



## A new species of Phyllomeniidae (Mollusca Solenogastres: Sterrofustia) from the South Shetland Islands, Antarctica

### Una nueva especie de Phyllomeniidae (Mollusca Solenogastres: Sterrofustia) de las Islas shetland del sur, antártida

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#### ABSTRACT

*Ocheyoherpia bursata* is a new species of Phyllomeniidae (Mollusca Solenogastres: Sterrofustia) collected at a depth of 248 m, on a gravel bottom off Deception Island (South Shetland Islands, Antarctica). The radula is distich, formed by pairs of hooked teeth (up to 48  $\mu$ m long x 11  $\mu$ m wide), each tooth with 5-6 lateral short denticles and a pair of long, curved and fused distal denticles, these distal denticles are located in the same plane as the radular tooth. Midgut with a pair of ventrolateral sacs posteriorly, which run ventrally under the spawning duct. The new species is compared with other two species of the genus. An amended diagnosis of the genus *Ocheyoherpia* is proposed.

#### RESUMEN

*Ocheyoherpia bursata* es una nueva especie de Phyllomeniidae (Mollusca, Solenogastres: Sterrofustia) recogida a 248 m de profundidad en un fondo de gravas en la Isla Decepción (Islas Shetland del Sur, Antártida). Rádula dística formada por pares de dientes ganchedos (hasta 48  $\mu$ m de largo x 11  $\mu$ m de ancho), cada diente con 5-6 denticulos laterales cortos y con un par de denticulos distales curvados y fusionados en su extremo distal, estos denticulos distales están situados en el mismo plano que el diente radular. El intestino medio presenta posteriormente un par de bolsas ventrolaterales situadas ventralmente al conducto de desove. La nueva especie se compara con las otras dos del género. Se propone una enmienda a la diagnosis del género *Ocheyoherpia*.

KEY WORDS: *Ocheyoherpia bursata*, Solenogastres, South Shetland Islands, Antarctica.

PALABRAS CLAVE: *Ocheyoherpia bursata*, Solenogastros, Islas Shetland del Sur, Antártida.

#### INTRODUCTION

During a sampling programme under the BENTART'95 project, a specimen was collected off Deception Island (South Shetland Island, Antarctica) that proved to belong to a new species of Solenogastres. Under the current classifi-

cation, the Solenogastres are grouped into four orders based on the type of the mantle sclerites. The mantle, in the orders Pholidoskepia Salvini-Plawen, 1978, and Neomeniamorpha Pelseneer, 1906, has scales, whereas in the orders

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Sterrofustia Salvini-Plawen, 1978, and Cavibelonia Salvini-Plawen, 1978, mostly acicular sclerites are found. The order Sterrofustia, to which the species described here belongs, is characterized by solid acicular sclerites unlike in the order Cavibelonia where the acicular sclerites are hollow. The order Sterrofustia comprises nine species, grouped into three families with seven genera. As in all the families of the class Solenogastres, the three families belonging to the order Sterrofustia are based on the combinations of two features: the radula type and the ventral foregut glandular organs. The family Phyllomeniidae Salvini-Plawen, 1978, to which this new species belongs, is characterized by a distich radula and subepithelial ventral foregut glandular organs (type A after SALVINI-PLAWEN, 1978) in ampoule-shaped, whereas the other two families have epithelial ventral foregut glandular organs (type B after SALVINI-PLAWEN, 1978).

## MATERIAL AND METHODS

One specimen was collected during the Spanish campaign (BENTART'95) to study the Antarctic benthos at 248 m depth, at station R-22, to the south of Deception Island (South Shetland Islands, Antarctica), using a rock dredge on a gravel bottom. The specimen was fixed and preserved in 70% alcohol. The sclerites were studied by separation of small pieces of cuticle from the central dorsal area of the body and from the ventral groove. These pieces were treated with 5% sodium hypochloride for 12 h in order to isolate the sclerites. The sclerites were later rinsed with distilled water, dried under a heater at 40°C and mounted with synthetic resin. For the anatomical study, the specimen was decalcified in ethylenediaminetetraacetic acid (EDTA) solution for 12 h, cut in paraffin in a series of 10 µm cross-sections. The staining method used was Azan (after Heidenhain) and the anatomy was reconstructed from the serial cross-sections.

## RESULTS

### Order STERROFUSTIA Salvini-Plawen, 1978

### Family PHYLLOMENIIDAE Salvini-Plawen, 1978

### *Ocheyoherpia* Salvini-Plawen, 1978

Type species: *Ocheyoherpia lituifera* Salvini-Plawen, 1978

*Amended diagnosis:* Cuticle thick or thin with solid, acicular and hooked sclerites. Mouth opening in the atrium, directly or via a posterior channel without sclerites. Radula distich, teeth with a pair of curved

and fused distal denticles. Midgut with diverticula. Without dorso-terminal sense organ. Unpaired genital orifice. With copulatory spicules and associated gland. Without respiratory folds.

### *Ocheyoherpia bursata* new species

**Type:** The holotype (cut in serial sections) is deposited in the Museo Nacional de Ciencias Naturales of Madrid, number MNCN 15.02/10.

**Type locality:** Deception Island (station R-22-BENTART'95) South Shetland Islands, Antarctica (63° 03' 26" S; 60° 39' 26" W) 248 m depth.

**Derivatio nominis:** The specific name, *bursata*, refers to the midgut sacs observed in the posterior part of the animal.

*Diagnosis:* Body measures 2.25 mm x 0.55 mm. Moderately thick cuticle

without keel, carina or protuberances. Two types of solid oar-shaped scales,

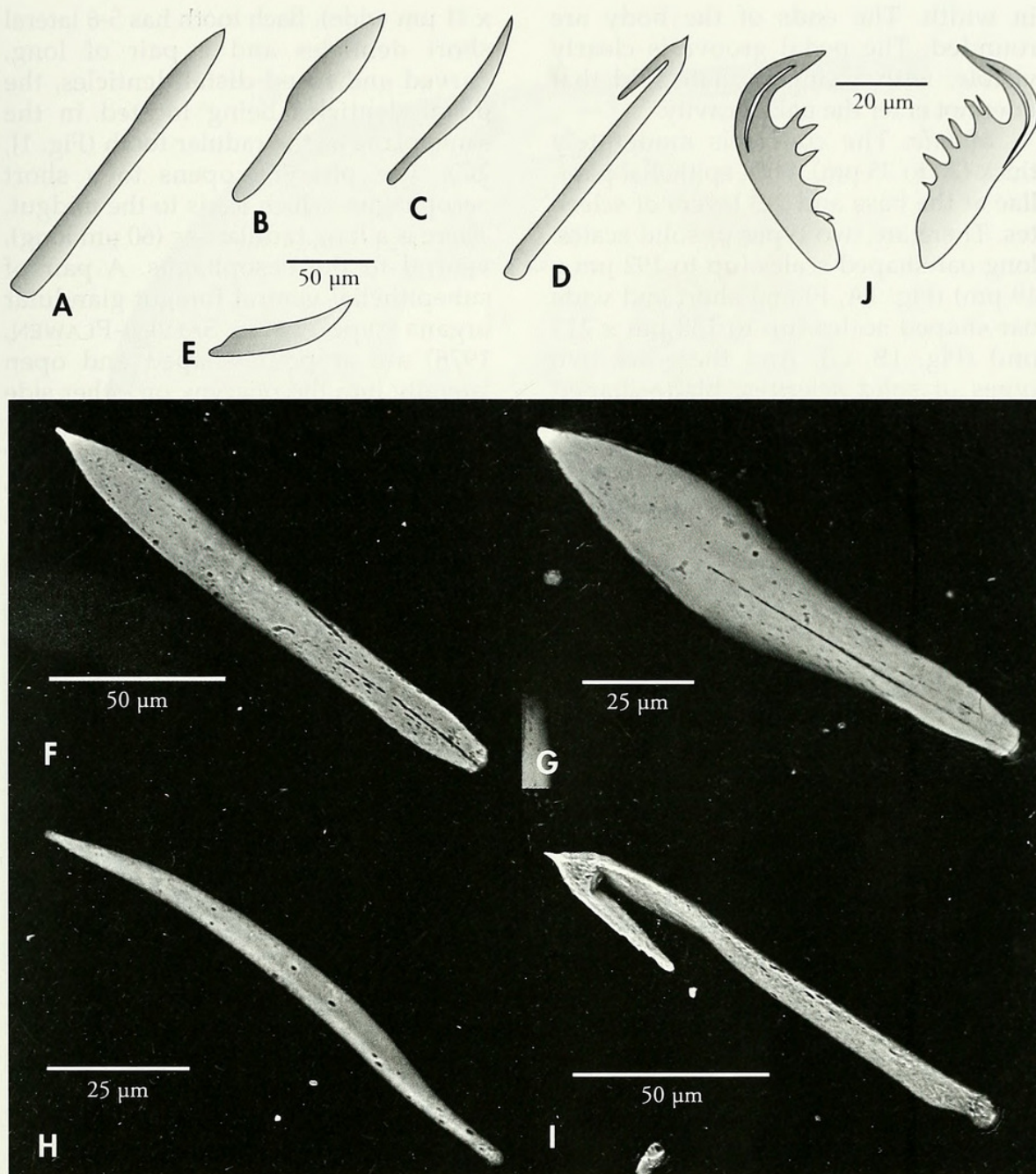


Figure 1. Mantle sclerites, and radular teeth of *Ocheyoherpia bursata* n. sp. A, F: long oar-shaped scale; B, G: short and wide oar-shaped scale; C, H: blade-shaped acicular sclerite; D, I: Hooked sclerite; E: blade-shaped scale from along the pedall groove; J: radular teeth

*Figura 1. Escleritos del manto y diente radular de Ocheyoherpia bursata n. sp. A, F: escama larga en forma de remo; B, G: escama corta y ancha en forma de remo; C, H: esclerito acicular en forma de hoja de cuchillo; D, I: esclerito ganchudo; E: escama en forma de hoja de chuchillo del surco pedio; J: diente radular.*

solid blade-shaped acicular sclerites and solid hooked sclerites. Mouth opens directly in the atrium. Pedal groove with a fold that does not enter the pallial cavity. Radula distich, teeth with 5-6 lateral denticles and one pair of curved and fused distal denticles. Midgut with

pair of dorso-rostral caeca and posterior pair of ventro-lateral sacs. Paired seminal vesicles. With paired seminal receptacles. Three pairs of copulatory spicules.

#### *Description*

*General morphology:* The specimen measures 2.25 mm in length x 0.55 mm

in width. The ends of the body are rounded. The pedal groove is clearly visible, with a single ciliate fold that does not enter the pallial cavity.

**Mantle:** The cuticle is moderately thick (30 to 35  $\mu\text{m}$ ), with epithelial papillae at the base and 2-3 layers of sclerites. There are two types of solid scales: long oar-shaped scales (up to 192  $\mu\text{m}$  x 19  $\mu\text{m}$ ) (Fig. 1A, F) and short and wide oar-shaped scales (up to 138  $\mu\text{m}$  x 213  $\mu\text{m}$ ) (Fig. 1B, G). And there are two types of solid sclerites: blade-shaped acicular sclerites (up to 119  $\mu\text{m}$  x 12.5  $\mu\text{m}$ ) (Fig. 1C, H) and hooked sclerites with a sharp point at the top of the hook (up to 173  $\mu\text{m}$  x 12  $\mu\text{m}$ ) (Fig. 1D, I). Blade-shaped scales occur along the pedal groove (up to 90  $\mu\text{m}$  x 14.5  $\mu\text{m}$ ) (Fig. 1E).

**Pallial cavity:** The pallial cavity is small and lacks respiratory folds and connects to the exterior through a narrow ventro-terminal opening (Fig. 3A). The anus is narrow and opens into the cavity dorsally. The unpaired genital aperture is located in the dorso-frontal wall of the pallial cavity.

**Sense organs and nervous system:** The atrio-buccal cavity connects to the exterior through a small opening. The lateral and dorsal walls of the atrium have a great number of individual and bifurcated papillae. There is no dorso-terminal sense organ. The cerebral ganglion is voluminous (150  $\mu\text{m}$  in width x 65  $\mu\text{m}$  in length), and is located dorsal to the pharynx (Fig. 2A). The lateral ganglia are small (40  $\mu\text{m}$  x 20  $\mu\text{m}$ ) and are situated on either sides of the cerebral ganglion. Two ventral ganglia (40-45  $\mu\text{m}$  in diameter) are located latero-ventral to the pharynx, and are found on the posterior area of the pedal pit. A pair of buccal ganglia (20  $\mu\text{m}$  in diameter) are located latero-dorsally to the pharynx. No suprarectal commissure was located.

**Digestive tract:** The mouth opens into the posterior area of the atrium (Fig. 2A). The buccal opening leads to a long pharynx with thickened walls and dorsal pharyngeal glands in its front part. The radula is distich, formed by pairs of hooked teeth (up to 48  $\mu\text{m}$  long

x 11  $\mu\text{m}$  wide). Each tooth has 5-6 lateral short denticles and a pair of long, curved and fused distal denticles, the distal denticles being located in the same plane as the radular tooth (Fig. 1J, 2C). The pharynx opens to a short oesophagus, which leads to the midgut. There is a long radular sac (60  $\mu\text{m}$  long), ventral to the oesophagus. A pair of subepithelial ventral foregut glandular organs (type A after SALVINI-PLAWEN, 1978) are ampoule-shaped and open laterally into the pharynx on either side of the beginning of the radula (Fig. 2A, C). The midgut has thick, glandular walls with lateral constrictions due to the dorso-ventral musculature. There is a very wide dorso-rostral caecum which frontally splits into two pouches (Fig. 2A, B). The posterior part of the midgut is narrow. It is extended postero-laterally by in a pair of sacs (similar to those described by HANDL (2002) in the posterior body of *Imeroherpia laubieri*). These run ventral to the spawning duct (Fig. 3A, C-E). Their dorsal walls have a glandular appearance similar to that observed in the midgut. The rectum is narrow and opens dorsally into the pallial cavity.

**Reproductive system:** The gonads were full of sperm and eggs. A pair of large sperm filled seminal vesicles lead laterally into the gonopericardial ducts, which also contain sperm (Fig. 3A, B). The pericardium is voluminous and also contains sperm. The heart is located in the dorsal wall of the pericardium. Two short pericardial ducts lead from the posterior part of the pericardium, which curve and turn towards the anterior part of the pericardium, and then laterally to lead into the mid part of the spawning duct, when this is still unpaired (Fig. 3A, E). The spawning duct is short (225  $\mu\text{m}$  long), its front half is paired, its posterior half is unpaired, wide and dorso-ventrally flattened. It opens dorso-rostrally into the pallial cavity through an unpaired genital pore. There are two small seminal receptacles, which lead into the dorso-rostral part of each spawning duct (Fig. 3A, C). There are three pairs of copulatory spicules and one

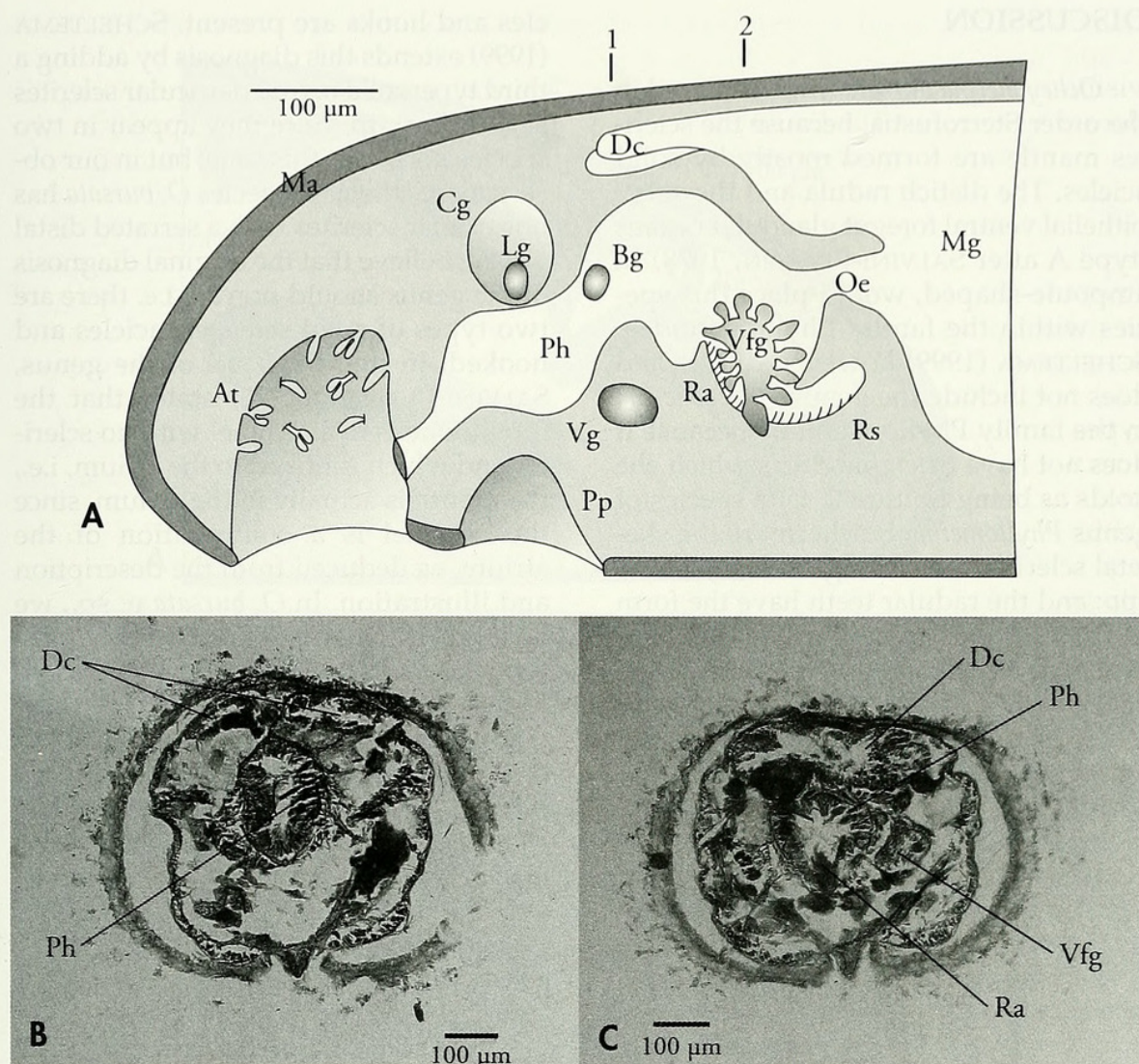


Figure 2. A: Schematic organization of the anterior part of the body of *Ocheyoherpia bursata* n. sp. B, C: Microphotographs of the cross-sections of the anterior region of the body corresponding to lines 1, 2. At: Atrial sense organ; Bg: Buccal ganglion; Cg: Cerebral ganglion; Dc: Dorsal caecum; Lg: Lateral ganglion; Ma: Mantle; Mg: Midgut; Oe: Oesophagus; Ph: Pharynx; Pp: Pedal pit; Ra: Radula; Rs: Radular sac; Vfg: Ventral foregut glandular organ; Vg: Ventral ganglion.

Figure 2. A. Organización esquemática de la parte anterior del cuerpo de *Ocheyoherpia bursata* n. sp. B, C. Microfotografías de los cortes en sección de la región anterior del cuerpo correspondientes a las líneas 1, 2. At: Órgano sensitivo atrial; Bg: Ganglio bucal; Cg: Ganglio cerebral; Dc: Ciego dorsal; Lg: Ganglio lateral; Ma: Manto; Mg: Intestino; Oe: Esófago; Ph: Faringe; Pp: Foseta pedia; Ra: Rádula; Rs: Saco radular; Vfg: Órgano glandular ventral de la faringe; Vg: Ganglio ventral.

pair of associated glands (Fig. 3A, D). The copulatory spicules comprise two groups of three located ventro-laterally, each group includes a long spicule (approximately 475 µm), a second shorter spicule (approximately 295 µm), located distally from the first, both extending to the pallial cavity and a third short spicule (approximately 100 µm) located in the area where the copulatory gland nar-

rows and terminates. The two copulatory glands are long (approximately 430 µm) and tubular (Fig. 3A, B), the glandular walls are very similar in appearance to the walls of the spawning duct. Anteriorly copulatory glands are wide (105 µm in diameter), posteriorly these glands narrow in a duct which appears to open on the posterior third of the longest copulatory spicule (Fig. 3A).

## DISCUSSION

*Ocheyoherpia bursata* n. sp. is placed in the order Sterrofustia, because the sclerites mantle are formed mostly by solid acicles. The distich radula and the subepithelial ventral foregut glandular organs (type A after SALVINI-PLAWEN, 1978) in ampoule-shaped, would place this species within the family Phyllomeniidae. SCHELTEMA (1999) however, differs and does not include the genus *Ocheyoherpia* in the family Phyllomeniidae because it does not have true gonoducts which she holds as being unique to true species of genus *Phyllomenia*. Furthermore the skeletal sclerites are lacking in *Ocheyoherpia* spp; and the radular teeth have the form of a bar with denticles, unlike the distichous hooks of the Phyllomeniidae. Nevertheless we think, as SALVINI-PLAWEN (1978, 2003), that the presence of true gonoducts could represent a specialisation within that genus. The sclerites mantle are mostly formed by solid acicles like genus *Phyllomenia* and *O. bursata* n. sp. has two types of oar-shaped scales similar to those described in species of the genera *Phyllomenia* Thiele, 1913, and *Lituiherpia* Salvini-Plawen, 1978 (SALVINI-PLAWEN, 1978). And the type of radula presented by the genus *Ocheyoherpia*, see Figure 1J here, Figure 93 (SALVINI-PLAWEN, 1978) in the original descriptions of *Ocheyoherpia lituifera* Salvini-Plawen, 1978 and Figure 4 (SCHELTEMA, 1999) in the original descriptions of *Ocheyoherpia trachia* Scheltema, 1999, show that they have radulae formed by pairs of hooked teeth with smaller lateral denticles, i.e., distich radulae, like those of the Phyllomeniidae and not bar-shaped radular teeth with denticles.

*O. bursata* n. sp., has characters diagnostic of the genus in the sense of SALVINI-PLAWEN (1978) and SCHELTEMA (1999). Some characters, however, are particular to this new species and do not correspond with those of the other two species of the genus (*O. lituifera* and *O. trachia*) and lead us to specify the diagnosis of the genus. In the original diagnosis of the genus (SALVINI-PLAWEN, 1978), it is reported that types of sclerites: solid aci-

cles and hooks are present. SCHELTEMA (1999) extends this diagnosis by adding a third type: solid serrated acicular sclerites at the distal tip, since they appear in two species known at this time; but in our observations, the new species *O. bursata* has no acicular sclerites with a serrated distal tip. We believe that the original diagnosis of the genus should prevail, i.e. there are two types of solid sclerites: acicles and hooked. In the diagnosis of the genus, SALVINI-PLAWEN (1978) states that the mouth opens in a channel with no sclerites and which is linked to the atrium, i.e., the mouth is actually in the atrium, since the channel is a continuation of the atrium, as deduced from the description and illustration. In *O. bursata* n. sp., we note that the mouth is clearly in the posterior part of the atrium; for this reason, in the generic diagnosis, should indicate that the mouth opens into the atrium, directly or via a posterior channel without sclerites. The radula in the genus *Ocheyoherpia* is distich, as per the original diagnosis (SALVINI-PLAWEN, 1978). Our observations coincide with those of SCHELTEMA (1999) in that the radular teeth present a pair of characteristic curved and fused distal denticles, a character which should be added to the diagnosis of the genus. In *O. bursata* n. sp., the distal denticles are located in the same plane as the rest of the radular tooth and are not curved upwards and back, as described by SCHELTEMA (1999) in *O. trachia*, so that this latter characteristic should not be included in the diagnosis. Consequently, we include an amended diagnosis of the genus *Ocheyoherpia* in the Results section.

Before this study two species of the genus *Ocheyoherpia* were known, both from Antarctic or sub-Antarctic waters (SALVINI-PLAWEN, 1978; SCHELTEMA, 1999): *O. lituifera* Salvini-Plawen, 1978 is known of the South Sandwich Islands, South Georgia and the South Shetland Islands; and *O. trachia* Scheltema, 1999 is known of the Macquarie Island.

There are clear differences (Table I) between *O. bursata* n. sp. and the other two species of the genus (SALVINI-PLAWEN, 1978; SCHELTEMA, 1999). *O. bursata*

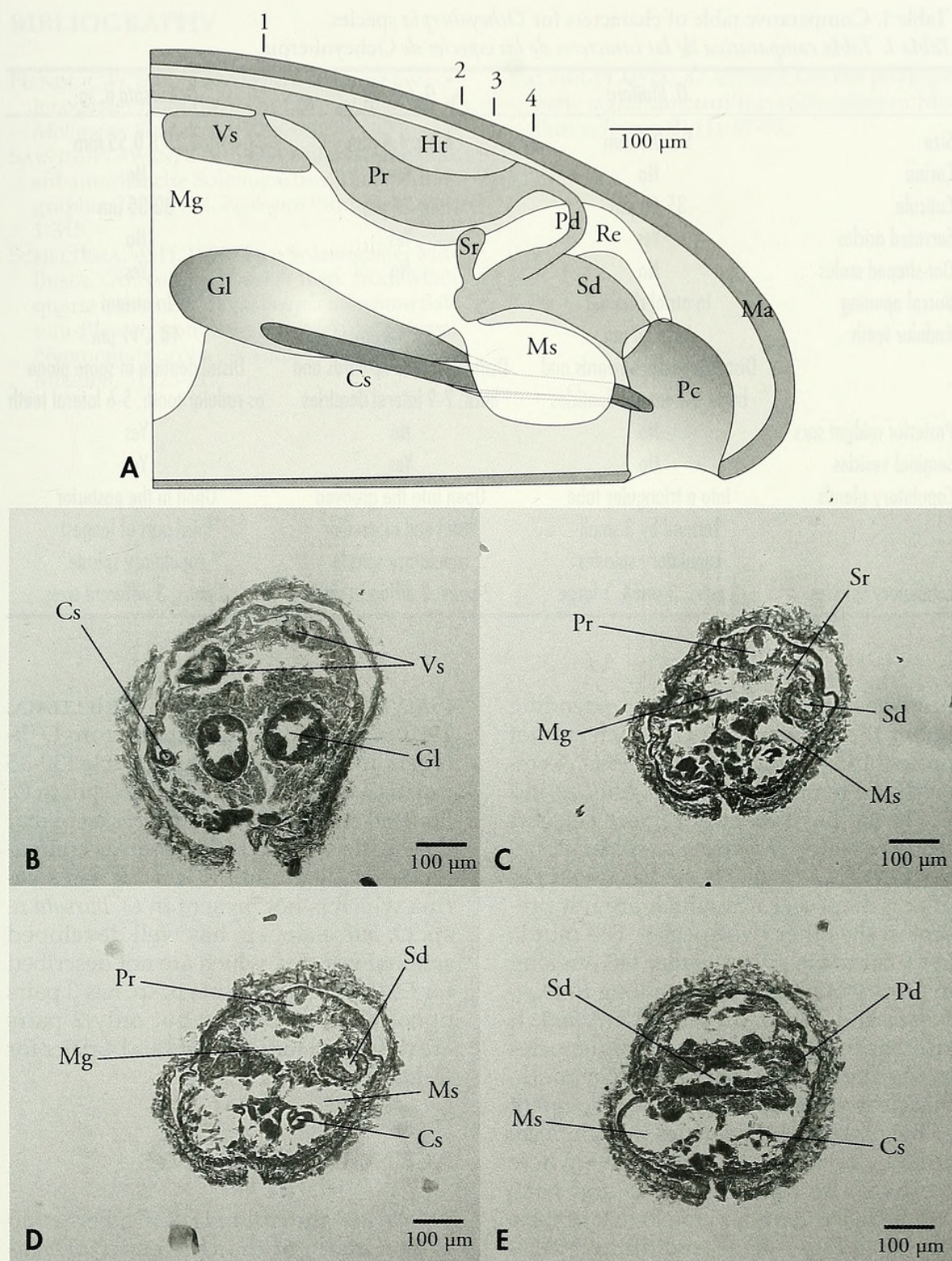


Figure 3. A: Schematic organization of the posterior part of the body of *Ocheyoherpia bursata* n. sp. B, C, D, E: Microphotographs of the cross-sections of the posterior region of the body corresponding to lines 1, 2, 3, 4. Cs: Copulatory spicule; Gl: Copulatory gland; Ht: Heart; Ma: Mantle; Mg: Midgut; Ms: Midgut sac; Pc: Pallial cavity; Pd: Pericardioduct; Pr: Pericardium; Re: Rectum; Sd: Spawning duct; Sr: Seminal receptacle; Vs: Seminal vesicle.

Figure 3. A: Organización esquemática de la parte posterior del cuerpo de *Ocheyoherpia bursata* n. sp. B, C, D, E: Microfotografías de los cortes en sección de la región posterior del cuerpo correspondientes a las líneas 1, 2, 3, 4. Cs: Espículas copulatrizes; Gl: Glándula copulatríz; Ht: Corazón; Ma: Manto; Mg: Intestino; Ms: Saco del intestino; Pc: Cavity paleal; Pd: Pericardioducto; Pr: Pericardio; Re: Recto; Sd: Conducto de desove; Sr: Receptáculo seminal; Vs: Vesícula seminal.

Table I. Comparative table of characters for *Ocheyoherpia* species.Tabla I. Tabla comparativa de los caracteres de las especies de *Ocheyoherpia*.

	<i>O. lituifera</i>	<i>O. trachia</i>	<i>O. bursata</i> n. sp.
Size	5 x 0.5 mm	6.5 x 1.4 mm	2.25 x 0.55 mm
Carina	No	Yes	No
Cuticula	35-60 µm	18-22 µm	30-35 µm
Serrated acicles	Yes	Yes	No
Oar-shaped scales	No	No	Yes
Buccal opening	In atrial channel	---	In atrium
Radular teeth	64 x 10 µm	75 x 18 µm	48 x 11 µm
	Distal denticles upwards and back. 5-6 lateral denticles	Distal denticles upwards and back. 7-9 lateral denticles	Distal denticle in same plane as radular tooth. 5-6 lateral teeth
Posterior midgut sacs	No	No	Yes
Seminal vesicles	No	Yes	Yes
Copulatory glands	Into a triangular tube formed by 3 small copulatory spicules	Open into the grooved distal end of smaller copulatory spicule	Open in the posterior third part of longest copulatory spicule
Copulatory spicules	4 pairs, 3 small, 1 large	2 pairs, 2 different sizes	3 pairs, 3 different sizes

n. sp. has a pair of midgut sacs extending under the spawning duct, which are not present in *O. lituifera* and *O. trachia*. As regards the mantle sclerites, *O. lituifera* and *O. trachia* have distally serrate acicular sclerites which *O. bursata* n. sp. lacks, nevertheless, *O. bursata* n. sp. has two types of oar-shaped scales which are not present in the other two species. The radula in *O. bursata* n. sp. is smaller (48 µm long in *O. bursata* n. sp. by 64 µm long in *O. lituifera* and 75 µm long in *O. trachia*). It also has the pair of fused distal denticles in the same plane as the radular tooth, this clearly differs from the arrangement of the fused distal denticles in *O. lituifera* and *O. trachia* (SCHELTEMA, 1999), where the denticles curve upwards and back and lie in a different plane to that of their base (see Figs . 4D, F and 5B in SCHELTEMA, 1999). The copulatory glands in *O. bursata* n. sp. open on the posterior third part of the longest copulatory spicule, however in *O. lituifera* it opens into a triangular tube formed by the three small copulatory spiculae and in *O. trachia* it opens into the grooved and ridged distal end of the smaller copulatory spicule. *O. bursata* n. sp. further differs (Table I) from each of the other two species in the genus

(SALVINI-PLAWEN, 1978; SCHELTEMA, 1999): *O. bursata* n. sp. differs from *O. lituifera* in that it has a thin cuticle (30-35 µm in *O. bursata* n. sp. and 35-60 µm in *O. lituifera*) and differs from *O. trachia* in that the cuticle is thicker (30-35 µm as compared with 18-22 µm). *O. trachia* has a carina which is not present in *O. bursata* n. sp. *O. bursata* n. sp. has well developed seminal vesicles, which are not described for *O. lituifera*. *O. bursata* n. sp. has 3 pairs of copulatory spicules but only 2 pairs are described for *O. trachia* and 4 pairs for *O. lituifera*

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