



## New species of Mollusca Solenogastres from the Bellingshausen Sea and the Antarctic Peninsula (Bentart-2006 Expedition)

### Nuevas especies de Moluscos Solenogastres del Mar de Bellingshausen y Península Antártica (Expedición Bentart-2006)

Oscar GARCÍA-ÁLVAREZ\*, María ZAMARRO\*\* and Victoriano URGORRI\*\*

*Recibido el 27-IV-2010. Aceptado el 31-X-2010*

#### ABSTRACT

The Bentart Projects aim to study the benthos of West Antarctica (South Shetland Islands, Antarctic Peninsula and Bellingshausen Sea). In this paper, one genus and two species new to science (*Neomenia expleta* sp. nov. and *Plicaherpia papillata* gen. and sp. nov.), as well as an incomplete juvenile of *Phyllomenia* sp. and an anterior body of *Amboherpia* sp. are studied, all collected during the expedition Bentart-2006 to the Antarctic Peninsula and Bellingshausen Sea and belonging to the families: Neomeniidae Ihering, 1876, Phyllomeniidae Salvini-Plawen, 1978 and Acanthomeniidae Salvini-Plawen, 1978.

#### RESUMEN

Los proyectos Bentart tienen como objetivo el estudio del bentos en la Antártida del Oeste (Islas Shetland del Sur, Península Antártica y Mar de Bellingshausen). En este artículo se estudian un género y dos especies nuevas para la ciencia (*Neomenia expleta* sp. nov. y *Plicaherpia papillata* gen. y sp. nov.), así como un juvenil incompleto de *Phyllomenia* sp. y la parte anterior de *Amboherpia* sp., recogidas durante la expedición Bentart-2006 en la Península Antártica y Mar de Bellingshausen, y pertenecientes a las familias: Neomeniidae Ihering, 1876, Phyllomeniidae Salvini-Plawen, 1978, and Acanthomeniidae Salvini-Plawen, 1978.

#### INTRODUCTION

During the Spanish expedition Bentart-2006 for the study of Antarctic benthos to the Antarctic Peninsula and Bellingshausen Sea, a small collection of Mollusca Solenogastres was made. In

the area of the Antarctic Peninsula and its adjacent islands some research had already been done regarding these Mollusca, with the result of about 30 described species, whereas the know-

\* Estación de Biología Marítima da Graña. Universidade de Santiago de Compostela. A Graña. 15590 Ferrol. Spain. ogarcia.alvarez@edu.xunta.es

\*\* Departamento de Zooloxía e Antropoloxía Física. Facultade de Biología. Universidade de Santiago de Compostela. Campus Sur s/n. 15782 Santiago de Compostela. Spain.

ledge of the Solenogastres fauna in the Bellingshausen Sea is very poor, with only four known species (GARCÍA-ÁLVAREZ AND URGORRI, 2003a, b; GARCÍA-ÁLVAREZ, ZAMARRO AND URGORRI, 2009; SALVINI-PLAWEN, 1978).

In this study four specimens from Bentart-2006 are studied, one collected in the Antarctic Peninsula and three in the Bellingshausen Sea, belonging to the families Neomeniidae Ihering, 1876, Phyllomeniidae Salvini-Plawen, 1978, and Acanthomeniidae Salvini-Plawen, 1978 and among which we recognize one genus and two species new to science. We also provide data about an incomplete juvenile of *Phyllomenia* sp. and an anterior body of *Amboherpia* sp.

The biodiversity of the Mollusca Solenogastres is still very little known; about 260 species have been described so far, which represent about 40% of the total of the species estimated to exist this group of Mollusca. In particular, the Antarctic Ocean is the best known geographical area concerning the Solenogastres fauna, as approximately 45% of the described species are Antarctic or Subantarctic. So far, the research of the Bentart collection from the four expeditions carried out to the South Shetland Islands, Antarctic Peninsula and Bellingshausen Sea, has resulted in the study of 14 species of Solenogastres (including those described here), 9 of which were new species to science, 2 were innominate species and only 3 were already known species (GARCÍA-ÁLVAREZ AND URGORRI, 2003a; GARCÍA-ÁLVAREZ ET AL., 2009). These facts clearly support the idea that the biodiversity of these Mollusca is still poorly known.

One of the greatest difficulties which hampers the study of Solenogastres is the scarcity of research material, as can be observed in most publications about this topic and as also happens in the study of the Bentart collection. It is very common to have only very few specimens available or even a single specimen for the characterization of the new species. This is due to the fact that

a high percentage of the samples of Solenogastres come from studies directed to the knowledge of the general marine benthos, for which the sampling methods used are not the most appropriate for the collection of small-sized fauna. When the capture systems used while sampling are more appropriate for the study of meiofauna, as for example epibenthic sleds, the results are different. These sampling systems are being systematically used, both in the expeditions for the study of the Atlantic abyssal basin and in the expeditions we are carrying out off the northwest coast of Spain. In both projects, in which a priority objective is the knowledge of the deep-sea biodiversity, the results obtained in the collection of small fauna are very satisfactory and a large number of specimens of Solenogastres were collected (GIL-MANSILLA, GARCÍA-ÁLVAREZ AND URGORRI, 2008, 2009).

## MATERIAL AND METHODS

The four specimens studied were collected during the expedition Bentart-2006, which was carried out on board the BIO Hespérides with an Agassiz trawl in January-February 2006 in the Bellingshausen Sea and the Antarctic Peninsula, with five stations sampled. Specimens were fixed and preserved in 70% ethanol. For the study of sclerites, small pieces of cuticle of the dorsal middle part of the body and of the ventral groove were separated. These pieces were treated with sodium hypochlorite at 5% for 12 hours to isolate the sclerites. They were then washed in water, dried in a drying chamber at 40°C and mounted on Canada balsam. For their anatomical study, specimens were decalcified in an EDTA solution for 12 hours, included in paraffin, cut in transverse series of 5 and 10 µm in section, and stained in Azan and Mallory trichromic. Reconstruction of the internal anatomy of their anterior and posterior body was performed manually.

## SYSTEMATICS (see GARCÍA-ÁLVAREZ AND SALVINI-PLAWEN, 2007)

Order NEOMENIAMORPHA Salvini-Plawen, 1978

Family NEOMENIIDAE Ihering, 1876

Genus *Neomenia* Tullberg, 1875*Neomenia expleta* sp. nov. (Figs. 1, 2)

**Type material:** Holotype 1 specimen, cut in serial sections. Antarctic Peninsula. (Bentart-2006, Station PA 42; coordinates: 65.16654° S; 68.9364° W). Water depth: 1272 m. The holotype (cut in serial sections) is deposited in the Museo Nacional de Ciencias Naturales of Madrid, number MNCN 15.02/26.

**Etymology:** Latin, *expletus* = completed, finished, achieved. Regarding its complete anatomical organization.

**Diagnosis.** Specimen 3.4 cm x 0.95 cm with 5-7 longitudinal keels. Cuticle 270 µm thick. Three types of sclerites with radial insertion: groove-shaped sclerites without spear-shaped distal end; solid, slightly bent needles; and solid blade-shaped scales. Pedal groove with 25-35 ciliated folds that do not get into the pallial cavity. Separate cerebral connectives. Pharynx with three regions. Posterior midgut with a pair of short ventrolateral caeca that surround the copulatory stylets. Seminal vesicles and seminal receptacle present. Opening of the paired spawning duct into a genital pouch. Spawning duct gland and stylet gland present. Suprapallial glands present. Two pairs of copulatory stylets. Prepallial spicules absent. Number of respiratory folds 40-45. A dorsoterminal sense organ present.

**Description.** *Habitus.* The specimen is 3.4 cm long, 0.95 cm thick in its middle area, narrower in its anterior and posterior parts, with 5-7 dorsal and lateral longitudinal keels, little marked (Fig. 1A). The pedal groove and the atriobuccal and pallial cavities are well-marked. Colour in alcohol is brown.

*Mantle.* The cuticle is thick, up to 270 mm with globular to club-shaped epidermal papillae. the matrix is up to 575 mm thick. There are three types of sclerites with radial insertion (Fig. 1B): groove-shaped sclerites without spear-shaped distal end (up to 290 mm long x 20 mm wide) dorsally more abundant; solid, slightly bent needles (up to 260 mm long) and solid blade-shaped scales (up to 125 mm long).

*Pedal groove and pallial cavity.* The pedal groove bears 25-35 ciliated folds that do not reach into the pallial cavity. The pallial cavity occupies a subterminal position and has 40-45 ciliated respiratory folds, long and narrow and radially arranged (Figs. 1D, 2A) in the dorso-posterior region; many folds have abundant yellow dyed secretory granules in their distal region. The pallial cavity has dorsally circular musculature and suprapallial glands (Fig. 1D). The pallial cavity forms in its ventroanterior region a genital pouch (Figs. 1D, 2B), into which both spawning ducts come out independently in its dorsolateral region (Fig. 2B). Both pairs of copulatory stylets also come out ventrolaterally into this pouch (Fig. 1D).

*Digestive system* (Fig. 1C). The mouth opens into the atrium, which is provided with papillae arranged in bundles. Three regions can be distinguished lengthwise in the pharynx. The first one bears 2 to 4 dorsal folds with folded walls; one of these folds separates mediofrontally the mouth from the anterior part of the atrium and a ventral fold is separated from the ventral wall of the digestive tract by a cleft. The folds make this first region of the pharynx laterally narrow and form small lateral caeca. The pharynx is internally covered in this region with a thin cuticle that continues in the second pharyngeal region; all walls are folded and it lacks glands. It has no defined buccal tube and lacks a buccal sphincter. In the second region, the pharynx narrows

dorsoventrally and lacks glands, frontally two caeca come out from it: a dorsoanterior one and a ventral one. In this area it has a dorsal wall without folds and with a very soft musculature, its ventral wall is folded and provided with a thick muscular layer; this ventral muscular layer becomes very weak posteriorly. The third region is characterized by presenting a strong sphincter and a folded interior wall, it opens frontally into the intestine, which it clearly penetrates. It lacks a radular system and ventral foregut glandular organs. The intestine has a short dorsoanterior caecum and a strong serial fold due to the dorsoventral musculature. Posteriorly, a pair of short ventrolateral caeca come out from the intestine; each of them surround a pair of copulatory stylets (Figs. 2E, F). The rectum is short and tubular; its interior wall is folded and ciliated. The anus opens dorsally on the frontal wall of the pallial cavity, flanked by respiratory folds.

*Nervous system and sense organs* (Figs. 1C, D). The cerebral ganglion is flat and relatively large (750 mm long, 360 mm high), several pairs of nerves come out from it to the atrial region and two pairs of independent connectives come out from its posterior region. The pair of ventral ganglia is located ventrolaterally in the anterior part of the pharyngeal region of the sphincter and is joined to the digestive tract by a ventral commissure. Both buccal ganglia are very small and located ventrolaterally to the pharyngeal region of the sphincter. The posterior part of the body possesses two pairs of thick ganglia, a ventral one and a lateral one. The supra-rectal commissure is wide and long and located dorsally to the pallial cavity, immediately posterior to the position of the anus. The atrial sense organ is provided with dense bundles of thin, basally joined papillae, mostly in dorsal and lateral positions. A dorsoterminal sense organ is located in the posterior end of the body.

*Reproductive system* (Fig. 1D) A pair of tubular and narrow gonads is located

on both sides of the dorsal blood sinus, no oocytes are observed, but they present spermatozoids in the posterior part close to the pericardium; in this region the gonads are provided with some small ventrolateral pouches, in which spermatozoids can be observed and which can be interpreted as seminal vesicles. The pericardium is voluminous and contains a very large heart joined to the pericardium wall only through its anterior and posterior ends; the heart is divided into two parts, a ventricle and an auricle. The pericardioducts come out ventrolaterally from the posterior part of the pericardium, they consist of a pair of narrow and internally folded ducts that run ventrolaterally to the pericardium and the digestive duct and present a pair of small seminal vesicles almost spherical (Fig. 2C) with spermatozoids, before joining the spawning ducts. The pair of spawning ducts is narrow and sinuous, not very glandular and come out dorsolaterally and separately into a ventral genital pouch of the pallial cavity (Fig. 2B). Each spawning duct has a narrow and sinuous seminal receptacle, located in the opening area of the pericardioducts into the spawning ducts as well as a spawning duct gland with glandular epithelium that comes out into the medial area of the spawning duct.

The copulatory system is paired, each part is made up of two stylets (Figs. 2E, F): a groove-shaped stylet and a spine within a common sheath; they are surrounded by the ventrolateral caeca of the intestine. Each pair of copulatory stylets is connected to a gland (stylet gland) that opens in the distal end of the stylets and from which a narrow duct comes out to the distal end of the spawning duct (Fig. 2D). No pre-pallial spines are present.

**Discussion.** Eighteen species of the genus *Neomenia* are described at present. Among the combination of characteristics that distinguish *Neomenia expleta* sp nov. from the other species in this genus, we should highlight the following for their specific nature: presence of keels (having keels: *N. carinata* Tullberg,

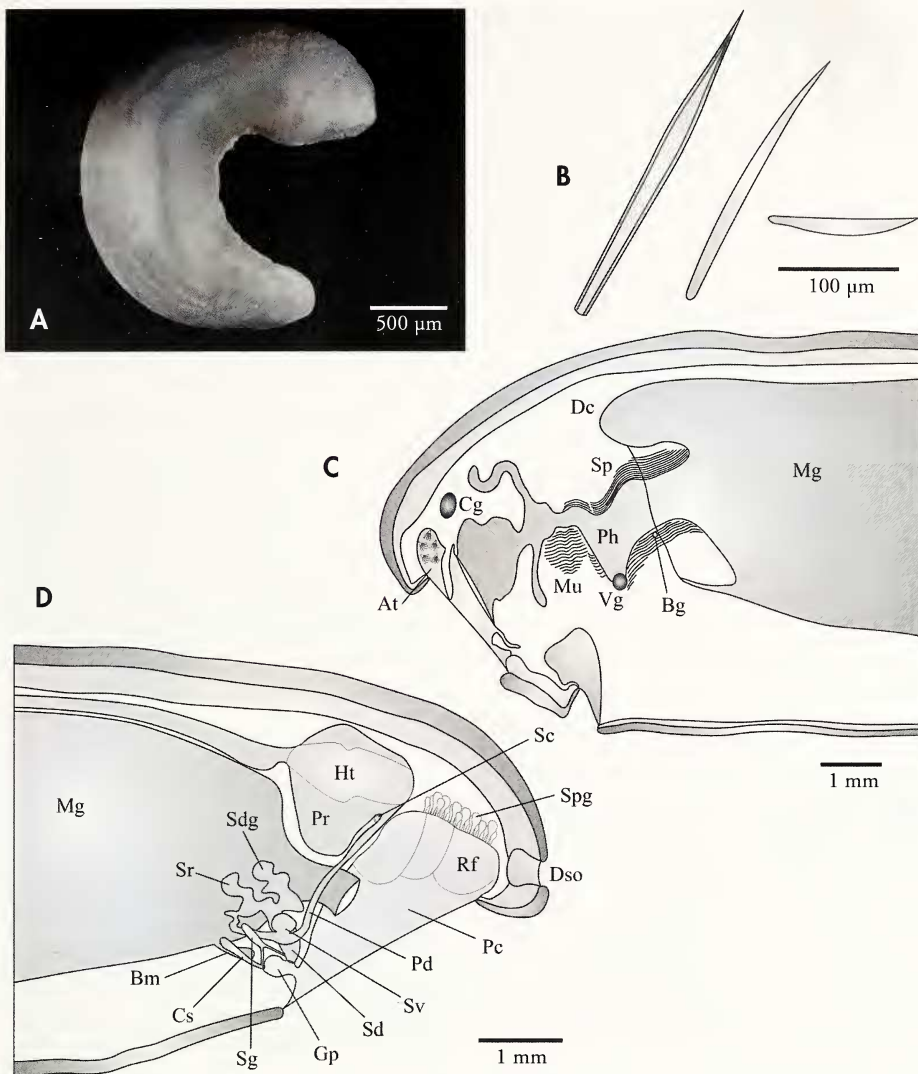


Figure 1. *Neomenia expleta* sp. nov. A: habitus; B: mantle sclerites; C: schematic organization of the anterior body; D: schematic organization of the posterior body. Abbreviations, At: atrial sense organ; Bg: buccal ganglion; Bm: posterior caecum of midgut; Cg: cerebral ganglion; Cs: copulatory stylet; Dc: dorsal caecum; Dso: dorsoterminal sense organ; Gp: genital pouch; Ht: heart; Mg: midgut; Mu: musculature; Pc: pallial cavity; Pd: pericardioduct; Ph: pharynx; Pr: pericardium; Rf: respiratory folds; Sc: suprarectal commissure; Sd: spawning duct; Sdg: spawning duct gland; Sg: copulatory stylet gland; Sp: sphincter; Spg: suprapallial gland; Sr: seminal receptacle; Sv: seminal vesicle; Vg: ventral ganglion.

Figura 1. *Neomenia expleta* sp. nov. A: habitus; B: escleritos del manto; C: esquema de la organización de la parte anterior del cuerpo; D: esquema de la organización de la parte posterior del cuerpo. Abreviaturas, At: órgano sensitivo atrial; Bg: ganglio bucal; Bm: ciego posterior del intestino; Cg: ganglio cerebral; Cs: estilete copulador; Dc: ciego dorsal; Dso: órgano sensitivo dorsoterminal; Gp: bolsa genital; Ht: corazón; Mg: intestino; Mu: musculatura; Pc: cavidad paleal; Pd: pericardioducto; Ph: faringe; Pr: pericardio; Rf: pliegues respiratorios; Sc: comisura suprarrectal; Sd: conducto de desove; Sdg: glándula del conducto de desove; Sg: glándula del estilete copulador; Sp: esfínter; Spg: glándula suprapaleal; Sr: receptáculo seminal; Sv: vesícula seminal; Vg: ganglio ventral.

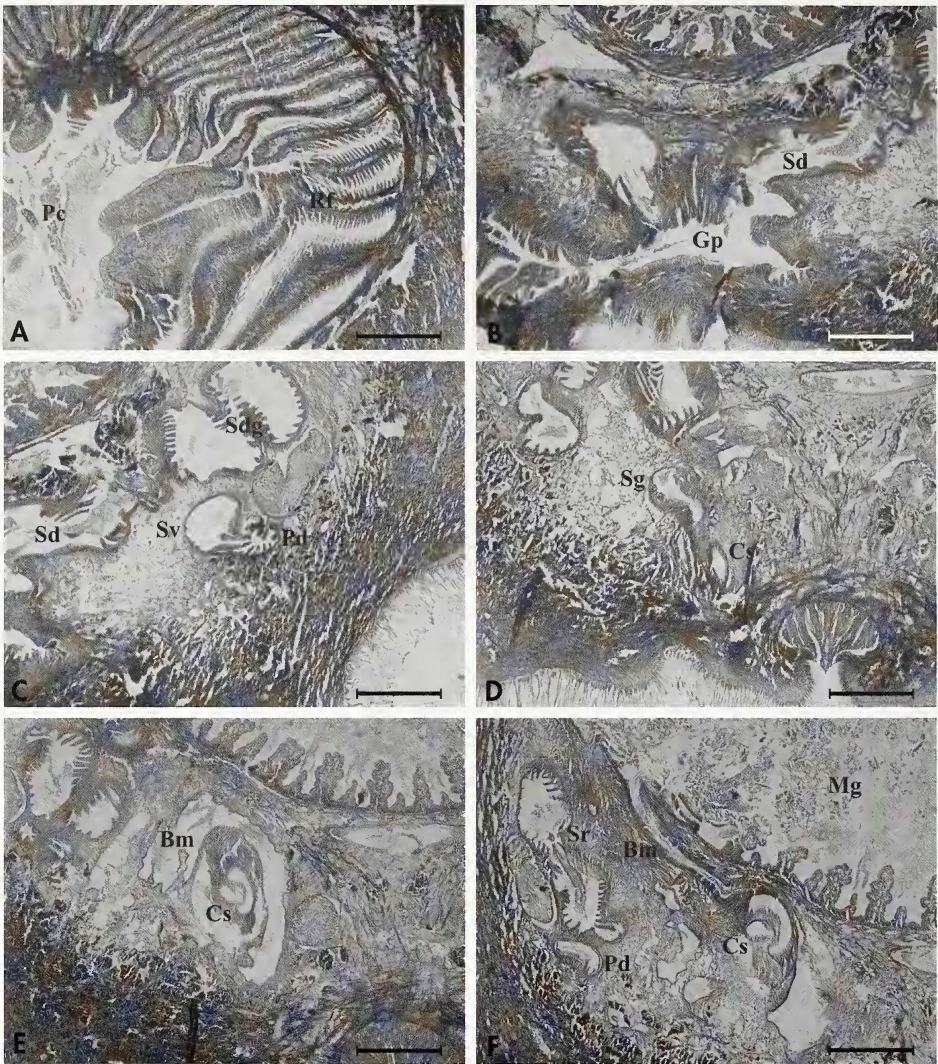


Figure 2. *Neomenia expleta* sp. nov. A: respiratory folds; B: spawning duct opening; C: seminal vesicle; D: copulatory stylet gland; E: copulatory stylet; F: posterior caecum of midgut. Abbreviations, Bm: posterior caecum of midgut; Cs: copulatory stylet; Gp: genital pouch; Mg: midgut; Pc: pallial cavity; Pd: pericardioduct; Rf: respiratory folds; Sd: spawning duct; Sdg: spawning duct gland; Sg: copulatory stylet gland; Sr: seminal receptacle; Sv: seminal vesicle. Scale bars, 200  $\mu$ m.

Figure 2. *Neomenia expleta* sp. nov. A: pliegues respiratorios; B: abertura del conducto de desove; C: vesícula seminal; D: glándula del estilete copulador; E: estilete copulador; F: ciego posterior del intestino. Abreviaturas, Bm: ciego posterior del intestino; Cs: estilete copulador; Gp: bolsa genital; Mg: intestino; Pc: cavidad paleal; Pd: pericardioducto; Rf: pliegues respiratorios; Sd: conducto de desove; Sdg: glándula del conducto de desove; Sg: glándula del estilete copulador; Sr: receptáculo seminal; Sv: vesícula seminal. Escalas, 200  $\mu$ m.

1875, *N. labrosa* Salvini-Plawen, 1978, *N. trapeziformis* Salvini-Plawen, 1978, *N. megatrapezata* Salvini-Plawen and Paar-

Gausch, 2004 and *N. trivialis* Salvini-Plawen and Paar-Gausch, 2004); lacking distally spear-shaped sclerites (having

Table I. Differences between genera of the family Phyllomeniidae (+ present; - absent).  
 Table I. Diferencias entre los géneros de la familia Phyllomeniidae (+ presente; - ausente).

	<i>Phyllomenia</i>	<i>Hapagoherpia</i>	<i>Lituitherpia</i>	<i>Ocheyoherpia</i>	<i>Plicaherpia</i> gen.nov.
Acicular sclerites	+	+	+	+	+
Paddle-shaped sclerites	+	-	+	+	+
Hook-shaped sclerites	-	-	+	+	+
Groove-shaped scales	-	-	-	-	+
Atrio-buccal opening	Separated	Separated	Common	Common	Common
Midgut constrictions	+	-	+	+	+
Gonoducts	+	-	-	-	-
Genital opening	Paired	Unpaired	Unpaired	Unpaired	Unpaired
Genital papilla	-	-	-	-	+
Capulatory stylets	+	-	-	+	-
Capulatory stylets gland	-	-	-	+	-
Cammera pallial cavity	One	One	One	One	Two
Respiratory organs	-	-	-	-	+
Dorsoterminal sense organ	-	+	-	-	-

these sclerites: *N. carinata*, *N. trapeziformis* Salvini-Plawen, 1978 and *N. naevata* Salvini-Plawen and Paar-Gausch, 2004); presence of anterior cleft in ventral pharynx (having ventral left: *N. carinata* and *N. crenagulata*, Salvini-Plawen, 1978); presence of separate cerebral connectives (present in: *N. oscar* Salvini-Plawen, 2006, *N. simplex* Salvini-Plawen, 2006 and partly *N. herwigii* Kaiser, 1976); presence of suprapallial glands (present in: *N. verrilli* Heath, 1918 and *N. naevata*); presence of midgut caecum (present in: *N. microsolen* Wirén, 1892); presence of latero-terminal midgut sacs (present in: *N. megatrpezata*, *N. trivialis* and *N. oscar*). (GARCÍA-ÁLVAREZ AND URGORRI, 2003a; SALVINI-PLAWEN, 1978, 2006; SALVINI-PLAWEN, AND PARA-GAUSCH, 2004 see Table I)

Five species of the genus *Neomenia* can be found in the same biogeographical range (García-Álvarez and Urgorri, 2003a; Salvini-Plawen, 1978, 2006), Antarctic Peninsula and adjacent islands, together with *Neomenia expleta* sp nov.. These are *N. labrosa* Salvini-Plawen, 1978; *N. laminata* Salvini-Plawen, 1978; *N. monolabrosa* Salvini-Plawen, 2006; *N. megatrpezata*; and *N.*

*trivialis*. Each of these species has a series of characteristics that clearly distinguish them from *Neomenia expleta* sp nov.

*N. labrosa* (South Shetland Islands, 220-240 m. deep), has an anterior cleft in the lateral pharynx; it lacks a terminal foregut sphincter, a midgut caecum and lateroterminal midgut sacs in the digestive duct; the opening of the spawning duct is unpaired; it possesses prepallial spines and a subvaginal epithelial gland and lacks both seminal vesicles and suprapallial glands (SALVINI-PLAWEN, 1978, 2006).

In *N. laminata* (South Orkney Islands, 298-302 m. deep) some anatomical data about its posterior part remain unknown; it has no pharyngeal lip formation, is provided with 4 foregut regions and lacks a terminal foregut sphincter and lateroterminal midgut sacs (SALVINI-PLAWEN, 1978, 2006).

Of *N. monolabrosa* (South Shetland Islands, 80 m deep) only the anterior part is known; it has a 30-50 mm cuticle, has an anterior cleft in the lateral pharynx, 4 foregut regions and no midgut caecum (GARCÍA-ÁLVAREZ AND URGORRI, 2003a; SALVINI-PLAWEN, 2006).

*N. megatrapezata* (South Shetland Islands, 640-670 m deep) can reach 18 cm long and has 4 well-marked longitudinal ridges; it possesses an anterior cleft in the lateral pharynx, 4 foregut regions and lacks a midgut caecum; the opening of the spawning duct is unpaired; it has prepallial spines and genital papilla and has neither seminal

vesicles nor suprapallial glands (SALVINI-PLAWEN, 2006).

*N. trivialis* (South Shetland Islands, 640-670 m deep) has no pharyngeal lip formation, lacks a midgut caecum, seminal vesicles and suprapallial glands; the opening of the spawning duct is unpaired and it possesses prepallial spines (SALVINI-PLAWEN, 2006).

Order STERROFUSTIA Salvini-Plawen, 1978  
Family PHYLLOMENIIDAE Salvini-Plawen, 1978  
Genus *Phyllomenia* Thiele, 1913

*Phyllomenia* sp. (Figs. 3, 4)

**Material examined:** 1 specimen, cut in serial sections. Bellingshausen Sea. (Bentart-2006, Station MB 34; coordinates: 70.12258° S; 84.8682° W). Water depth: 603 m. Only the posterior part of the body could be studied and reconstructed, as the anterior part was histologically strongly damaged.

**Description.** *Habitus.* The specimen is elongated, 8 mm long by 0.85 mm thick in its middle area, of circular section, with an anterior end 0.6 mm thick and a posterior one 0.58 mm thick. There are no longitudinal keels or swellings, the anterior end is truncated and the posterior end slightly acuminate (Fig. 3A). There are well-marked atriobuccal cavity, pedal groove and pallial cavity. The interwoven sclerites do not protrude from the cuticle. Colour in alcohol is white. A dorsoterminal sense organ is present at the posterior end of the body.

*Mantle.* The cuticle is thin, 30-40 mm thick in the lateral areas of the body and 50-60 mm thick in the dorsal area, with several layers of interwoven tangential sclerites. Five types of sclerites can be seen (Fig. 3B): solid acicular with pointed distal end and rounded proximal end slightly sigmoid (200 mm long x 15 mm wide); narrow solid paddle-shaped sclerites (230 mm long x 15 mm wide); wide solid paddle-shaped sclerites (200 mm long x 32 mm wide). Both types of solid paddle-shaped sclerites are abundant in the ventral area on both sides of the pedal groove; elongated and wide scales with a very pointed distal end and a straight proximal one (100 mm long x 30 mm wide) located above

all in its anterior end, atriobuccal cavity and pedal groove; blade-shaped scales (75 mm long x 13 mm wide).

*Pedal groove and pallial cavity.* The pedal groove bears a ciliated fold that gets into the pallial cavity. The pallial cavity is in subterminal position, it is small, without cilia on its epithelium and has no respiratory folds (Fig. 3C). The rectum is short and opens through a wide and circular anus located in the dorsoanterior wall of the pallial cavity. Both spawning ducts come out separately through a pair of narrow grooves located on the ventral wall of the pallial cavity. It has three pairs of copulatory stylets and abdominal spicules in a pair of small pouches located on both lateral walls of the pallial cavity.

*Reproductive system* (Fig. 3C). It has a pair of gonads, from which two long and narrow real gonoducts (350 mm long x 10-25 mm wide) come up, they run laterally to the pericardium until they join the proximal end of the pericardioducts (Fig. 4). The pericardium is short and wide; anteriorly it is blind, posteriorly two blind extensions come up from it and it extends dorsolaterally on both sides of the rectum; it lacks cilia on its interior epithelium and the dorsal blood sinus comes out into the dorsoanterior part of the pericardium. The heart



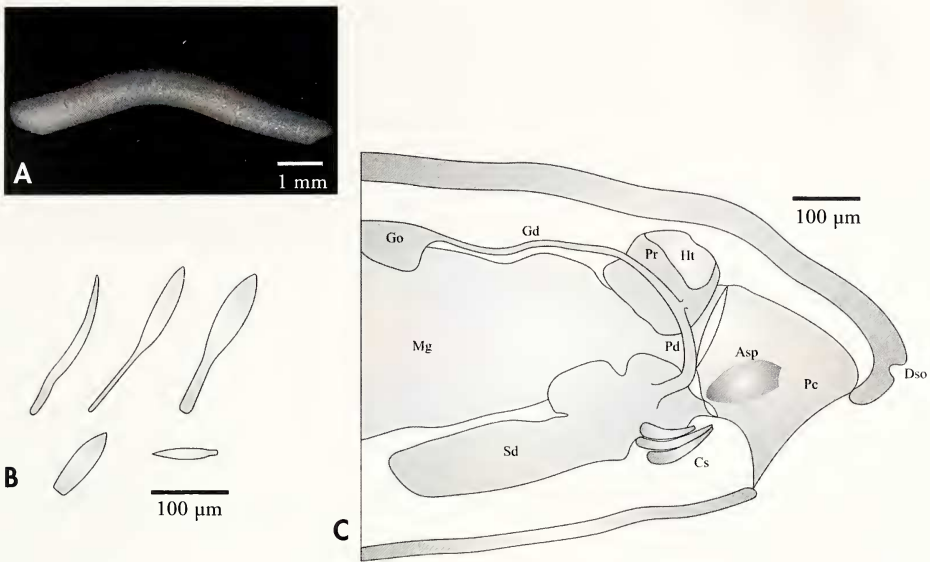


Figure 3. *Phyllomenia* sp. A: habitus; B: mantle sclerites; C: schematic organization of the posterior body. Abbreviations, Asp: Abdominal spicules pouch; Cs: copulatory stylet; Dso: dorsoterminal sense organ; Gd: gonoduct; Go: gonad; Ht: heart; Mg: midgut; Pc: pallial cavity; Pd: pericardioduct; Pr: pericardium; Sd: spawning duct.

*Figure 3. Phyllomenia sp. A: habitus; B: escleritos del manto; C: esquema de la organización de la parte posterior del cuerpo. Abreviaturas, Asp: bolsa de espículas abdominales; Cs: estilete copulador; Dso: órgano sensitivo dorsoterminal; Gd: gonoducto; Go: gónada; Ht: corazón; Mg: intestino; Pc: cavidad paleal; Pd: pericardioducto; Pr: pericardio; Sd: conducto de desove.*

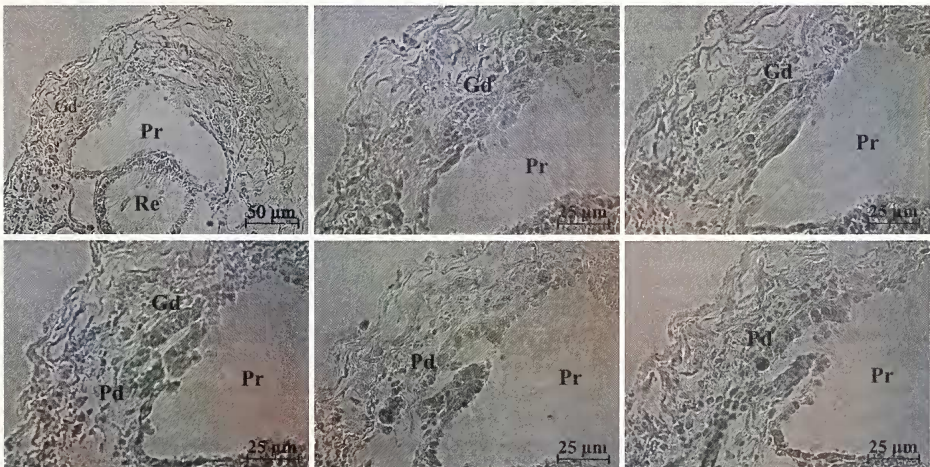


Figure 4.- *Phyllomenia* sp. Union of gonoduct and pericardioduct. Gd – gonoduct; Pd – pericardioduct; Pr - pericardium; Re – rectum.

*Figure 4.- Phyllomenia sp. Unión del gonoducto y del pericardioducto. Gd – gonoducto; Pd – pericardioducto; Pr - pericardio; Re – recto.*

hangs from the dorsal wall of the pericardium; anteriorly it is narrow and little lobulate (ventricle), posteriorly it is wide and extensively bilobulate (auricles). The pair of pericardioducts come up on both sides of the medial area of the pericardium, where they join the gonoducts (Fig. 4), they are short and of circular section and extend ventrally until they come out laterally into the spawning ducts, near the opening of these ducts into the pallial cavity. Both spawning ducts are tubular and narrower in their anterior half, posteriorly they get wider and come out separately through a short and narrow duct onto the ventral wall of the pallial cavity. It has three pairs of copulatory stylets located ventrolaterally to the spawning ducts, each group bears musculature and the three stylets; each is located dorsally to the other; they are short, flat and wide (80-100 mm long x 10-12 mm high x 40 mm wide).

**Remarks.** The organization of the anterior part of the body is unknown. However, its size (8 mm long, 0.85 mm thick) and the combination of sclerites

and characters of the posterior part of the body identify the specimen hereby studied as a juvenile individual of genus *Phyllomenia*. Two species are described in the genus *Phyllomenia* Thiele, 1913 (GARCÍA-ÁLVAREZ AND SALVINI-PLAWEN, 2007): *Phyllomenia austrina* present in different locations of the Antarctic Ocean (South Sandwich Island, Bransfield Strait, Ross Sea and Davis Sea), 148-465 m deep; and *Phyllomenia cornu-amentata* Salvini-Plawen, 1978, present in Tierra del Fuego (South America), 384-903 m deep. Both species have a complex and very similar organization of the pallial cavity and a gonopericardial system that changes as specimens become mature. In young specimens, the organization of the posterior part of the body is very similar to the rest of species of *Solenogastres* (SALVINI-PLAWEN, 1978), while adults develop from the pallial cavity and the spawning duct, a set of pouches, of which the function and relationship to the structures they originate from, are only partially known (SALVINI-PLAWEN, 1970, 1978; THIELE, 1913).

### Genus *Plicaherpia* gen. nov.

**Diagnosis.** Solid acicular sclerites combined with hook-shaped solid sclerites and elongated groove-shaped scales in a layer. With common atrio-buccal opening. Midgut with constrictions. Unpaired genital opening with genital papilla. Pallial

cavity with two chambers. Copulatory stylets absent. Respiratory organs present. Dorsoterminal sense organ absent.

**Etymology.** Latin, *plicare* = to fold. Greek, *herpeton* = to slither. Concerning the fact that it has respiratory folds.

### *Plicaherpia papillata* sp. nov. (Fig. 5)

**Type material:** Holotype: 1 specimen, cut in serial sections. Bellingshausen Sea. (Bentart-2006, Station MB 34-2; coordinates: 70.11620° S; 84.8604° W). Water depth: 603 m. Holotype (cut in serial sections) deposited in the Museo Nacional de Ciencias Naturales of Madrid, number MNCN 15.02/27.

**Etymology:** Latin, *papilla* = papilla; *-atus* = provided with. Concerning the fact that it has genital papilla.

**Diagnosis.** Specimen 2 mm x 0.77 mm, without longitudinal keels or swellings. Cuticle 10-20 mm thick. Four types of solid sclerites: slightly curved acicular; hook-shaped; long and narrow

groove-shaped scales, with a very pointed distal end, and long and wide groove-shaped scales. Pedal groove with a fold that does not reach into the pallial cavity. Radula with 2 medial den-

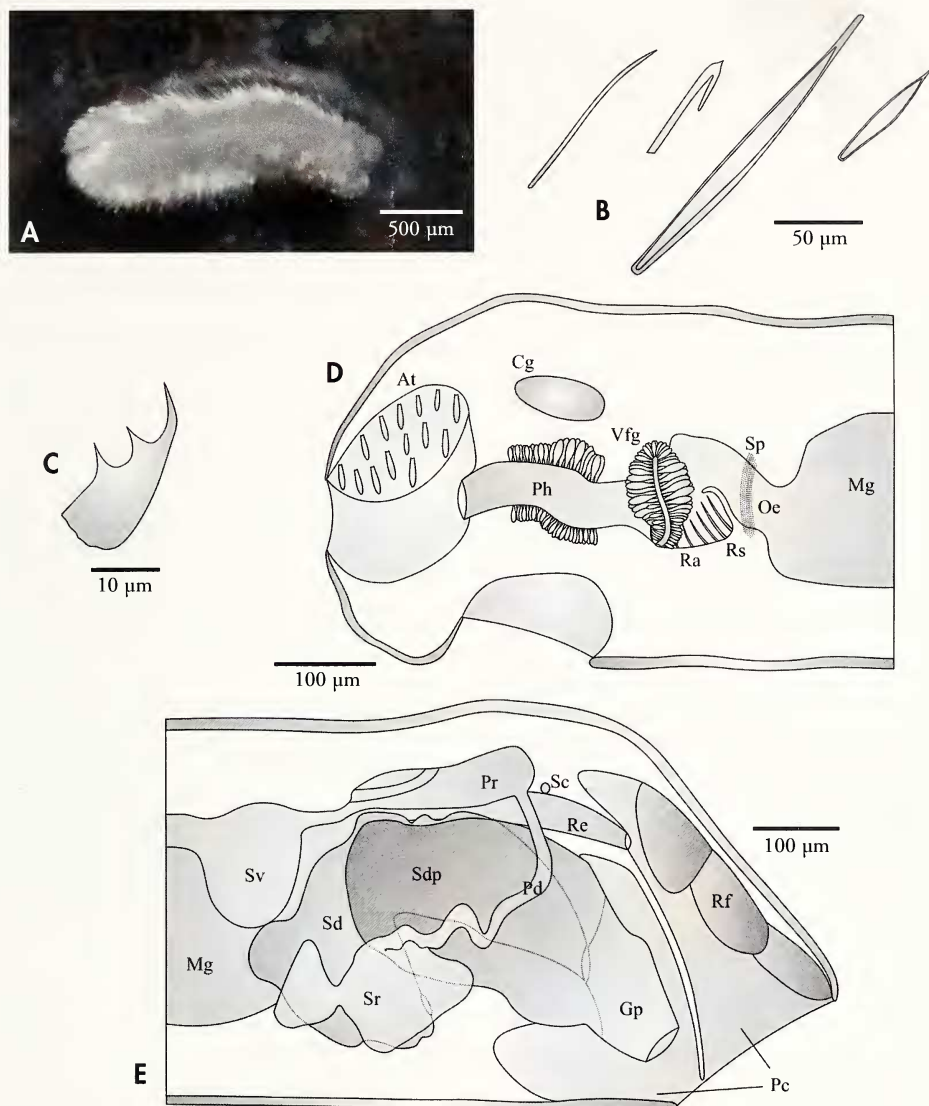


Figure 5. *Plicaherpia papillosa* gen. and sp. nov. A: habitus; B: mantle sclerites; C: radular tooth; D: schematic organization of the anterior body; E: schematic organization of the posterior body. Abbreviations, At: atrial sense organ; Cg: cerebral ganglion; Gp: genital papilla; Mg: midgut; Oe: oesophagus; Pc: pallial cavity; Pd: pericardioduct; Ph: pharynx; Pr: pericardium; Ra: radula; Re: rectum; Rf: respiratory folds; Rs: radular sac; Sc: suprarectal commissure; Sd: spawning duct; Sdp: spawning duct pouch; Sp: sphincter; Sr: seminal receptacle; Sv: seminal vesicle; Vfg: ventrolateral foregut glandular organs.

*Figure 5. Plicaherpia papillosa gen. y sp. nov. A: habitus; B: escleritos del manto; C: diente radular; D: esquema de la organización de la parte anterior del cuerpo; E: esquema de la organización de la parte posterior del cuerpo. Abreviaturas, At: órgano sensitive atrial; Cg: ganglio cerebral; Gp: papila genital; Mg: intestino; Oe: esófago; Pc: cavidad paleal; Pd: pericardioducto; Ph: faringe; Pr: pericardio; Ra: rádula; Re: recto; Rf: pliegues respiratorios folds; Rs: saco radular; Sc: comisura suprarrectal; Sd: conducto de desove; Sdp: bolsa del conducto de desove; Sp: esfinter; Sr: receptáculo seminal; Sv: vesícula seminal; Vfg: órgano glandular ventrolateral del intestino.*

ticles. Oesophagus with sphincter. Ventral foregut glandular organs with short ducts. Without dorsoanterior caecum of the intestine. Vesicles and seminal receptacles present. Opening of the unpaired spawning duct through a genital papilla. Number of respiratory folds 15. Pallial cavity with two chambers: a dorsal one with respiratory folds and anus and a ventral one with the opening of the spawning duct. Dorso-terminal sense organ absent.

**Description.** *Habitus.* The specimen is 2 mm long by 0.77 mm thick in its medial area, with an anterior end 0.45 mm thick and a posterior one 0.6 mm thick. Without longitudinal keels or swellings. There is a well-marked pedal groove, the anterior end of the body appears truncated due to the anterior position of the opening of the atriobuccal cavity; in the posterior end, the subterminal opening of the pallial cavity is clearly observed (Fig 5A). Sclerites protrude clearly from the cuticle and point posteriorly. Colour in alcohol is white.

*Mantle.* The cuticle is thin, 10-20 mm thick, with a layer of sclerites in oblique arrangement, an inclination of 70° pointing towards the posterior part of the body. Four types of sclerites are observed (Fig. 5B): solid acicular with a pointed distal end and a rounded proximal one slightly curved in its distal half (200 mm long x 5 mm wide); solid and hook-shaped, slightly protruding from the cuticle, similar to *Ocheyoherpia* hook-shaped sclerites (fragment, only observed at stereomicroscope in the animal); grooved scales elongated and narrow with thick margins, a pointed distal end and a rounded proximal one (210 mm long x 15 mm wide); and grooved scales elongated and wide with thick margins, a pointed distal end and a rounded proximal one (100 mm long x 11 mm wide).

*Pedal groove and pallial cavity.* The pedal groove bears a ciliated fold that does not get into the pallial cavity. The pallial cavity has a subterminal position and bears two chambers divided by a septum (Fig. 5E): a dorsal chamber that extends anterodorsally, where there are

15 short and wide respiratory folds with a radial arrangement and into which the rectum opens; the second chamber is ventral, it extends anteroventrally and the unpaired spawning duct opens into it through a genital papilla. It lacks copulatory stylets and abdominal spicules.

*Digestive system* (Fig. 5D). The common atriobuccal cavity opens frontally in the anterior end of the body, with the mouth located in the atrium bottom. There is a long pharynx, internally folded and encircled by a layer of soft circular musculature and a glandular layer which is thicker dorsally. It has a pair of ventrolateral foregut glandular organs tubular, narrow and short, encircled by subepithelial glands along its entire length, of type A (SALVINI-PLAWEN 1978; HAND AND TODT, 2005) they open in the radular anterior area. The distichous radula is made up of pairs of hook-shaped teeth (25 mm long) with 2 medial denticles (Fig. 5C). It has a ventral radular sac wide and short, in which several radular teeth can be observed. The oesophagus bears a soft sphincter and opens frontally into the intestine. The intestine lacks a dorsoanterior caecum and is provided with serial constrictions made up of the dorsoventral musculature. The rectum is tubular and narrow, located dorsally to the spawning duct. The anus opens in the anterior wall of the dorsal chamber of the pallial cavity.

*Nervous system and sense organs.* Anteriorly, only the cerebral ganglion, located dorsally to the pharynx and the pair of small buccal ganglia located on both sides of the pharynx in the area of the ventrolateral foregut glandular organs, were observed. There is a long supra-rectal commissure on the rectum. The atrial sense organ is large with simple and thick sense papillae. There is no dorso-terminal sense organ.

*Reproductive system* (Fig. 5E). There is a tubular and narrow pair of gonads. In the posterior area, the gonads present a pair of large seminal vesicles full of spermatozooids. A short pair of gonopericardioducts of circular section open anteriorly into the pericardium. The tubular heart is joined to the dorsal wall of the

anterior part of the pericardium only through its anterior and posterior ends. The pericardioducts come out from the ventroposterior part of the pericardium and open dorsally into the seminal receptacles. The pair of seminal receptacles are located laterally in the anterior half of the spawning duct and comprise two pouches (a smaller anterior one and a posterior one) divided by a constriction. The posterior pouch of seminal receptacle opens laterally into the spawning duct. The spawning duct is unpaired along its entire extension; in its anterior half, its section cut is higher than wide due to the fact that a ventral pouch comes out from it, posteriorly it gets narrower till becoming tubular and opens unpaired in the centre of the genital papilla. The genital papilla is encircled by soft musculature and extends ventroposteriorly till it opens into the ventral chamber of the pallial cavity. Two pouches open directly into the genital papilla. Their section cut is high and narrow and extends anteriorly on both sides of the spawning duct to the medial area of the seminal receptacles.

**Discussion.** The set of features present in *Plicaherpia* gen. nov. defines it clearly as a new genus within the family Phyllomeniidae Salvini-Plawen, 1978, of the order Sterrofustia Salvini-Plawen, 1978, which is characterized by the com-

bination of solid sclerites (with hook-shaped elements), distichous radula and ventrolateral foregut glandular organs with subepithelially arranged gland cell bodies (type A). (GARCÍA-ÁLVAREZ AND SALVINI-PLAWEN, 2007; SALVINI-PLAWEN, 1978). This family is hitherto composed of four genera: *Phyllomenia* Thiele, 1913, *Harpagoherpia* Salvini-Plawen, 1978, *Lituiherpia* Salvini-Plawen, 1978 and *Ocheyoherpia* Salvini-Plawen, 1978.

Of the features that define *Plicaherpia* gen. nov., the following are especially significant and make it differ from the rest of the genera of the family (Table I): the groove-shaped scales that can be observed on the mantle and the structure of the pallial cavity that is divided into two chambers, with respiratory folds and with the opening of the spawning duct through a genital papilla. Besides, *Phyllomenia* is provided with a mouth separated from the atrium, it has gonads with true gonoducts, a paired opening of the spawning duct and copulatory stylets. *Harpagoherpia* is provided with a mouth separated from the atrium. *Lituiherpia* has mantle sclerites arranged in several layers. *Ocheyoherpia* is provided with copulatory stylets with gland (GARCÍA-ÁLVAREZ AND SALVINI-PLAWEN, 2007; GARCÍA-ÁLVAREZ AND URGORRI, 2003b; SALVINI-PLAWEN, 1978; THIELE, 1913).

Family ACANTHOMENIIDAE Salvini-Plawen, 1978  
Genus *Amboherpia* Handl and Salvini-Plawen, 2002

*Amboherpia* sp. (Fig. 6)

**Material examined:** 1 specimen, cut in serial sections. Bellingshausen Sea. (Bentart-2006, Station MB 33; coordinates: 70.28911° S; 84.2841° W). Water depth: 430 m. Only the anterior part of the body and a part of the posterior could be studied and reconstructed, as the posterior part of the body was histologically damaged.

**Description.** *Habitus.* The specimen is 3 mm long by 0.50 mm thick in its anterior part, 0.40 mm in its medial part and 0.35 mm in its posterior part. There are no swellings or longitudinal keels (Fig. 6A). The pedal groove is well-marked. Sclerites protrude radially from the cuticle. Colour in alcohol is white.

*Mantle.* The cuticle is thin, 15-20 mm thick, without epidermal papillae. The sclerite layer has radial insertion, and there are three types of sclerites (Fig. 6B): hollow acicular with both ends pointed and slightly curved (235 mm long x 10 mm wide); narrow groove-shaped scales with a very pointed distal

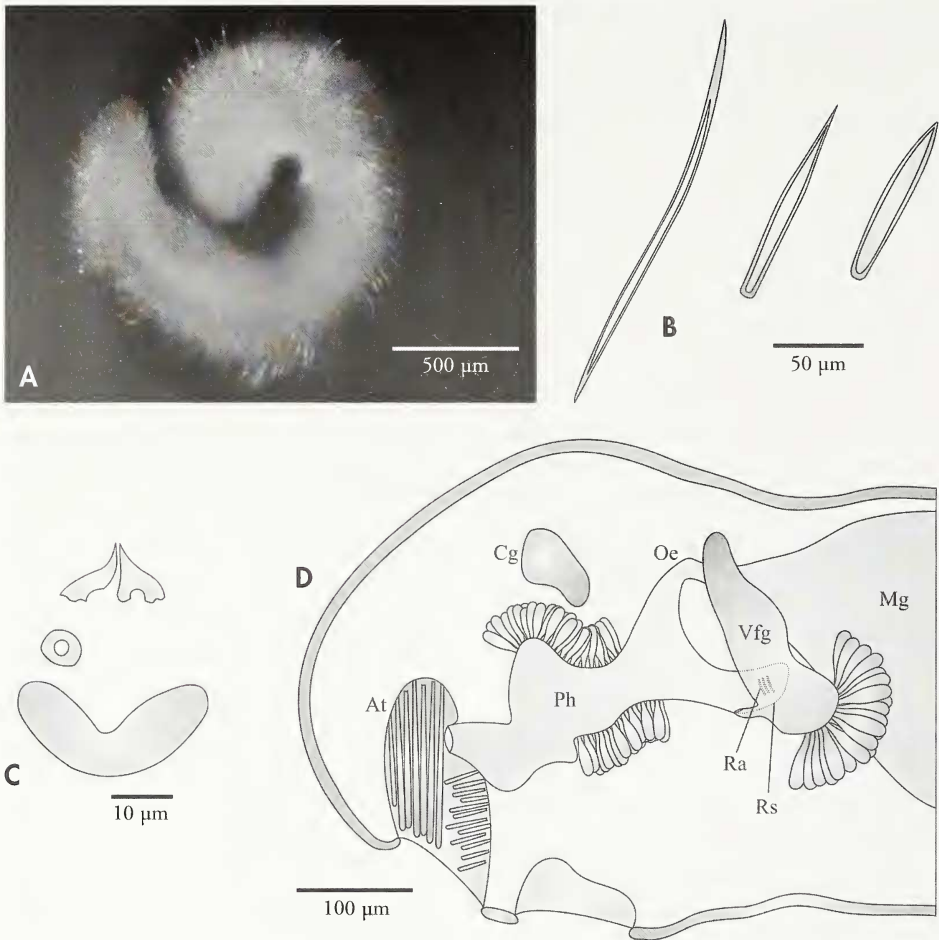


Figure 6. *Amboherpia* sp. A: habitus; B: mantle sclerites; C: radular teeth; D: schematic organization of the anterior body. Abbreviations, At: atrial sense organ; Bg: buccal ganglion; Cg: cerebral ganglion; Mg: midgut; Oe: oesophagus; Ph: pharynx; Ra: radula; Rs: radular sac; Vfg: ventrolateral foregut glandular organs.

Figure 6. *Amboherpia* sp. A: habitus; B: escleritos del manto; C: dientes radulares; D: esquema de la organización de la parte anterior del cuerpo. Abreviaturas, At: órgano sensitive atrial; Bg: ganglio bucal; Cg: ganglio cerebral; Mg: intestino; Oe: esófago; Ph: faringe; Ra: rádula; Rs: saco radular; Vfg: órgano glandular ventrolateral del intestino.

end and a slightly rounded one (125 mm long x 12.5 mm wide); and wide groove-shaped scales with a pointed distal end and a rounded proximal one (100 mm long x 13 mm wide).

*Pedal groove and pallial cavity.* The pedal groove bears a ciliated fold that does not get into the pallial cavity. The pallial cavity is very small, has a subter-

minal position and lacks both respiratory folds and copulatory stylets. The unpaired opening of the spawning duct into the pallial cavity could be observed.

*Digestive system* (Fig. 6D). There is a common atriobuccal cavity with mouth located in the posterior part of the atrium. The pharynx is encircled by a circular layer of musculature and a thicker

glandular layer. The radular sac is wide; several broken teeth of a monoserial radula were observed in it, possibly with two hollow denticles (Fig. 6C). Among the broken parts of the radula, several boomerang-shaped bases of the teeth could be recognized (up to 32 mm long x 8 mm wide) corresponding to a monoserial radula; a hollow circular part belonging possibly to the intermediate part of the tooth; and a pair of sharp denticles possibly located in the distal end of the radular tooth. The ventral foregut glandular organs consist of two short ducts encircled by musculature and opening into the pharynx at the level of the radula. In the posterior region of each duct there are bundles of glandular cells (type A according to SALVINI-PLAWEN, 1978; or type *Acanthomenia* according to HANDL AND TODT, 2005). It possesses a narrow oesophagus that opens dorsally into the intestine. The intestine lacks a dorsoanterior caecum.

*Nervous system and sense organs.* Only the cerebral ganglion located dorsally to the pharynx could be observed. The atrial sense organ is large with numerous sense papillae simple and very long. Despite some reservations, it seems to present a dorsoterminal sense organ located in the posterior part of the body.

*Remarks.* At present three genera of the family Acanthomeniidae Salvini-Plawen, 1978 are known: *Acanthomenia* Thiele, 1913; *Amboherpia* Handl and Salvini-Plawen, 2002 and *Veromenia* Gil-Mansilla, García-Álvarez and Urgorri,

2008. The three genera differ in the combination of several characteristics: organization of the atrio-buccal cavity; presence/absence of radula, presence/absence of respiratory folds and presence/absence of a dorsoterminal sense organ (GIL-MANSILLA ET AL., 2008 see table 2; HANDL AND SALVINI-PLAWEN, 2002; SALVINI-PLAWEN, 1978). The specimen is to be clearly included within the genus *Amboherpia* as it has a common atrio-buccal cavity, monoserial radula, it lacks respiratory folds and has, despite some reservations, a dorsoterminal sense organ. Two species are described in the genus *Amboherpia*: *A. heterotecta* Handl and Salvini-Plawen, 2002, Bergen (Norway), 610 m deep and *A. dolichopharyngeata* Gil-Mansilla, García-Álvarez and Urgorri, 2008, Angola Basin, 5415 m deep. Although the structure of its reproductive system is still unknown *Amboherpia* sp., has a combination of characteristics that enable us to distinguish it from the known species of the genus (GIL-MANSILLA ET AL., 2008 HANDL AND SALVINI-PLAWEN, 2002). *Amboherpia* sp. differs from *A. heterotecta* in the fact that: it lacks a preradular sphincter, it is provided with an oesophagus, and the ventrolateral foregut glandular organs have short ducts and a glandular association restricted to the terminal part. It differs from *A. dolichopharyngeata* in: having only groove-shaped scales, the pharynx is shorter and not divided in two regions, the oesophagus is shorter and lacks an intestinal dorso-anterior caecum.

## ACKNOWLEDGEMENTS

This paper is part of the research projects: Bentart (MEC-Spanish Government REN2003-01881/ANT) and Diva-

Artabria II (MEC-Spanish Government CTM-2004-00740; Xunta de Galicia PGIDIT07PXIB000120PR).

## BIBLIOGRAPHY

GARCÍA-ÁLVAREZ O. AND SALVINI-PLAWEN L.V. 2007. Species and diagnosis of the Families and Genera of Solenogastres (Mollusca). *Iberus*, 25 (2):73-143.

GARCÍA-ÁLVAREZ O. AND URGORRI V. 2003a. Solenogastres molluscs from the BENTART Collection (South Shetland Islands, Antarctica), with a description of a new species. *Iberus*, 21 (1):43-56.

- GARCÍA-ÁLVAREZ O. AND URGORRI V. 2003b. A new species of Phyllomeniidae (Mollusca Solenogastres: Sterrofustia) from the South Shetland Islands, Antarctica. *Iberus*, 21 (2): 99-107.
- GARCÍA-ÁLVAREZ O., ZAMARRO M. AND URGORRI V. 2009. Proneomeniidae (Solenogastres, Cavibelonia) from the Bentart-2006 Expedition, with description of a new species. *Iberus*, 27 (1): 67-78.
- GIL-MANSILLA E., GARCÍA-ÁLVAREZ O. AND URGORRI V. 2008. New Acanthomeniidae (Solenogastres, Cavibelonia) from the abyssal Angola Basin. In: Martínez Arbizu, P. and Brix, S. (Eds). Bringing Light into Deep-sea Biodiversity. *Zootaxa*, 1866: 175-186.
- GIL-MANSILLA E., GARCÍA-ÁLVAREZ O. AND URGORRI V. 2009. A new genus and two new species of Simrothiellidae (Solenogastres, Cavibelonia) from the Abyssal Angola Basin. *Journal of the Marine Biological Association of the United Kingdom*, 89 (7): 1507-1515.
- HANDL C. AND TODT C. 2005. Foregut Glands of Solenogastres (Mollusca): Anatomy and Revised Terminology. *Journal of Morphology*, 265: 28-42.
- HANDL C. AND SALVINI-PLAWEN L.V. 2002. New records of Solenogastres-Cavibelonia (Mollusca) from Norwegian fjords and shelf waters including three new species. *Sarsia*, 87: 423-450.
- SALVINI-PLAWEN L.V. 1970. *Phyllomenia austriaca* ein Phylogenetisch bedeutsamer Solenogaster (Mollusca, Aculifera). *Zeitschrift für Zoologie, Systematik u. Evolutionsforschung*, 8: 297-309.
- SALVINI-PLAWEN L.V. 1978. Antarktische und subantarktische Solenogastres-Eine Monographie: 1898-1974. *Zoologica, Stuttgart*, 128: 1-315.
- SALVINI-PLAWEN L.V. 2006. Five new Iberian Neomeniamorpha (Mollusca, Solenogastres). *Iberus*, 24 (2): 1-26.
- SALVINI-PLAWEN L.V. AND PAAR-GAUSCH I. 2004. Three new species of *Neomenia* (Mollusca, Solenogastres) from the Southern Hemisphere. *New Zealand Journal of Marine and Freshwater Research*, 38: 137-162.
- THIELE J. 1913. Antarktische Solenogastren. Deutsche Südpolar Expedition, 14, *Zoologie*, 6 (1): 35-65.