



Two new acotylean flatworms (Polycladida) of two genera unrecorded in the Eastern Atlantic

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Abstract

This paper describes two new species of two genera of polyclad flatworms found in the Iberian Peninsula, *Parviplana* and *Phaenoplana*. *Parviplana jeronimoi* sp. nov. is a small-sized polyclad with yellowish-brown background colour and pale yellow ventral body; gonopores well separated, with corrugated ventral body wall between them; and prostatic vesicle with a penis papilla surrounded by a penis sheath, both housed in a wide male atrium. *Phaenoplana caetaria* sp. nov. is characterised by a yellowish-brown dorsal body, without tentacles, ejaculatory duct projects inside the prostatic vesicle, spherical prostatic vesicle, twisted penis rod, well-developed male atrium and elongated small Lang's vesicle. This is the first record of the genera *Parviplana* and *Phaenoplana* in Europe, as well as in the Eastern Atlantic.

Keywords Platyhelminthes · Cadiz · Iberian peninsula · Biodiversity · Microanatomy

Abbreviations

cg Cement glands
cs Corrugated surface
ed Ejaculatory duct
el Epithelial lining
ev External vagina
fp Female pore
i Intestine
iv Internal vagina

lv Lang's vesicle
ma Male atrium
mw Muscular wall
ov Oviduct
ph Pharynx
pp. Penis papilla
pr Penis rod
ps Penis sheath
pv Prostatic vesicle
sv Seminal vesicle
vd Vas deferens

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Introduction

This study focuses on the description of two new species of polyclads whose genera have never been recorded before in either European or in the Eastern Atlantic marine waters: *Parviplana* Hyman, 1953, and *Phaenoplana* Faubel, 1983.

At present, the genus *Parviplana* has a small number of described species and none of them have not been found again since their original descriptions. This taxon was erected by Hyman in 1953, based on the study of an unidentified specimen sent by the United States National Museum (USNM). Throughout her studies, Hyman (1953) identified her specimen as *Stylochoplana californica* Woodworth, 1894, a species previously described from the same locality, the Gulf of

California. The description of *S. californica* provided information about the external anatomy only, but Hyman considered it enough to identify her material. This species shared some external similarities with the USNM material, such as the small size, the eye arrangement and the indication of the copulatory apparatus as three rounded masses behind the pharynx.

However, Hyman (1953) processed the worm histologically and noticed a particular arrangement of the ejaculatory duct through the prostatic vesicle, as well as the presence of a massive bulbous female antrum, features which are not assigned to *Stylochoplana* Stimpson, 1857. Furthermore, the genus *Stylochoplana* is characterised by a simple smooth epithelial lining and Hyman's specimen revealed a prostatic vesicle with not well-defined epithelial lining.

After the observation of these differences, Hyman (1953) decided to remove Woodworth's species from the genus *Stylochoplana* and created the new genus *Parviplana*, establishing *Parviplana californica* (Woodworth, 1894) as type species. Thus, the definition of the genus *Parviplana* was, according to Hyman (1953), based on the presence of a prostatic vesicle without chambers, an ejaculatory duct which crosses the prostatic vesicle, a female copulatory apparatus with a massive bulbous antrum and Lang's vesicle. The other *Parviplana* species described was *Stylochoplana lynca* Du Bois-Reymond Marcus, 1958, from the Brazilian coast, a species transferred to *Parviplana* by Faubel in 1983.

Concerning the genus *Phaenoplana*, Faubel (1983) includes five species previously assigned to the genus *Stylochoplana* or *Phaenocelis* Stummer-Traunfels, 1933. *Stylochoplana* spp. are characterised by a simple male copulatory apparatus with a conical penis papilla. It differs noticeably from *Phaenoplana* spp., due to the presence of a clear penis rod.

Almost all *Phaenoplana* spp. were described from the Pacific or Indian oceans, with the exception of one that has been described from the western Atlantic. The type species of the genus is *Phaenoplana conoceraea* (Schmarda, 1859), from Ceylon Island (Indian Ocean). It was named originally as *Imogine conoceraea* Schmarda, 1859, and the generic placement has changed several times. Diesing (1862) included the species in the genus *Stylochus* Ehrenberg, 1831, but in Lang's monograph (1884), it was assigned to a new genus, *Conoceros* Lang, 1884. Finally, Stummer-Traunfels (1933) listed the species in the genus *Stylochoplana*, but subsequently Faubel (1983) transferred it to the new genus *Phaenoplana*.

The second oldest species of this genus is *Phaenoplana challengerii* (Graff, 1892), described by Graff (1892) as *Planctoplana challengerii* Graff, 1892 based on material collected on driftwood in Humbolt Bay (Indonesia) during the Challenger expedition. Prudhoe (1950) renamed this species as *Stylochoplana challengerii* but Faubel (1983) changed its taxonomic placement moving it to the genus *Phaenoplana*.

The third older species of the genus, described originally from the Pacific waters, was *Phaenoplana taiwanica* (Kato, 1943), transferred by Faubel (1983) from the genus *Stylochoplana*. Like most of *Phaenoplana* spp., this one has never been found again.

The fourth species of this genus, *Phaenoplana longipenis* (Hyman, 1953) was described as *Stylochoplana longipenis* Hyman, 1953, from Mexico and California (Pacific Ocean). In the new millennium, this species was also recorded from the Atlantic Colombian coast by Quiroga et al. (2004).

Finally, the fifth species was described by Du Bois-Reymond Marcus and Marcus (1968) as *Phaenocelis peleca* from Curaçao, in the Atlantic Ocean and posteriorly assigned by Faubel (1983) as a new combination with the new genera, *Phaenoplana peleca* (Marcus & Marcus, 1968).

Following the discovery of many new species and the taxonomic contribution of Faubel, we have now the opportunity to revisit the microanatomy of these two genera and reinterpret the original descriptions. Considering this, we integrate the new information with the traditional one, providing new data for these taxa and arguing some taxonomic issues which will have to be taken into account throughout future studies.

Material and methods

The material was collected in different localities of the province of Cádiz (Spain), particularly in La Caleta Beach (36° 31' 55.50" N, 6° 18' 26.45" W), Santa María del Mar Beach (36° 31' 18.53" N, 6° 12' 18.17" W), Sancti Petri Beach (36° 22' 52.69" N, 6° 12' 18.17" W), Punta Carnero (36° 11' 10.16" N, 6° 15' 56.65" W) and Tarifa (36° 0' 42.59" N, 5° 35' 54.54" W) (Fig. 1). The specimens were found under stones and sampled using a brush during the low tide. The stones did not reveal any kind of macrobenthic fauna or algae. The

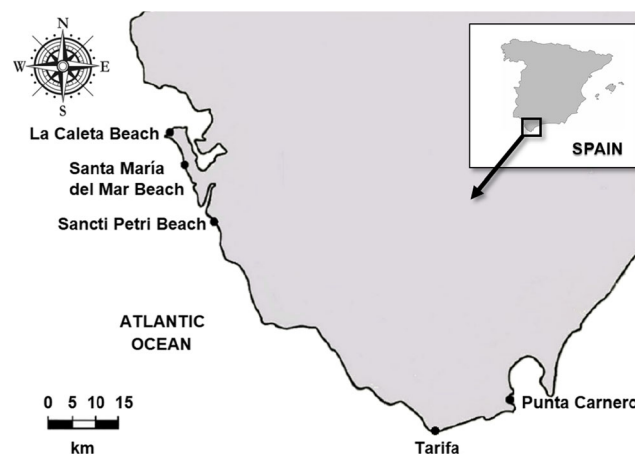


Fig. 1 Map of the coasts of the province of Cádiz showing the sampling stations studied. Map drawn by Patricia Pérez-García

dominant types of rocks are the polymictic conglomerates and sandstones.

The specimens were anaesthetised with 7.5% magnesium chloride and photographed alive (both ventrally and dorsally), preserving the maximum information about colour, shape and external morphology. A lateral piece of the specimen was cut and subsequently stored in absolute ethanol for further molecular studies. The flatworms fixed in frozen Bouin's solution or formaline 4% (Newman and Cannon 2003), stretching their body for a better posterior manipulation and preserved in 70% ethanol.

The fixed exemplars were processed histologically. Specimens were embedded in paraffin, sagittally sectioned at 7 μ m and stained with Azan trichrome method. Sections were also photographed and used for the reconstruction of the internal anatomy. Measurements were obtained from both living and fixed materials.

The type series was deposited in the Invertebrate Collection of the Museo Nacional de Ciencias Naturales of Madrid (MNCN), Spain, and the voucher specimens were deposited in the Invertebrate Collection of the Museu Nacional de História Natural e da Ciência of Lisbon MUHNAC, Portugal.

Results

Superfamily Leptoplanoidea Faubel, 1984

Family Leptoplanidae Stimpson, 1857

Genus *Parviplana* Hyman, 1953

Parviplana jeronimoi sp. nov. Pérez-García, Noreña & Cervera

urn:lsid:zoobank.org:act:4BB91231-C936-40D7-A4C1-2257A8647BFB

Material examined: Six specimens collected in Cádiz (Spain); all of them fixed for morphological studies.

Holotype: One mature specimen sagittally sectioned and stained with Azan, mounted on 48 slides. Captured in La Caleta Beach (36° 31' 55.50" N, 6° 18' 26.45" W), 24 April 2014. Deposited in the Invertebrate Collections of the MNCN; Cat. No. MNCN 4.01/1964 to 2011.

Paratype: One mature specimen sagittally sectioned and stained with Azan, mounted on 47 slides. Captured in La Caleta Beach (36° 31' 55.50" N, 6° 18' 26.45" W), 23 December 2014. Deposited in the Invertebrate Collections of the MNCN; Cat. No. MNCN 4.01/2012 to 2058.

Voucher material: One mature specimen serially sectioned, mounted on 41 slides. Collected in Santa María del Mar Beach (36° 31' 18.53" N, 6° 12' 18.17" W), 9 July 2013. Deposited in the Invertebrate Collection of the Museo Nacional de História Natural e da Ciência (MUHNAC); Cat. No. MNHNC MB16-000077. One mature specimen serially sectioned, mounted on 23 slides. Collected also in Santa María del Mar Beach, 21 August 2013. Cat. No. MNHNC MB16-

000078. One mature specimen serially sectioned, mounted on 17 slides. Captured in Sancti Petri Beach (36° 22' 52.69" N, 6° 12' 18.17" W), 24 July 2013. Cat. No. MNHNC MB16-000079. One mature specimen serially sectioned, mounted on 13 slides. Captured also in Sancti Petri Beach, 20 September 2013. Cat. No. MNHNC MB16-000080.

Type locality: La Caleta Beach, Cádiz, Spain. Collected in the intertidal area, from rocky substrate.

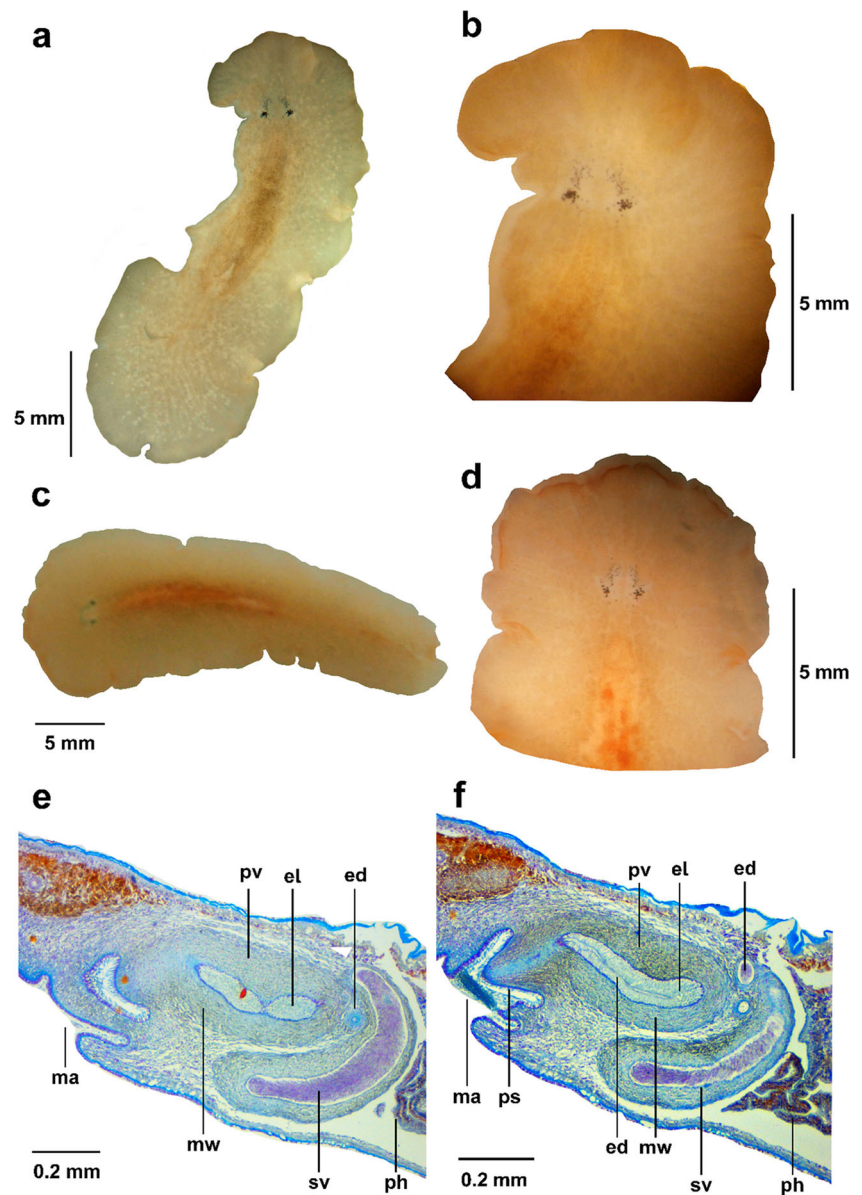
Etymology: The specific name is dedicated to Jerónimo Pérez, father of the first author, in acknowledgement and recognition for his support during her research on polyclads.

Diagnosis: Small-sized polyclad with yellowish-brown background colour; ventral body pale yellow; gonopores well separated, with corrugated ventral body wall between them; prostatic vesicle with penis papilla, surrounded by a penis sheath, both housed in a wide male atrium.

Description: Leptoplanidae with elongate body, wider and rounder in the anterior margin and narrow in the back end. Live specimen 20 mm long and 8 mm wide. Fixed specimen about 12 mm length. Paratype and voucher living specimens vary between 10 and 29 mm in length (17.4 ± 7.12). Ground colour yellowish-brown, with a darker brown spot along the pharynx (Fig. 2a). Ventral side pale yellow. Genital region lighter coloured, as well as the marginal band of the entire body. Tentacles absent. Tentacular eyes arranged in two clusters, with about 12 eyes each cluster. Cerebral eyes divided also in two clusters with approximately 35 eyes each one, scattering widely to the anterior margin (Fig. 2b). Frontal or marginal eyes absent. Ruffled pharynx located between first and second third of the body. Oral pore located on posterior end of the second third. Genital pores well separated (0.5 mm) situated shortly behind the pharynx (1.12 mm). Ovaries arranged dorsal to the testes.

Reproductive system: The male copulatory apparatus consists of a true seminal vesicle, an interpolated prostatic vesicle and a massive penis papilla (0.23 mm width). The male complex is enclosed in a muscular bulb, with the exception of the seminal vesicle. The vas deferentia are wide (0.16 mm), following sinuously the shape of the animal's body, curving upwards and downwards before entering the seminal vesicle proximally. The seminal vesicle is elongated and ventrally positioned, with vertical orientation (Figs. 2e, f and 3c). A thick and strong muscular duct emerges from its distal part leading to the prostatic vesicle. This one has an oval shape and a tall epithelial lining (0.04 mm), with a comparatively much thickened muscular wall (0.13 mm). Numerous extravescicular glands are observed (Figs. 2f and 3c). The ejaculatory duct crosses the whole male copulatory organ. The penis papilla has a conical shape with massive and muscular walls, projecting to the male atrium (Fig. 2e, f). The distal part of the penis papilla is surrounded by a penis sheath. The male atrium is wide, having a width up to 0.28 mm and connected to the exterior through a ventral pore.

Fig. 2 *Parviplana jeronimoi* sp. nov.: **a** dorsal view of a living specimen (holotype, Cat. No. MNCN 4.01/1964 to 2011); **b** dorsal view of the tentacular and cerebral eyes (holotype); **c** dorsal view of a living specimen (paratype, Cat. No. MNCN 4.01/2012 to 2058); **d** dorsal view of the tentacular and cerebral eyes (paratype); **e, f** histological section of the male copulatory organ (holotype)

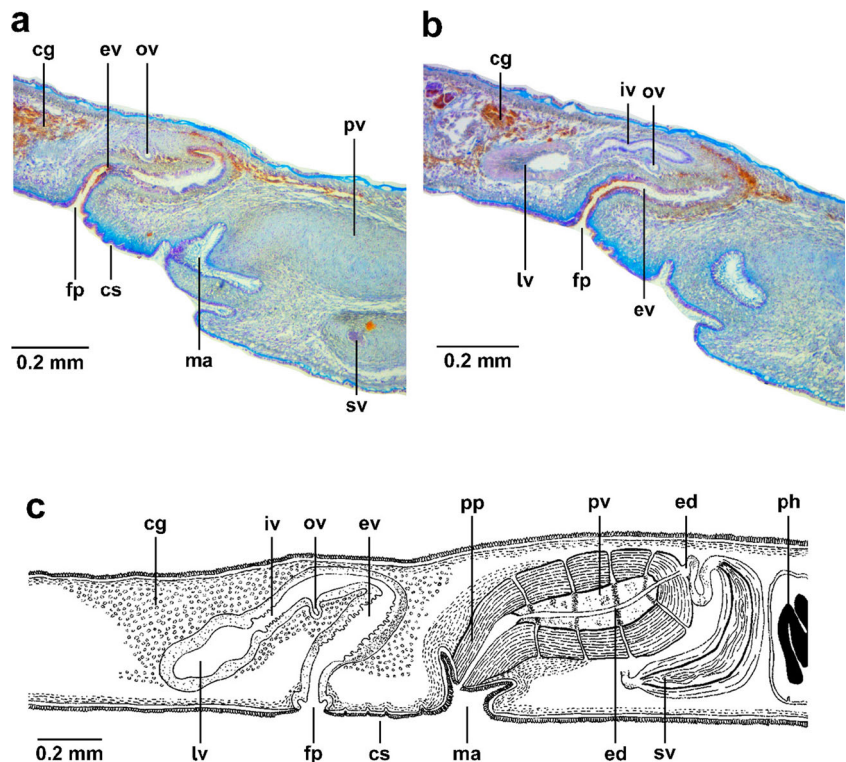


The female pore is separated from the male pore by a corrugated surface (Fig. 3a, c) which involves the outer epidermis, the dermis layer, the basement membrane and the adjacent musculature. The internal and the external vagina have numerous cement glands surrounding. The external vagina shows the characteristic feature of vagina bulbosa described by Faubel (1983) with epithelial folds. The latter narrows distally and extends to the dorsal side, almost reaching the male copulatory system. The internal vagina is wide, directed to the posterior end and displays some folds. The common oviduct enters the internal vagina proximally. Lang's vesicle is large and oval-shaped (0.14 mm width), is well-developed and covers one third the thickness of the animal's body (Fig. 3b, c).

Discussion: The new species belongs to the genus *Parviplana* based on the presence of a massive penis papilla housed in a well-developed atrium, an elongated prostatic vesicle, the arrangement of the ejaculatory duct (which crosses the whole male copulatory apparatus) and the presence of a vagina bulbosa in the female complex.

This taxon comprises only two species, *Parviplana californica* and *P. lynca*. As mentioned in the introductory section, *P. lynca* was transferred by Faubel (1983) from the genus *Stylochoplana*. On the other hand, *P. californica* was described by Hyman (1953), who identified her specimen as *Parviplana californica*, a species previously described by Woodworth (1894) as *Stylochoplana californica*. After the revision of the genus *Parviplana* made by Faubel (1983), he concluded that Woodworth's specimen was not the same species as *P.*

Fig. 3 *Parviplana jeronimoi* sp. nov.: **a, b** histological section of the female copulatory organ (holotype, Cat. No. MNCN 4.01/1964 to 2011); **c** sagittal reconstruction of the reproductive system (holotype)



californica from Hyman. Thus, Faubel (1983) gave a new name to Hyman's species, *Parviplana hymani* Faubel, 1983.

The new species of *Parviplana* described in this study shares some similarities with other species of the genus, although some characters are exclusive to *P. jeronimoi* sp. nov.: the presence of a corrugated surface between the genital pores and a penis sheath surrounding the distal part of the penis papilla. In *P. hymani*, the abovementioned corrugated surface and the penis sheath are absent; moreover, the genital pores are very close together and the female copulatory organ presents a highly muscularised *antrum bulbosum* (definition by Hyman 1953). In contrast, *P. jeronimoi* sp. nov. bears separated genital pores (0.5 mm) and the external vagina presents a simple atrium and a common vagina bulbosa described by Faubel (1983). Likewise, the seminal vesicle of *P. hymani* is horizontally oriented while the seminal vesicle of the Iberian species has a vertical position just behind the prostatic vesicle. Both differs also in the size of the Lang's vesicle, being small in the Pacific species and much bigger in *P. jeronimoi* sp. nov. Furthermore, *P. hymani* is distinguished from the Iberian species in body length, with *P. hymani* being considerably smaller when mature (5 mm) than *P. jeronimoi* sp. nov. (20 mm). The number of cerebral eyes are also considerably different; *P. hymani* bears 5 cerebral eyes compared with 35 cerebral eyes in *P. jeronimoi* sp. nov. Nevertheless, these two *Parviplana* species share some features such as the lack of head tentacles, the extrabulbar position of the seminal vesicle and the shape of the prostatic vesicle, being oval and with a massive penis papilla.

If we compare *Parviplana lynca* (Du Bois-Reymond Marcus, 1958) with *P. jeronimoi* sp. nov., we observe that they also differ in size, with the Brazilian species being much smaller (6.3 mm). A characteristic feature of *P. lynca* is the presence of head tentacles, which is exclusive to this species within the genus. The number of cerebral eyes in *P. lynca* is 16 while the Iberian species are more numerous (35 eyes). Moreover, the oral pore in *P. lynca* is located in a central position, while in *P. jeronimoi* sp. nov., it is located in the posterior end of the second third of the pharynx.

Like *P. hymani*, *P. lynca* also lacks the corrugated surface and the penis sheath, characters which are present in *P. jeronimoi* sp. nov. There are differences between the seminal vesicles too. *P. lynca* bears a small seminal vesicle with a spherical shape, enclosed in the male muscular bulb and joining the prostatic vesicle with a short intrabulbar ejaculatory duct. In contrast, *P. jeronimoi* sp. nov. presents an elongated extrabulbar seminal vesicle, much bigger in size (at least half the prostatic vesicle), connected with the prostatic vesicle and the bulb mass by a sinuous and elongated ejaculatory duct. The prostatic vesicle is elongated in the Pacific species and oval-shaped in *P. jeronimoi* sp. nov. Furthermore, the vas deferentia are well-developed in *P. lynca*, forming spermiducal vesicles, in contrast with the characteristic arrangement of the vas deferens in *P. jeronimoi* sp. nov. Regarding the female copulatory apparatus, they also differ in the shape of the Lang's vesicle, extending into two lateral diverticula in the Brazilian species while in *P. jeronimoi* sp.

nov., they extend to the posterior end and are bigger, covering one third of the thickness of the flatworm.

Notwithstanding the above, some issues should be considered. According to Faubel (1983), the genus *Parviplana* lacks tentacles as diagnostic feature, but *P. lynca* has small tentacles in the cephalic region. Furthermore, unlike the other two *Parviplana* species described, *P. lynca* encloses the seminal vesicle inside the muscular bulb together with the prostatic vesicle. Finally, recent molecular studies (Aguado et al. 2017, Bahia et al. 2017) pointed that the use of the prostatic vesicle as a diagnostic character may not be as significant as it is accepted currently. Then, further acotylean phylogenetic studies including species of the genus *Parviplana* could clarify the value of the diagnostic features of this genus.

Family Stylochoplanidae Faubel, 1983

Genus *Phaenoplana* Faubel, 1983

Phaenoplana caetaria sp. nov. Pérez-García, Noreña & Cervera.

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Material examined: Six specimens collected in Cádiz (Spain); all of them fixed for morphological studies.

Holotype: One mature specimen sagittally sectioned and stained with Azan, mounted on 25 slides. Captured in Punta Carnero (36° 11' 10.16" N, 6° 15' 56.65" W), 19 April 2015. Deposited in the Invertebrate Collections of the MNCN; Cat. No. MNCN 4.01/2059 to 2083.

Paratype: One mature specimen sagittally sectioned and stained with Azan, mounted on 21 slides. Collected in Tarifa (36° 0' 42.59" N, 5° 35' 54.54" W), 5 July 2015. Deposited in the Invertebrate Collections of the MNCN; Cat. No. MNCN 4.01/2084 to 2104.

Voucher material: One mature specimen serially sectioned, mounted on 60 slides. Collected in La Ballenera Beach (36° 5' 5.42" N, 5° 25' 59.53" W), 10 October 2014. Deposited in the Invertebrate Collection of the Museu Nacional de História Natural e da Ciência (MUHNAC); Cat. No. MNHNC MB16-000081. One mature specimen serially sectioned, mounted on 17 slides. Collected also in La Ballenera Beach, 20 February 2015. Cat. No. MNHNC MB16-000082. One mature specimen serially sectioned, mounted on 14 slides. Captured in La Ballenera Beach, 19 April 2015. Cat. No. MNHNC MB16-000083. One mature specimen serially sectioned, mounted on 8 slides. Captured in Punta Carnero (36° 11' 10.16" N, 6° 15' 56.65" W), 19 May 2015. Cat. No. MNHNC MB16-000084.

Type locality: Punta Carnero, Cádiz, Spain. Collected in the intertidal area, from rocky substrate.

Etymology: The specific name refers to Caetaria, the roman name of the area where the holotype was collected.

Diagnosis: *Phaenoplana* with small size; brownish dorsal colour, dotted with yellowish spots; ventral body pale brown; elongated form of the body; tentacles absent; ejaculatory duct

projects inside the prostatic vesicle; spherical prostatic vesicle; twisted penis rod; male atrium well developed; elongated small Lang's vesicle.

Description: Elongated worms, anteriorly broad and tapering distally. Marginal border slightly folded, being specially ruffled and irregular. Holotype with about 24 mm length and 8 mm width alive. Fixed specimen about 10 mm length. Paratype and voucher living specimens vary between 12 and 33 mm in length (17.8 ± 8.64). Background colour of the dorsal surface brown with yellowish spots, lighter along the body margin (Fig. 4a). Ventrally pale brown. Paratype presents a different colouration pattern, having a yellowish background (Fig. 4b). Tentacles lacking. Tentacular eyes arranged in two symmetrical clusters, with about 15 eyes each cluster. Cerebral eyes scattering forwards, with approximately 27 eyes each cluster (Fig. 4c). Marginal eyes absent. Ruffled pharynx positioned between the first and the second third of the animal's body. Oral pore located at the beginning of the last third. Genital pores well separated (0.9 mm). Male gonopore about 1.5 mm behind the pharynx and 2.4 mm from the female gonopore. Ovaries scattering dorsally. Testes are ventral.

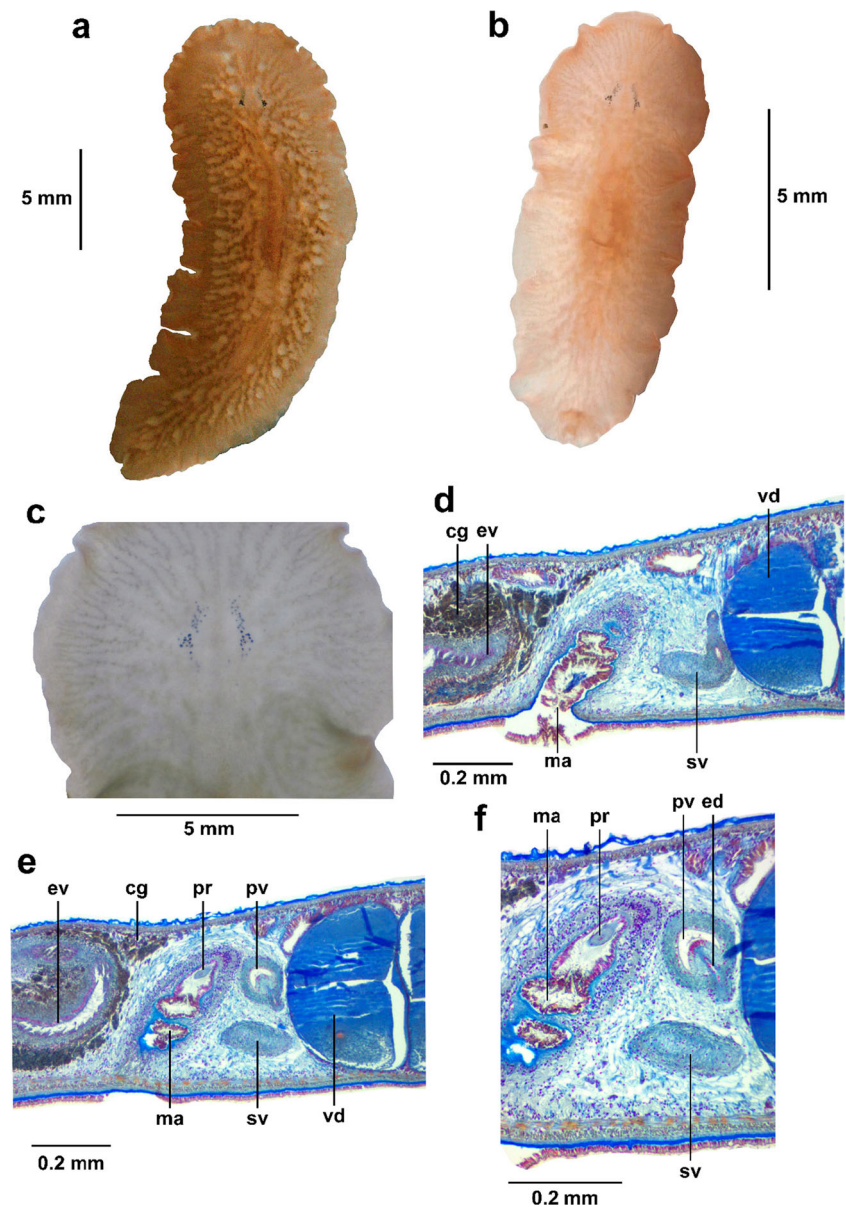
Reproductive system: The male reproductive complex is directed backwards, with a true seminal vesicle, an interpolated prostatic vesicle and a penis papilla with a penis rod (Figs. 4e, f and 5c). The vas deferentia run ventrally and enter the seminal vesicle proximally. The seminal vesicle is elongated, bent in two sections: the proximal section directed posteriorly and the distal section ventro-dorsally oriented. The ejaculatory duct projects inside the prostatic vesicle. The prostatic vesicle is small and has a spherical form, with smooth granular lining and strong muscular wall (0.02 mm). Distally, a twisted penis rod (about 0.15 mm length) is housed in a large and wide male atrium.

The female reproductive system consists of a well-developed vagina, both external and internal (0.11 mm width), surrounded by several cement glands (Fig. 5a–c). The vagina externa is strongly muscular, forming a vagina bulbosa which forms several folds. The latter rises dorsally and turns to the posterior end close to the male atrium. The vagina interna is covered with multiple folds until the opening of the common oviduct (Fig. 5b, c). Running to the left, the small Lang's vesicle is elongated and is located close to the dorsal surface.

Discussion: The presence of a penis rod in the male copulatory apparatus and a strongly muscular vagina externa places the new species into the genus *Phaenoplana*.

There are five species within the genus *Phaenoplana*: *P. conoceraea*, *P. challengerii*, *P. longipenis*, *P. taiwanica* and *P. peleca*. All these species had been transferred by Faubel (1983) from other genera because of the presence of the abovementioned diagnostic characters. Moreover, there are some characters which are exclusive of *P. caetaria* sp. nov., such as the twisting penis rod, the projection of the ejaculatory duct into the prostatic vesicle, a well-developed male atrium and a small elongated Lang's vesicle.

Fig. 4 *Phaenoplana caetaria* sp. nov.: **a, b** dorsal view of living specimens (holotype and paratype, respectively; Cat. No. MNCN 4.01/2059 to 2083 and Cat. No. MNCN 4.01/2084 to 2104); **c** dorsal view of the tentacular and cerebral eyes (paratype); **d, e** histological section of the male copulatory organ (holotype); **f** histological section of the detail of the prostatic vesicle (holotype)



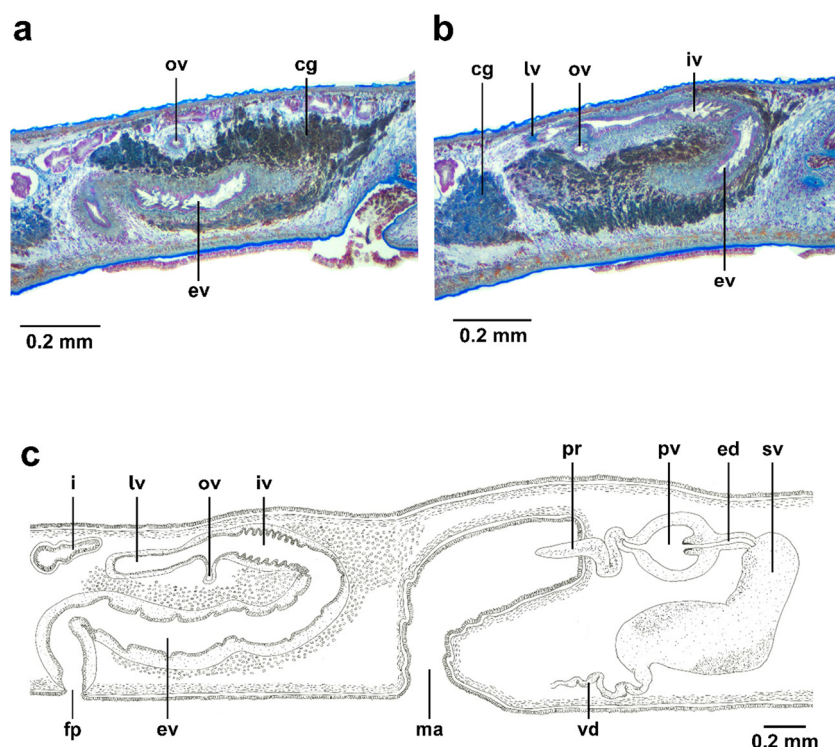
Regarding the colour pattern, *P. caetaria* sp. nov. and the type species of the genus, *P. conoceraea*, are similar, but *P. conoceraea* bears one pair of well-developed tentacles which are absent in *P. caetaria* sp. nov. Since the description of *P. conoceraea* concerns the external anatomy only, is not possible to enumerate other differences.

Phaenoplana challengerii presents a similar number of eyes, showing 13 nuchal eyes and 28 cerebral eyes instead of the 15 nuchal eyes and 27 cerebral eyes of *P. caetaria* sp. nov. Furthermore, both species share a well-developed muscular layer of the female canal. Nevertheless, externally, *P. challengerii* bears a brownish grey dorsal colouration and presents nuchal tentacles. Internally, it has an oval-shaped prostatic vesicle, presents a bursa copulatrix in the female organ and has a spherical Lang's vesicle. In contrast, *P. caetaria* sp. nov. is brownish, dotted with

yellowish spots, lacks nuchal tentacles and bears a spherical prostatic vesicle with the projection of the ejaculatory duct within it. Regarding the female complex, the bursa copulatrix is lacking in the Iberian species and the Lang's vesicle is elongated small.

The new species also share external similarities with *Phaenoplana longipenis*, such as the number of nuchal eyes, with *P. caetaria* sp. nov. having 15 eyes instead of 12 eyes in the Pacific species. Even so, *P. longipenis* shows a grey pattern, a tubular V-like prostatic vesicle and a remarkable penis rod, being very long. The male atrium has a tubular shape and the Lang's vesicle is large and voluminous. All these features differ from *P. caetaria* sp. nov., with this species having a brownish dorsal colour, a prostatic vesicle with a spherical shape and a twisted penis rod. Additionally, the male atrium is wide and the Lang's vesicle is elongated and narrow.

Fig. 5 *Phaenoplana caetaria* sp. nov.: **a, b** histological section of the female copulatory organ (holotype, Cat. No. MNCN 4.01/2059 to 2083); **c** sagittal reconstruction of the reproductive system (holotype)



In regard to *Phaenoplana taiwanica*, this species has approximately 25–30 tentacular eyes each cluster while *P. caetaria* sp. nov. has 15 eyes. In addition, *P. taiwanica* has a narrower male atrium and a very remarkable Lang's vesicle, which is horseshoe-shaped, an exclusive feature of the Pacific species. This character separates *P. taiwanica* and *P. caetaria* sp. nov., whose Lang's vesicle is simple and elongated.

Finally, if we compare *Phaenoplana peleca* with the Iberian species, they display similar number of nuchal and cerebral eyes. The Caribbean species presents 11–13 nuchal eyes and 33–34 cerebral eyes while *P. caetaria* sp. nov. has 15 nuchal eyes and 27 cerebral eyes. The most characteristic feature of *P. peleca* is the presence of marginal eyes around the entire body edge, lacking in *P. caetaria* sp. nov. Likewise, *P. peleca* has a short, curved and pointed penis papilla housed in a deep male atrium, as well as a globular Lang's vesicle. These characters differs from *P. caetaria* sp. nov., since it has a penis papilla with a characteristic twisted penis rod housed in a well-developed male atrium and the Lang's vesicle shows an elongated form. All these differences permit us to consider the specimens from Cadiz a different own species.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All applicable international, national and/or institutional guidelines for the care and use of animals were followed by the authors.

Sampling and field studies No permits are required from the authorities of Spain for sampling the animal taxon studied in the present work.

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