A new species of *Phorcus* (Vetigastropoda, Trochidae) from the Cape Verde Islands

Una nueva especie de *Phorcus* (Vetigastropoda, Trochidae) del archipiélago de Cabo Verde

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ABSTRACT

A recent molecular study has shown that the well-known intertidal Cape Verde topshell, previously identified as *Osilinus punctulatus*, *O. tamsi* or *O. atratus*, is a distinct undescribed species (Donald, Preston, Williams, Reid, Winner, Alvarez, Buge, Hawkins, Templado & Spencer, 2012). Therefore we describe it here as new for science and compare it to the closest species.

RESUMEN

Un estudio reciente basado en técnicas moleculares ha demostrado que la especie intermareal de las islas de Cabo Verde previamente identificada como *Osilinus punctulatus*, *O. tamsi* u *O. atratus*, es en realidad una especie diferente no descrita (Donald, Preston, Williams, Reid, Winner, Alvarez, Buge, Hawkins, Templado & Spencer, 2012). Por lo tanto, la describimos aquí como nueva para la ciencia y la comparamos con las especies más próximas.

INTRODUCTION

The more important and common algal grazers of intertidal rocky sea-shores of the northeastern Atlantic Ocean and Mediterranean Sea are limpets (of the genera *Patella* and *Cymbula*), winkles (of the genera *Littorina*, *Melarhaphe* and *Echinolittorina*) and topshells (of the genera *Gibbula* and *Phorcus*). The genus *Phorcus* has been recently redefined (Donald *et al.*, 2012) to include species previously under the genus names *Monodonta* or *Osilinus*. The classification of *Osilinus* has been historically confused, with species often included within the genus *Monodonta* (Gofas & Jabaud, 1997), in the Gibbulini tribe of the subfamily Trochinae (Hickman & Mclean, 1990). Nevertheless, *Osilinus* is morphologically (Hickman & Mclean, 1990) and genetically (Donald, Kennedy and Spencer, 2005) distinct from *Monodonta* and, based on molecular evidence, *Osilinus* has recently been moved into the subfamily Cantharidinae, separate from the Monodontinae and Trochinae (Williams, Donald, Spencer & Nakano, 2010). Species classification within *Osilinus* has also been unstable. Nordsieck (1982) recognised 16 species in the northeastern Atlantic and Mediterranean Sea, whereas Beck (1995) synonymized many of these species, reducing the total number to nine, and later Crothers (2001) recognised six species. On the other hand, Gofas & Jabaud (1997) restored the genus *Phorcus* Risso,

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1826, restricted to the Mediterranean, to include *O. mutabilis* and the type species commonly referred as *Gibbula richardi*, and they pointed out their close relationships to *Osilinus* Philippi, 1847. Recently, a complete molecular phylogeny of the *Osilinus*/*Phorcus* group (DONALD *ET AL*., 2012) recognizes nine species in a single genus *Phorcus* (older name than *Osilinus*), distributed from the Mediterranean Sea to the coasts of West Africa, mainland western Europe, Britain and Ireland and several Macaronesian Islands, including Madeira, Selvagens, Canaries and Cape Verde (it is absent from the Azores). The nine species (these authors consider each represents a divergent lineage) are the following: *P. richardi* (Payraudeau, 1826), *P. mutabilis* (Philippi, 1846), *P. articulatus* (Lamarck, 1822), and *P. turbinatus* (Born, 1778), from the Mediterranean, *P. lineatus* (Da Costa, 1778) and *P. sauciatus* (Koch, 1845), from Atlantic European coasts, the last extending to the northeastern African coast and to Madeira and Canary Islands, *P. atratus* (Wood, 1828), exclusive from Madeira and Canaries, *P. punctulatus* (Lamark, 1822), from Senegal (West Africa), and an additional species endemic to the Cape Verde Islands. The taxon *Osilinus atratus salvagensis* Talavera, 1978, from Selvagens Islands, was not included in the phylogenetic study of DONALD *ET AL*. (2012) and its taxonomic status should be clarified.

According to DONALD *ET AL*. (2012), the *Phorcus* species from the Cape Verde Islands, the mainland *P. lineatus*, from Atlantic European coasts, and *P. punctulatus*, from West Africa, are very close genetically. However, *P. punctulatus* and *P. lineatus* differ substantially in both colour pattern of the shell and geographic range. Shells of the former have a characteristic pattern of lines of white spots, which are absent in the later, and there is a geographical discontinuity between the two clades due to the long sandy coastline of southern Morocco and Mauritania. Consequently, if *P. lineatus* and *P. punctulatus* are considered to be separate species, then *Phorcus* sp. from Cape Verde must also be considered a different species since it is sister to the *punctulatus*/*lineatus* sister pair in the phylogeny obtained by DONALD *ET AL*. (2012).

The Cape Verde *Phorcus* species is a well-known and quite common topshell in the intertidal rocky coasts of this archipelago, previously identified as *Monodonta punctulata, M. tamsii* or *Osilinus atratus*. In the first faunal list of Cape Verde archipelago by ROCHEBRUNE (1881) this species appeared as *Monodonta punctulata*, and this author commented that it is the same species present in Senegal. NOBRE (1900) recorded this species under the name *Monodonta tamsi* Dunker, 1845, and the same name was employed by MARCHE-MARCHAD (1956). Latter, in the first monograph on the molluscan fauna of this archipelago, BURNAY & MONTEIRO (1977) used again the name *Monodonta punctulata* Lamarck, 1822, while NORDSIECK (1974) considered *Osilinus atratus* the species from Canary and Cape Verde Islands. GARCÍA-TALAVERA & BACALLADO (1981) repeated once more the name *M. tamsii* and, in opposition, COSEL (1982a, 1982b, 1982c) and BUYS (1991) used *M. punctulata* followed by GARCÍA-TALAVERA (1999). Finally, in recent monographs on the molluscs of the Cape Verde Islands by GUERREIRO & REINER (2000) and ROLÁN (2005) the names *Monodonta atrata* or *Osilinus atratus*, respectively, were used, and HERNÁNDEZ, ROLÁN & SWINNEN (2011) consider this species to be present in Madeira, Canaries and Cape Verde Islands.

Since the molecular data demonstrate that the Cape Verde *Phorcus* is a distinct species (DONALD *ET AL*. 2012), and if there is no available old name for it, it needs a name and should be described formally. That is the aim of this work. So, we complete here our previous paper on new species of Trochidae from the Cape Verde Archipelago (ROLÁN & TEMPLADO, 2001). The species here described is not rare and unknown, but a common and well-known species previously confused with others. Hence, it is now necessary to look for morpho-

logical characters that distinguish this undescribed species from the others of the same genus.

MATERIAL AND METHODS

Many shells and living specimens collected by the second author in several campaigns (now in the malacological collection of the Museo de Historia Natural de Santiago de Compostela) have been studied. In addition, the material of Atlantic species of the genus *Phorcus* in the malacological collection of the Museo Nacional de Ciencias Naturales of Madrid has been examined. Besides, Ramiro Fiadeiro collected in the Cape Verde Islands the studied live material of *Phorcus mariae* spec. nov., and Ramón Gómez provided specimens of *P. atratus* from Canaries for comparison.

Abbreviations:

MHNS= Museo de Historia Natural de Santiago de Compostela.
NHMUK= Natural History Museum of London.
MNCN= Museo Nacional de Ciencias Naturales, Madrid.
MNHN= Museum national d'Histoire naturelle, Paris.
s= empty shell.
spms= specimens with soft parts.

SYSTEMATIC PART

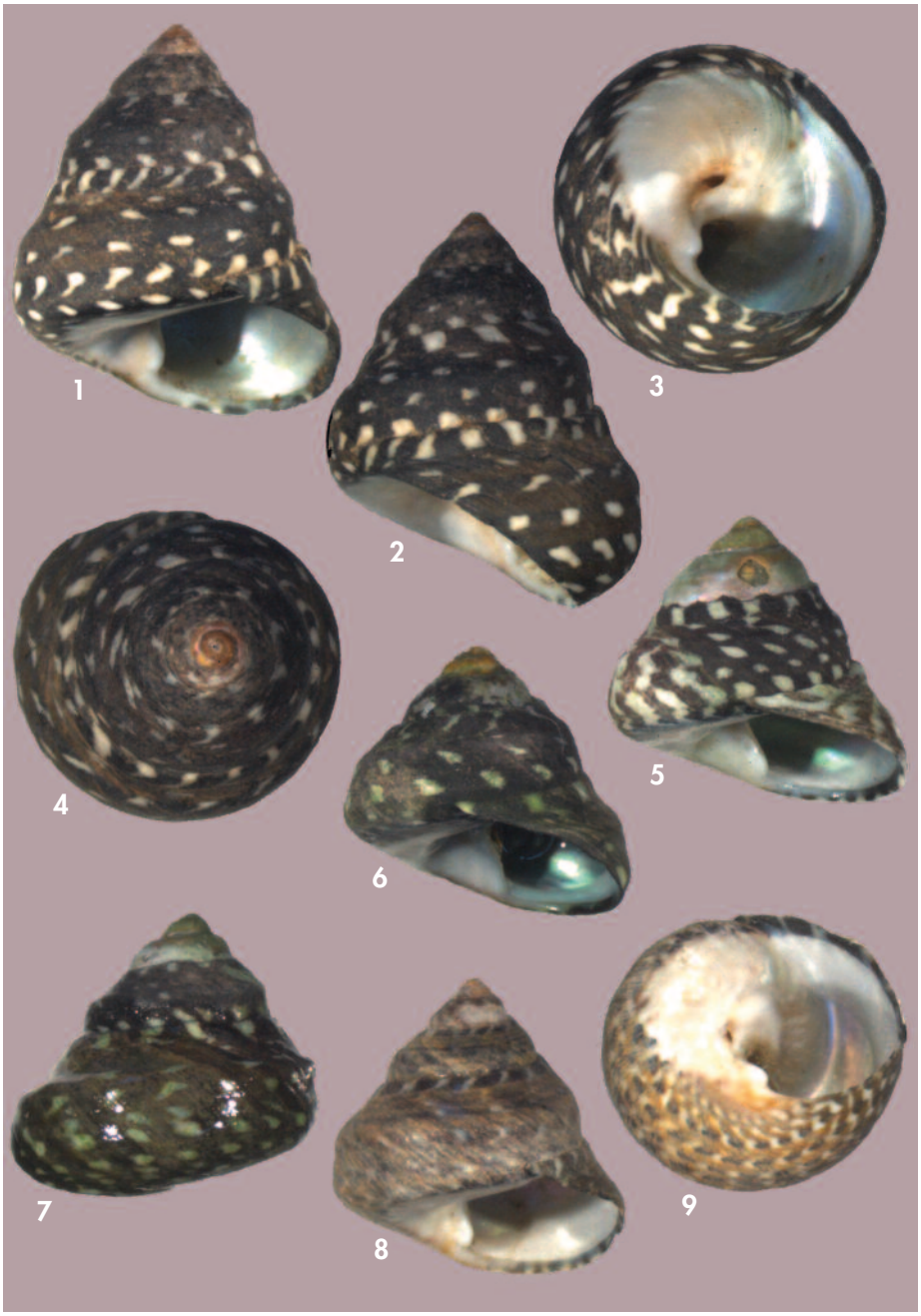
Genus *Phorcus* Risso, 1826
Phorcus mariae spec. nov. (Figs. 1-14, 19-21)

Type material: Holotype (s) (Figs. 1-4) and 10 paratypes (spms) (in MNCN, number 15.05/60049). Other paratypes in the following institutions: MNHN (25142, 10 spms), MHNS (100570, 5 spms), NHMUK(20120147-20120151, 5 spms), all from Sal-Rei y Ervatão, Boavista Island, Cape Verde Archipelago.
Other material examined: 5 spms from Maio (MHNS); 10 s from Santiago (MHNS); 12 s from Sal (MHNS), Cape Verde Islands; 55 s in three different boxes in the Hidalgo' collection (MNCN) from Cape Verde Islands (without specifying the particular locality or island), and originally identified as *Trochus tamsii* Dunker, 1858.
Type locality: Sal-Rei, Boavista Island, Cape Verde Archipelago.
Etymology: The name is after Maria Templado, daughter of the first author, for her constant support and companionship to both authors on many trips.

Description: Shell (Figs. 1-12) of medium size, trochiform, solid, not brilliant, dark in colour. Protoconch always strongly eroded in adult; examined in a juvenile (Fig. 19): it is whitish, with one whorl. Teleoconch begins with spiral cords separated by narrower interspaces. The adults have about 5 whorls, difficult to see due to erosion of the spire. The contour of the whorls forms a distinct sharp angle at about half the height of each whorl. The colour is dark, grayish brown, sometimes almost black, the base and the columella are white. Numerous and variable flame-like white stripes departing from the suture. Near the suture, a stronger cord is present, which is also regularly striped in white. The ovoid white blotches are clearly aligned spirally. Aperture wide, the external lip simple, sharp; interior iridescent; columella slightly prosocline, showing a quite elevated fold; umbilicus almost closed.

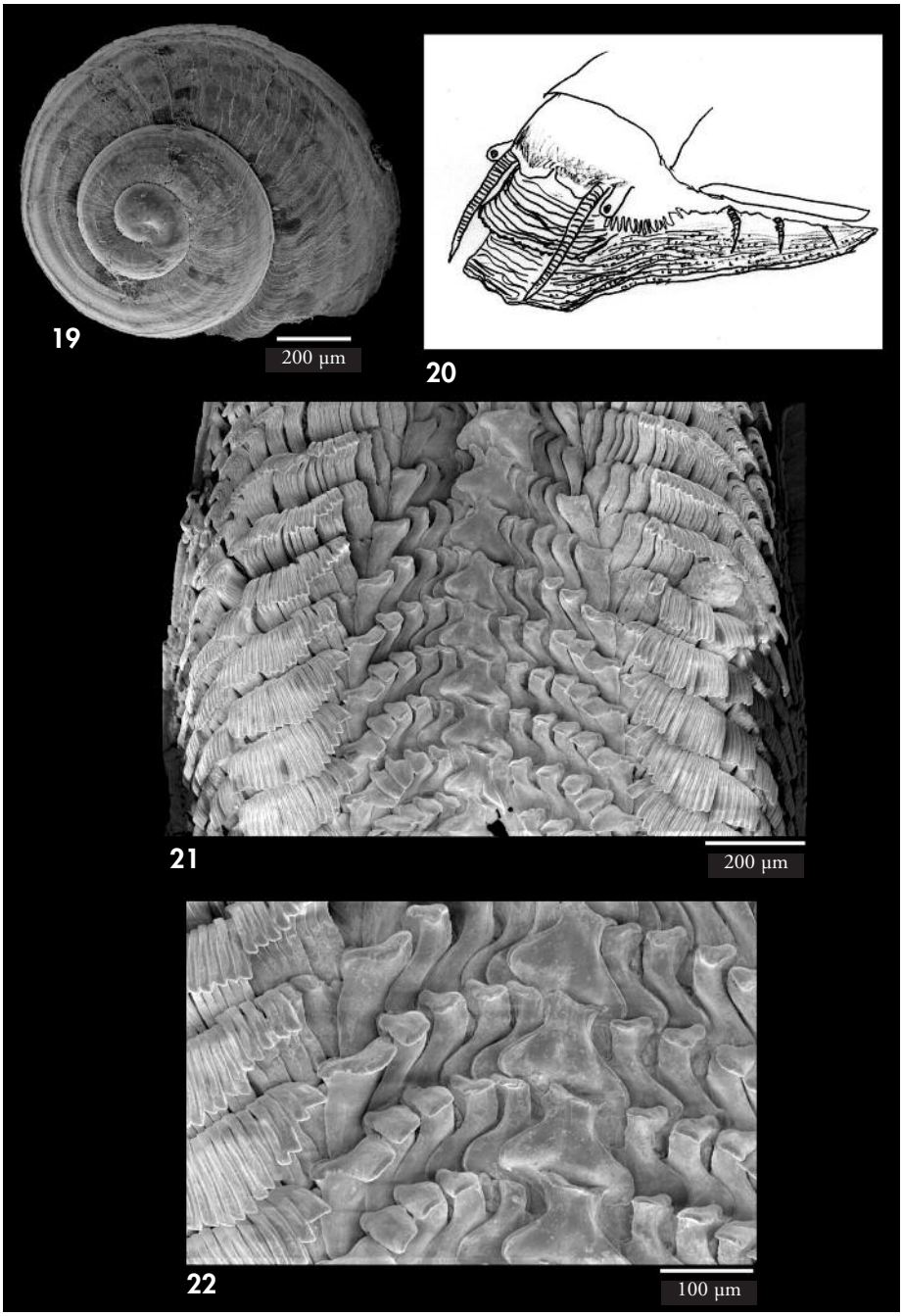
Dimensions: holotype 23.4 x 19.7 mm. The largest shells reach 25 mm in maximum dimension.

Soft parts of the animal (Fig. 20) with the head very dark (almost black). The lateral sides of the foot have a black background with minute orange tubercles aligned horizontally. The snout is almost black with dark orange lines. The base of the foot is dark green. The cephalic tentacles are black with lighter rings alternat-



Figures 1-9. *Phorcus mariae* spec. nov. 1-4: holotype, 23.4 mm in height (MNCN); 5: paratype, 17.3 mm in height (NHMUK); 6: paratype, 15.4 mm (MNHN); 7: paratype, 16.8 mm (MNHN); 8-9: paratype, 18.3 mm (MNCN). All from Sal-Rei, Boavista, Cape Verde Islands.
Figuras 1-9. Phorcus mariae *spec. nov. 1-4: holotipo, 23,4 mm de altura (MNCN); 5: paratipo, 17,3 mm de altura (NHMUK); 6: paratipo, 15,4 mm (MNHN); 7: paratipo, 16,8 mm (MNHN), 8-9: paratipo, 18,3 mm (MNCN). Todos procedentes de Sal-Rei, Boavista, Islas de Cabo Verde.*

Figures 10-12. *Phorcus mariae* spec. nov. 10: shell from Santiago Is., 20.4 mm (MHNS); 11, 12: shells from Sal Is., 17.3 mm (MHNS). 13: *Phorcus lineatus* (Da Costa, 1778), 21 mm, Vigo (MHNS). Figures 14, 15. *Phorcus punctulatus* (Lamarck, 1822), 16.5 mm, Senegal (MHNS). Figures 16-18. *Phorcus atratus* (Wood, 1822), Gran Canaria, Canary Islands (MHNS).
Figuras 10-12. Phorcus mariae *spec. nov. 10: concha de la isla de Santiago, 20,4 mm (MHNS), 11-12. conchas de la isla de Sal, 17,3 mm (MHNS). 13:* Phorcus lineatus *(Da Costa, 1778), 21 mm, Vigo (MHNS). Figuras 14, 15.* Phorcus punctulatus *(Lamarck, 1822), 16,5 mm, Senegal (MHNS). Figuras 16-18.* Phorcus atratus *(Wood, 1822), Gran Canaria, Islas Canarias (MHNS).*



Figures 19-22. *Phorcus mariae* spec. nov. 19: protoconch and first teleoconch whorls (juvenile from Palhona, N of Sal, Cape Verde Islands); 20: drawing of the soft parts; 21, 22: radula and detail.
Figuras 19-22. Phorcus mariae *spec. nov. 19: protoconcha y primeras vueltas de la teleoconcha (ejemplar juvenil de Palhona, N de Sal, Cabo Verde), 20: dibujo de las partes blandas; 21, 22: rádula y detalle de la misma.*

ing. Cephalic lappets with dark orange colour; eyes outwards of the cephalic tentacles, at the extreme end of a wide pedunculus. Left neck lobe with between 13-18 digitiform prolongations. Right neck lobe almost smooth at its border. Three epipodial tentacles at each side.

Operculum multispiral, yellowish and with a central nucleus.

Radula (Figs. 21-22) like in other species of the genus *Phorcus*, with regularly arcuate tooth rows with rachidian and five lateral teeth of similar size and shape. The rachidian with narrow neck and reduced cusp.

Distribution: Known from all the islands of the Cape Verde Archipelago, living on rocky coasts at the high tidal level.

Remarks: Morphologically, the closest species is *Phorcus atratus* from Canary and Madeira Islands. Both species have a profile somewhat conical with angulose whorls, but *P. atratus* is relatively higher, darker, and the white stripes are arranged in a more or less zigzag pattern and nonaligned. *Phorcus punctulatus* (Lamarck, 1822), from the coast of West Africa, is more depressed, lacking any angulation on the whorls, which present a regular curvature. The white spots are small and are usually aligned obliquely. *Phorcus lineatus* (Da Costa, 1778), from the Atlantic European coasts, has also a regular convex curvature of the whorls lacking any angulation. Its colour has a gray-green background with irregular dark stripes and lacks any white spots of stripes.

A possible available older name for this species could be *P. tamsii* (Dunker, 1845). *Trochus tamsii* was described by Dunker in Philippi's "*Abbildungen und Beschreibungen*" (vol. 1 p. 189 and pl. 5 fig 3; the *Trochus* monograph is dated January, 1845). According to the original description its type locality is Luanda, where the genus does not exist despite quite extensive modern prospection. Once the type locality was misplaced and since in the narrative (TAMS, 1845) of the expedition it is said that they visited Madeira, but also S. Anton, in the archipelago of Cape Verdes, it cannot be ruled out that the specimens studied by Dunker came from these islands. Therefore, the option to restore the name *tamsii* for the Cape Verde species could be taken into account, instead of assigning a new name. However, since there is no certainty about the origin of the specimens studied by Dunker and because this name has been used interchangeably to refer to the *Phorcus* species of Cape Verde, Canaries and Madeira, we believed that it is more appropriate to consider the name of Dunker as a *nomen dubium*, presumably a senior synonym of *P atratus*, and propose a new name with a formal description of the species.

This new species is endemic to the Cape Verde Archipelago, which once again confirms the high rate of endemism among marine gastropods in these islands. In some taxa lacking a pelagic larval phase, there has been a major radiation with endemism in each of the islands, such us in the genera *Conus* (DUDA & ROLÁN, 2005; CUNHA, CASTILHO, RÜBER & ZARDOYA, 2005), *Rissoina* (ROLÁN & LUQUE, 2000) or *Euthria* (ROLÁN, 2005). On the other hand, some species with a short pelagic larval phase are found in all islands but they seem to be isolated from other archipelagos or from the west African mainland coast, such as this new topshell or the limpet *Patella lugubris* Gmelin, 1791, that is also present in the rocky intertidal of the Cape Verde Islands.

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BIBLIOGRAPHY

BECK L.A. 1995. Zur Systematik und Evolution europäischer Trochiden (Kreiselschnecken) unter besonderer Berücksichtigung der Gattungen *Gibbula* Risso, 1826, *Osilinus* Philippi, 1847 und *Jujubinus* Monterosato, 1884 (Gastropoda, Prosobranchia). Europäische Kreiselschnecken (Trochoidea). http://www.staff.uni-marburg.de/~beck/diss1995/

BURNAY L.P. AND MONTEIRO A.A. 1977. *Seashells from Cape Verde Islands*. Backhuys P. Lisboa. 88 pp.

BUYS J.-P. 1991. Collecting shells on the Cape Verde Islands. *Vita Marina*, 41 (3): 101-113.

CROTHERS J.H. 2001. Common topshells: an introduction to the biology of *Osilinus lineatus* with notes on other species in the genus. *Field Studies*, 10: 115-160.

COSEL R. VON 1982. Ergebnisse deutsch-portugiesischer Sammelreisen auf den Marine Kapverdische Inseln (República de Cabo Verde). *Courier Forschungsinstitut Senckenberg*, 52: 15-25.

COSEL R. VON 1982. Marine mollusken von Santa Luzia, Branco und Razo (Kapverdische Inseln). *Cour. Forsch. Ins. Senckenberg*, 52: 27-33.

COSEL R. VON 1982. Marine mollusken der Kapverdische Inseln. *Courier Forschungsinstitut Senckenberg*, 52: 35-76.

CUNHA R.L., CASTILHO R., RÜBER L. AND ZARDOYA R. 2005. Patterns of cladogenesis in the venomous marine gastropod genus *Conus* from the Cape Verde Islands. *Systematic Biology*, 54: 634-650.

DONALD K.M., KENNEDY M. AND SPENCER H.G. 2005. The phylogeny and taxonomy of austral monodontine topshells (Mollusca: Gastropoda: Trochidae), inferred from DNA sequences. *Molecular Phylogenetics and Evolution*, 37: 474-483.

DONALD K.M., PRESTON J., WILLIAMS S.T., REID D.G., WINTER D., ALVAREZ R., BUGE B., HAWKINS S.J., TEMPLADO J. AND SPENCER H.G. 2012. Phylogenetics relationships elucidate colonization patterns in the intertidal grazers *Osilinus* Philippi, 1847 and *Phorcus* Risso, 1826 (Gastropoda: Trochidae) in the northeastern Atlantic Ocean and Mediterranean Sea. *Molecular Philogenetics and Evolution*, 62: 35-45.

DUDA T.F. AND ROLÁN E. 2005. Explosive radiation of Cape Verde *Conus*, a marine species flock. *Molecular Ecology*, 14: 267-272.

GARCÍA-TALAVERA F. 1999. Fauna malacológica del Cuaternario marino de Cabo Verde. *Revista de la Academia Canaria de las Ciencias*, 11 (3-4): 9-25.

GARCÍA-TALAVERA F. AND BACALLADO J.J. 1981. Nuevas aportaciones a la fauna de gasterópodos marinos (Mollusca, Gastropoda) de las islas de Cabo Verde. *Boletín del Instituto Español de Oceanografía*, 6: 202-208.

GOFAS S. AND JABAUD A. 1997. The relationships of the Mediterranean trochid gastropods *'Monodonta' mutabilis* (Philippi, 1846) and *'Gibbula' richardi* (Payraudeau, 1826).*The Journal of Molluscan Studies*, 63: 57-64.

GUERREIRO A. AND REINER F. 2000. *Moluscos marinos da Ilha de S. Vicente (Archipelago de Cab Verde)*. Cámara Municipal de Oeiras. Povoa de Santo Adrião. 279 pp.

HERNÁNDEZ J.M., ROLÁN E. AND SWINNEN F. 2011. Parte 3: Gastropoda; Prosobranchia: pp. 54-269. In Rolán (coord.): *Moluscos y conchas marinas de Canarias*. ConchBooks, Hackkenheim & Emilio Rolán, Vigo. 716 pp, 130 pls.

HICKMAN C.S. AND MCLEAN J.H. 1990. Systematic revision and suprageneric classification of trochacean gastropods.*Natural History Museum of Los Angeles County*, Sci. Ser., 35: 1-169.

MARCHE-MARCHAD I. 1956. Sur une collection de coquilles marins provenant de l'Archipel du Cap-Vert. *Bulletin IFAN*, 18 (1A): 39-74.

NOBRE A. 1900. Contribuções para a fauna malacologica das possessãos Portuguezas da Africa Occidental. *Annaes de Sciencias Naturaes*, 7: 164-172.

NORDSIECK F. 1974. The genus *Osilinus* Philippi, 1847 in the European Seas. *La Conchiglia*, 6 (67-68): 21-23.

NORDSIECK F. 1982. *Die europäischen Meeres-Gehäuseschnecken*. 2. Auflage. Gustav Fischer, Stuttgart. 539 pp.

ROCHEBRUNE A.T. de 1881. Materiaux pour la faune de l'Archipel du Cap Vert. *Nouvelles Archives du Muséum d'Histoire Naturelle*, ser. 2, vol. 4: 215-340, pls 17-19.

ROLÁN E. 2005. *Malacological fauna from the Cape Verde Archipelago*. Conchbooks, Vigo. 455 pp, 82 pls.

ROLÁN E. AND LUQUE A.A. 2000. The subfamily Rissoininae (Mollusca: Gastropoda: Rissoidae) in the Cape Verde Archipelago. *Iberus*, 18 (1): 21-94.

ROLÁN E. AND TEMPLADO J. 2001. New species of Trochidae (Mollusca, Gastropoda) from the Cape Verde Archipelago. *Iberus*, 19 (2): 41-55.

TAMS G. 1845. *Die portugiesischen Besitzungen in Süd-West-Afrika: ein Reisebericht*. Hamburg, Robert Kittler, xvi + 205 pp.

WILLIAMS S.T., DONALD K.M., SPENCER H.G. AND NAKANO T. 2010. Molecular systematics of the marine gastropod families Trochidae and Calliostomatidae (Mollusca: Superfamily Trochoidea). *Molecular Phylogenetics and Evolution*, 54: 783-809.