



# XENOPHORA

T A X O N O M Y

Supplément à Xenophora, Bulletin de l'Association Française de Conchyliologie



Revision of the *Pionoconus achatinus* Complex.

Description of three new species:

*P. koukae* n. sp. from Oman, *P. arafurensis* n. sp. from Northern Australia  
and *P. rouxi* n. sp. from Western Australia.

Eric Monnier, Loïc Limpalaër & Alain Robin

A new cone species from Aruba: *Perplexiconus wendrosi* n. sp.

Manuel Tenorio & Carlos Afonso



# Association Française de Conchyliologie

www.xenophora.org  
16 square La Fontaine  
75016 Paris

## Président

**Gilbert Jaux,**  
e-mail: gilbert.jaux@orange.fr  
3 Rue Saint-Honoré - 78000 VERSAILLES

## Vice-Président

**Alain Robin**  
e-mail: alrob38@orange.fr  
3 rue de la Croix au Beau - 78320 Le Mesnil St Denis



## Board of Referees for this issue

### *Pionoconus achatinus* complex:

**Patrice Bail, Paris, France**

**pat.bail@orange.fr**

**António Monteiro, Lisbon, Portugal**

**a.j.a.monteiro@netcabo.pt**

**John K. Tucker, Champaign, Ill., USA**

**johnktucker@gtec.com**

### New cone from Aruba

**John K. Tucker, Champaign, Ill., USA**

**johnktucker@gtec.com**

**XENOPHORA TAXONOMY** is a supplement to **XENOPHORA**, the quarterly bulletin published by AFC.  
It is shipped to all AFC members with the regular publication.

Cover: *Pionoconus koukae* n.sp. Masirah Island, Oman Photo A. Robin

## Guidelines

AFC and its magazine *Xenophora Taxonomy* accept to publish taxonomic works including descriptions of new species and revisions of supraspecific groups of mollusks, as well as other articles of valuable scientific character. The manuscripts must be in accordance with the rules and recommendations of the ICZN (International Code of Zoological Nomenclature). The manuscripts will be submitted to a board of referees before publication. Decisions to publish or not will follow careful refereeing and this committee may suggest changes to the author.

These descriptions will be sent to the Editor of *Xenophora* (redaction@xenophora.org) in english (with an abstract or introduction in French). The illustrations must be provided in high definition, on CD or other digital media. Colour pictures are preferred. Captions of the figures and plates must be provided with the references to the pictures. Texts shall be provided in \*.doc, \*.txt or \*.rtf format, or \*.xls for arrays, while the photos must be in jpg format with 300 dpi resolution. The pictures submitted can be used by *AFC-Xenophora* for any of its publication, magazine or its web-site.

Publication is free of charge for the authors. The senior author will receive ten print copies of the paper, the juniors five copies.

Copyright © Association Française de Conchyliologie  
Reproduction in whole or part without written permission is prohibited.

Impression: ERTI - ☎ 01 34 61 05 44  
1 et 3 Avenue Pavlov p15 - 78190 Trappes

# Revision of the *Pionoconus achatinus* complex.

## Description of three new species:

*P. koukai* n. sp. from Oman, *P. arafurensis* n. sp. from Northern Australia and *P. rouxi* n. sp. from Western Australia.

ERIC MONNIER \*, LOÏC LIMPALAËR \*\* & ALAIN ROBIN \*\*\*

- \* Conservatoire National des Arts et Métiers (CNAM)  
292, rue Saint-Martin, 75003 Paris (France)  
eric.monnier@cnam.fr Phone: + 33 620270836
- \*\* 11, rue de la Poste, 60510 Haudivillers (France)  
loic.limpalaer@wanadoo.fr
- \*\*\* 3, rue de la Croix au Beau, 78320 Le Mesnil St Denis (France)  
alrob38@orange.fr

**Key Words:** Taxonomy, new species, Conidae, *Pionoconus* Mörch, 1852, *P. achatinus* complex, *P. koukai* n. sp., *P. arafurensis* n. sp., *P. rouxi* n. sp., *P. vinctus*, *P. barbara*, *P. monachus*, *P. nigropunctatus*, *P. striolatus*, Oman, Western Australia, Northern Territory.

### Abstract

*Pionoconus koukai* n. sp. from Oman, *Pionoconus arafurensis* n. sp. from Northern Australia and *Pionoconus rouxi* n. sp. from Western Australia, are named.

*Pionoconus vinctus* (A. Adams, 1854) and *Pionoconus barbara* (Brazier, 1898) are reinstated as valid species.

Those five species are included in the genus *Pionoconus* and belong to a group of similar or closely related species including also *Pionoconus achatinus* (Gmelin, 1791), *P. monachus* (Linnaeus, 1758), *P. nigropunctatus* (Sowerby II, 1857) and *P. striolatus* (Kiener, 1845).

### INTRODUCTION

The family Conidae is a large monophyletic group of marine carnivorous gastropods, mostly tropical. The family is defined by the resorption of the inner walls of the shell and a radula of marginal enrolled teeth used as hypodermic darts. All species develop complex conopeptides mixtures that help in the capture of prey. Species with piscivorous diet are of special interest because some of their toxins find pharmaceutical applications. Molecular phylogenies show that piscivory evolved independently three times within the family. Tucker & Tenorio (2009) recognized five genera within these clades. The genus *Pionoconus* Mörch, 1852 is the most speciose of these with some thirty described species. Several groups (e.g. *Pionoconus magus* (Linnaeus, 1758)) are still in need of a comprehensive revision and appear to be complexes of several related and similar species. We present in this paper the results of our work on a group of species related to *Pionoconus achatinus* (Gmelin, 1791).

During three shell collecting trips to Masirah Island in Oman in 2007 and 2009, members of the French Conchological Association (AFC), among them the third author, collected shells that were quickly identified from available literature as *Pionoconus achatinus* (Gmelin, 1791).

Furthermore a journey to Broome, Western Australia, and surroundings in October 2011 allowed Christophe Roux and the third author to collect specimens identified in literature as *Pionoconus achatinus* (Gmelin, 1791).

One year later, on close examination, it appeared that the specimens collected during the two trips significantly differed from the typical *P. achatinus*. The authors decided to revise all shells comparable to this species in their collections. We found that nine species can be recognized: *Pionoconus achatinus* (Gmelin, 1791) *stricto sensu*, *Pionoconus vinctus* (A. Adams, 1854), *Pionoconus barbara* (Brazier, 1898), *Pionoconus monachus* (Linnaeus, 1758), *Pionoconus nigropunctatus* (Sowerby II, 1857), *Pionoconus striolatus* (Kiener, 1845) and three other species which are described as new herein: *Pionoconus koukai* n. sp. from Oman, *Pionoconus rouxi* n. sp. from Western Australia and *Pionoconus arafurensis* n. sp. from Northern Australia.

### INTRODUCTION

La famille des Conidae est un important groupe monophylétique de gastropodes carnivores, la majorité vivant dans les mers tropicales. La famille est définie à la fois par la résorption des parois internes de la coquille et par une radula composée de dents marginales enroulées sur elles mêmes et utilisées comme fléchettes hypodermiques. Toutes les espèces développent des mélanges complexes de conopeptides qui jouent un rôle essentiel dans la capture des proies. Les espèces ayant un régime piscivore font actuellement l'objet d'une attention particulière car certaines toxines peuvent être utilisées pour des traitements médicaux. Les phylogénies moléculaires montrent que les régimes alimentaires piscivores sont apparus indépendamment au moins trois fois au cours de l'évolution de la famille. Tucker & Tenorio (2009) reconnaissent cinq genres parmi ces clades. *Pionoconus* est le plus diversifié d'entre eux avec quelques trente espèces décrites. Plusieurs groupes (*Pionoconus magus* (Linné, 1758) par exemple) ont besoin d'une révision approfondie et constituent des complexes de plusieurs espèces apparentées. Nous présentons dans cette étude les résultats de notre travail sur un complexe d'espèces groupées autour de *Pionoconus achatinus* (Gmelin, 1791). Au cours de trois séjours sur l'île de Masirah à Oman en 2007 et 2009, plusieurs membres de l'Association Française de Conchy-

liologie (AFC), parmi lesquels le troisième auteur, ont pu récolter des coquilles qui ont été rapidement identifiées à partir de la littérature disponible comme *Pionoconus achatinus* (Gmelin, 1791).

Par ailleurs, un voyage à Broome (Western Australia) et dans ses environs en octobre 2011 a permis à Christophe Roux et au troisième auteur de récolter des spécimens également identifiés, dans la littérature, comme *Pionoconus achatinus* (Gmelin, 1791). Un an plus tard, par une observation détaillée des coquilles, il est apparu que les spécimens récoltés au cours des deux voyages différaient sensiblement de *Pionoconus achatinus* stricto sensu. Les auteurs ont donc décidé de réviser l'ensemble du matériel appartenant à ce complexe présent dans leurs collections.

Il en résulte que plusieurs groupes aux caractéristiques conchyliologiques distinctes ont pu être isolés.

Neuf espèces différentes sont identifiées dans ce complexe. Six ont déjà été nommées précédemment: *Pionoconus achatinus* (Gmelin, 1791) stricto sensu, *Pionoconus vinctus* (A. Adams, 1854), *Pionoconus barbara* (Brazier, 1898), *Pionoconus monachus* (Linnaeus, 1758), *Pionoconus nigropunctatus* (Sowerby II, 1857), et *Pionoconus striolatus* (Kiener, 1845). Trois nouvelles espèces sont nommées: *Pionoconus koukai* n. sp. originaire d'Oman, *Pionoconus rouxi* n. sp. du Nord Ouest de l'Australie et *Pionoconus arafurensis* n. sp. du Nord de l'Australie.

### *Pionoconus monachus* (Linnaeus, 1758)

#### Synonymy

*Conus monachus* (Linnaeus, 1758). Systema Naturae per Regna Tria Naturae, 10th ed., Vol. 1. p. 714 n°262. Figure representative of lectotype (Kohn, 1963) in Regenfuss, 1758: Auserlesne Schnecken Muscheln und andre Schaalthiere, pl. 12, fig. 68 (fig. 1). Type locality: none given.

*Conus nebulosus* Gmelin, 1791. Systema Naturae per Regna Tria Naturae 13<sup>th</sup> Ed. p. 3387 n°29. Lectotype in MSNP (fig. 2). Type locality: none given.

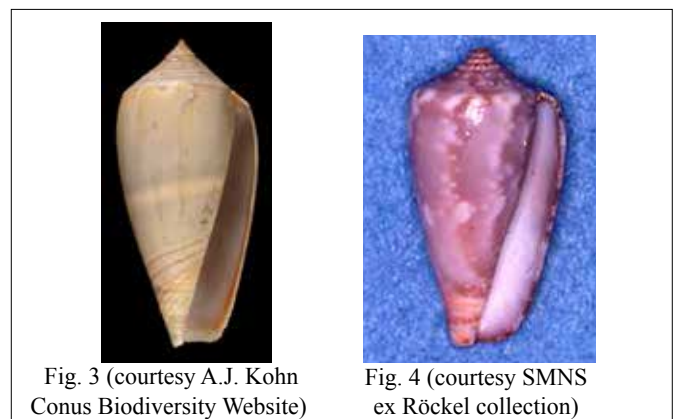
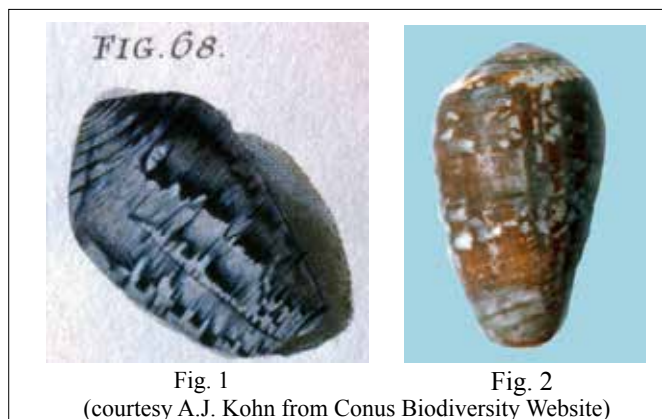
*Cucullus glaucus* Röding, 1798. Museum Boltenianum. p. 48 n° 615/108. No type designated but Röding refers to Martini, 1788: Neues Systematisches Conchylien-Cabinet Vol. 2, pl. 55 fig. 613. Type locality: none given.

*Cucullus guttatus* Röding, 1798. Museum Boltenianum. p. 48 n° 621/113. No type designated but Röding refers to Martini, 1788: Neues Systematisches Conchylien-Cabinet Vol. 2, pl. 55 fig. 613, 614. Type locality: none given.

*Cucullus maculosus* Röding, 1798. Museum Boltenianum. p. 48 n° 620/112. Figure representative of lectotype (Kohn, 1975) in Knorr, 1771: Vergnügen der Augen und des Gemüths... Part 5, pl. 18 fig. 4. Type locality: none given.

*Conus contusus* Reeve, 1848. Conchological Iconography. Vol. 1 Monograph of the Genus Conus Supplement. Species n° 276. Holotype in ZMUK (fig. 3). Type locality: "Moluccas".

*Conus frostiana* Brazier, 1898. New marine shells from the Solomon Islands and Australia. *Proceedings of the Linnean Society of New South Wales*, Vol. 22, p. 781. Holotype in SAM. (fig. 4). Type locality: "Solomon Islands".



#### Shell description

Shells are medium sized to moderately large (35 to 75 mm according to RKK, 1995). The last whorl is ventricosely conical with a low to moderately high spire of straight to slightly concave outline. The larval shell has 2.75 to 3 whorls and a maximum diameter of 0.7 mm (RKK, 1995) but is frequently eroded in adult shells. The first teleoconch whorls are only weakly tuberculate or undulate and weakly stepped. The sutural ramps have two to three shallow spiral threads whose number increase on the last whorls. The last whorl is strongly suffused with large amorphous patches of brown, olive or bluish grey colours. Brown spiral lines and dashes may appear on the last whorl. These are distant, only present in the darker brown or olive patches and are not interrupted by white dots or dashes. They are absent in the paler bluish grey patches.

The combination of the characters of the pattern, early teleoconch whorls and spiral threads helps in differentiating this species from others in the complex.

## References in literature

From Linnaeus' description alone it is difficult to identify his species. He cites three figures from previous works. Kohn (1963, 1992) established the identity of the present species in designating the figure of Regenfuss as representative of the lectotype (fig. 8). The five specimens of Linnaeus' collection stored in LSL and labelled under the name of *Conus monachus* all belong to *Lautoconus ventricosus* (Gmelin, 1791) and Kohn considers that "No authority as types may be attributed to those specimens". The figure from Regenfuss is poor and apparently made from a worn shell but shows the bluish colour of the last whorl with cloudy darker patches, absence of spiral lines and a ventricose shape all agreeing with the modern concept of the species. A specimen in ZIUU that Linnaeus studied is illustrated by Kohn (1992, fig. 30) and represents undoubtedly the present species. *Conus nebulosus* Gmelin, 1791 is based on a very worn specimen (fig. 9) that corresponds to *P. monachus*. *Cucullus glaucus* and *Cucullus guttatus* of Röding, 1798 are both based on the same figure in Martini's Neues Systematisches Conchylien Cabinet which is not clearly identifiable with an extant species. We agree with Kohn and other authors (eg. Walls, Filmer) that these names are probable synonyms of *P. monachus*. *Cucullus maculosus* Röding, 1798 is, in its turn, clearly based on a figure of *P. monachus*. *Conus contusus* Reeve, 1848 (fig. 10). It represents a pale beige shell without bluish blotches. This kind of pattern occurs episodically in specimens of *P. monachus*. Coomans, Moolenbeek & Wils (1985) consider this taxon as a juvenile of *Cucullus cinerarius* Röding, 1798. Finally the holotype of *Conus frostiana* (fig. 11) appears to be a young specimen of *P. monachus*.

## Geographical range

RKK give a range going from Indonesia to Melanesia through Philippines. In our collections and in literature we identified shells from: Philippines (LL, EM, INHS), North Western Australia (Rolan & Raybaudi), Queensland (INHS), Papua New Guinea (RKK), New Britain (INHS), Solomon Islands (LL, EM, INHS), Vanuatu (EM, GH), New Caledonia (LL, EM), Fiji (Cernohorsky, 1964).

## Discussion

The species has always been recognized as a valid one in literature. However some authors had a broad concept of the species including notably *P. achatinus*.

The authors of the main monographs of the nineteenth century all had a correct concept of the species and separated it from *P. achatinus*. Reeve (1843-1844) correctly stated that « *P. monachus* is very closely (sic) allied to the *Conus achatinus* ; it may however, be readily distinguished by not having any of the interrupted transverse lines which characterize that species ». Kiener also correctly separates *P. monachus* from *P. achatinus*. Sowerby (1857-1858) defines his *Conus monachus* as being « of a more oval form than *C. achatinus* and without the cross lines ». Tryon (1884) defines *C. monachus* as narrower at shoulder and thinner than *P. achatinus*. He also points out that it is « usually without the dotted revolving lines of *C. achatinus*, although a few such lines are sometimes vaguely apparent ».

Tomlin, in 1937, synonymized « *C. achatinus* Brug. » with *P. monachus* Linnaeus, 1758. He was followed by Walls (1979) (see discussion of *P. achatinus* below).

Cernohorsky (1964) gives a long discussion about the nomenclatural history of both *C. monachus* and *C. achatinus*. The shells he illustrates (plate 15, figs. 45 and 45a) actually are specimens of *P. monachus* but he fails in identifying them as such. Yet he points out that the fujian shells have « two distinct spiral threads on each whorl » a character only found in *P. monachus*.

## *Pionoconus achatinus* (Gmelin, 1791)

### Synonymy

*Conus achatinus* Gmelin, 1791. Systema Naturae per Regna Tria Naturae 13<sup>th</sup> Ed. p. 3386 n°25. Figure representative of lectotype (Kohn, 1966) in Chemnitz, 1788: Neues Systematisches Conchylien-Cabinet Vol. 10, pl. 142 fig. 1317 (fig. 5). Type locality: "Oceano Americano" corrected to "Java" by Coomans Moolenbeek & Wils (1979).

*Conus ranunculus* Hwass in Bruguière, 1792. Encyclopédie Méthodique ou par ordre de matières. Histoire naturelle des Vers. Cone. p. 671, n° 65. Figure representative of lectotype (Clench, 1942) in Seba, 1758: Locupletissimi Rerum Naturalium Thesauri Accurata Descriptio, pl. 43 fig. 36 (fig. 6). Type locality "l'Océan Amériquin" corrected in "Dutch Guiana" by Clench and considered an error by Kohn (1992).

*Conus achatinus* Hwass in Bruguière, 1792. Encyclopédie Méthodique ou par ordre de matières. Histoire naturelle des Vers. Cone. pp. 671-673, n° 66. Lectotype (Kohn, 1968) in MHNG (fig. 7). Type locality "l'Océan Asiatique".

*Cucullus cinerarius* Röding, 1798. Museum Boltenianum. p. 46 n° 590/89. Figure representative of lectotype (Kohn, 1966) in Knorr, 1768: Vergnügen der Augen und des Gemüths... Part 3, pl. 16 fig. 3. (fig. 8) Type locality: none given.

*Cucullus ventricosus* Röding, 1798. Museum Boltenianum. p. 49 n° 623/114. Figure representative of lectotype (Kohn, 1966) in Chemnitz, 1788: Neues Systematisches Conchylien-Cabinet, pl. 142 fig. 1317. (fig. 1). Type locality: none given.



Fig. 5  
(courtesy A.J. Kohn from Conus Biodiversity Website )



Fig. 6  
(courtesy A.J. Kohn from Conus Biodiversity Website)



Fig. 7



Fig. 8  
(courtesy M. Filmer)

*Conus achatinus* var. *infumata* Dautzenberg, 1937. Résultats Scientifiques du Voyage aux Indes Orientales Néerlandaises – Gastéropodes Marins 3. Famille Conidae. Figure representative of lectotype (Walls, 1979) in Chemnitz, 1788: Neues Systematisches Conchylien-Cabinet, pl. 142 fig. 1320 (fig. 9).

*Conus simonis* Bozzetti, 2010. *Conus simonis* (Gastropoda: Prosobranchia: Conidae) a new species from Southeastern Madagascar. *Malacologia Mostra Mondiale* n° 66: pp. 11-12. Holotype in MNHN (fig. 10). Type locality: Tolagnaro, Southeastern Madagascar.

*Pionoconus atimovatae* Bozzetti, 2012. *Pionoconus atimovatae* (Gastropoda: Prosobranchia: Conidae) a new species from South Madagascar. *Malacologia Mostra Mondiale* n° 77 pp. 24-25. Holotype in MNHN (fig. 11). Type locality: Lavanono, South Madagascar.



Fig. 9 (courtesy A.J. Kohn from Conus Biodiversity)

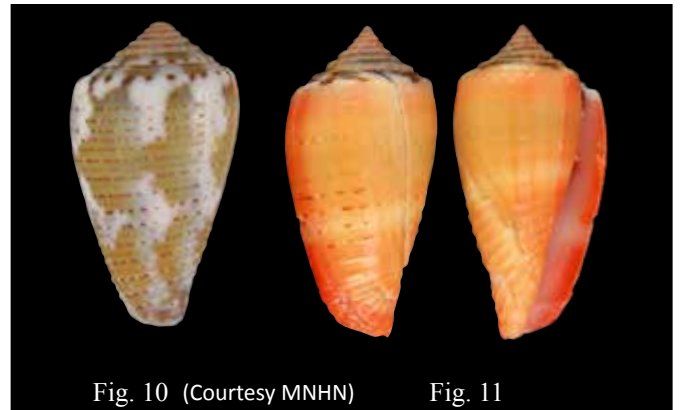


Fig. 10 (Courtesy MNHN)

Fig. 11

## Shell description

The shells are medium-sized to large (40 to 90 mm in adults), with a moderately elevated spire, a broadly ovate to ventricosely conical last whorl and rounded to subangulate periphery. The aperture widens towards the anterior part. There are raised cords on the base. The larval shell has 3.5 whorls and a maximum diameter of 0.7 to 0.8 mm (Röckel, Korn & Kohn, 1995) but is most often eroded in adult shells. The spire outline varies from slightly concave to slightly convex. The first teleoconch whorls are clearly stepped and are crenulated at shoulder. Their colour varies from beige to brown through pink or reddish. There are four spiral threads on the first whorls increasing to six on the last one. The body whorl is spirally sculptured with many narrow raised spiral cords that become more conspicuous near the base. The last whorl is glossy. The pattern is composed of a bluish grey background suffused with chesnut or almost black brown colour but may be also made of an almost solid reddish orange colour on the whole shell or basal third. This pattern is covered with 30 to about 45 spiral lines coinciding with the spiral cords composed of narrow articulated dark brown lines, dashes and dots. These markings are more conspicuous within the amorphous patches of brown or dark blue-black colour and turning in alternating brown and white dashes and dots over the light bluish grey background. Some very small white dots are also present between the lines. The pattern may show two lighter-coloured bands on the body whorl at base and middle of shell. Some very small white dots are also present between the lines in the paler bands.

Some shells have granulose ribs on the last whorl where the dark spiral lines are present.

The characters of the first teleoconch whorls together with the pattern structure are most important for separation from other species of the complex.

The periostracum is opaque and thick, brown and has a velvety texture.

## References in Literature

There is no doubt that *C. achatinus* of Gmelin (fig. 5) and Hwass (fig. 7) are the same species. *Cucullus ventricosus* of Röding is an objective junior synonym as it is based on the same figure as Gmelin's taxon.

The identity of *C. ranunculus* has long been discussed and the taxon was believed to apply to *Chelyconus ermineus ermineus* (Born, 1778) by Clench (1942) who designated the figure of the lectotype among those cited by Hwass (fig. 6 vide supra). Seba's figure is the only base for the taxon as no actual shell is extant and it is hard to identify without doubts. Clench was misled by the locality given by Hwass: "habite l'Océan Amériquin". Dautzenberg (1937) already strongly doubted the accuracy of this locality. We concur with Kohn (1992) that it is a synonym of *Pionoconus achatinus* (Gmelin, 1791). Coomans, Moolenbeek & Wils (1979) considered *C. ranunculus* as a granulated form of *C. achatinus*. We examined in MHNG the shell belonging to Hwass collection that was used by him for the description of *C. ranunculus* (fig. 12). Although its colours are faded it obviously is a specimen of *P. achatinus* (Gmelin, 1791) with a strong spiral sculpture.



Fig. 12

*Cucullus cinerarius* Röding, 1798 (fig. 4) is based on a figure that shows a shell with a conspicuous spiral lines that points to *P. achatinus* although all recent authors have placed this name in the synonymy of *P. monachus*.

The type figure designated by Walls (1979) as representative of the lectotype of *C. achatinus* var. *infumata* Dautzenberg, 1937 (fig. 9) represents a shell almost completely covered with a dark brown coat with spiral darker lines. It agrees with the descriptive text of Dautzenberg. This taxon only represents an extreme color form of *Pionoconus achatinus* (Gmelin, 1791).

## Geographical range

The range of *P. achatinus* (Gmelin, 1791) according to Röckel, Korn and Kohn (1995) goes from Tanzania, to Melanesia and Northern Australia through Philippines. From literature and our collections shells from the *achatinus* complex are also found in: Madagascar (LL, EM, MNHN), La Réunion (CGC) and Mauritius, Seychelles Islands (MF), Southern India (RKK), Thailand (LL, da Motta & Lenavat), Singapore (INHS), Indonesia, Viet Nam (GR), Philippines, Southern Japan (Habe), North Western Australia (Wilson & Gillett), Queensland (INHS), Solomon Islands (RKK), Vanuatu (GH, Estival), New Caledonia (LL, Estival).

## Discussion

Gmelin's diagnose is insufficient to identify clearly the species. The numerous figures he cited show that the concept of his species was a mix of *Pionoconus magus* (Linnaeus, 1758) and of the actual *P. achatinus*. Kohn (1966) designated a figure representative of the lectotype in order to stabilize the species concept.

The classic authors of the nineteenth century recognized the species as valid and illustrated shells that agree with the figure of the lectotype. Reeve (1843-1844) states that « the *Conus ranunculus* of Lamarck is merely a discoloured granulated example of the *Conus achatinus* ». This opinion is confirmed by our examination of the specimen of *C. ranunculus* from the Hwass' collection (fig. 12). Kiener illustrates four specimens. He states that *C. ranunculus* is an obvious variety of *P. achatinus*. He also shows one specimen with almost solid brown pattern. Sowerby (1857-1858) distinguishes *C. achatinus* from *C. monachus*. He also states that *C. vinctus* A. Adams, 1854 cannot be separated from *C. achatinus*. Tryon (1884) recognizes *P. achatinus* as a valid species. The first author who seems to place *P. achatinus* in synonymy with *P. monachus* is Tomlin (Catalogue of Recent and Fossil Cones, 1937). He only states in the « *achatinus* Brug. » entry: « cannot be separated from *monachus* L. ». No more explanations are given. He was followed by Walls (1979) who specifies that « *C. achatinus* intergrades commonly with typical *C. monachus*, with which it is often sympatric, so it cannot be retained ». In the paragraph about the variation in the species he gives descriptions of several geographically restricted variants but fails in recognizing that they form distinct species. His pictures show three different species : upper row are two *P. achatinus* Gmelin, 1791, lower left is a true *P. monachus* Linnaeus, 1758, and lower right is a picture of *P. barbara* (Brazier, 1898).

The designation by Kohn (1966) of a figure representative of the lectotype for *P. achatinus* agreeing with the species concept adopted in the major monographs of the nineteenth century helped in solving the confusion. However Wilson in 1994 still writes that *P. achatinus* is a synonym of *P. monachus*.

Bozzetti (2010) described *Conus simonis* from two shells collected in Tolagnaro, Southeastern Madagascar. Their respective height is 22.80 (fig. 6) and 26.50 mm. The author differentiates his species from *P. achatinus* by its smaller size, concave spire outline, conical outline of the last whorl and the presence of a brown spiral band of dots at shoulder.

In 2012, the same author described *Pionoconus atimovatae* (fig. 11) from a unique specimen collected in Lavanono, South Madagascar. The shell length is 21.39 mm. He compares this new species only with *C. simonis*.

We examined several shells (from MNHN and our collections) originating from various localities in Madagascar and ranging in size from 20 to 74 mm. They show ontogenic changes in shape and pattern during their growth. Young shells are plain orange, the spiral lines appear progressively and then the amorphous brown patches. Adults have the same patterns than specimens from other localities.

Our conclusion is that *Conus simonis* Bozzetti, 2010 and *Pionoconus atimovatae* Bozzetti, 2012 are synonyms of *Pionoconus achatinus* (Gmelin, 1791).

***Pionoconus striolatus* (Kiener, 1845)****Synonymy:**

*Conus striolatus* Kiener, 1845. *Spécies Général et Iconographie des Coquilles Vivantes* Vol. 2: p. 266. pl. 105, fig. 1. (fig. 13) Holotype was in MHNH and was destroyed during WWII and is figured in Kiener. Type locality designated by Delsaerd, 1994: "Rua Sura, Solomon Islands".

*Conus magus* var. *decurtata* Dautzenberg, 1910. *Journal de Conchyliologie* Vol. 58: p. 26. Lectotype in IRSNB designated by CMW, 1985. Type locality by original designation: "Rua Sura, Solomon Islands".

**Description:**

The shells are small to medium-sized (25 to 40 mm in adults). The spire is moderately high with a straight to slightly convex outline. The last whorl is ventricosely conical to ovate with an overall short, stout aspect. The periphery is subangulate. The aperture widens regularly towards the anterior part. There are five to six smooth raised cords on the base that may be granulose in some specimens. There may be weak spiral striae up to the periphery. The larval shell is said to be multispiral by RKK (1995). The first teleoconch whorls are neither stepped nor tuberculate. Their colour is pink as is the protoconch. The sutural ramps are flat and adpressed on the suture to the previous whorl. There are four spiral threads on the sutural ramps. The last whorl is covered with around thirty spiral lines composed of narrow almost black dots and dashes on the spiral striae. The background of the last whorl is whitish covered by olive brown to dark brown clouds. In these the black dashes are longer and may be separated by small white dots. Into the whitish zones, paler chevrons are visible with magnification.

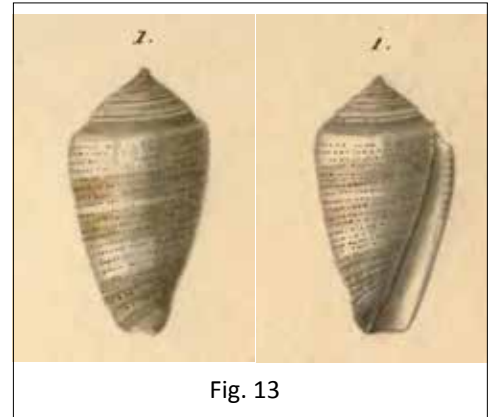


Fig. 13

**References in literature:**

Kiener gives a detailed description of his *Conus striolatus* that emphasizes the presence of fine striae articulated with small back dots and the pink apex. No type locality is given. The holotype was a very pale shell and this probably prevented following authors from identifying his taxon with the usual darker shells.

Reeve in his "Supplement to the genus *Conus*" in "Conchologia Iconica" illustrates and describes *Conus striolatus* from another shell present in Cuming's collection without locality indicated. He also states that it is "little removed from a certain variety of *Conus magus*". Reeve and Kiener have the same concept of the species.

Sowerby in his *Thesaurus Conchyliorum* places *C. striolatus* as a variety of *Conus ustulatus* Reeve, 1844. He illustrates a shell (figure 328, plate 13) that seems to be granulose with a pattern comparable to that of Reeve's figure of *C. striolatus*.

Jickeli (1875) gives localities in the Western Pacific Ocean in the paragraph on *Conus nigropunctatus* showing that he confuses this species with the similar *P. striolatus*.

Tryon places *C. striolatus* in the synonymy of *Conus magus* Linné, 1758. He also gives as representative of this taxon a freely extrapolated copy of Sowerby's *Thesaurus Conchyliorum*.

Dautzenberg describes in the *Journal de Conchyliologie* (Vol. 58 in 1910) *Conus magus* var. *decurtata* from Rua Sura in the Solomon Islands. His description is very short and reads (translated from French): "This form shows the same pattern and colouring than the *C. magus*; but it is smaller and much stockier". He refers to figures in the *Thesaurus Conchyliorum* (pl. 13, figs. 286 to 289) all originating from the Red Sea that represent Sowerby's concept of "*Conus adansonii*". Dautzenberg is therefore the first author to identify the Red Sea and the Pacific shells as belonging to the same species.

In his posthumous work published in 1937, Dautzenberg illustrates as "*Conus achatinus* var. *ranunculus* Hwass" a shell that actually looks like a worn specimen of *P. striolatus* (pl. 1 fig. 9). However this figure differs in the greyish ground colour of the shell and the conspicuous presence of articulated white and black dots in the spiral lines. This citation has influenced posterior identification of *P. striolatus* as *C. ranunculus*.

Cernohorsky in his revision of the Conidae of Fiji (1964) discuss this species under the name of *Conus cf. vinctus* A. Adams, 1854. He had not seen the actual type specimens and relied upon the original description which he writes "...fits the species recorded from Fiji fairly well". Cernohorsky also elaborates on Dautzenberg's identification of *Conus ranunculus*. He agrees with Dautzenberg and Tomlin who placed this species in the synonymy of *P. achatinus* (Gmelin, 1791) and introduces the hypothesis that further studies may show that his *C. cf. vinctus* from Fiji should actually be named *C. ranunculus*.

Later in Marine Shells of the Pacific (1967) his doubts have disappeared and he considers *C. ranunculus* as an older valid name for *C. decurtatus* and therefore for *P. striolatus*.

Holeman & Mc Gill (1969) discuss *P. striolatus* as *Conus ranunculus* Hwass. They give an accurate description of the species and illustrate four specimens. They reproduce the reasoning of Cernohorsky and make the same error as they have not seen the actual specimen from Hwass' collection now stored in MHNG. They also characterize the periostracum of the species as being "brown, nearly opaque, finely tufted along the spiral lirae and densely tufted on the spire."

Da Motta & Lenavat, 1979: they identify as *Conus vinctus* A. Adams, 1854 specimens of this species. Moreover, they indicate that "much confusion is still associated with this species" and cite the names other author associate with it. The actual *P. vinctus* is a different species that we describe above.

Walls (1979) considers *C. striolatus* as a possible synonym of *Calibanus furvus* (Reeve, 1949). He describes and illustrates this species under the name of "*Conus nigropunctatus* Sowerby II, 1857-1858". All shells he illustrates belong to *P. striolatus*.

CMW (1985) discuss *Conus magus* var. *decurtata* of Dautzenberg. They correctly emend the name to *decurtatus*. Dautzenberg used to accord his varietal names with the word "varietas" which is feminine in latin and not with the gender of the genus name. They discuss the use of the name "*Conus ranunculus*" to designate this taxon and reject these arguments on the grounds that neither the figure of the lectotype designated by Clench nor the shell from Hwass collection agree with *P. striolatus*. They agree with other authors (da Motta, Kohn) that *C. ranunculus* Hwass in Bruguière, 1792 is a specimen of *P. achatinus* (Gmelin, 1791). Finally they introduce the consideration that an older name for *C. decurtatus* is *Conus striolatus* Kiener, 1845. They base their conviction on the existence in ZMA (Naturalis) collection of shells from New Guinea that exhibit intermediate patterns between those of *C. decurtatus* and of *P. striolatus*.

Springsteen & Leobrera (1986) illustrate this species in plate 66 n° 10 as *Conus ranunculus* Hwass in Bruguière, 1792. They give Palawan and Samar, in the Philippines, as localities. They state that the species is "incorrectly figured as *C. nigropunctatus* in most books".

Delsaerdt (1994) sums up the knowledge about *P. striolatus* and designates a type locality for it. He gives a list of localities taken in the literature.

Kohn & Perron (1994) describe the egg capsules of the species. The small size of eggs (224 µm) indicates a planctonic period of about 21 days for the veliger larvae. This agrees with the wide geographical range of the species.

RKK (1995) give an extensive and accurate description of this species. They also describe and illustrate the pattern of the soft parts (pl. 75 fig. 29) and give a picture (pl. 79 third row, right) of a live specimen from Papua New Guinea confirming the description of the periostracum given by Holeman & Mc Gill. They also state that the species has an intertidal or upper subtidal habitat in muddy sand.

Filmer, 2001: he considers the species as valid and gives taxonomic information. *C. magus* var. *decurtata* of Dautzenberg is considered as a strict synonym of *P. striolatus*.

### Geographical range

Thailand (da Motta & Lenavat), Malaysia, Indonesia (EM), Taiwan (RKK), Philippines (LL, Springsteen & Leobrera, Raybaudi Massilia in Poppe), New Guinea (Holeman & Mc Gill), Solomon Islands (Dautzenberg, Delsaerdt), Queensland (RKK, EM), Vanuatu (LL), New Caledonia (LL), Fiji (Cernohorsky), Micronesia (RKK). Records from Tuamotu appear to be of somewhat unusual shells of *P. catus*.

### Discussion:

Although the species is common in collections it has a complicated taxonomic history and has been named differently by many authors. It has only been understood and correctly named some twenty five years ago after having been confused with *P. nigropunctatus* Sowerby II, 1857, an endemic from the Red Sea or with *Conus ranunculus* Hwass in Bruguière, 1792 which is a small granulate shell of *P. achatinus* (Gmelin, 1791).

The above description of *P. striolatus* (Kiener, 1845) only differs from that of *P. nigropunctatus* (Sowerby II, 1857) by details of the pattern. The former is always clouded with olive brown on a very pale background and the white spots do not form arrowheads. The latter has a darker background and the patches are reddish brown. Dark brown spots at the periphery are always absent from shells of *P. striolatus*. Both species have widely disjunct ranges. *P. nigropunctatus* is restricted to the Red Sea and its vicinity while *P. striolatus* only reaches the Indian Ocean in the Andaman Sea and is mainly present in the Western Pacific Ocean. Both species are absent in the Center and South West of the Indian Ocean.

Some shells of *Pionoconus metcalfeii* (Reeve, 1843) can be rather similar to *P. striolatus* (vide infra in the plates). The former is a

poorly understood species belonging to the “*magus* complex”. Its status is not yet fully assessed. The shells are more ventricose, of greater length, have brown flames on the sutural ramps that are darker than the pattern of the last whorl. The colour of the last whorl varies from orange to deep reddish brown with much more numerous and closely set brown interrupted spiral lines. Younger shells of *P. metcalfii* often are granulose up to the shoulder. This last character is never observed in *P. striolatus*. The flames on the sutural ramps have the same colour than the pattern of the last whorl which never shows orange or reddish tints.

*Pionoconus morrisoni* (G. Raybaudi, 1991) is also similar to *P. striolatus*. Both species share comparable shape, size (*P. morrisoni* is a little bit smaller than *P. striolatus*) and pink protoconch. However, *P. morrisoni* is endemic from a remote island off North Western Australia (Ashmore Island) and its pattern differs in colour, being salmon pink to orange, sometimes brown. Its pattern may contain inconspicuous spiral lines of darker brown or pink dashes but they do not form small dots and are replaced by white arrowheads or dashes in the pale pinkish background. The soft parts of the animal are also different in colour.

### ***Pionoconus vinctus* (A. Adams, 1854)**

#### **Synonymy**

*Conus vinctus* Adams, A., 1854. Descriptions of New Species of the Genus *Conus*, from the Collection of Hugh Cuming, Esq. *Proceedings of the Zoological Society of London*, 1853, Part XXI: p. 118. Holotype in NHMUK (fig. 14 & 15). Type locality: “Australia”.



Fig. 14 Lectotype (Courtesy NHMUK/Eddy Hardy)

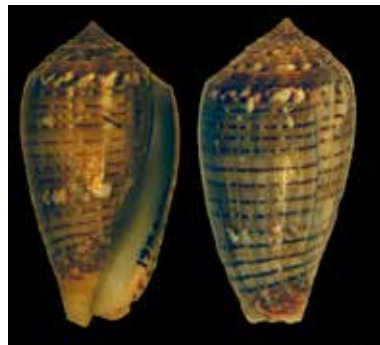


Fig. 15 paralectotype (Courtesy NHMUK/Eddy Hardy)

#### **Description**

Shells are medium sized to moderately large (40 to 50 mm). The last whorl varies from ventricosely conical to conoid cylindrical with a low to moderately high spire of straight outline. The protoconch was observed in a small specimen and is paucispiral with around two whorls. The first teleoconch whorls are only weakly tuberculate or undulate and distinctly stepped. The sutural ramps have three increasing to six or seven spiral threads on the last whorls. They are crossed by growth lines that give them a somewhat finely cancellate aspect. The last whorl has a very pale grey background that is coated on the major part with large amorphous patches of brown or olive brown. They leave a narrow band at shoulder and another one at the middle of the last whorl. The base is white. There are 15 to 25 distant spiral lines on the last whorl. These are only present in the darker patches with almost continuous lines or long dashes of brown colour separated by white dots or dashes. The white dots are small and limited to the spiral lines.

The shells are most often smooth but some are spirally ridged on the last whorl at the position of the dark brown lines and sometimes weakly beaded. Above the base there are five or six strongly raised spiral ribs. Moreover the shells of this species are quite light in weight.

The periostracum is described by Marsh & Rippingale (1968) as being thin and opaque. From a shell in INHS it is thin, brown and smooth and the pattern of the shell shows through it.

#### **References in literature**

Adams, A., 1854: in the original description there is only a brief latin diagnose, the indication of the type locality and that the shell belongs to Cuming's collection. No figure is given. It may be translated in English as follows: “turbinate-conical shell, solid, longitudinally strigose, olive, irregular white spots, transverse lines, articulated in black and white, ornate everywhere, conical spire elevated, base strongly grooved, apex pointed, arched lip, aperture articulated with black and brown within.”

Sowerby II, 1858: *Conus vinctus* A. Adams, 1854 is placed in synonymy with *Conus achatinus* Chemnitz (sic). In plate 15, fig. 343, the author illustrates for the first time the shell from Cuming's collection and gives “Philippines” as locality. In the text of species 334, page 38, he indicates that he “cannot separate the latter variety, as proposed by A. Adams, under the name *C. vinctus*”.

Tryon, 1884: like the previous author he places *Conus vinctus* A. Adams, 1853 (sic) in synonymy with *Conus achatinus* Chemnitz (sic) in the index and synonymy of his monograph on the Family Conidae.

Marsh & Rippingale, 1968: they illustrate under the name of "*Conus achatinus*" in plate 5, fig. 11 a shell from Northern Territory, Australia. Although the drawing is somewhat crude, it shows the main diagnostic characters of the species. In the explanatory text of the figure, in page 54, they state "This is a specimen from the North Western Australian coast. The range of colour pattern and design is extraordinarily beautiful from this part of the coast. The texture is very smooth. Length 2 inches. Periostracum thin, opaque."

Wils, 1969: *Conus vinctus* A. Adams, 1853 (sic) is placed in the synonymy of *Conus monachus* Gmelin, 1791.

Da Motta & Lenavat, 1979: they identify as *Conus vinctus* A. Adams, 1854 specimens of what is now known as *Pionoconus striolatus* (Kiener, 1845). Moreover, they indicate that "much confusion is still associated with this species". Our conclusion is that this reference does not show the actual *Pionoconus vinctus*.

Walls, 1979: the species is cited as a synonym of *Conus monachus* Linnaeus, 1758. The author illustrates in page 742 a black and white photograph of an Indonesian shell that matches exactly with the holotype. On the same page, he explains: "*C. vinctus* is a highly developed *achatinus* pattern with fusion of the dashes". Walls also lumps *Pionoconus achatinus* with *Pionoconus monachus*.

Abbott & Dance, 1990 (second print of third edition): the species is cited as a synonym of *Conus monachus* Linnaeus, 1758 as is *Conus achatinus* Gmelin, 1791. It is not illustrated.

Da Motta, 1991: he cites *Conus vinctus* in the list of species placed in *Dendroconus* (*Ketyconus*) among many other names but does not give any further comment on its validity or identity.

Wilson, 1994: His figure 1b in plate 50 appears to represent a specimen of *Pionoconus vinctus* A. Adams, 1854 from Darwin, Northern Territory. Wilson classifies it as *Conus monachus* Linnaeus, 1758. He still considers *C. achatinus* Gmelin, 1791 as a synonym of the former.

Rolan & Raybaudi Massilia, 1994: they illustrate on plate 19, fig. 126 (third row at right) a specimen of the species from Port Douglas, Queensland (coll. R. Evans) and three shells from Darwin, Northern Territory (second row three shells at left). They all are labelled as *Conus achatinus* Gmelin, 1791. In the text (p. 59) they indicate in the comments about the latter species, that "A population from Darwin, North Australia, shows somewhat distinctive characters and requires further investigation".

Röckel, Korn & Kohn, 1995: the species is cited as a synonym of *Conus monachus* Linnaeus, 1758. One shell is illustrated as *Conus achatinus* Gmelin, 1791, pl. 15 fig. 4 from Darwin, North Australia.

## Geographical Range

From Port Keats, Peron Islands and Darwin, Northern Territory to Queensland in Australia; Solomon Islands (LL, EM). Papua and Vanuatu (EM).

## Discussion

From the references in literature above, it appears that *Pionoconus vinctus* (A. Adams, 1854) has either been lumped with *P. achatinus* (Gmelin, 1791) and *P. monachus* (Linnaeus, 1758) or confused with *P. striolatus* (Kiener, 1845) (by da Motta & Lenavat (1979)). Since the name was introduced by A. Adams, no other author considered the species as valid.

In the course of our study of Australian members of the complex, we examined the spire of shells which revealed to be different from those of typical *P. achatinus*. The differences are summarized in the table 1 (vide infra). They are constant and allow separate *P. vinctus* from both *P. achatinus* and *P. monachus*.

Although the radular tooth and diet of this species have not yet been described in literature, it seems obvious that it is closely related to members of the genus *Pionoconus* Mörch, 1852 and notably *P. achatinus* (Gmelin, 1791) and *P. monachus* (Linnaeus, 1758).

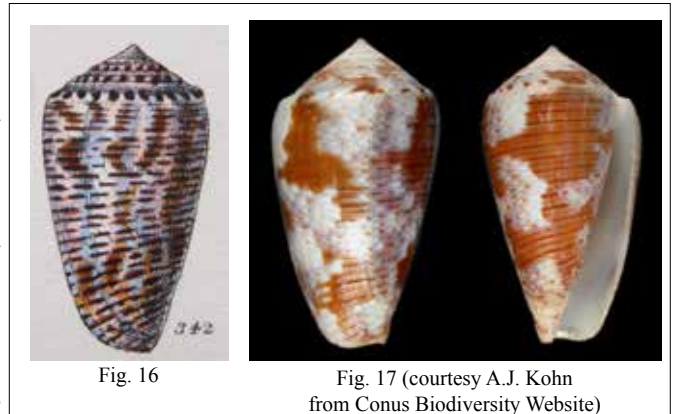
Kohn & Perron (1994) describe under the name of *Conus achatinus* Gmelin several egg masses collected in 1970 in Lee Point and Waigait, near Darwin, Northern Territory together with several adult individuals. The eggs contained in the capsules are extremely big (more than 0.8 mm) and their number in each egg mass is among the smallest observed in Conidae (714 to 775). These observations point to a direct development of the larvae. These specimens are stored in the Australian Museum (lot C 158483). We could obtain, thanks to the courtesy of the staff of the Australian Museum of Sydney, excellent photographs of the three shells contained in this lot. The animals are preserved with their shell and periostracum. The pattern visible through the removed periostracum of one specimen (illustrated herein in plate 10, fig. 4) confirms that they belong to *P. vinctus* A. Adams, 1854.

***Pionoconus nigropunctatus* (Sowerby II, 1857)****Synonymy**

*Conus nigropunctatus* Sowerby II, 1857. Thesaurus Conchyliorum Vol. 3: p. 38, n° 332 ; pl. 15, fig. 342. Figure representative of lectotype designated by Wils, 1986 (fig. 16). Type locality designated by Wils, 1986: "Eilat, Gulf of Aqaba, Red Sea".

*Conus nigropunctatus elatensis* Wils & al., 1971 (1969). Familie Conidae: p. 61 n°97; not figured. Lectotype designated by Coomans, Moolenbeek & Wils (1986) in NBC-ZMA (fig. 17). Type locality: "Nordelijk deel Golf van Akaba".

*Conus nigropunctatus* var. *peledi* Wils & al., 1971 (1969). Familie Conidae: p. 64 n°98; pl. 11, fig. 1. Type locality: "het gebied rond Eilat, in de Golf van Akaba". This name is unavailable for taxonomic purposes as it has been introduced as a varietal name after 1960 (art. 15-2 ICZN).

**Description**

The shells are moderately small to medium-sized (25 to 55 mm in adults). The maximal known size (Buijse & Verbinnen, 2010) is 58 mm. The spire varies from low to moderately high with a straight to slightly convex outline. The last whorl is ventricosely conical to almost conoid-cylindrical. The periphery is subangulate. The aperture widens regularly towards the anterior part. There are five to six smooth raised cords on the base. The larval shell is eroded in all shells we could examine and is said to be multispiral by Buijse and Verbinnen (2010). The first teleoconch whorls are neither stepped nor tuberculate. Their colour is pinkish. The sutural ramps are flat and adpressed on the suture to the previous whorl. There are four spiral threads on the first whorls decreasing to three on the last one. They are grouped in the middle of the sutural ramp. The last whorl is glossy and covered with spiral lines composed of narrow articulated dark brown lines and dashes separated by characteristic white arrowhead shaped spots. The background of the last whorl is light grey covered by darker grey clouds and occasionally in some shells with reddish brown irregular patches.

From a shell in INHS collection, the periostracum appears to be smooth, yellowish and transparent.

**References in literature**

Sowerby II, 1857: He described the species without giving a locality. In the Latin diagnose and in the English comments the presence of dark spots along the shoulder is said to be characteristic of the species. Sowerby compares *C. nigropunctatus* with his concept of *C. adansoni* and separates them by the shape that is more cylindrical in the former. The figured shells of the latter originate from Red Sea and appear to represent specimens of *P. nigropunctatus* too.

Jickeli, 1875: The author cites the species from various localities in the Red Sea and explains that his specimens agree with Sowerby's description in colouration. However he also states Tropical Pacific localities for the species showing that his concept of the species also incorporates *P. striolatus*.

Tryon, 1884: He places *C. nigropunctatus* as a variety of *Conus catus* Hwass in Bruguière, 1792 that he describes as "encircled by series of chocolate colored dots". His illustrations are copies of Sowerby's figures of *C. nigropunctatus* and *C. adansoni*. He appears to be the source for subsequent confusion of the species with *C. catus*.

Sturany, 1903: Like Tryon, he considers *C. nigropunctatus* as a variety of *C. catus*. He gives a series of localities into the Red Sea.

Wils, 1969-1974: Wils considered that *C. nigropunctatus* was the correct name for the species that is now called *Pionoconus striolatus* (Kiener, 1845). He found in the Red Sea a disjunct population that he named as a subspecies: *Conus nigropunctatus elatensis*. In the same book he introduces a varietal name "*peledi*" from the same origin.

Walls, 1979: This author uses the name of *C. nigropunctatus* for the species now known as *Pionoconus striolatus* (Kiener, 1845). Walls does not illustrate shells from the Red Sea and does not include this sea in the species range. It seems that Walls was unaware of Wils' description of *C. nigropunctatus elatensis*.

Bosch & Bosch, 1982: The species is illustrated on page 126 under its correct name and on the same page under the name of *Conus achatinus* (at right) together with two specimens of a hitherto unnamed species that will be described hereunder. However, the authors doubt that it is a valid species and state that it is difficult to separate from *P. achatinus* of which it is possibly only a variant. Like Sowerby they insist on the presence of dark spots along the shoulder.

Sharabati, 1984: The species is illustrated under the correct name and also as *Conus catus* Hwass in Bruguière, 1792 in plate 31. She explains that the species “lives in shallow water buried amongst eel-grass roots or under small stones”.

Coomans, Moolenbeek & Wils, 1986: The authors give supplemental informations on the type specimens of *C. nigropunctatus elatensis*. They designate and illustrate the lectotype (fig. 14 & 15 herein) and designate two paralectotypes. Details are given on the locality of the lectotype: “Sinai, Wadi Magresh”. They state that the Pacific shells formerly named as *C. nigropunctatus* belong in fact to *Pionoconus striolatus* f. *decurtatus* (Dautzenberg, 1937). In the previous issue of their series, the same authors had discussed in details the reasons for considering that the correct name for the Pacific species is *C. striolatus* Kiener, 1845.

Wils, 1986: He designates the figure 342, plate 15 from Thesaurus Conchyliorum as representative of the lectotype. He also designates a type locality: Eilat, in the Gulf of Aqaba in the Red Sea. By these actions Wils establishes clearly the identity of *C. nigropunctatus* Sowerby II, 1857 as a Red Sea species. He also allows distinguish it from *Pionoconus striolatus* (Kiener, 1845).

Abbott & Dance, 1990: They illustrate a specimen agreeing with those from the Red Sea in page 256 fig. 1/3. They give an “Indo Pacific” range meaning indirectly that they place *P. striolatus* within this species.

Coulombel, 1994: In page 97 a nice specimen from Djibouti is illustrated as *Conus catus* Hwass in Bruguière, 1792.

Röckel, Korn & Kohn, 1995: The species is cited as a synonym of *Conus catus* Hwass in Bruguière, 1792. In the morphometric table they give data for the typical form and *C. nigropunctatus* that show that the latter differs in being lighter and slender. They state that both forms feed on small fishes. Their conclusion is that *C. nigropunctatus* “intergrade with typical *C. catus* from Western Indian Ocean in all conchological characters”.

Filmer, 2001: He considers the species as valid and gives taxonomic information. Strangely he does not take into account the designation of a type locality by Wils in 1986 although he correctly states the designation of the figure representative of the lectotype by the same author.

Heiman, 2002: He correctly cites and illustrates *Conus nigropunctatus* from East Sinai.

Richard & Seguignes, 2005: The authors present a morphometric analysis on the basis of a sample of several tens of shells of *Conus nigropunctatus* Sowerby II, 1857 and *Conus catus* Hwass in Bruguière, 1792 originating from various localities. Their results are that both species are clearly separated by external shape. *C. nigropunctatus* is slender than *C. catus*.

Verbinnen & Wils, 2007: They cite the species under its correct name. They state that the animals live “from very shallow waters to diving depths. They are usually hidden among stones and dead coral.”. They illustrate one specimen in plate 2, figure 25.

Buijse & Verbinnen, 2010: The authors give a detailed study of the taxonomic history of the species and a complete list of citations in literature. They also give a description of the shells and information on its ecology and range. They compare the species with related ones.

## Geographical range

The species is present in all the Red Sea, the Gulf of Aden, from Yemen to Oman and from Djibouti to Somalia. Occasional specimens have been collected in Eastern Africa (e.g. Mozambique)

## Discussion

The original description and figure given by Sowerby may apply to several other species. Wils (1986) established the modern identity of this species. In literature three schools are found. The first confuses *P. nigropunctatus* with *P. striolatus* (Walls, Wils in 1969, Abbott & Dance). The second considers it is a synonym or form *P. catus* (Tryon, Sturany, Bosch & Bosch, Sharabati, Coulombel, RKK). Finally, some authors consider it is a valid species restricted to the Red Sea and surroundings (CMW, Wils, Filmer, Heiman, Richard & Seguignes, Verbinnen, Buijse & Verbinnen).

The species is easily separated from *P. catus* Hwass in Bruguière, 1792. The latter is heavier, wider and more sculptured on the anterior part of the last whorl with pustules on the spiral cords (Richard & Seguignes, Buijse & Verbinnen). *P. catus* is absent from the Red Sea.

*P. striolatus* Kiener, 1845 is restricted to the Western Pacific Ocean and Thailand. Shells without locality data may be rather difficult to identify. In *P. striolatus* the spiral lines of dark brown dots and dashes are more conspicuous than in *P. nigropunctatus*. In the latter the white dashes are bigger and often have an arrowhead shape. In *P. striolatus* the background often has a flesh or pinkish hue that is absent in the Red Sea taxon. The irregular patches on the last whorl are a chestnut or reddish brown in *P. nigropunctatus* and olive brown in the other species.

***Pionoconus barbara* (Brazier, 1898)****Synonymy**

*Conus barbara* Brazier, 1898. New marine shells from the Solomon Islands and Australia. *Proceedings of the Linnean Society of New South Wales*, Vol. 22, p. 781. Holotype in SAM (D 6176) fig. 18.

**Description**

Thirty three recently collected specimens have been examined and allow us to characterize this species.

**Shell**

Shell of medium to moderately large size varying in adults from 36 to 58 mm with an average L: 45.4 mm. The outline is ventricosely conical to conical with a moderately high spire (average relative height spire RSH: 0.14). The spire is straight to slightly convex.

In most studied specimens, the protoconch and first teleoconch whorls were eroded. However two shells show a protoconch of about two whorls. One is white, the other pink. The first teleoconch whorls are neither tuberculate nor stepped. The sutural ramps have an adpressed suture. The sutural ramp is sculptured with four to six spiral threads. Their number does not appear to increase with growth.

The last whorl is spirally sculptured with shallow raised cords that become more conspicuous towards the anterior end. One shell from WAM is granulose on its entire last whorl.

The position of the maximum diameter represent 87 % of the aperture length of the shell. The relative diameter of the last whorl varies from 0.57 to 0.64 (average RD: 0.60). The HMD / L ratio varies from 0.63 to 0.79 (average: 0.74).

The pattern of the last whorl has a background made of light grey that is marbled with darker bluish grey and irregular patches of olive green or greenish brown colour organized in two bands. The wider one begins at shoulder and extends down to one third of the body whorl. The second begins under the middle of the last whorl and may extend down to the base in some specimens. This pattern is covered by 35 to 40 spiral lines of dark brown dashes that are more conspicuous in the brownish patches. These spiral lines are articulated with white specks in the brownish patches that become bigger, irregular and extend beyond the spiral lines within the greyish background. The outer lip is sharp and bordered in its interior with the pattern of the last whorl showing first the spiral dark brown lines and then the darker patches on a distance of two to three millimetres. Then the colour turns to bluish white.

The periostracum is smooth, yellowish and translucent.

**Living animal**

The species has been live collected, the foot of the animal is pale cream striped with brown red shades (pl. 1). We have no information about the radular tooth of this species.

**References in literature**

There are only a limited number of references to this species in literature because since its publication it has always been considered a synonym of either *P. achatinus* (Gmelin, 1791) or *P. monachus* (Linnaeus, 1758).

The original description of *Conus barbara* Brazier, 1898 reads "Shell elongated, turbinated, subcylindrical, white, smooth, maculated with bluish-brown here and there, spirally ornamented with interrupted brown dots and opaque white lines; spire obtuse; whorls 8, suture narrow with three spiral deep groove; base somewhat deeply grooved, between finely punctured; aperture very narrow at the posterior end, wide at the anterior; peristome slightly angular, interior bluish white.". The shell is not illustrated in its original description. The given measurements are 40 mm in length and 20 mm wide.

Brazier compares his new species to "*C. achatinus*, Chem." and distinguishes it by its markings and sculpture. He also states that *C. barbara* is much shorter and narrower but these are the consequences of the worn state of the holotype that has the outer lip broken and the extremities strongly eroded. The author does not give any explanation about the etymology of the specific epithet he uses. The shell was in Mrs Kenyon collection and the locality given by Brazier is Solomon Islands. We will discuss below these two last issues.

Cotton (1945) illustrated a quite crude drawing of the holotype (pl. 4 fig. 2) and placed the species in the genus *Chelyconus*. He relegates it in synonymy indicating that it is probably a worn and damaged specimen of "*monachus*".

Also Coomans, Moolenbeek & Wils (1982) publish two pictures of the original shell (fig. 210) and follow the opinion of Cotton and consider it a synonym of *C. monachus*.

Zeidler (1985) publishes two photographs of the holotype. He slightly corrects the width of the shell to 20.3 mm. He states that

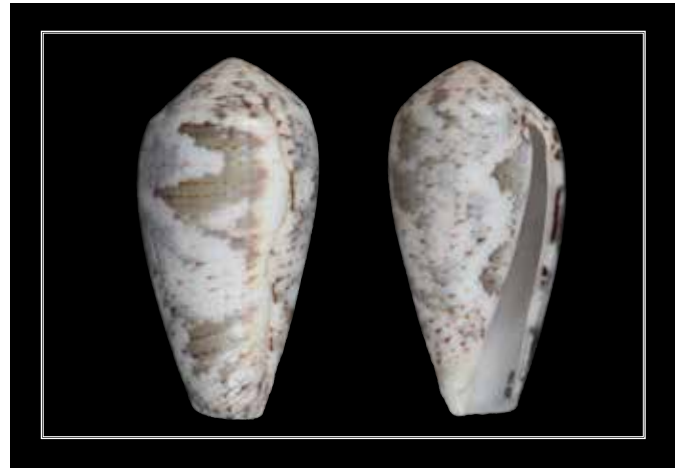


Fig. 18 Holotype SAM (D 6176)

the shell is a synonym of *Conus monachus*. He also adds that the shell was collected by Mrs Kenyon at an unknown date.

Röckel, Korn & Kohn (1995) like all of the previous authors consider *Conus barbara* as a synonym of *Pionoconus monachus*. Filmer (2012, on Internet: [www.TheConeCollector.com](http://www.TheConeCollector.com)) gives two colour pictures of this shell he shot years ago during a visit to SAM (Filmer pers. comm.).

### Habitat

This shell has been collected buried in sandy bottoms close to rocks at low tide in Broome and in its surroundings, and in Cape Missiessy north of Eighty Miles Beach, Western Australia by Christophe Roux and the third author.

### Geographical range

This species has been collected alive at and around Broome, Western Australia. We have shells from Cable Beach, Broome; Cape Missiessy, North of Eighty Miles Beach; off Port Hedland. In literature, localities checked with pictures of the shells are: Roebourne (RKK, 1995 as *C. achatinus*); Onslow area (Wilson & Gillett, 1971 as *C. achatinus*); Dampier Archipelago (Wilson, 1994 as *C. monachus*); Point Samson (Shikama, 1963 as *C. achatinus*). From this data, it seems that the species is restricted to the coast between Onslow and Broome in Western Australia. We also have a few shells claimed to come from Timor (LL & EM). It is not unlikely that the species may have established populations there as this island faces the North Western Coast of Australia on the other side of the Timor Sea. However confirmations are still needed to ascertain this locality.

### Designation of a new type locality

Brazier gives as type locality the Solomon Islands. From our researches it appears that *Pionoconus barbara* (Brazier, 1898) has not been collected in this archipelago since its description. The holotype fully conforms to specimens regularly collected in North Western Australia. We therefore consider that the designation of a new type locality in a place where the presence of this species is well documented is advisable. We here assign Entrance Point, Broome, Western Australia as the new type locality.

### Comparison

This species has long been confused with *Pionoconus achatinus* (Gmelin, 1791) and with *Pionoconus monachus* (Linnaeus, 1758). It must also be compared with *Pionoconus vinctus* (A. Adams, 1854) that lives in the same area but also further East. *Pionoconus koukai* n. sp. (vide infra) also has common features with *P. barbara*.

*Pionoconus achatinus* (Gmelin, 1791) is described above. It differs from the new species by its greater size reaching a length of more than 90 mm while the new species is not known to grow over 58 mm. The pattern of *P. barbara* is very constant with its greyish background and greenish to olive brown patches. Such colours are not seen in *P. achatinus* (orange, reddish brown to very dark brown). The dark brown spiral lines differ mostly in the white dashes that are arrowhead shaped in the new species and are also more conspicuous in the grey background. The most important differences are in the characters of the early teleoconch. In *P. achatinus* it is tuberculate and stepped while it is smooth and not stepped in the new species. The ground colour of the first whorls is whitish in *P. barbara* and is of various shades of brown in the former.

*Pionoconus monachus* (Linnaeus, 1758) is often smaller has a smoother and more shiny aspect. Its spire has only two or three spiral threads. The patterns are different: *P. monachus* does not have narrow spiral lines of dark brown and opaque white spots. Finally both species seem to be allopatric as we could not locate any true *P. monachus* within the range of *P. barbara*.

*Pionoconus vinctus* (A. Adams, 1854) has a different shape being generally conoid-cylindrical instead of ventricosely conical in the new species. The pattern is strikingly different: *P. vinctus* is an overall brown shell instead of bluish grey and olive brown in *P. barbara*. The spiral lines have much longer dark brown dashes. The white dots are much less visible particularly in the pale background. *P. barbara* does not seem to live in Northern Territory where *P. vinctus* (A. Adams, 1854) is collected around Darwin. *P. vinctus* is also living in Vanuatu and Solomon Islands.

*Pionoconus koukai* n. sp. is endemic to the Omani Coasts while *P. barbara* lives several thousands of kilometres away in South Eastern Indian Ocean. The shells of the two species may have the same shape and the same overall colours. It is always easy to separate them in observing the detail of the spiral lines of dark brown dashes that always are dominant in *P. barbara* while the white and irregular component is dominant in *P. koukai* n. sp. Moreover the dark brown dots are arrowhead shaped in the latter but not in the former.

### Discussion

At the beginning of our study of the *monachus-achatinus* complex we identified this distinctive species with a restricted range in North Western Australia that differed constantly from other related populations. We thought that it was unnamed and intended to describe it as new to science.

It was only during the course of the study of the various synonyms within the complex that we felt we needed good pictures of the holotype of *Conus barbara*. From the original description and later published figures the shell appeared to be badly worn and to have spiral rows of lines and brown dots. These characters are absent in *P. monachus* while the spiral lines are present in *P. achatinus*. However the pattern described by Brazier “white... maculated here and there with bluish brown” recalled those seen in our North Western Australian shells.

Thanks to the courtesy of Rachel King and Thierry Laperousaz of SAM, we could obtain high resolution pictures of the holotype showing details of its pattern. It became obvious that *Conus barbara* was a valid name for our species and neither a synonym of *P. monachus* (Linnaeus, 1758) nor of *P. achatinus* (Gmelin, 1791).

Brazier did not explain if the specific epithet “*barbara*” was given after the feminine christian name or if it was the latin adjective meaning “uncivilized” or “savage” in . In the latter case it should be accorded to the masculine genus name “*Conus*”. In the same paper Brazier also names “*Conus frostiana*” above cited as a synonym of *P. monachus* (Linnaeus, 1758). It seems that the author did not take much care of the respect of latin grammar in his publication. We could not find any indication of Brazier’s intentions as to the namesake when he coined *Conus barbara*. Therefore we chose to consider that the epithet “*barbara*” is a feminine noun in apposition and therefore does not need to be accorded with the gender of the genus name. This position preserves the original spelling of the species name and will facilitate research in anterior literature.

This species has been known for a long time and is present in most private collections. Its shallow habitat makes it easy to collect. In literature it was mistaken for *Pionoconus achatinus* (Gmelin, 1791) or even *Pionoconus monachus* (Linnaeus, 1758). Some illustrated references are given here:

Shikama, 1963: fig. 13 in plate 93 from Point Samson, Western Australia.

Wilson & Gillett, 1971: fig. 9a plate 101 from Onslow, Western Australia.

Walls, 1979, p. 473, lower right pictures a shell from Broome, Western Australia.

Wilson, 1994: his fig. 1a in plate 50 is a specimen from Dampier Archipelago, Western Australia.

RKK, 1995: their fig. 3 plate 15 shows a shell from Roebourne, Western Australia.

Sowerby illustrates in *Conchological Illustrations – Genus Conus* a specimen of « *Conus monachus* var ? » in the figure 73. He gives no description but from the picture it appears to be a pale bluish shell with dark brown interrupted spiral lines. This shell may be a specimen of *P. barbara*.

We have in our collections (EM) shells said to have been collected in Djibouti on a sand and muddy bottom sparsely with small rocks or coral debris at low tide close to Djibouti City. Other specimens are claimed to originate from Sri Lanka and Vanuatu. All these data remain unconfirmed by other finds from reliable sources.

DNA analysis performed by MNHN (N. Puillandre, Session Lecture in 1st International Cone Meeting in Stuttgart 2011) show that this new species genetically differs from *P. achatinus* (Gmelin, 1791), *P. monachus* (Linnaeus, 1758) and *P. koukai*, n.sp.

***Pionoconus koukai* n.sp.****Type material****Studied specimens** (measurements: L, MD, HMD, AH are given in millimeters, RD, PMD, RSH, HMD / L are without dimension).

| N°      | Length<br>L | Maximum<br>Diameter<br>MD | Height of<br>Maximum<br>Diameter<br>HMD<br>HMD/L | Aperture<br>height<br>AH | Relative<br>Diameter<br>of last whorl<br>RD = MD / AH | Position of<br>Maximum Diameter<br>of last whorl<br>PMD = HMD / AH | Relative Spire<br>Height<br>RSH = (L-AH) / L | Repository                     |
|---------|-------------|---------------------------|--------------------------------------------------|--------------------------|-------------------------------------------------------|--------------------------------------------------------------------|----------------------------------------------|--------------------------------|
| 1       | 39.60       | 21.90                     | 29.61<br>0.75                                    | 33.75                    | 0.65                                                  | 0.88                                                               | 0.15                                         | Holotype<br>MNHN 26936         |
| 2       | 39.60       | 21.00                     | 30.22<br>0.76                                    | 34.01                    | 0.62                                                  | 0.89                                                               | 0.14                                         | Paratype 1<br>Coll. EM         |
| 3       | 43.39       | 24.02                     | 33.15<br>0.76                                    | 387.11                   | 0.63                                                  | 0.87                                                               | 0.12                                         | Paratype 2<br>Coll. EM         |
| 4       | 36.27       | 20.50                     | 27.70<br>0.76                                    | 31.05                    | 0.66                                                  | 0.89                                                               | 0.14                                         | Paratype 3<br>Coll. AR         |
| 5       | 42.78       | 23.78                     | 30.4<br>0.71                                     | 37.5                     | 0.63                                                  | 0.81                                                               | 0.12                                         | Paratype 4<br>Coll. TJ         |
| 6       | 36.70       | 20.60                     | 26.10<br>0.71                                    | 32.6                     | 0.63                                                  | 0.80                                                               | 0.11                                         | Paratype 5<br>Coll. TJ         |
| 7       | 39.00       | 21.05                     | 27.15<br>0.70                                    | 33.10                    | 0.64                                                  | 0.82                                                               | 0.15                                         | Paratype 6<br>Coll. LL n° 7702 |
| 8       | 45.06       | 23.78                     | 34.71<br>0.77                                    | 38.82                    | 0.64                                                  | 0.82                                                               | 0.15                                         | Paratype 7<br>Coll. GH         |
| 9       | 46.81       | 25.61                     | 36.13<br>0.77                                    | 39.45                    | 0.61                                                  | 0.89                                                               | 0.14                                         | Paratype 8<br>Coll. GH         |
| 10      | 44.75       | 25.72                     | 34.68<br>0.77                                    | 38.78                    | 0.66                                                  | 0.89                                                               | 0.13                                         | Paratype 9<br>Coll. GH         |
| 11      | 41.06       | 21.30                     | 30.49<br>0.74                                    | 35.93                    | 0.59                                                  | 0.85                                                               | 0.12                                         | Paratype 10<br>Coll. GH        |
| 12      | 42.31       | 22.62                     | 31.25<br>0.74                                    | 36.00                    | 0.63                                                  | 0.87                                                               | 0.15                                         | Paratype 11<br>Coll. GH        |
| Average | 41.5        | 22.7                      | 31.0<br>0.75                                     | 35.8                     | 0.63                                                  | 0.87                                                               | 0.14                                         |                                |

**Holotype**

The Holotype is the specimen n°1. It is deposited in the Muséum National d'Histoire Naturelle, Paris: MNHN 26936 (Fig. 19)

**Paratypes**

The specimens numbered 2 to 12 are the 11 paratypes of the new species.

**Description****Shell**

Shell of medium size from 36 to 47 mm (Bosch & Bosch, 1982) with an average L: 41.5 mm. The outline is ventricosely conical to conical, with a moderately high spire (average relative spire height RSH: 0.14). The spire is rather straight, slightly sigmoid (concave in the first whorls and becoming progressively straighter).

In the studied adult specimens, the protoconch and first teleoconch whorls were eroded. The juvenile specimens (under 15 mm) we could examine show a paucispiral protoconch which colour varies from beige to pink. The first teleoconch whorls are neither tuberculate nor stepped. The sutural ramps have an incised suture and are sculptured all over with many very shallow and narrow spiral threads. The last whorl has an ovate shape. The aperture is long and widens gradually towards the base. The position of the maximum diameter represent 87 % of the aperture length of the shell. The relative diameter of the last whorl varies from 0.59 to 0.66 (average RD: 0.63).

The HMD / L ratio varies from 0.70 to 0.77 (average: 0.75). The last whorl is smooth and glossy with three to four sulci at the base. The pattern of the last whorl presents an intricately marbled background of light grey, blue-grey, olive green to blackish brown irregular patches. The background is covered by spiral lines of small and distant arrowhead shaped black dots that are



Fig. 19 Holotype MNHN 26936

more conspicuous in the brown patches. Between the black dots the shell is also covered by numerous irregular white flecks mostly organized in the same spiral lines than the black dots. The interior of the outer lip is bordered by black spots that may form a continuous line and correspond to the brown patches of the pattern of the last whorl. Further, the interior of the aperture becomes light bluish grey.

The periostracum is smooth, translucent and pale beige in colour.

#### **Living animal**

Live specimens have been collected by the third author but the pictures do not show enough of the soft parts of the animal. Only the siphon is apparent: it seems to be of cream colour mottled with reddish brown and a greyish tip. The radular tooth of the species has not been studied yet.

#### **Derivatio nominis**

This shell is named in honour to Alain Robin's wife, Kouka who constantly supports him in all his work for the AFC and the spreading of shell knowledge.

#### **Type locality**

Tidal reef in Sur, West Coast of Masirah Island, Oman, 20°29'10" N ; 58°46'51" E.

#### **Geographical Range**

As far as we know, this species has only been collected on reefs in Masirah Island and in Muscat, Oman (RKK, 1995). Bosch & Bosch (1982) state a general distribution in Oman.

#### **Habitat**

Specimens have been collected buried in sandy bottoms close to small rocks or coral debris on a flat at low tide during expeditions in Masirah Island in 2007 and 2009. Bosch & Bosch (1982) state that the species lives "under rocks in sand, partially buried".

#### **Comparison**

The new species must be compared with *Pionoconus nigropunctatus* (Sowerby II, 1857) and *Pionoconus achatinus* (Gmelin, 1791). Comparisons with other new species described hereunder will be done farther in this work.

*Pionoconus nigropunctatus* (Sowerby II, 1857) lives in the Red Sea and The Gulf of Aden and is said to reach the Persian Gulf. The new species is so far only known from Omani Coasts and specially Masirah Island and therefore has a more restricted range although they are overlapping. The shells of the new species are bigger on average, have a lower spire and a more rounded shape. The pattern allows identifying both species without doubts as *P. nigropunctatus* has reddish brown patches on the last whorl and arrowhead shaped white dots on the spiral lines while *P. koukae* n. sp. has olive brown to almost black patches and arrowhead shaped black dots on the spiral lines. The white dots on *P. koukae* n. sp. are bigger and of irregular shape. The blackish spots at shoulder, that may be present in *P. nigropunctatus*, are never seen in the new species.

*P. achatinus* (Gmelin, 1791) is a much bigger shell: adults vary from 45 to more than 90 mm high. As far as we know this species is absent from the North Western Indian Ocean and we could not locate any reliable reference in neither the Red Sea nor the Gulf of Aden. The range of *P. achatinus* is therefore disjunct from that of the new species. *P. achatinus* has a more elongated shell than the new species. The pattern of the last whorl of *P. achatinus* show 30 to 45 spiral lines of alternating white and black dots and dashes that never are arrowhead shaped nor forming irregular white flecks.

#### **Remarks**

The new species has been known for years and illustrated a few times in literature:

RKK (1995) picture it as *C. achatinus* Gmelin, 1791 in plate 15, figs. 5 and 8;

Bosch & Bosch show it in "Seashells of Oman" (1982) as *Conus achatinus* Hwass, 1792 (sic). In page 126 bottom, two pictures on left (the shell on the right is a *P. nigropunctatus*).

DNA analysis performed by MNHN (session lecture in 1st International Cone Meeting in Stuttgart 2011) show that this species genetically differs from *P. achatinus*, *P. monachus*, *P. barbara* and also from the new species described immediately hereunder.

## Type material

**Studied specimens** (measurements: L, MD, HMD, AH are given in millimeters).

\* estimated value

▲ subadult specimen

# freak spire specimen

| N°      | Length<br>L | Maximum<br>Diameter<br>MD | Height of<br>Maximum<br>Diameter<br>HMD<br>HMD/L | Aperture<br>height<br>AH | Relative<br>Diameter<br>of last whorl<br>RD = MD / AH | Position of<br>Maximum Diameter<br>of last whorl<br>PMD = HMD / AH | Relative Spire<br>Height<br>RSH = (L-AH) / L | Repository                                        |
|---------|-------------|---------------------------|--------------------------------------------------|--------------------------|-------------------------------------------------------|--------------------------------------------------------------------|----------------------------------------------|---------------------------------------------------|
| 1       | 42.60       | 21.20                     | 29.5*<br>0.69                                    | 35.7*                    | 0.59                                                  | 0.83                                                               | 0.16                                         | Holotype<br>INHS 44378<br>Darwin, Australia       |
| 2       | 36.80       | 18.00                     | 23.35<br>0.63                                    | 30.95                    | 0.58                                                  | 0.75                                                               | 0.16                                         | Paratype 1<br>Coll. LL n° 7513<br>Swain Reef, Qld |
| 3       | 44.46       | 22.27                     | 32.94<br>0.74                                    | 39.05                    | 0.57                                                  | 0.84                                                               | 0.12                                         | Paratype 2<br>Coll. EM<br>Broome, WA              |
| 4 #     | 41.23       | 19.58                     | 30.00<br>0.73                                    | 34.43                    | 0.57                                                  | 0.87                                                               | 0.16                                         | Paratype 3<br>Coll. EM<br>Swain Reef, Qld         |
| 5       | 40.90       | 20.77                     | 30.89<br>0.76                                    | 34.89                    | 0.60                                                  | 0.89                                                               | 0.15                                         | Paratype 4<br>Coll. CMB<br>Darwin, NT             |
| 6       | 34.43       | 17.68                     | 25.86<br>0.75                                    | 29.26                    | 0.60                                                  | 0.88                                                               | 0.15                                         | Paratype 5<br>Coll. CG<br>Australia               |
| 7       | 35.05       | 17.68                     | 26.67<br>0.76                                    | 29.93                    | 0.59                                                  | 0.89                                                               | 0.15                                         | Paratype 6<br>Coll. BM<br>Australia               |
| 8       | 49.67       | 23.51                     | 38.30<br>0.77                                    | 42.81                    | 0.50                                                  | 0.89                                                               | 0.13                                         | Paratype 7<br>Coll. JC<br>Port Hedland, WA        |
| 9       | 42.34       | 20.11                     | 32.15<br>0.76                                    | 36.81                    | 0.55                                                  | 0.87                                                               | 0.13                                         | Paratype 8<br>Coll. CR<br>Broome, WA              |
| 10      | 43.30       | 20.60                     | 32.1*<br>0.74                                    | 36.5*                    | 0.56                                                  | 0.88                                                               | 0.16                                         | Paratype 9<br>Coll. BO<br>W. Australia            |
| 11      | 46.50       | 22.00                     | 33.2*<br>0.71                                    | 39.9*                    | 0.55                                                  | 0.83                                                               | 0.14                                         | Paratype 10<br>Coll. BO<br>W. Australia           |
| 12 ▲    | 26.8        | 13.7*                     | 18.1*<br>0.68                                    | 22.5*                    | 0.61                                                  | 0.80                                                               | 0.16                                         | Paratype 11<br>Coll. MF<br>Darwin, NT             |
| 13 ▲    | 25.7        | 12.9                      | 18.0*<br>0.70                                    | 20.3*                    | 0.64                                                  | 0.89                                                               | 0.21                                         | Paratype 12<br>Coll. MF<br>Darwin, NT             |
| 14      | 40.6        | 19.9*                     | 27.8*<br>0.68                                    | 34.0*                    | 0.59                                                  | 0.82                                                               | 0.16                                         | Paratype 13<br>INHS 44379<br>Goose Isl., NT       |
| 15      | 50.3        | 23.7                      | 35.7*<br>0.71                                    | 42.9*                    | 0.55                                                  | 0.83                                                               | 0.15                                         | Paratype 14<br>Coll. OS<br>W. Australia           |
| 16      | 50.79       | 24.62                     | 37.62<br>0.74                                    | 43.07                    | 0.57                                                  | 0.87                                                               | 0.15                                         | Paratype 15<br>WAM S66441<br>Darwin, NT           |
| 17      | 48.12       | 23.24                     | 34.21<br>0.71                                    | 41.05                    | 0.57                                                  | 0.83                                                               | 0.15                                         | Paratype 16<br>WAM S66442<br>Darwin, NT           |
| 18      | 41.6        | 20.03                     | 29.38<br>0.72                                    | 33.64                    | 0.59                                                  | 0.87                                                               | 0.19                                         | Paratype 17<br>WAM S66443<br>Darwin, NT           |
| Average | 43.0        | 20.9                      | 31.2<br>0.72                                     | 36.5                     | 0.58                                                  | 0.85                                                               | 0.15                                         |                                                   |

**Holotype**

The holotype is the specimen n°1. It is deposited in the Illinois Natural History Survey in Champaign, USA under the number INHS 44378 (Fig. 20).

**Paratypes**

The specimens numbered 2 to 18 are the 17 paratypes of the new species.

**Description****Shell**

Shell of moderately small to medium size varying from 25 to more than 50 mm with an average L: 43.0 mm. The spire is moderately high (average relative height spire RSH: 0.15) and is rather straight to slightly concave. The last whorl shape is conical to ventricosely conical.

The position of the maximum diameter PMD represent 85 % of the aperture length of the shell. The relative diameter of the last whorl varies from 0.55 to 0.60 (average RD = 0.58). The HMD / L ratio varies from 0.69 to 0.77 (average: 0.72).

In all studied specimens, the protoconch and first teleoconch whorls were eroded. The adult shell of the new species has about ten whorls. The first teleoconch whorls are tuberculate and stepped. The suture attaches to the previous whorl below the angulate shoulder. The sutural ramp is sculptured with two spiral grooves that increase to nine or ten spiral striae on the last whorl. The shoulder of the teleoconch whorls remains undulate down to aperture.

The last whorl has a conical to ventricosely conical shape. It is spirally sculptured with 20 to 30 raised and pustulose cords from base to shoulder. The sculpture tends to fade progressively with growth. The pattern of the last whorl has a background made of very light blue-grey covered by irregular orange and orange brown patches more packed in two bands over and under the middle of the last whorl. In most specimens the pale blue-grey background occupies most of the surface of the last whorl. The raised cords are covered by spiral lines of dark brown dots articulated with white spots which correspond to the pustules. The outer lip is sharp and bordered one or two millimetre inside with a brown to purplish axial band.

The periostracum is brown and rather thick.

**Living animal**

No preserved animal was available to us for study. Therefore we cannot describe the external soft parts nor the radular tooth. The study of preserved sample would be of great interest.

**Derivatio nominis**

This shell is named after the Arafura Sea between the north coast of Australia and the south coast of New Guinea..

**Type locality**

Darwin, Northern Territory, Australia.

**Geographical range**

We could locate a number of specimens in INHS, WAM and private collections that help in delimiting the geographical range of this species: Western Australia (INHS); Finucane Island Reef, Port Hedland, Western Australia (JC); Darwin & Goose Island, Northern Territory (MF, INHS, WAM & MB); Swain Reefs, Queensland (LL & EM). In literature, the species is illustrated by Wilson & Gillett (1971) from Onslow, Western Australia.

The range therefore appears to cover the Northern Australia from Onslow to Darwin. The locality from Swain Reef in the Great Barrier off Queensland needs confirmation with more material.

**Habitat**

The shells from Swain Reefs, Queensland are said to have been collected in 140 m deep. The specimen from Finucane Island, Port Hedland, was found under a stone in a small pool and some from Darwin were washed ashore after a typhoon in 1975. The three paratypes from the WAM were collected by J. Cunningham in 1962 at Fannie Bay, Darwin: 12° 26'S, 130° 49' E.

**Comparison**

The new species needs to be compared with *Pionoconus achatinus* (Gmelin, 1791), *Pionoconus vinctus* (A. Adams, 1854) and *Pionoconus barbara*. It may also be similar to some members of the *Pionoconus magus* (Linnaeus, 1758) complex.



Fig. 20 Holotype: INHS 44378

*P. arafurensis* reaching only 50 mm in length is generally smaller than *P. achatinus* which can reach 90 mm high. In the new species the spire is stepped until its last whorl while this is not the case in *P. achatinus*. Moreover the latter is only rarely sculptured on its entire last whorl and pustulose only on the anterior third. The patterns are different with the new species being very constant in its pale greyish background with limited patches of orange and brown against *P. achatinus* being generally a much darker shell. Some specimens of *P. achatinus* from Thailand are plain orange coloured (Filmer coll.). The spiral lines in the latter species are more numerous on the last whorl (30 to 45) against 20 to 30 in the new species. These lines are more conspicuous in *P. achatinus* with the dark element dominating the white one. The proportion is reversed constantly in the specimens of the new species.

The geographical range of *P. vinctus* overlaps *P. arafurensis* n. sp. one. However the two species differ in shape: conoid-cylindrical in *P. vinctus* and ventricosely conical in the new species. The latter has a pattern where the brown patches are dominant over the pale background. The spiral lines have long dark brown dashes while these are only small dots in *P. arafurensis*. The spire is not stepped and the last whorl is never pustulose in *P. vinctus*. Although both species have an overlapping range, no intermediate shell has been seen among all the material observed.

*P. barbara* also lives in places where *P. arafurensis* has been found. The latter is generally slender than *P. barbara* which is also smoother with a pattern made of bluish grey with green olive brown patches while *P. arafurensis* is sculptured and pustulose on its last whorl. The spire of *P. barbara* is never stepped and its outline is slightly convex while it is straight in *P. arafurensis*. The spiral lines of dots are also different being much more conspicuous in *P. barbara*.

The combination of the pale white background mottled and grey and orange brown pattern with attenuated dark component of spiral lines and the pustulose sculpture of the last whorl together with the stepped spire and undulating shoulder are diagnostic of the new species. These characters are not found together in any other populations of the genus. The elongate shape and colouration may recall shells belonging to the *Pionoconus magus* (Linnaeus, 1758) complex from the Philippines. However the latter have a pink protoconch and early teleoconch. Their shoulder is not stepped and only tuberculate on the first whorls. Their sutural ramp is more coarsely sculptured and the brown flamules are darker than the pattern of the last whorl. Finally the spiral lines of brown dots on the last whorl are more crowded and much more numerous. Shells of members of the *P. magus* complex from Queensland have wide conical shells with straight sides and cannot be confused with *P. arafurensis* n. sp.

## Remarks

Our attention on this species was attracted by two specimens that were present in Jose Lauer collection (now in EM and LL collection). These shells were different from others seen from Australia. During the course of the study we asked several collectors and specialists of the family and we were happy to see that a fair number of specimens of this species were present in various collections. It confirmed the constancy of the shells and the geographical range of this species. The species has only been occasionally illustrated in previous literature. The only reference we could locate is in Wilson & Gillett (1971) plate 101 fig. 9b as *Conus monachus* Linnaeus, 1758. The pictured shell is 49.4 mm high.

***Pionoconus rouxi* n.sp.****Type material**\* *estimated value***Studied specimens** (measurements: L, MD, HMD, AH are given in millimeters).▲ *subadult specimen*

| N°      | Length<br>L | Maximum<br>Diameter<br>MD | Height of<br>Maximum<br>Diameter<br>HMD<br>HMD/L | Aperture<br>height<br>AH | Relative<br>Diameter<br>of last whorl<br>RD = MD / AH | Position of<br>Maximum Diameter<br>of last whorl<br>PMD = HMD / AH | Relative Spire<br>Height<br>RSH = (L-AH) / L | Repository                                |
|---------|-------------|---------------------------|--------------------------------------------------|--------------------------|-------------------------------------------------------|--------------------------------------------------------------------|----------------------------------------------|-------------------------------------------|
| 1       | 46.4        | 23.32                     | 33.45<br>0.72                                    | 39.91                    | 0.58                                                  | 0.84                                                               | 0.14                                         | Holotype WAM<br>S66439<br>Sunday Isl. WA  |
| 2       | 42.76       | 21.88                     | 33.38<br>0.78                                    | 38.16                    | 0.57                                                  | 0.87                                                               | 0.11                                         | Paratype 1<br>Coll. CR 3452<br>Broome WA  |
| 3       | 40.15       | 20.21                     | 30.35<br>0.76                                    | 35.16                    | 0.57                                                  | 0.86                                                               | 0.12                                         | Paratype 2<br>Coll. EM<br>W. Australia    |
| 4       | 43.80       | 22.80                     | 30.90<br>0.71                                    | 37.50                    | 0.61                                                  | 0.83                                                               | 0.14                                         | Paratype 3<br>Coll. AJM<br>W. Australia   |
| 5       | 52.20       | 27.20                     | 36.0*<br>0.69                                    | 43.8*                    | 0.62                                                  | 0.82                                                               | 0.16                                         | Paratype 4<br>Coll. BO<br>W. Australia    |
| 6 ▲     | 33.0        | 17.2                      | 25.3<br>0.77                                     | 28.3                     | 0.61                                                  | 0.89                                                               | 0.14                                         | Paratype 5<br>Coll. JC<br>W. Australia    |
| 7       | 39.30       | 20.9                      | 26.5*<br>0.67                                    | 34.3*                    | 0.61                                                  | 0.77                                                               | 0.13                                         | Paratype 6<br>Coll. MF<br>Dampier WA      |
| 8       | 37.4        | 18.7                      | 25.4*<br>0.68                                    | 32.0*                    | 0.58                                                  | 0.79                                                               | 0.14                                         | Paratype 7<br>Coll. MF<br>Dampier WA      |
| 9       | 35.4        | 19.5                      | 23.3<br>0.66                                     | 32.1                     | 0.61                                                  | 0.73                                                               | 0.09                                         | Paratype 8<br>INHS 45125<br>Broome WA     |
| 10      | 32.66       | 17.32                     | 23.87<br>0.73                                    | 27.08                    | 0.64                                                  | 0.88                                                               | 0.17                                         | Paratype 9<br>WAM S66440<br>Lord Isl., WA |
| Average | 40.3        | 20.9                      | 28.8<br>0.72                                     | 34.8                     | 0.60                                                  | 0.83                                                               | 0.13                                         |                                           |



Fig. 21 Holotype WAM S66439

**Holotype**

The holotype is the specimen n°1. It is deposited in the Western Australian Museum, Perth S66439 (Fig. 21).

**Paratypes**

The specimens numbered 2 to 10 are the 9 paratypes of the new species.

**Description****Shell**

Shell of medium size varying from 32 to 52 mm with an average L: 40.3 mm. The spire is moderately high (RSH: 0.13). The position of the maximum diameter (PMD) represents 83 % of the aperture length of the shell. The relative diameter of the last whorl (RD) varies from 0.57 to 0.64 (average RD = 0.60). The HMD / L ratio varies from 0.66 to 0.78 (average: 0.72).

The spire is distinctly convex giving it a domed outline.

The protoconch protrudes from the spire but is not well preserved in any of the few shells examined. The first teleoconch whorls are neither tuberculate nor stepped. Both are white. The sutural ramps have an adpressed suture and a slightly concave profile. The sutural ramp is sculptured with three increasing to six spiral grooves.

The last whorl has a slightly ovate shape. The last whorl is spirally sculptured with slightly raised cords that become more

conspicuous towards the anterior end. One shell in the collections of WAM is granulose on its entire last whorl. The pattern of the last whorl has a white background with irregular shaped patches of light orange colour. There is a whiter central zone at midwhorl. This pattern is overlaid by 30 to 35 unobvious spiral lines of alternating orange dots and white dashes. They are present indifferently in the white background as well as in the orange patches and are placed on the spiral cords. The outer lip is sharp and is completely white within.

The periostracum is yellowish.

#### **Living animal**

We have no information about the soft parts of the animal.

#### **Derivatio nominis**

This shell is named after Christophe Roux, French cone collector and friend of the authors.

#### **Type locality**

South East corner of Sunday Island, Kimberley, Western Australia 16°26.01' S ; 123° 11.60' E.

#### **Geographical range**

Western Australia from Dampier to Buccaneer Archipelago. We know shells from the following localities: Dampier; Finucane Island, Port Hedland; Cable Beach, Broome, Sunday Island, Buccaneer Archipelago.

#### **Habitat**

Two specimens from Sunday Island (Holotype) and Lord Island, Buccaneer Archipelago were collected in November 1994 by C. Bryce & F. Wells. Two specimens from Cable Beach, Broome (CR, JC) were collected under rocks in muddy conditions. Two shells from Dampier (MF) were found by Mike Filmer in February 1978 intertidal on flat reefs at low tide.

#### **Comparison**

The species must be compared with the sympatric *P. barbara* (Brazier, 1898), *P. morrisoni* (G. Raybaudi, 1991) and with the more distantly related *Floraconus cocceus* (Reeve, 1844).

The available informations on range and habitat show that both *P. barbara* and *P. rouxi* are sympatric all over their range. They also share a similar shell morphometry, *P. rouxi* being a little more ovate and less shouldered than *P. barbara*. However no intermediate specimens were found.

A striking difference is in the spire outline: distinctly domed in *P. rouxi* n. sp. while it is straight to slightly convex in *P. barbara*. The pattern is also different with a white background and light orange patches in *P. rouxi* n. sp. against pale grey with olive brown patches in *P. barbara*. The spiral lines of alternating white and brown dashes are of comparable structure. However they appear to be less numerous in *P. rouxi* than in *P. barbara*.

*Pionoconus morrisoni* (G. Raybaudi, 1991) is endemic from Ashmore Island that is situated at more than 600 kilometers from Broome where *P. rouxi* lives. *P. morrisoni* is smaller (25-30 mm.) than the new species (35-52 mm). *P. morrisoni* is salmon to brown while *P. rouxi* is very constant in colour, always being pale orange. The spire of *P. morrisoni* is straighter than that of the new species.

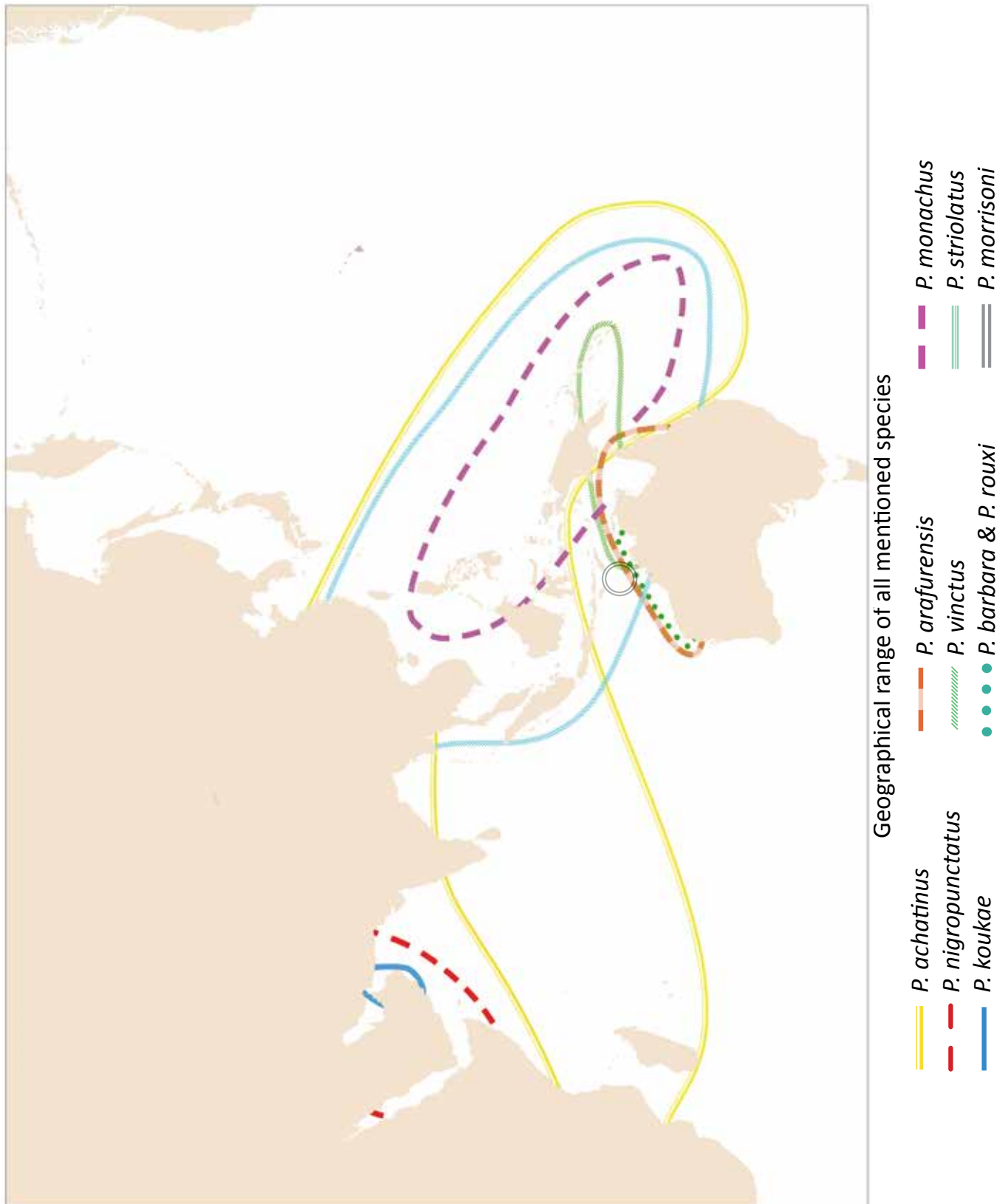
*Floraconus cocceus* (Reeve, 1844) has a range that extends from Albany at the South Western Corner of Australia to North West Cape. Thus it is not sympatric with the new species which occurs further North-East. *F. cocceus* has a paucispiral rounded protoconch of a greater diameter than that of the new species. The outline of the sutural ramps are convex instead of slightly concave in *P. rouxi* n. sp. The spire shape of *F. cocceus* is straight to slightly convex but not domed as in the new species. The sculpture of the last whorl of *F. cocceus* is made of many narrow and crowded spiral ribs that are crossed by the growth lines giving a somewhat cancellate aspect to the shell. The pattern is also very different, the colour is constant in *P. rouxi* and varying from white to orange in *F. cocceus*. In *F. cocceus* the orange patches are broken by white flecks of oval or tented shape and there are no spiral lines in the pattern.

#### **Remarks**

Christophe Roux was the first person to attract our attention on a strange pale orange shell he had in his collection and that challenged any identification with known species. Additionally the first author saw that a "strange" cone in his collection, misidentified as a *F. cocceus*, was identical to the one of Christophe Roux. We asked other collectors and specialists of the Conidae family worldwide and were surprised to receive several answers showing that these specimens were not alone and that no intermediate with *P. barbara* appeared. The shell shown in Wilson (1994) on plate 49 fig. 3 from Dampier Archipelago seems to be the only specimen of this species illustrated in books. *P. rouxi* n. sp. appears to be much rarer than *P. barbara* in their habitat and this may explain the fact that this distinctive species has not yet been recognized.

Table 1

| Species               | Protoconch                  | First teleo-conch whorls                                | Spire sculpture                                                | Shape of the last whorl                    | Sculpture of the last Whorl                                               | Pattern of last whorl: Background and blotches                                                                                         | Pattern of last whorl: spiral lines                                                                             |
|-----------------------|-----------------------------|---------------------------------------------------------|----------------------------------------------------------------|--------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|
| <i>achatinus</i>      | 3.5 whorls brown            | Stepped and Crenulated                                  | 3 to 5 spiral grooves                                          | Broadly ovate to ventricosely conical.     | Narrow weak spiral striae                                                 | Whitish to pale bluish grey with orange brown to dark brown blotches                                                                   | 35-45 dark brown spiral lines articulated with small white dots in background                                   |
| <i>monachus</i>       | 2.75 to 3 whorls dark brown | Weakly tuberculate and stepped during five first whorls | 2 spiral grooves grouped in upper part of the sutural ramp     | Ventricosely conical.                      | Smooth and shiny                                                          | Covered all over with irregular patches of shades going from pale bluish or greenish to dark greyish brown, olive green or olive brown | Usually absent. Only occasionally present close to aperture. No white dots in the spiral lines                  |
| <i>nigropunctatus</i> | ? pink                      | Neither stepped nor tuberculate                         | 4 to 5 weak spiral grooves.                                    | Ventricosely conical to conoid cylindrical | Smooth and waxy                                                           | Pale greyish with reddish brown clouds                                                                                                 | Brown articulated with white arrowhead shaped dashes                                                            |
| <i>striolatus</i>     | Multispiral pink            | Neither stepped nor tuberculate                         | 4 to 5 spiral grooves                                          | Ventricosely conical to ovate              | Narrow spiral striae. Granulate raised ribs at base                       | Whitish with olive brown to dark brown clouds                                                                                          | 30 articulated pure white and very dark brown spiral dots.                                                      |
| <i>vinctus</i>        | 2 whorls white              | Stepped and tuberculate                                 | 5 spiral grooves crossed by growth lines                       | Ventricosely conical to conoid cylindrical | Smooth and shiny                                                          | Olive brown or brown with white spots grouped in two belts at shoulder and midbody                                                     | 15 - 25 long dark brown dashes with few white dots                                                              |
| <i>koukae</i>         | ? White or pink             | Neither stepped nor tuberculate                         | 4 spiral grooves grouped on the upper part of the sutural ramp | Ventricosely conical to conical            | Smooth                                                                    | pale grey with irregular olive to dark brown patches                                                                                   | Irregular white dashes and black arrowheads                                                                     |
| <i>rouxi</i>          | Protruding white            | Neither stepped nor tuberculate                         | 4-5 spiral grooves                                             | Ventricosely conical to conical            | Narrow raised spiral striae                                               | Dirty white with scattered irregular orange patches                                                                                    | 30 - 35 articulated white and orange dashes                                                                     |
| <i>barbara</i>        | 2 whorls white or pink      | Neither stepped nor tuberculate                         | 4-5 spiral grooves                                             | Ventricosely conical to conical            | Narrow spiral striae                                                      | Pale bluish or greenish grey with olive brown clouds                                                                                   | 35 - 40 dark brown dots or dashes articulated with small white snowflakes also present between the spiral lines |
| <i>arafurensis</i>    | 2 to 3 whorls pink          | Tuberculate and stepped all over the spire              | 8 - 10 spiral grooves                                          | Ventricosely conical to conical            | Beaded spiral striae all over the last whorl. White dots are on the beads | Pale grey with irregular orange patches                                                                                                | 20 to 30 thin brown and white dashes. White snowflakes also present between lines                               |



## Acknowledgements

We heartily thank the following persons who helped us during the course of our study and without whom it could not have been completed:

**John K. Tucker** for data and pictures of shells from the collection of INHS and particularly for accepting the selection of the holotype of *P. arafurensis* n. sp., as well as his thorough proofreading and editing of our paper.

**Patrice Bail** and **António Monteiro** also gave an essential help in reading and correcting this manuscript. António provided us also with pictures and data of specimens from its collection.

**Mike Filmer** for data and pictures of shells from his collection and valuable information and suggestions.

**Kathie Way**, NHMUK authorized us to publish pictures of the types of *P. vinctus*.

**Gavin Malcolm** helped us to get in touch with NHMUK.

**Eddy Hardy** kindly accepted to picture the types of *P. vinctus* during his recent visit to NHMUK.

**Alan J. Kohn** for allowing us use pictures of type specimens from his "Conus Biodiversity Website".

**Christophe Roux** for data and pictures of shells from his collection, support, suggestions and much more...

**Gabriella Raybaudi Massilia** for useful informations on *P. vinctus* (A. Adams, 1854).

**Trevor & Marguerite Young** for data and pictures of some Australian specimens of interest for our study.

**Gérard Hervillard** for giving us access to the shells he collected in Masirah, Oman and also for his friendship.

**Lisa Kirkendale** and **Corey Whisson**, curator in WAM for the loan of specimens of *Pionoconus*.

**Mandy Reid & Alison Miller** kindly provided excellent pictures of specimens in the AMS collections.

**Rachel King** and **Thierry Laperousaz**, SAM for pictures of the holotype of *P. barbara*.

**Yves Finet**, **Jean Mariaux** and **Emmanuel Tardy** for their warm assistance during our visit to the MHNG and having allowed us to take pictures of shells from the collections.

**Philippe Bouchet** and **Virginie Heros**, MNHN for access to the MNHN collections and library.

**Nicolas Puillandre**, MNHN for informations on DNA of shells of this complex (to be published results).

**Baldomero Olivera**, **Bruno Mathé**, **Christian Galy-Cassit**, **Giancarlo Paganelli** and **Olivier Santini** for data and pictures of shells of their collection.

**Joël Cholet**, **Thierry Joly** and **Michel Blanchard** for the loan of shells from their collection.

## Photo credits

All pictures from Alain Robin, except the following:

P. 10: fig. 14-15 Eddy Hardy [www.gastropods.com](http://www.gastropods.com); P. 14: fig. 18 SAM; P. 20: J.K. Tucker; P. 30: fig. 1: J.K. Tucker fig. 6 C. Galit-Cassit fig. 7 B. Mathé; P. 31: fig. 9 C. Roux fig. 10 & 11 B. Olivera fig. 13 & 14 M. Filmer fig. 15 J.K. Tucker fig. 17 O. Santini; P. 32 fig. 2: C. Roux fig. 4 A. Monteiro fig. 5 B. Olivera fig. 7 & 8 M. Filmer fig. 9 J.K. Tucker; P. 33 fig. 9 C. Roux; P. 36: fig. 2 SAM Fig. 1,3-5, 10 C. Roux; P. 37: fig. 1 T. & M. Young fig. 2 M. Filmer fig. 4 AMS; P.38: fig. 6 C. Roux; P. 48: J. Pas.

## Abbreviations:

AJM: António Monteiro's collection

AR: Alain Robin's collection

BM: Bruno Mathé's collection

BO: Baldomero Olivera's collection

CGC: Christian Galy's collection

CMW: Coomans, Moolenbeek & Wils Alphabetical revision of (sub)species in recent Conidae

CR: Christophe Roux's collection

EM: Eric Monnier's collection

GH: Gérard Hervillard's collection

GP: Giancarlo Paganelli's collection

JC: Joël Cholet's collection

LL: Loïc Limpalaër's collection

MB: Michel Blanchard's collection

MF: Mike Filmer's collection

OS: Olivier Santini's collection

RKK: Röckel, Korn & Kohn's Manual of Living Conidae

AMS: Australian Museum (Sydney, Australia)

INHS: John K. Tucker collection, Illinois Natural History Survey (Champaign, Illinois, U.S.A.)

IRSNB (KBIN): Institut Royal des Sciences Naturelles de Belgique (Brussels, Belgium)

LSL: Linnean Society of London (London, U.K.)

MHNG: Muséum d'Histoire Naturelle de Genève

MHNH: Muséum d'Histoire Naturelle du Havre (Le Havre, France)

MNHN: Muséum National d'Histoire Naturelle (Paris, France)

MSNP: Museo di Storia Naturale Università di Pisa (Pisa, Italia)

NBC-ZMA: Naturalis Biodiversity Centre ex Zoological Museum of Amsterdam (Leiden, Netherlands)

NHMUK: Natural History Museum of United Kingdom (London, U.K.)

SAM: South Australian Museum (Adelaide, Australia)

WAM: Western Australian Museum (Perth, Australia)

ZIUU: Zoological Institute, University of Uppsala (Uppsala, Sweden)

## Bibliography

- **Abbott, R. T. & Dance, S. P., 1990.** Compendium of seashells. A full-color guide to more than 4 200 of the world's marine shells. 4<sup>th</sup> Ed. American Malacologists Inc. Melbourne (U.S.A.), 1-411 pp.
- **Adams A., 1854.** Descriptions of New Species of the Genus *Conus*, from the Collection of Hugh Cumming, Esq. *Proceedings of the Zoological Society of London*, 1853, Part XXI, London (England). 116-119 pp.
- **Bosch D. & Bosch E., 1982.** Seashells of Oman. Longman Group Ltd., Harlow (England). 1-206 pp.
- **Bozzetti L., 2010.** *Conus simonis* (Gastropoda: Prosobranchia: Conidae) a new species from Southeastern Madagascar. *Malacologia Mostra Mondiale* n° 66, Cupra Marittima (Italy). 11-12 pp.
- **Bozzetti L., 2012.** *Pionoconus atimovatae* (Gastropoda: Prosobranchia: Conidae) a new species from South Madagascar. *Malacologia Mostra Mondiale* n° 77, Cupra Marittima (Italy). 24-25 pp.
- **Brazier, J., 1898.** New marine shells from the Solomon Islands and Australia. *Proceedings of the Linnean Society of New South Wales*, Vol. 22 (4), Sydney, (Australia). 779-782 pp.
- **Buijse J. A. & Verbinnen G., 2010.** Red Sea Mollusca: Contribution to the knowledge of *Conus* (*Pionoconus*) *nigropunctatus* G.B. Sowerby II, 1858. *Gloria Maris*, Vol. 45 n°6. B.V.C., Antwerp (Belgium). 142-164 pp.
- **Cernohorsky, W. O., 1964.** The Conidae of Fiji (Mollusca: Gastropoda). *The Veliger*, Vol. 7 n° 2, Berkeley (U.S.A.) 61-94 pp.
- **Coomans, H. E., Moolenbeek, R. G. & Wils, 1979.** Alphabetical revision of the (sub)species in recent Conidae 1. *abbas* to *adansonii*. *Basteria*, Vol. 43 Backhuys Publishers, Leiden (Netherlands). 9-23 pp.
- **Coomans, H. E., Moolenbeek, R. G. & Wils, 1982.** Alphabetical revision of the (sub)species in recent Conidae 5. *baccatus* to *byssinus*. *Basteria*, Vol. 46 Backhuys Publishers, Leiden (Netherlands). 3-67 pp.
- **Coomans, H. E., Moolenbeek, R. G. & Wils, 1985.** Alphabetical revision of the (sub)species in recent Conidae 8. *dactylosus* to *dux*. *Basteria*, Vol. 49 Backhuys Publishers, Leiden (Netherlands). 145-196 pp.
- **Coomans, H. E., Moolenbeek, R. G. & Wils, 1986.** Alphabetical revision of the (sub)species in recent Conidae 9. *Ebraeus* to *extraordinarius* with the description of *Conus elegans ramalhoi* nov. Subspecies. *Basteria*, Vol. 50 Backhuys Publishers, Leiden (Netherlands). 93-150 pp.
- **Cotton B. C., 1945.** A catalogue of the cone shells (Conidae) in the South Australian Museum. *Records of the South Australian Museum*, Vol. 8, Adelaide (Australia). 229-280 pp.
- **Coulombel A., 1994.** Coquillages de Djibouti. Edisud, Aix en Provence (France). 1-143 pp.
- **Da Motta, A. J., 1991.** A systematic classification of the gastropod family Conidae at the generic level. *La Conchiglia*, Roma (Italy), 1-48 pp.
- **Da Motta, A. J. & Lenavat, P., 1979.** Cone Shells of Thailand. Bangkok (Thailand). 1-20 pp.
- **Dautzenberg P., 1910.** Liste de coquilles recueillies par le R.P. Aubin dans l'île de Rua-Sura (Archipel Salomon) en 1909. *Journal de Conchyliologie*, Vol. 58 (1<sup>er</sup> trimestre). Paris (France). 24-33 pp.
- **Dautzenberg P., 1937.** Résultats Scientifiques du Voyage aux Indes Orientales Néerlandaises – Gastéropodes Marins 3. Famille Conidae. *Mémoires du Muséum d'Histoire Naturelle de Belgique – Hors Série 2*, Bruxelles (Belgium). 1-184 pp.
- **Delsaerdt A., 1990.** The Conidae of the Solomon Islands. Part 2. *Gloria Maris*, Vol. 29 n°4-5. B.V.C., Antwerp (Belgium). 55-94 pp.
- **Delsaerdt A., 1991.** The Conidae of the Solomon Islands. Part 3. *Gloria Maris*, Vol. 30 n°1. B.V.C., Antwerp (Belgium). 1-24 pp.
- **Delsaerdt A., 1994.** The Conidae of the Solomon Islands. Part 5. *Gloria Maris*, Vol. 33 n°4-5. B.V.C., Antwerp (Belgium). 66-97 pp.
- **Estival J. C., 1981.** Cônes de Nouvelle Calédonie et du Vanuatu. Les Editions du Cagou, Pappete (French Polynesia). 1 - 126 pp.
- **Filmer, R.M., 2001.** A Catalogue of Nomenclature and Taxonomy in the Living Conidae 1758 -1998. Backhuys Publishers, Leiden (Netherlands). 1-388 pp.
- **Gmelin J. R., 1791.** Systema Naturae per Regna Tria Naturae, 13th Edition. Vol. 1 Part 6 (Vermes). G.E. Deer, Leipzig (Germany). 3021-3910 pp
- **Habe T., 1964.** Shells of the Western Pacific in Color, Vol. II. Hoikusha, Osaka (Japan). I - IX, 1 - 233 pp.

- **Heiman E. L., 2002.** Shells of East Sinai, an illustrated list. Conidae. *Triton* n°5. Israel Malacological Society, Rehovot (Israel). 19-23 pp.
- **Holeman J. & Mc Gill O., 1969.** The Conus corner – An Indo-Pacific species Discussed. *Hawaiian Shell News*. Vol. 17 n°8 (august). Hawaiian Malacological Society, Honolulu (U.S.A.). 3, 8 pp.
- **Jickeli C. F., 1875.** Studien über die Conchylien des Rothen Meeres, 2. Die Gattung *Conus*. *Jahrbücher der Deutschen Malakozoologischen Gesellschaft*, 2. Frankfurt (Germany). 43-71 pp.
- **Kiener L. C., 1845-1859.** Species général et iconographie des coquilles vivantes – Genre Cone (*Conus* LIN.). J.-B. Baillière & Fils, Paris (France). 1-379 pp. 111 pl.
- **Kohn A. J., 1992.** A chronological Taxonomy of *Conus*, 1758 - 1840. Smithsonian Institution Press, Washington (U.S.A.) and London (England). i-x, 1-315 pp. 26 pl.
- **Kohn A. J. & Perron F. E., 1994.** Life History and Biogeography – Patterns in *Conus*. Clarendon Press, Oxford (England). 1-104 pp.
- **Marsh J. A. & Rippingale O. H., 1968.** Cone Shells of the World. 2nd ed. The Jacaranda Press, Brisbane (Australia). 1-185 pp.
- **Raybaudi Massilia G., 1991.** A new Conidae from N.W. Australia (Gastropoda: Conidae). *La Conchiglia* Vol. XXII, n° 260, Roma (Italy). 20 - 25 pp.
- **Raybaudi Massilia G. in Poppe G.T., 2008.** Philippine Marine Mollusks Volume II – Conidae. ConchBooks, Hackenheim (Germany). 1-848 pp.
- **Reeve L. A., 1843-1844.** *Conchologia Iconica*, Vol. 1, Monograph of the Genus *Conus*, Reeve Brothers, London (England). Unnumbered.
- **Reeve L. A., 1848-1849.** *Conchologia Iconica*, Vol. 1, Monograph of the Genus *Conus* Supplement, Reeve Brothers, London (England). Unnumbered.
- **Richard G. & Seguignes. M., 2005.** Statut de *Conus nigropunctatus* de Mer Rouge par rapport à *Conus catus* à partir de la biométrie des coquilles. Actes du III<sup>e</sup> Congrès International des Sociétés Européennes de Malacologie. Université de La Rochelle, La Rochelle (France). 175-181 pp.
- **Röckel, D., Korn, W. & Kohn, A.J., 1995.** Manual of the Living Conidae - Volume 1: Indo-Pacific Region. Verlag Christa Hemmen, Wiesbaden (Germany). 1-517 pp.
- **Rolán, E. & Raybaudi Massilia, G., 1994.** New investigations on the radular teeth of *Conus* (Prosobranchia: Conidae). Part. 2. *Argonauta* Vol. 8 (7-12). AML, Roma (Italy). 7-68 pp.
- **Sharabati D., 1984.** Red Sea Shells. London (England). 1-128 pp.
- **Shikama T., 1963.** Selected Shells of the World illustrated in colours. Vol. 1. Hokuryu-Kan Publishing Co., Tokyo (Japan). 1-154 pp.
- **Sowerby, G. B. II, 1857-1858.** Thesaurus Conchyliorum or Monographs of the Genera of Shells. Vol. 3. G. B. Sowerby, London (England).
- **Springsteen F. J. & Leobrera F. M., 1986.** Shells of the Philippines. Carfel Seashell Museum, Manila (Philippines). 1 - 377 pp.
- **Sturany R., 1903.** Gastropoden des Rothen Meeres. Expeditionen S. M. Schiff "Pola" in das Rothe Meer, Zoologische Ergebnisse XXIII. Carl Gerold's Sohn, Wien (Austria). 1-75 pp. 7 pl.
- **Tryon, G. W., 1884.** Manuel of conchology, structural and systematic with illustrations of the species. Vol. 6: Conidae, Pleurotomidae. Tryon, Philadelphia (U.S.A.). 1-413 pp.
- **Tucker, J. K. & Tenorio, M. J., 2009.** Systematic Classification of Recent and Fossil Conoidean Gastropods. Conchbooks, Hackenheim (Germany). 1-296 pp.
- **Verbinnen G. & Wils E., 2007.** Red Sea Mollusca part 24: Conidae. *Gloria Maris*, Vol. 45 n°6. B.V.C., Antwerp (Belgium). 142-164 pp.
- **Walls, J. G., 1979.** Cone Shells: A synopsis of the living Conidae. TFH Publications Inc., Neptune City (U.S.A.). 1-1011 pp.
- **Wils, E. & al., 1969-1974.** Familie Conidae. Conchyliologische Studiegroep "Xenophora", Antwerp (Belgium). 1-108 pp.
- **Wils, E., 1986.** Red Sea Malacology III Revisie: De Conidae van de Rode Zee. *Gloria Maris*, Vol. 25 n° 5-6. BVC, Aarschot (Belgium). 161-206 pp.
- **Wilson, B. R., 1994.** Australian Marine Shells – Prosobranch Gastropods – Vol. 2. Odissey Publishing, Kallaroo (Australia). 1-370 pp.
- **Wilson, B. R. & Gillett, K., 1971.** Australian Shells. Charles E. Tuttle Company, Tokyo (Japan). 1-168 pp.
- **Zeidler, W., 1985.** Mollusc type-specimens in the South Australian Museum 2. Gastropoda: Conidae. *Records of the South Australian Museum*, Vol. 19 n°5, Adelaide (Australia) 69-75 pp.

Plate 1

*Pionoconus koukae* n. sp.



*Pionoconus koukae* n. sp.

- 1 39.60 mm Masirah Island, Oman Holotype MNHN 26936
- 2 39.60 mm Masirah Island, Oman Paratype 1 Coll. EM
- 3 43.39 mm Masirah Island, Oman Paratype 2 Coll. EM
- 4 41.06 mm Masirah Island, Oman Paratype 10 Coll. GH
- 5 17.10 mm Masirah Island, Oman juvenile Coll. GH

- 6 45.06 mm Masirah Island, Oman Paratype 7 Coll. GH
- 7 36.27 mm Masirah Island, Oman Paratype 3 Coll. AR
- 8 46.81 mm Masirah Island, Oman Paratype 8 Coll. GH
- 9 44.75 mm Masirah Island, Oman Paratype 9 Coll. GH
- 10 42.31 mm Masirah Island, Oman Paratype 11 Coll. GH

Plate 2

*Pionoconus arafurensis* n. sp.



*Pionoconus arafurensis* n. sp.

- |                                                            |                                                                            |
|------------------------------------------------------------|----------------------------------------------------------------------------|
| 1 42.60 mm Australia Holotype INHS 44378                   | 5 40.90 mm Australia Paratype 4 Coll. MB                                   |
| 2 36.80 mm Swain Reefs, Qld, Australia Paratype 1 Coll. LL | 6 34.43 mm Australia Paratype 5 Coll. CGC                                  |
| 3 44.46 mm Broome, Western Australia Paratype 2 Coll. EM   | 7 35.05 mm Australia Paratype 6 Coll. BM                                   |
| 4 41.23 mm Swain Reefs, Qld, Australia Paratype 3 Coll. EM | 8 49.67 mm Finucane Island, Port Hedland, W. Australia Paratype 7 Coll. JC |

Plate 3

*Pionoconus arafurensis* n. sp.



9



10



11



12



13



14



15



16



17



18

*Pionoconus arafurensis* n. sp

- 9 42.34 mm Broome, WA, Australia Paratype 8 Coll. CR  
10 43.3 mm Western Australia Paratype 9 Coll. BO  
11 46.50 mm Broome, WA, Australia Paratype 10 Coll. BO  
12 48.0 mm Fannie Bay, Darwin, WA Paratype 16  
WAM S66442  
13 25.7 mm Darwin, NT, Australia Paratype 11 Coll. MF

- 14 26.8 mm Darwin, NT, Australia Paratype 12 Coll. MF  
15 40.6 mm Western Australia Paratype 13 INHS 44379  
16 41.6 mm Fannie Bay, Darwin, WA Paratype 17  
WAM S66443  
17 50.3 mm Western Australia Paratype 14 Coll. OS  
18 50.1 mm Fannie Bay, Darwin, WA Paratype 15  
WAM S66441

Plate 5

*Pionoconus rouxi* n. sp.



*Pionoconus rouxi* n. sp.

1 46.20 mm Sunday Island, Western Australia

Holotype WAM S66439

2 42.76 mm Cable Beach, Broome, Western Australia Paratype 1  
Coll. CR

3 40.15 mm Western Australia Paratype 2 Coll. EM

4 43.80 mm Western Australia Paratype 3 Coll. AJM

5 52.20 mm Western Australia Paratype 4 Coll. BO

6 33.00 mm Western Australia Paratype 5 Coll. JC

7 39.30 mm Dampier, Western, Australia Paratype 6 Coll. MF

8 37.40 mm Dampier, Western Australia, Paratype 7 Coll. MF

9 35.40 mm Broome, Western Australia, Paratype 8 INHS 45125  
with periostracum

10 32.62 mm Lord Island, Buccaneer Archipelago,  
Western Australia Paratype 9 WAM S66440

Plate 6

*Pionoconus achatinus*

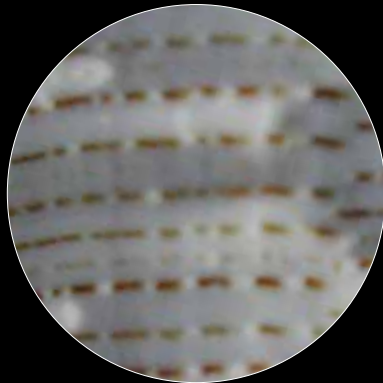


- 1 *Pionoconus achatinus* 35.9 mm Vanuatu Coll. CGC
- 2 *Pionoconus achatinus* 39.1 mm Samar, Philippines Coll. EM
- 3 *Pionoconus achatinus* 50.7 mm La Réunion Coll. CGC
- 4 *Pionoconus achatinus* 71.5 mm Vietnam Coll. EM
- 5 *Pionoconus achatinus* f. *atimovatae* 21.4 mm Lavanono, Madagascar Holotype MNHN
- 6 *Pionoconus achatinus* f. *simonis* 58.0 mm Tulear, Madagascar Coll. EM
- 7 *Pionoconus achatinus* f. *simonis* 43.9 mm Nosy Be, Madagascar Coll. EM
- 8 *Pionoconus achatinus* f. *simonis* 22.8 mm Nosy Be, Madagascar Holotype MNHN
- 9 *Pionoconus achatinus* 57.4 mm Bali, Indonesia Coll. CR
- 10 *Pionoconus achatinus* 47.6 mm Indo-Pacific granulose form Coll. CR

Plate 7



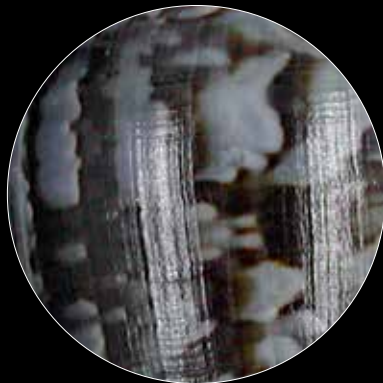
1



2



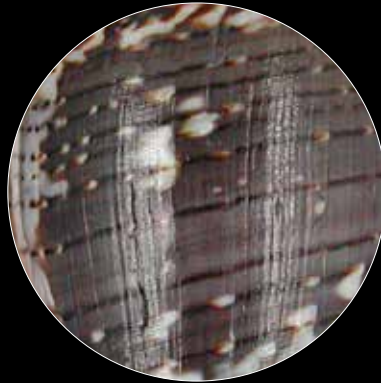
3



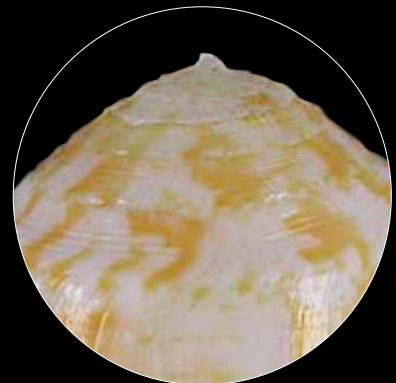
4

- 1 *P. achatinus* Vietnam  
2 *P. barbara* Western Australia  
3 *P. arafurensis* n. sp. Western Australia  
4 *P. monachus* Vanuatu

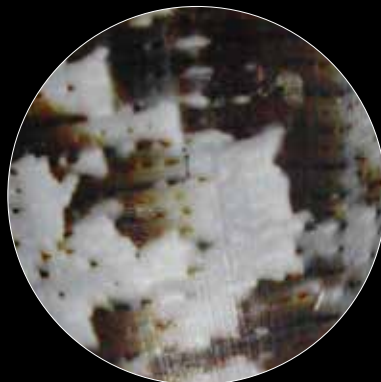
Plate 8



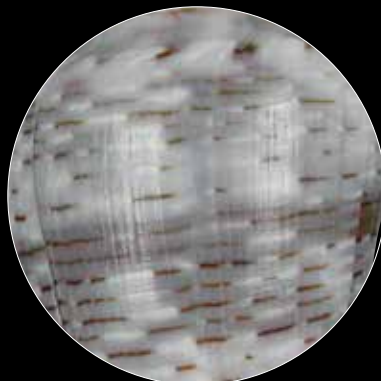
5



6



7



8

- 5 *P. vinctus* Western Australia
- 6 *P. rouxi* n. sp. Western Australia
- 7 *P. koukae* n. sp. Oman
- 8 *P. nigropunctatus* Red Sea

Plate 9

*Pionoconus barbara*



*Pionoconus barbara*

- 1 46.9 mm Broome, W. Australia Coll. CR
- 2 40.0 mm Solomon Islands Holotype SAM
- 3 43.1 mm Broome, W. Australia Coll. CR
- 4 42.7 mm Lord Island, W. Australia granulose form WAM
- 5 58.1 mm Broome, W. Australia Coll. CR
- 6 40.7 mm Broome, W. Australia Coll. EM

- 7 43.9 mm Gantheaume Point, Broome, W. Australia Coll. EM
- 8 54.6 mm Broome, W. Australia Coll. EM
- 9 47.0 mm Broome, W. Australia Coll. EM
- 10 42.8 mm Broome, W. Australia Coll. CR

Plate 10

*Pionoconus vinctus*



*Pionoconus vinctus*

- 1 48.5 mm Darwin, NT, Australia Coll. EM
- 2 50.0 mm Bathurst Island, NT, Australia Courtesy M. & T. Young
- 3 42.8 mm Darwin, NT, Australia Coll. MF Courtesy MF
- 4 41.5 mm Solomon Islands Coll. EM
- 5 with periostracum Australia courtesy AMS
- 6 42.7 mm Australia Coll. EM
- 7 45.0 mm Darwin, NT, Australia Coll. CR

Plate 11



- 1 *Pionoconus monachus* 43.0 mm New Caledonia Coll. EM
- 2 *Pionoconus monachus* 44.6 mm Vanuatu Coll. EM
- 3 *Pionoconus monachus* 44.0 mm Philippines Coll. EM
- 4 *Pionoconus nigropunctatus* 41.6 mm Red Sea Coll. EM
- 5 *Pionoconus nigropunctatus* 23.5 mm Sharm el Sheik, Egypt (Sinai) Coll. EM
- 6 *Pionoconus nigropunctatus* 31.5 mm Horn of Africa, Somalia Coll. EM
- 7 *Pionoconus nigropunctatus* 37.5 mm Dorale, Djibouti Coll. GL
- 8 *Pionoconus striolatus* 29.6 mm Papua New Guinea Coll. EM
- 9 *Pionoconus striolatus* 31.6 mm Philippines Coll. EM
- 10 *Pionoconus striolatus* 35.1 mm Solomon Islands Coll. EM
- 11 *Pionoconus metcalfei* 32.8 mm Sulu Sea Coll. EM

Plate 12



- 1 *Pionoconus morrisoni* 22.5 mm Ashmore Island, Western Australia Holotype SMNS  
2 *Pionoconus morrisoni* 24.8 mm Ashmore Island, Western Australia Coll. EM  
3 *Pionoconus morrisoni* 25.3 mm Ashmore Island, Western Australia Coll. EM  
4 *Pionoconus morrisoni* 27.3 mm Ashmore Island, Western Australia Coll. EM  
5 *Floraconus cocceus* 40.4 mm Esperance, Western Australia Coll. EM  
6 *Floraconus cocceus* 43.8 mm Mandurah, Western Australia Coll. EM  
7 *Floraconus cocceus* 45.7 mm Augusta, Western Australia Coll. CR  
8 *Floraconus cocceus* 52.7 mm Augusta, Western Australia Coll. CR  
9 *Floraconus cocceus* 36.0 mm Augusta, Western Australia Coll. EM



## A New Cone Species from Aruba: *Perplexiconus wendrosi* sp. nov. (Gastropoda, Conilithidae)

Manuel J. TENORIO

Facultad de Ciencias, Torren Norte, 1ª Planta, Universidad de Cádiz, 11510 Puerto Real, Cádiz, SPAIN  
e-mail: manuel.tenorio@uca.es

Carlos M. L. AFONSO

Centro de Ciências do Mar (CCMAR), Faculdade de Ciências e Tecnologia, Universidade do  
Algarve, Campus de Gambelas 8005-139 Faro, PORTUGAL e-mail: cmlafonso@ualg.pt

### ABSTRACT

*Perplexiconus wendrosi* sp. nov. is described from shallow water in Barcadera, a restricted area of the Western coast of Aruba. It is characterized by its small shell length, narrow body with a distinct anterior notch and a high spire. The radular tooth is of a typical Conilithinae, without serrations or terminating cusp, which exhibits a characteristic shaft fold and a broad, slanted base with a prominent spur. The new species is compared to *Perplexiconus puncticulatus puncticulatus* (Hwass in Bruguière, 1792) and *P. puncticulatus columba* (Hwass in Bruguière, 1792).

### INTRODUCTION

The genus *Perplexiconus* Tucker & Tenorio, 2009 includes three species distributed in the Eastern Pacific and the Western Atlantic, namely *P. perplexus* (Sowerby II, 1857), *P. lucidus* (Wood, 1828) and *P. puncticulatus* (Hwass in Bruguière, 1792). The shells of the specimens in this genus, closely related to *Jaspidiconus* Petuch, 2004, are characterized by the presence of an anterior notch which is generated by a twist in the anterior end of the columella. The Western Atlantic species *P. puncticulatus* was reviewed in Vink, 1990. It was considered a polytypic species, consisting of four separate subspecies, namely *P. puncticulatus puncticulatus* (widespread in the southern and eastern Caribbean and along the coasts of Panama and Colombia), *P. puncticulatus columba* (Hwass in Bruguière, 1792) (off the coast of North America and in the eastern Caribbean, mainly along the Lesser Antilles and the islands of Aruba, Bonaire and Curaçao), *P. puncticulatus millepunctatus* (Röding, 1798) (restricted to the coast of eastern Venezuela and the islands of Trinidad and Tobago), and *P. puncticulatus cardonensis* (Vink, 1990) (restricted to the Paraguana peninsula, Venezuela, with records from several localities). In his review of Vink's work, Tucker (2010) reduced the number of subspecies to two, the nominal species and *P. p. columba*, considering *P. p. millepunctatus* and *P. p. cardonensis* mere forms of *P. p. puncticulatus*. Other names in the literature such as *Conus mauritianus* Hwass in Bruguière, 1792, *Conus pygmaeus* Reeve, 1844, *Conus papillosus* Kiener, 1845 and *Conus scaber* Link, 1807 are all considered synonyms or forms of *P. p. puncticulatus*, whereas *Conus echinulatus* Kiener, 1845 is considered a synonym of *P. p. columba*. Walls (1979) and Tucker (2010) have illustrated shells from Oranjestad Harbor, Aruba, which were identified respectively as *P. p. puncticulatus* and juvenile *P. p. columba*. In recent travels of the authors to Aruba, and upon contacting with local divers and collectors, a population of cones matching the shells illustrated in Walls (1979) and Tucker (2010) was found in Barcadera, south of Oranjestad. This population stands aside from another population of typical, white *P. p. columba* living in the vicinity. No intergrades were observed. Detailed study of the morphology of this population and comparison with the local population of *P. p. columba* have led us to establish that this population actually represents a distinct species within genus *Perplexiconus*. The new species, *Perplexiconus wendrosi* sp. nov., is hereby described and compared with *P. p. puncticulatus* and *P. p. columba*.

### INTRODUCTION

Trois espèces, réparties dans l'ouest de l'Océan Atlantique et l'ouest de l'Océan Pacifique, font partie du genre *Perplexiconus* Tucker & Tenorio, 2009, à savoir: *P. perplexus* (Sowerby II, 1857), *P. lucidus* (Wood, 1828) and *P. puncticulatus* (Hwass in Bruguière, 1792). Les coquilles de ces espèces, proches de *Jaspidiconus* Petuch, 2004, sont caractérisées par la présence d'une encoche antérieure générée par une torsion de la partie antérieure de la columelle. L'espèce *P. puncticulatus* de l'Ouest Atlantique a été révisée par Vink en 1990. Elle est considérée comme une espèce polytypique, composée de quatre sous-espèces: *P. puncticulatus puncticulatus* (largement répandue dans le sud et l'est de la Caraïbe et le long des côtes de Colombie et de Panama), *P. puncticulatus columba* (Hwass in Bruguière, 1792) (sur les côtes de l'Amérique du Nord et dans l'est des Caraïbes, principalement dans les petites Antilles and les îles d'Aruba, Bonaire et Curaçao), *P. puncticulatus millepunctatus* (Röding, 1798) (seulement sur la côte est du Venezuela and les îles de Trinidad et Tobago), et *P. puncticulatus cardonensis* (Vink, 1990) (restreinte à la péninsule de Paraguana, Venezuela, trouvée en plusieurs localités.)

Dans son analyse du travail de Vink, Tucker (2010) a réduit le nombre de sous-espèces à deux, l'espèce nominale et *P. p. columba*, considérant *P. p. millepunctatus* et *P. p. cardonensis* comme de simples formes de *P. p. puncticulatus*. D'autres noms dans la littérature, comme *Conus mauritianus* Hwass in Bruguière, 1792, *Conus pygmaeus* Reeve, 1844, *Conus papillosus* Kiener, 1845 et *Conus scaber* Link, 1807 sont tous considérés comme des synonymes ou formes de *P. p. puncticulatus*, alors que *Conus echinulatus* Kiener, 1845 est un synonyme de *P. p. columba*. Walls (1979) et Tucker (2010) ont illustré des coquilles de Oranjestad Harbor, Aruba, qui sont identifiées respectivement comme *P. p. puncticulatus* et un juvénile *P. p. columba*. Lors

de récents voyages des auteurs à Aruba, et après de nombreux contacts avec des collectionneurs et plongeurs locaux, une population de cônes identiques aux coquilles figurées par Walls (1979) et Tucker (2010) est trouvée près de Barcadera, au sud d'Oranjestad. Cette population est distincte d'une autre typique de *P. p. columba*, blanche, vivant à proximité. Une étude détaillée de la morphologie et la comparaison avec la population locale de *P. p. columba* a mis en évidence le caractère spécial de cette espèce du genre *Perplexiconus*. Cette nouvelle espèce, *Perplexiconus wendrosi* sp. nov., est décrite et comparée à *P. p. puncticulatus* et *P. p. columba*.

## MATERIAL AND METHODS

The taxonomy used in the present article follows Tucker & Tenorio (2009). For the description of the shell morphometry we use the terminology established in Röckel, Korn & Kohn (1995). For the description of the radular morphology, we use the terminology established in Rolán (1992) and in Rolán & Rayabudi-Massilia (1994).

Specimens were collected by snorkel at the type locality in two campaigns during the years 2012 and 2013. Material was also kindly supplied by the local divers Leo G. Ros and Jordy Wendriks from Aruba.

Morphometric analysis of shell parameters was carried out on a sample of more than 50 specimens kindly provided by David P. Berschauer (Laguna Hills, California). The parameters shell length (L), maximum diameter (MD), aperture height (AH), spire height (SH), and height of maximum diameter (HMD) were measured, and these data were entered into the STATGRAPHICS 5.1 software package, which was used for performing the statistical tests.

For radular analyses, the soft parts were extracted from their corresponding shells and digested in concentrated aqueous KOH for 24 h. After that time, the resulting mixture was placed in a Petri dish and examined with the binocular microscope. In each case, the entire radula was separated from the remaining of the soft parts using fine tweezers and rinsed with distilled water. Then, the radula was mounted on a slide using Aquatex (Merck) Mounting Medium, and examined under the optical microscope. Photos were obtained with a CCD camera attached to the microscope, and these used for preparing the corresponding drawings.

## Abbreviations

### Museums and institutions

MNHN: Muséum National d'Histoire Naturelle, Paris, France.

MNCN: Museo Nacional de Ciencias Naturales de Madrid, Spain.

NHMUK: Natural History Museum, London, United Kingdom.

SBMNH: Santa Barbara Museum of Natural History, Santa Barbara, USA

MHNG: Muséum d'Histoire Naturelle, Geneva, Switzerland.

CMLA: Carlos M. L. Afonso collection.

MJT: Manuel J. Tenorio collection.

DPB: David P. Berschauer collection.

### Shell morphometry

L maximum shell length

RD relative diameter

RSH relative spire height

HMD height of the maximum diameter

PMD relative position of the maximum diameter

### Radular morphometry

LC/DR shell length/radular tooth size

DR/PA radular tooth size/apical portion length

DR/APA radular tooth size/apical portion width

100F/PA 100 x blade length/apical portion length

BW/L base width/radular tooth size

### Other

coll. collection

## RESULTS

### SYSTEMATICS

Family CONILITHIDAE Tucker & Tenorio, 2009  
 Subfamily CONILITHINAE Tucker & Tenorio, 2009  
 Genus *Perplexiconus* Tucker & Tenorio, 2009  
*Perplexiconus wendrosi* sp. nov. (Plate 1, Figs. 1-8)

**Previously figured in:** Walls (1979), p. 561, bottom left as *Conus puncticulatus puncticulatus* from Oranjestad Harbour, Aruba; Tucker (2010), p. 79, fig. 71A-C as *P. puncticulatus columba* from Oranjestad Harbor, Paarden Bay, Aruba; Afonso (2013), p. 10, fig. 3 as *Perplexiconus* cf. *puncticulatus* from Aruba.

**Type material:** Holotype, 14.7 x 7.1 mm (Plate 1, Figs. 2a-2b), deposited in the MNHN-Paris; Paratype 1, 14.3 x 7.2 mm (Plate 1, Fig. 5), MNCN-Madrid; Paratype 2, 13.7 x 6.8 mm (Plate 1, Fig. 7), NHMUK-London; Paratype 3, 13.0 x 6.4 mm (Plate 1, Figs. 1a-1b), SBMNH coll.; Paratype 4, 14.7 x 7.7 mm (Plate 1, Figs. 3a-3b), coll. MJT; Paratype 5, 18.5 x 9.3 mm (Plate 1, Fig. 6), coll. CMLA; Paratype 6, 16.1 x 7.9 mm (Plate 1, Figs. 4a-4b), coll. DPB; Paratype 7, 14.3 x 7.1 mm (Plate 1, Fig. 8), coll. MJT.

**Additional paratypes in the coll. of:** Carlos M. L. Afonso (Algarve, Portugal), Manuel J. Tenorio (Jerez, Spain), David P. Berschauer (California, USA), Leo G. Ros (Aruba), and Jordy Wendriks (Aruba).

**Other material examined:** More than 50 additional specimens from the type locality were studied.

**Type locality:** Barcadera, Leeward (West) coast of Aruba, in the Western Atlantic. Coordinates: 12° 28' 47" N, 60° 59' 27" W.

**Distribution and habitat:** To date, specimens have only been found at the type locality (Barcadera, Aruba) (see distribution map, figure 1). This new species of *Perplexiconus* is found inside a sandbar adjacent to a mangrove swamp. The water between the sandbar and the mangrove swamp is slightly acidic from decaying mangrove leaves, and is slightly brackish from rain water entering through the mangroves from the rolling hills. The cone snails can be found just under the sand on the sandbar from the shore to a depth of no more than 30 cm. The new species deposits its egg capsules attached to the stem of marine plants (Figure 2) and underneath dead mangrove leaves present in its habitat.

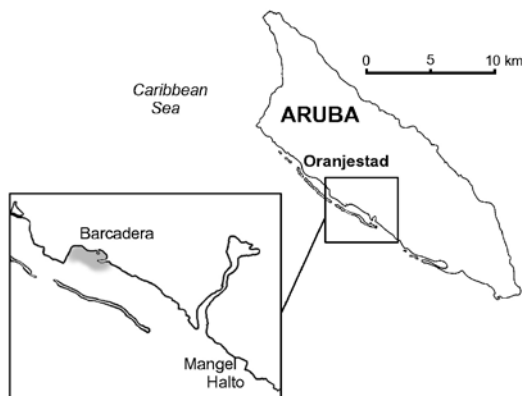


**Figure 1.-** Distribution map for *P. wendrosi* sp. nov.

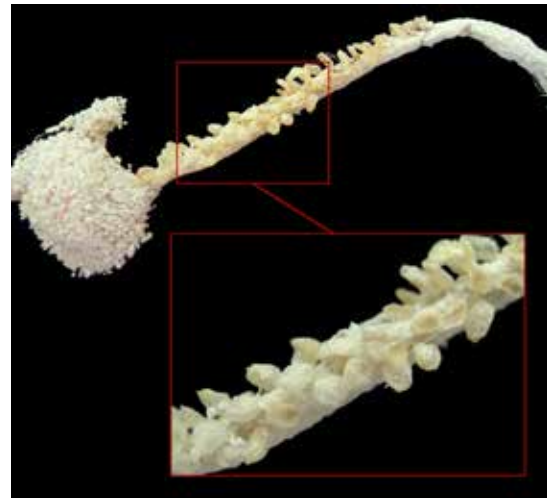


**Figure 2.-** Marine plant with egg cases of *P. wendrosi* sp. nov. attached to the stem.

**Etymology:** The species is named after Jordy Wendriks and Leo G. Ros, from Aruba, keen collectors and divers, and good friends, who brought specimens to the attention to the authors. The name of the new species, *wendrosi*, makes reference to both Jordy (*Wend*) and Leo (*Ros*).

**Description of the shell:** Morphometric parameters: L = 10 - 20 mm; average L = 14 mm; RD = 0.65 - 0.72; RSH = 0.21 - 0.31; PMD = 0.85 - 0.93. Shell is very small to small. General profile is conical, with a subangulated to slightly rounded shoulder. Spire high, sharp, often stepped in the 3 - 4 early whorls, concave in profile, with faint radial arcuate threads on the flat to slightly concave sutural ramps. Cords are absent. Protoconch paucispiral of 1.5 whorls, white, translucent (Figure 3).



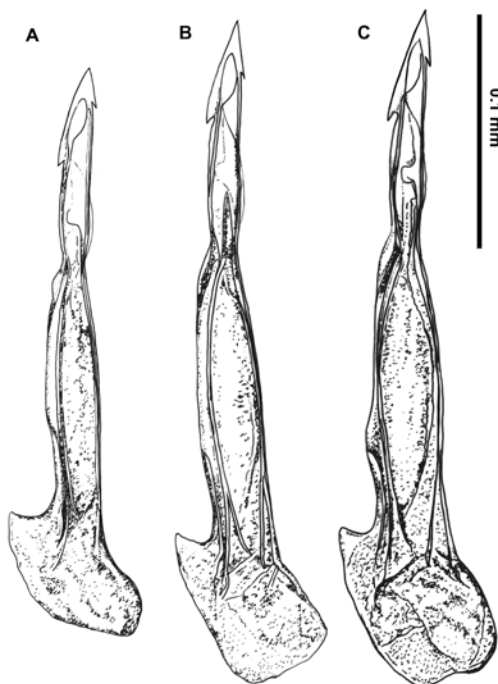
**Figure 3.-** Protoconch and early teleoconch of *P. wendrosi* sp. nov.

Sides of the last whorl are slightly convex. Body whorl is always smooth except for 8-12 spiral grooves that occupy almost the entire anterior third of the body whorl. Posterior notch moderate to deep. Anterior notch characteristic, well-developed. Spire is white with dark purplish axial flammules on the late sutural ramps. Last whorl bluish white covered by purplish brown axial flammules, often arranged in ziczac. This characteristic pattern can be dense or sparse. There are also spiral rows of brown dots and dashes, usually concentrated around the midbody. Columella white, twisted. Aperture is white, with diffuse pale purplish blotches in some specimens. Periostracum is very thin, yellow, smooth and translucent. Operculum relatively small, thin and elongated.

**Living animal and radula:** The animal is whitish, with the dorsum of the foot mottled with purplish grey towards the anterior part. The siphon is purplish gray, darker towards the tip (Figure 4). The sole of the foot is pale beige.



**Figure 4.-** Live specimens of *Perplexiconus wendrosi* sp. nov. In the photo on the right, it is shown accompanied by a specimen of *P. p. columba* from Mangel Halto, Aruba (Photos: C. M. L. Afonso)



Radular tooth is of the vermivorous type (figure 5A). There are 24 to 26 teeth in the radular sac; radular teeth small, LC/DR = 60. Waist is evident, and well above the midpoint of total length of the radular tooth: DR/PA 2.85-2.95. Apical part of the tooth is rather narrow: DR/APA 16 to 17. Small apical barb is present. Pointed blade, well- marked, occupying the upper half of the apical protion. 100F/PA = 50 to 52. Serrations and terminating cusp are absent. Posterior fold present. Shaft fold present. Base slanted, broad, with a strong basal spur. BW/L = 0.28 to 0.29.

**Figure 5.-** Radular teeth of **A)** *Perplexiconus wendrosi* sp. nov. (shell length 14.4 mm, from the type locality); **B)** *Perplexiconus puncticulatus columba* (shell length 14.4 mm, from Mangel Halto, Aruba); **C)** *Perplexiconus puncticulatus puncticulatus* (shell length 17.7 mm, from Mt. Irving Bay, Tobago).

We have performed a morphometric analysis on shell parameters of a sample of *P. wendrosi* sp. nov. from Barcadera, and similarly-sized *P. p. columba* from Mangel Halto, both from Aruba. Shell parameters were measured for a sample of 30 specimens of *P. wendrosi* sp. nov. and 21 specimens of *P. p. columba*. An analysis of covariance (ANCOVA) using SH as variable, species as factor, and L as covariate yielded statistically significant differences (F-score = 39.72,  $p = 0$ ). An analogous test using MD as variable also yielded statistically significant differences (F-score = 17.3,  $p = 0$ ). No statistically significant differences (F-score = 2.98,  $p = 0.09$ ) were found when the variable was HMD. The values of the least-squares means for the morphometric parameters and their corresponding standard errors are listed in Table 1.

| Taxon                       | N  | MD          | SH          | HMD         |
|-----------------------------|----|-------------|-------------|-------------|
| <i>P. wendrosi</i> sp. nov. | 30 | 6.96 (0.04) | 3.36 (0.04) | 9.00 (0.06) |
| <i>P. p. columba</i>        | 21 | 7.24 (0.05) | 2.92 (0.04) | 9.18 (0.07) |

Table 1.- Least-squares means (mm) and standard error (in parentheses) for the morphometric parameters of *P. wendrosi* sp. nov. and *P. p. columba*. N indicates the number of specimens included in the study.

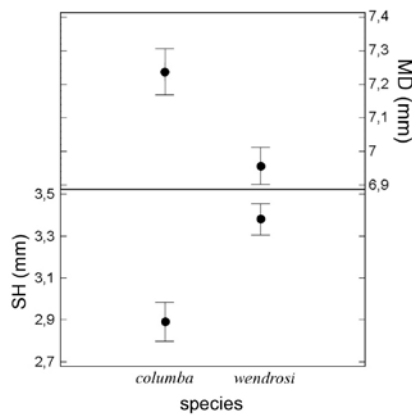


**Figure 6.-** Least-squares mean maximum diameters (top) and spire heights (bottom) and 95 % Bonferroni intervals for *P. wendrosi* sp. nov. and *P. p. columba*.

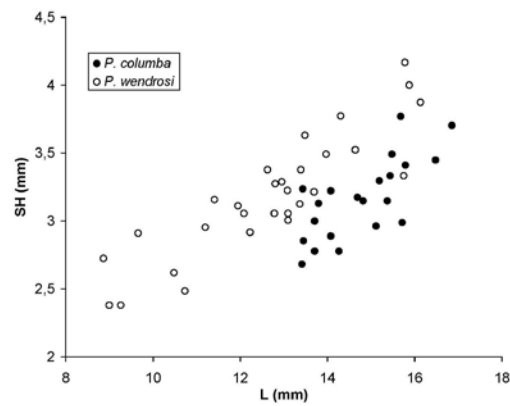


**Figure 7.-** Plot of spire height versus shell length for *P. wendrosi* sp. nov. (○) and *P. p. columba* (●), showing the differences in relative spire height and shell length.

The least-squares mean maximum diameters and 95 % Bonferroni intervals for *P. wendrosi* sp. nov. and *P. p. columba* are shown in Fig. 3. The plot (Fig. 6) of SH and MD versus shell length shows the differences in relative spire height and maximum diameter for both species. A scatter plot of SH versus L is shown in Fig. 7.

## DISCUSSION

*Perplexiconus wendrosi* sp. nov. can be easily separated from other Conidae species found in Aruba. *P. wendrosi* sp. nov. is most similar to *Perplexiconus puncticulatus puncticulatus* (plate 1, Fig. 9). As other members of genus *Perplexiconus*, *P. puncticulatus* is characterized by a paucispiral protoconch indicative of direct development and hence limited larval dispersal. Its radular tooth (Figure 5B) is very similar to that of *P. wendrosi* sp. nov. However, the shell of *P. wendrosi* sp. nov. is smaller, narrower bodied and with a much higher spire than that of typical *P. puncticulatus*. The typical purplish brown flammules in the pattern of the shell of *P. wendrosi* sp. nov. are not so well developed in shells of *P. p. puncticulatus*, in which the pattern is dominated by spiral rows of dots for which the species is named after. Typical *P. p. puncticulatus* is absent from Aruba. The form *cardonensis* of *P. p. puncticulatus* lives in the Paraguana peninsula, in Venezuela (plate 1, Fig. 11). This form is characterised by the usually smaller size of the shell, having a bluntly angled shoulder and a straight-sided spire that is lower than in typical *P. p. puncticulatus*, and hence than in *P. wendrosi* sp. nov. *P. p. puncticulatus* form *pygmaeus* (Reeve, 1844), which was considered in Clench (1942) a subspecies of *Jaspidiconus jaspideus* (Gmelin, 1791), applies to shells typically from Eastern Panama. This form is characterized by a pattern of brownish patches formed in long axially arranged zig-zag bars. However, both the holotype representation in Reeve (1844), pl. 47, fig. 260, as well as the shells shown in Clench (1942) p.2, pl 7, figs. 1 and 2, correspond to low-spired shells, relatively broader and with more rounded shoulders than *P. wendrosi* sp. nov.

The subspecies *P. p. columba* has been found in Aruba, in Mangel Halto, less than 3 kilometers south of Barcadera, the type locality for *P. wendrosi* sp. nov. *P. p. columba* and *P. wendrosi* sp. nov. have never been found living sympatrically in Aruba so far, and they seem to have different microhabitats (Berschauer *et al.*, 2013). *P. p. columba* is scattered throughout the Lesser Antilles, and is characterised by having a pure white (or bluish white) shell, proportionally wider at the shoulder and having more pronounced widely spaced grooves anteriorly. The radular tooth of *P. p. columba* (Figure 5C) is essentially identical to that of *P. p. puncticulatus* and of *P. wendrosi* sp. nov.

*P. wendrosi* sp. nov. had been previously treated as a juvenile, patterned form of *P. p. columba* from Aruba (Tucker, 2010). However, this is not the case. The shell of juveniles of *P. p. columba* is pure white, i.e. same color as the adults. The animal is also white in *columba*, whereas in *P. wendrosi* sp. nov. the siphon and the dorsum of the foot is mottled with purple-gray (Figure 4).

Statistical comparisons (see Results) indicate that statistically significant differences in shell morphometry (SH and MD) between *P. wendrosi* sp. nov. and *P. p. columba* do exist. Shells of *P. wendrosi* sp. nov. are narrower bodied and higher spired than those of *P. p. columba*. This fact together with evident differences in shell pattern (purple brown axial flammules and spiral rows of dots and dashes for *wendrosi* versus pure white, patternless shell for *columba*), animal color (whitish with purple dots and a purple gray siphon in *wendrosi* versus pure white in *columba*) and microhabitat (muddy sand near mangroves for *wendrosi* versus clean white sand for *columba*) allow the separation of these two taxa at the species level.

It is important to remark that due to the reproduction mode of species in genus *Perplexiconus* (direct development), it is possible that at least some of the many populations of *P. p. puncticulatus* scattered throughout the Caribbean might represent distinct species, as it has been shown hereby in the case of *P. wendrosi* sp. nov. following a detailed morphological study. Clearly, molecular analyses would be of great help in this task.

A final word about conservation: the restricted habitat in which the new species *P. wendrosi* sp. nov. has been found is expected to suffer likely severe degradation or even complete destruction. This is due to local plans for the expansion of the port of Barcadera. Let's keep our fingers crossed for the survival of this little but charming cone snail.

## ACKNOWLEDGMENTS

Our most sincere thanks to Mr. Leo G. Ros and Mr. Jordy Wendriks for bringing the new species to our attention; to Mr. David P. Berschauer for providing specimens from his collection for statistical analyses, as well as detailed information about ecology and habitat, and to Mr. John K. Tucker for the valuable suggestions and constructive criticism made upon reading the manuscript.

## BIBLIOGRAPHY

- AFONSO, C. M. L. A. 2013. Images of living coastal Cones from Aruba. *The Cone Collector*, 22:8-10.
- BERSCHAUER, D. P., ROS, L. G. & WENDRIKS, J. 2013. Microhabitats of Two *Perplexiconus* Forms or Species in Aruba. *The Cone Collector*, submitted for publication September 2013.
- CLENCH, W. J. 1942. The Genus *Conus* in the Western Atlantic. *Johnsonia* 6: 1-40.
- RÖCKEL, D., W. KORN & A. J. KOHN, 1995. Manual of the Living Conidae, Volume 1: Indo-Pacific Region: 1-517. Hackenheim. Verlag Christa Hemmen.
- ROLÁN, E. & G. RAYBAUDI MASSILIA, 1994. New investigation on the radular teeth of *Conus*. Part I. - *Argonauta* 8 (1-6): 6-59.
- TUCKER, J. K. & M. J. TENORIO, 2009. Systematic Classification of Recent and Fossil Conoidean Gastropods, with Keys to the Genera of Cone Shells. ConchBooks, Hackenheim, Germany, 295 pp.
- TUCKER, J. K. 2010. Danker L. N. Vink's The Conidae of the Western Atlantic. *The Cone Collector* Special Issue 14A:1-165.
- VINK, D. L. N. 1990. The Conidae of the western Atlantic. Part XIV. *La Conchiglia* 22(253/255):8-17.
- WALLS, J. G. 1979. Cone Shells A Synopsis of the Living Conidae. Neptune City, New Jersey: Tropical Fish Hobbiest (TFH), 1011 pp.

**Plate 1.- 1-8** *Perplexiconus wendrosi* sp. nov. All specimens from type locality: Barcadera, Leeward coast of Aruba Island, Aruba. **1a-b.** Paratype 3, ventral and dorsal views, SBMNH, 13.0 x 6.4 mm; **2a-b.** Holotype, dorsal and ventral views, MNHN – Paris, 14.7 x 7.1 mm. **3a-b.** Paratype 4, dorsal and ventral views, MJT collection, 14.7 x 7.7 mm. **4a-b.** Paratype 6, dorsal and ventral views, DPB collection, 16.1 x 7.9 mm. **5.** Paratype 1, MNCN 23775 – Madrid, 14.3 x 7.2 mm. **6.** Paratype 5, CMLA collection, 18.5 x 9.3 mm. **7.** Paratype 2, NHMUK – London, 13.7 x 6.8 mm. **8.** Paratype 7, MJT collection, 14.3 x 7.1 mm. **9.** Lectotype of *Conus puncticulatus*, MHNG, 27 mm, Colón, Panama (photo: Alan J. Kohn). **10.** *Perplexiconus puncticulatus columba*, DPB collection, 14.1 mm, Mangel Halto, Aruba. **11.** Holotype of *Conus puncticulatus cardonensis* Vink, 1990, MHNG, 20.9 mm, near Punta Cardón, Paraguana Peninsula, Venezuela (photo: Alan J. Kohn).

Plate 1





© Johan Pas

*Pionoconus barbara* (Brazier, 1898)



Association Française de Conchyliologie

