

***Drusia (Escutiella) alexantoni* n. sp. (Gastropoda, Pulmonata, Parmacellidae), a new terrestrial slug from the Atlantic coast of Morocco**

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Abstract

Drusia (Escutiella) alexantoni n. sp. (Gastropoda, Pulmonata, Parmacellidae), a new terrestrial slug from the Atlantic coast of Morocco.— We describe a new parmacellid, *Drusia (Escutiella) alexantoni* n. sp. from the Moroccan Atlantic coast. The species most closely related to the new taxon are *D. (E.) deshayesii* and *D. (D.) valenciennii*. The new parmacellid differs from *D. (E.) deshayesii* mainly by the presence of external spots and bands on both the back and the shield, a reproductive system with uneven atrial appendices of the horn-shaped organ, and a different reticulated pattern of the inner epiphallus. It differs from *D. (D.) valenciennii* mainly for the appearance of the shell and the pattern and disposition of the bumps inside the penis, the presence of an elbow-shape in this organ, and the reticulated appearance of the inner wall of the epiphallus. An updated dichotomous key of the family Parmacellidae is provided.

Key words: Slug, Parmacellidae, *Drusia (Escutiella) alexantoni*, New species, Morocco, North Africa.

Resumen

Drusia (Escutiella) alexantoni sp. n. (Gastropoda, Pulmonata, Parmacellidae), una nueva babosa del litoral atlántico de Marruecos.— Se describe un nuevo parmacélico, *Drusia (Escutiella) alexantoni* sp. n., de la costa atlántica marroquí. Las especies más afines al nuevo taxon son *D. (E.) deshayesii* y *D. (D.) valenciennii*. De la primera se diferencia por presentar externamente manchas y bandas sobre el dorso y escudo, un aparato reproductor con apéndices atriales del órgano corniforme bastante desiguales, y por el distinto aspecto del reticulado del interior del epifalo. De *D. (D.) valenciennii* se diferencia principalmente por la forma de su concha, así como por el aspecto y la disposición de los mamelones del interior del pene, la presencia de un marcado acodamiento en este órgano, así como por el aspecto reticulado del interior del epifalo. Se proporciona además una clave dicotómica actualizada de la familia Parmacellidae.

Palabras clave: Babosa, Parmacellidae, *Drusia (Escutiella) alexantoni*, Nueva especie, Marruecos, Norte de África.

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Introduction

In a recent article (Martínez–Ortí & Borredà, 2012) we revised the systematics of the family Parmacellidae P. Fischer, 1856 and we proposed a new systematic scenario for this family, which would be formed by four genera: *Candaharia* Godwin–Austen, 1888 (2 subgen., 4 spp.), from Central Asia; *Cryptella* Webb et Berthelot, 1833 (7 spp.) from the Canary Islands; *Parmacella* Cuvier, 1804 (2 spp.) from Libya and Egypt; and *Drusia* Gray, 1855 (2 subgen., 4 spp.), with a wide distribution detailed below.

In the previously mentioned paper, the genus *Drusia* Gray, 1855 was divided into two subgenera: *D. (Escutiella)* Martínez–Ortí & Borredà, 2012 and *D. (Drusia)* s. str. The subgenus *D. (Drusia)* includes three species: *D. (D.) valenciennii* (Webb et Van Beneden, 1836), from the South of the Iberian peninsula; *D. (D.) tenerifensis* (Alonso, Ibáñez & Díaz, 1985), from Tenerife and *D. (D.) iberica* (Eichwald, 1841) from the Caucasus–Caspian Sea area. Subgenus *D. (Escutiella)* was described to include only one species: *D. (E.) deshayesii* (Moquin–Tandon, 1848), from Algeria and Northern Morocco.

In January 2011, we carried out a malacological prospection along the Moroccan Atlantic coast, collecting numerous specimens of a parmacelle which we propose as a new species to be included in the subgenus *D. (Escutiella)*.

Results

After a detailed morpho–anatomical study of the collected specimens we observed that they corresponded to a parmacelle closely related to the species *Drusia (Drusia) valenciennii* and *Drusia (Escutiella) deshayesii*, particularly to the latter, but we believe it is a new species, and we propose naming it *Drusia (Escutiella) alexantoni* n. sp.

Family Parmacellidae P. Fisher, 1856

Genus *Drusia* Gray, 1855

Subgenus *D. (Escutiella)* Martínez–Ortí & Borredà, 2012

Drusia (Escutiella) alexantoni n. sp.

Typical locality

Road from Marrakech to Essaouira, 12 km before Essaouira, Taftchet. Essaouira. Morocco (UTM = 29RMQ4388) (January 2, 2011). Collectors: A. Martínez–Ortí, A. López Alabau and A. Pérez Ferrer (MVHN–100111GH01).

Other localities

Road of Essaouira to Agadir–Smimov, Smimov. Essaouira. Morocco (UTM = 29RMQ3274) (January 3, 2011) (Collectors: A. Martínez–Ortí, A. López Alabau and A. Pérez Ferrer) (MVHN–100111GH02; five specimens); Agadir–Ida–Outanane, close to a lake with coots beside the road (February 6, 2009) (Martínez, 2009) (UTM = 29RMP46).

Type material

Formed by 29 specimens. The holotype is deposited at the Museu Valencià d'Història Natural (Valencia, Spain) with the code MVHN–100111GH01a. There are 13 paratypes (in ethanol 70%) with the code MVHN–100111GH01b and four paratypes (in ethanol 96%) with the code MVHN–100111GH01c, all at the same institution. In addition, three paratypes (in ethanol 70%) were deposited at the Museu de Ciències Naturals de Barcelona (Zoologia, MZB) with the code MZB 2012–0728; three paratypes (in ethanol 70%) at the Nationaal Natuurhistorisch Museum–Naturalis of Leiden (The Netherlands) with the code RMNH. MOL.323195; three paratypes (in ethanol 70%) at the Museo Nacional de Ciencias Naturales of Madrid (Spain) with the code MNCN–15.05/60078; and two paratypes (in ethanol 70%) at the Senckenberg Museum of Frankfurt am Main (Germany) with the code SMF 341354.

Etymology

Species dedicated to Alejandro Pérez Ferrer and Antonio López Alabau, co–collectors of the studied specimens and enthusiastic Valencian amateurs of the malacology.

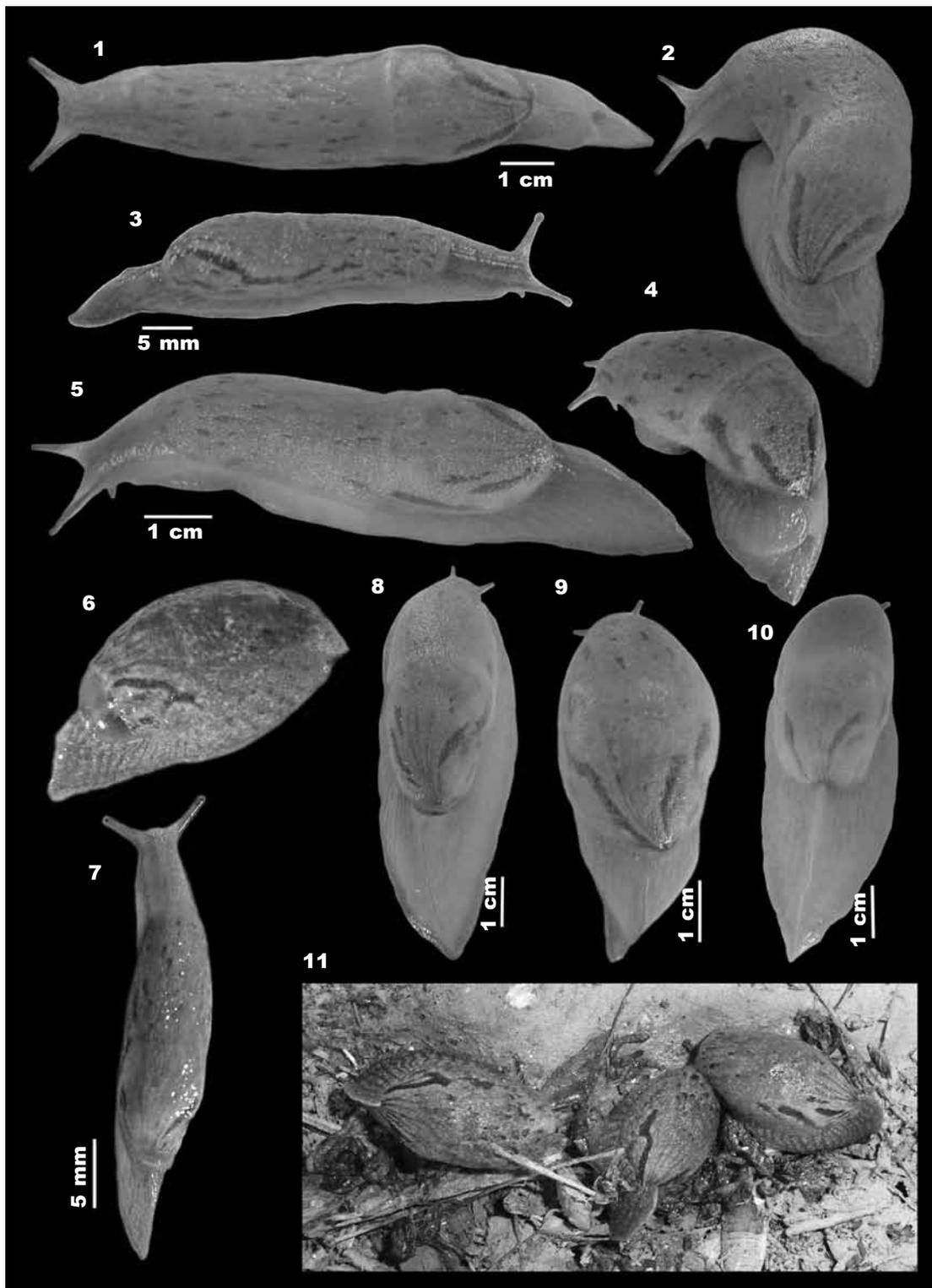
Common name

Slug of Barbary; Babosa de Berbería; Limace de Berberie.

Diagnosis

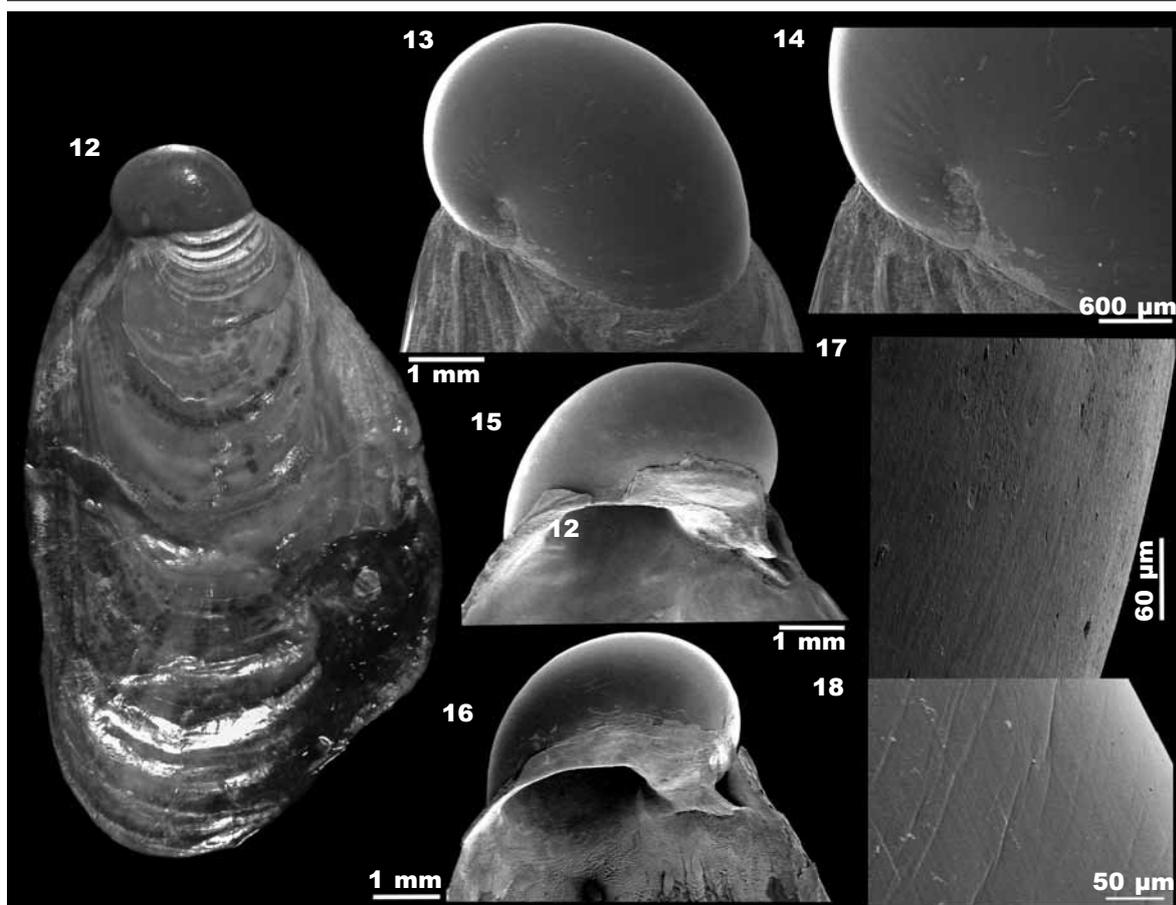
Parmacelle of great size. Young specimens present an olive brown dorsum with black lines and spots, especially on the shield, while adult specimens are light orange–brown and with lighter lines and spots. Toward the back of the shield, multiple lines or black bands of different thicknesses converge on the protoconch showing individual pattern variation (character less patent in adults). This protoconch is bright greenish, covered in adults and protruding slightly on the body surface of young individuals. Inside the reproductive atrium there is a thick ligula that extends inside the largest of the horn–shaped accessorial appendices. It has a penis with a lateral bulge, giving it an elbow–like shape and it has two thick internal bumps. The interior of the epiphallus has a characteristic reticulated form with thick longitudinal folds that can spread out. Between these folds there are other less patent transverse folds that are almost perpendicular.

External appearance (figs. 1–11): slug of the family Parmacellidae with external features characteristic of this family: large, rough skin, and large, granular shield with the pneumostome in its right posterior portion. Light orange dorsal keel on the caudal part of the animal. Orange dark keel clearly visible in the posterior part of the body, especially in well–developed adult specimens. Very acuminate tail. Foot is of aulacopod type and the sole is light in colour. Caudal gland absent. Adult individuals reach 15 cm in length. Young individuals present a dorsal olive brown background with black lines and spots, especially on the shield; dorsal black bands or lines converge



Figs. 1–11. *Drusia (E.) alexantoni* n. sp.: 1–2. Adult holotype; 3. Juvenile holotype; 4–5. Two paratypes; 6–7. Young paratypes showing the protoconch; 8–10. Shield pattern variability of three paratypes; 11. View of a group of several paratypes in the type locality.

Figs. 1–11. *Drusia (E.) alexantoni* sp. n.: 1–2. Holotipo adulto; 3. Holotipo juvenil; 4–5. Dos paratipos; 6–7. Paratipos juveniles mostrando la protoconcha; 8–10. Variabilidad de los dibujos de los escudos de tres paratipos; 11. Vista de un grupo de varios paratipos en la localidad tipo.



Figs. 12–18. Shell of *Drusia (E.) alexantoni* n. sp.: 12. Paratype (21.5 mm length) (digital photography); 13–14. Protoconch (scanning electron microscope); 14. Detail of the nucleus of the protoconch; 15–16. Posterior region of the shell showing the anchorage denticulation for the muscles; 17–18. Aspect of the surface of the protoconch; 18. Detail of the irregularly reticulated protoconch.

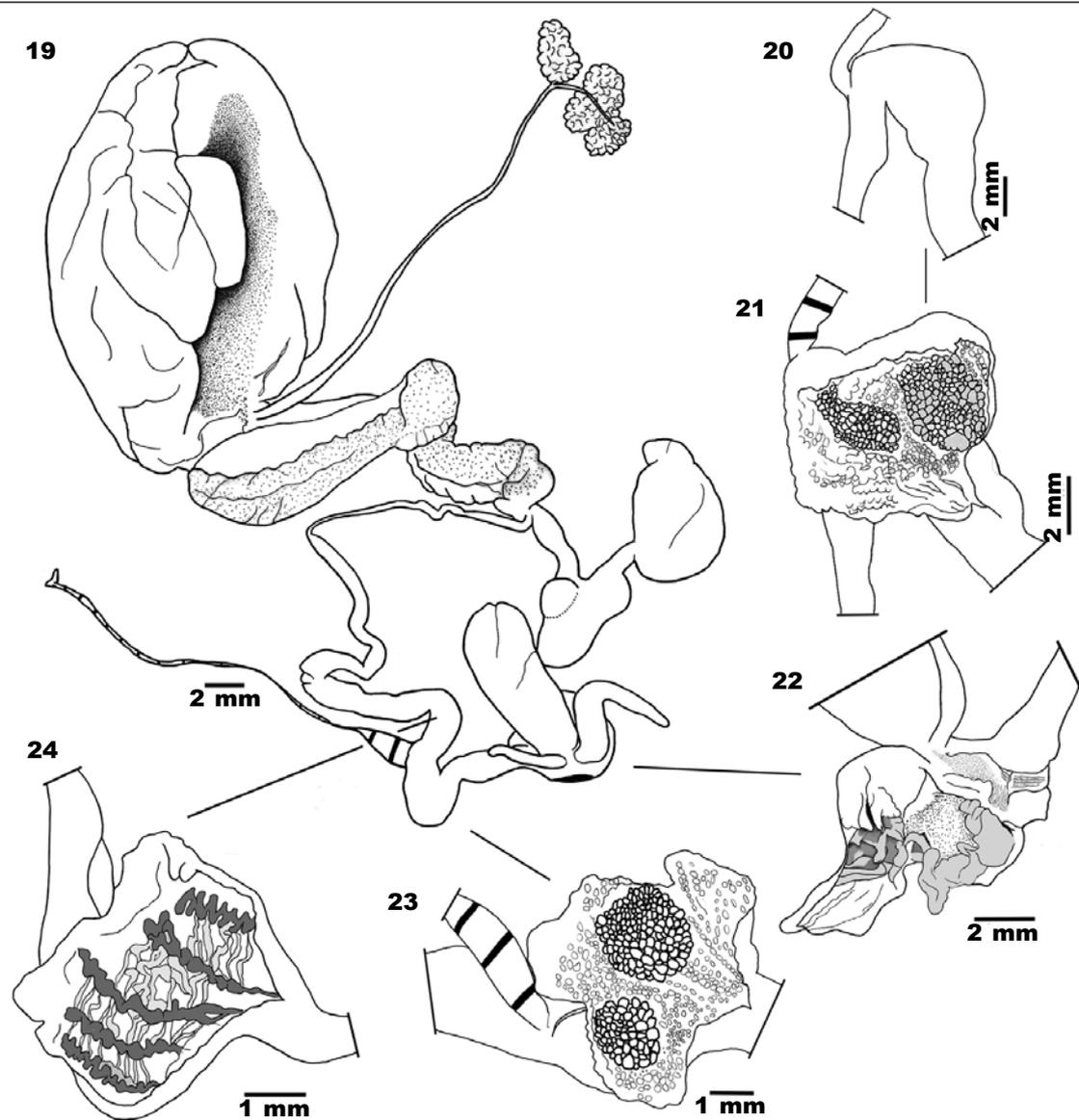
Figs. 12–18. Concha de *Drusia (E.) alexantoni* sp. n.: 12. Paratipo (21,5 mm de longitud) (fotografía digital); 13–14. Protoconcha (microscopio electrónico de barrido); 14. Detalle del núcleo de la protoconcha; 15–16. Región posterior de la concha, con denticulación para el anclaje muscular; 17–18. Aspecto de la ornamentación de la superficie de la protoconcha; 18. Detalle del reticulado irregular de la protoconcha.

toward the shield end, having individual pattern variation. The greenish, bright protoconch is slightly protruded in young individuals and even in sub-adult specimens (figs. 6–7). In well-developed adults, the overall tone of the body is light orange brown, with more visible bands and spots found only on the edge of the shield, while the rest of the dorsum shows a uniform appearance. In general, adult coloration is lighter than in younger animals.

Shell (figs. 6–7, 12–18): the shell is located under the mantle in the posterior part of the shield. It consists of a protoconch, from where a spiral begins, attached to a flat lamina, the limacella (or spatula). The protoconch is greenish, shiny, smooth, and relatively wide. The spiral is clearly visible. The limacella is white, slightly curved and paddle-shaped; it is slightly narrow in comparison

and not strictly flat, being more cupped than in other species of the family. The protoconch protrudes slightly from the posterior end of the mantle in young and sub-adult specimens; it is well-developed and presents a well-marked oval-circular opening (figs. 15–16). In the outer flange an arrowhead-shaped, anchoring tooth is appreciable (figs. 15–16). Although at a glance the protoconch looks smooth and glistening, high magnification reveals a characteristic form, consisting of longitudinal and transverse lines forming an irregular grid in some areas (figs. 17–18). The size of the shell from two of the adult paratypes varies from 12.0 to 14.0 mm in width and from 21.5 to 24.0 mm in length.

Reproductive system (figs. 19–24): hermaphrodite gland partly covered by digestive organs is bilobed and formed by irregular acini. In young specimens it

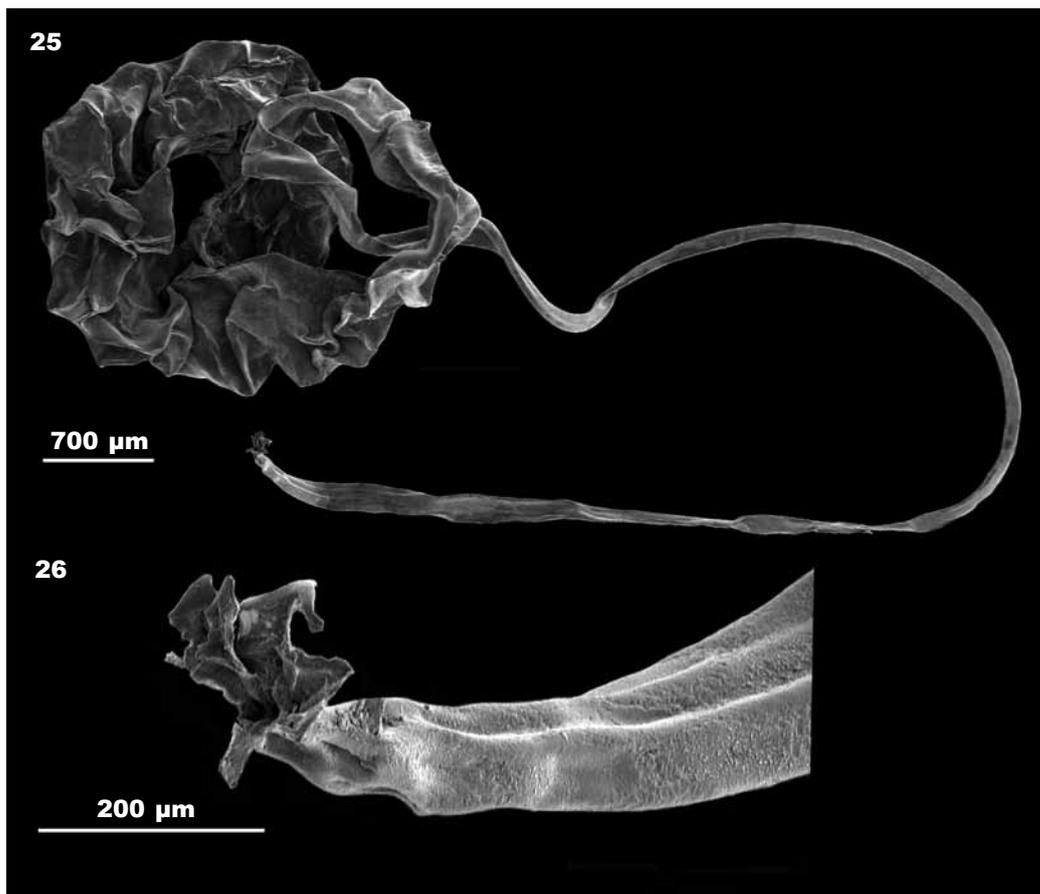


Figs. 19–24. Reproductive system of *Drusia* (*E.*) *alexantoni* n. sp.: 19, 22–24. A paratype genitalia: 19. Complete genitalia; 22. Atrium containing the ligula; 23. Detail of the interior of the penis showing the bumps; 24. Form of the inner wall of the epiphallus. 20–21. Penis of another paratype.

Figs. 19–24. Aparato reproductor de *Drusia* (*E.*) *alexantoni* sp. n.: 19, 22–24. Genitalia de un paratipo: 19. Genitalia completa; 22. Atrio con la ligula; 23. Detalle del interior del pene mostrando los mamelones. 24. Ornamentación de la pared interior del epifalo. 20–21. Pene de otro paratipo.

is lighter and in adults it is darker in colour, greyish, with the same colour as the hepatopancreas. Hermaphrodite duct long and winding. Very large, triangular, whitish and irregular albumen gland, larger than in *D. (E.) deshayesii* and *D. (D.) valenciennii*. Ovispermiduct relatively short, shorter than the albumen gland; distally it separates into feminine and masculine ducts. The masculine duct consists of vas deferens, epiphallus and penis, and together is longer than the ovispermiduct. The vas deferens is flared at its distal part,

turning into the epiphallus, which presents a series of very thick longitudinal folds that can spread out along with other transverse, perpendicular, some of them oblique, less patent folds which give it a reticular appearance interiorly (fig. 24). This reticular appearance is similar to that of *D. (E.) deshayesii*, although this species has both the transverse and longitudinal folds similarly well-marked. The retractor muscle is inserted in the distal part of the epiphallus and it enlarges markedly turning into the penis. The



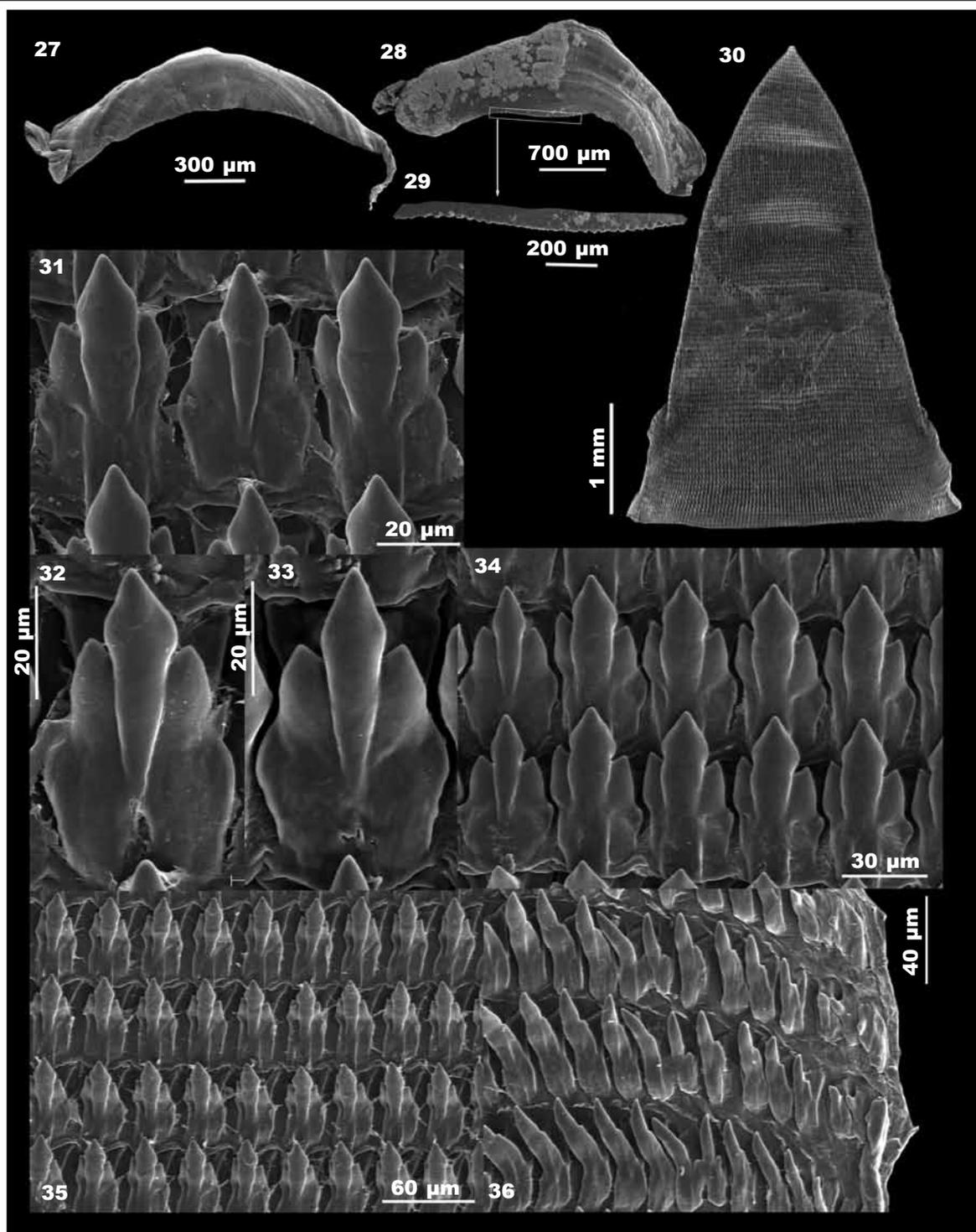
Figs. 25–26. Spermatophore of *Drusia (E.) alexantoni* n. sp.: 25. General view; 26. Anchoring disk detail.

Figs. 25–26. *Espermatóforo de Drusia (E.) alexantoni* sp. n.: 25. *Vista general*; 26. *Detalle del disco de anclaje*.

penis has a lateral protrusion close to the retractor muscle, giving it an elbow-like shape. Interiorly, the penis is completely covered with tight papillae. Inside the penis, in its proximal part, there is a bump next to the area of insertion of the muscle retractor (figs. 21, 23). Another larger bump is present in a distal position inside the elbow area. No complete spermatophores have been recovered (figs. 25–26). Inside the bursa copulatrix of four adult paratypes occurred several spermatophores (up to four in one of them), partially digested but quite complete. The spermatophores have the characteristics of the parmacelle morphology, and they are formed by a spiral from which a long filament emerges ending in a star-shaped fixing disk. We did not find entire anchoring disks whose morphology is a character of possible taxonomic value among the partially digested spermatophores, but some of them fairly complete (fig. 26). The female duct begins with a short and cylindrical free oviduct which ends in a widened structure which also converges at the duct of the bursa copulatrix. This widened structure is smooth and ovoid, with a hemispherical bulge in front of the

end of the short bursa duct; the bursa is rather large and has very thin walls, although its size and shape vary greatly depending on the presence and degree of digestion of the spermatophores (fig. 19). The widened area increases its width becoming more glandular in aspect, having a bean-shape; it is the so-called perivaginal gland. The vagina is surrounded by this gland and ends in the atrium, which is rather short and has two conspicuous appendices attached, unequal in size and shape (figs. 19, 22). They are the atrial appendices; together they constitute the corniform organ, which has an irregular croissant shape. In the interior of the atrium, as is typical in the genus *Drusia*, there is a highly developed fleshy ligula that expands through the larger corniform organ appendix (Martínez-Ortí & Borredà, 2012) (fig. 22).

Other characters (figs. 27–36): jaw of oxygnathous type and crescent-shaped (figs. 27–29), similar to that of *D. (E.) deshayesii*. In addition, it has a serrated edge, visible as tiny teeth at high magnification (fig. 29). The radulae of two examined paratypes



Figs. 27–36. Jaw and radula of *Drusia (E.) alexantoni* n. sp.: 27–29. Jaw: 27. Paratype; 28–29. Other paratype; 29. Detail of the serrated edge. 30–35. Radula; 30. General view of the radula; 31. Central tooth and first lateral teeth; 32–33. Central tooth; 34. Lateral teeth next to the central tooth; 35. Transition from the lateral teeth toward the edge of the radula. 36. Last lateral teeth.

Figs. 27–36. Mandíbula y rádula de *Drusia (E.) alexantoni* sp. n.: 27–29. Mandíbula: 27. Paratipo; 28–29. Otro paratipo; 29. Detalle del borde aserrado. 30–35. Rádula; 30. Vista general de la rádula; 31. Diente central y primeros laterales; 32–33. Diente central; 34. Dientes laterales próximos al diente central; 35. Transición de los dientes laterales hacia el borde de la rádula. 36. Últimos dientes laterales.

New key for the determination of the family Parmacellidae P. Fischer, 1856.

Nueva clave para la determinación de la familia Parmacellidae P. Fischer, 1856.

1	Vagina surrounded by a perivaginal gland not thickened and provided with a long finger–shape caecum	<i>Candaharia</i> (Central Asia)
	Vagina with a swollen perivaginal gland, well–developed and bean–shaped. No caecum.	2
2	Genital atrium without appendices. Bursa copulatrix without thickening	<i>Cryptella</i> (Canary Islands)
	Genital atrium with two appendices, or at least one. Duct of the bursa with a thickening where the spermatophores are attached	3
3	Atrial appendices of similar size. Elongated and well–developed distal part of the atrium from the insertion of appendices to the genital pore. Without intraatrial stimulators, only fleshy folds, with small ridges on its wall	<i>Parmacella</i> (Libya, Egypt) 4
	Atrial appendices of different size. Short distal part of the atrium. One or more intraatrial large and fleshy stimulator folds	<i>Drusia</i> 5
4	Ornamented protoconch with small parallel spiral grooves. Very long epiphallus with two bends	<i>P. festae</i>
	Smooth protoconch. Epiphallus shorter and with a single curvature	<i>P. olivieri</i>
5	Adults presenting dorsum with a shield that has dark stains and/or bands. Smooth penis without extrusion. Interior of the epiphallus not reticulated. Protoconch amber coloured and limacella in form of broad paddle	<i>D. (Drusia)</i> s. str. 6
	Adults with dorsum and shield of uniform reddish–brown colour, or only with small lines at the end of the shield. Epiphallus internally reticulated. Penis with side extrusion, sometimes elbow–shaped. Greenish protoconch and a little wide limacella in the form of elongated paddle. Morocco and Algeria	<i>D. (Escutiella)</i> 8
6	Shell with a spatula (limacella) shaped shovel, very wide. Animals of large size (70–95 mm in ethanol). Anchoring disk of the spermatophore curved like an umbrella. Tenerife, Canary Islands	<i>D. (D.) tenerifensis</i>
	Shell with spatula oval, much more narrow. Specimens of smaller size. Anchoring disk of the spermatophore almost flat	7
7	Wide spatula (limacella) of the shell (long/wide < 1.60). Stimulator fold in the Interior of the atrium thin and not very developed. Georgia, Kazakhstan, and other countries in the E of the Caspian Sea	<i>D. (D.) iberia</i>
	Spatula much narrower (long/wide > 1.85). Atrial appendices of very different sizes, sometimes only one. Stimulator fold of the atrium unique, pleated and very thick, occupying almost all of the intraatrial space. South of the Iberian peninsula, Spain and Portugal	<i>D. (D.) valenciennii</i>
8	Juvenile with dorsum and shield with black bands and spots, which tend to disappear in adults. Atrial appendices of the corniform organ quite unequal. Interior of the epiphallus with thick reticulate. Huge albumen gland. Atlantic coast of Morocco, Essaouira to Agadir	<i>D. (E.) alexantoni</i> n. sp.
	Dorsum and shield, both juveniles and adults, of reddish–brown uniform colour, no bands or spots. Slender reticulate inside the epiphallus. Only slightly unequal atrial appendices. Northern Morocco and Algeria	<i>D. (E.) deshayesii</i>

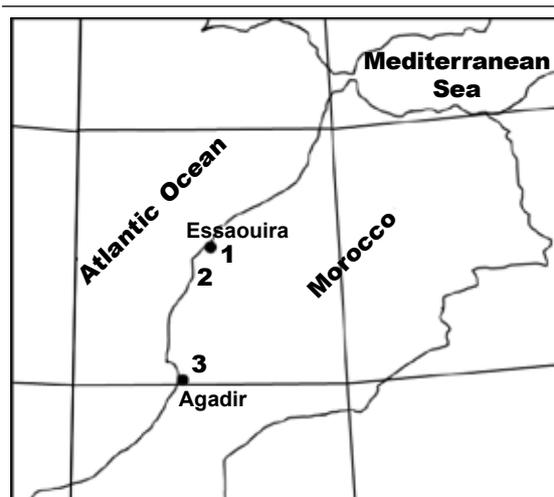


Fig. 37. Map of geographical distribution of *Drusia (E.) alexantoni* n. sp.

Fig. 37. Mapa de distribución geográfica de *Drusia (E.) alexantoni* sp. n.

consist of 100 and 116 rows and both measure 4.65 mm length and 3.0 mm wide. Its radular formula is: 51 + C + 51. Teeth are generally similar to *D. (E.) deshayesii* (figs. 30–36) (Martínez–Ortí & Borredà, 2012). The central tooth presents a deep cut in the shape of an isosceles triangle at the base of the mesocone and reaching the vertex and lower end of this triangle (figs. 31–33). The ectocones also present wing–shape expansions. Other teeth present at the base of the external ectocone with additional wing–shape expansions directed outwards (Martínez–Ortí & Borredà, 2012).

Geographical distribution and habitat

D. (E.) alexantoni n. sp. has been found on the Moroccan Atlantic coast, from Essaouira to Agadir (fig. 37), in crops of argan (*Argania spinosa* (L.) Skeels). One of the authors (Martínez–Ortí) collected all the specimens living in colonies underneath the stones and small walls between these crops along with the Papilionaceae plant *Ononis natrix* L. which is possibly part of their diet. It has also been cited in lacustrine riparian environments (Martínez, 2009).

Discussion

This new species undoubtedly belongs to the genus *Drusia* and we decided to include it in the subgenus *D. (Escutiella)* due to the appearance of its shell and other features. Besides, it is very similar to *D. (E.) deshayesii*

due to the following reproductive characters: i) penis with a lateral protrusion, ii) inside the penis there are two thick and solid bumps and iii) reticulated epiphallus inside with thick longitudinal folds.

It differs from *D. (E.) deshayesii* by i) a reproductive system with uneven atrial appendices of the horn–shaped organ, ii) lateral protrusion that gives it an elbow–like shape that is not present in *D. (E.) deshayesii*, iii) the arrangement and number of bumps inside the penis, only two of them in *D. (E.) alexantoni* n. sp. and up to four in *D. (D.) desayeshii*, iv) the reticulated appearance of the inner wall of the epiphallus is different, with the longitudinal folds being much larger in *D. (E.) alexantoni* n. sp. and v) the very large albumen gland of the new species.

These reproductive characters are taxonomically more relevant than the external appearance which in juveniles, with spots and bands, could be confused with the subgenus *D. (Drusia)* s. str. and with the species *Drusia (D.) valenciennii*. Equally, the two appendices of the corniform organ are very unequal in the new species, which makes it more like *D. (D.) valenciennii*. However, due to the set of characters mentioned and described above, it seems much more related to *D. (E.) deshayesii* and we have included it in the subgenus *D. (Escutiella)*. The radula maximum dimensions of *D. (E.) alexantoni* n. sp. are 4.65 x 3.00 mm, being slightly smaller than in *D. deshayesii* (6.75 x 3.95 mm) and *D. (D.) valenciennii* (7.00 x 4.00 mm). In addition, the radular formula of *D. (E.) alexantoni* n. sp. (51 + C + 51) is clearly different from *D. deshayesii* (70 + C + 70) and *D. valenciennii* (65 + C + 65) (Martínez–Ortí & Borredà, 2012).

Martínez–Ortí & Borredà (2012) provide a dichotomous key to identify the species in the family Parmacellidae but due to the discovery of *D. (E.) alexantoni* n. sp. and the new morpho–anatomical features provided it requires slight modifications (see above).

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