Stock, 1960) biramous, with 3-segmented rami. Intercoxal sclerite present in legs 1–4. Spine and seta formula as Table 1.

TABLE 1. Spine and seta formula of swiming legs for *Asterocheres complex*us Stock 1960.

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

Lateral margins of exopodal segments with minute serrations or spinular rows; those of endopodal segments with rows of setules.

Fifth leg (see Fig. 3B in Stock, 1960) with protopod incorporated into somite; outer basal seta displaced to laterodorsal surface (not longer than entire free segment). Free segment (exopod) elongate, with 2 smooth terminal setae and one short subterminal seta; outer and inner margins with spinules.

Sixth leg (see Fig. 3B in Stock, 1960) usually represented by paired opercular plates closing off gonopores on genital double somite; none seta neither spiniform element observed.

Adult male: only known from the habitus, antennule and exopod of leg 2 illustrated by Giesbrecht in 1899. Antennule 18-segmented, with aesthetascs on segments 13 and 17.

Distribution. Italy (Giesbrecht 1899), France (Stock 1960), India (Ummerkutty 1966; under the name of *A. latum*).

Remarks. This species was described by Stock (1960) from two females collected in Cap Béar (Mediterranean coast of France). As Stock pointed out, this species was originally described by Giesbrecht (1899) under the incorrect name *A. boecki*. Following the detailed description of *A. boecki* provided by Sars (1918), Stock stated that Giesbrecht´s specimens could belong to another Nordic species, *A. latum* (Brady). Comparisons among the material collected in Banyuls by Stock and the figures of *A. boecki* and *A. latum* illustrated by Sars revealed that Stock´s specimens belonged to a distinct, undescribed species. This new species was not properly described by Stock but was based on descriptions of *A. boecki* by Giesbrecht (habitus; Pl. 2, II; Giesbrecht 1899), *A. latum* by Sars (antennules, maxilla, maxilliped, and the exopods of leg 1-4; Sars 1918) and Stock added some illustrations (antenna, maxillule, urosome, exopod of leg 1 and endopod of leg 4 for female and leg 5 for male; Fig. 3 in Stock 1960).

The re-examination of the holotype resulted in some discrepancies with respect to previous descriptions: (1) the antennule is 21-segmented in the female, in contrast Sars described this antennule as very slender and composed of 20 segments; (2) the mandible was illustrated by Giesbrecht and Sars, but only the palp which is two-segmented, because the stylet is located inside the oral cone. The stylet with 5 large subapical teeth is illustrated and described here for the first time; (3) the maxilla possesses a flaccid element similar to an aesthetasc which was overlooked by Sars; (4) the maxilliped illustrated by Sars has some elements missing.

This species belongs to a group whose females have 21-segmented antennules and a 2-segmented mandibular palp; it contains 19 species: *A. astroidicola* Conradi, Bandera & López-González, 2006, *A. ellisi* Hamond, 1968, *A. espinosai* Varela , Ortiz & Lalana, 2007; *A. flustrae* Ivanenko & Smurov, 1997, *A. genodon* Stock, 1966, *A. hirsutus* Bandera, Conradi & López-González, 2005, *A. hoi* Bandera & Conradi, 2013, *A. jeanyeatmanae* Yeatman, 1970, *A. kervillei* Canu, 1898, *A. latus* (Brady, 1872), *A. lilljeborgi* Boeck, 1859, *A. peniculatus* Kim, 2010, *A. reginae* Boxshall & Huys, 1994, *A. simulans* (Scott, 1898), *A. suberitis* Giesbrecht, 1897, *A. tarifensis* Conradi & Bandera, 2011, *A. tenerus* (Hansen, 1923), *A. tenuicornis* Brady, 1910, *A. tubiporae* Kim, 2004, and *A. urabensis* Kim, 2004.

Considering the shape of the body, *A. complexus* can be separated from a few of its congeners. While this species has the usual cyclopiform body, with an oval cephalothorax and a cylindrical urosome, *A. ellisi, A. espinosai, A. jeanyeatmanae, A. lilljeborgi, A. reginae*, and *A. tubiporae* have a dorsoventrally flattened prosome (Bandera & Conradi 2009b; Varela *et al*., 2007; Yeatman 1970; Ivanenko & Ferrari 2003; Boxshall & Huys 1994; Kim 2004b). Also, *A. espinosai* is here treated as an incompletely described species due to the lack of accurate information of the oral appendages and the confusion between legs 2 and 3 in the original description. Therefore, the comparison of this species with its congeners is difficult.

The length of the siphon is a good feature to distinguish one species from another. *Asterocheres complexus* is characterized by its possession of an oral cone reaching the insertion of the maxillipeds, thus differing from *A. peniculatus, A. hirsutus, A. urabensis,* and *A. hoi* in which the siphon reaches the intercoxal plate of leg 1 and from *A. genodon, A. astroidicola* and *A. tenerus* whose the siphon overtakes the intercoxal plate of leg 2 (Kim 2010; Bandera *et al*. 2005; Kim 2004a; Bandera & Conradi 2013; Conradi *et al*. 2006; Bandera & Conradi 2009a).

Asterocheres complexus possesses a subquadrate caudal rami. In contrast, in this group there are species with a much longer caudal rami; in *A. simulans* and *A. kervillei* they are twice longer than wide, 1.5 times longer than wide in *A. suberitis*, 2.6 times longer than wide in *A. latus*, and 6 times longer than wide in *A. tenuicornis* (Ivanenko 1997; Bandera & Conradi 2009c, 2009a; Eiselt 1965).

The remaining species of the group, *A. flustrae* and *A. tarifensis*, are the most closely related species to *A. complexus*. However, these two species can be easily separated from *A. complexus* by the shape of the posterolateral angles of the cephalothorax. *A. complexus* presents the posterolateral angles of the cephalothorax straight and slightly produced into backwardly directed processes. In contrast, *A. flustrae* and *A. tarifensis* possess rounded posterior corners (Ivanenko & Smurov 1997; Conradi & Bandera 2011).

***Asterocheres eugenioi* sp. nov.**
(Figs 2–5)

Asterocheres suberitis Giesbrecht, 1897 in Norman and Scott 1906

Material examined.—holotype female (preserved in ethanol, NHM 1911.11.8.47277-281) and 8 female paratypes plus one allotype male and 2 male paratypes (preserved in ethanol, NHM 1191.11.8.47277-281) associated with *Suberitis domuncula* (Olivi), collected in Salcombe, Devon (Great Britain), on September of 1903 by Norman.

Description of adult female. Body cyclopiform, slender with cephalothorax oval and cylindrical urosome (Fig. 2A). Total length measured from rostral margin to posterior margin of caudal rami (excluding caudal setae) 585 µm; maximum width 384 µm. Ratio of length to width of prosome 1.1:1. Ratio of length of prosome to that of urosome 2.6:1. Prosome comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites. Epimeral areas of somites bearing legs 2 and 3 with pointed posterolateral angles (Fig. 2A). Somite bearing leg 4 much smaller and narrower than preceding ones.

Urosome 4-segmented comprising leg 5-bearing somite, genital double-somite and 2 free abdominal somites. Posterior margin of urosomites ornamented with hyaline frills with serrated free margins. Somite bearing leg 5 wider than long. Genital double-somite about 1.25 times wider than long, bearing genital apertures, paired gonopores located dorsolaterally; lateral margins with setular rows along distal third, posterior to genital apertures (Fig. 2B). Each genital area armed with one plumose seta and one spiniform element. Integumental pores and sensilla present on urosomal somites (Fig. 2B).

Caudal rami 1.5 times longer than wide (Fig. 2C); armed with 6 setae; seta I absent, setae II-VII all arranged around posterior margin with setae II and VII slightly offset onto dorsal surface.

Antennule 21-segmented (Fig. 2D), about 270 µm long; segmental fusion pattern as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-2, 11(XIV)-1+1 spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+ aesthetasc, 19(XXII-XXIII)-3, 20(XXIV-XXV)-3 and 21(XXVI-XXVIII)-6. Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX-XII).

Antenna biramous (Fig. 2E), about 195 µm long; coxa unarmed, with few spinules; basis unarmed, with fine spinule rows. Exopod 1-segmented, with one small lateral seta and two terminal setae. Endopod 3-segmented; first segment elongate, ornamented with lateral rows of fine spinules; second segment produced distally on medial side but articulating with distal segment proximally on lateral side and armed with one smooth terminal seta. Third segment with distal claw and two subterminal plumose setae; claw provided with fine spinules on lateral margin.
Siphon slender, about 195 µm long, reaching to posterior margin of intercoxal plate of leg 1.

Mandible (Fig. 3A) comprising stylet-like gnathobase and slender 2-segmented palp. First segment of palp ornamented with rows of spinules; second segment with 2 plumose, unequal apical setae. Stylet with an expansion at the middle of its length.

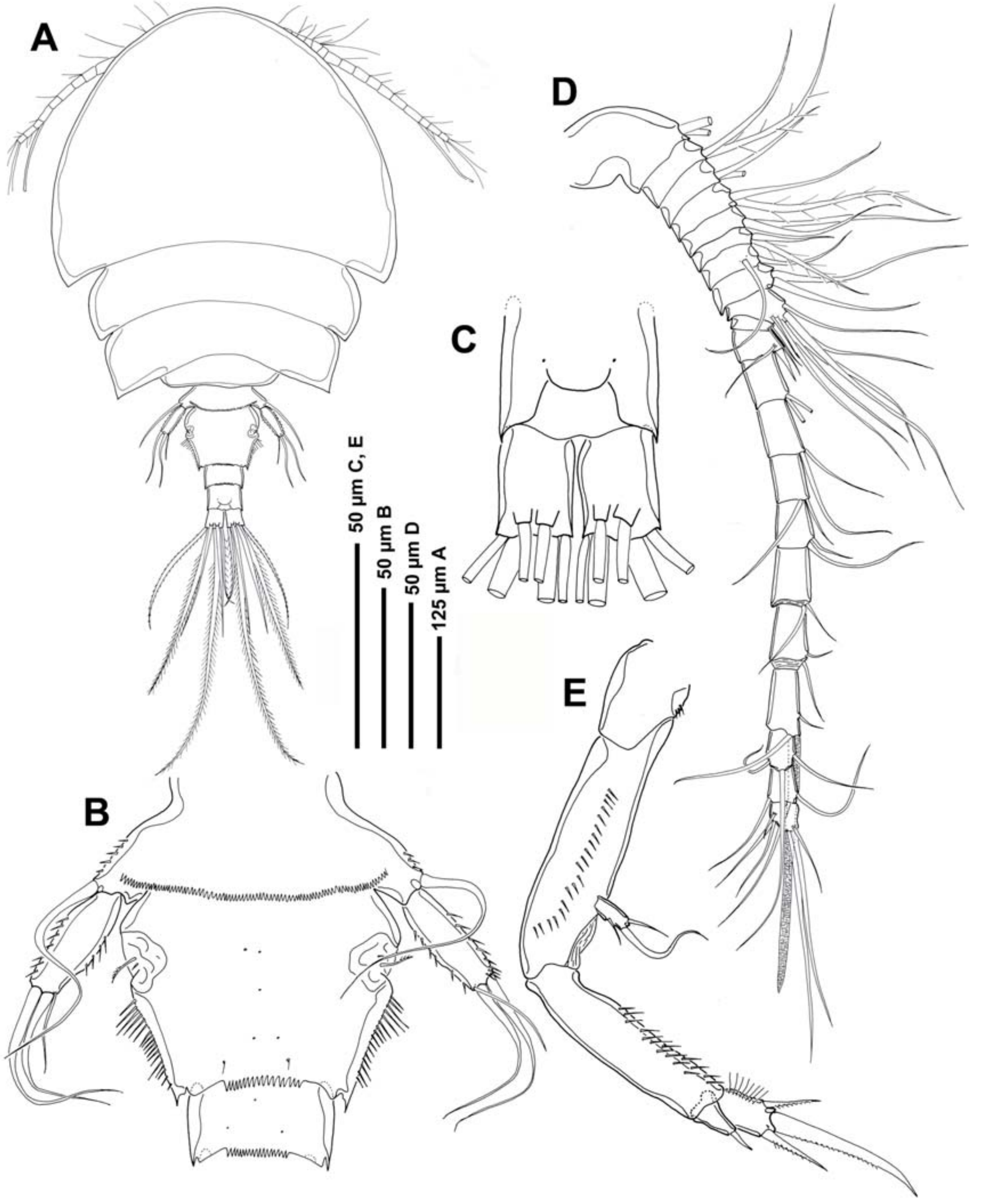

FIGURE 2. *Asterocheres eugenioi* new species (female). A, habitus dorsal; B, leg 5-bearing somite and genital double-somite; C, anal somite and caudal rami; D, antennule; E, antenna.

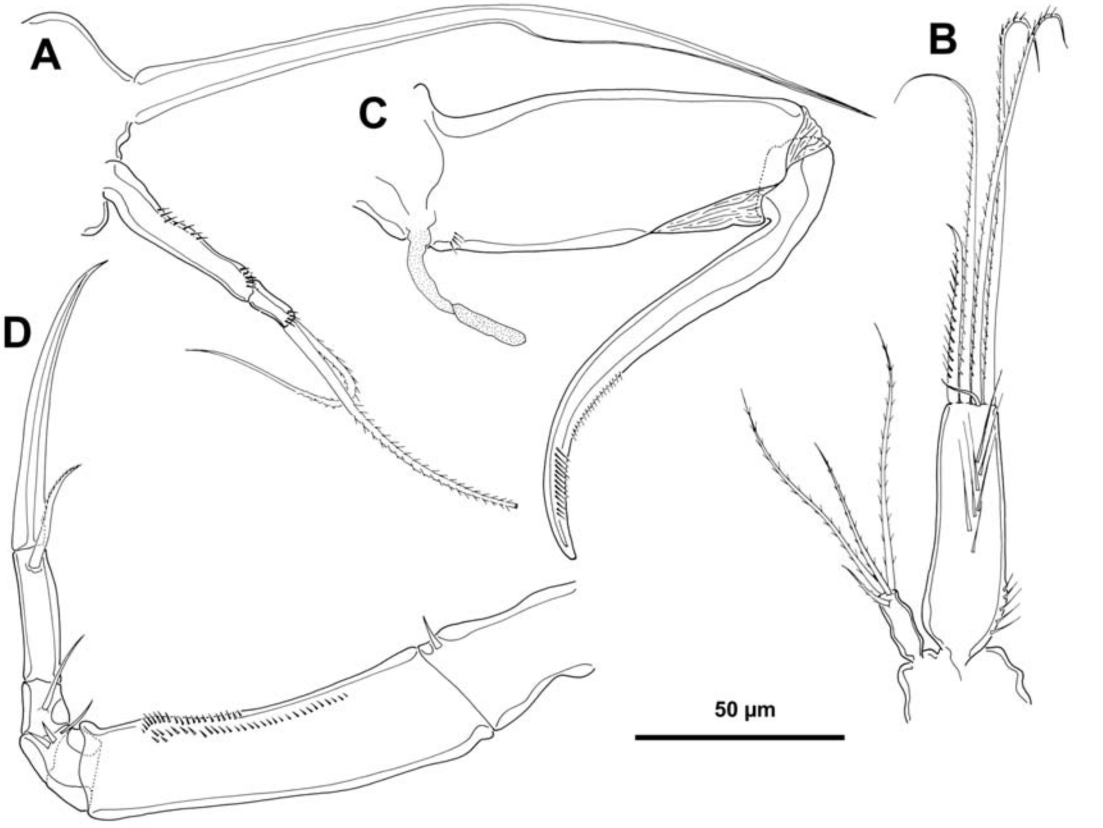

FIGURE 3. *Asterocheres eugenioi* new species (female). A, mandible; B, maxillule; C, maxilla; D, maxilliped.

Maxillule bilobed (Fig. 3B); praecoxal endite (inner lobe) more than three times longer than palp (outer lobe). Praecoxal endite armed with 5 distal setae, one of them smooth and short, ornamented with a row of long setules medially and a row of spinules on proximal outer margin. Palp armed with 3 terminal and one subterminal setae, all of them barbed.

Maxilla (Fig. 3C) 2-segmented but with partial suture on syncoxa (proximal segment) possibly marking plane of praecoxa-coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland; coxal part unarmed but ornamented with few spinules proximally. Claw-like basis with recurved end and ornamented with spinules distally.

Maxilliped 5-segmented (Fig. 3D) comprising short syncoxa, long basis and distal subchela consisting of 3 free endopodal segments armed with distal claw-like element. Syncoxa with one short seta distally; basis elongate and slender, with a row of spinules on lateral margin. First endopodal segment bearing two short setae and one longer distal seta; second endopodal segment armed with one medial seta. Third endopodal segment bearing recurved terminal claw plus additional subapical plumose seta. Distal margin of claw smooth.

Legs 1-4 biramous (Figs. 4A-D) with 3-segmented rami. Intercoxal sclerite present in legs 1-4, ornamented with patches of spinules in leg 1. Spine and seta formula as Table 2.

Coxae of legs ornamented with spinule rows laterally; coxal seta not present in leg 1. Outer spines of exopodal segments in legs 1-4 bilaterally serrate. Lateral margins of exopodal segments with minute serrations; lateral margins of endopodal segments with rows of setules.

Fifth leg (Fig. 2B) with protopodal segment incorporated into somite, with outer seta located dorsolaterally; elongate free segment, armed with two larger terminal setae and one shorter terminal seta, all of them smooth.

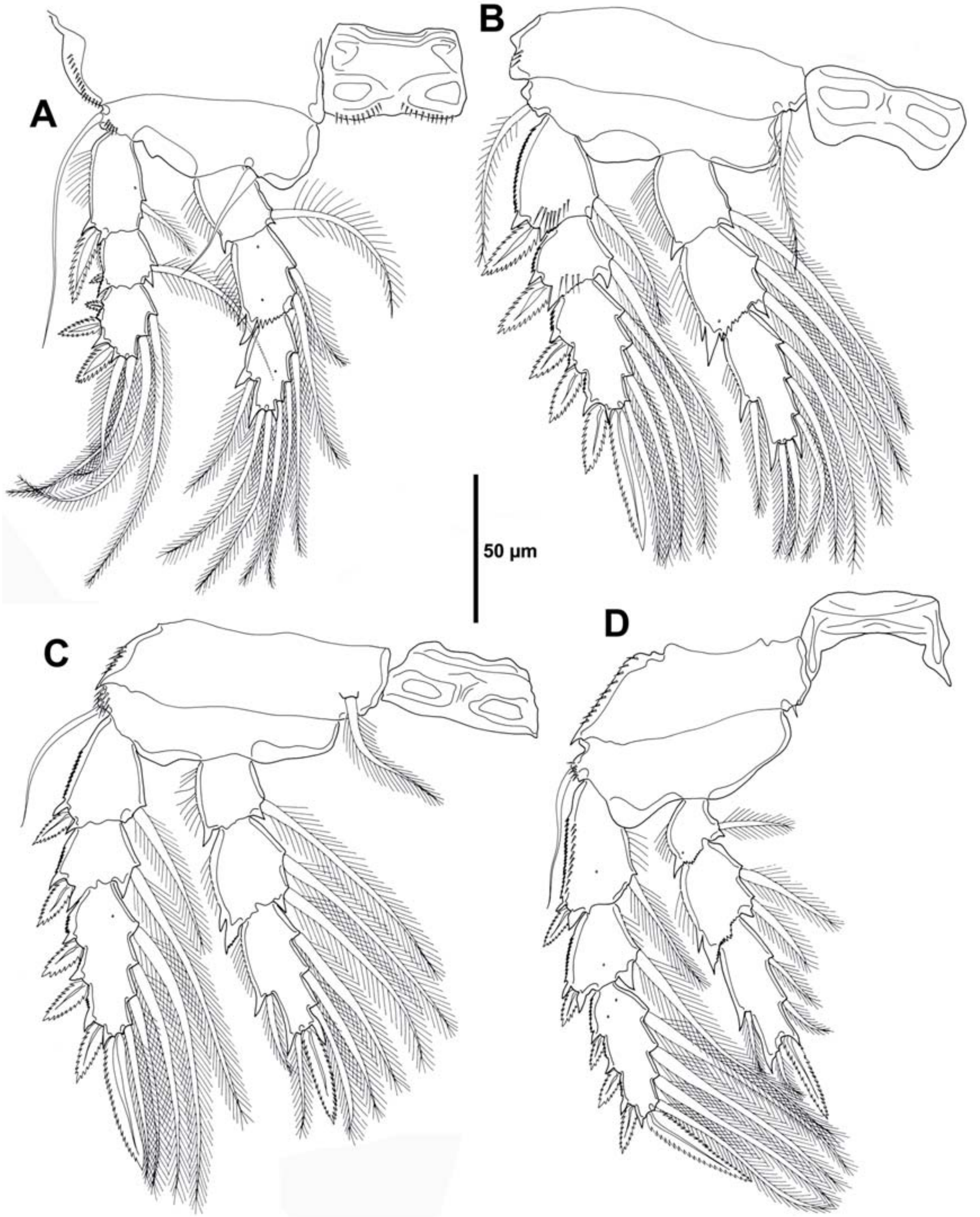

FIGURE 4. *Asterocheres eugenioi* new species (female). A, leg 1; B, leg 2; C, leg 3; D, leg 4.

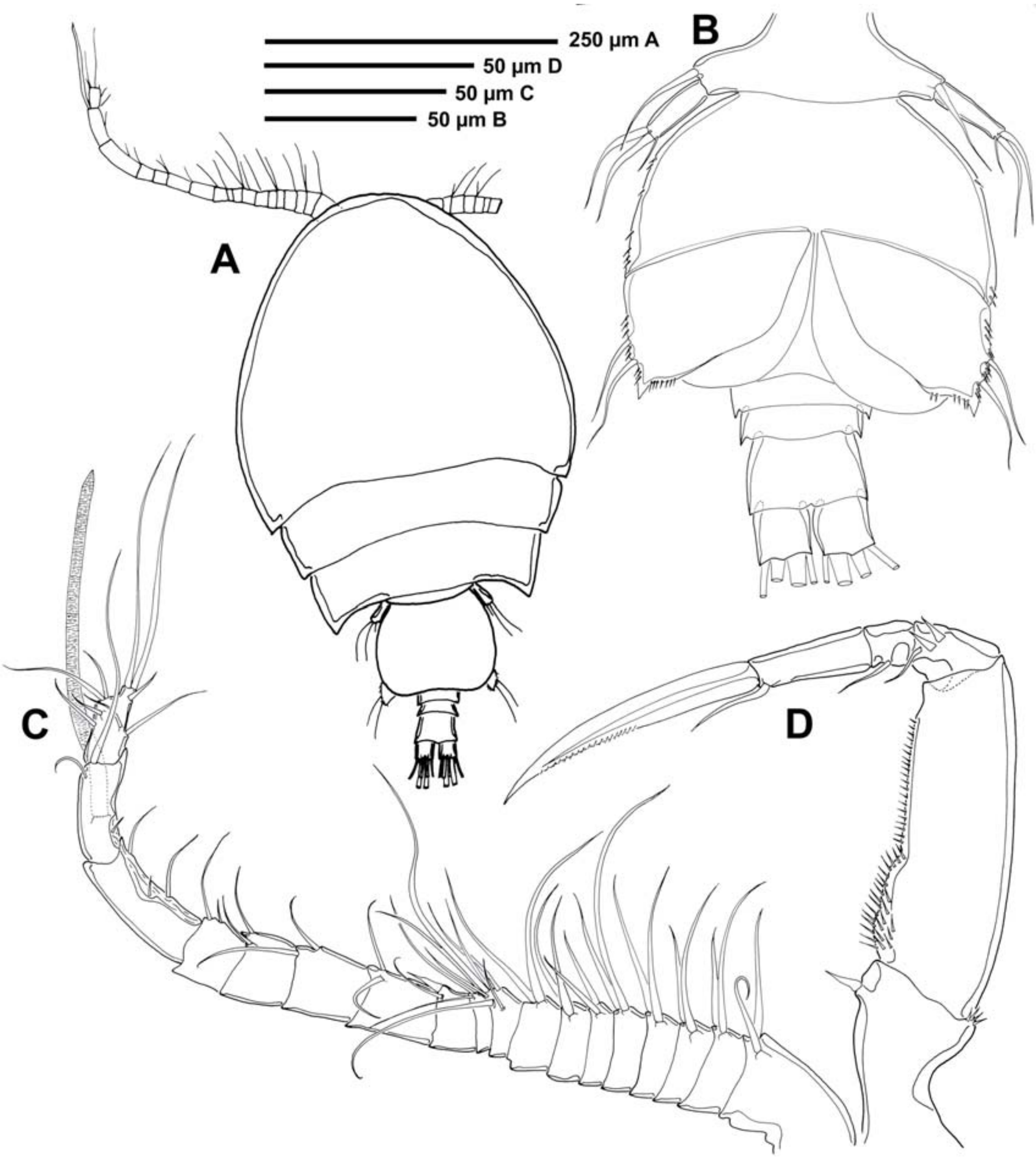

FIGURE 5. *Asterocheres eugenioi* new species (male). A, habitus dorsal; B, urosome ventral; C, antennule; D, maxilliped.

TABLE 2. Spine and seta formula of swiming legs for *Asterocheres eugenioi* n. sp.

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

Sixth leg (Fig. 2B) represented by paired opercular plates closing off gonopores on genital double somite; leg armed with one plumose seta and one spiniform element.

Adult male: Body cyclopiform (Fig. 5A), slightly slender and shorter than female, with cephalothorax oval and cylindrical urosome. Body length 485 µm and greatest width 290 µm. Prosome comprising cephalothorax fully incorporating first pedigerous somite and 3 free pedigerous somites. Epimeral areas of somites bearing legs 2 and 3 with pointed posterolateral angles (Fig. 5A). Somite bearing leg 4 much smaller and narrower than preceding ones. Urosome 5-segmented comprising 5th pedigerous somite, genital somite and 3 free abdominal somites. Genital somite about 1.2 times wider than long, bearing genital apertures posterolaterally on ventral surface (Fig. 5B). Appendages as for female except for antennules, maxillipeds, and sixth leg.

Antennule 18-segmented (Fig. 5C), about 260 µm long, geniculate; segmental fusion pattern as follow: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX-XII)-7, 10(XIII)-2, 11(XIV)-1+ 1 spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX-XX)-3, 17(XXI-XXII)-3 and 18(XXIII-XXVIII)-9. Geniculation located between segments 16 (XIX-XX) and 17(XXI-XXII). Segment 10 (XIII) reduced, partly overlapped by distal expansion of compound segment 9 (IX-XII).

Maxilliped 5-segmented (Fig. 5D), similar to that of female but basis with a small expansion provided with spinules in proximal half of medial region.

Sixth leg (Fig. 5B) forming large opercular plates closing off genital apertures, armed with 2 smooth setae, ornamented with rows of fine spinules.

Etymology. This species is named after Eugenio Bandera, father of the first author.

Distribution. United Kingdom (Norman and Scott 1906).

Remarks. This species was reported by Norman and Scott in 1906 as *Asterocheres suberitis* Giesbrecht and was collected in a gathering from Salcombe in 1903. They pointed out that the usual habitat of these specimens was the water-passages of *Suberites domuncula*, and probably also of other sponges. However, a detailed comparison with the original description revealed that these specimens do not belong to *Asterocheres suberitis* but represent a new species, *Asterocheres eugenioi* sp. nov.

The most striking features to distinguish these two species are: (1) The epimeral areas of somites bearing legs 2 and 3 have pointed posterolateral angles in *A. eugenioi*, thus contrasting with the rounded posterolateral corners of these somites in *A. suberitis*; (2) the inner maxillular lobe bears 4 distal setae in *A. suberitis* vs. 5 distal setae in *A. eugenioi*; (3) the maxillary proximal segment of the new species has a flexible setal element resembling an aesthetasc ; this element is absent in *A. suberitis*; (4) the siphon reaches the posterior margin of the intercoxal plate of leg 1 in the new species but in *A. suberitis* it barely reaches the insertion of maxillipeds; (5) the leg 1coxal seta is absent in *A. eugenioi* and it is present, short and plumose in *A. suberitis* (Taf. 2, I *Asterocheres suberitis*, Fig. 4; Giesbrecht 1899).

This species belongs to a group of congeners possessing a 21-segmented antennule in the female, 2-segmented mandibular palp, and oral cone reaching the intercoxal plate of leg 1. This group is composed by six more species: *A. urabensis* Kim, 2004, *A. hirsutus* Bandera, Conradi & López-González, 2005, *A. peniculatus* Kim, 2010, *A. ellisi* Hamond, 1968, *A. latus* (Brady, 1872), and *A. hoi* Bandera & Conradi, 2013. There is no information about the length of the siphon in *A. tenuicornis*. However, this species can be easily separated from the new species due to the length of the caudal rami, six times longer than wide, the longest within the genus (Eiselt 1965). In contrast, caudal rami are only 1.5 times longer than wide in the new species. Among these six species, *A. ellisi*, *A. urabensis* and *A. hoi* have the caudal rami slightly longer than wide, shorter than *A. eugenioi*; and *A. hirsutus* and *A. latus* possess a caudal rami equal or longer than 2.5 times longer than wide, longer than in the new species and in *A. peniculatus* they are about as long as wide (Bandera & Conradi 2009b; Kim 2004a; Bandera & Conradi 2013; Bandera *et al.* 2005; Bandera & Conradi 2009a; Kim 2010).

Kim (2010) expressed the requirement of being strict with the definition of the genus *Asterocheres*, especially in reference to the setation on the rami of legs 1-4, which is quite conservative in this genus. There are only three species, together with the new species here described, with the coxal seta of leg 1 absent: *A. pilosus* Kim, 2004, *A. trisetatus* Kim, 2010, and *A. fastigatus* Kim, 2010. These species do not share any additional significant similarity which justify placing them in a separate genus, it is likely that this common characteristic is a homoplasy (Dr. I.-H. Kim pers. comm.).

In addition, this group of seven species, including *A. tenuicornis*, can be distinguished from *A. eugenioi* sp. nov. by the shape of the body because the new species is the only one in the group with the epimeral areas of somites bearing legs 2 and 3 with pointed posterolateral angles, slightly produced into backwardly directed processes.

Asterocheres sarsi **Bandera & Conradi, 2009**
(Figs 6–8)

Ascomyzon latum Sars, 1915

Material examined. (a) holotype (preserved in ethanol, deposited in ZMO under registration number ZMO F21600a), and 10 females (preserved in ethanol, deposited in ZMO under registration number ZMO F21600b), collected from the bottom-residue of a large collecting-bottle containing a number of different invertebrate animals in RauØ by G.O. Sars. (b) 1 female (labelled as *Ascomyzom latum* and preserved in ethanol, deposited in ZMUC under registration number ZMUC-CRU-4937), collected from Kapt. Ørssad (58º11'NB 4ºØ, L. 658 ~).

Description of adult female. Body (Fig. 6A) cyclopiform, slender with cephalothorax oval and cylindrical urosome. Mean body length from anterior margin of rostrum to posterior margin of caudal rami 740 µm (710-780 µm); maximum width 450 µm (400-480 µm), based on 4 specimens. Prosome comprising cephalothorax (fully incorporating first pedigerous somite) and three free pedigerous somites. Somites bearing legs 2–3 broad; epimeral areas with posterolateral angles rounded (leg 2) or pointed (leg 3) (Fig. 6A). Somite bearing leg 4 much smaller and narrower than preceding ones and largely concealed under somite bearing leg 3.

Urosome 4-segmented, comprising leg 5-bearing somite, genital double-somite and two free abdominal somites. Urosome ornamented with large epicuticular spinules arranged in irregular pattern (Fig. 6A, C) in all urosomites except for leg-5 bearing somite which shows the spinules in overlapping rows pattern (Fig. 6C). Genital double-somite (Fig. 6C) slightly wider than long; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore (oviduct opening); lateral margins with setular tufts in distal third (posterior to genital apertures).

Caudal rami (Fig. 6C) about twice longer than wide (measured along outer margin); armed with seven setae; seta I present (Fig. 6C), minute and displaced onto lateral surface, setae II–VII all arranged around posterior margin with setae II and VII slightly displaced onto dorsal surface. All of them plumose except for seta I which is naked (Fig. 6A).

Antennule (Fig. 6B) 21-segmented, about 395 µm long. Segmental fusion pattern as follows (Roman numerals indicating ancestral segments): 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX–XII)-7, 10(XIII)-1+spine, 11(XIV)-1+spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-1, 16(XIX)-1, 17(XX)-2, 18(XXI)-2+ae, 19(XXII–XXIII)-3, 20(XXIV), 21(XXV–XXVIII)-6. Segment 10(XIII) reduced, forming incomplete sclerite partly overlapped by distal expansion of compound segment 9(IX–XII).

Antenna biramous (Fig. 6D), about 260 µm long. Coxa unarmed, with tufts of spinules. Basis unarmed, with fine spinule rows in lateral inner margin and longer spinule rows medially as shown in Figure 6D. Exopod one-segmented, slender, about 2.5 times longer than wide; with two small lateral setae and one long terminal seta. Endopod three-segmented; proximal segment elongated, ornamented with lateral and medial rows of spinules as figured; middle segment produced distally on medial side but articulating with distal segment proximally on lateral side, bearing one naked subterminal seta; distal segment with two pinnate setae, one of them subterminal, and one terminal claw with rows of fine spinules; surface of distal segment with long setules.

Siphon long and slender, about 230 µm long, reaching nearly to posterior margin of intercoxal sclerite of leg 1. Mandible (Fig. 7B) comprising stylet-like gnathobase and slender two-segmented palp. Proximal segment of palp longest, ornamented with rows of spinules on lateral and distal margins; distal segment shortest, with two plumose, unequal apical setae. Stylet located in oral cone, formed by anterior labrum and posterior labium. Stylet with denticulate margin subapically (Fig. 7B).

Maxillule (Fig. 7A) bilobed; praecoxal gnathobase (inner lobe) distinctly larger than palp (outer lobe). Praecoxal endite conical, ornamented with setules proximally and spinules distally on the lateral margin and a row of long setules medially; armed with one short and naked and four long but unequal plumose setae, the three longer with minute spines distally. Palp reduced, about three times shorter than praecoxal endite, with one short naked seta and three longer pinnate setae.

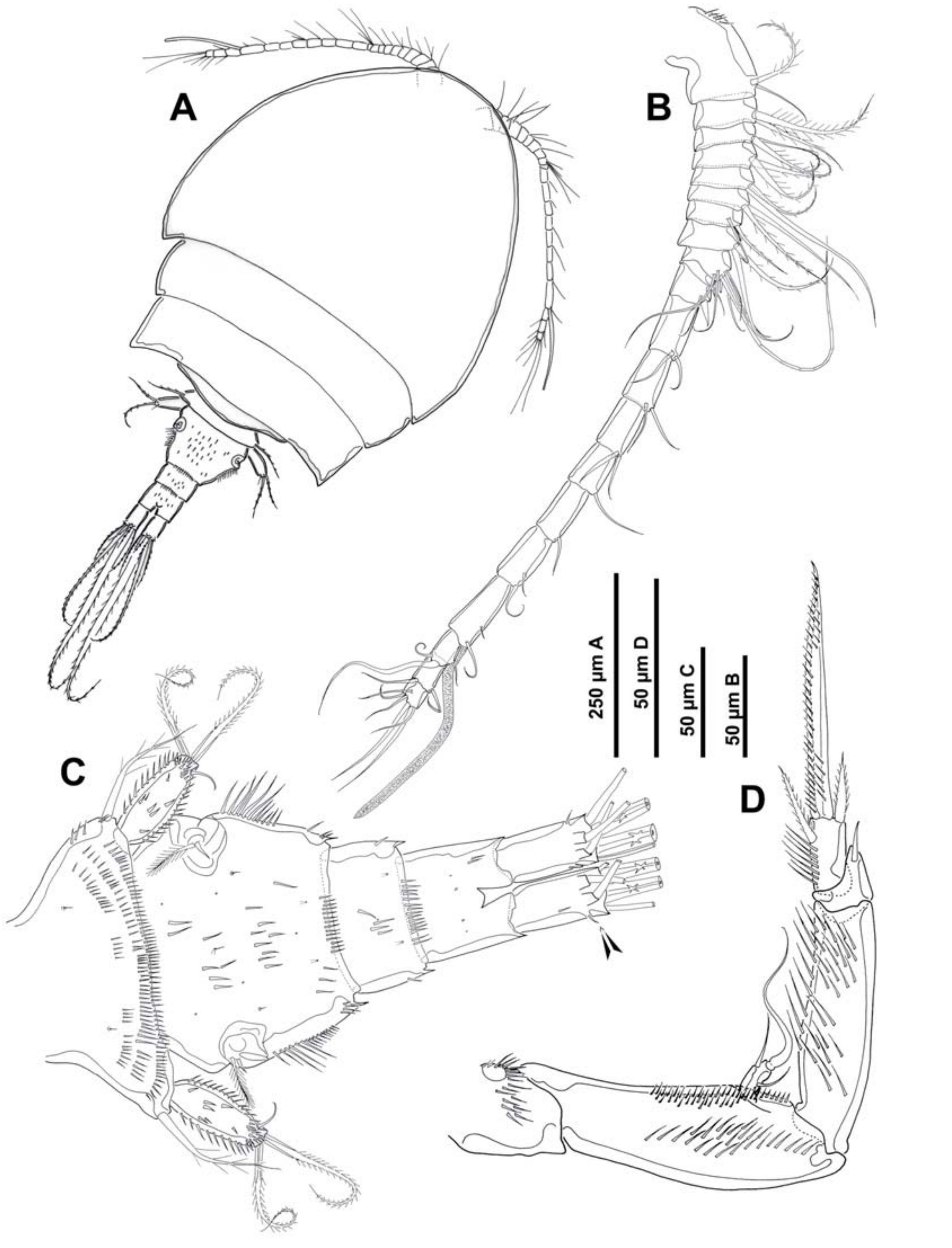

FIGURE 6. *Asterocheres sarsi* Bandera & Conradi 2009 (female). A, habitus dorsal; B, antennule; C, urosome, dorsal; D, antenna.

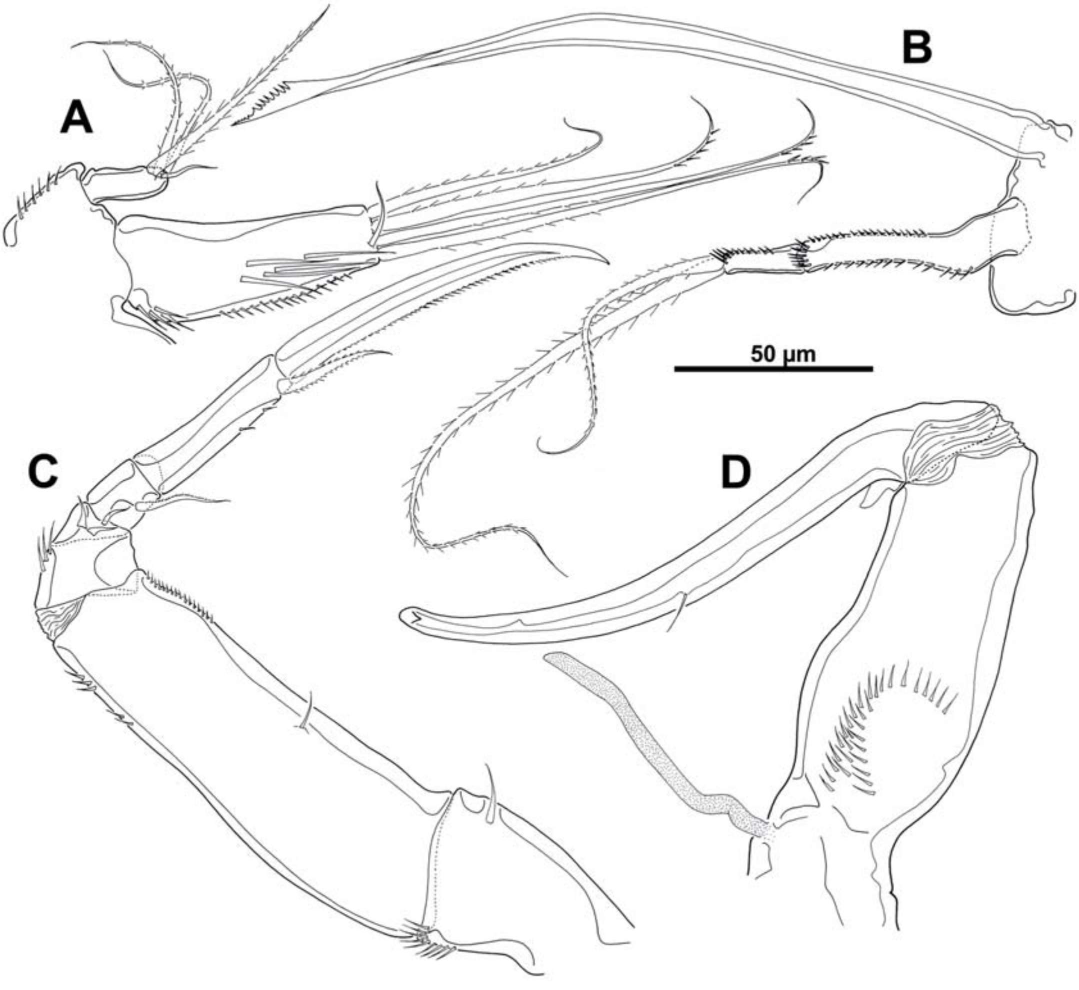

FIGURE 7. *Asterocheres sarsi* Bandera & Conradi 2009 (female). A, maxillule; B, mandible; C, maxilliped; D, maxilla.

Maxilla (Fig. 7D) two-segmented but with partial transverse surface suture on syncoxa (proximal segment) possibly marking plane of praecoxa-coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland; coxal portion unarmed but ornamented with a row of spinules medially as figured. Basis claw-like, more or less straight but recurved towards the apex; armed with one seta at middle length.

Maxilliped (Fig. 7C) five-segmented, comprising short syncoxa, long basis and three-segmented endopod. Syncoxa with one seta and a row of spinules distally. Basis with rows of spinules on distal outer and inner margin and one seta at middle length. First endopodal segment ornamented with spinules on lateral margin and armed with two medial setae and one short distal seta; second endopodal segment bearing one long barbed seta; third endopodal segment bearing recurved terminal claw plus additional apical pinnate seta. Distal margin of claw provided with a row of minute spinules.

Swimming legs 1–4 (Figs. 8A-D) biramous, with three-segmented rami. Intercoxal sclerite present in legs 1–4, ornamented with patches of spinules in legs 1–3.

Spine and seta formula as Table 3.

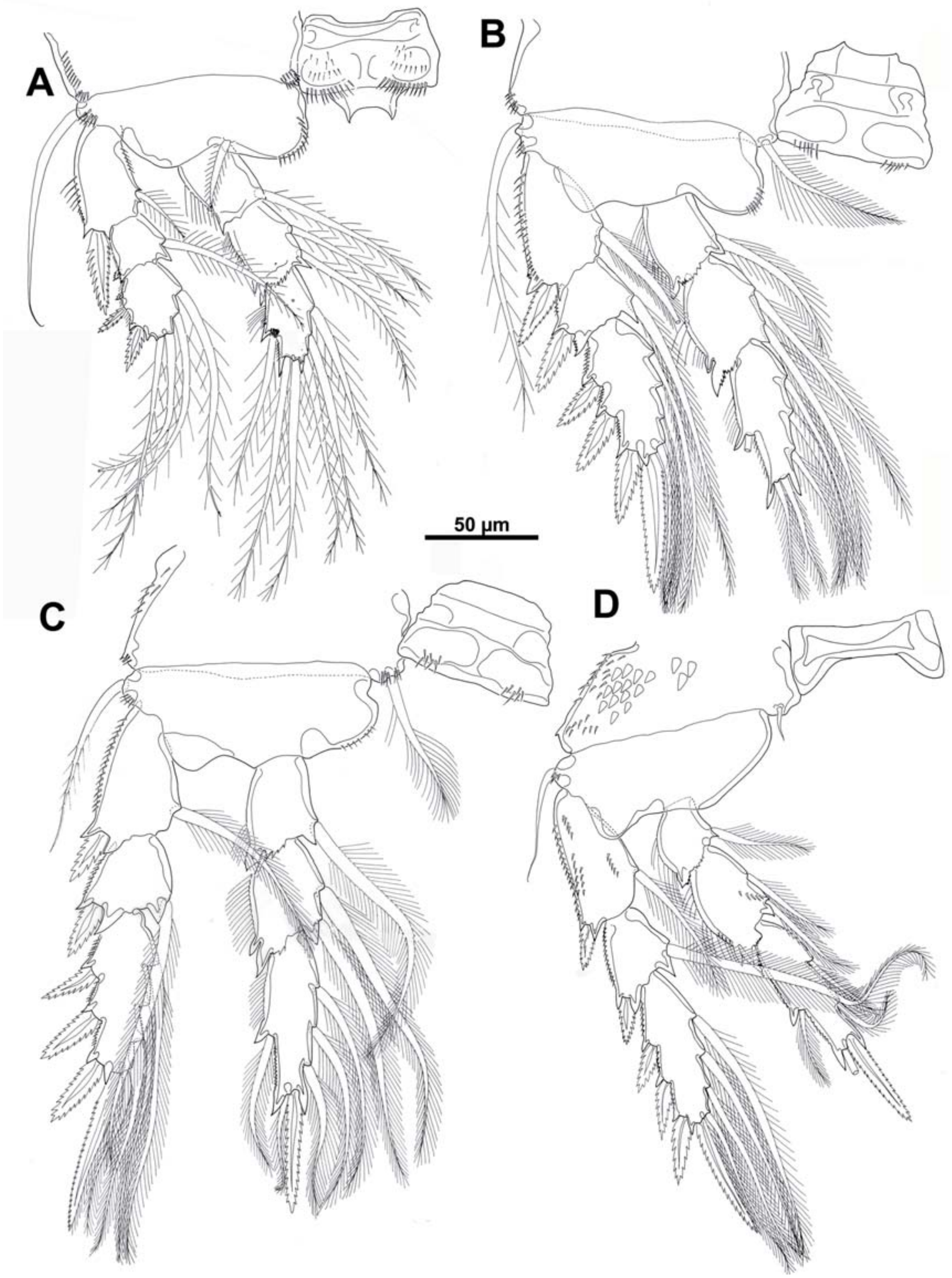

FIGURE 8. *Asterocheres sarsi* Bandera & Conradi 2009 (female). A, leg 1; B, leg 2; C, leg 3; D, leg 4.

TABLE 3. Spine and seta formula of swiming legs for *Asterocheres sarsi* Bandera & Conradi 2009.

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

Coxae ornamented with spinule rows around outer margin; inner coxal seta absent in leg 1 (ornamented with a crown of spinules as figured), long and plumose in legs 2-3 and short and bare in leg 4. Bases of legs 1-3 with spinules around inner margin; outer seta long and naked in leg 1, long and plumose in legs 2-3 and short and smooth in leg 4. Outer spines of exopodal segments in legs 1-4 bilaterally serrate. Lateral margins of exopodal segments with minute serrations or spinular rows; those of endopodal segments with rows of setules.

Fifth leg (Fig. 6C) with protopod incorporated into somite; outer basal seta displaced to laterodorsal surface. Free segment (exopod) elongate-oval, with one short naked seta subterminal and two long plumose setae distally; outer and inner margins with spinules.

Sixth leg (Fig. 6C) represented by paired opercular plates closing off gonopores on genital double-somite; armed each with one plumose seta and one spiniform element.

Distribution. Norway (Sars 1915).

Remarks. This species was poorly described by G.O. Sars (1915) as *Ascomyzon latum* . However, as Bandera and Conradi (2009b) pointed out, the specimens that Sars stated to be identical to *Cyclopicera lata* (Brady) and described as *Ascomyzon latum* were actually different from *A. echinicola* (=*A. violaceus*) and *Cyclopicera lata*. These authors redescribed *C. lata* as *Asterocheres latus* and named the species described by Sars as *Ascomyzon latum* as *Asterocheres sarsi* but they did not redescribed this species.

Asterocheres sarsi is characterized by the possession of 21 segments in the female antennule, 2-segmented mandibular palp, oral cone reaching to the posterior margin of intercoxal plate of leg 1, inner seta on coxa of leg 1 absent and body cyclopiform, with cephalotorax oval and cyclindrical urosome and epimeral areas of somite bearing leg 3 with posterolateral angles pointed. These features are only shared by another species, *A. eugenioi*, described above; however, the length of the caudal rami differs in both species. While *A. sarsi* presents caudal rami that are twice longer than wide, *A. eugenioi* has a shorter caudal rami, about 1.5 times longer than wide. In *A. sarsi,* caudal seta I is present but it is absent *A. eugenioi. Asterocheres sarsi* shows the antenna, including the claw, much more ornamented with spinules and setules than *A. eugenioi*; and the urosomal somites with large epicuticular spinules arranged in irregular pattern in all urosomites except for leg-5 bearing somite which shows the spinules in overlapping rows pattern. This kind of ornamentation has not been observed in the urosome of *A. eugenioi*.

As for the fifth leg, in *A. eugenioi* the seta of the protopodal segment and those of the free segment are naked. However, in *A. sarsi* the seta of the protopodal segment is plumose, the two longer setae belonging to the free segment are barbed and the shorter one is naked.

The stylet of the mandible also serves to separate these species. *A. sarsi* has a stylet with the tip sharply pointed; in contrast, *A. eugenioi* possesses a stylet with the margin multi-denticulated subapically.

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Artículo XI

Redescription of two *Asterocheres* species (Copepoda: Siphonostomatoida): *A. corneliae* Schirl, 1973 and *A. boeckii*(Brady, 1880), and a proposal of new genus for *A.fastigatus* Kim, 2010.

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RUNNING HEAD: *ASTEROCHERID REDESCRIPTIONS AND NEW GENUS*
BANDERA & CONRADI

Abstract

Asterocheres Boeck, 1860 is the largest genus in the family Asterocheridae and includes approximately 96 nominal species. Nevertheless, according to Kim (2010), the current assignment of twelve of these species to *Asterocheres* is debatable, and fifteen species are too incompletely described for reliable comparisons to be made. In this paper, two species, *A. corneliae* Schirl, 1973 and *A. boeckii* (Brady, 1880), are redescribed and compared with their congeners. As a result of the comparison between *A. boeckii* and *A. fastigatus* Kim, 2010, a new genus, *Kimcheres*, is erected to accommodate the only species of *Asterocheres* displaying the armature formula (0-1) on the second endopodal segment of leg 4. The taxonomic position of *A. longisetosus* Nair & Pillai, 1984, considered as *species inquirenda* by Kim (2010), is discussed. Examination of the original description and illustrations, especially the antennules and the mandible, casts doubts on the validity of the species.

Key words: Asterocheridae, *A. longisetosus*, *Kimcheres* **gen. nov.**

Introduction

The Siphonostomatoida is a well-defined order diagnosed by the shape of the mandible and the possession of an oral cone formed by the labrum and the medially fused paragnaths (labium)(Huys & Boxshall 1991). This order includes about 38 families that accommodate predominantly symbiotic copepods, living in association with fish and a variety of invertebrate hosts (Ho 1994). Among them, the Asterocheridae is one of the most speciose families, currently including about 250 species, the great majority of which utilize marine invertebrates as hosts. It is widely accepted that a revision of the various asterocherid genera is long overdue, since for more than a century the family Asterocheridae has served as a repository for genera and species which did not fit in any other siphonostomatoid family (Boxshall & Halsey 2004). This state of affairs has inevitably contributed to the heterogeneity of this family (Nair & Pillai 1984; Boxshall & Halsey 2004; Johnsson & Neves 2004). Currently, the Asterocheridae includes 62 genera and more than 60% of them are monotypic; only nine genera accommodate five or more species. *Asterocheres* Boeck, 1860 is the largest genus in the family, containing nearly 35% of the known species (approximately 96 nominal species).As Kim (2010) pointed out, it is necessary to consider the validity of the nominal species of *Asterocheres* in order to refine the definition of the genus. His attempt to sort the nominal species resulted in the recognition of valid species (69 species currently), incompletely described species that are hardly comparable with other congeners (15 species) and *species inquirendae* whose current position in *Asterocheres* is questionable (12 species). The species belonging to the last two groups need to be re-examined for morphological details before they can be placed in a particular genus and for reliable comparisons to be made. Most of these poorly known species have not been recorded since their original descriptions and future studies are ideally to be based on type material deposited in museums. A partial revision of the genus *Asterocheres*, based on type material deposited in various museums, was recently initiated to clarify the confused systematic and phylogenetic relationships of this genus. The present paper deals with the redescription of two species deposited in the Natural History Museum of London, the Natural History Museum of the University of Oslo and the Zoological Museum of the University of Copenhagen. Although this material belonged to the group of valid species recognized by Kim (2010), re-examination of *Asterocheres corneliae* Schirl, 1973 and *A. boeckii* (Brady, 1880) showed some discrepancies with their respective original descriptions and, furthermore, the comparison of the redescribed species with the remaining species of the genus, particularly with *A. fastigatus* Kim, 2010,necessitated the erection of a new genus, *Kimcheres*. In addition, the taxonomic position of *A. longisetosus* Nair & Pillai, 1984, relegated by Kim (2010) to *species inquirendae*, is reassessed in this paper.

Material and methods

Asterocherid material was loaned by various European museums, including specimens from the Natural History Museum of London (NHMUK) (three females belonging to the Norman Collection), seven specimens collected by Sars in Norway in 1915 and deposited in The Natural History Museum of the University of Oslo (ZMO), and two specimens deposited in the Zoological Museum of the University of Copenhagen (ZMUC).

When slide preparations from the different museums were not sufficient for a detailed description of some appendages, a whole specimen was stained with Chlorazol black E (Sigma® C-1144) prior to dissection in lactic acid. The dissected parts were then examined as temporary mounts in lactophenol and subsequently sealed with Entellan to make permanent mounts

All figures were drawn with the aid of a camera lucida on a Leica DMLB differential interference contrast microscope. All appendage segments and setation elements were named and numbered using the system established by Huys & Boxshall (1991).In the armature formula of the swimming legs 1–4, spines are indicated by Roman numerals and setae by Arabic numerals. Mean body length of the copepod was measured from the anterior margin of the rostrum to the posterior margin of the caudal rami.

Results

Order Siphonostomatida Burmeister, 1835

Family Asterocheridae Giesbrecht, 1899

***Asterocheres* Boeck,1860**

***Asterocheres corneliae* Schirl, 1973**

(Figs. 1–2)

Asterocheres corneliae Schirl, 1973: 71–77; Figs. 3–4, 5(g–j)

Material examined. Six females (NHMUK reg. no 1986.385), associated with a red sponge collected in a bay situated 2km north of Banyuls-sur-Mer, France; August 1983.

Description of female. Body cyclopiform, with oval cephalothorax and cylindrical urosome (Fig. 1A). Mean body length 756µm (n = 5; 710–790 µm) and mean maximum width 385 µm (n = 5; 375–404 µm). Prosome comprising cephalothorax (fully incorporating first pedigerous somite) and three free pedigerous somites.

Urosome 4-segmented, comprising leg 5-bearing somite, genital double-somite and two free abdominal somites (Fig. 1B). Except for leg 5-bearing somite, all other urosomites ornamented with epicuticular scales. Genital double-somite (Fig. 1B) slightly wider than long; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore (oviduct opening); lateral margins with long spinules in middle third (posterior to genital apertures). Each genital area provided with one very plumose seta (Fig. 1B).

Caudal rami (Fig. 1B) about as long as wide (measured along outer margin); armed with six setae: seta I absent; setae III–VI all plumose and arranged around posterior margin; insertion sited of setae II and VII slightly displaced onto dorsal surface, both of them smooth.

Antennule (Fig. 1C) 21-segmented, about 375 µm long. Segmental fusion pattern and armature as follows: 1(I)-1, 2(II)-1, 3(III)-1, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-1, 8(VIII)-2, 9(IX–XII)-8, 10(XIII)-1, 11(XIV)-1+1 spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+1 aesthetasc, 19(XXII–XXIV)-3, 20(XXV–XXVI)-3 and 21(XXVII–XXVIII)-6. Segment 10(XIII) reduced, forming incomplete sclerite partly overlapped by distal expansion of compound segment 9(IX–XII).

Antenna (Fig. 1D) biramous, about 240 µm long including terminal claw. Coxa small and ornamented with tuft of spinules in distal inner margin. Basis elongate and unarmed. Exopod 1-segmented, about twice longer than wide, armed with one lateral seta, one short subterminal seta and one very long terminal seta, all of them smooth. Endopod 3-segmented; proximal segment elongate and ornamented with rows of spinules along inner margin; middle segment produced distally on medial side but articulating with distal segment proximally on lateral side, bearing one plumose distal seta which is longer than the entire segment; distal segment armed with two subterminal setae, one of them plumose, and apical claw.

Siphon reaching to between bases of maxillipeds and intercoxal sclerite of leg 1.

Mandible (Fig. 2A) comprising stylet-like gnathobase and slender 1-segmented palp. Stylet with denticulate margin subapically. Palp elongated, with row of spinules at medial side and two barbed terminal setae of unequal length.

Maxillule (Fig. 2B) bilobed; praecoxal gnathobase (inner lobe) 3.5 times longer than palp (outer lobe). Praecoxal endite ornamented with short spinules laterally and tuft of long spinules medially; armed with five terminal setae, one of them very short and naked. Palp bearing two subterminal setae (one of them barbed and very short and the other one long and plumose) and two plumose terminal setae, equal in length.

Maxilla (Fig. 2C) 2-segmented. Coxa with row of spinules along proximal inner margin (not figured). Basis claw-like, longer than coxa, with recurved tip and ornamented with row of spinules in distal half.

Maxilliped (Fig. 2D) 5-segmented, comprising short syncoxa, long basis and 3-segmented endopod. Syncoxa with one short smooth seta along distal inner margin. Basis elongate with few short spinules along outer margin and minute seta halfway along inner margin. First endopodal segment compound, partial suture marking original separation of two ancestral segments, armature formula (2,0); second endopodal segment short, bearing one short naked seta medially; third endopodal segment armed with terminal claw plus additional plumose subterminal seta. Distal two-thirds of claw provided with spinules along medial margin.

Swimming legs 1–4 (Fig. 4A–D) biramous, with 3-segmented rami and intercoxal sclerite present in all legs (legs 1–4 as described and illustrated by Schirl (1973)). Spine and seta formula:

	coxa	basis	exopod	endopod
Leg 1	0-1	1-1	I-1;I-1;III,4	0-1;0-2;1,2,3
Leg 2	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,2,3
Leg 3	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,1+I,3
Leg 4	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,1+I,2

Fifth leg (Fig. 1B) with protopod incorporated into somite; outer basal plumose seta displaced to laterodorsal surface, longer than entire free segment. Exopod elongate, with three terminal setae, the longest two smooth and stout and the short one densely plumose; outer and inner margins with spinules.

Sixth leg (Fig. 1B) represented by paired opercular plates closing off gonopores on genital double-somite; armed each with one very plumose seta.

Male. Not examined.

Discussion. Schirl's (1973) description was based on specimens collected from Banyuls in the early 1960s that were found to be associated with three species of calcarean sponges, *i.e. Clathrina clathrus* (Schmidt, 1864), *C.primordialis* (Haeckel, 1872) and *Ascandra contorta* (Bowerbank, 1866). The specimens deposited in the Natural History Museum of London are labelled *Asterocheres cf. corneliae*, and upon re-examination were confirmed to belong to this species. However, some discrepancies with the original description were observed, including: (1) the antennule is 20-segmented in the female in the original description, although the illustration shows a 20-segmented antennule with the last segment indistinctly 2-segmented (with three and three setae each); our re-examination showed that the antennule is 21-segmented, with the last two segments clearly divided (three and six setae each); (2) the antenna bears three setae on the exopod instead of the two setae illustrated by Schirl, and the proximal segment of the endopod is ornamented with rows of spinules along the inner margin; (3) the mandibular palp was described as "probably 2-segmented, but the dividing line is barely visible"; the mandibular palp proved to be clearly 1-segmented and the stylet of the mandible is illustrated here for the first time; (4) the outer lobe of the maxillule is smaller and the terminal setae are shorter than those shown in the original description; the inner lobe is provided with one additional seta; (5) row of spinules along proximal inner margin in the coxa and row of spinules in distal half of basis claw-like are missing in Schirl's illustration of the maxilla; (6) the minute seta halfway along inner margin of basis and one seta on first endopodal segment are missing in Schirl's description of the maxilliped; (7) the leg 5-bearing somite and all other urosomites are ornamented with epicuticular scales which were overlooked in the original illustration.

Despite the discrepancies observed between the specimens examined herein and the original description, the species is easily identifiable as *A. corneliae*. As in other redescriptions of *Asterocheres* species (Bandera & Conradi 2009a, 2009b, 2013, 2014; Kim 2010), such discrepancies are mainly confined to the ornamentation and armature of oral appendages and are relatively common in descriptions published 40 or more years ago.

Asterocheres corneliae belongs to the group of *Asterocheres* species that display a 21-segmented antennule in the female. This group includes 27 species: *A. astroidicola*

Conradi, Bandera & López-González, 2006, *A. echinicola* (Norman, 1868), *A. ellisi* Hamond, 1968, *A. eugenioi* Bandera & Conradi, 2014, *A. faroensis* Crescenti, Baviera & Zaccone, 2010, *A. flustrae* Ivanenko & Smurov, 1997, *A. genodon* Stock, 1966, *A. hirsutus* Bandera, Conradi & López-González, 2005, *A. hoi* Bandera & Conradi, 2013, *A. jeanyeatmanae* Yeatman, 1970, *A. kervillei* Canu, 1898, *A. latus* (Brady, 1872), *A. lilljeborgii* Boeck, 1860, *A. madeirensis* Bandera, Conradi & López-González, 2007, *A. minutus* (Claus, 1889), *A. nudicoxus* Kim, 2010, *A. peniculatus* Kim, 2010, *A. reginae* Boxshall & Huys, 1994, *A. sarsi* Bandera & Conradi, 2009b, *A. simulans* (Scott, 1898), *A. siphonatus* Giesbrecht, 1897, *A. suberitis* Giesbrecht, 1897, *A. tarifensis* Conradi & Bandera, 2011, *A. tenerus* (Hansen, 1923), *A. tenuicornis* Brady, 1910, *A. tubiporae* Kim, 2004b, and *A. urabensis* Kim, 2004a.

Only six species of the group listed above are reported to have a 1-segmented mandibular palp as in *A. corneliae*, *i.e. A. echinicola*, *A. faroensis*, *A. madeirensis*, *A. minutus*, *A. nudicoxus* and *A. siphonatus*. The remaining species exhibit a 2-segmented mandibular palp. Although *A. nudicoxus* was described by Kim (2010) as having a 1-segmented mandibular palp, in the description he pointed out that the palp showed a vestigial articulation which was displayed in the illustration (Kim 2010: Fig. 34A). This vestigial articulation and the characteristic shape of the genital double-somite, consisting of a broad anterior part and a very short, narrower posterior part, with the anterior part strongly tapering anteriorly (Kim 2010: Fig. 33B) serve to separate *A. nudicoxus* from *A. corneliae*.

Two species, *A. echinicola* and *A. minutus*, differ from *A. corneliae* by the morphology of the maxillule. In both species the inner and outer lobes are approximately equal in length, and one of the four terminal setae on the inner lobe is four times longer than the remaining three setae (Bandera & Conradi 2009b; Conradi & Bandera 2011). In contrast, *A. corneliae* has an inner lobe which is about 3.5 times longer than the outer and bears four long and one short distal setae.

Asterocheres siphonatus can easily be separated from *A. corneliae* by the length of the siphon. In *A. corneliae* it extends beyond the bases of the maxillipeds but does not reach the intercoxal sclerite of the first leg, whereas in *A. siphonatus* the siphon extends to the posterior margin of the intercoxal sclerite of the fourth leg (Conradi & Bandera 2011).

Detailed comparison between *A. corneliae* and *A. faroensis* reveals a number of significant differences, including the size of the caudal rami (about as long as wide in *A.*

corneliae compared to 1.7 times longer than wide in *A. faroensis*) and the more dorso-ventrally flattened prosome in *A. faroensis* (Crescenti *et al.* 2010). The long aesthetasc-like element on the coxal part of maxilla is present in *A. faroensis* but was not discernible in *A. corneliae.*

The most similar species of the group mentioned above is *A. madeirensis* which can be distinguished by the following differences: (1) antennary exopod armed with two setae in *A. madeirensis* and three setae in *A. corneliae*; (2) mandibular stylet pointed in *A. madeirensis* but denticulated in *A. corneliae*; (3) siphon slightly longer in *A. corneliae*; (4) inner lobe of maxillule three times longer than outer lobe in *A. madeirensis* but four times longer in *A. corneliae*; (5) aesthetasc-like element present on coxal part of maxilla in *A. madeirensis* but absent in *A. corneliae*; (6) outer basal seta of protopod of leg 5 longer than the entire free segment in *A. corneliae* but shorter in *A. madeirensis*; and (7) lateral margins of the genital double-somite with long spinules in the middle third in *A. corneliae*, but much more spinous in *A. madeirensis* (Bandera *et al.* 2007).

***Asterocheres boeckii* (Brady, 1880)**

(Figs. 3–5)

Artotrogus Boeckii Brady, 1880: 60–61; Plate XCI, figs. 1–9.

Material examined. (a) seven females (ZMO F21599) from Ranø, collected by G.O. Sars; (b) two females (ZMUC; CRU-4936) from Talsnafiord Island, 1893; (c) three females (NHMUK-1911.11.8.47282–286) from Salcombe, Devon, England, 1875 (Norman collection); (d) seven females, three juveniles (NHMUK-1986.381) from Loch Riddon (Loch Ruel), Argyll and Bute, Scotland.

Description of female. Body cyclopiform, with very broad prosome and cylindrical urosome (Fig. 3A). Mean body length 864µm (n = 4; 791–920 µm) and mean maximum width 497 µm (n = 4; 396–620 µm). Prosome comprising cephalothorax (fully incorporating first pedigerous somite) and three free pedigerous somites. Cephalothorax with posterolateral angles rounded. Somites bearing legs 2–3 very broad; epimeral areas with posterolateral angles rounded. Somite bearing leg 4 much smaller and narrower than preceding ones, largely concealed under pleurotergite of leg 3-bearing somite.

Urosome 4-segmented, comprising leg 5-bearing somite, genital double-somite and two free abdominal somites. Posterior hyaline frills of urosomites with serrate free margins (Fig. 3B). Genital double-somite ornamented with flattened epicuticular scales arranged in irregular pattern dorsally (Fig. 3B); about as long as wide; paired genital apertures bipartite, each comprising lateroventral copulatory pore and dorsolateral gonopore (oviduct opening); lateral margins with setular tufts in distal half (posterior to genital apertures).

Caudal rami (Fig. 3B) slightly wider than long (measured along outer margin); trapezoid with inner margin shorter than outer one; armed with six setae; seta I absent; setae II–VII all arranged around posterior margin with setae II and VII slightly displaced onto dorsal surface.

Antennule (Fig. 3D) 21-segmented, about 370 µm long. Segmental fusion pattern and armature as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-1, 7(VII)-1, 8(VIII)-2, 9(IX–XII)-7, 10(XIII)-1, 11(XIV)-1+1 spine, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI)-2+1 aesthetasc, 19(XXII–XXIII)-2 , 20(XXIV–XXV)-3 and 21(XXVI–XXVIII)-6. Segment 10(XIII) reduced, forming incomplete sclerite partly overlapped by distal expansion of compound segment 9(IX–XII).

Antenna (Fig. 3E) biramous, about 350 µm long including terminal claw. Coxa unarmed, with few spinules. Basis unarmed, with fine spinule row as shown in Figure 3E. Exopod 1-segmented, small, about 1.5 times longer than wide; with one short proximal seta and two terminal setae unequal in length, all of them smooth. Endopod 3-segmented; proximal segment elongate, ornamented with lateral and distal rows of fine spinules; middle segment produced distally on medial side but articulating with distal segment proximally on lateral side, bearing one distal smooth seta; distal segment with long terminal claw and two subterminal pinnate setae; inner margin of distal segment and claw with spinules.

Siphon reaching to the intercoxal sclerite of leg 1.

Mandible (Fig. 4B) comprising stylet-like gnathobase and slender 2-segmented palp. Proximal segment of palp longest (3.9 times longer than distal one), ornamented with rows of spinules; short distal segment, with two plumose unequal apical setae.

Stylet located in oral cone, with denticulate margin subapically as figured.

Maxillule (Fig. 4A) bilobed. Inner lobe much larger than outer lobe, about three times longer than wide. Inner lobe ornamented with spinules on lateral margin and tuft of long setules medially; armed with one minute and naked seta and four long but unequal setae, latter setae ornamented with spinules. Outer lobe armed with two long plumose setae, one subterminal spinulose seta and one lateral stout seta densely covered by spinules (Fig. 4A).

Maxilla (Fig. 3F) 2-segmented but with partial transverse surface suture on syncoxa (proximal segment) possibly marking plane of praecoxa-coxa fusion; praecoxal portion bearing flaccid aesthetasc-like element medially, representing tubular extension of external opening of maxillary gland; coxal portion unarmed. Basis claw-like and much longer than coxa, more or less straight but recurved towards the apex; margins provided with rows of spinules as figured.

Maxilliped (Fig. 4C) 5-segmented, comprising short syncoxa, long basis and 3-segmented endopod. Syncoxa with one short seta distally. Basis with few spinules on distal outer margin. First endopodal segment bearing two unequal distal setae; second endopodal segment with one plumose medial seta; third endopodal segment bearing recurved terminal claw and subterminal plumose seta. Distal margin of claw with rows of spinules.

Swimming legs 1–4 (Fig. 5A–D) biramous, with 3-segmented rami; intercoxal sclerite present. Spine and seta formula as follows:

	coxa	basis	exopod	endopod
Leg 1	0-1	1-1	I-1;I-1;III,4	0-1;0-2;1,2,3
Leg 2	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,2,3
Leg 3	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,1+I,3
Leg 4	0-1	1-0	I-1;I-1;III,I,4	0-1;0-2;1,1+I,2

Coxae ornamented with spinule rows around outer margin; inner coxal seta short and naked in legs 1 and 4, long and plumose in legs 2–3. Outer basal seta long and naked in legs 1–2 and short in legs 3–4 (the last one plumose). Outer spines of exopodal segments in legs 1–4 bilaterally serrate. Lateral margin of exopodal segments with minute serrations or spinular rows; those of endopodal segments with rows of setules.

Fifth leg (Fig. 3B–C) with protopod incorporated into somite; outer basal seta displaced to laterodorsal surface. Free segment elongate-oval, with three terminal setae, two of them long and pinnate and one of them shorter and plumose; margins with spinules.

Sixth leg (Fig. 3B) represented by paired opercular plates closing off gonopores on genital double-somite; armed each with one plumose seta and one spiniform element.

Discussion. This species was originally described by Brady (1880) under the name *Artotrogus boeckii* Brady, 1880, based on two or three specimens taken in a surface-net, and amongst weeds, at about 3.6 m depth in Westport Bay (Co. Mayo) and Roundstone Bay (Co. Galway), on the west coast of Ireland. Most workers have subsequently referred to it as *Asterocheres boecki* (*e.g.* Sars 1915; Stock 1966; Hamond 1973; Schirl 1973; Humes 1980; Kim 2014). However, the use of the genitive ending *-i* in a subsequent spelling of a species-group name that is a genitive based upon a personal name in which the correct original spelling ends with *-ii*, is to be treated as an incorrect subsequent spelling, even if the change in spelling is deliberate (ICZN Art. 33.4). The correct spelling of the specific epithet should therefore be *boeckii* and is reinstated here. The same applies to the type species of the genus which is widely cited as *Asterocheres lilljeborgi* but was originally spelled as *A. Liljeborgii* by Boeck (1860). Since the species was named after the Swedish zoologist Wilhelm Lilljeborg, the incorrect original spelling was subsequently corrected to *lilljeborgi* by Brady (1880), Canu (1892), Giesbrecht (1997) and others, but unfortunately, the correct suffix *–ii* was lost in the process. The correct spelling is adopted here as *Asterocheres lilljeborgii* Boeck, 1860. Similarly, the type species of *Ascomyzon* Thorell, 1859 (a synonym of *Asterocheres*), should be cited by its original spelling *Ascomyzon lilljeborgii* Thorell, 1859. Note that *Ascomyzon* (published 14 Sep 1859) takes priority over *Asterocheres* Boeck, 1860 (date of publication to be adopted is 31 December when only the year is specified or demonstrated (ICZN 21.3.2)). A ruling by the International Commission on Zoological Nomenclature will be required to avoid upsetting a long-accepted name in its accustomed meaning. In addition, since *Ascomyzon lilljeborgii* Thorell, 1859 has become the senior secondary homonym of *Asterocheres lilljeborgii* Boeck, 1860, the latter will need to be replaced, in this case by its oldest junior synonym, *Asterocheres asterocheres* (Sars, 1915).

Brady (1880) listed *Ascomyzon lilljeborgii* Thorell, 1859 as a synonym of *A. boeckii*, although in the text he mentioned that Thorell's (1859) specimens were obtained from *Corella* (as *Ascidia*) *parallelogramma* (Müller, 1776) and he himself "… had never seen any examples taken from ascidians". Giesbrecht (1899), in his monograph of asterocherids from the Gulf of Naples, amended the description of *A. boeckii* and illustrated the male and female. However, Sars (1915) pointed out that the specimens used in Giesbrecht's redescription of *A. boeckii* belonged to another species which was later described by Stock (1960) as *Asterocheres complexus* Stock, 1960. In the same paper, Sars also redescribed *A. boeckii*, transferred it to *Ascomyzon* (*Asterocheres* was considered invalid), and stated that *Asc. lilljeborgii* Thorell, 1859 and *Asc. Lilljeborgii* (Boeck, 1860) were different species, both being distinct from *Asc. boeckii* (Brady, 1880).

Asterocheres boeckii was poorly described and illustrated by Brady (1880) and the only available redescription and illustrations that are more complete are those by Sars (1915). The specimens of this species deposited in different European museums show some discrepancies with the previous descriptions, *i.e.* (1) the antennule is 21-segmented in female instead of the 20 segments reported by Brady and Sars; (2) the antennary exopod has not two but three elements; Sars missed one lateral seta; (3) although Brady described the mandible in the text as "… produced into a long filiform seta, and destitute of a palp", his illustration shows a 1-segmented palp with two terminal setae (Brady 1880: Plate XCI, Fig. 3); the stylet is here described and illustrated for the first time; (4) the inner lobe of the maxillule possesses five setae instead of the four setae illustrated by Sars; (5) the maxilla has a long aesthetasc-like element medially which was not illustrated or mentioned in previous descriptions; (6) the maxilliped is 5-segmented with the armature formula: (1, 0, 2, 1, 1 + claw), but the majority of these setae or spines are missing in preceding descriptions; (7) according to Sars's illustration, the armature formula for the second endopodal segment of leg 4 is (0-1); however, the second endopodal segment of leg 4 bears two setae as is usual for the genus; and (8) the exopod of leg 5 shows not two but three terminal setae; there is one terminal seta missing in previous descriptions.

This species belongs to the *Asterocheres* species group characterized by 21-segmented antennules in the females, a 2-segmented mandibular palp and a siphon reaching to the intercoxal sclerite of leg 1. This group is composed of nine species: *A. ellisi*, *A. eugenioi*, *A. hirsutus*, *A. hoi*, *A. latus*, *A. peniculatus*, *A. sarsi*, *A. tenuicornis* and *A. urabensis*. Although there is no information about the length of the siphon in *A. tenuicornis*, this species can easily be separated from *A. boeckii* by the length of the caudal rami, being six times longer than wide, the longest within the genus (Eiselt 1965). Caudal ramus length can also be used to separate both *A. latus* and *A. hirsutus* from *A. boeckii* since the caudal rami is 2.6 times longer than wide in *A. latus*, 2.5 times longer than wide in *A. hirsutus* and slightly wider than long in *A. boeckii* (Bandera & Conradi 2009b; Bandera *et al.* 2005).

Asterocheres boeckii can be separated from *A. ellisi*, *A. eugenioi* and *A. sarsi* by differences in body shape. While *A. boeckii* shows a cyclopiform body, with very broad prosome and cylindrical urosome, *A. ellisi* is characterized by a dorsoventrally flattened prosome (Hamond 1968: Fig. 7); *A. eugenioi* and *A. sarsi* have an oval cephalothorax, a cylindrical urosome, and epimeral areas of somites bearing legs 2–3 with pointed posterolateral angles (Bandera& Conradi 2014: Figs. 2A, 6A).

Kim (2010) stated that "… *A. boeckii* differs from *A. peniculatus* having the more expanded prosome, the narrower genital double-somite which is as long as wide, the rostrum with rounded posterior margin, a single inner seta on the second endopodal segment of leg 4, and only two distal setae on the free segment of leg 5, according to the description and figures made by Sars (1915)". After our redescription of *A. boeckii*, it is now confirmed that the last two differences do not exist and *A. peniculatus* and *A. boeckii* share a similar leg 4 and exopod of leg 5. However the other three differences listed above remain valid to separate these two species.

Two other species are very similar to *A. peniculatus* and *A. boeckii*, *i.e. A. genodon* and *A. astroidicola*. The latter can be distinguished from the first two by the length of the siphon (extending beyond the intercoxal sclerite of leg 2 in *A. astroidicola* but reaching the bases of leg 1 in *A. peniculatus* and *A. boeckii*) (Conradi *et al.* 2006). Furthermore, *A. genodon* shows a feature that separates this species from the other three: the presence of seven caudal setae, including a small, naked ventral seta (Kim 2010: Fig. 39C).

The remaining two species of the group, *A. hoi* and *A. urabensis*, differ from *A. boeckii* in the morphology of the free segment of leg 5, the maxillule and the terminal spine of the third exopodal segment of legs 2–4. The exopod of leg 5 is 2.5 times longer than wide in *A. hoi*, 3.8 times longer than wide in *A. urabensis* butonly 1.9 times longer than wide in *A. boeckii*. The length ratio between the inner and outer lobes of the maxillule is about 3 in *A. hoi* and *A. urabensis*, but only 1.8 in *A. boeckii*. The terminal spine of the third exopodal segment of leg 2–4 is much longer than the entire segment in *A. boeckii*; in contrast, this spine is almost equal in length or slightly shorter than the segment in *A. hoi* and *A. urabensis* (Kim 2004a; Bandera & Conradi 2013).

***Kimcheres* gen. nov.**

Diagnosis. Asterocheridae. Body cyclopiform, with large prosome and small urosome. Siphon of medium size, extending beyond bases of maxillipeds. Sexual dimorphism in urosomal segmentation, antennules, maxillipeds, size of leg 5 and leg 6.

Urosome 4-segmented in female and 5-segmented in male. Antennule 17-segmented in female, with large aesthetasc on segment 14; 14-segmented in male, with large aesthetasc on segment 13. Antenna with very long 1-segmented exopod and 3-segmented endopod with terminal claw. Mandibular palp 2-segmented, second segment with two plumose distal setae. Maxillule bilobed. Maxilla 2-segmented, proximal segment with aesthetasc-like element and a claw-like basis, strongly curved distally. Maxilliped 6-segmented, comprising short syncoxa, long basis and 4-segmented endopod; male basis with weak proximal process. Legs 1–4 biramous, with 3-segmented rami. Inner seta on coxa of leg 4 lacking. Armature formula of second endopodal segment of leg 4 (0-1). Leg 5 with protopod incorporated into somite and 1-segmented exopod bearing three setae.

Etymology. The genus is named in honour of Prof. Il-Hoi Kim (Gangneung National University, Korea), who described its type species, in recognition of his contribution to the systematics on symbiotic copepods. The generic name is derived from “Kim” and the suffix *–cheres*, frequently used in the names of asterocherid genera.

Type species. *Asterocheres fastigatus* Kim, 2010 = *Kimcheres fastigatus* (Kim, 2010) **comb. nov.** by original designation (Kim 2010: 64–68; figs. 45A–I, 46A–G, 47A–E).

Discussion. Kim (2010) placed his new species *Asterocheres fastigatus* in *Asterocheres* but expressed some reservations about this generic assignment. He pointed out three characters as the most striking features of this species: (1) armature formula of second endopodal segment of leg 4 (0-1); (2) coxa of leg 1 lacking inner seta, and (3) the elongate antennary exopod. Three other species share the absence of the inner coxal seta of leg 1 with *A. fastigatus*: *A. trisetatus* Kim, 2010, *A. eugenioi* and *A. sarsi*. However, the absence of this coxal seta is the only characteristic shared among these four species.

Although Kim (2010) mentioned that the elongate antennary exopod (longer than half the length of the first endopodal segment) is not present in other species of *Asterocheres*, there is one other species sharing this character. In *A. ellisi* the antennary exopod is six times longer than wide. The most striking differences between *A. fastigatus* and *A. ellisi* are the segmentation of the female antennule (17-segmented vs

21-segmented, respectively) and the body shape which is dorso-ventrally flattened in *A. ellisi* (Hamond 1968; Bandera & Conradi 2009a). The morphology of the antenna is very similar to that displayed by the two species of the genus *Stockmyzon* Bandera & Huys, 2008. Both *Stockmyzon* species had previously been included in *Asterocheres* (Bandera & Huys 2008) but do not share any other characteristics of special relevance. Members of the genus *Orecturus* Humes, 1992 also exhibit a very elongate antennary exopod, but the segmentation of the antennary endopod, the remaining appendages and the general body appearance are completely different (Humes 1992: Fig. 9C).

The striking segmentation pattern of the female antennules was not highlighted in the original description of *A. fastigatus*. The basic number of segments in the female antennules of *Asterocheres* is 21, and the reduction in the number of segments predominantly occurs in the distal part of the antennule (Kim 2010). Typically, species belonging to *Asterocheres* have a compound segment 9(IX–XII) which usually bears seven or eight setae. Segmental fusions proximal to segment 9 are uncommon within the Asterocheridae and are often diagnostic at genus level (*e.g.*,*Acontiophorus* Brady 1880). *Asterocheres fastigatus* displays three segmental fusions proximal to segment 9, *i.e.*, the second segment with three setae, the third with eight setae and the fifth with six setae. However, this is not the only example in the genus showing antennulary fusions proximal to segment 9. In *A. bahamensis* Kim, 2010 the second segment is also a compound one, bearing four setae, but shows a vestigial articulation on the anterior side (Kim 2010: Fig. 9E). Therefore, *A. fastigatus* is the only species in the genus with three clear and complete fusions proximal to segment 9, showing a total of seven segmental fusions in the female antennule: 1(I)-2, 2(II–III)-3, 3(IV–VII)-8, 4(VIII)-2, 5(IX–XI)-6, 6(XII)-2, 7(XIII)-2, 8(XIV)-2, 9(XV)-2, 10(XVI)-2, 11(XVII)-2, 12(XVIII)-2, 13(XIX)-2, 14(XX–XXI)-2+aesthetasc, 15(XXII–XXIII)-2, 16(XXIV–XXV)-4 and 17(XXVI–XXVIII)-7.

Another characteristic considered being very relevant and of potential generic significance is the possession of only a single inner seta on the second endopodal segment of leg 4. According to Kim (2010) this characteristic is shared only by *A. boeckii*, as illustrated by Sars (1915), and *A. fastigatus*. Kim considered this similarity as potential evidence for assigning these species to a separate genus but the lack of other similarities between them prevented him from doing so. Our redescription of *A. boeckii* revealed that Sars's (1915) illustration of leg 4 was incorrect and confirmed that the species has two instead of one inner setae on the second endopodal segment as is typical for the genus *Asterocheres*. Therefore, *A. fastigatus* is the only species in the genus which exhibits the 1-seta condition. Although some other characteristics (mandible, maxillule, maxilla, maxilliped, leg 5) resemble those of *Asterocheres* species, the four striking features listed above warrant the proposal of a new genus, *Kimcheres* **gen. nov.** Two other asterocherid genera display the armature formula (0,1) on the second endopodal segment of leg 4, *i.e. Hermacheres* Stock, 1987 and *Gomumucheres* Humes, 1996. However, *Hermacheres*, characterized by several apomorphic reductions in the armature of legs 1 to 4, differs from *Kimcheres* in many others characters, such as (1) the exopodal segment of leg 4, (2) the minute antennary exopod being reduced to a bud, (3) the form of the mandibular stylet, being shortish, rather wide, sinuous and distally widened into a toothed blade, and(4) the barrel-shaped siphon without tubiform distal part (features shown by the type species *Hermacheres diploriae* Stock, 1987). *Gomumucheres* shows the armature formula (0,1) on the second endopodal segment of both leg 3 and leg 4. The formula 2,2,1,1, indicating the number of inner setae on the second endopodal segment of legs 1–4 differentiates the genus from all others in the Asterocheridae (Humes 1996).

Taxonomic position of *Asterocheres longisetosus* Nair & Pillai, 1984

Asterocheres longisetosus was described by Nair &Pillai (1984: 362–365; figs. 20–23) on the basis of five females found associated with *Porites rus* (Forskål, 1775) [as *Porites convexa* Verill, 1864] from Chetlat Island (Lakshadweep archipelago) in the Arabian Sea. Unfortunately, the specimens deposited in the Indian Museum in Kolkata were lost and since the species has not been recorded again, there is no material available to re-examine it. Although *A. longisetosus* was fully described, Kim (2010) remarked that it can hardly be recognized as a member of *Asterocheres.* He based this assessment on the setation of the third endopodal segment of leg 3 which was originally described with the formula (1, 2, 3) rather than (1, 1+I, 3). According to the figures provided by Nair & Pillai, this is not the only feature exhibited by this species which does not conform to the diagnosis of *Asterocheres*. There are five more features which together with that proposed by Kim (2010), serve to separate this species from *Asterocheres*: (1) the long aesthetasc on the apical segment of the female antennule; (2) the mandibular palp bearing three terminal setae; (3) the setation of the third exopodal segment of leg 4 being III, I, 3 instead of III, I, 4; (4) the exopod of the fifth leg with two long setae and two very short spines; (5) the basis of the first leg being produced at the inner distal part into a conspicuous lobe (Nair & Pillai 1984: figs. 22, 24, 28, 30, 32).

Female members of the family Asterocheridae typically possess antennules consisting of six to 21segments and carrying a single large aesthetasc on the segment homologous with ancestral segment XXI. Depending on the fusion patterns in the distal part of the antennule the position of this aesthetasc can either be on the preantepenultimate, antepenultimate, penultimate, or, rarely, the terminal segment (Boxshall & Halsey 2004). Within the family the presence of an aesthetasc on the last antennulary segment is shared only by four genera, *i.e. Onychocheres* Stock & Gooding, 1986, *Asterocheroides* Malt, 1991, *Siphonopontius* Malt, 1991 and *Cephalocheres* Kim, 2010. A common characteristic observed in the antennules of these genera is the elongate terminal segment (Stock & Gooding 1986: Fig. 11; Malt 1991: Figs. 7K, 9C; Kim 2010: Fig. 110C). In *Asterocheres*, the female antennule typically has short and wide segments 1–10, and long and narrow segments 11–21. Usually, compound segments are longer than free ones, and the aesthetasc present on segment XXI is retained in most species. The antennule illustrated by Stock & Gooding (1986: Fig. 11) in the original description of *Onychocheres* shows the segmental fusion pattern as follows: 1(I)-2, 2(II)-2, 3(III)-2, 4(IV)-2, 5(V)-2, 6(VI)-2, 7(VII)-2, 8(VIII)-2, 9(IX–XII)-7, 10(XIII)-2, 11(XIV)-2, 12(XV)-2, 13(XVI)-2, 14(XVII)-2, 15(XVIII)-2, 16(XIX)-2, 17(XX)-2, 18(XXI–XXVIII)-16+1 aesthetasc. The compound segment 18(XXI–XXVIII) retains all the setae belonging to the ancestral segments XXI-2, XXII-1, XXIII-1, XXIV-2, XXV-2, XXVI-2, XXVII-2 and XXVIII-4 and the aesthetasc belonging to ancestral segment XXI. This segment is elongate, long enough to bear all the setae and aesthetasc belonging to the ancestral segments XXI–XXVIII. However, this characteristic has not been observed in the illustration of *A. longisetosus* (note the short last antennulary segment and the similarity of the last four segments with those of typical 21-segmented antennules). Although Nair & Pillai (1984) described and illustrated the antennule of *A. longisetosus* as 20-segmented, they only provided the armature for 19 segments. This armature is difficult to match with the basic pattern for female copepods as proposed by Huys & Boxshall (1991: Fig. 1.5.1).

The antennule is not the only appendage that is in need of redescription since the setation of the mandibular palp also does not correspond with that given by Kim (2010) in his redefinition of the genus *Asterocheres*. Usually, the mandibular palp of *Asterocheres* species bears two distal setae instead of the three setae present in *A.*

longisetosus. According to Huys & Boxshall (1991), the mandibular palp of siphonostomatoids bears a maximum of two setae on its apex, suggesting that the third supernumerary seta in Nair & Pillai's (1984) description is based on an observational error. Members of the genus *Asterocheres* typically have three setae on the exopodal segment of the fifth leg, one of which is usually small or obsolete (Kim 2010). Conversely, *A. longisetosus* displays a free exopodal segment with two long setae and two very short spines. This combination of setae and spines obviously does not fit the *Asterocheres* condition, although it can be found in other members of the Asterocheridae such as some species of *Orecturus* Humes, 1992.

Asterocheres longisetosus resembles other species of *Asterocheres* in many aspects, such as the body shape, the antenna with a 1-segmented exopod and 3-segmented endopod, the segmentation and form of the maxillule, the maxilla and the maxilliped, but the atypical characters mentioned above warrant its removal from this genus. Although its assignment to the Asterocheridae is irrefutable, the unusual characteristics observed in the antennule and mandible prevent inclusion of *A. longisetosus* in any of the existing genera. However, the inconsistencies in Nair & Pillai's (1984) description combined with the loss of the type material, and the unavailability of other specimens have dissuaded us from erecting a new genus.

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Figure legends

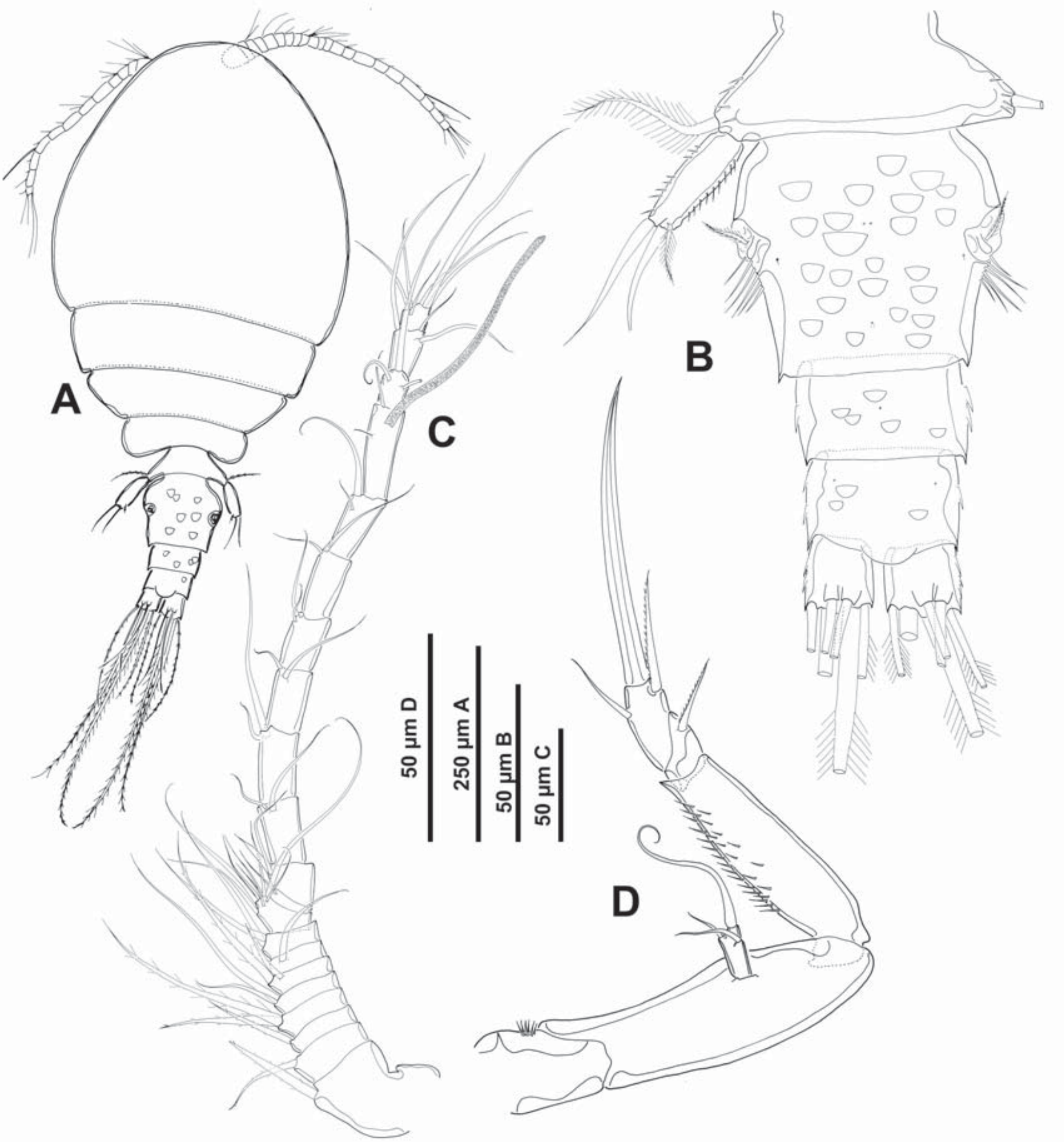
Figure 1. *Asterocheres corneliae* Schirl, 1973 (female). A, habitus, dorsal; B, urosome, dorsal; C, antennule; D, antenna.

Figure 2. *Asterocheres corneliae* Schirl, 1973 (female). A, mandible; B, maxillule; C, maxilla; D, maxilliped.

Figure 3. *Asterocheres boeckii* (Brady, 1880) (female). A, habitus, dorsal; B, urosome, dorsal; C, exopod of leg 5; D, antennule; E, antenna; F, maxilla.

Figure 4. *Asterocheres boeckii* (Brady, 1880) (female). A, maxillule; B, mandible; C, maxilliped.

Figure 5. *Asterocheres boeckii* (Brady, 1880) (male). A, leg 1; B, leg 2; C, leg 3; D, leg 4.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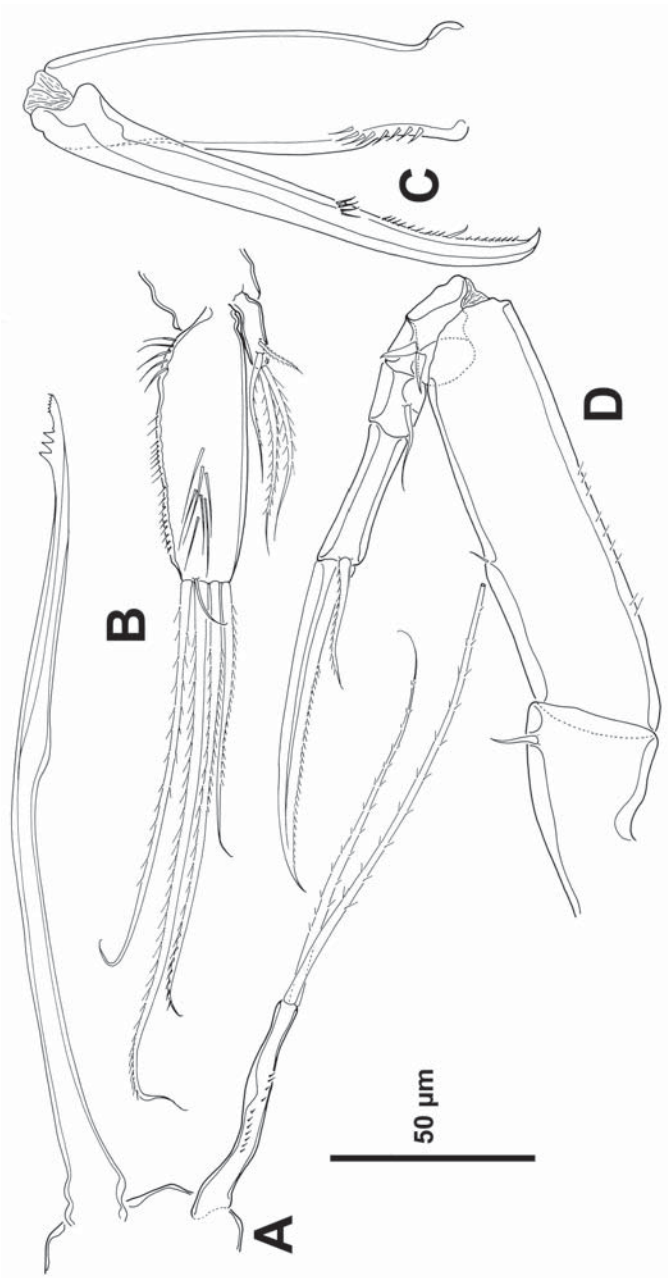
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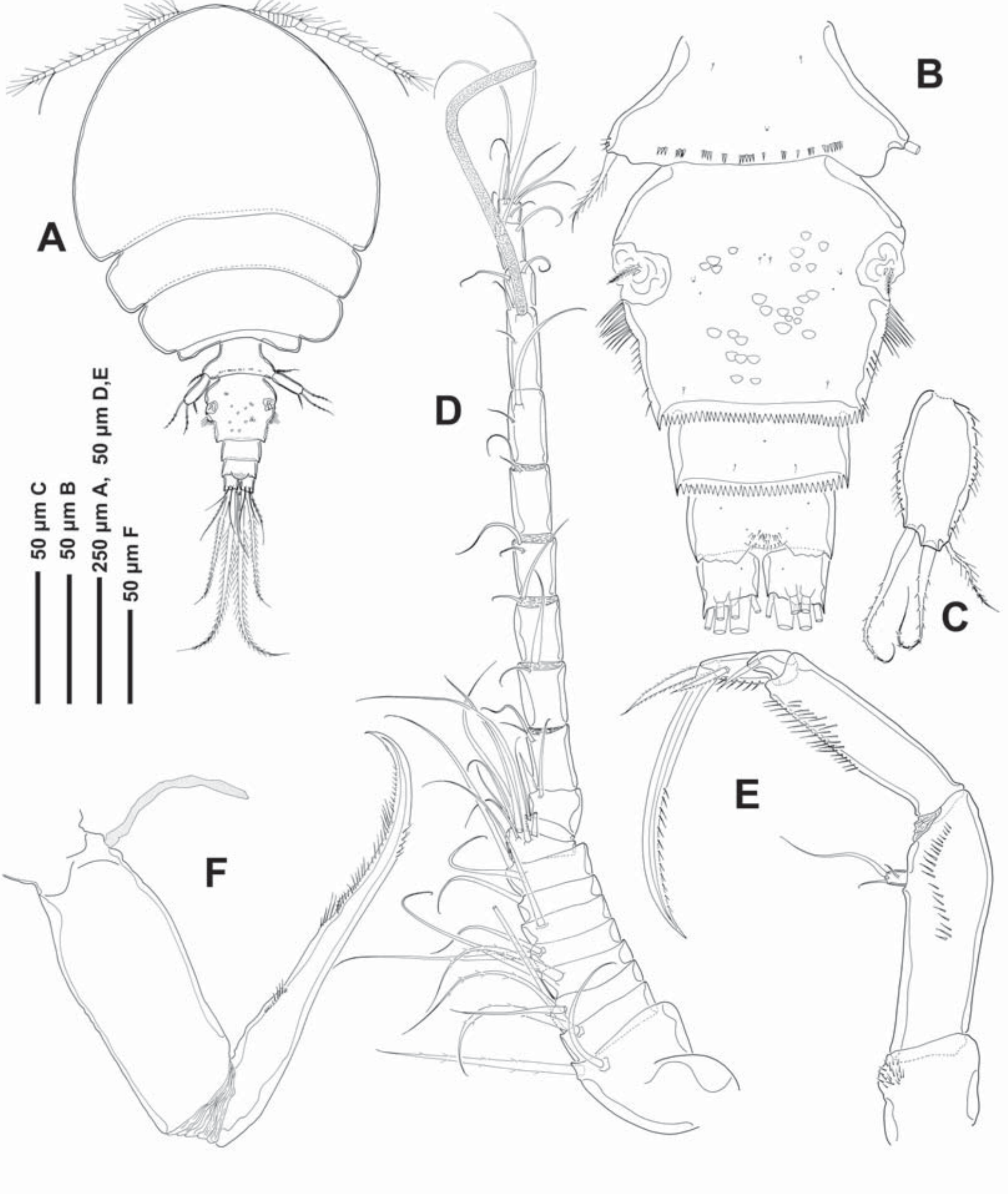
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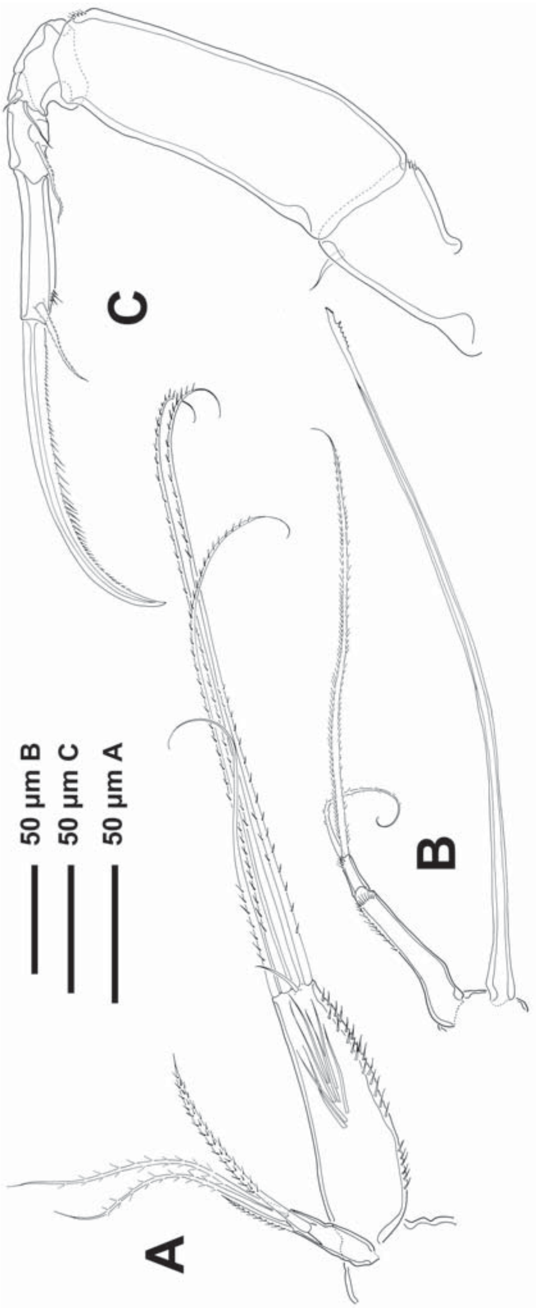
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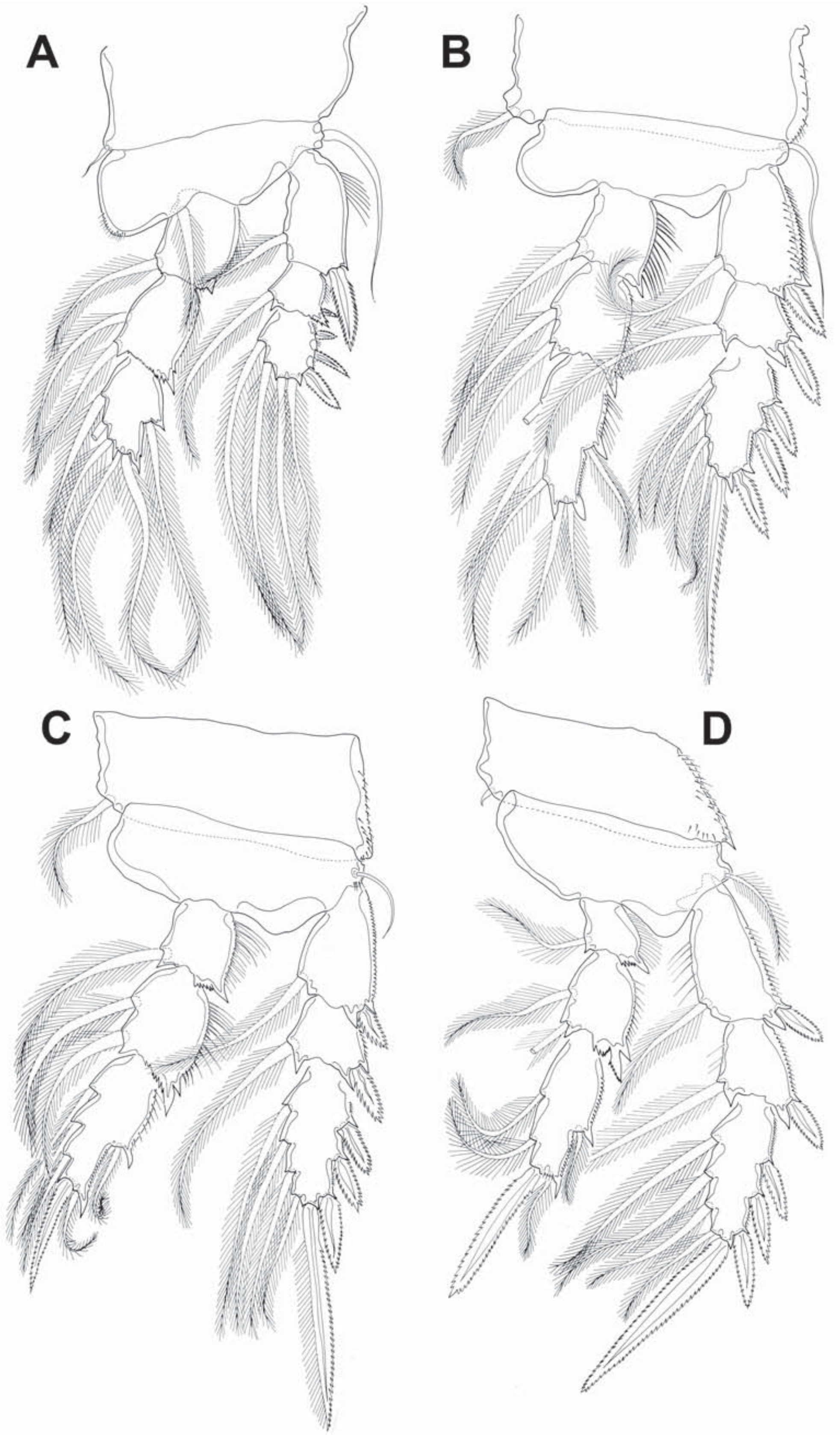
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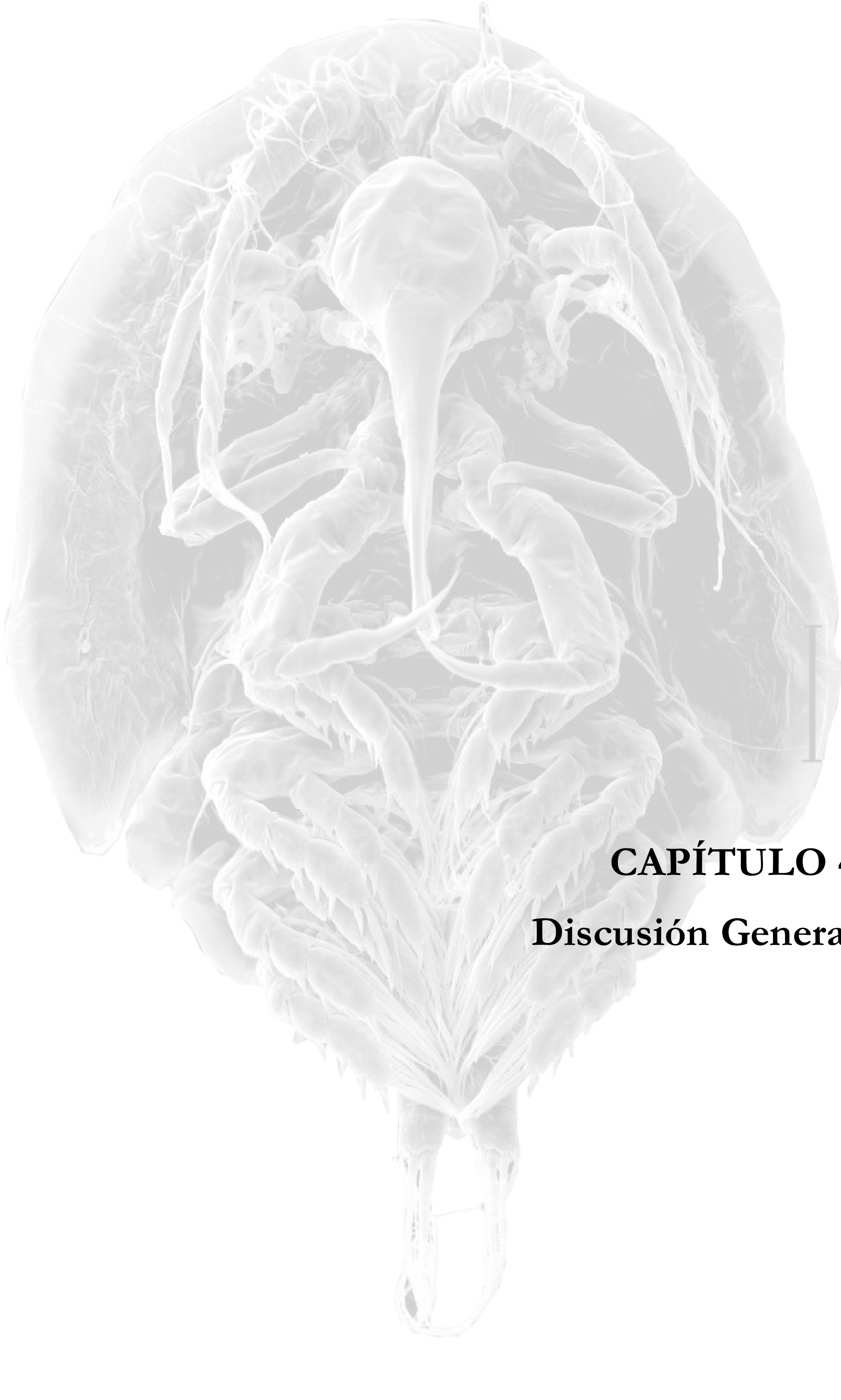

CAPÍTULO 4

Discusión General

4.- DISCUSIÓN GENERAL

Asterocheres Boeck, 1860, el género con mayor número de especies dentro de la familia Asterocheridae y que contiene aproximadamente el 40% de las especies conocidas, contaba con 72 especies nominales al inicio de la realización de la presente memoria, aproximadamente a finales del año 2004, entre las cuales estaban (según la página web "The World of Copepods" del Museo Nacional de Historia Natural – Smithsonian Institution): *Asterocheres abrolhensis* Johnsson, 1998; *Asterocheres abyssi* (Hansen, 1923); *Asterocheres aesthetes* Ho, 1984; *Asterocheres alter* Eiselt, 1965; *Asterocheres aplysinus* Johnsson, 2002; *Asterocheres bacescui* Marcus, 1965; *Asterocheres boecki* (Brady, 1880); *Asterocheres bulbosus* Malt, 1991; *Asterocheres canui* Giesbrecht, 1897; *Asterocheres complexus* Stock, 1960; *Asterocheres corneliae* Schirl, 1973; *Asterocheres crenulatus* Johnsson, 1998; *Asterocheres crinoidicola* Humes, 2000; *Asterocheres dentatus* Giesbrecht, 1897; *Asterocheres dysideae* Humes, 1996; *Asterocheres echinicola* (Norman, 1869); *Asterocheres ellisi* Hamond, 1968; *Asterocheres enewetakensis* Humes, 1997; *Asterocheres flustrae* Ivanenko & Smurov, 1997; *Asterocheres genodon* Stock, 1966; *Asterocheres halichondriae* Stock, 1966; *Asterocheres hongkongensis* Malt, 1991; *Asterocheres indicus* Sewell, 1949; *Asterocheres intermedius* (Hansen, 1923); *Asterocheres jeanyeatmanae* Yeatman, 1970; *Asterocheres kervillei* Canu, 1897; *Asterocheres latus* (Brady, 1872); *Asterocheres lilljeborgi* Boeck, 1859; *Asterocheres longisetosus* Nair & Pillai, 1984; *Asterocheres lunatus* Johnsson, 1998; *Asterocheres mainensis* Murnane, 1969; *Asterocheres major* Thompson I.C. & Scott A., 1903; *Asterocheres manaarensis* Thompson I.C. & Scott A., 1903; *Asterocheres maxillatus* Stock, 1987; *Asterocheres micheli* Gurney, 1927; *Asterocheres minor* Thompson I.C. & Scott A., 1903; *Asterocheres minutus* (Claus, 1889); *Asterocheres mucronipes* Stock, 1960; *Asterocheres neptunei* Johnsson en: Johnsson, Rocha & Neves, 2002; *Asterocheres orientalis* Sewell, 1949; *Asterocheres ovalis* Sewell, 1949; *Asterocheres paraboecki* Johnsson, 1998; *Asterocheres parvus* Giesbrecht, 1899; *Asterocheres picinguabensis* Johnsson en: Johnsson, Rocha & Neves, 2002; *Asterocheres pilosus* Kim I.H., 2004 *Asterocheres proboscideus* Stock, 1966; *Asterocheres reginae* Boxshall & Huys, 1994; *Asterocheres renaudi* Canu, 1892; *Asterocheres rotundus* Malt, 1991; *Asterocheres ruber* Stock, 1966; *Asterocheres scutatus* Stock, 1966; *Asterocheres simplex* Schirl, 1973; *Asterocheres similans* Stock, 1966; *Asterocheres simulans* (T. Scott, 1898); *Asterocheres siphonatus* Giesbrecht, 1897; *Asterocheres spinopaulus* Johnsson, 1998; *Asterocheres spinulosus* Murnane, 1969; *Asterocheres spongus* Johnsson, 2002; *Asterocheres stimulans* Giesbrecht, 1897; *Asterocheres stocki* Nair & Pillai, 1984; *Asterocheres suberitis* Giesbrecht, 1897; *Asterocheres suberitis antarctica* Scott, T., 1912; *Asterocheres tenerus* (Hansen, 1923); *Asterocheres tenuicornis* Brady, 1910; *Asterocheres tetrasetosus* Johnsson, 1998; *Asterocheres tubiporae* Kim I.H., 2004; *Asterocheres uncinatus* (Kritchagin, 1873); *Asterocheres unicus* Johnsson en: Johnsson, Rocha & Neves, 2002; *Asterocheres urabensis* Kim I.H., 2004; *Asterocheres ventricosus* (Brian, 1928); *Asterocheres violaceus* (Claus, 1889) y *Asterocheres walteri* Kim I.H., 2004 (Walter & Boxshall, 2004). Hay que puntualizar que las descripciones de dos de estas especies *A. mainensis* Murnane, 1969 y *A. spinulosus* Murnane, 1969, no han sido nunca publicadas y que otras dos, *A. ruber* Stock, 1966 y *A. similans* Stock, 1966, se consideraron como *nomina nuda* a partir de Johnsson, 1998.

A este listado habría, además, que añadir una especie, *Asterocheres serrulatus* (Humes, 1996), que fue originalmente descrita por Humes (1996) como un género nuevo, *Madacheres* Humes, 1996 para ser éste, posteriormente sinonimizado con *Asterocheres* por Ivanenko (1998).

A partir de este año, 2004, y hasta la actualidad el número de especies descritas para este género se han incrementado en más de un 25%. Así, en los años 2005 y 2006 se describieron cuatro especies nuevas de *Asterocheres,* dos por cada año: *Asterocheres brevisurculus* Kim I.H., 2005 y *Asterocheres hirsutus* Bandera, Conradi & López-González, 2005 en el año 2005 y *Asterocheres astroidicola* Conradi, Bandera & López-González, 2006 y *Asterocheres bimbarrensis* Bispo, Johnsson & Neves, 2006 en el 2006 (Kim, 2005; Bandera, Conradi & López-González, 2005; Conradi, Bandera &

López-González, 2006; Johnsson & Neves, 2006). En el siguiente año, 2007, se describieron tres especies nuevas: *Asterocheres espinosai* Varela, Ortiz & Lalana, 2007, *Asterocheres garridoi* Varela, Ortiz & Lalana, 2007 y *Asterocheres madeirensis* Bandera, Conradi & López-González, 2007 (Varela, Ortiz & Lalana, 2007a, 2007b; Bandera, Conradi & López-González, 2007).

Aunque en el año 2008 no se describió ninguna especie nueva de *Asterocheres*, se estableció un nuevo género, *Stockmyzon* Bandera & Huys, 2008 para acomodar a *Asterocheres mucronipes* Stock, 1960, por lo que obviamente esta especie dejaba de formar parte del género *Asterocheres* pasando a llamarse *Stockmyzon mucronipes* (Stock, 1960) (Bandera & Huys, 2008). De hecho, cuando Stock describió su nueva especie *A. mucronipes*, expresó algunas reservas acerca de su asignación al género *Asterocheres*. El propio Stock reconocía que aunque había una similitud superficial en el prosoma ensanchado con algunas otras especies de *Asterocheres* como *A. lilljeborgii* Boeck, 1859 y *A. ovalis* Sewell, 1949, su nueva especie, *A. mucronipes*, mostraba otros caracteres distintos y potencialmente de "valor genérico". Concretamente, Stock (1960) mencionó el característico proceso espinoso de los endópodos de las cuatro primaras patas, la inusual armadura de la cuarta pata (el segmento proximal del exópodo presenta una seta externa), el "bi-articulado" estilete mandibular, y la presencia de solo dos setas, en vez de cuatro, en el palpo maxilular, una de las cuales era típicamente gruesa (de "aspecto inflado" según Stock). Este autor también observó que el macho de *Asterocheres stimulans* Giesbrecht, 1897 presentaba un proceso espinoso en las cuatro primeras patas similar al de su nueva especie y que el palpo maxilular de *Asterocheres canui* Giesbrecht, 1897 mostraba un estado transitorio entre la condición típica de los *Asterocheres* y la que tenía *A. mucronipes*. Todas estas razones fueron las que llevaron a Stock a considerar *A. mucronipes* perteneciente al género *Asterocheres*. Sin embargo, la nueva interpretación de las ilustraciones del macho de *A. stimulans* de Giesbrecht (1899) realizadas por Bandera y Huys (2008), reveló que el ejemplar macho descrito por Giesbrecht como *A. stimulans* era co-específico de *A. mucronipes*. Además, estos autores también demostraron que la maxílula del ejemplar descrito por Canu (1892) como *A. canui* Giesbrecht, 1897 ((=*A. lilljeborgii sensu* Canu (1892); cf. Giesbrecht (1897:11)), con un palpo sin atrofiar y sin engrosamiento de la seta lateral, la cual además no era excesivamente plumosa, ni estaba típicamente recurvada y oculta bajo el endito de la gnatobase, no coincidía con la que presentaba *A. mucronipes*.

Según Bandera y Huys (2008), una de las autoapomorfías del género *Stockmyzon* es el anillamiento del estilete de la mandíbula, puesto que, si bien algunas especies de *Asterocheres* podían presentar un estrechamiento de la cutícula del estilete hacia la mitad de su longitud, nunca presentaban una fuerte anillación. La única vez que se documentó esta anillación en el género *Asterocheres* fue en la descripción de *Asterocheres crenulatus* Johnsson, 1998, sin embargo, el posterior examen de una hembra paratipo de esta especie (NHM reg. No. 1997.185) reveló que Johnsson había cometido un error de observación y que el estilete de *A. crenulatus* carecía de dicha segmentación o anillamiento (Bandera & Huys, 2008). Otras características del género *Stockmyzon* son: la marcada disparidad de tamaño entre el lóbulo interno y el externo de la maxílula y el atrofiado palpo con dos o tres pequeñas setas además de la seta lateral que es grande y densamente plumosa. Según Bandera y Huys (2008), el único género dentro de la familia Asterocheridae, que presenta una característica similar es *Acontiophorus* Brady, 1880, género que representa un linaje completamente distinto en la familia, desviándose de todos los demás en la morfología de la anténula, antena y mandíbula.

Dos fueron las características consideradas por Bandera y Huys (*op. cit.*) como las más relevantes del género *Stockmyzon*: la primera fue la fórmula de la armadura de las patas natatorias que eran similares a las que presentan las especies de *Asterocheres,* excepto por el primer segmento del exópodo de la cuarta pata que posee una seta externa en vez de una espina externa. Esta transfomación fue considerada por Bandera y Huys (2008) como una apomorfía única dentro de la familia Asterocheridae. De la misma manera, Kim en 2004 sugirió que dos especies de

Asterocheres, *A. crenulatus* Johnsson, 1998 y *A. spinopaulus* Johnsson, 1998, ambas con una transfomación similar pero en el basis de la primera pata (una seta reemplazada por una espina), deberían ser trasladadas (junto con otras tres especies descritas por Johnsson en 1998: *A. abrolhensis*, *A. paraboecki* y *A. tetrasetosus*) a un género distinto de *Asterocheres* (Kim, 2004b; Bandera & Huys, 2008). La segunda característica fue la presencia de un gran proceso espinoso en forma de pico en los segmentos de los endópodos de las cuatro primeras patas. Este carácter también se había observado en algunos géneros asignados a la familia Coralliomyzontidae que también utilizaban escleractinias como hospedadores como por ejemplo *Coralliomyzon tenens* Humes & Stock, 1991 (Humes & Stock, 1991; Humes, 1997b), así como en una especie del género *Asterocheres*, *A. tubiporae* Kim, 2004. En este mismo trabajo Bandera y Huys (2008) también describieron otra especie del género *Stockmyzon*, *Stockmyzon crassus* Bandera & Huys, 2008, anteriormente confundida por el propio Stock (1966b) con *A. mucronipes*. Las diferencias que estos dos autores establecieron entre *S. crassus* con respecto a *S. mucronipes* fueron las siguientes: (1) escamas epicuticulares del somito doble genital y de los somitos abdominales libres más grandes; (2) el somito doble genital es más estrecho y menos expandido lateralmente; (3) todas las setas de las anténulas son lisas; (4) el sifón es ligeramente más corto; (5) el palpo de la maxílula presenta una seta alargada y muy plumosa y sólo dos setas cortas pinnadas; (6) apéndices menos ornamentados en general y (7) las setas y procesos espinosos de las patas tienen distinta longitud, siendo generalmente más cortos que en *S. mucronipes* (Bandera & Huys, 2008).

Aunque en el año 2009 no se describió ninguna especie para el género *Asterocheres*, se redescribieron un total de 13 especies con material depositado en distintos museos. Estas especies fueron: *A. bulbosus* Malt, 1991, *A. ellisi* Hamond, 1968, *A. hongkongensis* Malt, 1991, *A. indicus* Sewell, 1949, *A. ovalis* Sewell, 1949, *A. rotundus*, Malt, 1991, *A. echinicola* (Norman, 1968), *A. latus* (Brady, 1872), *A. kervillei* Canu, 1898, *A. abyssi* (Hansen, 1923), *A. intermedius* (Hansen, 1923), *A. suberitis* Giesbrecht, 1897 y *A. tenerus* (Hansen, 1923) (Bandera & Conradi, 2009a,b,c). Otras especies, como por ejemplo *A. micheli* Gurney, 1927, no pudieron ser redescritas por falta de material ya que según Bandera y Conradi (2009b), el material considerado por el Museo de Historia Natural de Londres (NHM) como material tipo de Gurney para esta especie (este autor no mencionó en su publicación de 1927 donde depositó el material tipo de *A. micheli*) resultó ser un copépodo harpacticoide , por lo que el material tipo de *A. micheli* debe ser considerado como "perdido" y la especie no puede ser redescrita al no haberse encontrado otra vez desde su descripción original (Bandera & Conradi, 2009b). En el mismo año, los mismos autores también encontraron dificultades para redescribir la especie *A.abyssi* (Hansen, 1923) puesto que aunque el material depositado en el Museo Zoológico de la Universidad de Copenague (ZMUC) sí correspondía a dicha especie, el ejemplar estaba seriamente dañado (Bandera & Conradi, 2009a). La descripción original de Hansen (1923) se basó en un individuo macho dañado y el examen del espécimen realizado más de 80 años después no arrojó ninguna información taxonómica útil debido a las malas condiciones en las que se encontraba el ejemplar (Bandera & Conradi, 2009a). Sólo tres descripciones de las especies del género *Asterocheres* (*A. abyssi*, *A. ovalis* y *A. alter*) están basadas en machos, las restantes descripciones se basan en ejemplares hembras, y además, en más de un tercio de las especies de este género el macho es desconocido. A pesar de que todas las características nombradas por Hansen fueron confirmadas por Bandera y Conradi (2009a), éstas no eran suficientes para distinguir a esta especie de sus congéneres y por ello a partir de esta fecha, *A. abyssi* es considerada como un taxón indeterminado (Bandera & Conradi, 2009a; Kim, 2010). En la redescripción de *A. intermedius* (Hansen, 1923) sólo se pudieron detallar los apéndices pre-orales ya que el holotipo diseccionado y depositado en el Museo Zoológico de la Universidad de Copenague (ZMUC) estaba muy dañado. A pesar de ello, algunas características como la longitud del sifón y del somito doble genital, servían para separar a esta especie de sus congéneres, si bien, tal y como apuntan Bandera y Conradi (2009a), convendría realizar una descripción detallada cuando esta especie vuelva a ser encontrada. Estos autores también redescribieron la especie *A.*

suberitis y confirmaron las diferencias que T. Scott encontró en 1903 entre sus ejemplares recogidos en la Bahía de Escocia (Orcadas del Sur, Antártida), nombrados como *Asterocheres suberitis antárctica*, y los ejemplares de *A. suberitis* recogidos en el Golfo de Nápoles y descritos por Giesbrecht en 1897. Estas diferencias podrían elevarse a nivel de especie, no de subespecie, sin embargo, Bandera y Conradi no elevaron esta subespecie de categoría puesto que el material recogido por T. Scott en la Antártida ya no existe y consideraron más prudente posponer el establecimiento de una nueva especie hasta que se vuelvan a recolectar más ejemplares (Bandera & Conradi, 2009a).

La redescripción de *A. echinicola* y *A. latus* realizada por Bandera y Conradi (2009c), llevó a cambios importantes en el género *Asterocheres*. En su estudio, los autores revelaron la gran confusión que hasta entonces había existido entre la especie *A. echinicola*, descrita por Norman en 1868 como *Ascomyzon echinicola* y las especies descritas como *Cyclopicera lata* Brady, 1872, *A. suberitis* Giesbrecht, 1897, *A. kervillei* Canu, 1898 y *A. parvus* Giesbrecht, 1897 (*A. parvum sensu* Sars, 1915) (Norman, 1868; Brady, 1872, 1880; Giesbrecht, 1897; Canu, 1898; Sars, 1915; Stock, 1967; Hamond, 1968). Todas estas dificultades para distinguir *A. echinicola* de sus congéneres se debían a las deficiencias en su descripción original que era muy concisa y carecía de ilustraciones, por lo tanto Bandera y Conradi acometieron el estudio de la especie tipo de Norman para resolver los problemas taxonómicos que esta especie había creado en el género. Aunque Norman (1968) no había designado ningún holotipo para esta especie, los sintipos de *A. echinicola* están depositados en el NHM. Bandera y Conradi (2009c) constataron que, si bien estos especímenes pertenecían a la misma especie, claramente reconocibles por su corta anténula, el extremadamente corto sifón, su característica maxílula y el extremo redondeado del exópodo de la quinta pata, estas características no coincidían con los caracteres diagnósticos con los que Norman definió a *A. echinicola* sino que correspondían a los de otra especie conocida y descrita por Claus, *Asterocheres violaceus* (Claus, 1889). Como todas las características proporcionadas por Norman cuando describió *A. echinicola* se cumplen en *A. violaceus*, a excepción de la longitud de las ramas caudales, Bandera y Conradi (2009c) supusieron que la confusión entre ambas especies vino después, cuando Brady consideró que la especie tipo que Norman le había prestado para su estudio era idéntica a *Cyclopicera lata* (Brady, 1880). Estos autores consideraron muy probable que Norman hubiera mezclado las dos especies, ya que las muestras de *Asterocheres* recogidas más tarde por él y etiquetadas como *A. echinicola*, sí tienen las características diagnósticas que definen a esta especie. Por lo tanto, y puesto que los sintipos tienen las características de *A. violaceus*, Bandera y Conradi (2009c) consideraron que esta última especie es sinónima de *A. echinicola*, y que los especímenes descritos por Brady como *Cyclopicera lata*, son en realidad una especie distinta de *A. echinicola* (=*A. violaceus*). Aunque Brady no designó ningún holotipo, estos autores consideraron que su ilustración del urosoma de *Cyclopicera lata* no arrojaba ninguna duda de que se trataba de la misma especie que Sars llamó *Ascomyzon parvum* en 1915 y Giesbrecht identificó como *Asterocheres echinicola* en 1899. Además, este estudio también estableció que los especímenes que Sars (1915) declaró ser idénticos a *Cyclopicera lata* y describió como *Ascomyzon latum* eran también una especie diferente de *A. echinicola* (=*A. violaceus*) y de *Cyclopicera lata*. El nombre que Bandera y Conradi (2009c) impusieron a esta especie, dado que *Cyclopicera lata* fue nombrada, por prioridad y a partir de 2009 en adelante, como *Asterocheres latus* (Brady, 1872) (= *Cyclopicera lata* de Brady, *Ascomyzon parvum* de Sars y *Asterocheres echinicola* de Giesbrecht) fue *Asterocheres sarsi* y fue descrita por estos mismos autores en el año 2014 (Bandera & Conradi, 2014). Por último, la publicación de Bandera y Conradi (2009c) también restableció la validez de la especie *Asterocheres kervillei*, especie que fue sinonimizada con *A. latus*, aunque con ciertas reservas por parte de Giesbrecht (1899) y sin ninguna duda por parte de Stock (1967). Los especímenes recogidos en la costa de Tarifa (España) en 1991, asociados a la ascidia *Pseudodistoma lyrnusense* Pérès, 1952, el material depositado en el NHM (recogido en Norfolk por D. Hamond en 1988) junto con la redescripción de *A. latus* establecieron que las principales diferencias entre *A. kervillei* y *A. latus* eran: (1) el tamaño y la forma del cuerpo; (2) la ornamentación del urosoma; (3) la longitud de las ramas caudales;

(4) el patrón de fusión de los segmentos de la anténula; (5) la longitud del sifón y (6) la armadura del área genital. Por lo tanto, aunque estas dos especies fueron consideradas sinónimas durante más de 40 años, las diferencias encontradas entre ambas fueron suficientes para considerarlas como especies distintas.

En el año 2010 se describieron un total de 18 especies nuevas para el género *Asterocheres*: *Asterocheres antillensis* Varela, 2010, *Asterocheres bahamensis* Kim I.H., 2010, *Asterocheres cubensis* Varela, 2010, *Asterocheres faroensis* Crescenti, Baviera & Zaccone, 2010, *Asterocheres fastigatus* Kim I.H., 2010, *Asterocheres fernandezmilerai* Varela, 2010, *Asterocheres galeatus* Kim I.H., 2010, *Asterocheres indivisus* Kim I.H., 2010, *Asterocheres nudicoxus* Kim I.H., 2010, *Asterocheres oricurvus* Kim I.H., 2010, *Asterocheres peniculatus* Kim I.H., 2010, *Asterocheres planus* Kim I.H., 2010, *Asterocheres plumosus* Kim I.H., 2010, *Asterocheres sensilis* Kim I.H., 2010, *Asterocheres tenuipes* Kim I.H., 2010, *Asterocheres tricuspis* Kim I.H., 2010, *Asterocheres trisetatus* Kim I.H., 2010 y *Asterocheres unioviger* Kim I.H., 2010 (Varela, 2010a,b; Crescenti *et al.*, 2010; Kim, 2010). Además, Kim (2010) redescribió dos especies: *A. crinoidicola* Humes, 2000 y *A. genodon* Stock, 1966 y enmendó la diagnosis del género siendo muy estricto con la fórmula de la armadura de las cuatro primeras patas. Esta nueva diagnosis del género estableció que las 72 especies nominales de *Asterocheres* se distribuían en: especies válidas, que cumplían con las características expuestas en la nueva descripción del género, especies incompletamente descritas, y por lo tanto difícilmente comparables con sus congéneres, y especies *inquerendae*, que no podían ser consideradas como *Asterocheres* ya que no mostraban las características definidas del género. El grupo de especies válidas estaba formado por 45 especies más las 14 especies que él mismo describió en esta publicación. Entre las especies incompletamente descritas podemos encontrar a *A. abyssi, A. alter, A. bacescui, A. garridoi, A. indicus, A. intermedius, A. major, A. manaarensis, A. micheli, A. minor, A. orientalis, A. ovalis, A. parvus, A. renaudi* y *A. uncinatus* (=*Ascomyzon carausi* Marcus & Por, 1960). En las descripciones originales de estas especies, y en registros posteriores, se aporta una información taxonómica muy limitada (principalmente en la morfología de las piezas bucales y la armadura de las patas), por lo que apenas se pueden comparar con sus congéneres. En el grupo de especies *inquerendae* se incluían *A. abrolhensis, A. aplysinus, A. bimbarrensis, A. crenulatus, A. longisetosus, A. lunatus, A. paraboecki, A. picinguabensis, A. spinopaulus, A. spongus, A. tetrasetosus* y *A. unicus*. Kim (2010) explicó que estas especies no pueden ser reconocidas como miembros de *Asterocheres* y que necesitan volver a ser examinadas para concretar detalles morfológicos antes de determinar su posición genérica. También señaló que es imposible situarlas en alguno de los géneros conocidos de Asterocheridae por las siguientes razones: (1) el basis de la primera pata se describió con una espina interna en vez de una seta en *abrolhensis, crenulatus, paraboecki, spinopaulus, tetrasetosus, spongus* y *bimbarrensis*; (2) el tercer segmento del exópodo de la segunda pata fue descrito con tres espinas y cinco setas (II,I,5) en vez de (III,I,4) en *lunatus, paraboecki, spinopaulus, tetrasetosus* y *aplysinus*; (3) el tercer segmento del exópodo de la tercera pata se describió con tres espinas y cinco setas (II,I,5) en vez de (III,I,4) en *abrolhensis, paraboecki, spinopaulus, tetrasetosus* y *unicus*; (4) el tercer segmento del endópodo de la tercera pata se describió con seis setas (1,2,3) en vez de (1,1+I,3) en *longisetosus, abrolhensis, lunatus, paraboecki, spinopaulus, tetrasetosus, picinguabensis, unicus* y *aplysinus*; (5) el tercer segmento del exópodo de la cuarta pata se describió con tres espinas y cinco setas (II,I,5) en vez de (III,I,4) en *abrolhensis, paraboecki, spinopaulus, tetrasetosus* y *aplysinus*; (6) el tercer segmento del endópodo de la cuarta pata se describió con las siguientes armaduras (1,I+1,2) o (1,II,2) en vez de (1,1+I,2) en *tetrasetosus, unicus, aplysinus, spongus* y *bimbarrensis*. En ninguno de estos tres grupos de especies está incluida *A. espinosai*, descrita en el 2007, sin embargo debe ser añadida al grupo de especies *inquerendae*, ya que además de faltar detalles de ornamentación y armadura en las piezas bucales, la armadura de las patas no corresponde con la descrita en la nueva definición del género (Kim, 2010): (1) el basis de la primera pata presenta una espina interna; (2) el tercer segmento del endópodo de la segunda pata presenta (2,I,3) en vez de (1,2,3); (3) el tercer segmento del exópodo de la tercera pata presenta (IV,5) en vez de (III,I,4) (aunque en la ilustración sólo aparecen cuatro setas en vez de cinco); (4) el tercer segmento del endópodo de la tercera pata presenta (1,5) en vez de (1,1+I,3) (Varela *et al.*, 2007b). También es probable que los autores hayan confundido la segunda pata con la tercera, o viceversa, ya que los terceros segmentos de los endópodos de estas patas parecen estar intercambiados. En cualquier caso, la descripción debe ser revisada, completando la armadura de las piezas bucales, especialmente la del maxilípedo, y cerciorándose de que la espina interna del basis de la primera pata no es en realidad una seta.

En el año 2011 se describe una especie nueva, *Asterocheres tarifensis* Conradi & Bandera, 2011, y se redescriben *Asterocheres minutus* (Claus, 1889) y *Asterocheres siphonatus* Giesbrecht, 1897 (Conradi & Bandera, 2011). Al año siguiente, 2012, se describen tres especies más del género *Asterocheres*: *Asterocheres humesi* Varela, 2012, *Asterocheres kimi* Varela, 2012 y *Asterocheres siphunculus* Bahia *et al.*, 2012 (Varela, 2012; Bahia *et al.*, 2012). Durante el año 2013 se describen *Asterocheres spinosus* Kim I.H. & Min, 2013, *Asterocheres rai* Kim I.H. & Min, 2013, *Asterocheres hoi* Bandera & Conradi, 2013 y se renombra a *A. stocki* Varela, 2012 como *Asterocheres lalanai* Varela, 2013 (Kim & Min, 2013; Bandera & Conradi, 2013; Varela, 2013). Esta última especie fue descrita en el año 2012 bajo el nombre de *A. stocki* Varela, 2012, sin embargo, y dado que este nombre ya existía con anterioridad para nombrar a una especie descrita por Nair & Pillai en 1984, Varela la renombra como *A. lalanai* en 2013 para solventar la homonimia, aplicando el Principio de Prioridad establecido en el Código Internacional de Nomenclatura Zoológica (Varela, 2013). Además, durante este año también se redescribieron las siguientes especies *A. genodon* Stock, 1966 (una pequeña enmienda hecha a la redescripción de Kim, 2010), *A. halichondriae* Stock, 1966, *A. maxillatus* Stock, 1987, *A. proboscideus* Stock, 1966 y *A. scutatus* Stock, 1966 (Bandera & Conradi, 2013).

En el año 2014 se describe la especie *Asterocheres eugenioi* Bandera & Conradi, 2014 y se redescriben *A. complexus* Stock, 1960 y *A. sarsi* Bandera & Conradi, 2009 que no fue descrita cuando fue nombrada en el año 2009 (Bandera & Conradi, 2014). *A. complexus* fue originalmente descrita por Giesbrecht (1899) bajo el nombre incorrecto de *A. boeckii* y posteriormente redescrita como *A. complexus* por Stock (1960). Este autor comparando la descripción de *A. boeckii* que hizo Sars (1915) con la descripción de los especímenes de Giesbrecht, sugirió que estos últimos podrían pertenecer a otra especie nórdica, *A. latum* (Brady). Las comparaciones entre el material de Stock (dos hembras recogidas en Cap Béar, costa mediterránea de Francia) y las figuras de *A. boeckii* y *A. latum* ilustradas por Sars, revelaron que los especímenes de Stock pertenecían a una especie distinta y no descrita. Esta nueva especie no fue propiamente descrita por Stock, puesto que este autor se basó en parte de las descripciones de *A. boecki* de Giesbrecht (habitus; Giesbrecht, 1899: Pl. 2, II), *A. latum* de Sars (anténula, maxila, maxilípedo y los exópodos de las cuatro primeras patas; Sars, 1915: Pl. LVI) y algunas ilustraciones que él mismo añadió (antena, maxílula, urosoma, exópodo de la primera pata y endópodo de la cuarta pata de la hembra y quinta pata del macho; Stock, 1960: Fig. 3). Los ejemplares de *Asterocheres eugenioi*, asociados a la esponja *Suberitis domuncula* y recogidos en Salcombe (Reino Unido) por Norman y Scott en 1903, fueron determinados erróneamente como *A. suberitis* Giesbrecht. Más tarde, Bandera y Conradi (2014) aclararon que estos especímenes no pertenecían a *A. suberitis* sino a una especie nueva que llamaron *A. eugenioi*. Por su parte, *Asterocheres sarsi* fue descrita por G.O. Sars (1915) como *Ascomyzon latum*, sin embargo, este autor también consideró a esta especie como sinónima de *Cyclopicera lata* (Brady). Bandera y Conradi (2009c), demostraron que la especie descrita como *Ascomyzon latum* era, en realidad, diferente a la especie *A. echinicola* (=*A. violaceus*) y *Cyclopicera lata*. Por lo tanto, estos autores redescribieron *C. lata* como *Asterocheres latus* y nombraron la especie que Sars describió bajo el nombre de *Ascomyzon latum* como *Asterocheres sarsi*.

Por último, en el año 2015, se redescriben las especies *A. corneliae* Schirl, 1973 y *A. boeckii* (Brady, 1880) (Bandera & Conradi, aceptado). En este mismo trabajo, y como consecuencia de la redescripción de *A. boeckii*, se propone un nuevo género para *A. fastigatus* Kim, 2010. Cuando Kim (*op. cit.*) describió esta especie, expresó algunas reservas sobre su asignación genérica y señaló tres caracteres como los más relevantes de esta especie: (1) la armadura del segundo segmento del endópodo de la cuarta pata es (0-1); (2) la coxa de la primera pata carece de seta interna y (3) la antena posee un exópodo muy alargado. Estas características son compartidas con algunas especies de *Asterocheres*, así, por ejemplo *A. trisetatus*, *A. eugenioi* y *A. sarsi*, al igual que *A. fastigatus*, comparten la ausencia de seta interna en la coxa de la primera pata, si bien, es verdad que ésta es la única característica que poseen estas cuatro especies en común (Kim, 2010). En este trabajo se afirmaba que sólo dos especies de *Asterocheres* presentaban la fórmula (0,1) en el segundo segmento del endópodo de la cuarta pata: *A. boeckii* (como fue ilustrada por Sars en 1915) y *A. fastigatus* y Kim aludió a esta característica para separar a ambas especies en un género independiente, pero la falta de similitudes significativas en otros caracteres lo disuadió de nombrar un nuevo género. Más tarde, la redescripción de *A. boeckii* reveló que la cuarta pata ilustrada por Sars en 1915 no era correcta y confirmó que el segundo segmento del endópodo de esta pata presentaba dos setas internas, como es usual en el género (Bandera & Conradi, aceptado), por lo que *A. fastigatus* era la única especie de *Asterocheres* con la fórmula (0,1) en el segundo segmento del endópodo de la cuarta pata. Bandera y Conradi (aceptado) mencionaron a dos géneros de la familia Asterocheridae con la misma fórmula en el segundo segmento del endópodo de la cuarta pata presente en *A. fastigatus*, *Hermacheres* Stock, 1987 y *Gomumucheres* Humes, 1996. Sin embargo, *Hermacheres*, caracterizado por varias reducciones apomóficas en la armadura de las cuatro primera patas, difiere de *A. fastigatus* en muchos otros caracteres como: (1) el diminuto exópodo de la antena, reducido a una yema; (2) la mandíbula con un estilete corto, algo ancho, sinuoso, ensanchado distalmente en una hoja dentada, y (3) el sifón en forma de barril carente de una parte distal en forma de tubo (características pertenecientes a *Hermacheres diploriae*, especie tipo; Stock, 1987). Respecto al género *Gomumucheres*, la fórmula (0,1) no sólo la presenta en la armadura del segundo segmento del exópodo de la cuarta pata, sino también en la tercera pata. Además, característicamente este género se distingue de otros incluidos en la familia

Asterocheridae en la fórmula 2,2,1,1 referente a las setas del lado interno de los segundos segmentos de los endópodos de las cuatro primeras patas (Humes, 1996a).

Aunque no fue observado por Kim (*op. cit.*), el exópodo alargado de la antena de *A. fastigatus* (más largo que la mitad de la longitud del primer segmento del endópodo) es similar al de *A. ellisi* (con una longitud seis veces mayor a su anchura), si bien estas dos especies son muy diferentes en cuanto a la segmentación de la antenúla de la hembra -17 segmentos en *A. fastigatus* y 21 segmentos en *A. ellisi*-, y la forma del cuerpo –con el prosoma muy grande y expandido y el urosoma pequeño en *A. fastigatus* y dorso-ventralmente aplanado en *A. ellisi*- (Hamond, 1968; Bandera & Conradi, 2009b; Kim, 2010). Es más, la antena de estas dos especies de *Asterocheres* es muy similar a las que presentan las especies del género *Stockmyzon,* que habían sido incluidas previamente en el género *Asteroheres*, así como a aquellas del género *Orecturus* Humes, 1992; sin embargo, estas especies no comparten otras características relevantes (Humes, 1992: Fig. 9C; Bandera & Huys, 2008).

Curiosamente, Kim (2010) no destacó la llamativa segmentación de la anténula de *A. fastigatus*, puesto que como muy bien apunta este autor, el número básico de segmentos en las anténulas de las hembras de *Asterocheres* es 21 y la reducción de los segmentos antenulares ocurren principalmente en su parte distal. La primera fusión de segmentos de la anténula en especies pertenecientes al género *Asterocheres* se da típicamente en el segmento 9(IX-XII) que normalmente lleva siete u ocho setas siendo muy poco común que se den fusiones de segmentos anteriores al noveno, si bien éstas son frecuentes, e incluso características, en otros géneros de la familia Asterocheridae como por ejemplo *Acontiophorus* Brady, 1880 (Brady, 1880: Plate XC, Fig. 2) (Bandera & Conradi, aceptado). El reducido número de segmentos de la anténula de *A. fastigatus* con respecto al resto de *Asterocheres* se debe a que presenta tres fusiones de segmentos anteriores al noveno: el segundo segmento con tres setas, el tercero con ocho setas y el quinto con seis setas. Esta especie no es la única del género que presenta fusiones de segmentos antenulares anteriores al noveno puesto que *A. bahamensis* Kim, 2010 posee 4 setas en el segundo segmento de la anténula (Bandera & Conradi, aceptado). Sin embargo, en este último caso, el segundo segmento antenular muestra un vestigio de articulación en el lado anterior (véase Kim, 2010: Fig. 9E), por lo que no es una fusión completa. Por tanto, *A. fastigatus* es la única especie del género *Asterocheres* con tres reducciones claras y completas de segmentos anteriores al noveno, mostrando un total de siete fusiones de segmentos a lo largo de la anténula: 1(I)-2, 2(II-III)-3, 3(IV-VII)-8, 4(VIII)-2, 5(IX-XI)-6, 6(XII)-2, 7(XIII)-2, 8(XIV)-2, 9(XV)-2, 10(XVI)-2, 11(XVII)-2, 12(XVIII)-2, 13(XIX)-2, 14(XX-XXI)-2+estetasco, 15(XXII-XXIII)-2, 16(XXIV-XXV)-4 y 17(XXVI-XXVIII)-7. Esta característica, junto con las tres mencionadas anteriormente llevaron a Bandera y Conradi (aceptado) a nombrar un nuevo género, *Kimcheres* Bandera & Conradi, para incluir a *Asterocheres fastigatus* a pesar de que esta especie presenta algunas características como la mandíbula, maxílula, maxila, maxilípedo y quinta pata, que recuerdan a *Asterocheres*.

Bandera y Conradi (aceptado) también estudiaron la posición taxonómica de *Asterocheres longisetosus* Nair & Pillai, 1984, que había sido incluida por Kim (2010) en el grupo de especies *inquerendae*. Esta especie fue descrita a partir de 5 ejemplares hembra asociados a *Porites convexa* (Dana) en Chetlat Island, Mar de Arabia (Nair & Pillai, 1984). Desafortunadamente, los especímenes depositados en el Indian Museum (Calcuta) se han perdido, y como esta especie no ha vuelto a ser recogida, no hay material disponible para estudiarlo. La posición *inquerenda* de esta especie se basó en la anómala setación del tercer segmento del endópodo de la tercera pata que fue originalmente descrito con la fórmula (1,2,3) en vez de (1,1+I,3) característica de *Asterocheres* (Kim, 2010). Sin embargo, esta no es la única característica exhibida por esta especie que no se corresponde con la definición del género *Asterocheres* puesto que Bandera y Conradi (aceptado) apuntan otras cinco que, junto con la propuesta por Kim (2010), sirven para separar esta especie de *Asterocheres*: (1) el estetasco situado en el segmento apical en la anténula de la hembra; (2) el palpo mandibular presenta tres setas terminales; (3) la setación del tercer segmento del exópodo de la cuarta pata fue descrito con la armadura (III,I,3) en vez de (III,I,4); (4) el segmento libre de la quinta pata tiene dos setas largas y dos espinas cortas; (5) el basis de la primera pata muestra un proceso interno distal en forma de lóbulo que sobresale (véase Nair & Pillai, 1984: Figs. 22, 24, 28, 30 y 32).

La familia Asterocheridae típicamente posee anténulas con seis a 21 segmentos en la hembra y un único y largo estetasco en el segmento homólogo con el segmento ancestral XXI, es decir el pre-antepenúltimo, antepenúltimo, penúltimo, o, raramente, el segmento terminal (Boxshall & Halsey, 2004). Sólo cuatro géneros en la familia Asterocheridae, *Onychocheres* Stock & Gooding, 1986, *Asterocheroides* Malt, 1991, *Siphonopontius* Malt, 1991 y *Cephalocheres* Kim, 2010, presentan el estetasco en el segmento terminal de la anténula. Estos géneros presentan, además, un característico segmento terminal alargado (véase Stock & Gooding, 1986: Fig. 11; Malt, 1991: Figs. 7K y 9C; Kim, 2010: Fig. 110C). Según apuntan Bandera y Conradi (aceptado) los segmentos de las anténulas de *Asterocheres*, del primero al décimo son cortos y anchos, y largos y estrechos del 11 al 21, los segmentos compuestos son más largos que los segmentos simples y el estetasco presente en el segmento XXI es retenido en la mayoría de las especies. Estos autores, tomando como modelo el patrón de fusión del género *Onychocheres* (Stock & Gooding, 1986: Fig. 11) observaron como el segmento compuesto 18(XXI-XXVIII) retenía todas las setas pertenecientes a los segmentos ancestrales XXI-2, XXII-1, XXIII-1, XXIV-2, XXV-2, XXVI-2, XXVII-2 y XXVIII-4 y el estetasco perteneciente al segmento ancestral XXI. Este segmento era lo suficientemente largo para contener todas las setas y estetasco que llevan los segmentos ancestrales XXI a XXVIII, de ahí su longitud característica. Sin embargo, *A. longisetosus* presentaba el último segmento antenular corto y sus cuatro últimos segmentos tenían una gran similitud con aquellos últimos segmentos característicos de las anténulas que poseen 21 segmentos. Ademas, en *A. longisetosus* la armadura de las anténulas en el texto no corresponde con la presentada en la ilustración (aunque Nair

& Pillai describieron e ilustraron la anténula con 20 segmentos, solo proporcionaron la armadura de 19 segmentos) (Nair & Pillai, 1984) y esta armadura difícilmente se corresponde con la estructura básica de la anténula de una hembra de copépodo propuesta por Huys & Boxshall en 1991 (Huys & Boxshall, 1991: Fig. 1.5.1).

Las anténulas no son el único apéndice que necesita redescripción ya que *A. longisetosus* presenta tres setas en el palpo mandibular lo que no coincidía con las dos setas características de la nueva diagnosis del género *Asterocheres* (Kim, 2010) ni con la máxima setación que un copépodo sifonostomatoide puede llevar en el ápice del palpo mandibular (Huys & Boxshall, 1991), lo que sugiere que Nair y Pillai (1984) han incluido erróneamente una seta extra en el palpo mandibular (Bandera & Conradi, aceptado). Otra característica inusual de *A. longisetosus* es la fórmula del segmento libre de la quinta pata con dos setas largas y dos espinas muy cortas, mientras que Asterocheres presenta típicamente tres setas, una de las cuales normalmente es pequeña u obsoleta (Kim, 2010). Esta combinación de setas y espinas, aunque no concuerda con la definida en *Asterocheres*, se puede observar en otros géneros de la familia Asterocheridae como por ejemplo *Orecturus* Humes, 1992 (Bandera & Conradi, aceptado). Por todo ello, Bandera y Conradi (aceptado) concluyeron que aunque *A. longisetosus* comparte algunas características con las especies incluidas en *Asterocheres* (la forma del cuerpo, la antena con un exópodo unisegmentado y un endópodo con tres segmentos, la segmentación y forma de la maxílula, la maxila y el maxilípedo), las diferencias presentadas en los caracteres mencionados anteriormente serían suficiente para separar a esta especie del género *Asterocheres*. Sin embargo, dadas las grandes dudas que estos autores manifestaron sobre la validez de la descripción original de *A. longisetosus* para la anténula y mandíbula junto con la imposibilidad de redescribir la especie, no sólo del holotipo, que está perdido, sino de material nuevo (esta especie no ha sido recogida desde su descripción original), los disuadió de nombrar un género nuevo para incluir a esta especie, quedando en el grupo de especies *inquerendae* (Bandera & Conradi, aceptado).

Por todo lo comentado anteriormente, en la presente memoria se considerará que el género *Asterocheres* consta de un total de 68 especies válidas, 17 que necesitan ser redescritas y 15 *inquerendae* (Tabla 6).

Aunque ya se han comentado las modificaciones realizadas al listado de especies válidas del género *Asterocheres* presentado por Kim en 2010, quedan por explicar los cambios que se han realizado en esta memoria respecto a las especies consideradas como descritas incompletamente o aquellas contempladas como *inquerendae* por este autor. Concretamente, a la lista de especies incompletas propuestas por Kim se han añadido dos especies más, *A. canui* y *A. ventricosus*. Giesbrecht en 1897 nombra a *A. canui* para designar a un especimen que Canu (1892) había identificado erróneamente como *A. lilljeborgii* Boeck, 1859 (basándose en un macho que él mismo describe como mutilado y desprovisto de abdomen). Años más tarde, Sars (1915) corrobora la teoría de Giesbrecht y asegura que *Ascomyzon lilljeborgii* de Canu no es la misma especie que *Asterocheres lilljeborgii* de Boeck. Si bien la descripción e ilustraciones de las piezas bucales realizadas por Canu son muy completas, falta toda la información del abdomen y de las patas natatorias segunda a cuarta por lo que en la presente memoria se incluye esta especie entre las especies incompletamente descritas ya que no permite hacer comparaciones de confianza con el resto de especies de *Asterocheres*. La segunda especie, *A. ventricosus* fue pobremente descrita por Brian en 1927 como *Ascomyzon ventricosum* a partir de una única hembra recogida entre esponjas y algas en Capo Bove (Mar Egeo). La descripción carece de muchos detalles, así por ejemplo, la anténula presenta 20 segmentos pero no se ilustra ni se describe su armadura, en la ilustración de la antena no aparece el exópodo, no dice nada de la mandíbula, en los dibujos de las patas natatorias faltan setas y espinas y si los terceros segmentos de los endópodos de la tercera y cuarta patas están correctamente ilustrados, no concuerdan con la nueva diagnosis de Kim (2010) para el género. Además, Brian (1927) describe el segmento genital como "voluminoso y alargado" tanto que le confiere un aspecto característico a la especie y por eso la nombra "*ventricosum*". Sin embargo, el abdomen

Tabla 6: Clasificación actual de las especies del género *Asterocheres*

Especies válidas	Especies descritas incompletamente	Especies *inquerendae*
A. aesthetes Ho, 1984	*A. abyssi* (Hansen, 1923)	*A. abrolhensis* Johnsson, 1998
A. astroidicola Conradi, Bandera & López-González, 2006	*A. alter* Eiselt, 1965	*A. antillensis* Varela, 2010
A. bahamensis Kim, 2010	*A. bacescui* Marcus, 1965	*A. aplysinus* Johnsson, 2002
A. boeckii (Brady, 1880)	*A. canui* Giesbrecht, 1897	*A. bimbarrensis* Bispo, Johnsson & Neves, 2006
A. brevisurculus Kim, 2005	*A. garridoi* Varela, Ortiz & Lalana, 2007	*A. crenulatus* Johnsson, 1998
A. bulbosus Malt, 1991	*A. indicus* Sewell, 1949	*A. espinosai* Varela, Ortiz & Lalana, 2007
A. complexus Stock, 1960	*A. intermedius* (Hansen, 1923)	*A. longisetosus* Nair & Pillai, 1984
A. corneliae Schirl, 1973	*A. major* Thompson & Scott, 1903	*A. lunatus* Johnsson, 1998
A. crinoidicola Humes, 2000	*A. manaarensis* Thompson & Scott, 1903	*A. paraboecki* Johnsson, 1998
A. cubensis Varela, 2010	*A. micheli* (Gurney, 1927)	*A. picinguabensis* Johnsson, Rocha & Neves, 2001
A. dentatus Giesbrecht, 1897	*A. minor* Thompson & Scott, 1903	*A. spinopaulus* Johnsson, 1998
A. dysideae Humes, 1996	*A. orientalis* Sewell, 1949	*A. spongus* Johnsson, 2002 *A. tenerus* (Hansen, 1923)
A. echinicola (Norman, 1868)	*A. ovalis* Sewell, 1949	*A. tetrasetosus* Johnsson, 1998
A. ellisi Hamond, 1968	*A. parvus* Giesbrecht, 1897	*A. unicus* Johnsson, Rocha & Neves, 2001
A. enewetakensis Humes, 1997	*A. renaudi* Canu, 1892	
A. eugenioi Bandera & Conradi, 2014	*A. ventricosus* (Brian, 1927)	
A. faroensis Crescenti, Baviera & Zaccone, 2010	*A. uncinatus* (Kritchagin, 1873)	
A. fernandezmilerai Varela, 2010		
A. flustrae Ivanenko & Smurov, 1997		

Tabla 6 (Continuación)

Especies válidas	Especies descritas incompletamente	Especies *inquerendae*
A. galeatus Kim, 2010		
A. genodon Stock, 1966		
A. halichondriae Stock, 1966		
A. hirsutus Bandera, Conradi & López-González, 2005		
A. hoi Bandera & Conradi, 2013		
A. hongkongensis Malt, 1991		
A. humesi Varela, 2012		
A.indivisus Kim, 2010		
A.kervillei Canu, 1898		
A. jeanyeatmanae Yeatman, 1970		
A. kimi Varela, 2012		
A. lalanai Varela, 2013		
A. latus (Brady, 1872)		
A. lilljeborgii Boeck, 1859		
A. madeirensis Bandera, Conradi & López-González, 2007		
A. maxillatus Stock, 1987		
A.minutus (Claus, 1889)		
A. neptunei Johnsson, 2001		
A. nudicoxus Kim, 2010		
A. oricurvus Kim, 2010		
A. peniculatus Kim, 2010		
A. pilosus Kim, 2004		
A. planus Kim, 2010		
A. plumosus Kim, 2010		
A. proboscideus Stock, 1966		
A. rai Kim & Min, 2013		
A. reginae Boxshall & Huys, 1994		
A. rotundus Malt, 1991		
A. sarsi Bandera & Conradi, 2009		
A. scutatus Stock, 1966		
A. sensilis Kim, 2010		
A. serrulatus (Humes, 1995)		
A. siphonatus Giesbrecht, 1897		
A. siphunculus Bahia, Canário, Neves & Johnsson, 2012		
A. simplex Schirl, 1973		
A. simulans (T. Scott, 1898)		
A. spinosus Kim & Min, 2013		

Tabla 6 (Continuación)

Especies válidas	Especies descritas incompletamente	Especies *inquerendae*
A. stocki Nair & Pillai, 1984		
A. suberitis Giesbrecht, 1897		
A. tarifensis Conradi & Bandera, 2011		
A. tenuicornis Brady, 1910		
A. tenuipes Kim, 2010		
A. tricuspis Kim, 2010		
A. trisetatus Kim, 2010		
A. tubiporae Kim, 2004		
A. unioviger Kim, 2010		
A. urabensis Kim, 2010		
A. walteri Kim, 2004		

de esta especie es muy parecido al de *A. trisetatus* y, aunque en menor grado, al de *A. bahamensis*. Stock (1966b) en la discusión de su especie *A. scutatus*, ya apunta que la fórmula de las patas de *A. ventricosus* se desvía bastante de las restantes especies del género. Por lo tanto, y hasta que la especie vuelva a ser recogida para ser redescrita, consideramos que esta especie debe incluirse en el listado de especies descritas incompletamente.

Respecto al listado de especies *inquerendae* de Kim (2010), se le han añadido otras tres especies, *A. antillensis*, *A. espinosai* y *A. tenerus*. La inclusión de la primera especie en este listado es debida a la falta de correspondencia entre la fórmula de la armadura de las patas en el texto y en las ilustraciones de la descripción original (Varela, 2010b). En el texto la fórmula de la armadura de las patas es la habitual para el género *Asterocheres*, sin embargo, en las ilustraciones, las segunda y tercera patas presentan la fórmula (III,I,5) en el tercer segmento del exópodo, que no se correspondería con la descripción del género. Como el propio autor no recuerda si la fórmula correcta para esta especie es la del texto o la de la figura (Varela com. pers.), y dado que la política de préstamo del Acuario Nacionel de Cuba no permite el envío del holotipo al extranjero, *A. antillensis* será considerada como especie *inquerenda* en la presente memoria hasta que la especie sea revisada. De hecho, esta especie ya había sido tratada como *inquerenda* recientemente por otros autores (Bahía *et al.*, 2012). La segunda especie incluida, *A. espinosai* presenta una armadura en las patas inusual en el género *Asterocheres*. Así, por ejemplo, la presencia de una espina interna en el basis de la primera pata, las fórmulas del tercer segmento del endópodo de la segunda pata (2,I,3), del tercer segmento del exópodo de la tercera pata (IV,5) y del tercer segmento del endópodo de la misma pata (1,5) (Varela *et al.*, 2007b) hacen imposible la pertenencia de esta especie al género *Asterocheres*. En *Asterocheres tenerus*, descrita por Hansen en 1923 y más recientemente, tras el estudio del holotipo, redescrita por Bandera y Conradi (2009a), la fórmula de la armadura para el basis de la primera pata es (1-0) en vez de (1-1) como aparece en la diagnosis del género de Kim (2010). Aunque el resto de los rasgos que caracterizan a esta especie son los propios del género *Asterocheres,* la ausencia de seta interna en el basis de la primera pata hace imposible su permanencia en este género. Este carácter anómalo para el género *Asterocheres* no es compartido por ninguna de las especies incluidas en el listado de especies *inquerendae*.

El género *Asterocheres* es conocido como uno de los géneros más diversos de la familia Asterocheridae (Stock 1966a,b; Ho 1984; Humes 1996a; Ivanenko & Smurov 1997; Kim 2004a, 2005). Algunos autores, como Giebrecht (1899), han intentado agrupar las especies según la posesión de determinados caracteres. Así, por ejemplo, Giesbrecht (1899) en su Monografia del Golfo de Nápoles dividió al género, cuando solo contaba con 14 especies reconocidas, en cuatro grupos (a, b, c y d) según la longitud y forma del sifón, la armadura de las patas, la estructura de la primera maxila y el número de segmentos de la anténula del macho (Giesbrecht, 1899: pág. 99). Sin embargo, esta propuesta no tuvo mucho éxito y Stock (1966b) declaró que las especies descritas con posterioridad a 1899 eran difíciles de encajar en los grupos propuestos por Giesbrecht, sobretodo si se le añade la dificultad de que muchas de las descripciones realizadas carecen de ciertos detalles y que en la mayoría de las especies sólo se conoce un sexo, la hembra. En la presente memoria las especies se han agrupado en tres grandes grupos atendiendo al número de segmentos que presenta la anténula de la hembra: 19, 20 o 21 segmentos. A su vez, estos tres grupos se han subdividido atendiendo a la segmentación del palpo mandibular (Tabla 7).

El grupo de especies que presentan 19 segmentos en la anténula de la hembra (grupo 19) es el menos numeroso con un total de 16 especies (tabla 2). De entre estas especies únicamente cuatro, *A. brevisurculus*, *A. hongkongensis*, *A. kimi* y *A. scutatus*, poseen un palpo mandibular con un único segmento (subgrupo 19A) y sólo dos de ellas, *A. hongkongensis* y *A. kimi* muestran el cuerpo aplanado dorso-ventralmente (Bandera & Conradi, 2009b; Malt, 1991; Varela, 2012). Estas dos especies se diferencian en: (1) la antena es alargada y estilizada, con la seta apical menor que la mitad de la longitud de la garra en *A. kimi* mientras que es corta y robusta, con la seta apical mayor que la mitad de la longitud de la garra en *A. hongkongensis*; (2) la maxílula tiene cinco setas terminales en el lóbulo interno en *A. hongkongensis* y *A. kimi* sólo presenta cuatro; (3) la maxila tiene el borde de la garra con espínulas distales y una pequeña seta en *A. hongkongensis* y el borde liso en *A. kimi*; (4) el somito genital doble de la hembra es ligeramente más largo que ancho en *A. kimi* y en *A. hongkongensis* es ligeramente más ancho que largo; (5) el segmento libre de la quinta pata es rectangular en ambas especies, sin embargo, las setas terminales son muy cortas en *A. hongkongensis* (la seta más larga mide menos de la mitad de la longitud del propio segmento) y más largas en *A. kimi* (tan largas como el propio segmento); (6) las setas caudales son muy largas en *A. kimi* (más largas que el abdomen completo) y muy cortas en *A. hongkongensis* (escasamente más larga que la rama caudal), son las más cortas de todo el género (Bandera & Conradi, 2009b; Malt, 1991; Varela, 2012). Cuando Malt describió *A. hongkongensis* en 1991 asignó a la segunda pata la fórmula (1,1+I,3) para el tercer segmento del endópodo, en vez de (1,2,3). Esta fórmula para la armadura de la segunda pata no coincide con la definición del género. Tras un examen del holotipo en el NHM, se comprobó que Malt ilustró dos terceras patas en las figuras 4I y 4J (Malt, 1991). Por lo tanto la figura 4I, que en la leyenda corresponde a la segunda pata, es incorrecta. Una de las segundas patas está rota, pero en la otra se

Tabla 7: Grupos en los que se ha dividido las especies válidas del género *Asterocheres* en esta memoria.

Anténula con 19 segmentos	**Anténula con 20 segmentos**	**Anténula con 21 segmentos**
Palpo mandibular con 1 segmento (subgr. 19A)	**Palpo mandibular con 1 segmento (subgr. 20A)**	**Palpo mandibular con 1 segmento(subgr. 21A)**
A. brevisurculus	*A. aesthetes*	*A. corneliae*
A. hongkongensis	*A. bulbosus*	*A. echinicola*
A. kimi	*A. indivisus*	*A. faroensis*
A. scutatus	*A. planus*	*A. madeirensis*
Palpo mandibular con 2 segmentos (subgr. 19B)	*A. proboscideus*	*A. minutus*
A. bahamensis	*A. sensilis*	*A. nudicoxus*
A. cubensis	*A. spinosus*	*A. siphonatus*
A. dysideae	*A. stocki*	**Palpo mandibular con 2 segmentos (subgr. 21B)**
A. enewetakensis	*A. stimulans*	*A. astroidicola*
A. fernandezmilerai	**Palpo mandibular con 2 segmentos (subgr. 20B)**	*A. boeckii*
A. humesi	*A. crinoidicola*	*A. complexus*
A. pilosus	*A. dentatus*	*A. ellisi*
A. plumosus	*A. galeatus*	*A. eugenioi*
A. rotundus	*A. halichondriae*	*A. flustrae*
A. serrulatus	*A. lalanai*	*A. genodon*
A. unioviger	*A. maxillatus*	*A. hirsutus*
A. walteri	*A. neptunei*	*A. hoi*
	A. oricurvus	*A. jeanyeatmanae*
	A. rai	*A. kervillei*
	A. simplex	*A. latus*
	A. siphunculus	*A. lilljeborgii*
		A. peniculatus
		A. reginae
	A. tenuipes	*A. sarsi*
	A. tricuspis	*A. simulans*
	A. trisetatus	*A. suberitis*
		A. tarifensis
		A. tenerus
		A. tenuicornis
		A. tubiporae
		A. urabensis

puede observar que la fórmula para el tercer segmento del endópodo es (1, 2, 3). Esto fue pasado por alto en la redescripción de Bandera y Conradi en 2009.

Las otras dos especies que presentan 19 segmentos en la anténula de la hembra y un palpo mandibular con un único segmento (subgrupo 19A) son *A. brevisurculus* y *A. scutatus*, y aunque poseen un prosoma ancho, sus cuerpos no están aplanados dordo-ventralmente. La anchura del prosoma es mucho mayor en el caso de *A. scutatus*, y no solo es ancho el prosoma sino también el urosoma, sobretodo el somito genital doble que está expandido lateralmente (Bandera & Conradi, 2013; Kim, 2005; Stock, 1966a). Estas dos especies se pueden distinguir a simple vista por la forma del cuerpo, pero además presentan otras diferencias: (1) *A. brevisurculus* posee el estetasco de la anténula en el segmento 18 y en *A. scutatus* se encuentra en el 17; (2) el lóbulo interno de la maxílula presenta cinco setas terminales en *A. brevisurculus* y sólo cuatro setas en *A. scutatus*; (3) el sifón es más corto en *A. brevisurculus*; (4) el somito que lleva la segunda pata tiene los ángulos postero-laterales apuntados hacia atrás en *A. scutatus*; (5) el somito genital es casi dos veces más ancho que largo en *A. scutatus* y en *A. brevisurculus* es tan ancho como largo (Bandera & Conradi, 2013; Kim, 2005; Stock, 1966a).

Entre las 12 especies que poseen 19 segmentos en la anténula de la hembra y dos segmentos en el palpo mandibular (subgrupo 19B; tabla 2) sólo cuatro, *A. pilosus, A. plumosus, A. rotundus* y *A. unioviger,* no presentan el cuerpo aplanado dorso-ventralmente. De estas cuatro especies, las más parecidas son *A. pilosus* (recogida sobre *Eucidaris thouarsii* (Valenciennes) en la Costa Pacífica de Panamá) y *A. unioviger* (recogida sobre *Eucidaris tribuloides* (Lamarck) en Bahamas). Según Kim (2004a) estas dos especies de copépodos comparten importantes características: (1) una de las setas apicales del lóbulo externo de la maxílula es grande y unilateralmente plumosa, con largas sétulas "peludas"; (2) el maxilípedo porta una sétula pequeña en el margen interno del segundo segmento y (3) el tercer segmento del endópodo de la primera pata tiene una prolongación distal. Presumiblemente, *A. unioviger* y *A. pilosus* divergieron desde la formación del istmo de Panamá (alrededor de 300 millones de años) de un ancestro común que probablemente estaba asociado con un erizo de mar ancestral (Kim, 2004a). A pesar de la gran similitud existente entre estas dos especies de copépodos, se pueden distinguir en base a las siguientes diferencias: (1) el tamaño del cuerpo es ligeramente superior en *A. pilosus*; (2) el primer segmento antenular de *A. pilosus* está armado con una seta plumosa y una lisa y en *A. unioviger* presenta dos setas lisas; (3) *A. pilosus* no tiene seta interna en la coxa de la primera pata y en *A. unioviger* si está presente; (4) la esquina distal interna del basis de la segunda pata es redondeado en *A. pilosus* y angular en *A. unioviger*.

Las otras dos especies que presentan 19 segmentos en la anténula de la hembra, dos segmentos en el palpo mandibular (subgrupo 19B) y no presentan el cuerpo aplanado dorso-ventralmente son *A. plumosus* y *A. rotundus* y se diferencian en: (1) la anténula de *A. plumosus* tiene el estetasco en el segmento 18, en cambio, en *A. rotundus* aparece en el 17; (2) el exópodo de la antena es muy largo en *A. plumosus* (cinco veces más largo que ancho) con una seta terminal, una subterminal y una lateral, y la garra terminal del tercer segmento del endópodo es más corta que el primer segmento del endópodo. En *A. rotundus* el exópodo de la antena es corto y lleva dos setas terminales y la garra terminal del tercer segmento del endópodo es casi tan larga como el endópodo completo; (3) el lóbulo interno de la maxílula tiene cuatro setas en *A. rotundus* y cinco setas en *A. plumosus*; (4) el sifón es más largo en *A. rotundus*, ya que sobrepasa la inserción del maxilípedo y en *A. plumosus* apenas alcanza la inserción del maxilípedo; (5) el somito genital doble es más largo que ancho en *A. plumosus* y más ancho que largo en *A. rotundus* (Bandera & Conradi, 2009b; Malt, 1991; Kim, 2010).

De las ocho especies restantes del grupo con 19 segmentos en la anténula de la hembra, dos segmentos en el palpo mandibular (subgrupo 19B) y el cuerpo aplanado dorso-ventralmente, *A. serrulatus* es la que presenta mayor longitud del cono oral ya que éste alcanza el esclerito intercoxal del primer par de patas (Humes, 1996b). Además, esta especie se caracteriza por: (1) tener el cefalosoma más ancho que el resto de los somitos del metasoma y estar aplanado dorso-ventralmente; (2) el cefalotórax y los somitos pedígeros segundo y tercero tienen los márgenes laterales redondeados mientras que el cuarto somito pedígero tiene los márgenes en ángulo recto y se encuentra en parte solapado dorsalmente por el somito que le precede (forma corporal parecida a *A. reginae* y *A. galeatus* pero con distinto número de segmentos en la anténula); (3) las ramas caudales tienen un proceso triangular en los márgenes postero-ventrales; (4) los segmentos uno, tres, cuatro, seis y ocho de la anténula de la hembra tienen una seta con el extremo romo bifurcado; (5) la parte basal de la maxílula está extendida hacia el exterior en forma de lóbulo redondeado (véase Humes, 1996b: Fig. 28f) y (6) el segmento libre de la quinta pata es siete veces más largo que ancho (Humes, 1996b). Hay que destacar que como en la mayoría de las especies de *Asterocheres* descritas por Humes, si no en todas (véase también *A. dysideae* y *A. enewetakensis*), en el texto de la descripción de *A. serrulatus* el elemento interno del basis de la primera pata es una espina, aunque esté dibujado como una seta, que es lo que realmente presenta la especie y lo característico del género. Esto fue corroborado por Kim (2010) en su redescripción de *A. crinoidicola* por lo que en esta memoria se considera que en el resto de las especies descritas por Humes el elemento interno del basis de la primera pata es una seta. Otra especie del subgrupo 19B que presenta el segmento libre de la quinta pata alargado y el prosoma aplanado dorso-ventralmente es *A. bahamensis*. Sin embargo, se diferencia claramente de sus congéneres en que los 19 segmentos de su anténula se deben a fusiones de segmentos entre el segundo y tercero ancestrales (de ahí que presente un vestigio de articulación en en el lado anterior del segundo segmento) y los dos segmentos terminales. También es destacable que: (1) algunas de las setas terminales del lóbulo externo de la maxílula son más largas que las del lóbulo interno; (2) el segmento libre de la quinta pata es 4,5 veces más largo que ancho; (3) las primeras y terceras patas presentan dimorfismo sexual, concretamente el tercer segmento del endópodo de la primera pata del macho exhibe una fila oblicua de sétulas cerca de la base de la seta externa y el tercer segmento del endópodo de la tercera pata de la hembra presenta la fórmula (1,1+I,3), y en el macho (1,I,3) (Kim, 2010). Entre las seis especies restantes de este subgrupo 19B, todas ellas con 19 segmentos en la anténula de la hembra, el cuerpo dorso-ventralmente aplanado y dos segmentos en el plapo de la mandíbula, sólo *A. dysideae* y *A. enewetakensis* no presentan las ramas caudales casi tan largas como anchas o casi cuadradas. En el caso de *A. dysideae* son ligeramente más anchas que largas y puede ser distinguida del resto de especies de este grupo por varias características: (1) el contorno del prosoma es casi circular; (2) el somito que porta el primer par de patas está separado del cefalosoma por una sutura transversa dorsal muy débil; (3) las ramas caudales muestran un proceso hialino de forma triangular posteroventral conspicuo, y presenta una pequeña seta ventral, además de las cuatro setas terminales y las dos dorsales (haciendo un total de siete setas); (4) las anténulas son muy largas, 550 µm de longitud total, especialmente los segmentos 11 al 17; (5) el sifón es corto, no llega a la inserción de los maxilípedos; (6) la maxílula tiene cuatro setas terminales en el lóbulo interno y tres setas terminales en el externo; (7) la coxa de la pata cuarta carece de setas (0-0) y (8) el somito genital doble presenta una fila de largas sétulas (entre ocho y nueve) en la mitad posterior de los márgenes laterales (Humes, 1996a).

Asterocheres enewetakensis, al contrario que la especie anterior, tiene las ramas caudales 1,4 veces más largas que anchas. En su descripción, Humes (1997a) destaca la longitud del segmento libre de la quinta pata (ratio 6:1) y la forma del somito doble genital de la hembra, más largo que ancho (ratio 1,16:1) con la parte más ancha hacia la mitad de su longitud. Además esta se caracteriza por tener: (1) setas truncadas en los segmentos uno y dos de la anténula de la hembra; (2) el segmento libre de la antena pequeño; (3) el sifón sobrepasa ligeramente la inserción de los maxilípedos (véase Humes, 1997a: Fig. 1f) y (4) la maxílula tiene cuatro setas terminales en el lóbulo interno y tres setas terminales en el lóbulo externo. Otra especie del subgrupo 19B (19 segmentos en la anténula de la hembra y dos segmentos en el palpo de la mandíbula) con el cuerpo aplanado dorso-ventralmente es *A. walteri* que fue descrita por Kim (2004a) a partir de especimenes recogidos por Humes en Saboga Island (costa Pacífica de Panamá), donde vivía asociado a la estrella de mar *Oreaster brevispinis*. En la armadura de esta especie, llama la atención la longitud de algunas de sus setas, especialmente largas en los siguientes apéndices: (1) en los segmentos uno, dos, cuatro, cinco y seis de la anténula; (2) segundo y tercer segmento del endópodo de la antena; (3) lóbulo externo de la maxílula; (4) garra de la maxila; (5) cuarto y quinto segmentos del maxilípedo y (6) la seta interna del basis de la primera pata es ligeramente más larga de lo habitual. Esta especie presenta, además, dimorfismo sexual en el tercer segmento del endópodo de la tercera pata, que en el macho tiene la fórmula (1,I,3) con la seta distal externa muy reducida (Kim, 2004a). En la maxílula de *A. walteri*, Kim (2004a) describió: "…*con un lóbulo interno de 54 µm, con cuatro setas grandes y lisas de tamaños sub-iguales. Lóbulo externo de 69 µm de largo, ligeramente más grande que el lóbulo interno, con largas sétulas laterales y cinco setas terminales, una de ellas diminuta*…". En la descripción de este apéndice, claramente se ha confundido el lóbulo interno con el externo, ya que según Huys y Boxshall (1991) "… *la máxima setación de los lóbulos de la maxílula es cinco setas para el lóbulo interno y cuatro setas para el externo*…". Este apéndice es precisamente el más característico de esta especie y la distingue del resto de especies de este grupo, ya que no es habitual que las setas terminales del lóbulo externo de la maxílula sean más anchas y largas que las del lóbulo interno. Las tres especies restantes del subgrupo 19B han sido recogidas en Cuba: *A. humesi* se distuingue por poseer las siguientes características combinadas: (1) el cuerpo es ciclopiforme, con prosoma moderadamente alargado, aplanado dorsoventralmente y urosoma ciclíndrico. Además, el cefalotórax y los somitos pedígeros dos, tres y cuatro tienen las áreas epimerales puntiagudas y ligeramente proyectadas hacia atrás; (2) la anténula de 19 segmentos tiene el estetasco en el segmento 17 en la hembra; (3) el segmento libre de la antena porta dos setas terminales de distinta longitud; (4) el palpo de la mandíbula tiene dos segmentos y dos setas terminales de la misma longitud; (5) el sifón sobrepasa la inserción del maxilípedo, aunque no alcanaza el esclerito intercoxal de la primera pata; (6) el lóbulo interno de la maxílula tiene cuatro setas terminales y el lóbulo externo sólo tres setas; (7) el segmento libre de la quinta pata tiene un engrosamiento proximal en el margen interno que sólo se ha observado en la hembra y (8) el somito postgenital es ligeramente más largo que el somito anal (Varela, 2012). Las dos especies cubanas restantes fueron descritas por el mismo autor, Varela, en el mismo trabajo (2010a). Esta publicación presenta una errata en las ilustraciones de las dos especies, ya que las figuras 1, 2 y 3 pertenecen a *A. cubensis* y las figuras 4 y 5 corresponden a *A. fernandezmilerai*, y no al revés como se ha reflejado en el trabajo (Varela, comunicación personal). Estas dos especies son ligeramente parecidas a *A. humesi*, aunque en ninguna de ellas las áreas epimerales del cefalotórax o de los somitos pedígeros son puntiagudas, sino que son redondeada. Además, los lóbulos tanto internos como externos de las maxílulas presentan cuatro setas terminales cada uno en ambas especies. Estas dos especies, *A. cubensis* y *A. fernandezmilerai*, son muy similares pero se distinguen fácilmente por la quinta pata: *A. cubensis* tiene el segmento libre de esta pata muy largo, aproximadamente siete veces más largo que ancho, y esta armado con tres setas terminales; en cambio *A. fernandezmilerai* tiene el exópodo más corto y solo porta dos setas terminales (Varela, 2010a). *A. fernandezmilerai* es la única especie de *Asterocheres* con 19 segmentos en la anténula de la hembra, que exhibe sólo dos setas en el exópodo de la quinta pata.

El grupo de especies que presentan 20 segmentos en la anténula de la hembra (grupo 20, tabla 2) está formado por 23 especies de las que sólo ocho presentan un palpo mandibular con un único segmento (subgrupo 20A): A. *aesthetes, A. bulbosus, A. indivisus, A. planus, A. proboscideus, A. sensilis, A. spinosus*, *A. stimulans* y *A. stocki*. La especie, *A. stimulans*, junto con *A. proboscideus* y *A. stocki*, son las que presentan el cono oral más largo de todo el subgrupo 20A, aunque también se pueden distinguir del resto de especies por la forma del cuerpo: (1) *A. proboscideus* tiene un cefalosoma casi circular y corto, el segundo somito pedígero es muy ancho, más del doble del siguiente somito, y el sifón se extiende hasta más allá de las ramas caudales (posee el sifón más largo de todo el género) (Stock, 1966b: Fig. 9a); (2) *A. stocki*, según su descripción original, presenta un prosoma desproporcionadamente grande, un urosoma pequeño y el sifón alcanza el margen posterior del quinto somito pedígero (Nair & Pillai, 1984); (3) *A. stimulans* también posee un prosoma muy grande, unas tres veces más largo que el usosoma, e igual de ancho que de largo, y el cono oral sobrepasa la tercera pata, rozando el margen anterior de la cuarta pata (Giesbrecht, 1897, 1899). Además, estas tres especies coinciden también en la ausencia de seta interna en la coxa de la cuarta pata (Nair & Pillai, 1984; Stock, 1966b). Las seis especies restantes que poseen un único segmento en el palpo de la mandíbula (subgrupo 20A) presentan sifones mucho más cortos. Entre todas ellas, la que tiene el sifón más largo es *A. spinosus* que sobrepasa el maxilípedo pero no alcanza la placa intercoxal de la primera pata. La característica más relevante de esta especie antártica asociada a esponjas, entre todas las restantes del grupo, es la longitud y ornamentación de sus ramas caudales. Las ramas caudales de *A. spinosus* están cubiertas de pequeñas espínulas tanto en su superficie ventral como dorsal y son 1,9 veces más largas que anchas (Kim & Min, 2013). Aunque los autores en el texto de la descripción mencionan que el exópodo de la quinta pata tiene una seta en el lado interno y tres setas terminales, en la ilustración de la quinta pata, tanto de la hembra como del macho, solo aparece una seta interna subterminal y dos setas terminales (véase Kim & Min, 2013: Figs. 2G y 3I). La forma del cuerpo, con un prosoma aplanado dorso-ventralmente y en forma de disco, distingue claramente a *A. planus* del resto de las especies del grupo (subgrupo 20A) puesto que es la única especie del grupo con 20 segmentos en la anténula y un único segmento en el palpo de la mandíbula que tiene estas características. Además, presenta un exópodo de la antena muy alargado, más de tres veces más largo que ancho, característica poco común en el género *Asterocheres* si bien es compartida por otras especies del género que poseen un número de segmentos en la anténula de la hembra distinto de 20, como son *A. echinicola, A. ellisi, A.dysideae, A. flustrae, A. pilosus* y *A. plumosus*. *A. planus* tiene, además, una maxila y un maxilípedo muy robustos y la garra distal de la maxila está muy curvada (Kim, 2010).

La característica de *A. sensilis*, otra especie del subgrupo 20A, más relevante es la presencia de estetascos cortos en los segmentos cuarto, sexto y décimo (uno en cada segmento) y en el noveno segmento (dos estetascos) de la anténula del macho. Estos estetascos tienen característicamente forma de barra y no muestran variabilidad ni en el tamaño ni en la forma en los 30 machos estudiados por Kim (2010). El autor también destaca que la segunda pata del macho presenta un proceso externo distal trifurcado en el segundo segmento del endópodo y cuatro cúspides en la segunda espina externa del tercer segmento del exópodo (véase Kim, 2010: Fig. 29B). Además, el maxilípedo de esta especie no presenta dimorfismo sexual, es decir, que el macho no muestra el característico proceso proximal en el margen interno del segundo segmento del maxilípedo, como ocurre en la mayoría de los miembros de la familia Asterocheridae (Kim, 2010). Contrariamente, *A. indivisus* se puede distinguir del resto de las especies del subgrupo 20A por su llamativo dimorfismo sexual: el maxilípedo del macho presenta un pequeño proceso en el margen interno distal adicional al proceso proximal, de mayor tamaño, que típicamente presenta el género *Asterocheres* (Kim, 2010: Fig. 32D). El macho de *A. indivisus* también se caracteriza por presentar sólo cinco setas en el tercer segmento del endópodo de la segunda pata, en vez de seis setas como ocurre en la hembra (Kim, 2010). En cuanto a la hembra de esta especie, es la única del género que presenta las dos setas apicales del palpo mandibular unisegmentado de casi la misma longitud (Kim, 2010: Fig. 30G). La mayoría de las especies de *Asterocheres* presentan estas dos setas apicales del palpo mandibular de longitudes muy distintas, una muy larga y la otra marcadamente corta (Bandera & Conradi, 2013; Humes, 1997a; Kim, 2010) y en las pocas especies estas dos setas son de la misma longitud, el palpo posee dos segmentos. Otras características diagnosticas de *A. indivisus* son la presencia de dos setas muy largas distales y una muy pequeña subdistal (más de cinco veces menor que las setas distales) en el segmento libre de la quinta pata y de cinco a siete espínulas grandes en los márgenes laterales del somito genital doble. Las dos especies que quedan con 20 segmentos en la anténula y un único segmento en el palpo mandibular (subgrupo 20A) son *A. aesthetes* y *A. bulbosus*. Entre estas dos especies, muy parecidas en la forma del cuerpo, podemos encontrar las siguientes diferencias: (1) en *A. aesthetes* la armadura de los ocho primeros segmentos de la anténula se caracteriza por tener una seta plumosa y una espina roma con un flagelo terminal (Ho, 1984: Fig. 18B) y en *A. bulbosus* todas las setas son lisas; (2) el exópodo de la antena tiene tres setas en *A. aesthetes* y sólo dos setas en *A.*

bulbosus; (3) el estilete de *A. aesthetes* esta característicamente curvado hacia la mitad de su longitud, con dientes distales y las setas del palpo son espinosas (Ho, 1984: Fig. 18E), mientras que en *A. bulbosus* las setas del palpo son lisas; (4) el sifón de *A. bulbosus* tiene forma de pera y no llega a la base de los maxilípedos, es el más corto de todas las especies del grupo, en cambio, en *A. aesthetes* el sifón llega a los maxilípedos y termina en un corto tubo distal; (5) *A. aesthetes* tiene el lóbulo interno de la maxílula con cinco setas terminales y el externo con cuatro setas terminales; en *A. bulbosus* el lóbulo interno lleva cuatro setas y el externo tres setas; (6) la maxila de *A. aesthetes* presenta un estetasco en la pre-coxa, en cambio *A. bulbosus* carece de estetasco y (7) en *A. aesthetes* el exópodo de la quinta pata presenta dos setas terminales largas y una subterminal más corta que las anteriores (mide menos de la mitad de la longitud de las setas terminales), y en *A. bulbosus* el exópodo tiene dos setas terminales y una subterminal siendo las tres de la misma longitud (Bandera & Conradi, 2009b; Ho, 1984; Malt, 1991). Hay que destacar que en la descripción de *A. aesthetes*, la fórmula para la armadura del tercer segmento del exópodo de la primera pata es (III,I,3), sin embargo en la ilustración (Ho, 1984: Fig. 19A) se aprecia que en la parte apical del segmento aparecen dos setas, por lo tanto, en el texto debería aparecer (III,2,2) que es la fórmula habitual de las especies de *Asterocheres*.

Entre las 14 especies con 20 segmentos en la anténula de la hembra y dos segmentos en el palpo de la mandíbula (subgrupo 20B; tabla 2) sólo tres, *A. lalanai*, *A. neptunei* y *A. siphunculus*, presentan el prosoma dorso-ventralmente aplanado. Estas tres especies se pueden separar en base a la longitud de su cono oral siendo *A. neptunei* la que presenta el sifón más largo, llegando a alcanzar el esclerito intercoxal del primer par de patas. Esta especie se caracteriza, además, por la presencia de sólo dos setas terminales en el segmento libre de la quinta pata (véase Jonhsson *et al.*, 2001: Fig. 3a), poco común en el género *Asterocheres*. La especie *A. lalanai* tiene el sifón de tamaño intermedio, sobrepasa la inserción de los maxilípedos pero no alcanza el esclerito intercoxal de la primera pata. Esta especie fue descrita como *A. stocki* Varela, 2012, pero fue renombrada como *A. lalanai* en el año 2013 debido a la homonimia creada con *A. stocki* Nair & Pillai, 1984 (Varela, 2013). Podemos distinguir a *A. lalanai* de las otras especies del subgrupo 20B con prosoma dorso-ventralmente aplanado por las siguientes características: (1) el urosoma es estilizado; (2) el somito genital doble es 1,4 veces más largo que ancho y el somito postgenital es el doble de largo que el somito anal; (3) el exópodo de la antena presenta una única seta terminal muy larga (característica muy poco común en *Asterocheres*, solo compartida con *A. hongkongensis*, pero en ésta última la seta es corta) y (4) el palpo de la mandíbula tiene dos setas terminales de la misma longitud. En la ilustración de la mandíbula de la descripción original (Varela, 2012: Fig. 6F: aunque en la leyenda de esta figura mencione que es la maxílula, corresponde con la mandíbula) aparece un palpo con un único segmento, sin embargo el palpo de *A. lalanai* tiene dos segmentos como se indica en el texto de la descripción (Varela, com. pers.). La especie con el prosoma aplanado dorso-ventralmente y el sifón más corto es *A. siphunculus* puesto que sólo alcanza la maxila. Esta especie se caracteriza básicamente por la forma del cuerpo, que es fácil de reconocer a simple vista, ya que presenta un cefalosoma casi el doble de ancho que de largo y distintivamente más ancho que los somitos pedígeros posteriores. El cefalosoma y los somitos pedígeros segundo, tercero y cuarto tienen los extremos postero-laterales ligeramente apuntados hacia atrás. El cuarto somito, además, tiene el margen posterior cóncavo. Otras características de esta especie son: (1) la seta subterminal y las dos setas terminales del segmento libre de la antena son cortas y del mismo tamaño; (2) el endópodo del maxilípedo tiene sólo dos segmentos y (3) las ramas caudales son 1,7 veces más largas que anchas (Bahia *et al.*, 2012).

Otras tres especies del subgrupo 20B (con 20 segmentos en la anténula de la hembra y palpo mandibular con dos segmentos), se pueden distinguir a simple vista por la forma característica de sus cuerpos: *A. galeatus, A. maxillatus* y *A. tenuipes*. *A. galeatus* se caracteriza por tener el cefalotórax en forma de "casco", expandido lateralmente (una vez y media más ancho que largo) con los márgenes posterolaterales apuntados hacia atrás y extendiéndose hasta la mitad del tercer somito pedígero que tiene los márgenes postero-laterales angulosos, pero no expandidos; el segundo y tercer somitos pedígeros son más estrechos que el cefalotórax y el cuarto somito pedígero es mucho más pequeño que los anteriores (véase Kim, 2010: Fig. 42A). Esta forma corporal es muy parecida a la que presenta *Phyllocheres petalus* Humes, 1996, si bien esta similitud es sólo superficial, ya que ambas especies muestran diferencias significativas en otros caracteres como la armadura de la primera y segunda pata y en la anchura del tercer somito pedígero que es mucho más ancho en *Phyllocheres* y cubre totalmente al resto del prosoma (Humes, 1996a). Otras características de *A. galeatus* son: (1) las ramas caudales tienen una gran escama triangular en el margen postero-ventral (véase Kim, 2010: Fig. 42C) y (2) la cuarta pata carece de seta interna en la coxa (Kim, 2010). En *A. maxillatus* el cefalotórax y los somitos pedígeros segundo y tercero forman un "escudo redondo" y cubren totalmente al cuarto y quinto somitos pedígeros y la mitad del somito genital doble (véase Stock, 1987: Fig. 1a). Esta forma corporal no se encuentra en ninguna otra especie del grupo. Además de esta característica, esta especie también se identifica por presentar lóbulos en la maxílula muy estilizados: el lóbulo interno es 4,8 veces más largo que ancho y el lóbulo externo (que es la mitad de largo que el anterior) es seis veces más largo que ancho (Bandera & Conradi, 2013). *A. tenuipes* se caracteriza por presentar los siguientes caracteres: (1) el prosoma es grande, con el tercer somito pedígero el doble de ancho que el somito que le precede y con los márgenes postero-laterales en ángulo recto, y el urosoma es pequeño; (2) las ramas caudales presentan una escama transparente grande y otra pequeña de forma triangular y el margen posterior ventral está ornamentado con varias espínulas; (3) la quinta pata tiene dos segmentos, el primero de ellos bien definido, y el segmento libre muy alargado, aproximadamente 7,5 veces más largo que ancho (Kim, 2010). Según Kim (*op. cit.*), en el género *Asterocheres* sólo hay siete especies con una longitud del exópodo de la quinta pata superior a cuatro veces su anchura, pero a excepción de *A. crinoidicola*, todas tienen un número de segmentos en la anténula diferente de *A. tenuipes*. En la descripción original de *A. crinoidicola* el ratio del exópodo de la quinta pata es cinco (Humes, 2000), en cambio, en la resdescripción llevada a cabo por Kim en 2010, el ratio es aproximadamente tres.

Entre las ocho especies con 20 segmentos en la anténula, dos segmentos en el palpo de la mandíbula (subgrupo 20B) y el prosoma no aplanado dorso-ventralmente, *A. oricurvus* es la que tiene el sifón más largo, llegando a la inserción de la cuarta pata. Además de la longitud del sifón, hay otras tres características que identifican a esta especie: (1) el sifón es claramente curvo en vista lateral; (2) el palpo mandibular es esbelto, tiene dos segmentos de igual longitud, y las dos setas terminales también son de la misma longitud y (3) el exópodo de la quinta pata presenta el margen interno ensanchado (véase Kim, 2010: Fig. 22G).

Cuando Humes describió *A. crinoidicola* en 2000 (con material recogido en Belize en 1999 sobre crinoideos), destacó entre todas sus características la exagerada prolongación del tercer segmento del endópodo de la primera pata (véase Humes, 2000: Fig. 2h), en ambos sexos, ya que habitualmente las especies de *Asterocheres* hasta entonces descritas o no tenían nada o sólo presentaban un pequeño proceso espiniforme. De hecho, en aquella época, sólo se podía comparar *A. crinoidicola* con *A. mucronipes* ya que ésta también presentaba una prolongación espiniforme larga, si bien era diferente en tamaño y forma a la de *A. crinoidicola*. Existian, además, otras características que separaban a estas dos especies, como la forma del cuerpo, la longitud del exópodo de la antena, la longitud del sifón, la forma y tamaño del estilete mandibular, la forma de los lóbulos de la maxílula y la longitud y la forma de las setas que portaban. *A. mucronipes* se encuentra actualmente en otro género, *Stockmyzon mucronipes* (Stock, 1960), ya que estas características la separaban no sólo de *A. crinoidicola*, sino también del resto de las especies del género *Asterocheres* (características expuestas anteriormente en esta discusión). *A. crinoidicola* puede separarse de las restantes especies del subgrupo 20B por otras características adicionales a la ya comentada: (1) el exópodo de la antena es extremadamente corto; (2) el primer segmento del endópodo de la antena es muy largo (seis veces más largo que ancho); (3) una de las setas terminales del lóbulo interno de la maxílula es seis veces más larga que el propio segmento y (4) el exópodo de la quinta pata es muy largo (Humes, 2000). Diez años más tarde de la publicación de Humes, Kim describió otras dos especies de *Asterocheres* que presentan una prolongación distal en el tercer segmento del endópodo de la primera pata como ocurre en *A. crinoidicola*, son *A. unioviger* y *A. trisetatus* (Kim, 2010). Estas dos especies, junto con otra especie que el mismo describió en 2004, *A. pilosus*, y otra especie descrita posteriormente, en 2013, *A. rai*, forman según Kim (2010) un grupo denominado "crinoidicola group". *A. trisetatus* se distingue de *A. pilosus* y *A. unioviger* por presentar un segmento más en la anténula de la hembra (20 segmentos, frente a los 19 de las otras dos especies) y de *A. crinoidicola* por tener el exópodo de la antena más largo y el primer segmento del endópodo más corto. Pero además de estas características, presenta otras que la diferencian del resto de las especies del subgrupo 20B: (1) el somito genital doble está muy expandido lateralmente en la mitad superior (véase Kim, 2010: Fig. 6B); (2) la rama caudal posee una seta media interna terminal muy reducida (más corta que la seta media externa terminal); (3) carece de seta interna en la coxa de la primera pata y (4) presenta sólo tres setas en el lóbulo externo de la maxílula (de esta característica deriva su nombre). En este mismo trabajo, Kim (2010) describió a la especie *A. tricuspis* que posee varias características que la distinguen del resto de especies del subgrupo 20B: (1) los somitos pedígeros segundo y tercero están curvados hacia atrás y sus márgenes laterales presentan unas membranas estrechas (véase Kim, 2010: Fig. 12A); (2) el somito genital doble está expandido lateralmente en la mitad inferior y, tras el área genital, los márgenes laterales presentan unos procesos tricúspides en las esquinas postero-laterales de la parte más ancha del somito, situados entre cinco o seis sétulas anteriores y dos o tres espínulas posteriores (véase Kim, 2010: Fig. 12B); (3) la anténula tiene en sus segmentos anteriores algunas setas con el extremo bifurcado; (4) presenta una fila de escamas pectinadas en el lado externo del basis de la antena y (5) la seta interna de la coxa de la primera pata es muy larga, tan larga como el endópodo completo y se extiende más allá del margen externo del exópodo, característica esta última que se considera muy llamativa puesto que no se ha encontrado hasta ahora en ninguna especie del género (Kim, 2010). Siguiendo con las especies restantes del mencionado "crinoidicola group", *A. rai* puede ser fácilmente reconocible, según su descripción original, por sus cuatro características diagnósticas: (1) su gran tamaño que alcanza aproximadamente 1,61 mm de longitud (generalmente las especies de *Asterocheres* tienen un tamaño inferior al milímetro de longitud) y es, probablemente, el registro de longitud más largo del género; (2) la ausencia de setas o espinas en los márgenes laterales del somito genital doble de la hembra (Normalmente las hembras de *Asterocheres* llevan sétulas y ocasionalmente espínulas en los márgenes laterales del somito genital, aunque esto ha sido generalmente ignorado en la taxonomía de Asterocheridae y no se le ha dado importancia como valor taxonómico; sin embargo, el número de sétulas o espínulas es muy constante dentro de una especie, pero variable de una especie a otra (Kim, 2010)). Los márgenes laterales lisos del somito genital son considerados por Kim y Min (2013) una característica significativa de *A. rai*. (3) la presencia de una única seta propiamente dicha en el exópodo de la antena (en este género, el exópodo de la antena esta normalmente armado con una seta terminal, una subterminal y una lateral o proximal; en muy pocas ocasiones poseen una única seta o dos). En *A. rai* podemos encontrar una seta terminal muy larga y dos setas transformadas que están cubiertas por una sustancia mucilaginosa tanslúcida (véase Kim & Min, 2013: Figs. 4E,F). Esta característica es única en el género. Esta especie se distingue de las restantes especies del "crinoidicola group", *A. crinoidicola, A. pilosus, A. trisetatus* y *A. unioviger*, porque en estas cuatro especies las ramas caudales son más largas que anchas, el somito genital doble de la hembra presenta setas o espínulas en los márgenes laterales y el cono oral no se extiende más allá de los maxilípedos, contrariamente a lo que ocurre en *A. rai* (Kim & Min, 2013).

De las tres especies que quedan en el grupo, *A. simplex, A. halichondriae* y *A. dentatus*, solo *A. simplex* tiene las ramas caudales más largas que anchas (1,5 veces más larga que ancha). Esta especie de prosoma ovoide y cefalotórax ancho se caracteriza por presentar un exópodo en la antena 3,8 veces más largo que ancho, con dos setas terminales de distinta longitud, y un exópodo en la quinta pata con solo dos setas terminales (Schirl, 1973). Esta última característica distingue a esta especie del resto de especies con 20 segmentos en la anténula de la hembra, dos segmentos en el palpo de la mandíbula y cuerpo no aplanado dorso-ventralmente.

Las diferencias que podemos encontrar entre *A. halichondriae* y *A. dentatus* son: (1) aunque ambas presentan un cuerpo típicamente ciclopoide, en *A. halichondriae* el cefalotórax se aproxima más a una forma triangular y en *A. dentatus* se aproxima más a una forma cuadrada; (2) el sifón en *A. halichondriae* presenta una parte corta tubular distal y sobrepasa la inserción del maxilípedo; en cambio, en *A.dentatus*, el sifón tiene forma de pera y carece de parte tubular, alcanzando apenas la inserción del maxilípedo; (3) en *A. halichondriae* el somito genital es sólo un poco más ancho que largo, de contorno redondeado, mientras que *A. dentatus* tiene el somito genital más ancho que largo y presenta un proceso en forma de diente a cada lado, tras el área genital; (4) la seta del quinto somito pedígero es más corta que el segmento libre (aproximadamente la mitad de la longitud del exópodo) en *A. dentatus* y en *A. halichondriae* es bastante más larga que el segmento libre (la longitud de la seta del somito supera la vez y media la longitud del exópodo) (Giesbrecht, 1897, 1899; Stock, 1966b).

El grupo de especies que poseen el mayor número de segmentos en la anténula de la hembra, 21, es también el que esta integrado por un mayor número de especies, 29 (grupo 21; véase la tabla 2). En este grupo se encuentra incluida *Asterocheres boeckii* que originalmente fue descrita por Brady (1880) bajo el nombre de *Artotrogus boeckii* Brady, 1880, y que la mayoría de los investigadores se han referido a ella con posterioridad como *Asterocheres boecki* (por ejemplo: Sars, 1915; Stock, 1966b; Hamond, 1973; Schirl, 1973; Kim, 2004a). Sin embargo, según la versión en español del Código Internacional de Nomenclatura Zoológia (aprobada en 2009 y hecha disponible con el consentimiento del International Trust for Zoological Nomenclature), se considera que *"el uso de la desinencia de genitivo –i en una grafía posterior de un nombre de nivel especie que es un genitivo basado en un nombre personal cuya grafía original correcta termina –ii o viceversa, es una grafía posterior incorrecta, incluso si el cambio de grafía es* *deliberado*" (ICZN Art. 33.4). La grafía correcta del epíteto específico debería, por tanto, ser *boeckii*. Lo mismo se aplica para la especie tipo del género *Asterocheres* que es ampliamente citada como *A. lilljeborgi* pero que fue originalmente deletreada como *A. liljeborgii* por Boeck (1860); ya que la especie llevaba el nombre de el zoólogo sueco Wilhelm Lilljeborg. La incorrecta grafía original fue posteriormente corregida a *lilljeborgi* por Brady (1880), Canu (1892), Giesbrecht (1897) y otros, perdiéndose desafortunadamente, el sufijo correcto *–ii* en el proceso. En la presente memoria se utilizan las grafías correctas de estas especies, *Asterocheres boeckii* (Brady, 1880) y *A. lilljeborgii* Boeck, 1860 siguiendo a Bandera y Conradi (aceptado).

Entre las 29 especies con 21 segmentos en la anténula de la hembra, sólo siete especies muestran un único segmento en el palpo de la mandíbula, *A. corneliae, A. echinicola, A. faroensis, A. madeirensis, A. minutus, A. nudicoxus* y *A. siphonatus* (subgrupo 21A; tabla 2). De todas estas especies, *A. nudicoxus* es un caso particular, ya que, aunque el palpo tiene un único segmento, presenta un vestigio de articulación (Kim, 2010: Fig. 34A). Esta especie también se caracteriza por presentar: (1) un prosoma plano y casi circular; (2) el somito genital doble muestra una parte anterior ancha que se estrecha fuertemente hacia arriba y una parte posterior estrecha y corta, con dos penachos de sétulas (uno anterior con ocho o nueve sétulas grandes y uno posterior con siete u ocho sétulas parecidas a espínulas); (3) una de las setas presentes en cada uno de los segmentos de la anténula primero, segundo, cuarto y sexto tiene la punta bifurcada; (4) el maxilípedo posee seis segmentos; (5) la cuarta pata carece de seta interna en la coxa y (6) el exópodo de la quinta pata es muy largo (6,36:1) en la hembra y mucho más corto en el macho (4,8:1) (Kim, 2010). Esta especie es parecida a *A. tubiporae* e incluso viven asociadas al mismo hospedador, el estolonífero *Tubipora música* (Linnaeus), en Madagascar. Sin embargo, se pueden distinguir, entre otras características por la longitud del segmento libre de la quinta pata, mucho más largo en *A. nudicoxus*, y el palpo de la mandíbula que posee claramente dos segmentos en *A. tubiporae* (Kim, 2004b, 2010).

Asteroheres faroensis, especie recogida en un lago meromíctico sometido a grandes fluctuaciones medioambientales en Sicilia, se distingue fácilmente de las demás especies porque presenta un prosoma ovoide en vista dorsal y que se encuentra aplanado dorso-ventralmente, y por tener unas ramas caudales muy largas (1,7 veces más largas que anchas). Además de estas características, también posee: (1) un sifón que sobrepasa el maxilípedo pero no alcanza el esclerito intercoxal de la primera pata; (2) un maxilípedo con seis segmentos; (3) una anténula del macho con 17 segmentos y dos estetascos, uno en el segmento 10 y otro en el 16; y (4) un dimorfismo sexual en la primera pata del macho que muestra dos procesos distales de distinta longitud en el tercer segmento del endópodo (Crescenti, Baviera & Zaccone, 2010).

Asterocheres echinicola ha sido redescrita recientemente por Bandera & Conradi (2009c), quienes descubrieron que los sintipos depositados en el NHM tenían las características diagnósticas de *A. violaceus*, por lo que, tal y como se ha explicado anteriormente, se debe considerar a ésta última (*A. violaceus*) como sinónima de la primera (*A. echinicola*). *A. echinicola* es una especie fácilmente reconocible a simple vista por las siguientes características: (1) la anténula presenta los segmentos anchos y cortos; (2) el sifón alcanza apenas el margen posterior de la inserción de la maxila; (3) los lóbulos interno y externo de la maxílula son aproximadamente de la misma longitud y de las cinco setas terminales del lóbulo interno, una es cuatro veces y media más larga que las restantes y está adornada con grandes sétulas; (4) el margen posterior del exópodo de la quinta pata es característicamente redondeado (véase Bocquet *et al.*, 1963: Fig. 6e). La especie más parecida a *A. echinicola* es *A. minutus* pudiéndose separar estas especies por: (1) la longitud del cuerpo, *A. minutus* es mucho más corta que *A. echinicola*; (2) el exópodo de la antena es ligeramente más largo en *A. minutus*; (3) la seta más corta del lóbulo interno de la maxílula, es más corta en *A. echinicola*; (4) la parte terminal del segmento libre de la quinta pata es más redondeado en *A. echinicola* y (5) *A. minutus* tiene tres setas terminales de la misma longitud en el exópodo de la quinta pata y *A. echinicola* posee una seta corta y dos largas (aproximadamente el doble de largas que la seta corta) (Bandera & Conradi, 2009c;

Conradi & Bandera, 2011). Estas dos especies proporcionan un ejemplo clásico de especies hermanas en equinoideos regulares de las costas occidentales europeas (Bocquet *et al.*, 1963; Bocquet & Stock, 1962; Gotto, 1979; Conradi & Bandera, 2011). Las dos especies se solapan en su distribución en el Mediterráneo y se pueden encontrar juntas en el mismo erizo sin mostrar ninguna preferencia territorial. Bocquet *et al.* (1963) consideraron que *A. minutus* derivaba de *A. echinicola* y creían que la situación actual podía ser interpretada como una consecuencia de la especiación alopátrica. Conradi y Bandera (2011) supusieron que una población de una especie ancestral de *Asterocheres* parásita de erizos de mar en un amplio rango geográfico, se dividió en un momento dado en dos componentes: uno "occidental" (Atlántico) y otro "oriental" (Mediterráneo) debido a una barrera de tierra. La población atlántica permanecería, con respecto a su ancestro, relativamente inalterada dado el ambiente estable del océano Atlántico mientras que la población del Mar Mediterráneo, sujeta a considerables fluctuaciones a través de su historia, acumuló suficientes mutaciones para transformarse en la especie que actualmente se conoce como *A. minutus*. Para cuando se produjo la apertura del Estrecho de Gibraltar y se restableció la comunicación entre el Océano Atlántico y el Mar Mediterráneo, la separación entre las especies era completa. Este restablecimiento de la comunicación entre ambas aguas, permitió a la euriplástica *A. echinicola* recolonizar el Mediterráneo, pero no permitió a *A. minutus*, una especie por ahora estenoplásticamente adaptada a las condiciones peculiares de un mar "aislado", ampliar su rango de expansión hacia el oeste (Bocquet & Stock, 1963). Por lo tanto, el modelo cladístico que más se aproxima al origen de estas dos especies de *Asterocheres* es la hipótesis de "budding" descrita por Queiroz (1998) ya que una de las especies es el origen de la otra, y ambas especies (la original y la nueva) coexisten en el tiempo, aunque aisladas en sus respectivos hospedadores.

Entre las especies restantes del subgrupo 21A, *A. siphonatus* es la que presenta un sifón más largo. Las características más destacadas de esta especie son: (1) las superficies dorsal y ventral del quinto somito pedígero, del somito genital doble, de los somitos abdominales libres y de las ramas caudales están adornadas con escamas epicuticulares grandes y planas ordenadas en filas superpuestas; (2) presenta un cono oral muy largo y esbelto, alcanzando el margen posterior del esclerito intercoxal de la cuarta pata; (3) el palpo mandibular tiene un único segmento y sus dos setas terminales tienen la misma longitud; (4) carece de seta interna en la coxa de la cuarta pata; (5) las superficies de las cuatro primeras patas y el exópodo de la quinta pata estan adornadas con escamas epicuticulares aplanadas ordenadas en un patrón irregular (Conradi & Bandera, 2011). Esta especie fue descrita por Thorell como la especie tipo de su género *Ascomyzon*, *Asc. lilljeborgi*, en 1859. Si bien el nombre específico *lilljeborgii*, ya había sido pre-ocupado por *Asterocheres lilljeborgii* Boeck, 1859, hecho que Brady puso de manifiesto en 1880, aunque él también consideró *Artotrogus* Boeck, 1859 como sinónimo de estos géneros. La confusión se produjo porque estos tres géneros *Ascomyzon*, *Asterocheres* y *Artotrogus*, fueron descritos en el mismo año, sin embargo no hay dudas acerca de la prioridad de los dos nombres propuestos por Boeck ya que Thorell citó el trabajo de Boeck en su monografía y por lo tanto es posterior. Entre estos dos nombres de Boeck, Brady favoreció a *Artotrogus*, considerándolo "menos cuestionable que el término *Asterocheres*", por lo que él propuso el nombre de *Artotrogus boeckii* para la especie de Thorell y *Artotrogus lilljeborgi* para la de Boeck. Más tarde Giesbrecht (1897) corrgió la sugerencia de Brady puesto que demostró la sinonimia entre *Asterocheres* y *Ascomyzon* (y también *Cyclopicera* Brady, 1872), la validez del género *Artotrogus* y las diferencias entre las especies descritas por Thorell como *Ascomyzon lilljeborgii* y por Brady como *Artotrogus boeckii*. Puesto que el nombre específico de *lilljeborgii* estaba ya ocupado por *Asterocheres lilljeborgii* Boeck, 1859, Giesbrecht propuso el nombre de *Asterocheres siphonatus* para la especie de Thorell (*Ascomyzon lilljeborgi* de Thorell) y consideró la especie de Brady como *Asterocheres boeckii* (Brady, 1880). Sin embargo más tarde, Sars volvió a utilizar *Ascomyzon lilljeborgii* para nombrar la especie de Thorell, consideró *Asterocheres siphonatus* Giesbrecht 1897 como un sinónimo de *Ascomyzon lilljeborgi* y cambió el nombre específico de la especie de Boeck a *Ascomyzon asterocheres*. Gurney (1927), Van

Oorde-de lint *et al.* (1936), Bocquet (1952) y Lang (1949) siguieron la sugerencia errónea de Sars, pero diez años más tarde, Bresciani y Lützen (1962) restablecieron la prioridad del nombre *Asterocheres* y propusieron el nombre específico de *thorelli* para la especie de Thorell sin considerar que esta especie había sido ya nombrada anteriormente por Giesbrecht. Desde entonces, esta especie ha sido nombrada equívocamente como *A. thorelli* (Sars G.O., 1879) (Brun, 1976; Barel & Kramers, 1977; Humes, 1986), hasta la excelente monografía de Gotto (1993) donde, siguiendo el Código Internacional de Nomenclatura Zoológica (art. 60.3), citó esta especie como *A. siphonatus* Giesbrecht, 1897.

Otra especie con 21 segmentos en la anténula y un segmento en el palpo mandibular (subgrupo 21A) es *A. madeirensis*. Esta especie se encontró asociada a la esponja *Petrosia ficiformis* (Poiret, 1789), recogida en Porto da Cruz, Madeira (Portugal) y se caracteriza por presentar: (1) las superficies dorsal y ventral de los somitos del urosoma adornados con escamas epicuticulares ordenadas en filas superpuestas; (2) el exópodo de la antena tiene sólo dos setas, una terminal larga y ancha y una subterminal mucho más corta y estrecha; (3) la garra terminal del tercer segmento del endópodo de la antena es muy larga (casi tan larga como en endópodo completo) y presenta filas de pequeñas espínulas en ambos márgenes; (4) el palpo de la mandíbula tiene un único segmento y está armado con dos setas terminales de distinta longitud; (5) el cono oral alcanza la inserción de los maxilípedos; (6) los segundos y terceros segmentos de los endópodos de las patas segunda a cuarta tienen un proceso espiniforme bífido distal moderadamente marcado y (7) el exópodo de la quinta pata tiene dos setas largas y lisas y una corta y plumosa en la hembra y dos setas largas y plumosas y una corta y lisa en el macho (Bandera, Conradi & López-González, 2007). En la descripción original de esta especie, el elemento interno del basis de la pata primera aparece en el texto citado como espina y sin embargo esta ilustrado como una seta, con la parte final flexible. Bandera y colaboradores, tras el examen del holotipo, confirmaron que el elemento interno del basis de la primera pata es una seta.

La última especie del subgrupo 21A, con 21 segmentos en la anténula de la hembra y un único segmento en el palpo de la mandíbula, es *A. corneliae*. Esta especie fue originalmente descrita con 20 segmentos en la anténula y con un palpo mandibular "*posiblemente con 2 segmentos, pero la línea divisoria es apenas visible*" (Schirl, 1973). Sin embrago, la reciente redescripción de Bandera y Conradi (aceptado) demostró que la anténula poseía 21 segmentos, con los dos últimos segmentos claramente divididos (con tres y seis setas cada uno) y el palpo mandibular poseía un único segmento. *A. corneliae* se diferencia de *A. nudicoxus* porque esta última especie tiene un somito genital doble con una parte anterior ancha y muy corta, y una parte posterior mucho más estrecha (Kim, 2010: Fig. 33B). *A. echinicola* y *A. minutus*, se separan de *A. corneliae* por la morfología de la maxílula ya que en estas dos especies los lóbulos internos y externos son aproximadamente de la misma longitud, y una de las cuatro setas terminales del lóbulo interno es cuatro veces más larga que las restantes tres setas (Bandera & Conradi, 2009c; Conradi & Bandera, 2011). Por el contrario, *A. corneliae* posee un lóbulo interno que es 3,5 veces más largo que el externo y tiene una seta corta y cuatro setas largas distales. *A. siphonatus* se diferencia fácilmente de *A. corneliae* por la longitud del sifón: en *A. corneliae* se extiende más allá de la inserción de los maxilípedos aunque no alcanza el esclerito intercoxal de la primera pata, mientras que en *A. siphonatus* el sifón se extiende hasta el margen posterior del esclerito intercoxal de la cuarta pata (Conradi & Bandera, 2011). *A. faroensis* se distingue de *A. corneliae* por la longitud de sus ramas caudales (casi tan largas como anchas en *A. corneliae* mientras que las de *A. faroensis* son 1,7 veces más largas que anchas), por el prosoma que está dorso-ventralmente aplanado en *A. faroensis* (Crescenti et al., 2010) y por el estetasco de la coxa de la maxila que está presente en *A. faroensis* y sin embrago no se ha observado en *A. corneliae*. La especie más similar de todo el subgrupo 21A es *A. madeirensis* que puede ser distinguida por las siguientes diferencias: (1) el exópodo de la antena tiene dos setas en *A. madeirensis* y tres setas en *A. corneliae*; (2) el estilete mandibular es puntiagudo en *A. madeirensis* y denticulado en *A. corneliae*; (3) el sifón es ligeramente más largo en *A. corneliae*; (4) el lóbulo interno de la maxílula es tres veces más largo que el lóbulo externo en *A. madeirensis*, y cuatro veces más largo en *A. corneliae*; (5) *A. madeirensis* tiene un estetasco en la coxa de la maxila que está ausente en *A. corneliae*; (6) la seta basal externa del quinto somito pedígero es más larga que el segmento libre completo en *A. corneliae*, y más corta en *A. madeirensis* y (7) los márgenes laterales del tercio medio del somito genital tiene seis largas sétulas en *A. corneliae* y en *A. madeirensis* es mucho más espinoso (Bandera, Conradi & López-González, 2007).

Las 22 especies restantes del grupo con 21 segmentos en la anténula, poseen un palpo con dos segmentos en la mandíbula (subgrupo 21B; tabla 2). Entre estas especies, podemos distinguir a tres, *A. complexus, A. eugenioi* y *A. sarsi*, por presentar los extremos de del segundo y tercer somitos pedígeros ligeramente recurvados y angulosos. Aunque estas tres especies tienen una forma corporal parecida, se pueden distinguir por: (1) el cefalotórax y los somitos pedígeros segundo y tercero presentan los ángulos posterolaterales ligeramente puntiagudos en *A. complexus* y *A. eugenioi*. En *A. sarsi* tanto el cefalotórax como el tercer somito pedígero tienen los márgenes posterolaterales puntiagudos, pero el margen del segundo somito pedígero es redondeado; (2) las ramas caudales son casi tan largas como anchas en *A. complexus*, 1,5 veces más largas que anchas en *A. eugenioi* y dos veces más largas que anchas en *A. sarsi*. Además, *A. complexus* y *A. eugenioi* carecen de seta I en las ramas caudales mientras que ésta está presente en *A. sarsi* (diminuta y desplazada a la superficie lateral); (3) *A. complexus* y *A. eugenioi* tienen una seta y una espina en el segmento 11 de la anténula, y *A. sarsi* posee una seta y una espina en los segmentos 10 y 11 de la anténula; (4) el exópodo de la antena tiene sólo dos setas en *A. complexus* y tres setas en *A. eugenioi* y *A. sarsi*; (5) el sifón alcanza el maxilípedo en *A. complexus* y el margen posterior del esclerito intercoxal de la primera pata en *A. eugenioi* y *A. sarsi*; (6) el estilete de la mandíbula tiene cinco grandes dientes subapicales en *A. complexus*, con una expansión hacia la mitad de su longitud, mientras que su punta es lisa y aguda en *A. eugenioi*, y presenta ocho dientes grandes y otros tantos más pequeños subapicales en *A. sarsi*; (7) *A. eugenioi* y *A. sarsi* no presentan la seta interna de la coxa de la primera pata y en *A. complexus* si está presente; (8) la seta del quinto somito pedígero es más corta que la longitud del exópodo y éste tiene tres setas lisas de distinta longitud en *A. complexus*. En *A. eugenioi* la seta del quinto somito pedigero es más larga que el doble de la longitud del exópodo y éste tiene dos setas lisas muy largas terminales y una subterminal más corta (aproximadamente la mitad de la longitud de las anteriores) y lisa. La seta del quinto somito pedígero es 1,5 veces más larga que el exópodo y éste tiene dos setas largas y pinnadas terminales y una muy corta y lisa subterminal en *A. sarsi*; y (9) el urosoma y algunos apéndices (antena, cuarta pata y exópodo de la quinta pata) muy adornados con espínulas y sétulas en *A. sarsi*, mientras que esta ornamentación no se ha observado en *A. complexus* y *A. eugenioi* (Bandera & Conradi, 2014). Hay que destacar que, además de *A. eugenioi* y *A. sarsi*, sólo dos especies más de *Asterocheres* carecen de seta interna en la coxa de la primera pata, *A. pilosus* y *A. trisetatus,* sin embargo, estas especies no comparten ninguna otra similitud por lo que esta característica común debería considerarse como una homoplasia (Dr. I.-H. Kim, comunicación personal).

Entre las especies del subgrupo 21B encontramos siete especies que presentan el prosoma aplanado dorso-ventralmente: *A. ellisi, A. jeanyeatmanae, A. lilljeborgii, A. reginae, A. simulans, A. tenuicornis* y *A. tubiporae*. Entre éstas, *A. simulans* y *A. tenuicornis* destacan por la longitud de sus ramas caudales. La primera, *A. simulans*, fue descrita por Th. Scott en 1898 y redescrita más tarde por Ivanenko (1997) y se diferencia de todos sus congéneres por la marcada "hinchazón" que presenta en los segmentos del urosoma lo que le confiere un aspecto globoso, y por poseer las ramas caudales más cortas del género, aproximadamente dos veces más anchas que largas (según las ilustraciones de Ivanenko, 1997). Presenta, además, otras características: (1) el urosoma está cubierto de pequeñas escamas epicuticulares; (2) el sifón tiene forma cónica carente de una parte distal en forma de tubo y alcanza la inserción de los maxilípedos; (3) el estilete de la mandíbula tiene el margen subapical denticulado; y (4) el lóbulo interno de la maxílula posee unas sétulas largas en el margen proximal interno (Ivanenko, 1997). La segunda especie, *Asterocheres tenuicornis*, fue descrita por

Brady en 1910 y posteriormente redescrita por Eiselt (1965). En este caso, *A. tenuicornis* se separa del resto de *Asterocheres* por tener las ramas caudales más largas de todo el género (seis veces más largas que anchas). Además, esta especie tiene un prosoma muy ancho y aplanado con un contorno casi circular y un urosoma cilíndrico. Entre los apéndices orales podemos destacar el exópodo de la antena que tiene sólo dos setas y las setas terminales del lóbulo interno de la maxílula que son más cortas de lo que habitualmente se observa en el género (la seta más larga tiene aproximadamente la misma longitud que el propio segmento) (Eiselt, 1965).

Continuando con las especies del subgrupo 21B con el prosoma aplanado dorso-ventralmente, destacar que *A. ellisi* es la que tiene el cono oral más largo ya que sobrepasa la inserción de la pata primera si bien no alcanza la inserción de la segunda. Esta especie fue descrita por Hamond en 1968 y posteriormente redescrita por Bandera & Conradi (2009b). En la descripción original esta especie presentaba 20 segmentos en la anténula, no se distinguía si el palpo mandibular tenía uno o dos segmentos (véase Hamond, 1968: Fig. 11) y las patas primera y cuarta carecían de las setas del basis. Trás la redescripción, la especie pasó a formar parte del grupo de especies con 21 segmentos en la anténula de la hembra, ya que el segmento 10(XIII) había sido pasado por alto en la descripción original. Además, el palpo de la mandíbula exhibía claramente dos segmentos y se podían observar con toda nitidez las setas del basis de las patas primera y cuarta (Bandera & Conradi, 2009b: Figs. 2A,C,3C,D). La antena de *A. ellisi* es muy característica, con un exópodo muy largo (seis veces más largo que ancho) que es muy poco común en el género, de ahí que esta característica la separe de todos sus congéneres; si bien aparece en otros géneros como *Stockmyzon* Bandera & Huys, 2008, *Orecturus* Humes, 1992 y *Kimcheres* Bandera & Conradi. La característica que distingue a *A. jeanyeatmanae*, especie descrita por Yeatman en 1970 y recogida en Chesapeake Bay (Virginia y Maryland, E.E.U.U.) asociada a las esponjas *Halichondria bowerbanki* Burton, 1930 y *Microciona prolifera* (Ellis & Solander, 1786), del resto de especies con 21 segmentos en la anténula de la hembra es la armadura del segmento libre de la quinta pata, que exhibe sólo dos setas lisas terminales (Yeatman, 1970: Figs. 18, 35). Esta especie, además, tiene unas ramas caudales casi tan largas como anchas, un sifón corto que alcanza sólo la inserción de los maxilípedos, un maxilípedo con seis segmentos y el exópodo de la quinta pata es cuatro veces más largo que ancho (Yeatman, 1970).

La especie tipo del género, *Asterocheres lilljeborgii*, fue descrita por Boeck en 1860 y resdescrita con posterioridad por varios autores, por ejemplo, Sars (1915) bajo el nombre de *Ascomyzon asterocheres* Boeck, si bien la redescripción más detallada es la realizada por Ivanenko & Ferrari (2003). Esta especie, de gran tamaño (puede alcanzar los 1,47 mm de longitud), se caracteriza por presentar el prosoma dorso-ventralmente aplanado con las pleuras laterales expandidas y apuntadas posteriormente hacia atrás (de contorno casi redondo). Otras características son: (1) un sifón corto, apenas alcanza la base de la maxila; (2) las ramas caudales son dos veces más largas que anchas; (3) la superficie del urosoma presenta espínulas; y (4) las setas terminales del lóbulo externo de la maxílula son más largas que las del lóbulo interno.

Asterocheres reginae fue descrita por Boxshall y Huys en 1994 y se caracteriza por tener un prosoma muy ancho (aproximadamente 1,16 veces más ancho que largo) y tanto el cefalotórax como los tres somitos pedígeros libres tienen márgenes epimerales bien desarrollados. El urosoma presenta grandes escamas epicuticulares planas ordenadas en filas irregulares superpuestas, unas ramas caudales ligeramente más largas que anchas, armadas con siete setas (seta I en la superficie lateral cerca del margen proximal) (Boxshall & Huys, 1994: Figs. 1C,D) y un segmento libre de la quinta pata muy largo (5,4 veces más largo que ancho) con tres setas terminales. Esta especie fue seleccionada por Huys y Boxshall (1991) como el sifonostomatoide típico porque retiene muchos de los caracteres plesiomórficos que manifiesta el orden, incluyendo la anténula de la hembra con 21 segmentos, el endópodo de la antena con tres segmentos y el exópodo con un segmento, el palpo mandibular tiene dos segmentos y el endópodo del maxilípedo presenta tres segmentos, al menos en el macho (Boxshall & Huys, 1994).

La última especie del grupo de Asterocheres con 21 segmentos en la anténula de la hembra, palpo mandibular con dos segmentos (subgrupo 21B) y prosoma dorso-ventralmente aplanado es *A. tubiporae*. Esta especie fue descrita por Kim (2004b) con 22 segmentos en la anténula de la hembra, sin embargo Bandera y Huys (2008) aludiendo a que ningún otro sifonostomatoide existente tiene más de 21 segmentos en la anténula, compararon la anténula de *A. tubiporae* con la de *A. reginae* y concluyeron que Kim (2004b) había inadvertidamente intercalado un segmento extra entre el segmento ancestral XIV que lleva la espina y el segmento XXI que lleva el estetasco. Años más tarde, Kim (2010) admitió que había descrito e ilustrado erróneamente la anténula de la hembra de *A. tubiporae*, ya que su quinceavo segmento estaba duplicado, y, por tanto, el número correcto de segmentos de la anténula era 21. Esta especie se caracteriza por presentar: (1) un prosoma circular, en forma de disco, con el tercer somito pedígero el doble de ancho que el anterior; (2) un sifón corto, sobrepasando ligeramente la inserción de los maxilípedos; (3) una maxílula muy característica, con dos de las setas del lóbulo interno marcadamente engrosadas y adornadas con una fila longitudinal de dientes como púas (Kim, 2010: Fig. 2C); (4) la quinta pata con un exópodo largo (4,4 veces tan largo como ancho) con tres setas terminales; (5) un proceso terminal interno en el tercer segmento del endópodo de la primera pata distintivamente curvado y afilado; más marcado en el macho; (6) la coxa de la cuarta pata carece de seta interna; y (7) un proceso posteroventral puntiagudo en las ramas caudales. Este proceso aparece también en *A. dysideae* y en *A. serrulatus*, sorprendentemente estas dos especies también tienen en común un prosoma expandido y con forma circular (Kim, 2004b).

Asterocheres hirsutus se puede distinguir de las 12 especies restantes del subgrupo 21B (con 21 segmentos en la anténula y dos segmentos en el palpo mandibular) por presentar: (1) un cuerpo esbelto, con el prosoma ovoide y el urosoma cilíndrico; (2) el urosoma, los apéndices orales y los segmentos de las patas natatorias cubiertos por espínulas (Bandera, Conradi & López-González, 2005: Figs. 1A,C,D,E,2G,H,4C,D); (3) las ramas caudales 2,5 veces más largas que anchas; (4) el sifón largo, alcanzando el esclerito intercoxal de la primera pata; (5) el lóbulo interno de la maxílula es más de cuatro veces la longitud del lóbulo externo; y (6) aunque en la descripción de la maxila se indica que presenta tres segmentos, en realidad se refiere a que cerca de la base de la syncoxa hay una sutura parcial que puede representar un vestigio de la articulación precoxa-coxa, además del segmento distal en forma de garra que esta formado con el basis y el endito basal (Boxshall, 1990).

Asterocheres genodon, descrita por Stock (1966b), redescrita por Kim (2010) y revisada por Bandera y Conradi (2013), se puede distiguir por tener: (1) el somito genital doble de la hembra con un ángulo en el margen posterior lateral precedido por unas 14 sétulas finas (Kim, 2010: Fig. 40H); (2) la garra terminal de la antena es delgada y muy larga (es más larga que el endópodo completo); (3) el sifón es largo, sobrepasa el esclerito intercoxal de la segunda pata; (4) el estilete mandibular es muy delgado en los dos tercios finales, aunque en la punta se ensancha un poco para contener a los cuatro dientes subapicales (Kim, 2010: Fig. 39H); (5) las garras terminales de la maxila y el maxilípedo son muy largas; en el caso de la maxila es mucho más larga que el segmento proximal; (6) el macho presenta dimorfismo sexual en el maxilípedo y en los endópodos de las dos primeras patas (Kim, 2010: Figs. 41E,F); y (7) las ramas caudales son ligeramente más largas que anchas y presentan siete setas caudales siendo la seta I pequeña, lisa y ventral (Kim, 2010: Fig. 39C). Este último caracter es muy poco común, ya que solo hay dos especies más en el género que presenten siete setas en las ramas caudales, *A. reginae* y *A. sarsi* (Boxshall & Huys, 1994; Bandera & Conradi, 2014).

Dos especies, de las 10 que nos quedan por comentar, son muy parecidas: *A. astroidicola* y *A. urabensis*. Ambas especies viven asociadas a una escleractinia, *Astroides calycularis* (Pallas, 1766) en Tarifa (España, Estrecho de Gibraltar) en el caso de *A.*

astroidicola y *Pocillopora damicornis* (L.) en Uraba Island (costa Pacífica de Panamá) en el caso de *A. urabensis*. Sin embargo, estas dos especies se diferencian por: (1) la garra terminal de la antena es más larga que el endópodo completo en *A. urabensis* y más corta que el endópodo en *A. astroidicola*; (2) el cono oral es más largo en *A. astroidicola* ya que sobrepasa el margen posterior del esclerito intercoxal de la segunda pata, en cambio en *A. urabensis* alcanza el esclerito intercoxal de la primera pata; (3) el lóbulo interno de la maxílula es menos de tres veces la longitud del lóbulo externo en *A. urabensis*, mientras que en *A. astroidicola* es más de cuatro veces la longitud y más de tres veces la anchura del lóbulo externo; (4) el segmento libre de la quinta pata tiene tres setas lisas y la seta del quinto somito pedígero es un tercio de la longitud del exópodo en *A. urabensis* y en *A. astroidicola* el exópodo tiene dos setas plumosas y una lisa y la seta del quinto somito pedígero es tan larga como el exópodo completo (Conradi, Bandera & López-González, 2006; Kim, 2004a). Además de estas diferencias, en *A. urabensis* se aprecian unos dimorfismos sexuales en las patas primera y tercera que no se han observado en *A. astroidicola.* La primera pata del macho de *A. urabensis* exhibe una espina externa alargada en el tercer segmento del endópodo (Kim, 2004a: Fig. 15E) y el tercer segmento del endópodo de la tercera pata presenta la armadura (1,I,3) y tiene un proceso interno distal (Kim, 2004a: Fig. 15F).

Asterocheres kervillei ha sido sinónima de *A. latus* durante más de 40 años, hasta que Bandera & Conradi (2009c) compararon las redescripciones de ambas especies y encontraron suficientes diferencias para mantenerlas como especies separadas. Estas diferencias fueron: (1) el patrón de fusión de las anténulas era diferente en las dos especies: mientras que en *A. latus* los tres últimos segmentos de la anténula tenían la fórmula 19(XXII-XXIII)-2, 20(XXIV-XXV)-3, 21(XXVI-XXVIII)-7; en *A. kervillei* era 19(XXII)-1, 20(XXIII-XV)-4, 21(XXVI-XXVIII)-7; (2) la garra terminal de la antena tenía la misma longitud que el endópodo completo en *A. latus*, mientras que en *A. kervillei* era mucho más corta que el endópodo; (3) el sifón era ligeramente más largo en *A. latus* ya que sobrepasaba la inserción de los maxilípedos si bien no alcanzaba el esclerito intercoxal de la primera pata; en cambio, en *A. kervillei* llegaba sólo a la inserción de los maxilípedos; (4) el estilete de la mandíbula presentaba una cavidad alargada en el tercio distal y el extremo era puntiagudo y liso en *A. latus*, mientras que en *A. kervillei* el extremo distal exhibía espínulas o dientes; (5) la seta interna de la coxa de la cuarta pata estaba presente, aunque muy reducida, en *A. latus* y en *A. kervillei* estaba ausente; (6) las ramas caudales de *A. latus* eran 2,5 veces más largas que anchas; en cambio, en *A. kervillei* eran apenas dos veces más largas que anchas; (7) el urosoma de *A. latus* tenía filas irregulares de escamas epicuticulares planas que en ocasiones se superponenían y en el caso de *A. kervillei*, en vez de escamas, presentaba espínulas ordenadas siguiendo un patrón simétrico en la superficie ventral (Bandera & Conradi, 2009c: Figs. 6C, 10D,E); y por último (8) el área genital de *A. latus* mostraba dos pequeñas setas plumosas, mientras que la de *A. kervillei* tenía una pequeña seta lisa y un elemento espiniforme. *A. kervillei* presentaba, además, dimorfismo sexual en el segundo y tercer segmento del endópodo de la primera pata del macho (Bandera & Conradi, 2009c: Fig. 9E).

Asterocheres tarifensis, especie recogida en Tarifa (Estrecho de Gibraltar, España) asociada a la escleractinia *Astroides calycularis* (Pallas), tiene un sifón corto que alcanza solo la inserción del maxilípedo y se caracteriza por tener la superficie del urosoma, principalmente el somito genital doble y los somitos posteriores, cubierto de grandes escamas epicuticulares superpuestas y carecer de estetasco en el segmento proximal de la maxila, lo que es raro en este subgrupo de especies (subgrupo 21B). De hecho, entre las especies con 21 segmentos en la anténula de la hembra sólo hay cuatro especies, además de *A. tarifensis*, que no tienen estetasco en la maxila (*A. corneliae, A. lilljeborgii, A. siphonatus,* y *A. suberitis*) y hay otras dos especies, *A. jeanyeatmanae* y *A. tenuicornis*, cuyas descripciones no mencionan nada al respecto (Bandera & Conradi, aceptado; Ivanenko & Ferrari, 2003; Conradi & Bandera, 2011; Bandera & Conradi, 2009a; Yeatman, 1970; Eiselt, 1965). Podemos distinguir a *A. tarifensis* de las especies antes mencionadas porque: (1) *A. corneliae* exhibe un único segmento en el plapo de la mandíbula, en vez de los dos segmentos que posee *A. tarifensis*; (2) *A. lilljeborgii* presenta el prosoma aplanado dorso-ventralmente y las ramas caudales son dos veces más largas que anchas en contraposición con el prosoma no aplanado de *A. tarifensis* y las ramas caudales apenas un poco más largas que anchas; (3) *A. siphonatus* muestra un sifón muy largo, que alcanza el margen posterior del esclerito intercoxal de la cuarta pata mientras que el sifón de *A. tarifensis* sólo llega a la inserción del maxilípedo; (4) las ramas caudales de *A. suberitis* son 1,5 veces más largas que anchas y las de *A. tenuicornis* seis veces más largas que anchas, en cambio las de *A. tarifensis* son ligeramente más largas que anchas; (5) *A. jeanyeatmanae* es la única especie del grupo que presenta sólo dos setas terminales en el exópodo de la quinta pata y *A. tarifensis* posee tres setas terminales que es lo habitual en el género (Bandera & Conradi, aceptado; Ivanenko & Ferrari, 2003; Conradi & Bandera, 2011; Bandera & Conradi, 2009a; Yeatman, 1970; Eiselt, 1965). El patrón de fusión de los segmentos de la anténula de *A. tarifensis* en la descripción original es errónea a partir del segmento 19 puesto que aparece como: 19(XXII)-2, 20(XXIII-XXIV)-4 y 21(XXV-XXVIII)-7 (Conradi & Bandera, 2011) cuando debería aparecer: 19(XXII-XXIII)-2, 20(XXIV-XXV)-4 y 21(XXVI-XXVIII)-7.

Asterocheres suberitis, al igual que la especie anterior, carece de estetasco en el segmento proximal de la maxila. Los caracteres que separan a esta especie de *A. tarifensis* son: (1) el cuarto somito pedígero de *A. tarifensis* tiene los márgenes laterales muy redondeados; en cambio, en *A.suberitis* el cuarto somito pedígero está en su mayor parte oculto bajo el somito que le precede y los márgenes laterales son menos redondeados; (2) al contrario que *A. tarifensis*, *A. suberitis* no presenta escamas epicuticulares en el urosoma; (3) *A. suberitis* muestra tres setas en el exópodo de la antena, en cambio *A. tarifensis* tiene sólo dos; (4) el estilete de la mandíbula de *A. tarifensis* posee siete grandes dientes subapicales y en *A. suberitis* el estilete es mucho más puntiagudo y solo tiene 5 dientes apenas perceptibles; y (5) una de las cuatro setas terminales del lóbulo interno de la maxílula de *A. suberitis* presenta espínulas subapicales y la punta en forma de cuchara (Bandera & Conradi, 2009a).

De las cuatro especies del subgrupo 21B que nos quedan por discutir, *A. peniculatus* y *A. flustrae* son muy parecidas puesto que comparten, además de los 21 segmentos en la anténula de la hembra, los dos segmentos del palpo mandibular y el prosoma no aplanado dorso-ventralmente, las siguientes características: (1) las ramas caudales son tan largas como anchas, casi cuadradas; (2) el segmento proximal de la maxila tiene estetasco; y (3) el maxilípedo posee seis segmentos. Sin embargo, cada una de estas especies presenta características que las distuingue: (1) los individuos de *A. peniculatus* son de menor tamaño (longitud media del cuerpo 723 μm) que los de *A. flustrae* (longitud media del cuerpo 950 μm); (2) *A. flustrae* tiene escamas epicuticulares ordenadas en filas irregulares en el urosoma mientras que *A. peniculatus* carece de esta ornamentación; (3) algunas de las setas de los segmentos proximales de la anténula de la hembra de *A. peniculatus* presentan el extremo romo con una seta diminuta en la punta; en cambio, en *A. flustrae* esas setas terminan en foma de boquilla, cuya base está rodeada por un círculo de dentículos cuticulares, con un poro apical (véase Ivanenko & Smurov, 1997: Figs. 11E,F); (4) el segundo y tercer segmento del endópodo de la antena de *A. peniculatus* tiene los extremos bifurcados lo cual no se ha observado en *A. flustrae*; y (5) el sifón es más largo en *A. peniculatus* puesto que alcanza el esclerito intercoxal de la primera pata; en cambio, en *A. flustrae* sólo llega a la inserción de los maxilípedos (Kim, 2010; Ivanenko & Smurov, 1997).

Para finalizar, las dos últimas especies del subgrupo 21B, *A. boeckii* y *A. hoi*, son especies parecidas en tener 21 segmentos en la anténnula de la hembra, dos segmentos en el palpo mandibular, el prosoma no aplanado dorso-ventralmente y el segmento proximal de la maxila con estetasco. Sin embargo, entre ellas también existen diferencias: (1) el prosoma de *A. boeckii* es más ancho y el cuarto somito pedígero está casi totalmente oculto bajo el somito que lo precede; por el contrario, el prosoma de *A. hoi* es más esbelto y el cuarto somito pedígero es totalmente visible; (2) la superficie dorsal del somito genital doble de *A. boeckii* está adornado con escamas epicuticulares planas ordenadas en un patrón irregular; mientras que en *A. hoi* no se ha observado esta ornamentación; (3) el área genital de *A. boeckii* muestra una seta y un elemento espiniforme y en *A. hoi* sólo hay una seta lisa y larga; (4) el exópodo de la quinta pata es 2,5 veces más largo que ancho en *A. hoi* y sólo 1,9 veces más largo que ancho en *A. boeckii*; (5) el ratio de longitud entre el lóbulo interno y externo de la maxílula es aproximadamente tres en *A. hoi* y sólo 1,8 en *A. boeckii*; y (6) las espinas terminales de los terceros segmentos de los exópodos de las patas segunda a cuarta son mucho más largos que el segmento completo en *A. boeckii* y, por el contrario, estas espinas son casi iguales o ligeramente más cortas que el segmento en *A. hoi* (Bandera & Conradi, 2013, aceptado). Por último destacaremos el error del patrón de fusión de los segmentos de la anténula de *A. hoi* que aparece en la descripción original a partir del segmento 19: 19(XXII)-2, 20(XXIII-XXIV)-4 y 21(XXV-XXVIII)-6 (Bandera & Conradi, 2013), cuando en realidad debería ser: 19(XXII-XXIII)-2, 20(XXIV-XXV)-4 y 21(XXVI-XXVIII)-6.

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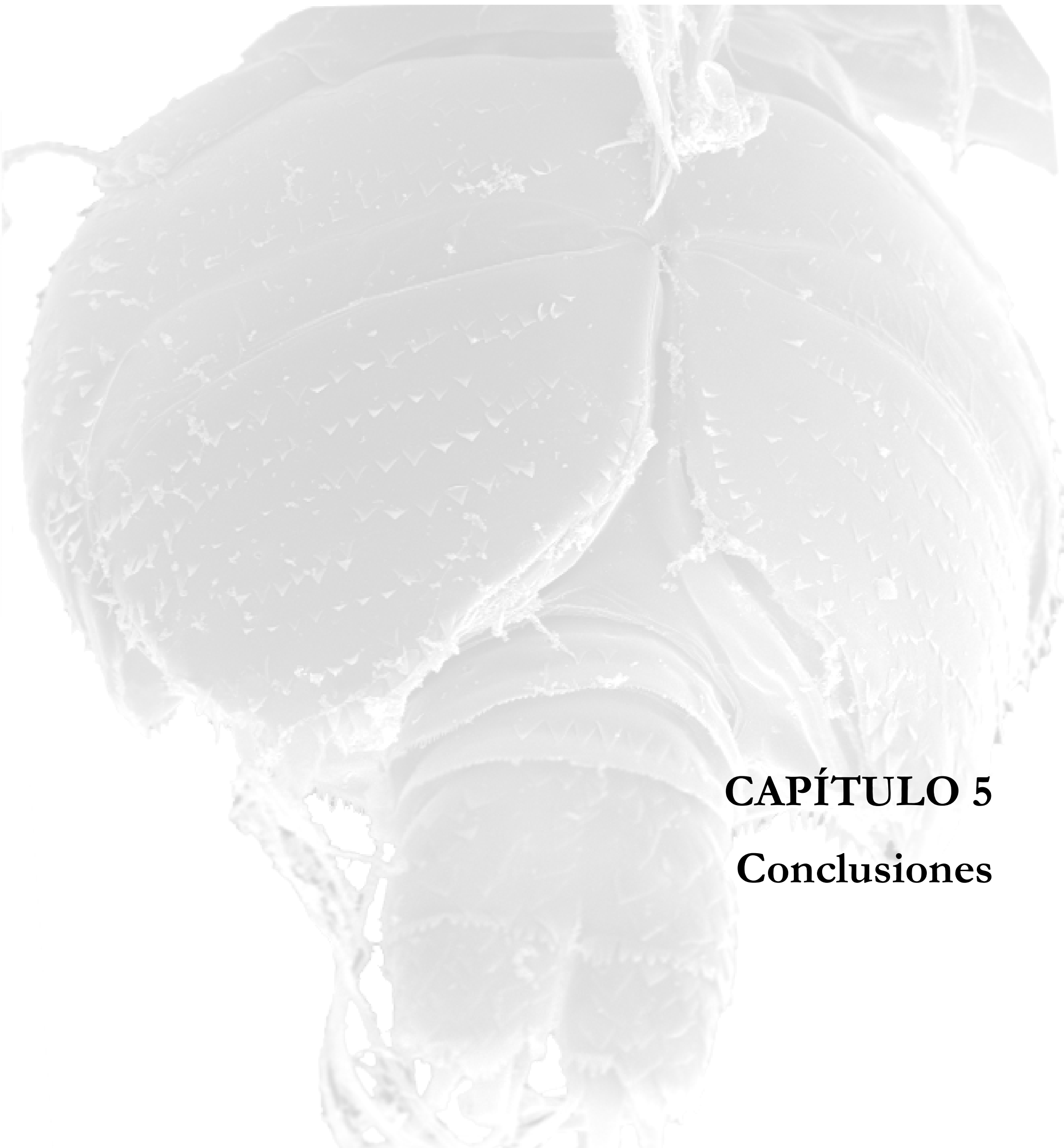


CAPÍTULO 5

Conclusiones

5.- CONCLUSIONES

A continuación se detallan las conclusiones obtenidas a partir del presente estudio.

1.- El género *Asterocheres* Boeck, 1860 está compuesto por 100 especies nominales, de las que 68 se consideran especies válidas, 17 especies están incompletamente descritas y 15 especies *inquirendae*.

2.- Durante la realización de esta memoria se han descrito ocho especies nuevas: *Asterocheres hirsutus* Bandera, Conradi & López-González, 2005, *Asterocheres astroidicola* Conradi, Bandera & López-González, 2006, *Asterocheres madeirensis* Bandera, Conradi & López-González, 2007, *Asterocheres sarsi* Bandera & Conradi, 2009, *Asterocheres tarifensis* Conradi & Bandera, 2011, *Asterocheres hoi* Bandera & Conradi, 2013, *Asterocheres eugenioi* Bandera & Conradi, 2014 y Stockmyzon crassus Bandera & Huys, 2008.

3.- Se han redescrito 21 species: *Asterocheres abyssi* (Hansen, 1923); *Asterocheres boeckii* (Brady, 1880), *Asterocheres bulbosus* Malt, 1991, *Asterocheres complexus* Stock, 1960, *Asterocheres corneliae* Schirl, 1973, *Asterocheres echinicola* (Norman, 1868), *Asterocheres ellisi* Hamond, 1968, *Asterocheres genodon* Stock, 1966, *Asterocheres halichondriae* Stock, 1966, *Asterocheres hongkongensis* Malt, 1991, *Asterocheres indicus* Sewell, 1949; *Asterocheres intermedius* (Hansen 1923); *Asterocheres latus* (Brady, 1872), *Asterocheres maxillatus* Stock, 1987, *Asterocheres minutus* (Claus, 1889), *Asterocheres ovalis* Sewell, 1949; *Asterocheres proboscideus* Stock, 1966, *Asterocheres rotundus* Malt, 1991, *Asterocheres scutatus* Stock, 1966, *Asterocheres siphonatus* Giesbrecht, 1897 y *Asterocheres suberitis* Giesbrecht, 1897.

4.- Se les ha restituido su status de "especie válida" a tres especies consideradas previamente como sinónimas: *Asterocheres kervillei* Canu, 1898, considerada anteriormente sinónima *Asterocheres echinicola* Giesbrecht, 1899 (esta especie actualmente es *Asterocheres latus* (Brady, 1872)). Por otra parte, *Cyclopicera lata* Brady 1872 se consideró sinónima de *Asterocheres echinicola* (Norman) *sensu* Giesbrecht, 1899 y actualmente es *Asterocheres latus* (Brady, 1872). Por último, *Ascomyzon latum* (Brady) *sensu* Sars, 1915 es actualmente *Asterocheres sarsi* Bandera & Conradi, 2009.

5.- Se ha considerado a la especie *Asterocheres abyssi* (Hansen, 1923) como taxón indeterminado.

6.- Se ha clasificado a las especies *Asterocheres antillensis* Varela, 2010, *Asterocheres espinosai* Varela, Ortiz & Lalana, 2007 y *Asterocheres tenerus* (Hansen, 1923) como especies *inquirendae*.

7.- Dos especies *Asterocheres canui* Giesbrecht, 1897 y *Asterocheres ventricosus* (Brian, 1927) se han considerado como especies descritas incompletamente y por tanto se han calificado como especies no válidas.

8.- Se ha relegado la especie *Asterocheres violaceus* (Claus, 1889) a sinónimo de *Asterocheres echinicola* (Norman, 1868).

9.- Basándonos en la especie *Asterocheres mucronipes* Stock, 1960 se ha descrito un nuevo género *Stockmyzon* Bandera & Huys, 2008 constituido por *Stockmyzon mucronipes* (Stock, 1960) y la nueva especie *Stockmyzon crassus* Bandera & Huys, 2008.

10.- Se han reinterpretado las ilustraciones de la especie *Asterocheres stimulans* Giesbrecht, 1897. Se designa al espécimen hembra ilustrado por Giesbrecht como lectotipo de *Asterocheres stimulans* y se considera al espécimen macho ilustrado por Giesbrecht co-específico con *Stockmyzon mucronipes* (Stock, 1960).

11.- Se ha excluido la especie *Asterocheres fastigatus* Kim, 2010 del género *Asterocheres* para incluirla en un nuevo género *Kimcheres* Bandera & Conradi.

12.- Se han aportado nuevas evidencias para incluir a la especie *Asterocheres longisetosus* Nair & Pillai, 1984 en el grupo de especies *inquirendae* y se indica que la descripción debe ser considerada como errónea.

13.- Se rehabilitan las grafías de los epítetos específicos *boeckii* y *lilljeborgii* como originalmente fueron descritas y de manera correcta según el Código Internacional de Nomenclatura Zoológica.

5.- CONCLUSIONS

The conclusions obtained from this study are detailed.

1.- The genus *Asterocheres* Boeck, 1860 includes 100 nominal species, which are sorted to 68 valid species, 17 incompletely described species and 15 species *inquirendae*.

2.- During the present study eight new species have been described: *Asterocheres hirsutus* Bandera, Conradi & López-González, 2005, *Asterocheres astroidicola* Conradi, Bandera & López-González, 2006, *Asterocheres madeirensis* Bandera, Conradi & López-González, 2007, *Asterocheres sarsi* Bandera & Conradi, 2009, *Asterocheres tarifensis* Conradi & Bandera, 2011, *Asterocheres hoi* Bandera & Conradi, 2013, *Asterocheres eugenioi* Bandera & Conradi, 2014 and Stockmyzon crassus Bandera & Huys, 2008.

3.- Twenty one species have been redescribed: *Asterocheres abyssi* (Hansen, 1923); *Asterocheres boeckii* (Brady, 1880), *Asterocheres bulbosus* Malt, 1991, *Asterocheres complexus* Stock, 1960, *Asterocheres corneliae* Schirl, 1973, *Asterocheres echinicola* (Norman, 1868), *Asterocheres ellisi* Hamond, 1968, *Asterocheres genodon* Stock, 1966, *Asterocheres halichondriae* Stock, 1966, *Asterocheres hongkongensis* Malt, 1991, *Asterocheres indicus* Sewell, 1949; *Asterocheres intermedius* (Hansen 1923); *Asterocheres latus* (Brady, 1872), *Asterocheres maxillatus* Stock, 1987, *Asterocheres minutus* (Claus, 1889), *Asterocheres ovalis* Sewell, 1949; *Asterocheres proboscideus* Stock, 1966, *Asterocheres rotundus* Malt, 1991, *Asterocheres scutatus* Stock, 1966, *Asterocheres siphonatus* Giesbrecht, 1897 and *Asterocheres suberitis* Giesbrecht, 1897.

4.- Three species previously considered as junior synonyms have been reinstated and now are determined as valid species: *Asterocheres kervillei* Canu, 1898 was treated before as junior synonym of *Asterocheres echinicola* Giesbrecht, 1899 (this last species is now *Asterocheres latus* (Brady, 1872)). On the other hand, *Cyclopicera lata* Brady 1872 was considered as synonym of *Asterocheres echinicola* (Norman) *sensu* Giesbrecht, 1899 and presently is *Asterocheres latus* (Brady, 1872). Finally, *Ascomyzon latum* (Brady) *sensu* Sars, 1915 whose specimens Sars stated to be identical to *Cyclopicera lata* (Brady), is now *Asterocheres sarsi* Bandera & Conradi, 2009.

5.- *Asterocheres abyssi* (Hansen, 1923) has been classified as an undetermined taxon.

6.- *Asterocheres antillensis* Varela, 2010, *Asterocheres espinosai* Varela, Ortiz & Lalana, 2007 and *Asterocheres tenerus* (Hansen, 1923) have been classified as species *inquirendae*.

7.- *Asterocheres canui* Giesbrecht, 1897 and *Asterocheres ventricosus* (Brian, 1927) have been considered as incompletely described species and therefore they have been classified as no valid species.

8.- *Asterocheres violaceus* (Claus, 1889) has been relegated to a synonym of *Asterocheres echinicola* (Norman, 1868).

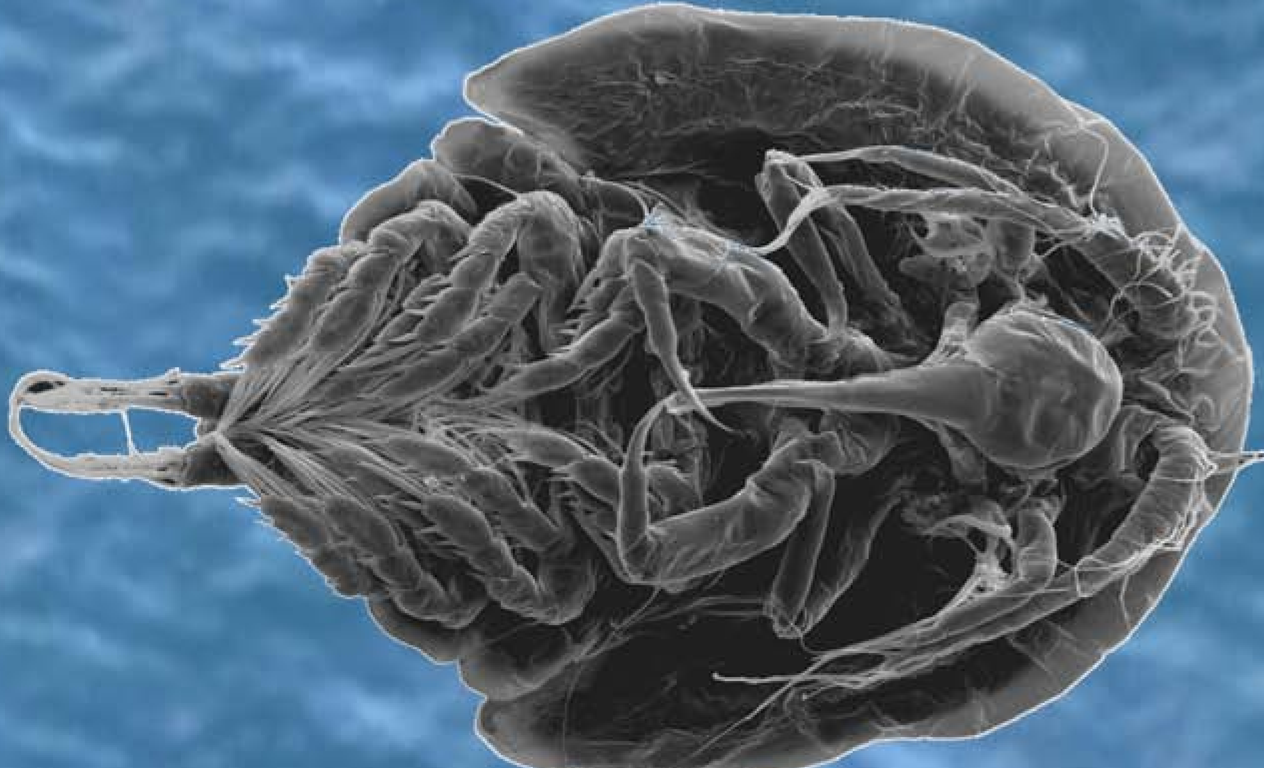
9.- A new genus *Stockmyzon* Bandera & Huys, 2008 has been erected to accomodate *Asterocheres mucronipes* Stock, 1960, presently *Stockmyzon mucronipes* (Stock, 1960), and the new species *Stockmyzon crassus* Bandera & Huys, 2008.

10.- Based on the reinterpretation of Giesbrecht´s (1899) illustrations of *Asterocheres stimulans* Giesbrecht, 1897: the female specimen illustrated by Giesbrecht (1899) is designated as the lectotype of *A. stimulans* and the male illustrated in Giesbrecht (1899) is considered as conspecific with *Stockmyzon mucronipes* (Stock, 1960).

11.- A new genus, *Kimcheres* Bandera & Conradi, has been erected to accomodate the species *Asterocheres fastigatus* Kim, 2010, now named *Kimcheres fastigatus* (Kim, 2010) comb. nov.

12.- New evidences are provided to include the species *Asterocheres longisetosus* Nair & Pillai, 1984 in the group of species *inquirendae*. The original description is inadequate and inaccurate and therefore it should be considered as erroneous.

13.- The correct spelling of the specific epithet *boeckii* and *lilljeborgii* are reinstated as they were originally described and according to the International Code of Zoological Nomenclature.



Revisión del género *Asterocheres* Boeck 1860 (Copepoda, Siphonostomatoida, Asterocheridae)

M. E. Bandera

Los copépodos son un grupo de diminutos crustáceos acuáticos con una amplia diversidad de estructuras y hábitos así como una gran capacidad de adaptación. Aunque estos pequeños crustáceos son conocidos como miembros abundantes del plancton y del bentos, también han tenido un gran éxito ecológico formando distintos grados de asociación con los diversos filos de Metazoos. El orden Siphonostomatoida es uno de los nueve órdenes de la subclase Copepoda, y el único que incluye especies exclusivamente asociadas o parásitas de otros metazoos. La autapomorfía que define a este orden es la presencia de una mandíbula con estilete típicamente contenido en un cono oral o sifón. La familia con mayor número de géneros es Asterocheridae, que es además una de las más plesiomórficas. Esta familia es muy heterogénea y sus representantes pueden vivir como asociados internos o externos de una amplia variedad de filos de invertebrados marinos aunque algunos hospedadores son aún desconocidos. El género que presenta un mayor número de especies es *Asterocheres*; si bien muchas descripciones están incompletas o son erróneas, lo que hace muy difícil compararlas con sus congéneres. En la mayoría de los casos, estas especies no han vuelto a ser recogidas desde su descripción original, por tanto para estudiarlas hay que recurrir al material depositado en los museos. En la presente memoria se revisa el género *Asterocheres* a partir de material recogido por personal del grupo de investigación y material depositado en distintos museos europeos: (1) el género *Asterocheres* se compone de 100 especies nominales; (2) se describen ocho especies nuevas; (3) se redescriben 21 especies; (4) se nombran dos géneros nuevos; (5) se le devuelve el status de "especie válida" a tres especies consideradas previamente como sinónimas; (6) se considera una especie como taxón indeterminado, dos especies como "incompletamente descritas" y tres especies como *inquirendae*; (7) se relega *Asterocheres violaceus* a sinónimo de *Asterocheres echinicola*; (8) se nombra lectotipo para la especie *Asterocheres stimulans*; (9) se confirma la clasificación *inquirendae* para *Asterocheres longisetosus* y se cataloga su descripción como errónea; y (10) se rehabilitan las grafías originales de los epítetos específicos *boeckii* y *lilljeborgii* de acuerdo con el Código Internacional de Nomenclatura Zoológica.