Iberus

Vol. 28 (1)

REVISTA DE LA SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

Oviedo, junio 2010

Iberus

Revista de la

SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

COMITÉ DE REDACCIÓN *(BOARD OF EDITORS)*

EDITOR DE PUBLICACIONES *(EDITOR-IN-CHIEF)*

Serge Gofas	Universidad de Málaga, España

DIRECTOR DE REDACCIÓN *(EXECUTIVE EDITOR)*

Gonzalo Rodríguez Casero	Apdo. 156, Mieres del Camino, Asturias, España

EDITORA EJECUTIVA *(MANAGING EDITOR)*

Eugenia Mª Martínez Cueto-Felgueroso	Apdo. 156, Mieres del Camino, Asturias, España

EDITORES ADJUNTOS *(ASSOCIATE EDITORS)*

Francisco Javier Conde de Saro	Embajada de España, Japón
Benjamín Gómez Moliner	Universidad del País Vasco, Vitoria, España
Ángel Antonio Luque del Villar	Universidad Autónoma de Madrid, Madrid, España
Emilio Rolán Mosquera	Universidad de Vigo, Vigo, España
José Templado González	Museo Nacional de Ciencias Naturales, CSIC, Madrid, España
Jesús S. Troncoso	Universidad de Vigo, Vigo, España

COMITÉ EDITORIAL *(BOARD OF REVIEWERS)*

Kepa Altonaga Sustacha	Universidad del País Vasco, Bilbao, España
Eduardo Angulo Pinedo	Universidad del País Vasco, Bilbao, España
Rafael Araujo Armero	Museo Nacional de Ciencias Naturales, Madrid, España
Thierry Backeljau	Institut Royal des Sciences Naturelles de Belgique, Bruselas, Bélgica
Rüdiger Bieler	The Field Museum, Chicago, Estados Unidos
Sigurd v. Boletzky	Laboratoire Arago, Banyuls-sur-Mer, Francia
Jose Castillejo Murillo	Universidad de Santiago de Compostela, Santiago de Compostela, España
Karl Edlinger	Naturhistorisches Museum Wien, Viena, Austria
Antonio M. de Frias Martins	Universidade dos Açores, Açores, Portugal
José Carlos García Gómez	Universidad de Sevilla, Sevilla, España
Gonzalo Giribet de Sebastián	Harvard University, EE.UU.
Edmund Gittenberger	National Natuurhistorisch Museum, Leiden, Holanda
Ángel Guerra Sierra	Instituto de Investigaciones Marinas, CSIC, Vigo, España
Gerhard Haszprunar	Zoologische Staatssammlung München, München, Alemania
Yuri I. Kantor	A.N. Severtzov Institute of Ecology and Evolution, Moscú, Rusia
María Yolanda Manga González	Estación Agrícola Experimental, CSIC, León, España
Jordi Martinell Callico	Universidad de Barcelona, Barcelona, España
Ron K. O'Dor	Dalhousie University, Halifax, Canada
Takashi Okutani	Nihon University, Fujisawa City, Japón
Marco Oliverio	Universitá di Roma "La Sapienza", Roma, Italia
Pablo E. Penchaszadeh	Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina
Winston F. Ponder	Australian Museum, Sydney, Australia
Carlos Enrique Prieto Sierra	Universidad del País Vasco, Bilbao, España
Mª de los Ángeles Ramos Sánchez	Museo Nacional de Ciencias Naturales, CSIC, Madrid, España
Francisco Javier Rocha Valdés	Instituto de Investigaciones Marinas, CSIC, Vigo, España
Paul G. Rodhouse	British Antarctic Survey, Cambridge, Reino Unido
Joandomènec Ros i Aragones	Universidad de Barcelona, Barcelona, España
María Carmen Salas Casanovas	Universidad de Málaga, Málaga, España
Gerhard Steiner	Institut für Zoologie der Universität Wien, Viena, Austria
Victoriano Urgorri Carrasco	Universidad de Santiago de Compostela, Santiago de Compostela, España
Anders Warén	Swedish Museum of Natural History, Estocolmo, Suecia

PORTADA DE *Iberus*

Iberus gualtieranus (Linnaeus, 1758), una especie emblemática de la península Ibérica, que da nombre a la revista. Dibujo realizado por José Luis González Rebollar "Toza".

Iberus

REVISTA DE LA
SOCIEDAD ESPAÑOLA
DE MALACOLOGÍA

Vol. 28 (1) **Oviedo, junio 2010**

Iberus

Revista de la

SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

Iberus publica trabajos que traten sobre cualquier aspecto relacionado con la Malacología. Se admiten también notas breves. *Iberus* edita un volumen anual que se compone de dos o más números.

INSTRUCCIONES PARA LOS AUTORES

Los manuscritos deben remitirse a: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, España.

Los trabajos se entregarán por triplicado (original y dos copias). Se recomienda a los autores leer cuidadosamente las normas de publicación que se incluyen en cada número de la revista.

SUBCRIPCIONES

Iberus puede recibirse siendo socio de la Sociedad Española de Malacología, en cualquiera de sus formas, o mediante intercambio. Aquellos socios que deseen adquirir números atrasados deberán dirigirse al bibliotecario.

Los no socios deberán ponerse en contacto con BACKHUYS PUBLISHERS, P.O. Box 321, 2300 AH Leiden, The Netherlands. Tel.: +31-71-51 70 208, Fax: +31-71-51 71 856, Correo Electrónico: backhuys@euronet.nl

Los resumenes de los artículos editados en esta revista se publican en Aquatic Science and Fisheries Abstracts (ASFA) y en el Zoological Records, BIOSIS.

Contents list published in Aquatic Science and Fisheries Abstracts and Zoological Records, BIOSIS.

Dep. Leg. B-43072-81
ISSN 0212-3010
Diseño y maquetación: Gonzalo Rodríguez
Impresión: LOREDO, S. L. - Gijón

© *Sociedad Española de Malacología* — *Iberus*, 28 (1): 1-11, 2010

Reproduction du mollusque envahisseur *Corbicula fluminea* (O. F. Müller, 1774) (Bivalvia: Corbiculidae) et recrutement et distribution de ses juvéniles dans un canal de la région toulousaine (France)

Reproducción del molusco invasor *Corbicula fluminea* (O. F. Müller, 1774) (Bivalvia: Corbiculidae) y reclutamiento y distribución de sus juveniles en un canal la región de Toulouse (France)

Charles DUBOIS et Alberto MARTÍNEZ-ORTÍ*

Recibido el 13-V-2009. Aceptado el 6-X-2009

RÉSUMÉ

Les données recueillies sur un cycle d'un an (mars 1993 – mars 1994) concernant l'incubation des larves et le recrutement des juvéniles du *Corbicula fluminea*, bivalve d'origine asiatique introduites en Europe, sont présentées pour deux habitats différents (milieu du canal et herbiers) d'un même site du Canal Latéral, près de Toulouse. La présence de larves incubées au niveau des hémibranchies internes des adultes est observée durant 5 mois: de mi-mai à mi-octobre, où deux périodes d'incubation se dégagent. Le nombre de larves incubées s'élève à plusieurs milliers et se trouve proportionnel à la taille de la coquille des adultes. Le recrutement des juvéniles de taille comprise entre 1,5 et 2,5 mm s'observe du mois d'août au mois de juin de l'année suivante, où l'on peut également distinguer deux périodes: une première s'étalant d'août à novembre et une seconde débutant en décembre jusqu'à juin. Selon l'habitat considéré, ces périodes de recrutement ont une importance relative très différentes: la première (fin été – automne), quasi-inexistante au niveau des herbiers, est importante dans la zone profonde. Inversement, lors de la seconde (hivers – début printemps), le nombre de juvéniles par rapport au nombre d'adultes est plus fort au niveau des herbiers. Cette différence dans le recrutement suggère une migration ou une dispersion de la part de ces petits individus, notamment durant la saison chaude où de nombreux bateaux naviguent, créant des remous importants.

ABSTRACT

Data obtained over a cycle of one year (March 1993 – March 1994) regarding the incubation of the larvae and the recruitment of the juveniles of *Corbicula fluminea*, bivalve of Asian origin introduced in Europe, are shown for two different habitats (middle part of the channel and vegetated area) of the same area of the Canal Latéral, near Toulouse (France). The presence of incubated larvae in the inner demibranchs of the adults has been observed during five months: from mid May to mid October, in which there are two different periods of incubation. The number of incubated larvae amounts to several thousands and is proportional to the shell size of the adults. The recruitment of the juveniles of size between 1.5 and 2.5 mm is observed between August and June of the following

---

* Departament de Zoologia. Facultat de Ciències Biològiques. Universitat de València. c/. Dr. Moliner, 50. E-46100 Burjassot (Valencia, Espagne) et Museu Valencià d'Història Natural.

year, where two periods can also be distinguished: the first one from August to November and the second one from December until June. According to the considered habitat, these periods of recruitment have a very different importance: the first one (end of summer – autumn), almost non-existent at the vegetated level, is important in the deep zone. On the contrary, in the second one (winter – beginning of spring), the number of juvenile in relation to the number of adults is higher in the vegetated area. This difference in the recruitment suggests a migration or dispersion of these small individuals, particularly during the warm season where a large number if boats are sailing, which can create important eddies in the water column.

RESUMEN

Se muestran los datos obtenidos durante un ciclo de un año (marzo 1993 – marzo 1994) sobre la incubación de las larvas y el reclutamiento de los juveniles de *Corbicula fluminea*, bivalvo de origen asiático introducido en Europa, se muestran en dos hábitats diferentes (centro del canal y zona lateral con vegetación) de un mismo lugar del Canal Latéral, cerca de Toulouse (Francia). Se ha observado la presencia de larvas incubadas en las hemibranquias internas de los ejemplares adultos durante cinco meses: desde mitad de mayo a mitad de octubre, existiendo dos periodos diferentes de incubación. El número de larvas incubadas es de varios miles y es proporcional al tamaño de la concha de los adultos. El reclutamiento de los juveniles, de tamaño comprendido entre 1,5 y 2,5 mm, se observa entre los meses de agosto y junio del año siguiente, donde se pueden igualmente distinguir dos periodos: el primero desde agosto a noviembre y el segundo desde diciembre hasta junio. Según el hábitat considerado, estos periodos de reclutamiento tienen una importancia relativa muy diferente: el primero (final del verano – otoño), casi inexistente al nivel de la zona de vegetación, es importante en la zona profunda. Inversamente, en el segundo periodo (invierno – comienzo de la primavera), el número de juveniles en relación al número de adultos es más elevado en la zona de vegetación. Esta diferencia en el reclutamiento sugiere una migración o una dispersión de parte de estos pequeños individuos, especialmente durante la estación cálida, cuando numerosos barcos navegan por el canal creando importantes remolinos en la columna de agua.

INTRODUCTION

Au début des années 1980, la présence du bivalve envahisseur *Corbicula fluminea* (O.F. Müller, 1774) (Fig. 1A), d'origine asiatique, fut signalée en Europe occidentale pour la première fois (Mouthon, 1981). A l'heure actuelle, de nombreux cours d'eau européens hébergent ce mollusque, qui fut décrit comme une véritable peste aux Etats-Unis dont la colonisation remonte aux années 1930 (Isom, 1986): le fleuve Rhin aux Pays-Bas (Bij de Vaate et Greijdanus-Klaas, 1990), en Allemagne (Bij de Vaate, 1991; Den Hartog, Van den Brink et Van der Velde, 1992), en Belgique (Swinnen, Leynen, Sablon, Duvivier et Vanmaele, 1998), en Pologne (Domagala, Labecka, Pilecka-Rapacz et Migdalska, 2004; Labecka, Domagala et Pilecka-Rapacz, 2005), en République Tchèque (Beran, 2006) et au Royaume Uni (Baker, Clarke et Howlett, 1999; Aldridge et Müller, 2001). En France les fleuves Dordogne, Loire, Garonne, Rhône, Seine, l'Adour, le Lot, le Canal du Midi et le Canal Latéral, le Tarn et l'Aude (Mouthon, 1981; Girardi, 1989; Tourenq. et Pujol, 1991; Gruet, 1992; Dubois, 1995a, 1995b; Dubois et Tourenq, 1995; Dubois et Origny, 1998; Mouthon, 2001a, 2001b, 2003). En Espagne, la rivière Miño, le Guadalquivir, l'Ebre, le Guadiana et le Piedras sont également colonisées (Pérez-Quintero, 1990, 2008; Araujo, Moreno et Ramos, 1993), ainsi que l'estuaire du Tage, le Duero et les affluents de Guadiana au Portugal (MOUTHON, 1981; ARAUJO *ET AL.*, 1993; PÉREZ-QUINTERO, 2008). ARAUJO *ET AL.* (1993) jugent que seul *C. fluminea* colonise les cours d'eaux français et espagnols.

C. fluminea incube les larves au niveau des hémibranchies internes des adultes (Fig. 1B) jusqu'à leur libération en pleine eau où elles se dispersent par flottaison (PRETZANT ET CHALERMWAT, 1984; DUBOIS, 1995a, 1995b).

L'objet de cette publication s'inscrit dans l'étude de la dynamique des populations et dans l'analyse des modalités de dispersion à l'échelle saisonnière de *C. fluminea*, menées dans le Canal Latéral, au nord de Toulouse (FRANCE) (SITE DE LALANDE). DUBOIS ET TOURENQ (1995) ont réalisé une étude préliminaire sur la zone profonde du même Canal toulousaine qui nous continuons et nous présentons ici les données recueillies en 1993-94 concernant la reproduction et le recrutement des juvéniles des deux sous-populations benthiques: celle habitant les bords du canal, colonisé par des macrophytes immergés et celle habitant le sédiment de la zone profonde; ainsi que la répartition inter et intra-habitat

MATÉRIEL ET MÉTHODES

Le Canal Latéral, qui relie Toulouse à Bordeaux (France), a une largeur d'une vingtaine de mètres et une profondeur de 2,5 m au centre du lit. Les bords, sur une largeur d'environ 1,5 m, sont peu profonds (0,5 m à 0,8 m) et sont colonisés d'herbiers de macrophytes immergés (*Vallisneria spiralis* L.).

Les 10 premiers centimètres de sédiment sont composés de vase, très enrichie en débris organiques (feuilles en décomposition, essentiellement de platanes, qui bordent le canal). Plus profondément, le sédiment est un limon argileux progressivement réduit (sur environ 15 cm), reposant sur une couche d'argile imperméable.

La vitesse du courant, relativement constante, s'élève à 7 cm/s en moyenne. La température à la mi-journée varie entre 6 °C (janvier) et 25 °C (août); la température maximale relevée étant de 27°C.

Pour l'étude de la reproduction nous avons prélevé dans les herbiers, tous les 15 jours, 20 à 30 individus adultes [dont la longueur antéro-postérieure maximale L est supérieure à 10 mm, d'après ALDRIGE ET MC MAHON (1978)], de manière à suivre le nombre de larves incubées dans les hémibranchies internes (Fig. 1B). Pour cela, les spécimens sélectionnés ont été fixés au formol (à 10 %), puis disséqués: une hémibranchie interne par individu a été prélevée et délicatement lacérée afin de recueillir les larves. Celles-ci sont alors maintenues en suspension dans un volume d'eau distillée. Des échantillons (en général 5) de 4 ml sont prélevés (à l'aide d'une seringue graduée), les larves dénombrées et le nombre total incubé est estimé. De cette manière, l'erreur standard (SE= $\sqrt{}$ (s^2/n) avec s^2= variance, n= nombre d'échantillons) par rapport à la moyenne n'excède jamais 5% pour un adulte gravide.

Pour le suivi de la structure de la population, des prélèvements quantitatifs ont été effectués à l'aide d'une benne de type Eckman (surface= 225 cm^2) pénétrant à une profondeur d'environ 10 cm dans le sédiment. A chaque campagne de terrain (une fois par mois), 6 échantillons de 2 bennes ont été récoltés dans les herbiers et 8 échantillons de 4 bennes le long d'un transect dans la zone profonde (sauf cas particuliers, *cf* Tableau I). Au laboratoire, les individus sont triés du matériel retenu et mesurés (L= longueur antéropostérieure maximale, à 0,1 mm près) sous une loupe binoculaire pour L<10 mm (grossissement x10, précision: 0,05 mm) ou avec un pied-à-coulisse pour L>10 mm (précision: 0,02 mm). Les plus petits spécimens considérés ont une taille de 1,5 mm, et nous prendrons en compte dans ce travail que des juvéniles de taille comprise entre 1,5 et 2,5 mm.

RÉSULTATS

Figure 1. *Corbicula fluminea* du Canal Latéral (Toulouse, France). A. Coquille (24,2 mm de largeur). B. Hémibranchie interne avec des larves.
Figura 1. Corbicula fluminea *del Canal Latéral (Toulouse, Francia). A. Concha (24,2 mm longitud). B. Hemibranquia interna mostrando las larvas incubadas.*

Incubation des larves

La période d'incubation des larves dans les hémibranchies internes des adultes dure 5 mois, de la mi-mai à la mi-octobre (Fig. 2). Nous pouvons discerner 3 pics de fort taux d'incubation (TI= proportion d'adultes incubant des larves, en %): un premier couvrant le mois de juin (TI maximal= 90,5%) et les deux suivants (TI maximal= 80,0% et 66% respectivement) qui couvrent les mois d'août et septembre (Fig. 2).

Sur l'ensemble de la période d'incubation, le nombre de larves est très

Tableau 1. Densité des juvéniles (1,5 – 2,5 mm) aux différentes dates de prélèvement. Ne= nombre d'échantillons; Nb= nombre de bennes pour un échantillon; dens= densité en ind./m^2; SE= erreur standard relative (en %).

Tabla 1. Densidad de juveniles (1,5 – 2,5 mm) en diferentes periodos de recolección. Ne= número de muestras; Nb= número de dragas por muestra; dens= densidad en ind./m^2; SE= error estándar relativo (en %).

ZONE PROFONDE					HERBIERS				
Date	**Ne**	**Nb**	**dens**	**SE (%)**	**Date**	**Ne**	**Nb**	**dens**	**SE(%)**
23.03.93	4	5	120	26,3	23.03.93	1	5	2027	-
20.04.93	8	4	178	15,3	30.04.93	5	2	876	11,9
18.05.93	8	4	143	21,8	28.05.93	6	2	1178	11,3
22.06.93	8	4	46	16,1	28.06.93	6	2	159	33,5
20.07.93	8	4	0	0,0	27.07.93	6	2	59	46,1
23.08.93	6	4	254	22,6	30.08.93	6	2	48	49,7
20.09.93	8	4	340	16,4	28.09.93	6	2	385	31,5
18.10.93	8	4	413	14,4	26.10.93	6	2	122	38,9
24.11.93	8	4	182	16,6	29.11.93	6	2	81	15,2
-	-	-	-	-	29.12.93	6	2	215	28,5
17.01.94	8	4	265	14,4	02.02.94	6	2	911	23,6

variable. Le nombre moyen par hémibranchie de larves trouvées dans un exemplaire adulte de taille moyenne est de 2114 (Fig. 3). Cependant, le maximum observé est proportionnel à la taille de l'individu mature considéré. De sorte que nous avons pu établir la relation:

$$Nm = -8568 + 691\,L\,(mm) \quad (1)$$

où:

Nm= nombre maximal théorique de larves par hémibranchie interne.

L (mm)= taille (en mm) de l'adulte considéré.

Parmi les adultes gravides, nous avons alors calculé le "taux moyen de remplissage hémibranchial" (TRHg) à chaque date de prélèvement. Nous définissons TRHg comme la moyenne, sur l'ensemble des individus gravides d'un prélèvement, du pourcentage observé par rapport au nombre maximal théorique:

$$TRHg = 1 / n \sum_{i=1}^{n} (Ni / Nmi)$$

avec:

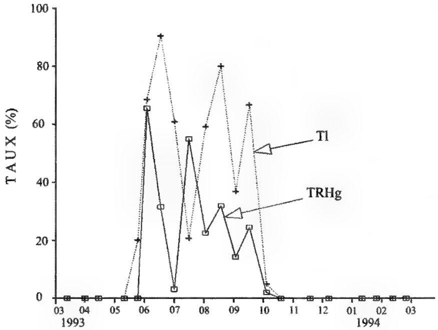
n= nombre d'adultes gravides i observé.

Ni= nombre observé de larves incubées par hémibranchie interne de l'adulte i.

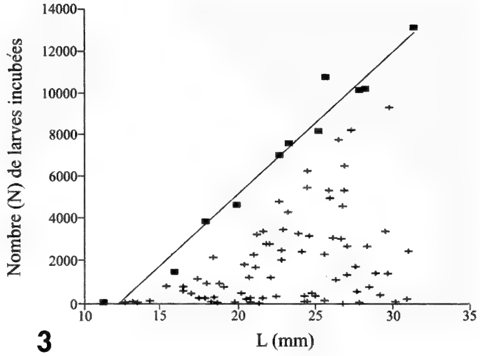
Nmi= nombre maximal théorique de larves incubées par hémibranchie interne de l'adulte i, obtenu d'après (1).

Pour un prélèvement, nous pouvons considérer que le taux moyen de remplissage hémibranchial est indépendant de la structure fréquence-taille de l'échantillon (la proportion Ni/Nmi est indépendante de la taille, contrairement à Ni), si bien que les valeurs TRHg sont immédiatement comparables entre elles (Fig. 3), et peuvent être directement appliquées à la population (dont la structure est différente de celle des échantillons).

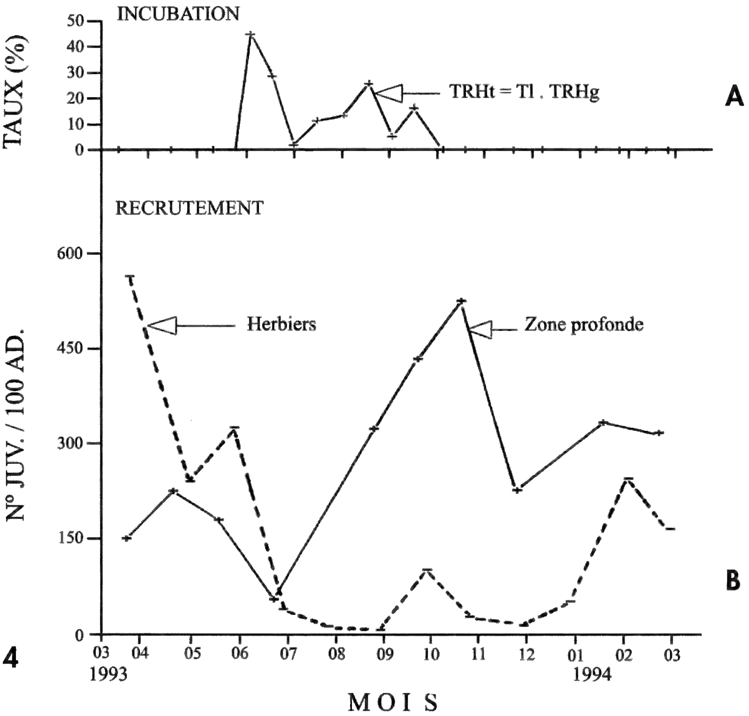
Le taux moyen de remplissage TRHg connaît une évolution similaire à celle du taux d'incubation TI, avec deux périodes qui se dégagent (Fig. 2): une première couvrant le mois du juin (TRHg maximal= 65,5 %), et une seconde comprenant plusieurs pics, de juillet (TRHg maximal= 54,9%) à début



2



3



4

Figure 2. Evolution temporelle du taux d'incubation (TI, en %) et l'indice de remplissage hémibranchial des adultes gravides (TRHg, en %). Figure 3. Nombre de larves incubées en fonction de la taille des adultes gravides. Les carrés noirs représentent les valeurs maximales observées, à partir desquelles fut établie la régression linéaire. Figure 4. A: Evolution temporelle de l'indice de remplissage hémibranchial de la population totale d'adultes (TRHt, en %); B: Evolution temporelle du nombre de juvéniles de la première classe de taille (1,5-2,5 mm) rapportée au nombre d'adultes, au niveau des herbiers et de la zone profonde.

Figura 2. Evolución temporal de la tasa de incubación (TI, en %) y el índice de rellenado hemibranquial de los adultos grávidos (TRHg, en %). Figura 3. Número de larvas incubadas respecto al tamaño de los adultos grávidos. Los cuadros negros representan los valores máximos observados, a partir de los cuales se estableció la regresión lineal. Figura 4. A: Evolución temporal del índice de rellenado hemibranquial de la población total de adultos (TRHt, en %); B: Evolución temporal del número de juveniles de la primera clase de tamaño (1,5-2,5 mm) en función del número de adultos, a nivel de la vegetación y de la zona profunda.

Tableau II. Paramètres de la relation puissance de Taylor: $S^2= aX^b$. L'indice d'agrégation "b" est donné avec un intervalle de confiance de 95%. R^2= coefficient de variation; p= niveau de probabilité du test de Student.

Tabla II. Parámetros de la relación de Poder de Taylor: $S^2= aX^b$. El índice de agregación "b" se da con un intervalo de confianza del 95%). R^2= coeficiente de variación; p= nivel de probabilidad del test de Student.

Habitat	a	b	R^2	p
Zone profonde	0,415	1,886 ± 0,288	0,954	< 0,005
Herbiers	12,779	1,355 ± 0,407	0,826	< 0,005

octobre où TRHg diminue progressivement.

Le décalage que l'on observe entre les deux courbes résulte de l'asynchronisme dans la reproduction entre les individus.

Ceci rend difficile l'estimation du temps d'incubation des larves, mais on peut considérer cependant qu'il est inférieur ou égal au pas de temps choisi –15 jours– puisqu'on observe de grosses variations entre certaines dates successives.

Le produit de ces deux courbes (Fig. 4A) donne l'évolution du taux moyen de remplissage hémibranchial de la population entière d'adultes (gravides et non-gravides: THRt= TI x TRHg).

Recrutement et distribution des juvéniles

Nous donnons l'évolution de la densité benthique des plus petits juvéniles considérés: dont la taille est comprise entre 1,5 et 2,5 mm, dans la zone profonde du canal et au niveau des herbiers à *Vallisneria* (Fig. 4B).

La densité des adultes (L>10 mm) est très différente selon l'habitat: elle s'élève, en moyenne sur l'ensemble des prélèvements, à 78 ± 5 ad./m^2 en zone profonde et à 359 ± 32 ad./m^2 au niveau des herbiers. Ainsi, nous exprimons (Fig. 4B) la densité des juvéniles en nombre pour 100 adultes (juv./100 ad.) de manière à comparer les évolutions du recrutement dans les deux habitats (les densités exprimées en nombre par m^2 sont données Tableau I).

Dans la zone profonde, on observe trois pics de recrutement d'importance décroissante. Le premier pic (octobre) correspond au recrutement des juvéniles issus de la première période d'incubation (juin). Ce recrutement débute dès le mois d'août et s'étale jusqu'au mois de novembre. Les pics suivants (janvier et avril) correspondent au recrutement issu de la seconde période d'incubation (mi-juillet – fin septembre) et s'étale de décembre à juin (Fig. 4B).

Au niveau des herbiers, le recrutement des juvéniles issus de la première période d'incubation s'étend de fin septembre à début octobre, et est très peu marqué (densité maximale= 107 juv./100 ad.) par rapport à celui observé en zone profonde (densité maximale= 529 juv./100 ad., avec une amplitude plus forte). Le recrutement correspondant à la seconde période d'incubation apparaît début janvier et s'étale jusqu'au mois de juin. Cette phase de recrutement possède à peu près la même amplitude que celle observée en zone profonde, mais elle est cette fois-ci d'intensité supérieure (les densités maximales s'élèvent à 565 juv./100 ad. au niveau des herbiers et 340 juv./100 ad. en zone profonde) (Fig. 4B).

Nous donnons les erreurs standards obtenues par rapport aux densités moyennes des juvéniles considérés (SE en %) à chaque prélèvement (Tableau I). Au niveau des herbiers, ces valeurs sont en moyenne plus fortes et augmentent (globalement) lorsque la densité diminue, ce qui n'est pas le cas en zone profonde.

De manière à savoir si ces variations traduisent une variation de la répartition au sein d'un même habitat (au cours du cycle) et comparer les résultats entre herbiers et zone profonde, nous avons appliqué la loi de puissance de TAYLOR (1961): $S^2= a.X^b$, où S^2 est la variance et X la moyenne.

Cette loi générale s'applique à une grande gamme de taille de surface d'échantillonnage (PALOHEIMO ET VUKOV, 1976; TAYLOR, WOIWOD ET PERRY, 1978). L'exposant b traduit le degré de contagion et peut donc être assimilé à un indice d'agrégation :

lorsque b= 1, la distribution est au hasard.

lorsque b< 1, il y a tendance vers une distribution uniforme (quand b diminue).

lorsque b> 1, il y a tendance vers une distribution contagieuse (quand b augmente).

Le terme constant a est plus difficile à interpréter et dépend des conditions d'échantillonnage (DOWNING, 1979). Cependant, toutes choses égales par ailleurs, le terme a est d'autant plus fort que SE est important (c'est-à-dire que S^2 est grand devant X).

Cette analyse (Tableau II) nous permet de conclure que, pour les deux habitats, la répartition des juvéniles est constante au cours de l'année puisque les régressions puissances sont statistiquement significatives (p< 0,005). Aussi, ces répartitions sont contagieuses (b> 1 dans les deux cas) et le degré de contagion est plus fort en zone profonde (b= 1,886) qu'au niveau des herbiers (b= 1,355). Cependant, il semble que l'échantillonnage des juvéniles considérés soit de moins bonne qualité dans les herbiers que dans la zone profonde, au regard de la constante a (Tableau II), ce qui réduit la puissance de l'affirmation précédente.

DISCUSSION

D'après la littérature, nous savons que *C. fluminea* est une espèce hermaphrodite simultanée. Les spermatozoïdes sont émis dans le milieu aquatique, mais la fécondation a lieu, au niveau des hémibranchies internes. Les zygotes s'y développent, puis sont libérés au premier stade juvénile avec une taille d'environ 220 µm (BRITTON ET MORTON, 1979; KRAEMER ET GALLOWAY, 1986; RAJAGOPAL, VAN DER VELDE ET BIJ DE VAATE, 2000).

Deux périodes de reproduction, c'est-à-dire d'émission des spermatozoïdes, ont été observées chez cette espèce: l'une au printemps – début été, lorsque la température augmente sensiblement; l'autre à la fin de l'été – automne lorsque la température, alors forte et stable, commence à diminuer. Plus précisément, c'est la spermatogénèse qui est amorcée par ces variations de température, alors que l'ovogénèse est continue tout au long de l'année (avec un ralentissement en hiver) chez les individus adultes (KRAEMER *ET AL.*, 1986).

Notre étude sur le suivi du taux d'incubation et du taux moyen de remplissage hémibranchial permet de distinguer en effet deux périodes: l'une, intense, durant le mois de juin et l'autre s'étalant de mi-juillet à début octobre, présentant plusieurs pics, où le nombre de larves incubées décroît progressivement (Fig. 2). Par contre, la relation avec la température n'est pas claire puisque la seconde période d'incubation est amorcée en juillet, alors que les températures maximales sont atteintes au mois d'août.

Cependant ces deux périodes sont très proches dans le temps, si bien que leur distinction est délicate, compte tenu, de plus, de l'asynchronisme entre les individus. Aussi, le nombre et la distinction des périodes d'incubation dépendent du pas de temps choisi pour les prélèvements (15 jours dans notre étude) par rapport au temps d'incubation.

En laboratoire, KING, LANGDON ET COUNTS (1986) et KORNIUSHIN ET GLAUBRECHT (2003) ont observé que les larves sont libérées après 4 à 5 jours d'incubation. Par contre, ENG (1979) estime, au cours d'une étude en milieu naturel, que la durée d'incubation s'élève à 1 mois, mais doit dépendre des conditions environnementales. D'après nos données, il est clair que cette durée est inférieure à 1 mois, et probablement inférieure à 15 jours. Ainsi, la première période d'incubation dériverait d'une phase d'émission de spermatozoïdes, alors que la seconde résulterait de plusieurs phases d'émission, avec un asynchronisme marqué (Figs. 3 et 4A), ce qui est conforme aux observations de KRAEMER ET GALLOWAY (1986).

En ce qui concerne le recrutement des juvéniles considérés (1,5–2,5 mm), la comparaison des courbes de densité (Fig. 4B) indique que les maxima – en octobre en zone profonde et en mars dans les herbiers – sont de même ordre de grandeur: respectivement 529 et 565 juv. / 100 ad., c'est-à-dire que l'on retrouve au mieux 5 à 6 juvéniles de cette classe de taille par adulte, alors que des milliers de larves sont incubées puis libérées. Ce nombre de juvéniles libérés par adultes a été estimé dans un lac américain (Lake Arlington, Texas) à 387 par jour durant la première période de reproduction et à 320 par jour durant la seconde (ALDRIDGE ET MC MAHON, 1978).

Aussi, ces courbes montrent cette opposition dans l'importance relative des deux phases de recrutement: la première phase est quasi-inexistante au niveau des herbiers et très intense en zone profonde; la seconde phase, de forte amplitude, est moins intense dans la zone profonde que dans les herbiers. L'apparition tardive (mi-décembre environ) et l'étendue de cette seconde phase de recrutement s'explique par la faible croissance individuelle annuelle (DUBOIS ET TOURENQ, 1995).

Il est probable que l'opposition de phase observée soit le résultat de migration ou dispersion des juvéniles, dont certains mécanismes sont connus. Nous savons en effet que les petits individus peuvent développer un filament de type « byssus » leur permettant de s'attacher, notamment à des particules qui peuvent être mises en suspension dans l'eau (KRAEMER, 1979). Aussi, ces organismes ont la capacité de sécréter un filament muqueux, conduit par le siphon exhalant, qui leur permet de flotter en pleine eau (en abaissant la densité corporelle). Cette sécrétion est stimulée, en aquarium, par le courant à partir de vitesses de 10 à 20 cm/s (PREZANT ET CHALERMWATT, 1984).

La vitesse du courant dans le Canal Latéral est certes faible (7 cm/s en moyenne), mais en saison estivale, un grand nombre de bateaux de plaisance naviguent, créant un remous important qui peut être à l'origine d'une dispersion (Neck, 1986). Enfin, il a également été mis en évidence une forte capacité de la part de *C. fluminea* à se mouvoir sur le substrat dans un courent artificiel: 250 cm/h pour des individus de taille inférieure à 2 mm (KRAEMER, 1979).

Les résultats concernant la répartition intra-habitat indiquent que celle-ci est constante tout au long de l'année aussi bien dans les herbiers qu'en zone profonde, en dépit des variations de densité dues au recrutement. Les indices de contagion calculés (Tableau II) sont du même ordre de grandeur que ceux obtenus par DOWNING (1979) à partir de couples de données (S^2, X) tirées de la littérature: b= 1,496 (a= 7,87) pour divers bivalves (138 données); b= 1,462 (a= 5,24) pour les invertébrés benthiques en général (1462 données).

Cependant, il semble que le degré d'agrégation soit plus important en zone profonde (b= 1,886) qu'au niveau des herbiers (b= 1,355). Nous avons en effet observé (non quantifié) que le sédiment récolté n'était pas toujours homogène (pour la granulométrie ou la teneur en débris organiques) le long d'un transept dans la zone profonde, ce qui peut augmenter le degré de contagion. A l'inverse, les zones à herbiers sont très homogènes quant à la nature du sédiment et la densité de *Vallisneria*.

REMERCIEMENTS

Au Dr. Rafael Araujo du Museo Nacional de Ciencias Naturales de Madrid pour la révision critique du manuscrit et au Dr. Jean Noël Tourenq du Laboratoire d'Hydrobiologie à la Université Paul Sabatier de Toulouse, ainsi que pour son aide sur le terrain. Aux techniciens de la Section de Microscopie Electronique du S.C.S.I.E. de l'Universitat de València, pour leur aide à l'utilisation du M.E.S Hitachi S- 4100.

RÉFÉRENCES BIBLIOGRAPHIQUES

ALDRIDGE D.W. ET MC MAHON R.F. 1978. Growth, fecundity and bioenergetics in a natural population of the Asiatic freshwater clam *Corbicula manilensis* Philippi, from North Central Texas. *Journal of Molluscan Studies*, 44: 49-70.

ALDRIDGE D.C. ET MÜLLER S. 2001. The Asiatic clam, *Corbicula fluminea*, in Britain: current status and potential impacts. *Journal of Conchology*, 37(2): 177-183

ARAUJO R., MORENO D. ET RAMOS M.A. 1993. The Asiatic clam *Corbicula fluminea* (Müller, 1774) (Bivalvia: Corbiculidae) in Europe. *American Malacological Bulletin*, 10: 39-49.

BAKER R., CLARKE K. ET HOWLETT D. 1999. The Asiatic clam *Corbicula fluminea* (Müller) new to the U.K. *Transactions of the Norwich Naturalists' Society*, 31: 70-76.

BERAN L. 2006. Spreading expansion of *Corbicula fluminea* (Mollusca: Bivalvia) in the Czech Republic. *Heldia*, 6(3-4):187-192.

BIJ DE VAATE A. 1991. Colonization of the German part of the river Rhine by the Asiatic clam, *Corbicula fluminea* Müller, 1774 (Pelecypoda, Corbiculidae). *Bulletin Zoölogisch Museum Universiteit van Amsterdam*, 13: 13-16.

BIJ DE VAATE A. ET GREIJDANUS-KLASS M. 1990. The Asiatic clam, *Corbicula fluminea* (Müller, 1774) (Pelecypoda, Corbiculidae), a new immigrant in the Netherlands. *Bulletin Zoölogisch Museum Universiteit van Amsterdam*, 12: 173-177.

BRITTON J.C. ET MORTON B. 1979. *Corbicula* in North America: the evidence reviewed and evaluated. In: J.C. Britton (ed.), *Proceedings First International Corbicula Symposium, Texas Christian University, Fort Worth, Texas*: 249-287.

DEN HARTOOG C., VAN DEN BRINK F.W.B. ET VAN DER VELDE G. 1992. Why was the invasion of the River Rhine by *Corophium curvispinum* and *Corbicula* species so successful?. *Journal of Natural History*, 26: 1121-1129.

DOMAGALA J., LABECKA A.M., PILECKA-RAPACZ M. ET MIGDALSKA B. 2004. *Corbicula fluminea* (O.F. Müller, 1774) (Bivalvia, Corbiculidae) a species new to the polish malacofauna. *Folia Malacologica*, 12(3):145-148.

DOWNING J.A. 1979. Aggregation, transformation and the design of benthos sampling programs. *Journal of the Fisheries Research Board of Canada*, 36. 1454-1463.

DUBOIS C. 1995a. *Biologie et démo-écologie d'une espèce invasive, Corbicula fluminea (Mollusca: Bivalvia) originaire d'Asie: Etude in situ (Canal Latéral à la Garonne, France) et en canal expérimental*. Thèse de Doctorat. Université de Toulouse. 1-169 pp. Toulouse.

DUBOIS C. 1995b. *Corbicula fluminea*: un mollusque opportuniste. *Revue Agence de l'Eau Adour-Garonne*, 63: 13-16.

DUBOIS C. ET TOURENQ J.N. 1995. Étude préliminaire dynamique des populations de *Corbicula fluminea* (Bivalvia: Corbiculidae) dans la zone profonde d'un canal de la région toulousaine (France). *Hydroécologie appliquée*, 7(1-2): 19-28..

DUBOIS C. ET ORIGNY R. 1998. *Corbicula fluminea* (O.F. Müller, 1774). Un mollusque bivalve venant d'Asie, trouvé dans le Cher. *Bulletin de la Société des Sciences Naturelles de Touraine*, 1997: 49-59.

ENG L.L. 1979. Population dynamics of the Asiatic clam, *Corbicula fluminea* (Müller), in the Concrete-lined Delta Mendota Canal of Central California. In: J.C. Britton (ed.), *Proceedings First International Corbicula Symposium, Texas Christian University, Forth Worth, Texas*: 39-68.

GIRARDI H. 1989. Deux bivalves d'eau douce récents pour la faune française (Mollusca, Bivalvia). *Bulletin de la Société d'Étude des Sciences Naturelles du Vaucluse*, 2: 87-93.

GRUET Y. 1992. Un nouveau mollusque bivalves pour notre région: *Corbicula* sp. (Heterodonta: Sphaeriacea). *Bulletin de la Société des Sciences Naturelles de l'Ouest de la France*, 14: 37-43.

ISOM B.G. 1986. Historical review of Asiatic clam (*Corbicula*) invasion and biofouling of waters and industries in the Americas. In: *J.C. Britton (ed.), Proceedings 2nd Int. Corbicula Symposium, American Malacological Bulletin*, special edition 2: 1-5.

KING C.A., LANGDON C.J. ET COUNTS C.L. 1986. Spawning an early development *Corbicula fluminea* (Bivalvia: Corbiculidae) in laboratory culture. *American Malacological Bulletin*, 4: 81-88.

KRAEMER L.R. 1979. Juvenile *Corbicula*: their distribution in the Arkansas River benthos. In: J.C. Britton (ed.), *Proceedings First International Corbicula Symposium, Texas Christian University, Fort Worth, Texas*: 89-97.

KRAEMER L.R. ET GALLOWAY M.L. 1986. Larval development of *Corbicula fluminea* (Müller) (Bivalvia: Corbiculacea): an appraisal of its heterochrony. *American Malacological Bulletin*, 4: 61-71.

KRAEMER L.R., SWANSON C., GALLOWAY M. ET KRAEMER R. 1986. Biological basis of behaviour in *Corbicula fluminea* II. Funtional morphology of reproduction and development and review of evidence for self-fertilitation. In: J.C. Britton (ed.), *Proceedings of 2nd International Corbicula Symposium, American Malacological Bulletin*, special edition 2: 193-201.

LABECKA A.M., DOMAGALA J. ET PILECKA-RAPACZ M. 2005. First record of *Corbicula fluminea* (O.F. Müller, 1774) (Bivalvia: Corbiculidae) in Poland. *Folia Malacologica*, 13(1): 25-27.

KORNIUSHIN A.V. ET GLAUBRECHT M. 2003. Novel reproductive modes in freshwater clams: brooding and larval morphology in Southeast Asian taxa of *Corbicula* (Mollusca, Bivalvia, Corbiculidae). *Acta Zoologica*, 84: 293-315.

MOUTHON J. 1981. Sur la présence en France et au Portugal de *Corbicula* (Bivalvia: Corbiculidae) originaire d'Asie. *Basteria*, 45: 109-116.

MOUTHON J. 2001a. Life cycle and population dynamics of the Asian clam *Corbicula fluminea* (Bivalvia: Corbiculidae) in the Saone River at Lyon (France). *Hydrobiologia*, 452(1-3): 109-119.

MOUTHON J. 2001b. Life cycle and population dynamics of the Asian clam *Corbicula fluminea* (Bivalvia: Corbiculidae) in Rhône River at Creys-Malville (France). *Archiv für Hydrobiologie*, 151(4): 571-589.

MOUTHON J. 2003. Longitudinal and temporal variations of density and size structure of *Corbicula fluminea* (Bivalvia) populations in the Saône and Rhône rivers (France). *Annales de Limnologie*, 39(1): 15-25.

NECK R.W. 1986. *Corbicula* in public recreation waters of Texas: habitat spectrum and clam-human interactions. In: J.C. Britton (ed.), *Proceedings 2nd International Corbicula Symposium, American Malacological Bulletin*, 2: 179-184.

PALOHEIMO J.E. ET VUKOV A.M. 1976. On measures of aggregation and indices of contagion. *Mathematical Biosciences*, 30: 69-97.

PÉREZ-QUINTERO J.C. 1990. Primeros datos sobre la presencia de *Corbicula fluminea* Müller (Bivalvia, Corbiculidae) en España. Biometría. *Scientia Gerundensis*, 16(1): 175-182.

PÉREZ-QUINTERO J.C. 2008. Revision of the distribution of *Corbicula fluminea* (Müller 1744) in the Iberian Peninsula. *Aquatic Invasions*, 3(3): 355-358.

PREZANT R.S. ET CHALERMWAT K. 1984. Flotation of the bivalve *Corbicula fluminea* as a means of dispersal. *Science*, 225: 1491-1493.

RAJAGOPAL S., VAN DER VELDE G. ET BIJ DE VAATE A. 2000. Reproductive biology of the Asiatic clams *Corbicula fluminalis* and *Corbicula fluminea* in the river Rhine. *Archiv für Hydrobiologie*, 149(3): 403-420.

SWINNEN F., LEYNEN M., SABLON R., DUVIVIER L. ET VANMAELE R. 1998. The Asiatic clam *Corbicula* (Bivalvia: Corbiculidae) in Belgium. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique, Biologie* 68: 47-53.

TAYLOR L.R. 1961. Aggregation, variance and the bivalve *Corbicula fluminea* as a means of dispersal. *Science*, 225: 1491-1493.

TAYLOR L.R., WOIWOD I.P. ET PERRY J.N. 1978. The density-dependence of special behaviour and the rarity of randomness. *Journal of Animal Ecology*, 47: 383-406.

TOURENQ J.N. ET PUJOL J.L. 1991. *Recherches sur la bio-écologie de Corbicula fluminea. Étude bibliographique et observations dans la Garonne. Moyen de lutte pour en limiter les nuisances dans les circuits d'irrigation du Sud-Ouest.* DDA du lot et Garonne. 1-312 pp. Toulouse.

© *Sociedad Española de Malacología* ——— *Iberus*, 28 (1): 13-22, 2010

La Arqueomalacología: una introducción al estudio de los restos de moluscos recuperados en yacimientos arqueológicos

Archaeomalacology: an introduction to the analysis of shellfish remains from archaeological sites

Víctor BEJEGA GARCÍA, Eduardo GONZÁLEZ GÓMEZ DE AGÜERO y Carlos FERNÁNDEZ RODRÍGUEZ*

Recibido el 21-IX-2009. Aceptado el 23-II-2010

RESUMEN

La presencia de moluscos en yacimientos arqueológicos genera la necesidad de desarrollar una metodología de estudio. Para ello, la Arqueomalacología nace como disciplina dentro de la Arqueozoología. A través del estudio de los diferentes elementos de los moluscos, aplicando diversas metodologías analíticas, podemos conocer una serie de aspectos importantes de la vida en las sociedades del pasado. La alimentación, las estrategias de recolección, la economía, la temperatura del mar, el comercio, el uso de adornos son algunos de los temas que pueden ser estudiados a través de ésta disciplina arqueológica.

ABSTRACT

The presence of shellfish remains in archaeological sites has prompted the development of a methodology for their study. With this purpose, archaeomalacology emerges as a discipline within archaeozoology. A number of important aspects of life in ancient societies may be known by studying shellfish middens using analytical methods. The origin of food supplies, gathering strategies, economy, temperature of the sea water, trade, use of ornaments and so on, are all subjects approached by a discipline such as archaeomalacology.

INTRODUCCIÓN

La Arqueomalacología es la rama de la Arqueozoología encargada del estudio de los restos de moluscos aparecidos en contextos arqueológicos. Sus inicios se remontan al siglo XIX, como respuesta a la atención prestada a las importantes concentraciones de moluscos de origen antrópico y cronología prehistórica presentes principalmente en las costas noroccidentales europeas, a las que se denominó con el término danés de *kjoekkenmoeddings* (literalmente "restos de cocina"). El estudio de estos depósitos supuso el desarrollo de la Arqueomalacología, cuyo objetivo es, como hemos señalado, el de analizar e interpretar los moluscos presentes en los yacimientos arqueológicos.

En la Península Ibérica, los estudios arqueomalacológicos tienen sus inicios a finales del siglo XIX, como resultado de los hallazgos de depósitos de conchas

---

* Universidad de León. Área de Prehistoria. Facultad de Filosofía y Letras. Campus de Vegazana s/n. 24007.

en dos zonas geográficas diferenciadas: una localizada en torno al río Muge, en Portugal, y la segunda vinculada al río Sella, en Asturias. En ambos casos se trataba de grandes acumulaciones de moluscos marinos (denominadas *concheros*), adscritas al Mesolítico, que en el caso del Sella servirán para definir un determinado periodo cultural desarrollado a inicios del Holoceno, el Asturiense. El estudio de estos depósitos se ve motivado por dos aspectos: la información potencial que pueden aportar acerca del modo de vida de los grupos humanos que los originaron y la excelente capacidad de conservación que aportan a otros tipos de evidencias materiales.

No obstante aquellos primeros episodios, la Arqueomalacología no se consolidará como parte habitual en los estudios arqueológicos hasta la década de los 70 del siglo XX. A partir de ese momento, se va a producir una evolución metodológica que permite ampliar la información obtenida de los análisis de los concheros, destacando en este aspecto el trabajo que constituye la Tesis Doctoral de MORENO NUÑO (1994).

Como hemos señalado, la Arqueomalacología se ocupa del estudio de los restos de moluscos (incluyendo ocasionalmente crustáceos y equinodermos) que se documentan en los yacimientos arqueológicos, ya sea como elementos aislados o en acumulaciones (concheros).

La aparición de moluscos aislados en contextos arqueológicos suele ser un hecho bastante habitual, tanto en yacimientos prehistóricos como históricos. Por otra parte, estos restos no son exclusivos de yacimientos costeros, no resultando extraordinario encontrarlos en sitios alejados del litoral, de manera especial -aunque no como norma taxativa- a partir de época romana. La documentación de estas evidencias, y especialmente en el caso de restos alterados intencionalmente, no siempre debe relacionarse con una finalidad alimenticia, sino que han podido también utilizarse como material constructivo o incluso estar relacionados con la ornamentación u otras actividades vinculadas con el ámbito ritual o simbólico. La presencia de colgantes, collares y otros elementos de adorno realizados con moluscos es conocida ya desde el Paleolítico Superior, con especial relevancia de algunas especies como es el caso de *Columbella rustica* (Linné, 1758) (TABORIN, 1993a; 1993b).

El principal problema que se plantea con relación a estos materiales es su recuperación durante el proceso de excavación. En muchas ocasiones únicamente se recogen, en el mejor de los casos, los más llamativos o los mejor conservados; a lo que debe añadirse que la ausencia de un proceso de cribado provoca que fácilmente pasen desapercibidos este tipo de evidencias.

El término *conchero*, como traducción del danés "*kjoekkenmoedding*", es utilizado por primera vez en España, según VEGA DEL SELLA (1923), por Aquilino Padrón en el *Boletín de la Sociedad Geográfica* de 1877 refiriéndose a los depósitos de conchas existentes en las Canarias. No obstante, hay que tener presente que un conchero no está formado exclusivamente por conchas de moluscos, sino que puede incluir otros muchos tipos de materiales tanto orgánicos como inorgánicos (ictiofauna, macrofauna, cerámica, industria lítica, metal,...), con un muy buen estado de conservación, incluso aun cuando se trate de suelos ácidos, debido a la capacidad aislante del carbonato cálcico de los moluscos. Objeto de debate ha sido el porcentaje de conchas presente en un depósito necesario para su consideración o no como un conchero (una revisión del tema en BEJEGA GARCÍA, 2009a; 2009b), aceptándose como valor medio un 30-50% de la composición total (MEIGHAN, 1980; BOWDLER, 2006).

Estos depósitos (Figura 1) suelen corresponderse con basureros formados como resultado de la deposición continuada de las partes duras de los moluscos que han sido utilizados como alimento, aun cuando también pueden albergar algún elemento de esta misma naturaleza que haya tenido otra función. Así, en ocasiones existen problemas a la

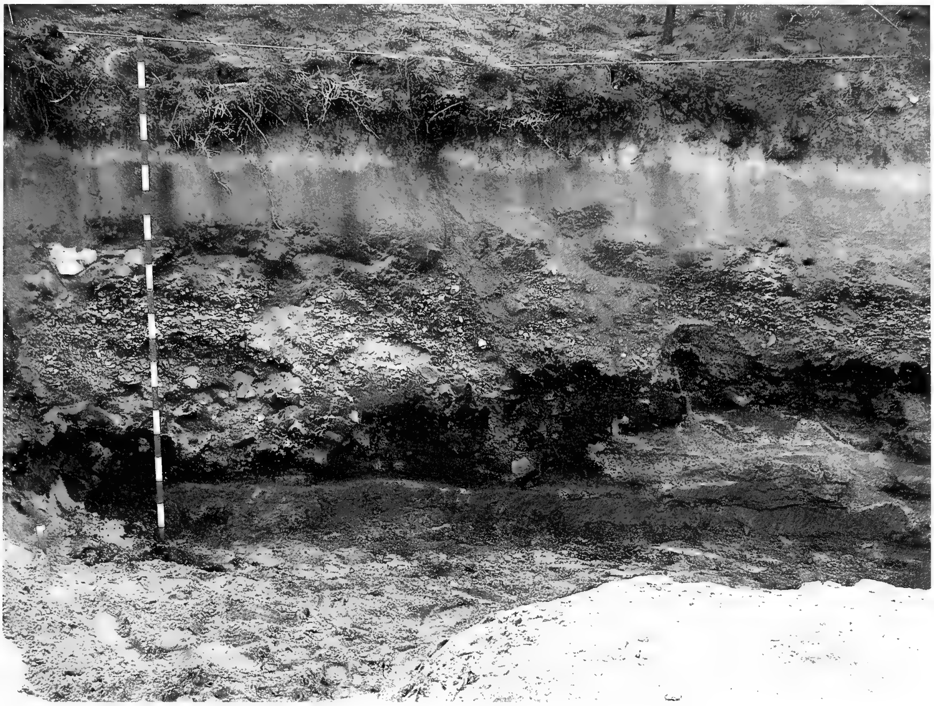


Figura 1. Conchero de un castro Galaico-romano (San Cibrao, Lugo)
Figure 1. Shell Miden of Galaico-roman hillfort (San Cibrao, Lugo, Spain)

hora de asignar alguno de los restos a una categoría tafonómica concreta, ya que su presencia puede reflejar causas bien diferenciadas (alimento, intrusión, adorno,…).

Del mismo modo, también se han propuesto diferentes criterios a la hora de clasificar los tipos de concheros, basados en aspectos tales como la cronología (MEIGHAN, 1980), la densidad de materiales (STEIN, 1992; CLAASSEN, 1998) o la morfología (DUPONT, 2008), siendo este último el que consideramos más adecuado para definir las estructuras que habitualmente venimos estudiando (Tabla 1, Figura 2).

METODOLOGÍA DE ANÁLISIS

A la hora de realizar un estudio arqueomalacológico el primer aspecto básico a tener en cuenta es la aplicación de una metodología adecuada a las particularidades del depósito, ya desde el proceso de recuperación de muestras. Es sin duda un requisito indispensable para la obtención de la mayor cantidad de información posible. Este proceso analítico se puede dividir en tres fases generales:

Excavación y muestreo: en esta fase se obtiene el objeto de estudio. Durante la excavación se debe prestar especial atención a la aparición de moluscos aislados, así como a su correcta documentación estratigráfica. En caso de existir un conchero, es recomendable la aplicación de diferentes sistemas de muestreo (BEJEGA GARCÍA, 2009a; 2009b), destacando, por ser los más habituales, el de columnas y el selectivo.

Análisis de las muestras: fase analítica propiamente dicha, que engloba básicamente cuatro procesos: cribado (Figura 3), triado, cuantificación y biometría. El cribado consiste en el lavado de las muestras utilizando un tamiz (en

Tabla I. Nomenclatura aplicada a los distintos tipos de conchero, según DUPONT (2008).
Table I. Nomenclature applied to different types of shell deposits, following DUPONT (2008).

Depósitos en positivo:	**Depósitos en negativo:**
Conchero: depósito en relieve con un volumen superior a dos metros cúbicos.	**Nivel o Estrato de conchas en negativo**: depósito con un relieve inferior a 10 cm desde el suelo.
Depósito de conchas: depósito en relieve con un volumen inferior a dos metros cúbicos.	**Nivel o Estrato de conchas en negativo de hábitat**: depósito de menores dimensiones ubicado en zona habitada
Nivel o estrato de conchas: depósito con débil relieve (inferior a 10 cm desde el suelo) formado por conchas esparcidas.	**Depósito de conchas en hoyo de almacenamiento u otro**

nuestro caso, teniendo en cuenta el tipo de evidencias que pueden recuperarse, solemos utilizar cribas con diámetro de malla no superior a 1 mm). El triado consiste en un proceso de selección de los restos conforme a la identificación taxonómica. Finalmente, se realiza una cuantificación y se toman una serie de valores: peso y biometría (siempre que se conserven las dimensiones máximas originales de altura, anchura y longitud). Asimismo, durante esta fase también se procede a la asignación de restos a las diferentes Categorías de Fragmentación (MORENO NUÑO, 1994; GUTIÉRREZ ZUGASTI, 2005), que serán la base para el cálculo de abundancias.

Estimación de Abundancias: para conocer la importancia de cada una de las diferentes especies de moluscos en un conchero, se aplican tres Estimadores de Abundancias, con las adaptaciones necesarias para el cálculo de este tipo de evidencias arqueológicas (MORENO NUÑO, 1994; GUTIÉRREZ ZUGASTI, 2008; 2005; BEJEGA GARCÍA, 2009a; 2009b): Número Mínimo de Individuos (NMI), Número de Restos (NR) y Peso. Los datos obtenidos por estos estimadores son básicos para realizar la posterior interpretación de los componentes malacológicos del conchero.

Al tratarse de restos arqueológicos las partes blandas del animal no se han conservado, lo que indudablemente dificulta una correcta identificación taxonómica. Este hecho se hace más evidente en aquellas especies que, aun disponiendo de ejemplares vivos, presentan dificultades para una asignación específica, como las del género Patella. Estas deben ser identificadas en base a la morfología de la concha, no pudiendo considerar los criterios diagnósticos reconocidos en la rádula, la coloración u otros elementos clarificadores para la diferenciación interespecífica, tal y como señalan diferentes autores (p.e. CABRAL Y SILVA, 2003). Así mismo, los altos índices de fragmentación que presentan habitualmente estas piezas dificultan su identificación, impidiendo frecuentemente, por ejemplo, la diferenciación entre *Solen marginatus* (Pulteney, 1799) y *Ensis siliqua* (Linné, 1758), o entre *Mytilus galloprovincialis* (Lamarck, 1819) y *Mytillus edulis* (Linné, 1758). Por este motivo, en arqueomalacología suele utilizarse la identificación por asociación, consistente en realizar una asignación específica de determinados restos con caracteres diagnósticos que sólo permiten su identificación a niveles taxonómicos supraespecíficos, mediante su asociación con restos que sí son asignables a una especie concreta (MORENO NUÑO, 1994).

INFORMACIÓN POTENCIAL DE LOS ESTUDIOS ARQUEOMALACOLÓGICOS.

Con el fin de poder determinar el uso que han tenido los moluscos en un yacimiento, se realiza una evaluación tafonómica de los restos. Los grupos tafonómicos se establecen siguiendo dos

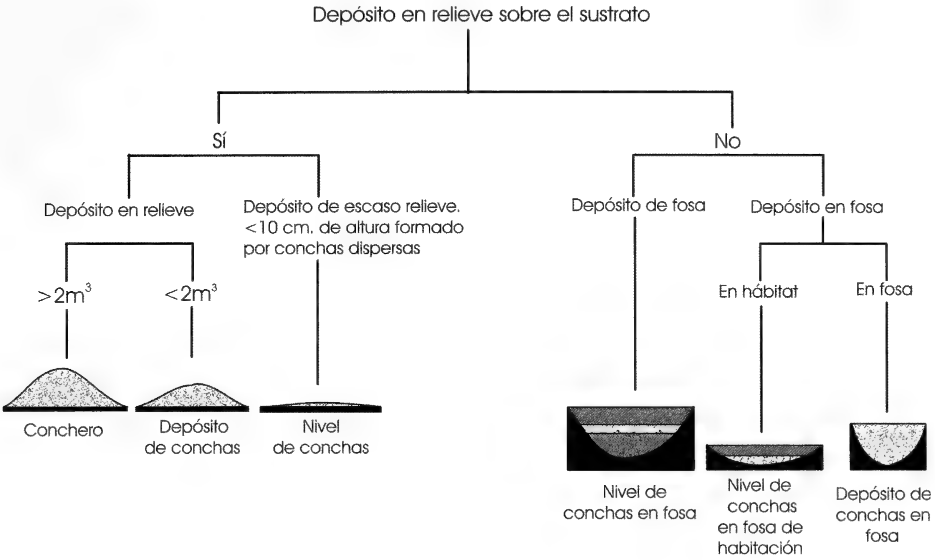


Figura 2. Tipos de conchero (DUPONT, 2006)
Figure 2. Types of shell middens (DUPONT, 2006)

criterios: el agente que deposita los restos (antrópico o no antrópico) y, en su caso, la función para la que fueron recolectados (GUTIÉRREZ ZUGASTI, 2005; 2008). Su adscripción a cada uno de los diferentes grupos definidos sigue unos criterios generales que MORENO NUÑO (1994) adaptó de los establecidos por GAUTIER (1987):

Restos alimenticios: aquellos que aparentemente han sido objeto de consumo por los humanos.

Restos alterados: los que presentan alteraciones antrópicas para la confección de utensilios, adornos... o aquellos con modificaciones naturales, pero cuya morfología ha propiciado su uso por los humanos.

Restos de funcionalidad antrópica desconocida: restos recolectados una vez el animal está ya muerto y que no presentan ningún tipo de modificación que nos permita intuir su función.

Restos intrusivos: los no acumulados intencionalmente por el ser humano. Se pueden diferenciar dos grupos:

a) Intrusivos penecontemporáneos: depositados al mismo tiempo de formación del depósito.

b) Intrusivos posteriores: introducidos con posterioridad a la formación del depósito.

En la mayoría de las ocasiones los restos de moluscos se adscriben a la primera de las categorías taxonómicas citadas, la de restos alimenticios. No obstante, la información que podemos obtener mediante un estudio arqueomalacológico es muy diversa, abarcando planteamientos mucho más amplios que una mera enumeración de especies (GONZÁLEZ GÓMEZ DE AGÜERO, 2009a; 2009b):

Información alimenticia

Como hemos señalado con anterioridad, los restos de moluscos recuperados en un yacimiento arqueológico se identifican mayoritariamente con desechos alimenticios (al igual que suele suceder con otros ecofactos, como macrofauna, ictiofauna o semillas). La importancia real de los moluscos en la dieta no es fácil de evaluar: un mayor volumen de conchas no implica un mayor aporte cárnico, ya que la proporción de carne de un molusco no se corresponde con el tamaño de la concha, influyendo un gran número de factores. Además hay

Figura 3. Proceso de cribado de una muestra con una malla de 0,8mm
Figure 3. Screening process with a 0.8 mm mesh

que tener en cuenta que su consumo está condicionado por toda una serie de valores sociales (gustos, modas, tabúes, etc.). Por otro lado, la proporción existente entre las especies de moluscos que componen la muestra nos ofrece información sobre el tipo de sustratos explotados, y consecuentemente podemos evaluar las posibles áreas de captación y las técnicas de recolección utilizadas, tanto en el caso de moluscos marinos como en el de moluscos fluviales y terrestres (Callapez, 2002; Stein, 1992).

Los resultados del análisis biométrico pueden reflejar diferentes tendencias. Así, por ejemplo, una rápida reducción en las tallas de los individuos normalmente apunta a una sobreexplotación del medio, ya sea debida tanto a un periodo de carestía como a una incipiente presión sobre el entorno (Shackleton, 1980; Davies, 2008), aunque también puede estar indicando la incidencia de la recolección en una zona concreta.

Información comercial

La presencia de moluscos marinos en yacimientos arqueológicos de interior o la aparición de especies procedentes de ecosistemas muy distintos a los del entorno inmediato de un yacimiento litoral determinado suponen un proceso antrópico de traslado.

Así, es frecuente la aparición de restos de moluscos en yacimientos romanos del interior, tales como *Asturica Augusta* (Astorga), *Lucus Augusti* (Lugo) o el campamento de la *Legio VII* en León, por citar algunos ejemplos en el noroeste de la Península Ibérica. Este tipo de evidencias nos indica la existencia de redes de comercio capaces de abastecer de moluscos a poblaciones relativamente alejadas del mar, respondiendo a una demanda vinculada a los grupos sociales con mayor poder adquisitivo y que se especifica en una serie de especies entre las que cabe destacar, para época romana, *Ostrea edulis* (Linné,

Figura 4. Concha de *Ostrea edulis procedente del castro de Neixón (Boiro, A Coruña) de la II Edad de Hierro*
Figure 4. Shell of Ostrea edulis *from Neixón hillfort of 2nd Iron Age (Boiro, A Coruña, Spain)*

1758) (Figura 4), pero también otras como *Ruditapes decussatus* (Linné, 1758), *Osilinus lineatus* (da Costa, 1778), etc.

A la existencia de estas redes de comercio deberíamos sumar el desarrollo de sistemas de conservación y transporte de los moluscos que permitiesen su consumo, evitando su deterioro. En este sentido, se ha venido planteando una doble hipótesis: la utilización de métodos de conserva, tales como la salazón, o el transporte de los animales vivos, sea en contenedores con agua o bien en recipientes sin agua aprovechando la capacidad de algunas especies para resistir varios días mediante la almacenada en su interior tras cerrar las valvas.

Información paleoclimática

La sensibilidad de los moluscos a los factores abióticos y bióticos hace que las diferentes especies puedan asociarse a ecosistemas muy concretos, cuyas características de temperatura y salinidad del agua, en el caso de los moluscos marinos, son conocidas. Partiendo del principio de que las especies no han variado sus preferencias de hábitat (SPARKS, 1980), podemos suponer que estos moluscos son representantes de un paleoclima determinado, lo que permite reconstruir las condiciones del medio en el que fueron recolectados, información a su vez de interés para valorar las condiciones de vida de las sociedades del pasado.

De este modo, la existencia en los yacimientos gallegos del cambio de Era (siglos I a.C.- I d.C.) de especies como *Stramonita haemastoma* (Linné, 1758) que actualmente no se encuentran en las costas gallegas, nos indica un descenso de la temperatura de unos 2,5-3° C entre ese momento y la actualidad (Rodríguez López y Fernández Rodríguez, 1996).

Igualmente, los moluscos terrestres son un claro indicador de las condiciones climáticas de la época de formación del yacimiento, así como de las características del ecosistema que lo rodeaba (Sparks, 1980). La presencia de especies como *Pomatias elegans* (Muller, 1774), por ejemplo, indica un entorno húmedo, de temperaturas suaves y con suelos calcáreos.

Uno de los principales métodos aplicados en la interpretación paleoclimática es la comparación entre la distribución actual de las especies y su presencia en los depósitos arqueológicos (Gutiérrez Zugasti, 2005; 2008). Sin embargo, este tipo de análisis no resulta totalmente definitorio, debido a que gran cantidad de especies son euritermas y eurohalinas, siendo necesario complementarlo con otros estudios.

Un sistema más preciso para la reconstrucción paleoclimática se basa en el análisis de los isótopos de oxígeno (O16, O17 y O18) presentes en las conchas de los moluscos, cuya proporción varía en función de las fases cálidas y frías. Sin embargo, a pesar de tratarse de un análisis que ofrece una fiabilidad contrastada a la hora de definir grandes episodios climáticos, las dificultades inherentes al mismo, motivadas por la fluctuación de la temperatura del agua y su composición isotópica, limitan su aplicación ante eventos de menor entidad (Shackleton, 1980; Stein, 1992; Claassen, 1998).

Estacionalidad

La diferencia en el grosor de las líneas de crecimiento correspondientes a cada ciclo estival e invernal, especialmente en los bivalvos, permite diferenciar cada uno de estos ciclos. Así, las líneas más gruesas son propias de períodos estivales, con una mayor cantidad de alimento y unas mejores condiciones del agua, frente a las de menor espesor propias de ciclos invernales.

En consecuencia, el análisis de las líneas de crecimiento teóricamente permite identificar la época de recolección de los moluscos, pudiendo establecer si se trata de un recurso anual o estacional, lo que a su vez tiene implicaciones relativas a las estrategias de aprovisionamiento de las comunidades humanas y la importancia que estos recursos tendrían en su sistema económico.

Otros tipos de información

Los moluscos recuperados en los yacimientos arqueológicos también pueden aportar información relacionada con otro tipo de actividades humanas no asociadas con la alimentación. Por ejemplo, la utilización de los murícidos para la elaboración de tintes (obtención del color púrpura) se tradujo en la existencia de una actividad industrial, reflejada en el establecimiento de factorías dedicadas a los procesos de recolección y transformación de estos moluscos.

Otro tipo de evidencias indirectas que reflejan el uso y la importancia que tuvieron los moluscos para determinadas sociedades del pasado son las impresiones de determinadas especies, especialmente *Cerastoderma edule* (Linné, 1758), como método de decoración de la cerámica, dando lugar a la denominada "cerámica cardial".

Por otro lado la existencia de colgantes, pulseras y otros objetos de adorno fabricados a partir de conchas, o la presencia de las partes duras de los moluscos en determinados contextos como los funerarios pueden ser evidencia del valor simbólico y/o ritual que también han recibido en ocasiones estos materiales.

En relación con los moluscos no marinos presentes en los yacimientos arqueológicos, aun cuando su tratamiento analítico de cuantificación no varía con respecto a aquellos, sí lo hace su interpretación. En el caso de los moluscos fluviales, debe prestarse especial atención a los ecosistemas característicos de cada especie presente, ya que pueden indicarnos zonas de recolección y ayudar a valorar la intencionalidad o no de su recogida. Incluso la presencia de moluscos terrestres y micromoluscos puede ser indicativa de las condiciones de formación de un depósito de moluscos fluviales o marinos, evidenciando la cantidad de tiempo que el mismo permaneció expuesto hasta ser enterrado.

CONCLUSIONES

Los restos de moluscos presentes en los yacimientos son una fuente de información básica, tanto biológica como socio-cultural. El estudio sistemático de los depósitos con conchas permite obtener información sobre las estrategias de abastecimiento y la dieta de las poblaciones humanas, pero además son un elemento indispensable para estudiar otros aspectos, tanto socio-económicos como paleoambientales.

Uno de los errores que deben evitarse es el de interpretar la diversidad biológica de un periodo concreto a partir de las evidencias de origen arqueológico. Los moluscos reflejan la presencia de determinadas especies en el medio en un momento concreto, pero no pueden considerarse como poblaciones biológicas, ya que los concheros son acumulaciones antrópicas en las que van a resultar muy importantes los factores socio-culturales. De este modo la mayor presencia de *Patella* sp. en muchos castros galaicos puede que no esté reflejando la mayor abundancia de esta especie, sino una preferencia alimenticia, bien por motivos sociales (simbolismo, gusto, tabú...) o económicos (fácil recolección, mayor rendimiento, etc.).

Sin duda alguna, para la correcta validación de estos estudios es necesaria una metodología de excavación, muestreo e identificación muy precisa, ya que lo contrario supondría inevitablemente una pérdida de información.

Pese a que la Arqueomalacología tiene un largo desarrollo en el tiempo como disciplina arqueológica, ha sido poco utilizada e incluso se ha infrautilizado en muchas ocasiones. Actualmente está adquiriendo importancia debido tanto al avance metodológico de la disciplina, así como por el conocimiento de la información potencialmente obtenible mediante su aplicación. El aprovechamiento de los recursos marinos por las comunidades del pasado y su evolución a lo largo del tiempo es un aspecto a tener presente si queremos conocer y definir de forma correcta y global los modos de vida de aquellos grupos humanos.

BIBLIOGRAFÍA

Bejega García V. 2009a. Composición y metodología de análisis de concheros aplicada a los castros litorales gallegos. *Actas de las I Jornadas de Jóvenes en Investigación Arqueológica (JIA): Dialogando con la cultura material (Madrid, 2008)*, Tomo I: 247-254.

Bejega García V. 2009b. *El aprovechamiento de los recursos marinos en el Castro Grande de O Neixón (Boiro, A Coruña): un análisis arqueomalacológico.* Tesina de Licenciatura. Universidad de León. Inédita.

Bowdler S. 2006 Mollusks and other shells. En Balme J. y Paterson A. (Eds.): *Archaeology in Practice. A Student Guide to Archaeological Analyses.* Blackwell Publishing: 317-337.

Cabral J.P., Coelho F. y Da Silva A. 2003. Morphometric analysis of limpets from an Iron-Age shell midden found in northwest Portugal. *Journal of Archaeological Science*, 30: 817-829.

Callapez P. 2002. A malacofauna críptica da Gruta do Caldeirao (Tomar, Portugal) e as faunas de gastrópodes terrestres do Plistocénico superior e Holocénico da Extremadura portuguesa. *Revista Portuguesa de Arqueología*, Vol 5 nº2 : 5-28

Claassen C. 1998. *Shells.* Cambridge Manuals in Archaeology, Cambridge University Press. 266 pp.

Davies P. 2008. *Snails. Archaeology and Landscape change.* Oxbow Books, Oxford. 199 pp.

DUPONT C. 2006 La malacofaune de sites mésolithiques et néolithiques de la façade atlantique de la France: Contribution à l'economie et à l'identité culturelle des groupes concernés. *British Archaeological Reports, International Series*, 1571, v+439 pp.

GAUTIER A. 1987. Taphonomic Groups: How and Why? *Archaeozoologia*, 1 (2): 47-52.

GONZÁLEZ GÓMEZ DE AGÜERO E. 2009a. Resultados obtenidos en el análisis de un conchero: el caso de los castros litorales gallegos. *Actas de las I Jornadas de Jóvenes en Investigación Arqueológica (JIA): Dialogando con la cultura material* (Madrid, 2008). Madrid: 255-262.

GONZÁLEZ GÓMEZ DE AGÜERO E. 2009b. *El marisqueo en los castros galaico-romanos de la costa cantábrica gallega: el conchero de Punta Atalaya (San Cibrao, Cervo, Lugo).* Tesina de Licenciatura. Universidad de León. Inédita.

GUTIÉRREZ ZUGASTI I. 2005. *La explotación de moluscos en la cuenca baja del río Asón (Cantabria, España) a inicios del Holoceno (10.000-5.000 B.P.) y su importancia en las comunidades humanas del Aziliense y del Mesolítico.* Trabajo de Investigación de Doctorado. Universidad de Cantabria. Inédito.

GUTIÉRREZ ZUGASTI I. 2008. *La explotación de moluscos y otros recursos litorales en la región cantábrica durante el Pleistoceno Final y el Holoceno Inicial.* Tesis Doctoral. Edición CD. Universidad de Cantabria.

MEIGHAN C.W. 1980. Los moluscos como restos de alimentos en los sitios arqueológicos. En Brothwell D. y Higgs E. (Coord.): *Ciencia en Arqueología.* Fondo de Cultura Económica, México: 427-434.

MORENO NUÑO R. 1994. *Análisis arqueomalacológicos en la Península Ibérica. Contribución metodológica y biocultural.* Tesis Doctoral. Universidad Autónoma de Madrid. Inédita.

RODRÍGUEZ LÓPEZ C. Y FERNÁNDEZ RODRÍGUEZ C. 1996. Una aproximación al estudio de los yacimientos castreños del litoral galaico: dimensiones ambientales y económicas. En Ramil Rego P., Fernández Rodríguez C. y Rodríguez Guitián (Coord.): *Biogeografía Pleistocena-Holocena de la Península Ibérica.* Xunta de Galicia: 363-375.

SHACKLETON N.J. 1980. Los moluscos marinos en Arqueología. En Brothwell D. y Higgs E. (Coord.): *Ciencia en Arqueología.* Fondo de Cultura Económica, México: 418-426.

SPARKS B.W. 1980. Los moluscos no marinos en la Arqueología. En Brothwell D. y Higgs E. (Coord.): *Ciencia en Arqueología.* Fondo de Cultura Económica, México: 406-417.

STEIN K.J. (Ed.). 1992. *Deciphering a Shell Midden.* Academic Press, xix + 375 pp.

TABORIN Y. 1993a. La parure en coquillage au Paléolithique. *Gallia Préhistoire*, supplément 29, Centre National de la Recherche Scientifique. 544 pp.

TABORIN Y. 1993b. Traces de façonnage et d'usage sur les coquillages perforés. *Traces et fonction: les gestes retrouvés.* Vol. 50. Colloque International de Liège. Editions Études et Recherches Archéologiques de l'Université de Liège, 50(2): 255-267.

VEGA DEL SELLA R.E. Conde de la 1923. *El Asturiense. Nueva industria preneolítica. Memorias de la Comisión de Investigaciones Paleontológicas y Prehistóricas*, 32 (serie Prehistórica 27), Museo Nacional de Ciencias Naturales, Madrid.

© Sociedad Española de Malacología ——— Iberus, 28 (1): 23-60, 2010

Las especies del género *Chauvetia* (Gastropoda, Neogastropoda, Buccinidae) del área ibero-marroquí, con descripción de cuatro especies nuevas

The species of the genus *Chauvetia* (Gastropoda, Neogastropoda, Buccinidae) in the Ibero-moroccan area, with the description of four new species

Serge GOFAS* y Joan Daniel OLIVER**

Recibido el 25-III-2010. Aceptado el 22-IV-2010

RESUMEN

Se revisan las especies del género *Chauvetia* Monterosato, 1884 encontradas en Andalucía, el sur de Portugal y Marruecos. En esta área se reconocen doce especies, cuatro de las cuales se describen como nuevas, dos con localidad tipo en el estrecho de Gibraltar y dos con localidad tipo en el noroeste marroquí. El estrecho de Gibraltar alberga la diversidad más alta para el género en Europa, apareciendo hasta ocho especies en la misma muestra.

ABSTRACT

The species belonging to the genus *Chauvetia* Monterosato, 1884 are revised for the area including Andalucía, southern Portugal and Morocco. Twelve species are recognized in this area, of which four are described as new, two with a type locality in the Strait of Gibraltar and two with a type locality in northwestern Morocco. The Strait of Gibraltar holds the highest diversity for the genus in Europe, with up to eight species potentially occurring in the same sample.

INTRODUCCIÓN

El género *Chauvetia* Monterosato, 1884 comprende pequeños gasterópodos incluidos en la familia Buccinidae, cuya taxonomía resulta particularmente dificultosa debido al elevado número de especies y a la escasa diferenciación entre éstas. El género se conoce exclusivamente en el Mediterráneo y en la parte adyacente del Atlántico, entre el Canal de la Mancha y Senegal. La mayor diversidad de especies se conoce hasta la fecha entre Senegal (14 especies en el área de Dakar, OLIVER Y ROLÁN, 2008) y las costas del Sáhara (9 especies, OLIVER Y ROLÁN, 2009).

Existen varios trabajos dedicados a la taxonomía de este género en el Mediterráneo, entre ellos los de TIBERI (1868), NORDSIECK (1976), MICALI (1999) y HERGUETA, LUQUE Y TEMPLADO (2002). Sin embargo, son aún muchos los problemas taxonómicos sin aclarar. En el presente trabajo se revisan las especies del entorno ibero-marroquí, con particular atención a las especies del estrecho de Gibraltar.

---

* Departamento de Biología Animal, Facultad de Ciencias, Universidad de Málaga, E-29071 Málaga.
** Alcorisa, 83-12C, E-28043 Madrid.

MATERIAL Y MÉTODOS

El material estudiado para esta revisión incluye el recolectado por los autores en el área de estudio, así como el existente en las colecciones del Muséum National d'Histoire Naturelle de París (MNHN) y el Museo Nacional de Ciencias Naturales de Madrid (MNCN). Una parte sustancial de los datos usados para este trabajo se deriva de tres campañas organizadas por el MNHN. Los datos de las localidades se recogen en la Tabla I.

La campaña Ceuta 1986 se desarrolló en mayo de 1986, y durante la misma se muestrearon una decena de puntos entre el nivel de bajamar y 40 m, situados alrededor de la península de Ceuta, desde La Almadraba (Mediterráneo) hasta Benzú (Estrecho), principalmente mediante el uso de una aspiradora submarina de aire comprimido. Al llegar a puerto, las muestras eran inmediatamente tamizadas en agua de mar y observadas bajo una lupa binocular, lo que posibilitó la observación en vivo de muchas especies, entre ellas nueve de *Chauvetia*. Para las especies de pequeño tamaño se realizó un dibujo del animal vivo, identificado por un número en la etiqueta del ejemplar correspondiente. El material recolectado está repartido entre el MNHN y el SMNH.

La campaña Algarve 1988 se desarrolló en mayo de 1988 en la bahía de Sagres, próxima al extremo suroccidental de la Península Ibérica, y en junio del mismo año en la zona de la Ría Formosa y en algunos puntos cerca de Tavira, en la parte oriental de la costa del Algarve. Los métodos de muestreo eran básicamente los mismos, y también se realizaron dibujos de los animales vivos. En la zona de Sagres, las especies de *Chauvetia* estaban representadas por un número de individuos mayor de lo habitual, mientras el género no se encontró en el muestreo de las lagunas de Ría Formosa, a pesar de realizarse un esfuerzo de muestreo similar. En esta campaña se pudieron observar en vivo cinco especies, todas ellas también presentes en el material de Ceuta.

El material procedente de los bancos submarinos de Gorringe y Ampère, en el que se halló una especie de *Chauvetia*, fue recolectado durante la campaña Seamount 1 llevada a cabo en el B/O "Le Noroît" en 1987.

Se ha examinado material procedente de diversas colecciones depositadas en el MNCN como las colecciones de Hidalgo (1913), Azpeitia (1934) y Cobos (2000). En algunos casos se indica que estas colecciones incluyen otras como las de Gavala, Boscá o Sierra. También se ha estudiado material del MNCN aportado por José Templado y material procedente de las Campañas Fauna Ibérica III (1994) y IV (1996).

Se estudió el material de la colección del segundo autor (JDO), procedente de material arrojado a las playas o de sedimentos recogidos a poca profundidad (entre 0 y 20 m). El material de Alborán se ha obtenido a partir de sacos de sedimentos depositados en su momento en el MNCN, y procede de las redes de barcos de pesca de coral rojo del puerto de Almería, que faenaron entre 1984 y 1986 con el arte de la "barra italiana" entre 80 y 200 metros de profundidad (Peñas, Rolán, Luque, Templado, Moreno, Rubio, Salas, Sierra y Gofas, 2006).

El material examinado se discrimina en el apartado correspondiente de cada especie, distinguiendo entre ejemplares recogidos vivos (ej.) y conchas vacías (c.); para cada lote se dan las dimensiones de los ejemplares adultos (con el labio formado) más pequeño y mayor; los juveniles se indican con j. Las protoconchas fueron medidas bajo la lupa binocular equipada de un micrómetro ocular, a un aumento de 40×, en vista apical, según las pautas indicadas en la Figura 1.

Los ejemplares destinados a ser fotografiados en microscopía electrónica de barrido fueron limpiados en un baño de lauril sulfato de sodio (un detergente de pH neutro) al 10%, sometidos a una breve (pocos segundos) exposición a ultrasonidos en agua, montados en los portaobjetos con un pegamento conductor y metalizados con oro. Las observa-

Tabla I. Localidades de Ceuta, del Algarve y de los bancos lusitanos muestreadas en las campañas del MNHN, y de la costa mediterránea ibérica muestreadas en las campañas del MNCN (Fauna Ibérica).
Table I. Localities from Ceuta, Algarve and the lusitanian banks sampled during MNHN campaigns, and those from the Iberian mediterranean coast sampled during MNCN campaigns (Fauna Ibérica).

Localidad	**Coordenadas**	**Hábitat**	**Profundidad (m)**
Campaña Ceuta 1986			
Benzú	35º 55,0′ N – 05º 22,5′ W	Infralitoral rocoso	0-4
Playa Benítez	35º 54,6′ N – 05º 20,0′ W	Cascajo bioclástico	15-25
Punta Almina	35º 54,1′ N – 05º 16,5′ W	Acantilado rocoso	25-40
Punta del Saudiño	35º 54,1′ N – 05º 18,0′ W	Acantilado rocoso	17-35
Ensenada de Sarchal	35º 53,4′ N – 05º 17,8′ W	Infralitoral rocoso	0-3
Ensenada de La Almadraba	35º 52,5′ N – 05º 19,0′ W	Fondo blando enfangado	20-36
Campaña Algarve 1988			
Sagres, Ponta da Baleeira	37º 00,3′ N – 08º 55,5′ W	Bajo de acantilado rocoso	17-23
Sagres, Baía da Baleeira	37º 00,7′ N – 08º 55,0′ W	Fondo rocoso	3-15
Sagres, Baía da Baleeira	37º 00,8′ N – 08º 55,0′ W	Intermareal rocoso	
Sagres, Baía de Sagres	36º 59,8′ N – 08º 56,3′ W	Cascajo bioclástico	20-30
Sagres, Pontal dos Corvos	37º 01,3′ N – 08º 58,3′ W	Bajo de acantilado rocoso	17-22
Sagres, Ponta dos Caminhos	37º 02,0′ N – 08º 52,0′ W	Cascajo bioclástico	23-33
Tavira, Pedra do Barril	37º 02,4′ N – 07º 39,7′ W	Fondo rocoso enfangado	25
Tavira, Cabanas	37º 06,1′ N – 07º 35,5′ W	Fondo rocoso enfangado	14
Campaña Seamount 1			
Banco Gorringe, DW04	36° 32′ N – 11° 34′ W	Piedras, bioclastos y rodolitos	93-96
Banco Gorringe, DW05	36° 32′ N – 11° 38′ W	Fondo con bioclastos	180
Banco Gorringe, DW06	36° 30′ N – 11° 38′ W	Fondo de bioclastos con ofiuras	250
Banco Gorringe, DW08	36° 28′ N – 11° 37′ W	Fondo endurecido con bioclastos gruesos	470-485
Banco Gorringe, DE09	36° 31′ N – 11° 38′ W	Fondo con arena bioclástica	350-360
Banco Gorringe, DW32	36° 31′ N – 11° 35′ W	Fondo con rocas y algas	54-62
Banco Gorringe, DW33	36° 31′ N – 11° 34′ W	Fondo con rocas y algas	55-70
Banco Ampère, DW92	35° 03′ N – 12° 53′ W	Fondo con arena bioclástica gruesa y rodolitos	117-129
Banco Ampère, DE98	35° 03′ N – 12° 55′ W		300-325
Fauna Ibérica			
Punta Foradada (Mallorca)	39º 45′ N – 02º 37′ E	Cascajo bajo un extraplomo	24
Cabo Nati (Menorca)	40º 43′ N – 03º 49′ E	Arena y cascajo entre Posidonia	31
Punta Galera (I. Espardell, Ibiza)	38º 47′ N – 01º 28′ E	Sedimento	35
Bleda Mayor (Ibiza)	38º 58′ N – 01º 09′ E	Detrítico costero	45
Cala Eubarco (Ibiza)	39º 04′ N – 01º 21′ E	Roca con coralígeno y detrítico	44
Placer Barra Alta N. (Columbretes)	39º 49′ N – 00º 32′ E	Arena gruesa y restos calcáreos	32
Norte Isla Columbrete Grande	39º 54′ N – 01º 41′ E	Coralígeno rocoso, detrítico	47
Isla de Alborán	35º 58′ N – 02º 58′ W	Fondo rocoso	35-37

ciones y micrografías se realizaron en un microscopio electrónico de barrido JEOL JSM-840, ampliado con un sistema de adquisición digital de imágenes.

Las descripciones están basadas en el material examinado de la zona de estudio, por lo que pueden no tener en cuenta elementos de variabilidad que se manifiesten fuera de esta zona. Las especies asignadas al género *Chauvetia* presentan una gran homogeneidad morfológica, por lo que se hace primero una diagnosis de los caracteres genéricos compartidos entre todas las especies, que no serán repetidos en las descripciones de cada especie.

Abreviaturas

CINZ: Código Internacional de Nomenclatura Zoológica.
Col.: colección.
JDO: Joan Daniel Oliver.
SG: Serge Gofas.
SMNH: Swedish Museum of Natural History, Estocolmo
USNM: National Museum of Natural History (Smithsonian).

PARTE TAXONÓMICA

Chauvetia Monterosato, 1884

Chauvetia Monterosato, 1884. *Nom. Gen. Spec.*: 137. [*Nomen novum* para *Nesaea* Risso, 1826; especie tipo: *Nesaea mamillata* Risso, 1826, ver notas nomenclaturales].

Nesaea Risso, 1826 (non Lamarck, 1812, nec Leach, 1814). *Hist. Nat. Eur. Mérid.*, iv: 211. [Especie tipo por designación subsiguiente de Bucquoy, Dautzenberg y Dollfus, 1883: *Nesaea mamillata* Risso, 1826, ver notas nomenclaturales].

Lachesis Risso, 1826 (non Daudin, 1803, nec Wood, 1804). *Hist. Nat. Eur. Mérid.*, iv: 223. [Especie tipo por monotipia: *Lachesis mamillata* Risso, 1826].

Donovania Bucquoy, Dautzenberg y Dollfus, 1883 (non *Donovania* Leach, 1814). *Moll. Roussillon*, vol. 1: 85, 112. [*Nomen novum* para *Lachesis* Risso, 1826 y *Nesaea* Risso, 1826].

Folineaea Monterosato, 1884. *Nom. Gen. Spec.*: 136. [Especie tipo por designación subsiguiente de Crosse, 1885: *Buccinum lefebvrii* Maravigna, 1840].

Adansonia Pallary, 1902. *J. Conchyl.* 50: 13. [*Nomen novum* para *Folineaea* Monterosato, 1884, non *Folinia* Crosse, 1868].

Syntagma Iredale, 1918. *Proc. Malac. Soc. London*, 13: 34-35. [*Nomen novum* para *Donovania* Bucquoy, Dautzenberg y Dollfus 1883].

Chauvetiella Nordsieck, 1968. *Eur. Gehäuseschn.*: 137. [Especie tipo por designación original: *Chauvetiella vulpecula* (Monterosato, 1884)].

Donovaniella Nordsieck, 1968. *Eur. Gehäuseschn.*: 136. [Especie tipo por designación original: *Donovaniella minima* (Montagu, 1803)].

Diagnosis: La concha es fusiforme, sólida, con espira alta y un tamaño generalmente comprendido entre 5 y 10 mm en los adultos (aunque la mayor especie conocida, *Chauvetia gigantissima* Oliver y Rolán, 2009, de la plataforma continental del Sáhara, alcanza hasta 20 mm). La protoconcha consta por lo general de poco más de una vuelta, cuyo núcleo hemisférico alcanza alrededor de la mitad del diámetro de la vuelta siguiente. La escultura de la protoconcha puede incluir cordoncillos espirales aplanados, costillas axiales o una combinación de ambos. La transición con la teleoconcha es difícil de apreciar; se considera el punto en el que las costillas axiales, después de aproximarse entre sí al final de la primera vuelta, se vuelven a distanciar. Un poco antes de ese paso, todavía pueden apreciarse claramente los cordoncillos espirales de la protoconcha y se inician los primeros cordones de la teleoconcha.

La teleoconcha tiene una escultura de cordones espirales y costillas axiales, pudiendo variar el aspecto y el número de estos elementos. Generalmente, hay entre 3 y 5 cordones espirales en las vueltas de la espira y 15-20 en la última

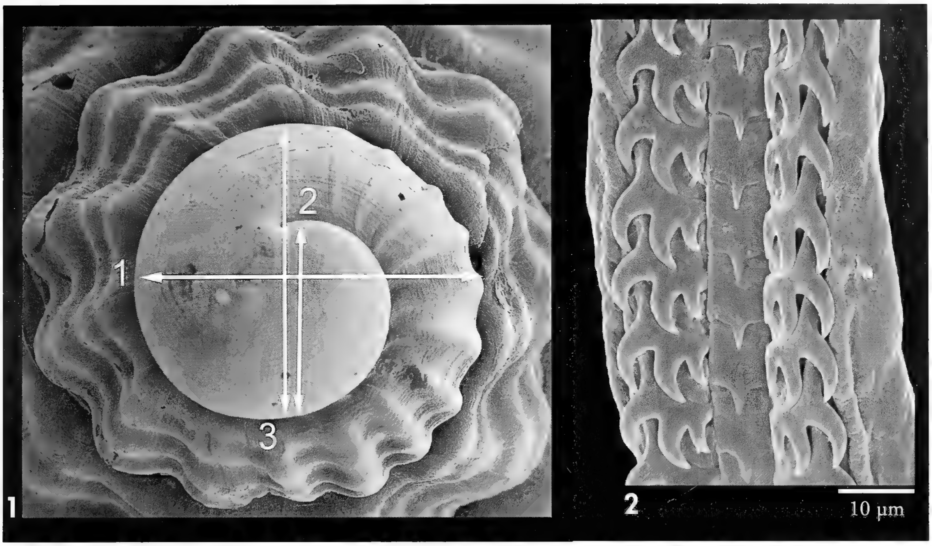


Figura 1. Medidas tomadas en las protoconchas. 1: diámetro máximo, medido entre el medio de la zona de transición y el borde opuesto de la protoconcha; 2: diámetro del núcleo, 3: diámetro de la primera media vuelta, ambos medidos en un eje perpendicular al máximo diámetro de la protoconcha. Figura 2. Vista parcial de la rádula de *Chauvetia mamillata* (Risso, 1826), especie tipo del género. Ejemplar de Sagres 17-23 m.

Figure 1. Measurements taken on the protoconchs. 1: maximum diameter, measured between the transition zone and the opposite side of the protoconch; 2: diameter of the nucleus; 3: diameter of the first half-whorl, both measured along an axis perpendicular to the maximum diameter. Figure 2. Partial view of the radula of Chauvetia mamillata *(Risso, 1826), type species of the genus. Specimen from Sagres 17-23 m.*

vuelta, siendo los que cubren el canal sifonal mucho más finos que los de la parte adapical de la última vuelta. La terminación de las costillas forma amplias ondulaciones en la sutura. La abertura es ovalada, continuada en el lado abapical por un canal sifonal muy corto y ancho. En los ejemplares adultos, el labio está engrosado por su lado externo, pero esta variz no está separada de la parte previa de la última vuelta por ninguna discontinuidad.

El animal es relativamente pequeño con relación a la concha, con un pie alargado, truncado por delante y redondeado en su extremo posterior, que se estrecha progresivamente hacia atrás. La parte posterior del pie está cubierta por un opérculo ovalado bien desarrollado, con núcleo subterminal. La cabeza carece de morro y es estrecha y bifurcada, con los ojos situados lateralmente en cada rama y los tentáculos cefálicos delgados. El sifón extendido es cilíndrico y relativamente largo. El color de fondo del animal es blanco o amarillento con reflejos irisados, y puede tener un patrón de pigmentos negros cuya presencia y configuración es propia de cada especie.

La rádula se ha estudiado en ejemplares del Algarve de *Chauvetia mamillata* (Fig. 2). Es muy pequeña con relación al tamaño del animal, unos 200 µm de largo por menos de 40 µm de ancho, y cada hilera de dientes consta de un diente central y un par de dientes laterales. El diente central es casi cuadrado, con una cúspide axial, bastante estrecha, aguzada y situada en el mismo plano que la base. Los dientes laterales son el doble de anchos que los centrales y su borde lleva tres cúspides muy fuertes, curvadas, la interna más pequeña y la externa más grande. Por lo que se conoce en esta especie (véase también HERGUETA *ET AL.*, 2002) y otras (*C. brunnea* en WOODWARD, 1899; varias especies africanas en PEÑAS Y ROLÁN, 2008) es de poca utilidad para la discriminación de especies afines y no se ha estudiado sistemáticamente en este trabajo.

La puesta se conoce en el caso de *C. mamillata* (HERGUETA *ET AL.*, 2002, y nuestro material de Sagres) y consta de una pequeña (menos de 1 mm) cápsula semitransparente en forma de copa, sujeta al sustrato por un pedúnculo muy corto. La parte superior está truncada, limitada por un reborde marcado, y funciona como una tapadera que se abre en el momento de la eclosión. Esta puesta contiene un solo huevo, que se desarrolla en su interior hasta formar una protoconcha de algo más de una vuelta. Este tipo de puesta y de protoconcha indica un desarrollo directo sin fase pelágica, pero, a la vez, estas cápsulas muy ligeras y generalmente fijadas a las algas constituyen un potente medio de dispersión pasiva en el caso de que las algas sean arrancadas por el oleaje y floten a la deriva. Considerando la homogeneidad morfológica que se observa entre todas las especies, consideramos que este tipo de desarrollo directo se puede inferir para las demás especies estudiadas.

Notas nomenclaturales: La nomenclatura supraespecífica de este grupo tiene una historia de una complejidad poco común. En ocasiones, se ha incluido este género en la subfamilia Donovaniinae Casey, 1904 (= Lachesinae L. Bellardi, 1877). Ambos nombres son inválidos según el artículo 39 del CINZ, al ser los géneros tipo homónimos más recientes; sin embargo, al no estar en uso, no procede establecer un nombre de sustitución basado en un nombre genérico válido.

En cuanto a la nomenclatura genérica, RISSO (1826) no deja claro cuáles son los caracteres que diferencian *Lachesis* de *Nesaea*, ni hace ninguna comparación entre los dos géneros; además, existen ciertas incoherencias entre las diagnosis genéricas y las de las especies incluidas. Una de las diferencias literales entre las dos diagnosis genéricas está en la espira, que se describe como muy elevada en *Lachesis* y moderadamente elevada en *Nesaea*, si bien esta diferencia no es obvia en las figuras. La otra diferencia literal atañe a la descripción del refuerzo del labio ("peritrema" en el vocabulario de Risso), ausente en *Lachesis* y sencillo y ligeramente desviado hacia dentro en *Nesaea*; en ambos casos se trataría de los caracteres de los juveniles de las figuras 65 y 67 de RISSO (1826). Sin embargo, tanto en las diagnosis de *Nesaea granulata* como de *N. mamillata* este autor indica pliegues (dentículos) en el lado izquierdo (interno) del peritrema (labio), lo cual solamente aparece en su figura 69 de *N. mamillata*, así como en el lectotipo (ARNAUD, 1978; OLIVER Y ROLÁN, 2009: figuras 1-2) de esta especie.

TIBERI (1868) incluye una diagnosis revisada para cada uno de estos dos géneros, pero añade confusión al tener un concepto de *Nesaea granulata* obviamente distinto al de RISSO (1826). Las diferencias literales entre las diagnosis genéricas se resumen a una espira bastante elevada, con vueltas algo convexas, sutura poco profunda y labio sencillo (es decir, sin variz) en *Lachesis*, y espira moderadamente elevada, con vueltas redondeadas, sutura profunda y labio varicoso en el lado externo en *Nesaea*. Quizás sea más aclaratorio el reparto de especies que hizo MONTEROSATO (1884), teniendo a mano la colección de Tiberi que había comprado, y usando *Donovania* (= *Lachesis*) para el grupo de *D. mamillata*, y *Chauvetia* (= *Nesaea*) para *C. granulata* sensu Tiberi, o sea las especies de forma más tosca. Esta distinción carece de importancia, dado que *Donovania* se considera sinónimo de *Chauvetia*.

Existe, además, un problema nomenclatural acerca de la especie tipo de *Chauvetia*. La designación por MONTEROSATO (1884) de *Buccinum candidissimum* Philippi, 1836 es inválida, al no tratarse de una de las especies originalmente incluidas por RISSO (1826) en el género sustituido *Nesaea*. Crosse (1885) designó formalmente "*Nesaea granulata* Tiberi", lo cual se debe entender como una referencia al concepto que TIBERI (1868) tuviera de *Nesaea granulata*. Siendo así, deja de ser una de las especies originalmente incluidas en *Nesaea* y, por lo tanto, no se puede aplicar el artículo 69.2.4 del CINZ sobre especies tipo con identificación errónea, ni aceptar este acto como designación válida. Sin embargo, la designación anterior de *Donovania minima* (Montagu, 1803) como especie tipo de *Donovania* por parte de BUCQUOY, DAUTZENBERG Y DOLLFUS (1883) se aplica también a *Nesaea* (y por consecuencia, a *Chauvetia*) en virtud del artículo 67.8 del CIZN y cumple con los requisitos establecidos en el artículo 69.2.2 al incluir en la sinonimia de *D. minima* una, y una sola (*N. mamillata*), de las especies originalmente incluidas en *Nesaea*. El propio género *Donovania* siendo *nomen novum* simultáneamente para dos géneros distintos (*Nesaea* y *Lachesis*), escapa a las especificaciones del CINZ; de cualquier modo la cuestión es irrelevante, puesto que este nombre también está preocupado.

El lectotipo (ARNAUD, 1978) de *Nesaea granulata* Risso, 1826 es un ejemplar juvenil de color uniforme que asignamos a *C. mamillata*, con localidad tipo implícita en los alrededores de Niza. Sin embargo, BUCQUOY *ET AL.* (1883) y MONTEROSATO (1884), siguiendo el criterio de TIBERI (1868), consideran que *N. granulata* es una especie extremadamente rara y muy distinta, e indican una distribución en el sur de Italia (golfo de Nápoles), las costas norteafricanas y el Adriático. Siendo así, nos parece verosímil la sugerencia por parte de MICALI (1999: 57) de que *Chauvetia granulata* sensu Tiberi sea lo mismo que *C. ventrosa* Nordsieck, 1976, un endemismo centromediterráneo que no se encuentra en las costas ibéricas.

Chauvetia mamillata Risso, 1826 (Figs. 2-14, 23-26, 97-98)

Nesaea mamillata Risso, 1826. *Hist. Nat. Eur. Mérid.*, iv: 223-224, lám. 5, fig. 69. [Localidad tipo: Alpes-Maritimes, Francia].

Nesaea granulata Risso, 1826. *Hist. Nat. Eur. Mérid.*, iv: 223, lám. 5, fig. 67. [Localidad tipo: Alpes-Maritimes, Francia].

Lachesis mamillata Risso, 1826. *Hist. Nat. Eur. Mérid.*, iv: 211, lám. 5, fig. 65. [Localidad tipo: Alpes-Maritimes, Francia].

Fusus turritellatus Deshayes, 1835. *Exp. Sc. Morée, Moll.*: 174, lám. 19 figs. 28, 45. [Localidad tipo: Peloponeso, Grecia].

Buccinum minimum Philippi, 1836 (non Montagu, 1803). *En. Moll. Siciliae,* vol. 1: 222. [Localidad tipo: Palermo y Catania, Sicilia].

Donovania minima var. *attenuata* Bucquoy, Dautzenberg y Dollfus, 1883. *Moll. Roussillon*, vol. 1: 113-114.

Donovania minima var. *submamillata* Bucquoy, Dautzenberg y Dollfus, 1883. *Moll. Roussillon*, vol. 1: 113, lám. 15 fig. 30.

Donovania minima var. *insignis* Bucquoy, Dautzenberg y Dollfus, 1883. *Moll. Roussillon*, vol. 1: 114.

Material tipo: *Nesaea mamillata*: lectotipo (Arnaud, 1978), MNHN 6600 y 4 paralectotipos, MNHN 5599; *Nesaea granulata*: lectotipo (Arnaud, 1978), MNHN 6601; no se han encontrado los tipos de *Lachesis mamillata*, pero fueron examinados junto con los dos anteriores por Monterosato (1872: 48), quién los consideró coespecíficos.

Material estudiado: Baleares: Punta Foradada (Mallorca), 4 c. + 39 j. (6,1 × 2,8 mm), MNCN; Santa Ponça (Mallorca), 6 c. (6,8 × 2,8 mm) + 2 j., MNCN; Menorca (Mahón), 8 c. (5 morfotipo no mamilar, 7,2 × 2,7 mm; 3 morfotipo mamilar, 6,0 × 2,5 mm) + 1 j., col. Hidalgo, MNCN; Menorca (cabo Natí), 2 c. (7,2 × 3,0 mm) + 1 j., MNCN; Ibiza (Cala Eubarco), 1 c. (6,0 × 2,6 mm) + 25 j., MNCN; Ibiza (Punta Galera), 1 c. (7,5 × 2,9 mm) + 9 j., MNCN. Levante ibérico: Columbretes (Placer de la Barra Alta), 2 c. (morfotipo mamilar, 6,5 × 2,8 mm), MNCN; Norte Columbrete Grande (47 m), 3 j., MNCN; Valencia, 17 c. (11 morfotipo mamilar, 6,0 × 2,3 – 7,3 × 3,0 mm, 6 morfotipo no mamilar, 6,3 × 2,9 mm) + 4 j., col. Rosselló en col. Azpeitia, MNCN; Valencia, 3 c. (morfotipo no mamilar, 6,3 × 2,5 mm), col. Boscá en col. Azpeitia, MNCN; Cullera (15 m); 80 c. + 200 j. (todas morfotipo mamilar, 5,7 × 2,4 – 7,3 × 3,0 mm), col. JDO; Denia (arrojadas a la playa), 140 c.+ 100 j. (morfotipo mamilar 40 c. + 40 j., 5,8 × 2,4 – 7,5 × 3,2 mm, morfotipo oscuro 50 c. + 30 j., 5,6 × 2,6 – 7,1 × 3,4 mm, morfotipo con bandas 50 c. + 30 j., 5,5 × 2,3 – 7,0 × 2,6 mm), col. JDO; Jávea (arrojadas a la playa), 11 c. + 17 j. (3 ej. morfotipo mamilar; 11 morfotipo con bandas, 5,1 × 2,0 mm – 6,0 × 2,6 mm + 14 j.), col. JDO; cabo de Palos, 27 c. (15 morfotipo mamilar, 5,3 × 2,3 – 7,1 × 3,2 mm + 14 j.; 12 morfotipo no mamilar, 5,8 × 2,4 – 6,6 × 2,7 mm), MNCN; cabo de Palos, 43 c., (morfotipo mamilar, 5,4 × 2,4 – 6,9 × 3,7 mm), col. Hidalgo, MNCN; cabo de Palos, 5 c. (5,0 × 2,3 – 5,7 × 2,6 mm), col. Azpeitia, MNCN; Cartagena (morfotipo no mamilar), 2 c. (6,2 × 2,5 mm), col. Hidalgo, MNCN. Mar de Alborán y estrecho de Gibraltar: Cabo de Gata, Punta de Loma Pelada (15 m), 3 j. (morfotipo mamillar); Almería, 10 c. (morfotipo con bandas, 7,3 × 3,2 – 7,9 × 3,4 mm), col. A. Sierra, MNCN; Almería (40 m), 506 c. + 22 j. (486 morfotipo con bandas, 4,8 × 2,3 – 6,4 × 2,7 mm; 40 c. + 22 j. morfotipo mamilar, 6,1 × 2,6 – 7,9 × 3,5 mm), col. A. Sierra en col. Cobos, MNCN; Dorsal de la isla de Alborán (35° 58′ N, 02° 58′ W), 15 c. + 45 j. (morfotipo de Alborán, 5,5 × 2,5 – 7,5 × 3,1 mm), MNCN; La Herradura (Granada), 2 ej. (morfotipo con bandas, 7,3 × 3,1 – 7,4 × 3,1 mm), col. SG, MNHN; Calahonda (Málaga), 21 c. (morfotipo con bandas, 5,3 × 2,3 – 6,5 × 2,9 mm), col. SG 1978, MNHN. Sotogrande (Cádiz), bajamar, 13 ej. (5,5 × 2,4 – 6,3 × 2,7 mm) + 34 c. (5,4 × 2,3 – 6,6 × 2,9 mm), col. SG, MNHN; bahía de Algeciras, 4 c. + 1 j. (morfotipo con bandas, 6,6 × 2,9 – 7,1 × 3,4 mm), MNCN; Tarifa, Torre de la Peña, 32 c. (5,8 × 2,6 – 7,7 × 3,4 mm) + 2 j., col. SG, MNHN; Cádiz, 12 c. (morfotipo con bandas, 5,6 × 2,5 – 6,5 × 2,9 mm) col. Hidalgo, MNCN; Cádiz, 5 c. (morfotipo con bandas, 5,1 × 2,5–7,2 × 3,1 mm), col. Azpeitia, MNCN; M'diq (Marruecos), 27 c. + 4 ej. (10 morfotipo algo más claro, resto morfotipo con bandas; 5,2 × 2,3 – 6,4 × 2,6 mm), col. SG, MNHN; Ceuta, Almadraba, 20–36 m, 3 c. (4,9 × 2,2 – 6,3 × 2,8 mm); Ceuta, Sarchal, 0-3 m, 4 ej. (morfotipo con bandas, 5,9 x 2,8 – 6,5 x 3.0 m) + 10 j.; Ceuta, Punta Almina, 25–40 m, 107 ej. + c. (42 morfotipo claro, 6,2 × 2,8 – 7,5 × 3,3 mm; 65 morfotipo con bandas, 5,9 × 2,9 mm – 7,3 × 3,1 mm); Ceuta, puerto, 4 ej. (1 morfotipo claro, resto con bandas; 6,9 × 2,4 – 7,5 × 2,8 mm); Ceuta, Punta del Saudiño, 10 ej. (1 morfotipo con bandas, resto morfotipo claro; 6,1 × 2,6 – 7,1 × 2,9 mm; ejemplar dibujado); Ceuta, Playa Benítez, 15–25 m, 2 c. (7,0 × 3,0 – 7,4 × 3,3 mm); Benzú, infralitoral rocoso, 87 c. (35 morfotipo claro, 5,3 × 2,4 – 7,0 × 3,0 mm; 52 morfotipo con bandas oscuras, 5,5 × 2,5 mm – 7,3 × 3,1 mm) + 4 ej. (morfotipo oscuro, 5,6 × 2,5 – 6,4 × 2,8 mm) + 4 j.; Punta Cires, 1 ej., col. SG, MNHN (morfotipo claro, 6,8 × 2,7 mm) + 1 ej. j.; Tánger, 4 c., col. SG, MNHN (morfotipo claro, 5,5 × 2,4 – 6,8 × 2,9 mm). Portugal: Tavira, Pedra do Barril, 12 c. (5,8 × 2,6 – 6,8 × 2,8 mm); Tavira, Cabanas, 2 ej. + 2 c. (7,0 × 2,7 – 7,3 × 2,9 mm); Sagres, Baía da Baleeira, bajamar, 72 ej. (5,5 × 2,4 – 6,4 × 2,6 mm) + 20 j.; Sagres, Baía da Baleeira 3–15 m, Sagres, Baía da Baleeira 3–15 m, 60 ej. (5,2 × 2,2 – 6,6 × 2,7 mm) + 10 j.; Sagres, Ponta da Baleeira, 17–23 m, 451 ej. (315 morfotipo con bandas oscuras 6,0 × 2,3 – 7,2 × 2,8 mm; 136 morfotipo *affinis* 5,6 × 2,3 – 6,8 × 2,7 mm) + 316 j.; Sagres, Pontal dos Corvos, 5 ej. (6,3 × 2,6 – 7,0 × 2,7 mm); Sagres, Ponta dos Caminhos, 14 c. (6,4 × 2,7 – 6,8 × 2,8 mm) + 4 j. Banco Gorringe: Seamount 1, DW04, 100 c.; DW05, 15 c.; DW06, 7 c.; DW08, 2 j.; DW09, 6 c.; DW32, 1 ej. + 1 j.; DW 33, 5 ej. (5,7 × 2,6 mm) + 2 j. Banco Ampère: "Seamount 1" DW92, 10 c.; DW98, 4 c.

Descripción: Concha de hasta 7,7 mm (generalmente, menos de 7,5 mm), con 5 1/2-6 vueltas de espira convexas, con la sutura bastante marcada.

Protoconcha de 600-650 µm de diámetro máximo (núcleo: 300–350 µm, primera media vuelta: 500–550 µm). Desde el mismo núcleo aparece una escultura de cordoncillos espirales aplanados, de grosor similar a los interespacios, en el fondo de los cuales se aprecian diminutas laminillas transversales paralelas a las líneas de crecimiento; hay 20-22 cordoncillos al final de la primera media vuelta. En la segunda media vuelta se añade una escultura de 4-5 costillas axiales algo sigmoideas y opistoclinas, de anchura similar a los espacios que las separan, sobre las cuales los cordoncillos discurren sin interrupción.

Teleoconcha con ornamentación formada por cordones espirales, el doble de anchos que sus interespacios, y por costillas axiales amplias sobre las cuales los cordones discurren sin discontinuidad e incluso se ensanchan un poco en la parte más saliente de la costilla. En la primera vuelta aparecen normalmente cuatro cordones espirales (a veces 3, en poblaciones del Estrecho y de Alborán);

el cordón subsutural se desdobla en las vueltas siguientes. En la última vuelta, hay un total de 15-17 cordones, de los cuales 4 ó 5 continúan los de la penúltima vuelta, los 5 medios son de un grosor equivalente, y el grosor de los siguientes cordones decrece marcadamente hacia el canal sifonal. Las costillas axiales son suaves y de igual anchura que los interespacios y se reparten de forma aleatoria, sin estar sistemáticamente alineadas entre una vuelta y otra. En la penúltima vuelta se aprecian 11-14 costillas axiales (hasta 15 en algunos ejemplares del Algarve), algo flexuosas y prosoclinas. La última vuelta alcanza en torno al 60% de la altura total, y la abertura en torno al 40%.

Exterior del labio engrosado en los ejemplares adultos, con los cordones que persisten, aunque atenuados, sobre la variz externa. En el interior del labio se observan, en los ejemplares muy adultos, hasta 6-7 dentículos poco pronunciados, alargados hacia el interior de la abertura.

El color de la concha es variable. En el lectotipo de *Nesaea mamillata* y en las demás poblaciones mediterráneas, hasta un límite occidental que se sitúa en la provincia de Almería, aparece un patrón de color amarillento con las intersecciones de cordones y costillas de un color castaño oscuro (Figs. 3 y 5, "morfotipo mamilar" en material examinado). En toda la zona de estudio, el patrón más frecuente es un color castaño claro con los cordones resaltados por bandas castañas más oscuras, incluso sobre el exterior del labio (Figs. 4 y 6). En la isla de Alborán, en algunas localidades del Estrecho (Figs. 7, 8) y en los bancos lusitanos (Fig. 14), este patrón puede estar muy contrastado, con los intervalos entre cordones hasta casi blancos. En la zona del Estrecho, aparecen con frecuencia ejemplares de un color amarillento claro uniforme (Figs. 9, 10). Finalmente, en algunos ejemplares de Sicilia, incluido el posible sintipo de *Chauvetia affinis*, se observa un patrón de color con las intersecciones de los cordones y de las costillas más claras sobre un fondo castaño.

Animal con una pigmentación negra superficial, uniforme o formando densas manchas negras sobre fondo blanco; el extremo anterior y la suela del pie, el espacio que rodea los ojos y la base del sifón son más claros.

Distribución: Mediterráneo; Atlántico, común en el banco Gorringe y el litoral del suroeste ibérico desde el cabo de San Vicente hasta el estrecho de Gibraltar; esporádico en la costa de Marruecos (MICALI, 1999), el banco Ampère y Canarias (PEÑAS Y ROLÁN, 2009)

Notas: Desde el punto de vista nomenclatural, si se consideran coespecíficas *Lachesis mamillata*, *Nesaea granulata* y *N. mamillata*, fue SCACCHI (1836: 12) quien actuó como primer revisor, utilizando el nombre *Murex granulatus* y citando los otros dos nombres como sinónimos. Sin embargo, el uso del nombre *C. mamillata* está tan generalizado que es indeseable un cambio, sobre todo si tenemos en cuenta que los usos posteriores del nombre *C. granulata* se entienden generalmente en el sentido de TIBERI (1868).

La forma mediterránea habitualmente identificada como *Chauvetia mamillata* se caracteriza por un patrón de color en el que las intersecciones de los cordones con las costillas están marcadas por manchas subcuadradas de color castaño oscuro, sobre un fondo amarillento claro. Este patrón no se ha encontrado jamás al oeste de la provincia de Almería. Existen patrones de transición que BUCQUOY *ET AL.* (1883) distinguieron como variedad *submamillata*. En esta revisión nos atenemos a la conclusión de HERGUETA *ET AL.* (2002), de que hay formas con bandas castañas continuas o de color castaño uniforme, sin que por ello se puedan reconocer especies distintas. En todo el estrecho de Gibraltar, las formas de color amarillento pálido uniforme son frecuentes, aunque coexisten con las formas con bandas castañas. En estos ejemplares amarillentos, el albinismo de la concha no se extiende al animal, que sigue mostrando el patrón con pigmentos negros superficiales característico de la especie.

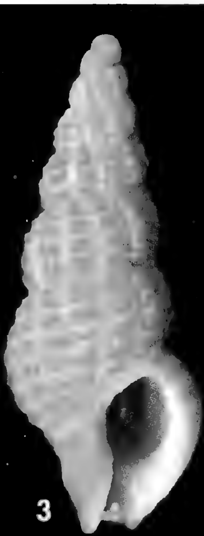
En los bancos submarinos de Gorringe y Ampère, al oeste de Portugal y de Marruecos respectivamente, existen poblaciones que asignamos a *Chauvetia mamillata* y que se parecen mucho a las formas con bandas del estrecho de Gibraltar. Son algo más pequeñas, con un tamaño muy uniforme de unos 6 mm y el patrón de coloración del animal es negro, como en los ejemplares del Estrecho. Los ejemplares vivos se han recogido en la zona fótica, en la parte más somera del Banco Gorringe y las numerosas conchas recogidas hasta unos 500 metros de profundidad fueron probablemente transportadas desde zonas más someras. El aislamiento de los bancos, junto al tamaño necesariamente pequeño de estas poblaciones, son circunstancias que propician su divergencia evolutiva, pero, de momento, las diferencias observadas no pasan de lo que se puede atribuir a la variación intraespecífica.

En las muestras de los alrededores de Sagres, en el extremo sudoccidental de la Península Ibérica y muy cerca del límite norte de distribución, la especie es extremadamente abundante y variable y se encuentra en las mismas muestras que *C. brunnea*, *C. retifera*, *C. dentifera* spec. nov. y *C. taeniata* spec. nov. En muchos ejemplares el número de costillas es más elevado (hasta 15 en la última vuelta, frente a 11-13 habitualmente, Figs. 11, 12), y éstas son menos flexuosas. En este aspecto se aproximan a lo descrito por MONTEROSATO (1889) para su *Chauvetia affinis* "con reticulado áspero como una lima"; sin embargo, existen transiciones con el tipo morfológico más habitual (Fig. 13) y entra en nuestro concepto de *C. mamillata* del sur ibérico. OLIVER Y ROLÁN (2009, figs. 6-9) ilustran ejemplares de Sicilia identificados por Monterosato como *C. affinis* y enviados a Locard, actualmente conservados en el MNHN. Al contrario de la tendencia habitual de *C. mamillata* en el Mediterráneo, estos ejemplares sicilianos tienen las intersecciones de los cordones y las costillas más claras que el color de fondo, con lo que no se puede descartar que se trate de una especie distinta. En los ejemplares portugueses, el color más oscuro se sitúa, como es habitual en *C. mamillata*, sobre los cordones, aunque poco contrastado.

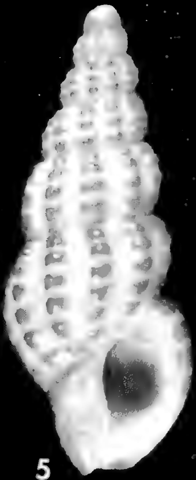
MICALI (1999) distingue a nivel específico entre *Chauvetia mamillata* y *C. turritellata* e ilustra bajo este último nombre tres animales vivos de Aci Trezza (Sicilia), con un patrón de manchas negras mucho más disperso

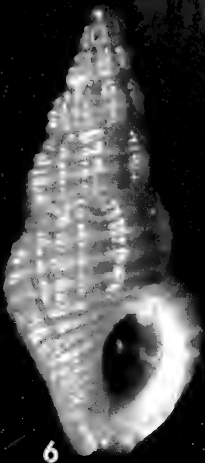
(Página derecha) Figuras 3-14. *Chauvetia mamillata* (Risso, 1826), principales variaciones de la concha en la zona de estudio. 3, 4: patrón con las intersecciones de cordones y costillas de un color castaño oscuro, exclusivo del Mediterráneo, y patrón con bandas castañas, Denia (6,4 y 6,2 mm); 5, 6: los mismos patrones de color, Almería (6,0 y 5,9 mm); 7, 8: patrón con bandas castañas sobre los cordones, habitual en el mar de Alborán, Estrecho y Atlántico, Punta Almina (Ceuta), 32-40 m (6,4 mm); 9, 10: patrón de color muy pálido, frecuente en el Estrecho, Punta del Saudiño (6,7 mm); 11, 12: ejemplar de Sagres, con escultura más fina al modo de *Chauvetia affinis* (5,8 mm); 13: ejemplar de la misma localidad, con la escultura más habitual en *C. mamillata* del mar de Alborán y del Estrecho; 14: ejemplar del Banco Gorringe, Seamount 1, DW33, 55-70 m (5,7 mm).

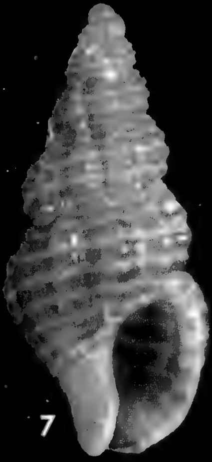
(Right page) *Figures 3-14.* Chauvetia mamillata *(Risso, 1826), most common variants of the shells in the study area. 3, 4: pattern with dark brown intersections of cords and ribs, found only in the Mediterranean, and pattern with brown bands, Denia (6.4 and 6.2 mm); 5, 6: the same colour patterns, Almería (6.0 and 5.9 mm); 7, 8: colour pattern with brown bands over the cords, usual in the Alborán Sea, the Straits and the Atlantic, Punta Almina 32-40 m (6.4 mm); 9, 10: very pale colour pattern, frequent in the Straits, Punta del Saudiño (6.7 mm); 11, 12: specimen from Sagres, with a sculpture in the mode of* Chauvetia affinis *(5.8 mm); 13: specimen from the same locality, with sculpture more as usual in* C. mamillata *from Alborán Sea and the Straits; 14: specimen from Gorringe Bank, "Seamount 1" DW33, 55-70 m (5.7 mm).*

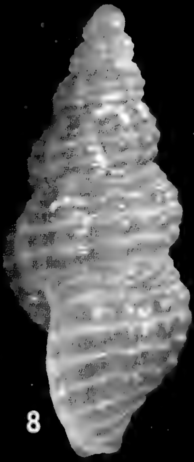

3

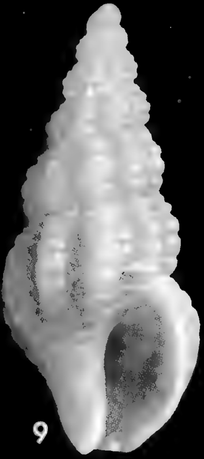

4

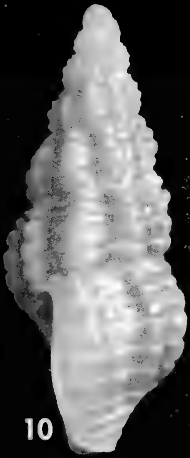

5

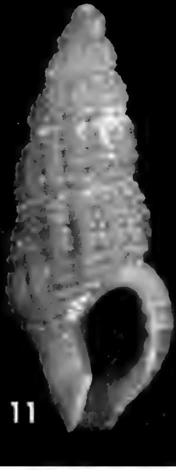

6

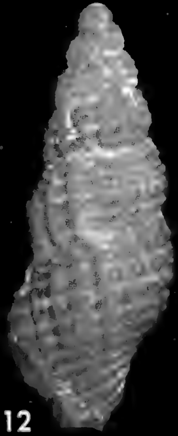

7

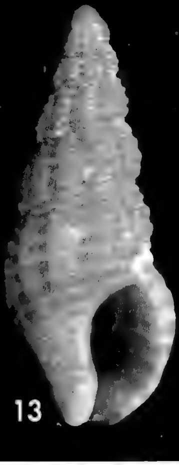

8


9

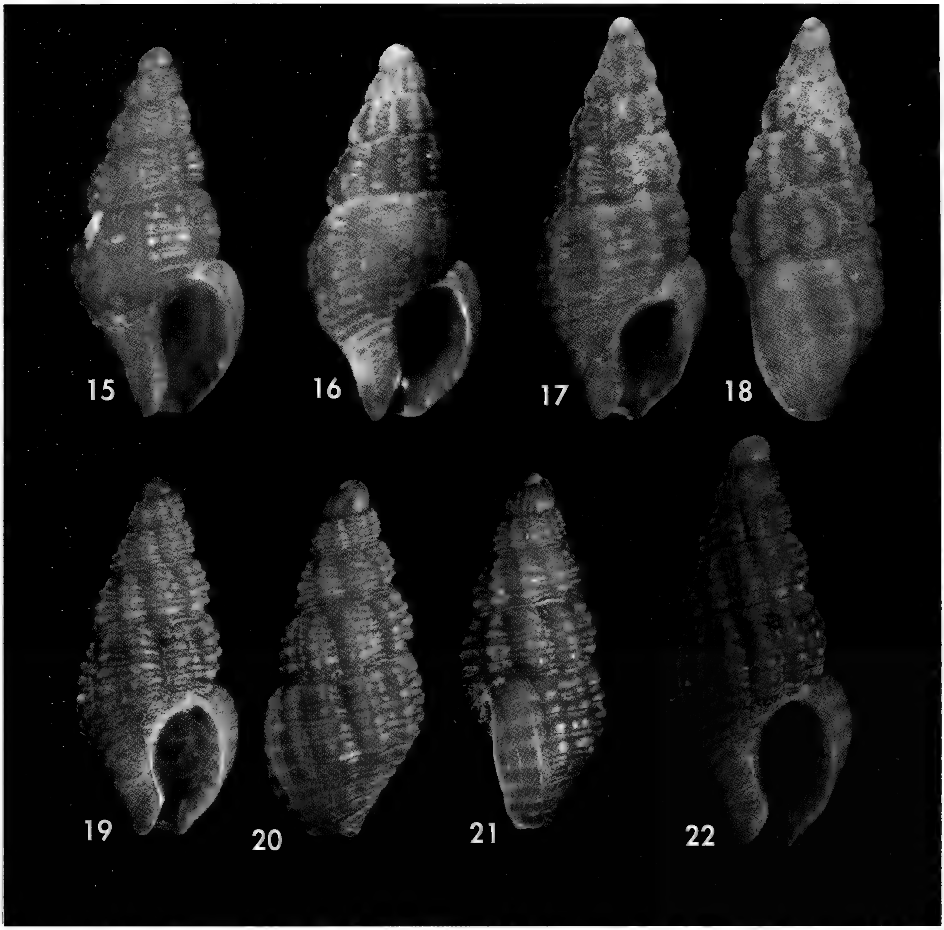

10


11


12


13


14



Figuras 15-18. *Chauvetia brunnea* (Donovan, 1804). 15: ejemplar de Ile de Sein, Bretaña (4,7 mm); 16: ejemplar de La Toja, Galicia (4,0 mm); 17, 18: ejemplar de Baia da Baleeira Sagres, Portugal (5,5 mm); nótese el aspecto liso del exterior de la variz. Figuras 19-22. *Chauvetia maroccana* spec. nov. 19-21: holotipo de El Jadida (4,2 mm); 22: ejemplar de Essaouira (4,8 mm).
Figures 15-18. Chauvetia brunnea *(Donovan, 1804). 15: specimen from Ile de Sein, Brittany (4.7 mm); 16: specimen from La Toja, Galicia (4.0 mm); 17, 18: specimen from Baia do Martinhal, Sagres, Portugal (5.5 mm); note the smooth appearance of the exterior of the varix. Figures 19-22.* Chauvetia maroccana *spec. nov. 19-21: holotype from El Jadida (4.2 mm); 22: specimen from Essaouira (4.8 mm).*

que en los ejemplares del sur de la Península Ibérica. Dicho autor no cita esta última especie en España, aunque sí en el sur de Marruecos, Canarias (se trata de la forma referida por OLIVER Y ROLÁN, 2009 a *Chauvetia affinis*) y Senegal.

En el material estudiado del área iberomarroquí, a pesar de una indiscutible variabilidad, no hemos encontrado criterios que permitan distinguir más de una especie en lo que tratamos aquí como *C. mamillata*. No obstante, se debe de tener en cuenta que la localidad tipo de *Fusus turritellatus* se sitúa en el Peloponeso, en la cuenca oriental del Mediterráneo y que la revisión de dicho taxón debe contar con material procedente de esta zona.

Chauvetia brunnea (Donovan, 1804) (Figs. 15-18, 27-30, 99-100)

Buccinum minimum Montagu, 1803. *Test. Brit.*: 247, lám. 8, fig. 2. [Localidad tipo: Devon, Gran Bretaña; preocupado por *Buccinum minimum* Berckenhout, 1795; *Buccinum minimum* Turton, 1802].

Buccinum brunneum Donovan, 1804. *Brit. Sh.* vol. 5: lám. 179, fig. 2. y explicación de la lámina (no paginada) [Localidad tipo: Cornwall, Gran Bretaña].

Fusus subnigris Brown, 1827. *Ill. Conch.*: 5 , lám. 48, figs. 58-59.

Buccinum rubrum Potiez y Michaud, 1838. *Catal. Mus. Douai*, I: 381, lám. 32, fig. 17-18.

Lachesis minima var. *pallescens* Jeffreys, 1867. *Brit. Conch.* vol. iv: 313.

Material estudiado: Canal de la Mancha y Bretaña: Guernesey, Rocquaine Bay (49° 27′ N, 02° 39′ W), bajamar, 2 ej. (4,4 × 1,9 mm, ejemplar dibujado), col. SG, MNHN; Roscoff, "les Cochons Noirs", –20 m, 1 ej. (4,6 × 2,1 mm), col. SG, MNHN; Ploumanac'h, en *Corallina* en bajamar, 5 j., col. SG, MNHN; Ile de Sein, bajamar, 2 ej. (4,3 × 2,1 – 4,7 × 2,1 mm) + 5 j.; Lampaul-Ploudalmézeau, bajamar, 2 j., col. SG, MNHN; Baie de Bertheaume 20-30 m, 17 c. (3,6 × 1,8 – 4,7 × 2,1 mm), col. SG, MNHN. Asturias: Muros, 1 ej. (4,7 × 2,1 mm, ejemplar dibujado). Galicia: La Toja, 1c. (4 × 1,8 mm), col. JDO. Portugal: Sagres, Ponta da Baleeira 17–23 m, 52 ej. (4,3 × 2,3 – 5,6 × 2,1 mm); Sagres, Baia da Baleeira, bajamar, 10 ej. (4,5 × 2,0 – 5,3 × 2,3 mm); Sagres, Baia da Baleeira, 3–15 m, 1 ej. (5,0 × 2,0 mm); Sagres, Ponta dos Caminhos, 4 c. (4,5 × 2 – 4,8 × 2,1 mm); Sagres, Pontal dos Corvos, 1 ej. (5,0 × 2,1 mm); Tavira, Pedra do Barril, 3 ej. (5,4 × 2,4 – 5,7 × 2,4 mm); Tavira, Cabanas, 1 ej. (5,7 × 2,4 mm) + 1 j. Estrecho de Gibraltar y mar de Alborán: Calahonda (Málaga), 1 ej. (5,2 × 2,3 mm), col. SG 1978, MNHN; Sotogrande (Cádiz), bajamar, 2 ej. (morfotipo claro, 4,9 × 2,0 – 5,6 × 2,5 mm) + 2 c. (4,2 × 1,9 – 4,9 × 2,2 mm), col. SG, MNHN; Tarifa, Torre de la Peña, 1 c. (5,2 × 2,2 mm), col. SG, MNHN; Ceuta, Sarchal, 0-3 m, 4 ej. (4,2 × 1,8 – 5,0 × 2,1 mm); Ceuta, Punta Almina, 25–40 m, 4 ej. (conchas muy claras, 5,0 × 2,2 – 5,2 × 2,2 mm, ejemplar dibujado); Ceuta, Benzú, 0–4 m, 1 ej. (5,0 × 3,2 mm, ejemplar dibujado).

Descripción: Concha de hasta 5,7 mm (generalmente, menos de 5 mm), con cuatro a cinco vueltas de espira convexas, con la sutura bastante marcada.

Protoconcha de 500-550 μm de diámetro máximo (núcleo: 260-300 μm, primera media vuelta: 400-450 μm). El núcleo es inicialmente casi liso, luego aparece una escultura de cordoncillos aplanados y desiguales, más anchos que los interespacios, en el fondo de los cuales se aprecian diminutas laminillas transversales paralelas a las líneas de crecimiento. En algunos ejemplares bien conservados, los cordoncillos se manifiestan desde el núcleo; hay 20-25 cordoncillos al final de la primera media vuelta. En la segunda media vuelta aparece una escultura de costillas axiales algo sigmoideas y opistoclinas, de anchura similar a los espacios que las separan, y sobre las cuales los cordoncillos tienden a atenuarse.

Teleoconcha con ornamentación formada por cordones espirales, el doble de anchos que sus interespacios, y por costillas axiales amplias, sobre las cuales los cordones discurren sin discontinuidad o incluso se ensanchan un poco en la parte más saliente de la costilla. En la primera vuelta aparecen normalmente cuatro cordones, que persisten en las vueltas sucesivas de la espira; el cordón subsutural está a veces algo desdoblado al final. En la última vuelta hay un total de 17-18 cordones, de los cuales cuatro continúan los de la penúltima vuelta, los 5 medios son de un grosor equivalente y los que cubren el canal sifonal son marcadamente más finos. Las costillas axiales son 9-10 en la penúltima vuelta, casi ortoclinas, algo más estrechas que los interespacios y con tendencia a alinearse aproximadamente entre una vuelta y otra. La última vuelta alcanza el 61% de la altura total, mientras que la abertura ocupa en torno al 42%.

Exterior del labio muy engrosado en los ejemplares adultos, sobre todo en su porción adapical, que suele formar una variz en la cual los cordones están extremadamente atenuados o incluso llegan a desaparecer, siendo la parte adapical completamente lisa. En el interior del labio se observan, en los ejemplares muy adultos, hasta 6-7 dentículos poco pronunciados, alargados hacia el interior de la abertura.

El color de la concha es castaño uniforme. Animal de color amarillento uniforme, con puntitos blancos brillantes.

Distribución: Desde el Canal de la Mancha hasta el estrecho de Gibraltar, sin citas comprobadas para el Mediterráneo más al este del extremo occidental del mar de Alborán. Esta distribución un tanto extraña la tiene también el rissóido *Setia pulcherrima* (Jeffreys, 1848) y el pulmonado *Otina ovata* (Brown, 1827).

Notas: Coincidimos con MONTEROSATO (1884: 136) y con HERGUETA *ET AL*. (2002) en considerar que esta especie atlántica con localidad tipo en Gran Bretaña es distinta a la que predomina en el Mediterráneo occidental (*C. mamillata*) y que se ha confundido habitualmente con ella (BUCQUOY *ET AL*. 1883, entre otros).

Chauvetia brunnea es más pequeña que la especie mediterránea, superando poco los 5 mm, tiene menos costillas axiales en la última vuelta (9-10), el lado adapical externo de la variz del labio es liso y brilloso, sin que se marque la continuación de los cordones de la última vuelta y la concha suele ser monocroma; en *C. mamillata*, los cordones, y eventualmente sus bandas oscuras, se continúan, aunque atenuados, sobre la parte externa del labio. El animal de *C. brunnea* es siempre amarillento con puntitos blancos, sin ninguna marca negra por muy oscura que sea la concha, mientras que es negro liso o densamente moteado de negro en *C. mamillata*, también en los individuos con concha clara.

Las muestras de los alrededores de Ceuta contienen unos pocos ejemplares que se caracterizan por un color muy claro, amarillento, de la concha. El animal de estos ejemplares carece completamente de pigmentos negros y se ajusta al patrón observado en el Atlántico europeo; por esta razón, se consideran como pertenecientes a *C. brunnea*.

Chauvetia maroccana spec. nov. (Figs. 19-22, 31-34)

Material tipo: Holotipo [ej., 4,2 × 1,9 mm], col. SG 1991 (MNHN 22868) y 10 paratipos (5 ej., MNHN 22869, 5 ej. MNCN 15.05/53585), todos de la localidad tipo.

Material estudiado: Marruecos: Temara, bajamar, 3 ej. (4,5 × 1,9 – 4,7 × 2,1 mm) + 7 j.; El Jadida, bajamar, 43 ej. (3,9 × 1,8 – 4,9 × 2,1 mm; incluye material tipo) + 28 j. Essaouira, bajamar, 41 ej. + 40 j. (4,2 × 1,9 – 5,1 × 2,3 mm).

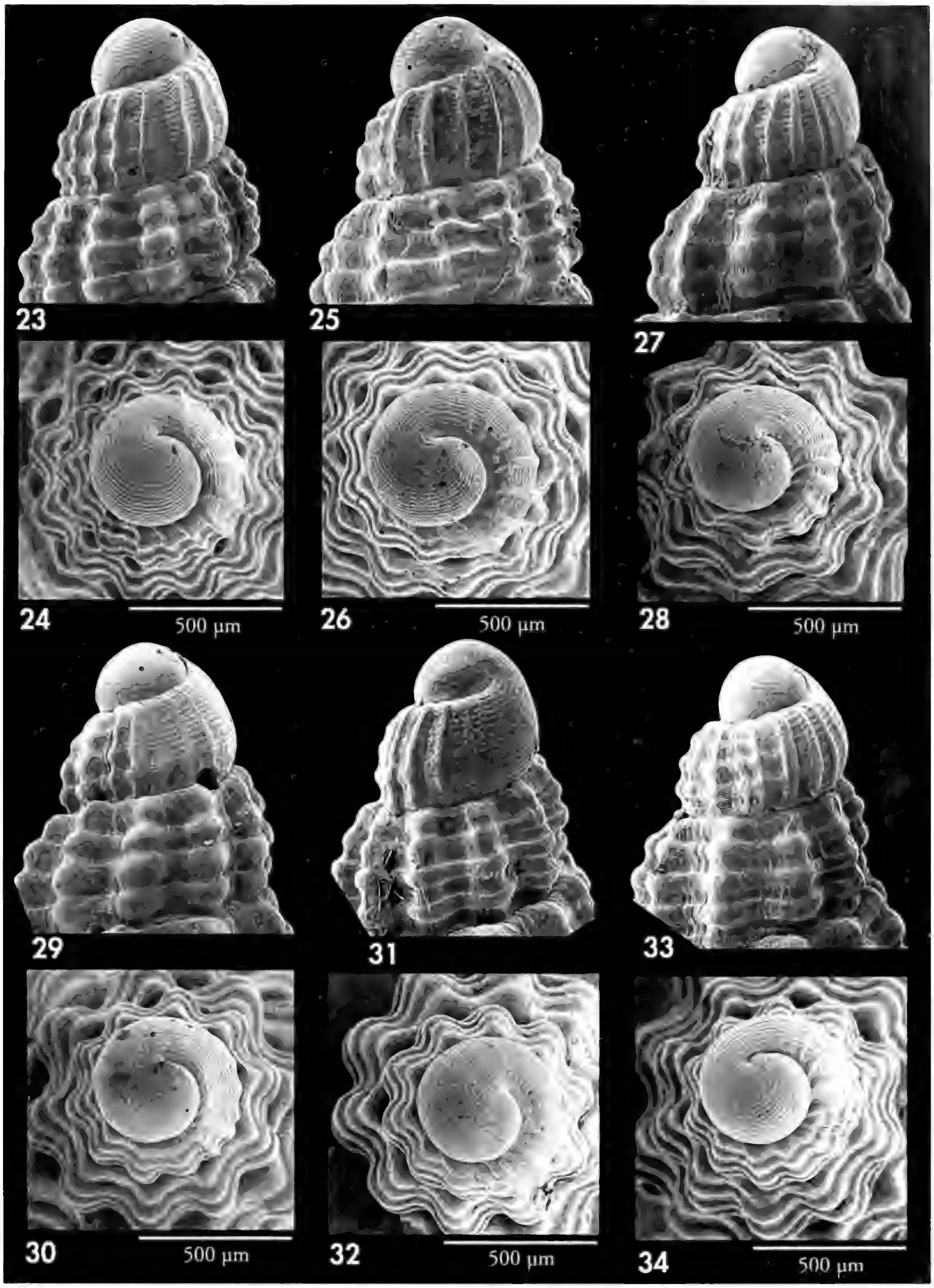
Localidad tipo: El Jadida, Marruecos (33º 15,1′ N – 08º 29,7′ W, intermareal).

Etimología: El nombre alude a la distribución geográfica de la especie en la costa marroquí.

Descripción: Concha de hasta 5,1 mm (generalmente menos de 5 mm), con unas cuatro vueltas de espira convexas, con la sutura bastante marcada.

Protoconcha de 500-550 μm de diámetro máximo (núcleo: 260-300 μm, primera media vuelta: 400-450 μm). Desde el núcleo aparece una escultura de cordoncillos aplanados, desiguales, más estrechos que los interespacios o iguales a ellos, en el fondo de los cuales se aprecian diminutas laminillas transversales paralelas a las líneas de crecimiento; hay 20-25 cordoncillos al final de la primera media vuelta. En la segunda media vuelta aparece una escultura de costillas axiales algo sigmoideas y opistoclinas, de anchura similar a los espacios que los separan, sobre las cuales los cordoncillos tienden a atenuarse.

Teleoconcha con ornamentación formada por cordones espirales altos, más estrechos o igual de anchos que sus interespacios, y por costillas axiales amplias, sobre las cuales los cordones discurren sin discontinuidad. En la primera vuelta aparecen cuatro cordones, que persisten en las vueltas sucesivas de la espira y están nítidamente delimitados de los interespacios. En la última vuelta hay un total de 18-20 cor-



Figuras 23, 34. Protoconchas en vista lateral y apical, todas a la misma escala. 23-24: *Chauvetia mamillata*, Punta de Loma Pelada, Almería; 25, 26: *Chauvetia mamillata*, Punta da Baleeira, Sagres; 27, 28: *Chauvetia brunnea*, Tarifa; 29, 30: *Chauvetia brunnea*, Baia da Baleeira, Sagres; 31-34: *Chauvetia maroccana* spec. nov., El Jadida.

Figures 23, 34. Protoconchs in lateral and apical views, all to scale. 23-24: Chauvetia mamillata, *Punta de Loma Pelada, Almería; 25, 26:* Chauvetia mamillata, *Punta da Baleeira, Sagres; 27, 28:* Chauvetia brunnea, *Tarifa; 29, 30:* Chauvetia brunnea, *Bay of Baleeira, Sagres; 31-34:* Chauvetia maroccana *spec. nov., El Jadida.*

dones, de los cuales cuatro continúan los de la penúltima vuelta, los 5 medios son de un tamaño equivalente y los que cubren el canal sifonal son marcadamente más finos. Las costillas axiales son 9-10 en la penúltima vuelta, relativamente rectas, equivalentes a los interespacios y con tendencia a alinearse aproximadamente entre una vuelta y otra. La última vuelta alcanza menos del 60% de la altura total, mientras que la abertura ocupa en torno al 40%.

Exterior del labio engrosado en los ejemplares adultos, formando una variz en la cual los cordones se continúan, aunque algo atenuados. En el interior del labio se observan, en los ejemplares adultos, hasta 5-6 dentículos poco pronunciados, alargados hacia el interior de la abertura.

El color de la concha es castaño oscuro uniforme. Animal de un color amarillento uniforme, con puntos de color blanco brillante.

Distribución: Esta especie se ha encontrado hasta ahora sólo en las muestras procedentes de tres localidades de la costa atlántica marroquí, en lavados de algas del piso intermareal.

Notas: Se parece mucho a *Chauvetia brunnea* por el tamaño y el color del animal, pero se diferencia claramente por tener hasta una vuelta menos en la teleoconcha, un perfil de espira menos puntiagudo en un tamaño comparable y, sobre todo, en la forma de los cordones espirales, que son de igual anchura o más estrechos que los interespacios (compárense las figuras 27 y 29 con las figuras 31 y 33) y ello, desde las primeras vueltas. Los cordones espirales están nítidamente delimitados y, a diferencia de *C. brunnea,* se continúan sobre la parte externa del labio. *Chauvetia maroccana* forma abundantes poblaciones en el piso intermareal de dos de los tres lugares donde fue recolectada, siendo allí uno de los moluscos más abundantes, mientras *C. brunnea* suele ser poco abundante, incluso en localidades como Sagres, donde son abundantes otras especies del género.

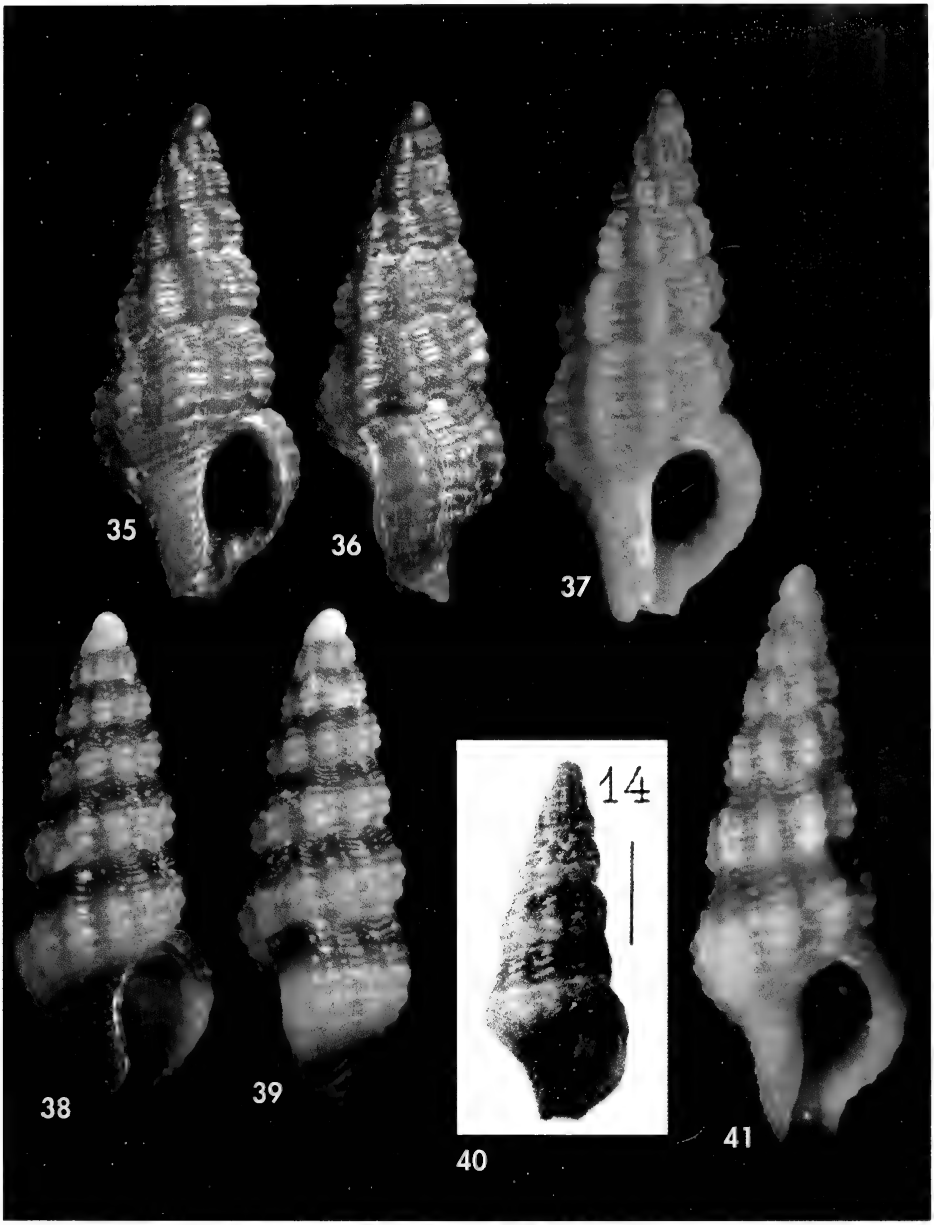
La especie marroquí tiene también un cierto parecido con *Chauvetia borgesi* Oliver y Rolán 2009, de Canarias, pero, con un tamaño comparable, esta última se diferencia por tener cinco cordones espirales en las primeras vueltas de la teleoconcha, que son más anchos que los interespacios; el animal de *C. borgesi* se diferencia por tener el sifón pigmentado de negro.

Chauvetia procerula (Monterosato, 1889) (Figs. 35-41, 42-45)

Donovania procerula Monterosato, 1889. *J. Conchyl.* 37: 116. [Localidad tipo: Casablanca, Marruecos y Argel, Argelia].

Material tipo: No mencionado por Micali (1999) entre las *Chauvetia* de la colección Monterosato en Roma.

Material examinado: Levante ibérico: Islas Columbretes (Placer de la Barra Alta), 2 c. (7,9 × 2,9 mm), MNCN; Denia (arrojadas a la playa), 2 c. (6,5 × 2 ,7 – 8,3 × 3,5 mm) + 6 j., col. JDO; Cullera (15 m), 3 c. (6,8 × 2,7 – 7,3 × 3,0 mm), col. JDO; Jávea (arrojada a la playa), 1 j., col. JDO. Mar de Alborán y estrecho de Gibraltar: isla de Alborán, 5 c. (7,1 × 3,0 – 7,9 × 3,1 mm) + 35 j., col. JDO; Rincón de la Victoria (Málaga), 1 c. (8,3 × 3,3 mm), col. SG, MNHN; Benalmádena costa (Málaga), 2 ej. (6,8 × 2,7 – 7,0 × 2,8 mm), col. SG; Sotogrande (Cádiz), 1 j.; Tarifa, Torre de la Peña, 1 c. (7,3 × 3,0 mm); Barbate, 29 m, 1 j., col. SG; Cabo de Trafalgar (36° 08′ N, 06° 01′ W), 4 j., MNCN; Cádiz, 22 c. (7,2 × 3,1 – 8,5 × 3,7 mm) + 4 j., col. Azpeitia MNCN; M'diq (200 m), 1 c. (7,3 × 3,1 mm), col. "Al Mounir", MNHN; Ceuta, Punta Almina, 25-40 m, 3 ej. (7,2 × 3,0 – 8,2 × 3,4 mm) + 2 j.; Ceuta, playa en el puerto, 2 c. (8,1 × 3,1 y 8,4 × 3,2 mm); Ceuta, Punta del Saudiño, 1 ej. (7,2 × 3,0 mm, ejemplar dibujado); Tánger, 12 c. (6,8 × 2,9 – 8,1 × 3,3 mm), coll. SG, MNHN. Portugal: Tavira, Pedra do Barril, 33 c. (6,7 × 2,8 – 8,7 × 3,6 mm) + 34 c. j.; Algarve (36° 58,0′ N, 08° 55,6′ W, 65 m), 1 c. (7,9 × 3,2 mm) + 1 j., col. Pérès, Gautier, Vacelet 7,8,1957, MNHN; Sagres, Baía da Baleeira, 3-15 m, 36 ej. (6,6 × 2,7 – 9,4 × 3,6 mm, ejemplar dibujado); Sagres, Ponta da Baleeira, 17-23 m, 31 ej. (7,7 × 3,2 – 9,7 × 3,6 mm, ejemplar dibujado) + 30 j.; Sagres, Pontal dos Corvos, 5 ej. (8,0 × 3,3 – 8,9 × 3,5 mm);



Figuras 35-41. *Chauvetia procerula* (Monterosato, 1889). 35, 36: ejemplar de Benalmádena, Málaga (6,8 mm); 37: ejemplar de Denia (7,2 mm); 38, 39: ejemplar con el patrón de color con banda blanca, Benzú, Ceuta (7,2 mm); 40: ilustración de PALLARY (1902, fig. 14), correspondiente al concepto que dicho autor tenía de *Chauvetia decorata* Monterosato, 1889, Tánger; 41: otro ejemplar con banda blanca, Cádiz (7,7 mm).

Figures 35-41. Chauvetia procerula *(Monterosato, 1889). 35, 36: specimen from Benalmádena, Málaga (6.8 mm); 37: specimen from Denia (7.2 mm); 38, 39: specimen with a colour pattern with a white band, Benzú, Ceuta (7.2 mm); 40: illustration in PALLARY (1902, fig. 14) matching this author's concept of* Chauvetia decorata *Monterosato, 1889, Tangiers; 41: another specimen with a white band, Cádiz (7.7 mm)*

Sagres, Ponta dos Caminhos, 9 c. (7,8 × 3,2 – 8,8 × 3,6 mm); entre Faro y Sagres, redes de pesca, 2 ej. (subadultos, 6,5 × 2,5 – 7,3 × 3,0 mm, ejemplares dibujados); entre Salema y Praia da Luz, redes de pesca –70 m, 10 ej. (morfotipo claro, 7,3 × 3,0 – 8,6 × 3,4 mm). *Patrón de color con banda blanca*: Punta Almina (Ceuta), 25-40 m, 1 c. (7,2 × 2,6 mm); Ceuta, Punta del Saudiño, 2 ej. (7,0 × 2,9 – 7,1 × 3,1 mm, ejemplar dibujado); Ceuta, Benzú, 12 c. 6,4 × 2,7 – 7,7 × 3,1 mm), col. SG, MNHN; Tánger (arrojadas a la playa), 7 c. (6,0 × 2,7 – 6,8 × 2,8 mm), col. SG, MNHN; Asilah, 1 j., col. SG, MNHN; Mohammedia, 2 c. (6,7 × 2,6 mm), col. SG, MNHN.

Descripción: Concha de hasta 9,7 mm (generalmente menos de 8 mm), con 6–6$^1/_2$ vueltas de espira convexas, con la sutura bastante marcada.

Protoconcha de 600-650 μm de diámetro máximo (núcleo: 350-400 μm, primera media vuelta: 500-550 μm). Desde el mismo núcleo aparece una escultura de cordoncillos aplanados y anchos, bien visibles en microscopía óptica, desiguales entre sí, mucho más anchos que los interespacios, en el fondo de los cuales se aprecian diminutas laminillas transversales paralelas a las líneas de crecimiento; hay 15-16 cordoncillos al final de la primera media vuelta. En la segunda media vuelta se añade una escultura de costillas axiales algo sigmoideas y opistoclinas, de anchura progresivamente mayor hasta el principio de la teleoconcha; en esta parte, los cordoncillos espirales se vuelven más altos o pasan a ser más estrechos que los interespacios.

Teleoconcha con ornamentación formada por cordones espirales, de anchura equivalente a sus interespacios, y por costillas axiales amplias sobre las cuales los cordones discurren sin discontinuidad e incluso se vuelven más gruesos, formando tubérculos a modo de perlas. En la primera vuelta aparecen cuatro cordones espirales; el cordón subsutural se desdobla en la tercera vuelta, de modo que hay 5 cordones en la penúltima vuelta. En la última vuelta, hay un total de 19-20 cordones, de los cuales 5 continúan los de la penúltima vuelta, los 5 medios son de un tamaño equivalente y, en la parte abapical, los cordones decrecen progresivamente en tamaño. Las costillas axiales son altas y más estrechas que los interespacios y tienden a alinearse entre vueltas sucesivas. En la penúltima vuelta se aprecian 9-10 costillas axiales algo prosoclinas. La última vuelta alcanza el 57% de la altura total, mientras que la abertura ocupa en torno al 39%.

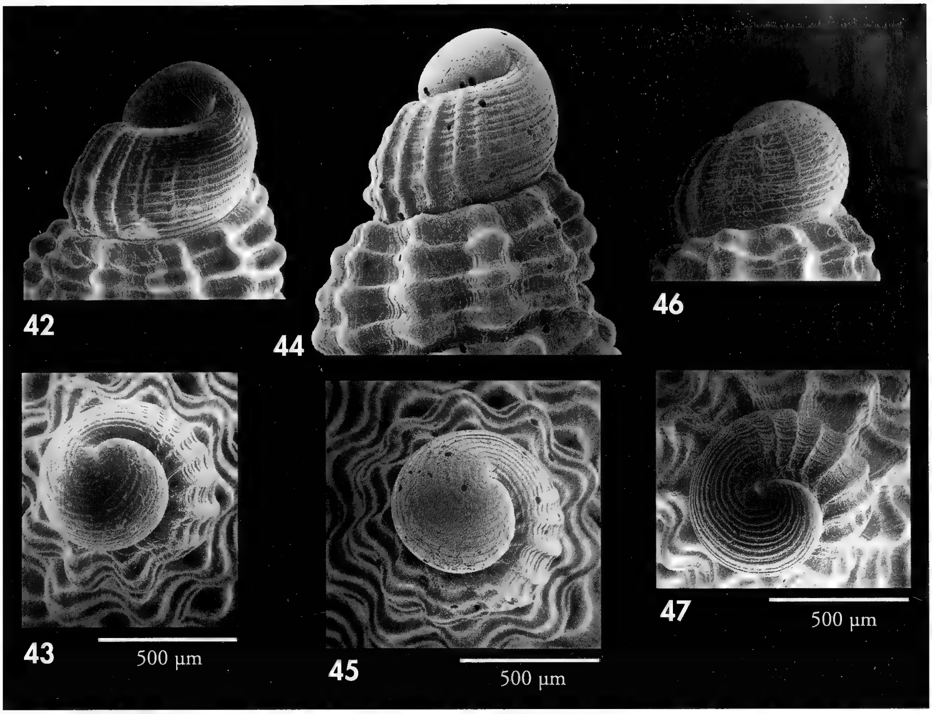
Exterior del labio muy engrosado en los ejemplares adultos con los cordones continuados, aunque algo atenuados, sobre la variz externa. El perfil de la última vuelta está marcadamente estrechado en su tercio abapical alrededor del canal, que así aparece más prominente. En el interior del labio se observan, en los ejemplares adultos, hasta 7-8 dentículos poco pronunciados, alargados hacia el interior de la abertura.

El color de la concha es habitualmente castaño uniforme, en algunos casos amarillento claro; en ningún caso los cordones se destacan con un color distinto a los interespacios. En el estrecho de Gibraltar y en la costa atlántica marroquí aparecen ejemplares con la protoconcha casi blanca, la teleoconcha castaña en la mitad adapical de las vueltas y en la parte abapical de la última vuelta, con una zona blanca en la mitad abapical de las vueltas de espira, continuada como una banda en la mitad de la última vuelta.

El animal es de color negro uniforme, tendiendo a veces a más pálido en la parte anterior del pie y en los tentáculos cefálicos; una zona descolorida bajo el opérculo, donde éste hace contacto con el pie.

Distribución: Mediterráneo; Atlántico, común en el litoral del suroeste ibérico desde el cabo de San Vicente hasta el estrecho de Gibraltar; esporádico en la costa de Marruecos (MONTEROSATO, 1889; MICALI, 1999) y Canarias (OLIVER Y ROLÁN, 2009). La cita en Senegal de MICALI (1999) se da por dudosa, puesto que la especie no fue confirmada en el extenso material estudiado por OLIVER Y ROLÁN (2008).

Notas: Los cordoncillos de la protoconcha en esta especie son marcada-



Figuras 42-47. Protoconchas en vista lateral y apical. 42, 43: *Chauvetia procerula*, con patrón de color uniforme, isla de Alborán y Denia. 44, 45: *Chauvetia procerula*, con banda blanca, Benzú. 46, 47: *Chauvetia recondita*, Denia e isla de Alborán.
Figures 42-47. Protoconchs in lateral and apical views, all to scale. 42, 43: Chauvetia procerula, *with a uniform colour pattern, Alborán Island and Denia. 44, 45:* Chauvetia procerula, *with a white band, Benzú. 46, 47:* Chauvetia recondita, *Denia and Alborán Island.*

mente más anchos que en *C. mamillata*; la teleoconcha difiere por tener las costillas axiales más altas y los cordones no más anchos que los interespacios. El perfil de la última vuelta está más marcadamente estrechado alrededor del sifón que en las demás especies.

El color de la concha suele ser castaño uniforme, sin formar bandas sobre los cordones. Las formas con banda blanca del estrecho de Gibraltar y de Marruecos fueron identificadas por PALLARY (1902) con *Chauvetia decorata* Monterosato, 1889. Este patrón de color de la concha existe en al menos cuatro especies de la zona y, teniendo en cuenta que Pallary se correspondía con Monterosato durante su estudio de la fauna de Marruecos, podríamos pensar que su interpretación (Fig. 40) ha de ser la correcta. Sin embargo, cuesta aceptar que MONTEROSATO (1889), en el auge de su trayectoria malacológica, describiese en el mismo trabajo dos variantes de color bajo nombres genéricos (*Donovania* y *Chauvetia*) distintos, por lo que identificamos *C. decorata* con otro taxón descrito más adelante.

Estos ejemplares con banda blanca coinciden con los demás de *C. procerula* en la protoconcha con cordoncillos anchos, así como en el color completamente negro del animal. Por esta razón, consideramos tentativamente estos ejemplares dentro de la variabilidad de *C. procerula*, a falta de otros caracteres diferenciales que se puedan correlacionar con el color de concha.

MICALI (1999: 58) figuró ilustró un animal vivo de Aci Trezza (Sicilia) atribuido a *C. procerula*. Sin embargo, este animal se diferencia por un color del cuerpo amarillento con puntos brillantes, completamente distinto de lo observado en los ejemplares del sur de la Península Ibérica. Cabe la posibilidad de que sea una especie distinta, pero hay que ser prudente en la interpretación de este carácter, puesto que hemos observado ejemplares con la pigmentación negra atenuada o ausente en algunas muestras del Algarve.

Chauvetia recondita (Brugnone, 1873) (Figs. 46-47, 48-51, 103)

Lachesis recondita Brugnone, 1873. *Misc. Malac.*: 10, fig. 15. [Localidad tipo: Palermo, Sicilia, fósil del Plio-Pleistoceno].

Lachesis vulpecula Monterosato, 1874. *J. Conchyl.*: 276. [Localidad tipo: Capo San Vito, Sicilia].

? *Chauvetia vulpecula attenuata* Nordsieck, 1976. [Preocupado por *Donovania minima* var. *attenuata* Bucquoy, Dautzenberg y Dollfus, 1883].

Material tipo: Dos sintipos de *Lachesis vulpecula* en MNHN, col. Locard ex Monterosato (4,8 × 2,2 – 5,2 × 2,3 mm). Los tipos de *L. recondita* podrían estar en la col. Jeffreys del USNM.

Material estudiado: Islas Baleares: Ibiza (Bleda Mayor), 4 j., MNCN; Ibiza (Cala Eubarco), 2 j., MNCN. Levante ibérico: Denia, 10 c. (5,3 × 2,1 – 6,4 × 2,6 mm) + 13 j., col. JDO; Cullera, 5 c. + 2 j. (5,9 × 2,7 – 5,8 × 2,2 mm), col. JDO; Columbretes 1c. +1 j., MNCN. Sicilia: Banco Skerki (37° 53,6′ N, 10° 48,6′ E, 113 m), 1 c. (4,8 × 2,1 mm), leg. Taviani 12-1996, Museo di Zoologia, Bologna. Mar de Alborán y estrecho de Gibraltar: Dorsal de la isla de Alborán (35° 58′ N, 02° 58′ W), 4 j., MNCN; isla de Alborán, 16 c. (5,5 × 2,7 – 6,5 × 2,9 mm) + 50 j., col. JDO; Cádiz, 1 c. (5,6 × 2,5 mm), col. Azpeitia, MNCN; Ceuta, Punta Almina, 25-40 m, 1 ej. + 5 c. (4,5 × 2,3 – 5,5 × 2,5 mm, ejemplar dibujado); Ceuta, Almadraba 20-36 m, 2 c. (5,9 × 2,7 mm); M'diq (35° 41,5′ N, 05° 12,0′ W, 200 m), 1 c. (4,7 × 2,2 mm), col. "Al Mounir", MNHN; Marbella (Málaga), 1 j.; Estrecho de Gibraltar [sin más precisión], 3 j. Portugal: Algarve (36° 58,0′ N, 08° 55,6′ W, 65 m), 1 c. (5,2 × 2,4 mm), leg. Pérès, Gautier, Vacelet 7-8-1957, MNHN; Tavira, 15 ej. (3,7 × 1,8 – 5,8 × 2,4 mm).

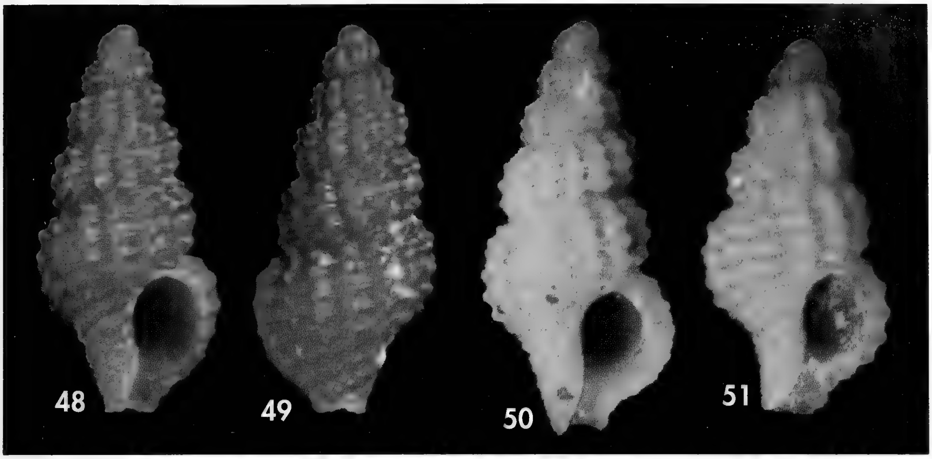
Descripción: Concha de hasta 6,5 mm, con $5^1/_2$–6 vueltas de espira convexas, con la sutura muy marcada.

Protoconcha de 620-650 µm de diámetro máximo (núcleo: 350-400 µm, primera media vuelta: 500 µm). Desde el mismo núcleo aparece una escultura de cordoncillos altos, bien visibles en microscopía óptica, de anchura equivalente a los interespacios, en el fondo de los cuales se aprecian diminutas laminillas transversales paralelas a las líneas de crecimiento; hay 16-18 cordoncillos al final de la primera media vuelta. Desde el inicio de la segunda media vuelta se añade una escultura de costillas axiales algo sigmoideas y opistoclinas, altas, más estrechas que los espacios que las separan, sobre las cuales continúan los cordoncillos.

Teleoconcha con ornamentación formada por cordones espirales altos, algo más estrechos que sus interespacios, y por costillas axiales sobre las cuales los cordones discurren formando tubérculos a modo de perlas. En la primera vuelta aparecen cuatro cordones espirales que se mantienen a lo largo de la espira. En la última vuelta, hay 14-15 cordones, de los cuales 4 continúan los de la penúltima vuelta, los 5 medios son de un tamaño equivalente y, en la parte abapical, los cordones decrecen algo en tamaño. Las costillas axiales son altas y más estrechas que los interespacios y se distribuyen aleatoriamente entre vueltas sucesivas. En la penúltima vuelta se aprecian 9-10 costillas axiales algo prosoclinas. La última vuelta alcanza el 60% de la altura total, mientras que la abertura ocupa en torno al 40%.

Exterior del labio muy engrosado en los ejemplares adultos, con los cordones continuados sobre la variz externa. En el interior del labio se observan, en los ejemplares adultos, hasta 6-7 dentículos poco pronunciados, alargados hacia el interior de la abertura.

El color de la concha es castaño, en algunos casos amarillento claro, frecuen-



Figuras 48-51. *Chauvetia recondita* (Brugnone, 1873). 48, 49, ejemplar de Punta Almina, Ceuta (5,2 mm); 50, 51: ejemplares de la isla de Alborán (5,5 y 4,5 mm).
Figures 48-51. Chauvetia recondita *(Brugnone, 1873). 48, 49, specimen from Punta Almina, Ceuta (5.2 mm); 50, 51: specimens from Alborán Island (5.5 and 4.5 mm).*

temente con una línea más oscura a lo largo de los cordones espirales. El animal es de color negro moteado, tendiendo a más pálido en la parte anterior del pie, la base del sifón y los tentáculos cefálicos.

Distribución: Conocida en el Mediterráneo desde la costa oriental de Sicilia hasta el mar de Alborán y, en el Atlántico, desde el cabo de San Vicente hasta Marruecos.

Chauvetia candidissima (Philippi, 1836) (Figs. 52-54, 63-64)

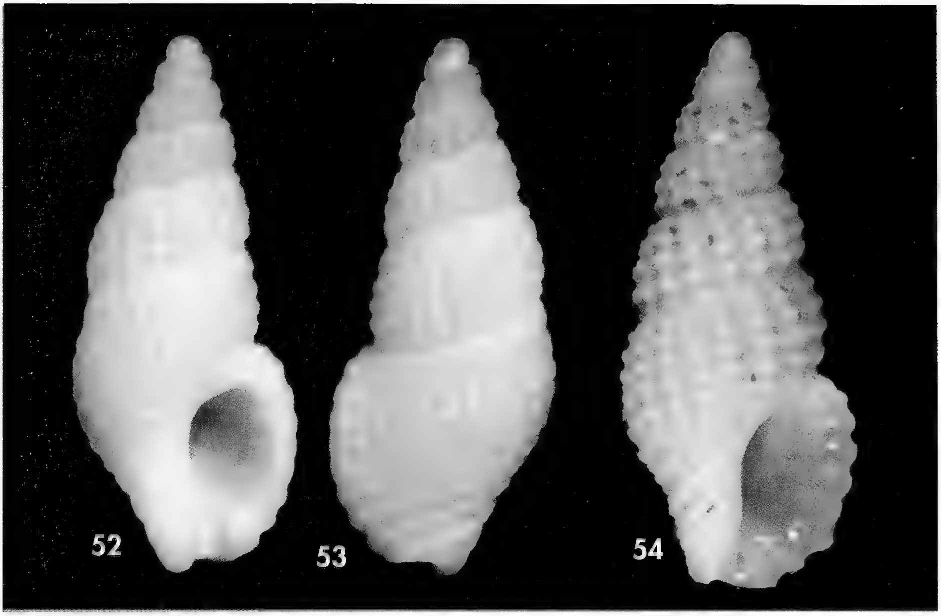
Buccinum candidissimum Philippi, 1836. *Enum. Moll. Siciliae,* vol. 1: 222, lám. 11, fig. 18. [Localidad tipo: Catania, Sicilia].

Material estudiado: Sicilia: Localidad sin precisar, 1 c. (9,6 × 4,4 mm), col. Petit, MNHN; Messina, 1 ej. (9,0 × 3,8 mm), col. A. Peñas. Estrecho de Gibraltar: Ceuta, Benzú, 20 c. (8,4 × 3,7 – 9,1 × 3,9 mm); Cádiz, 1 c. (9,4 × 3,9), col. Gavala en col. Azpeitia, MNCN. Marruecos: Asilah, Oued el Helou, 1 j., col. SG, MNHN; Mohammedia, 2 c. (8,5 × 3,7 – 8,6 × 3,8 mm), col. SG, MNHN.

Descripción: Concha de hasta 9,1 mm, sólida, con unas seis vueltas de espira poco convexas y una sutura moderadamente marcada.

Protoconcha de 820 μm de diámetro máximo (núcleo: 450-500 μm, primera media vuelta: 625 μm). El núcleo es liso, y al final de la segunda media vuelta aparece una escultura de costillas axiales algo sigmoideas y opistoclinas; no se aprecia escultura espiral.

Teleoconcha con ornamentación formada por cordones espirales, el doble de anchos que sus interespacios, y costillas axiales de poco relieve que forman nódulos cuadrangulares aplanados, a modo de adoquines, al cruzarse con los cordones. En la primera vuelta aparecen dos cordones espirales; un tercer cordón aparece en la tercera vuelta por desdoblamiento del cordón subsutural; este cordón adapical se vuelve a ensanchar y se desdobla de nuevo en la última vuelta. En la última vuelta, hay unos 15 cordones, de los cuales 4 continúan los de la penúltima vuelta, los 5 medios son



Figuras 52-54. *Chauvetia candidissima* (Philippi, 1836). 52, 53, ejemplar de Benzú, Ceuta (8,6 mm); 54, ejemplar de Messina, Sicilia, col. A. Peñas (9,0 mm).
Figures 52-54. Chauvetia candidissima *(Philippi, 1836). 52, 53, specimen from Benzú (8.6 mm); 54, specimen from Messina, Sicilia, col. A. Peñas (9.0 mm).*

de tamaño equivalente y los que cubren el canal sifonal son algo más delgados y dejan de ser granulosos. La terminación de las costillas no se manifiesta apenas sobre la sutura. En la penúltima, así como en la última vuelta, se aprecian 22-24 costillas axiales algo prosoclinas. La última vuelta alcanza en torno al 60% de la altura total, mientras que la abertura ocupa en torno al 42%.

Exterior del labio engrosado en los ejemplares adultos con los cordones continuados. En el interior del labio se observan, en los ejemplares adultos, hasta 6-7 dentículos alargados hacia el interior de la abertura.

El color de la concha es blanco. El animal no se ha observado.

Distribución: Sicilia, Malta, Argelia (MICALI, 1999) y estrecho de Gibraltar; las citas de Senegal corresponden a otras especies (véase OLIVER Y ROLÁN, 2008).

Notas: *Chauvetia tenuisculpta* (Dautzenberg, 1890) es un endemismo de Senegal, que se distingue por tener unas costillas axiales muy fuertes desde la primera media vuelta de la protoconcha. Las citas de dicha especie para el estrecho de Gibraltar (MICALI, 1999; OLIVER Y ROLÁN, 2008, con dudas) nos parecen dudosas y tal vez estén basadas en ejemplares de *C. candididissima* del Estrecho, como los que describimos aquí. Estos ejemplares del Estrecho se parecen más, por su forma general, a *C. tenuisculpta*, pero tienen la mayor parte de la protoconcha lisa, como los ejemplares de *C. candidissima* de Sicilia. Sin embargo, los ejemplares de Sicilia que hemos visto se diferencian por tener las vueltas mucho más convexas y, sobre todo, los cordones mucho más marcados en el exterior del labio. Es posible que la forma del Estrecho sea una especie distinta, pero haría falta un seguimiento de su variabilidad a lo largo de las costas norteafricanas, si es que allí existe, antes de llegar a una conclusión.

Chauvetia lefebvrii (Maravigna, 1840) (Figs. 55-58, 65-68)

Buccinum lefebvrii Maravigna, 1840. *Rev. Zool. Soc. Cuvier.*: 325. [Localidad tipo: Aci Trezza, Sicilia].
Chauvetia lefebvrei auct. [Ortografía subsiguiente incorrecta, iniciada por Locard, 1892: 72].
Fusus granulatus Calcara, 1839, non *Nesaea granulata* Risso, 1826. *Ric. Malac.*: 16, fig. 10. [Localidad tipo: Palermo, Sicilia].
Buccinum folineae, sensu Philippi, 1844, non *Murex folineae* Delle Chiaje, 1828. *En. Moll. Sic.* vol. 2: 189, lám. 27, fig. 10.
Lachesis areolata Tiberi, 1868. *J. Conchyl.*: 73. [Localidad tipo: Sicilia].
? *Folinia retifera* var. *glomulus* Monterosato, 1889. *J. Conchyl.*, 37: 117. [Localidad tipo: Casablanca].
? *Folinia retifera* var. *labrosa* Monterosato, 1889. *J. Conchyl.*, 37: 117. [Localidad tipo: Casablanca].
Chauvetia pellisphocae sensu Nordsieck, 1976, non *Pleurotoma pellisphocae* Reeve, 1845.

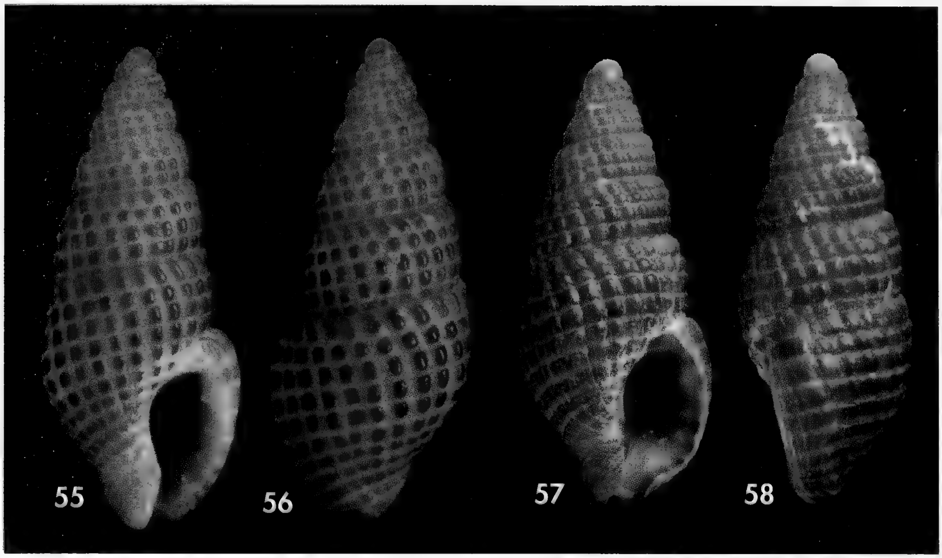
Material estudiado: Sicilia: Capo dei Mulini, 10 c. (5,6 × 2,7 – 6,4 × 2,8 mm), MNHN; Isola Lachea, 1 c. (6,0 × 3,7 mm), MNHN. Argelia: Argel, 9 c. (5,8 × 2,8 – 6,6 × 3,1 mm), col. Hidalgo, MNCN; Argel, 5 c. (5,7 × 2,8 – 7,4 × 3,3 mm), col. Azpeitia, MNCN; Argel, 3 c. (7,2 × 3,2 – 7,5 × 3,2 mm), col. Pallary, MNHN; Dellys, 4 c. (6,8 × 3,1 mm), col. Pallary, como *L. folineae* det. Dautzenberg, MNHN. Baleares: Ibiza (Punta Galera), 2 protoconchas, MNCN; Mallorca (Punta Foradada), 2 c. (deterioradas) + 2 fragmentos + 2 protoconchas, MNCN; Mar de Alborán y estrecho de Gibraltar: La Herradura (Granada), 50 ej., MNCN; Mijas (Málaga), 4 ej., MNCN; Algeciras, 30 c., MNCN; Getares (Cádiz), 2 c. (6,5 × 3,1 mm – 7,8 × 3,5 mm), col. SG, MNHN; Tarifa, 4 c. (8,5 × 3,6 – 9,0 × 3,9 mm), col. Gavala en col. Azpeitia, MNCN; Barbate, 1 c. (6,8 × 3,1 mm), col. SG; Ceuta, Benzú, 0–4 m, 3 ej. (9,0 x 3,8 mm – 10,0 x 4,0 mm; ejemplar dibujado); Ceuta, Benzú, 24 c. (8,9 × 3,7 – 10,3 × 4,3 mm), col. SG, MNHN. *Forma de color castaño uniforme*: Marruecos: Asilah, 3 c. (6,8 × 3,2 – 7,0 × 3,5 mm), col. SG, MNHN; Temara, 33 ej. (5,8 × 2,8 – 8,5 × 3,7 mm) + 15 j., col. SG, MNHN; Temara, 18 c. (8,5 × 3,8 mm) MNCN; Mohammedia, 2 c. (8,9 × 4,0 mm), col. SG, MNHN; Casablanca, 7 c. (arrojadas a la playa), col. Rigotard 1917, MNHN; El Jadida, 52 ej. (8,6 × 3,7 – 10,1 × 4,4 mm) + 12 j., col. SG, MNHN; Essaouira, 60 ej. (8,0 × 3,7 – 9,4 × 4,0 mm) + 29 j., col. SG, MNHN; Essaouira 6 c. + 1 j. (8,2 × 3,7 mm), MNCN. Estrecho de Gibraltar: Tarifa, 34 c. (7,9 × 3,3 – 11,1 × 4,3 mm) + 4 j. + 3 protoconchas, col. Gavala en col. Azpeitia, MNCN.

Descripción: Concha de hasta 11,1 mm, sólida, con unas seis vueltas de espira poco convexas, con la sutura moderadamente marcada.

Protoconcha de 900 μm de diámetro máximo (núcleo: 500 μm, primera media vuelta: 750 μm). El núcleo es liso o casi liso; desde la primera media vuelta se pueden apreciar unos cordoncillos espirales muy débiles, de tamaño irregular, alternando gruesos y finos. En la segunda media vuelta aparece una escultura de costillas axiales algo sigmoideas y opistoclinas, de anchura similar a los espacios que las separan, sobre las cuales se continúan los cordoncillos.

Teleoconcha con ornamentación formada por cordones espirales, el doble de anchos que sus interespacios, y costillas axiales de poco relieve que forman nódulos cuadrangulares aplanados, a modo de adoquines, al cruzarse con los cordones. La terminación de las costillas repercute un poco sobre la sutura, que es algo canaliculada. En la primera vuelta aparecen tres cordones espirales; un cuarto cordón aparece en la tercera vuelta por desdoblamiento del cordón subsutural; este cordón adapical se vuelve a ensanchar y se desdobla de nuevo en la última vuelta. En la última vuelta, hay 17-18 cordones, de los cuales 4 continúan los de la penúltima vuelta, los 5 medios son de tamaño equivalente y los que cubren el canal sifonal decrecen marcadamente en grosor. En la penúltima vuelta, así como en la última, se aprecian 20-24 costillas axiales algo prosoclinas. La última vuelta alcanza el 56-58% de la altura total, mientras que la abertura ocupa en torno al 40%.

Exterior del labio muy engrosado en los ejemplares adultos, particularmente en su parte adapical; cordones muy atenuados en su parte externa. En el interior del labio se observan 4-5 dentículos,



Figuras 55, 56. *Chauvetia lefebvrii* (Maravigna, 1840), con patrón de color con nódulos oscuros, habitual en el Mediterráneo y en el estrecho de Gibraltar, Benzú, Ceuta (9,2 mm). Figuras 57, 58. *Chauvetia* cf. *lefebvrii*, forma de color castaño uniforme propia de la costa atlántica de Marruecos, Temara (8,2 mm).

Figures 55, 56. Chauvetia lefebvrii (Maravigna, 1840), the colour pattern with dark nodes, usual in the Mediterranean and Strait of Gibraltar, Benzú (9.2 mm). Figures 57, 58. Chauvetia *cf.* lefebvrii, *with pattern of continuousdark bands over the cords, as found on the Atlantic coast of Morocco, Temara (8.2 mm).*

de los cuales el adapical es más pronunciado, y el abapical constituye el borde externo del canal sifonal.

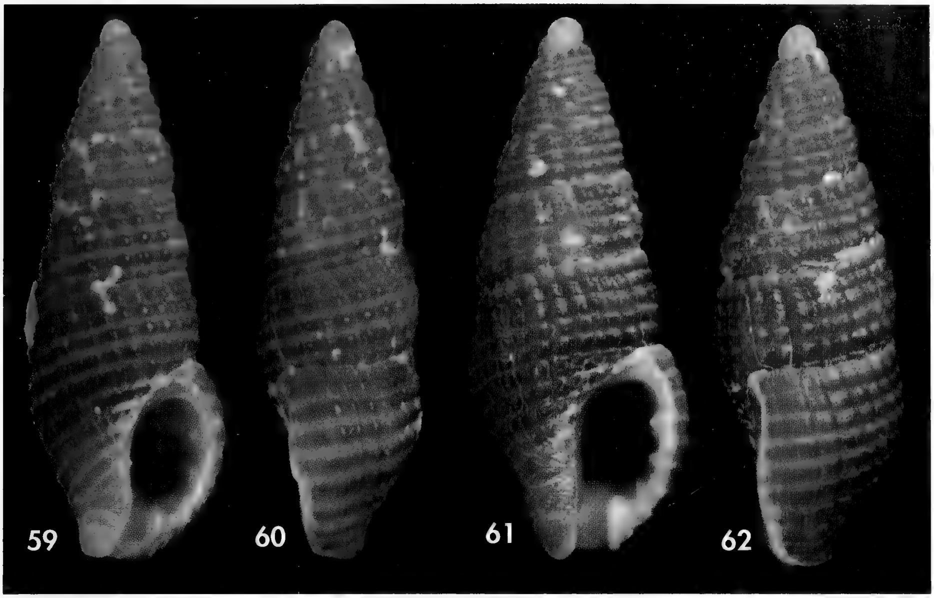
El color de la concha es blanco rosáceo con puntos de color castaño rojizo en la intersección de los cordones espirales con las costillas axiales; estos puntos son más pálidos en las primeras vueltas y al principio tienden a confluir a lo largo de los cordones. En la última vuelta, se dibujan bandas castañas sobre el borde externo del labio, en continuidad con las filas espirales de puntos.

El animal es blanquecino con puntos de color blanco lácteo.

Distribución: Conocida en el Mediterráneo desde la costa oriental de Sicilia hasta el mar de Alborán, y el estrecho de Gibraltar (forma con nódulos oscuros) y en la costa atlántica de Marruecos (*Chauvetia* cf. *lefebvrii*, forma de color castaño uniforme). No hemos encontrado esta especie en el abundante material del Algarve, y la cita para la ría de Vigo (ROLÁN, 1983) corresponde en nuestra opinión a *C. retifera*.

Notas: La sinonimia de esta especie fue establecida por MONTEROSATO (1884) teniendo en mano la colección de Tiberi. De ello se entiende que TIBERI (1868), al considerar *Buccinum lefebvrii* una sinonimia de *Lachesis mamillata*, volvió a describir la verdadera *C. lefebvrii* como especie nueva (*L. areolata*).

La descripción anterior se aplica a poblaciones del Mediterráneo y de las costas del Estrecho. En la costa atlántica de Marruecos se encuentra una forma de color castaño uniforme que MICALI (1999) considera una variedad de *C. retifera*. En nuestra opinión, la protoconcha, el perfil de la espira, la configuración de los tubérculos a modo de adoquines desde las primeras vueltas y los cuatro cordones situados sobre la abertura en la última vuelta se ajustan más a *C.*



Figuras 59-62. *Chauvetia retifera* (Brugnone, 1880). 59, 60: ejemplar de Benzú, Ceuta (9,4 mm); 61, 62: ejemplar de Sagres, 3-15 m (9,5 mm).
Figures 59-62. Chauvetia retifera *(Brugnone, 1880). 59, 60: specimen from Benzú (9.4 mm); 61, 62: specimen from Sagres, 3-15 m (9.5 mm).*

lefebvrii que a *C. retifera*. A esta forma de coloración se le puede aplicar, si se demostrase que se trata de una especie distinta, alguno de los nombres propuestos por MONTEROSATO (1889) como variedades de *C. retifera*.

Chauvetia retifera (Brugnone 1880) (Figs. 59-62, 70-72, 104)

Lachesis retifera Brugnone,1880. *Bull. Soc. Malac. Ital.*: 111, lám. 1, fig. 6. [Localidad tipo: Giannettello, cerca de Caltanisetta, Sicilia; fósil plio-pleistocénico].
Lachesis dolioliformis Monterosato, 1884. *Nom. Gen. Spec.*; 137. [Nombre introducido en la sinonimia de *Chauvetia retifera* y nunca usado como válido; por lo tanto, no disponible en nomenclatura].
Folinia retifera var. *lirifera* Monterosato, 1889. *J. Conchyl.*: 117.
Donovania (*Adansonia*) *pellisphocae* sensu Pallary, 1920, non *Pleurotoma pellisphocae* Reeve, 1845.
Chauvetia elongata Nordsieck y Talavera, 1979. [Localidad tipo: sur de Gran Canaria, probablemente un error, según Oliver y Rolán, 2009: 152].

Material estudiado: Galicia: Bayona: 1 c., (7,8 × 3,1 mm), MNCN. Portugal: Peniche, 1 c. (arrojada a la playa, 10,5 × 4,2 mm), col. SG, MNHN; Sagres, Punta da Baleeira, 17-23 m, 31 ej. (8,4 × 3,7 – 10,0 × 3,7 mm) + 6 j.; Sagres, Ponta dos Caminhos, 23-33 m, 4 c. (9,0 × 3,7 – 11,0 × 3,7 mm); Sagres, 3-15 m, 1 c. (9,7 × 3,8 mm); Sagres, Pontal dos Corvos, 2 c. (8,7 × 3,8 – 9,3 × 3,7 mm); Sagres, Praia do Martinhal, bajamar, 1 c. (10,3 × 3,7 mm); Salema, pesca de arrastre, 1 ej. (dibujado); Tavira, Pedra do Barril, 13 c. (8,6 × 3,5 – 10,6 × 3,7 mm); Tavira, Cabanas, 3 c. (10,5 × 3,8 mm). Mar de Alborán y estrecho de Gibraltar: cala Higuera (Almería), 1 c. (sin protoconcha), col. Cobos, MNCN; Benalmádena (Málaga), 1 c. (10,4 × 4,0 mm), col. SG; Tarifa, isla de Tarifa, 2 ej. (10,0 × 3,8 mm) + 1 j., col. SG; Tarifa, Torre de la Peña, 1 c., col. SG, MNHN; Tarifa, 20 c. (8,9 × 3,7 – 12,5 × 4,4 mm), col. Gavala en col. Azpeitia, MNCN; Barbate, 2 c. (8,8 × 3,5 mm – 9,8 × 3,8 mm), col. SG; Cádiz, La Cortadura, 2 c. (8,0 × 3,4 mm), col. SG, MNHN; Cádiz, 1 c. (8,4 × 3,4 mm), col. Gavala en col. Azpeitia, MNCN; Ceuta, Punta Almina, 25-40 m, 4 c. (8,6 × 3,5 – 8,6 × 3,6 mm); Ceuta, Benzú, 0-4 m, 2 ej. (9,6 x 3,6 mm – 10,3 x 3,8 mm; ejemplar dibujado); Ceuta, Benzú, 46 c. (8,5 × 3,5 – 11,2 × 3,8 mm), col. SG, MNHN. Marruecos: Tánger, muelle Este del puerto, 14 ej. + c. (9,0 × 3,4 – 11,5 × 4,4 mm) + 3 j., MNHN; Asilah, 3 c. (10,0 × 3,7 mm), MNHN; Temara, 5 ej. (9,2 × 3,5 – 9,9 × 3,8 mm) + 5 j., col. SG, MNHN; Temara, 5 c. (8,1 × 3,5 – 9,9 × 3,7 mm) + 2 j., MNCN; Casablanca 9 c. (arrojadas a la playa), col. Rigotard 1917, MNHN; Essaouira, 7 ej. (8,7 × 3,4 – 9,7 × 3,5 mm) + 2 j., col. SG, MNHN; Essaouira, 1 j., MNCN.

Descripción: Concha de hasta 12,5 mm, sólida, con unas seis vueltas de espira altas, poco convexas, con la sutura moderadamente marcada.

Protoconcha de 850 µm de diámetro máximo (núcleo: 450 µm, primera media vuelta: 650 µm). El núcleo es liso o casi liso; desde la primera media vuelta aparece una escultura de costillas axiales muy fuertes, de anchura similar a los espacios que las separan, sin ningún rastro de escultura espiral.

Teleoconcha con ornamentación formada por cordones espirales, el doble de anchos que sus interespacios, y costillas axiales de muy poco relieve que forman nódulos cuadrangulares aplanados, a modo de adoquines, al cruzarse con los cordones. La terminación de las costillas se manifiesta un poco sobre la sutura, que es algo canaliculada. En la primera vuelta aparecen tres cordones espirales; en la tercera vuelta aparece un cuarto cordón por desdoblamiento del cordón subsutural; este cordón adapical se vuelve a ensanchar y se desdobla de nuevo en la penúltima vuelta. En la última vuelta, hay 17-18 cordones, de los cuales 5 continúan los de la penúltima vuelta, los 4 medios son de grosor similar, y los que cubren el canal sifonal decrecen en grosor. En la penúltima vuelta, así como en la última, se aprecian 20-24 costillas axiales algo prosoclinas. La última vuelta alcanza el 56-58% de la altura total, mientras que la abertura ocupa algo menos del 40%.

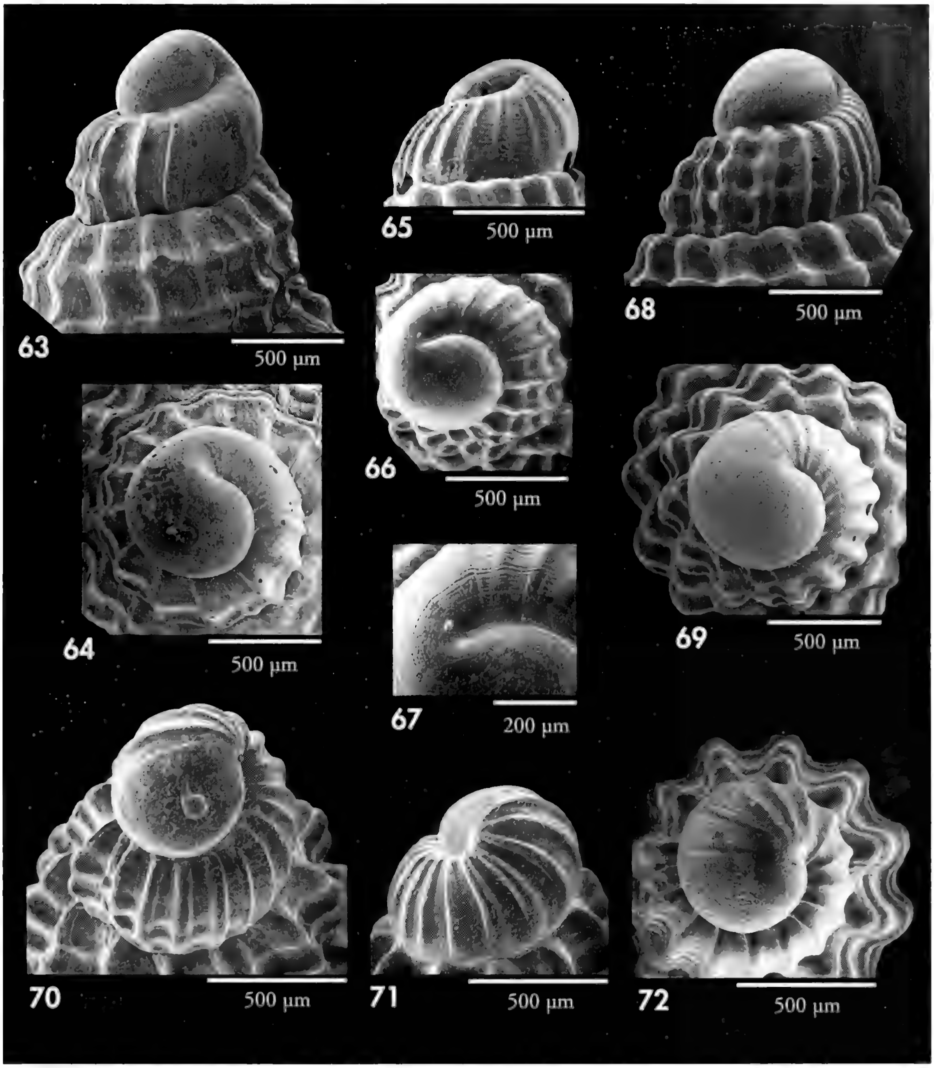
Exterior del labio muy engrosado en los ejemplares adultos, particularmente en su parte adapical; cordones muy atenuados en su parte externa. En el interior del labio se observan 4-5 dentículos, de los cuales el adapical es más pronunciado y está bastante separado del extremo de la abertura, y el abapical constituye el borde externo del canal sifonal.

El color de la protoconcha es blanco, el de la teleoconcha es blanco rosáceo o amarillento, más pálido en las primeras vueltas, con bandas de color castaño rojizo que cubren completamente los cordones espirales sin interrumpirse en los intervalos y se continúan sobre el borde externo del labio.

El animal es blanquecino, con algunos puntos de color blanco lácteo en la parte alta del cuerpo.

Distribución: Mediterráneo, solamente en el mar de Alborán; Atlántico, desde Galicia hasta Marruecos. No se ha encontrado en Canarias en el extenso material examinado por Oliver y Rolán (2009).

Notas: Esta especie fue citada por PALLARY (1902, 1920) con el nombre erróneo de *Chauvetia pellisphocae* (Reeve, 1845) pero, según Maes (1983), este nombre específico corresponde a una especie del Caribe, perteneciente al género *Crassispira* (superfamilia Conoidea) y superficialmente parecida. *Chauvetia retifera* se parece mucho a *C. lefebvrii* y coexiste con ella en gran parte de su área de distribución. Las dos especies tienen en común una concha gruesa con vueltas poco convexas, el tamaño relativamente grande de la protoconcha, el color blanquecino del animal, y la existencia de dentículos fuertes en la abertura. *Chauvetia retifera* se distingue, sin embargo, por tener un perfil más alto, por el dentículo adapical del labio más apartado de lo alto de la abertura y por la protoconcha que carece de microescultura espiral y tiene fuertes costillas axiales desde la primera media vuelta. En este último aspecto, se parece a la



Figuras 63-72. Protoconchas en vista lateral y apical. 63, 64: *Chauvetia candidissima*, Benzú, Ceuta; 65: *Chauvetia lefebvrii*, forma con nódulos oscuros, Cádiz; 66, 67: *Chauvetia lefebvrii*, forma con nódulos oscuros, La Herradura, Granada. 68, 69: *Chauvetia* cf. *lefebvrii*, forma con color uniforme, Temara. 70-72: *Chauvetia retifera*, La Herradura, Granada.
Figures 63-72. Protoconchs in lateral and apical views. 63, 64: Chauvetia candidissima, *Benzú; 65:* Chauvetia lefebvrii, *form with dark nodes, Cádiz; 66, 67: same, La Herradura. 68, 69:* Chauvetia *cf.* lefebvrii, *with uniform colour pattern, Temara. 70-72:* Chauvetia retifera, *La Herradura.*

especie senegalesa *C. tenuisculpta*, pero ésta difiere por su color completamente blanco. El color con bandas castañas continuas en los cordones espirales es otro carácter distintivo en las costas ibéricas, pero en el litoral marroquí existe este mismo patrón de color también en formas que asignamos a *C.* cf. *lefebvrii*, manteniéndose las diferencias citadas en la protoconcha y el perfil de la concha.

Chauvetia dentifera spec. nov. (Figs. 73-76, 85-88, 105)

Material tipo: Holotipo [ej., 6,9 × 3,2 mm], MNHN 22872, y 10 paratipos (5 ej. MNHN 226873, 5 ej. MNCN 15.05/53587), todos de la localidad tipo.

Material estudiado: Mar de Alborán y estrecho de Gibraltar: Mijas Costa (Málaga), 1 c. + 1 j., col. A. Peñas; Sotogrande (Cádiz), 1 ej. (8,0 × 3,5 mm), col. SG, MNHN; Barbate, 1 c. j., col. SG; Cádiz, 10 c. + 1 j. (7,1 × 3,1 – 7,8 × 3,9 mm), col. Azpeitia, MNCN; M'diq, 1 c. (5,5 × 2,8 mm), col. SG, MNHN; Ceuta, La Almadraba, 1 c. j.; Ceuta, Punta Almina, 25-40 m, 32 ej. y c. (6,7 × 3,2 – 7,8 × 3,5 mm) y 18 j.; Ceuta, puerto, 1 c. (11,0 × 3,9 mm); Ceuta, Benzú, 16 c. (5,6 × 2,7 – 6,3 × 3,0 mm), col. SG, MNHN. Portugal: Cascais, B/O "Faial" P3 (38° 24,1' N, 09° 14,1' W, 47-50 m), 5 c. (6,0 × 3,0 – 7,0 × 3,3 mm), col. Pérès, Gautier, Vacelet, 5-8-1957, MNHN; Sines, 1 c. (arrojada a la playa) (7,2 × 3,0 mm), col. Locard, MNHN; Sagres, Ponta da Baleeira, 17-23 m, 148 ej. (6,5 × 3,1 – 7,8 × 3,4 mm) + 28 j.; Sagres, Baia da Baleeira, 3-15 m, 7 ej. (7,3 × 3,2 – 8,3 × 3,5 mm) + 1 j.; Sagres, Ponta dos Caminhos, 20 c. (7,3 × 3,3 – 8,2 × 3,4 mm); Sagres, Pontal dos Corvos, 16 ej. + 2 j. (6,8 × 3,2 – 8,0 × 3,0 mm); Tavira, Pedra do Barril, 23 ej. (6,4 × 3 – 7,7 × 3,3 mm) + 4 j.; Tavira, Cabanas, 1 ej. (7,8 × 3,3 mm) + 2 j. Marruecos: Asilah, 1 c. j., col. SG, MNHN; Rabat, "Vanneau" sta. 37, 33° 59' N, 07° 50' W, 155 m, 6 c. (5,5 × 2,8 – 6,2 × 2,9 mm) + 3 j., MNHN; Safi, 10 km sur ciudad, 3 c. (8,0 × 3,4 mm), col. J. de Lepiney, MNHN. Sáhara: 22° 35' N, 16° 58' W, 1c ; 23° 05' N, 16° 25' W, 2 c. Mauritania: Cabo Blanco, 80 m, 1 c. (fotografía en Oliver y Rolán, 2009: fig. 24).

Localidad tipo: Punta Almina, Ceuta (35° 54,1' N – 05° 16,5' W, 25-40 m).

Etimología: el nombre específico alude al dentículo labial propio de esta especie.

Descripción: Concha fusiforme algo pupoide, sólida, con $5^1/_2$-6 vueltas de espira y hasta 7,8 mm. Las primeras vueltas son regularmente convexas, con una sutura bastante marcada, la penúltima y la última tienen el máximo de convexidad cerca de la sutura y la parte media más aplanada.

Protoconcha con algo más de una vuelta, diámetro máximo de 650-700 μm (núcleo: 380-400 μm, primera media vuelta: 530-550 μm). El núcleo tiene cordoncillos espirales muy tenues, casi inapreciables con microscopía óptica, desiguales entre sí, con interespacios de aspecto poroso a mucho aumento; a partir de la segunda media vuelta aparece una escultura de costillas axiales algo sigmoideas y opistoclinas, de anchura similar a los espacios que las separan. En los espacios se puede apreciar la continuación de los cordoncillos espirales muy débiles y de tamaño irregular, alternando gruesos y finos.

Teleoconcha con ornamentación formada por cordones espirales y costillas axiales. En la primera vuelta aparecen cuatro cordones espirales bien marcados, los dos adapicales algo más estrechos; a partir de la tercera vuelta, el cordón subsutural se desdobla, mientras que los cordones abapicales se ensanchan y aplanan, siendo en esta parte mucho más anchos que los interespacios. En la última vuelta los cordones de la parte media están tan aplanados que llegan a ser indistintos; la parte abapical está separada del resto de la vuelta por un ligero surco y lleva 15-16 cordones algo más patentes, decreciendo algo en tamaño al acercarse al canal sifonal. En la penúltima vuelta se aprecian 11-12 costillas axiales, y en la parte final de la última vuelta las costillas se van atenuando.

La última vuelta alcanza el 60% de la altura total, mientras que la abertura ocupa en torno al 40%

Abertura oval, con un canal sifonal muy corto y ancho. Labio engrosado en los ejemplares adultos, particularmente en su parte adapical; el lado externo forma una variz suave, no delimitada del resto de la vuelta. En el interior del labio de los ejemplares completamente adultos, se observan 4-5 dentículos poco marcados, alargados y situados muy adentro de la abertura; sin embargo, el interior de la abertura de los ejemplares subadultos es frecuentemente liso. La parte abapical del labio forma en su borde un dentículo saliente, situado en la terminación del surco externo de la última vuelta (Fig. 76) y apuntando en la dirección de crecimiento del borde

Figura 73-76. *Chauvetia dentifera* spec. nov. 73, 74, holotipo de Punta Almina, Ceuta, 32-40 m (6,9 mm); 75, 76, ejemplar de Sotogrande (8,0 mm).
Figure 73-76. Chauvetia dentifera *spec. nov. 73, 74, holotype from Punta Almina, Ceuta, 32-40 m (6.9 mm); 75, 76, specimen from Sotogrande (8.0 mm).*

El color de la concha es castaño en la mitad adapical de las vueltas y en la parte abapical de la última vuelta, con una zona amarillenta en la mitad abapical de las vueltas de espira, continuada como una banda central en la última vuelta.

El animal es blanquecino con puntos de color blanco lácteo.

Distribución: Mediterráneo, solamente en la costa occidental de Málaga; Atlántico, desde el sur de Portugal hasta el cabo Blanco.

Notas: Esta especie ha sido confundida (MICALI, 1999) con *Chauvetia crassior* (Odhner, 1932), descrita de la plataforma insular de Gran Canaria. El holotipo de *C. crassior* (véase OLIVER Y ROLÁN 2009: 116-117, fig. 19-20), conservado en el SMNH, es subadulto y el carácter del dentículo labial puede no estar expresado por esta razón; sin embargo, muestra una diferencia considerable en la configuración de las costillas axiales, que son menos numerosas, más altas y más separadas en lo que sería la penúltima vuelta. Los ejemplares adultos de *Chauvetia crassior* de Gran Canaria, ilustrados en OLIVER Y ROLÁN (2009, figs. 21-23) no llegan a desarrollar un dentículo labial aunque el labio esté muy engrosado.

El dentículo labial observado en esta especie es un rasgo que se conoce entre numerosas especies de Caenogastropoda (VERMEIJ, 2001), la mayoría de ellas, así como los casos más extremos, pertenecientes a la familia Muricidae. Se considera este rasgo como convergente en distintos linajes y relacionado con el comportamiento predador. Se señala aquí por primera vez en el género *Chauvetia*, aunque de momento no se conoce el uso que el animal pueda hacer de este dentículo.

Chauvetia taeniata spec. nov. (Figs. 77-80, 89-90)

Material tipo: Holotipo [ej., 7,9 × 3,6 mm], MNHN 22870, y 10 paratipos (5 ej. MNHN 22871, 5 ej. MNCN 15.05/53586), todos de la localidad tipo.

Material estudiado: Estrecho de Gibraltar: Cádiz, 10 c. + 2 j. (6,9 × 3,4 – 9,0 × 3,7 mm), col. Gavala en col. Azpeitia, MNCN; Ceuta, La Almadraba, 3 c. (8,5 × 3,9 mm); Ceuta, Punta Almina, 25-40 m, 24 ej. + c. (7,2 × 3,4 – 7,9 × 3,6 mm; ejemplar dibujado); Ceuta, Benzú, 5 c. (6,5 × 3,3 – 7,6 × 3,3 mm). Tánger, 1 c. (7,8 × 3,3 mm), vol. SG, MNHN. Portugal: Sagres, Ponta da Baleeira, 17-23 m, 20 ej. (7,2 × 3,2 – 7,8 × 3,6 mm) + 9 j.; Sagres, Ponta dos Caminhos, 6 c. + 1 j. (7,6 × 3,5 – 8,1 × 3,5 mm); Sagres, Pontal dos Corvos, 5 ej. (8,2 × 3,6 – 8,5 × 3,7 mm); entre Faro y Sagres, redes de pesca, 1 j.; Tavira, Pedra do Barril, 21 ej. (7,0 × 3,2 – 7,8 × 3,6 mm) + 12 j.

Localidad tipo: Punta Almina, Ceuta (35° 54.1′ N – 05° 16.5′ W, 25-40 m).

Etimología: Del latín *taenia*, venda o cinta, aludiendo a la forma aplanada de los cordones.

Descripción: Concha fusiforme, sólida, con $5^1/_2$-6 vueltas y hasta 8,5 mm. Las primeras vueltas son poco pero regularmente convexas, con una sutura bastante marcada, y crecen regularmente en diámetro sin formar una espira cirtoconoide.

Protoconcha con algo más de una vuelta, diámetro máximo de 750-800 µm (núcleo: 400-420 µm, primera media vuelta: 550-600 µm). Desde el mismo núcleo aparece una escultura de cordoncillos aplanados y anchos, muy desiguales entre sí, mucho más anchos que los interespacios, en el fondo de los cuales se aprecian diminutas laminillas transversales irregulares; hay 15-18 cordoncillos al final de la primera media vuelta. Al final de la segunda media vuelta se añade una escultura de costillas axiales estrechas algo sigmoideas y opistoclinas, de anchura progresivamente mayor hasta el principio de la teleoconcha; en esta parte, los cordoncillos espirales se vuelven más altos y pasan a ser más estrechos que los interespacios.

Teleoconcha con ornamentación formada por cordones espirales y costillas axiales. En la primera vuelta de la teleoconcha aparecen cuatro cordones espirales bien marcados, aumentando algo en tamaño hacia el ápice; a partir de la tercera vuelta, el cordón subsutural se desdobla, de modo que hay cinco cordones en la penúltima vuelta. En la última vuelta, los cordones de la parte media se ensanchan y aplanan, siendo en esta parte mucho más anchos que los interespacios; en la parte abapical, los cordones pasan a ser más fuertes y más estrechos que los interespacios, decreciendo algo en tamaño al acercarse al canal sifonal; hay en total 25-30 cordones en la última vuelta. En la penúltima vuelta se aprecian 9-10 costillas axiales muy marcadas, y en la parte final de la última vuelta las costillas se van atenuando.

La última vuelta alcanza el 60% de la altura total, mientras que la abertura ocupa algo más del 40%

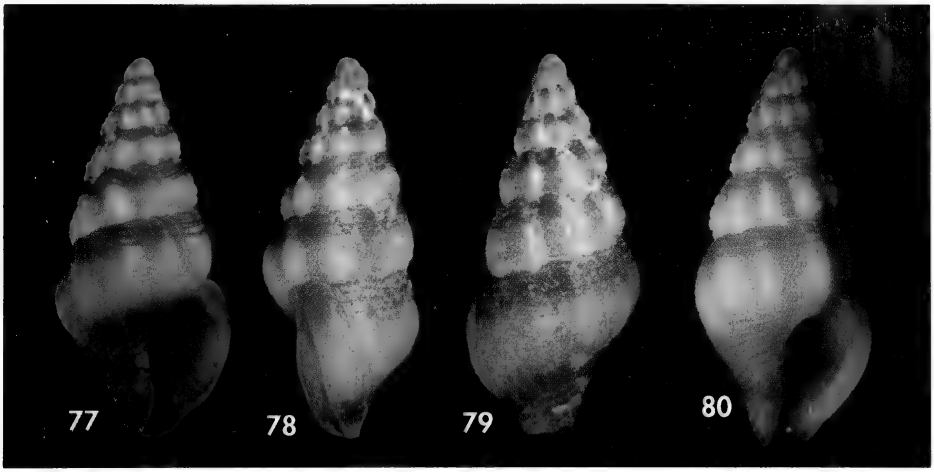
Abertura oval, engrosada en los ejemplares adultos, con canal sifonal relativamente corto y ancho. Labio grueso en los ejemplares adultos, particularmente en su parte adapical; el lado externo forma una variz suave, no delimitada del resto de la vuelta, sobre la cual los cordones se atenúan o casi desaparecen. En el interior del labio de los ejemplares completamente adultos, se observan 9-10 dentículos poco marcados, alargados y situados muy adentro de la abertura; sin embargo, el interior de la abertura de los ejemplares subadultos es frecuentemente liso.

Protoconcha castaña muy clara; teleoconcha castaña en la parte adapical de las vueltas, con una zona blanca en los dos tercios abapicales de las vueltas de espira, continuada como una banda ancha central en la última vuelta.

El animal es blanquecino con puntos de color blanco lácteo.

Distribución: Suroeste de Portugal y estrecho de Gibraltar.

Notas: Esta especie tiene una protoconcha muy parecida a la de *C. procerula*, aunque algo más grande. La teleoconcha, sin embargo, es muy distinta y se caracteriza por la tendencia de los



Figuras 77-80. *Chauvetia taeniata* spec. nov. 77-79: holotipo de Punta Almina 32-40 m (7,9 mm); 80: ejemplar de Cádiz (8 mm).
Figures 77-80. Chauvetia taeniata *spec. nov. 77-79: holotype from Punta Almina 32-40 m (7.9 mm); 80: specimen from Cádiz (8 mm).*

cordones a hacerse aplanados y anchos, hasta casi desaparecer en la última vuelta. El patrón de color es parecido al de *C. dentifera* spec. nov. y *C. decorata* y los estadios juveniles podrían confundirse, pero los juveniles de *C. dentifera* son proporcionalmente más anchos y toscos, reflejando el perfil de espira algo cirtoconoide de ésta, y la protoconcha de *C. dentifera* tiene cordoncillos mucho más tenues, y el doble en número. *Chauvetia decorata* tiene una protoconcha marcadamente más pequeña y las tres especies se separan con claridad en las localidades, como Punta Almina, donde ocurren juntas.

Chauvetia decorata Monterosato, 1889 (Figs. 81-84, 91-94)

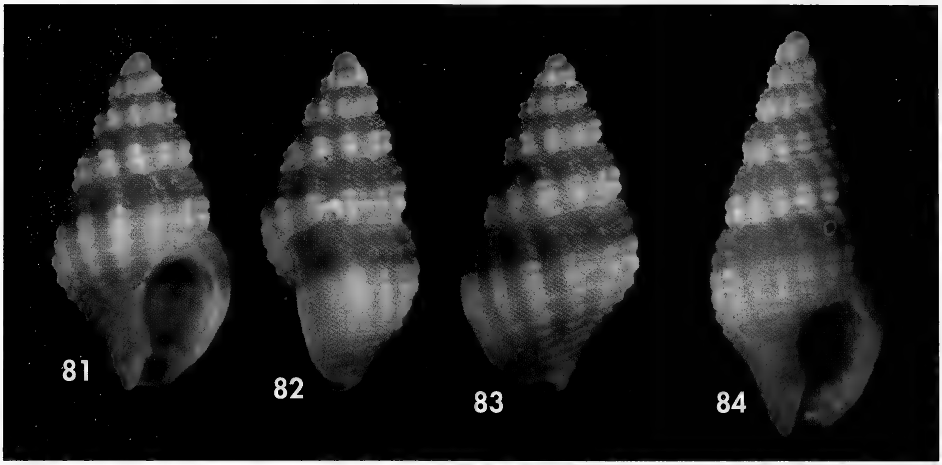
Chauvetia decorata Monterosato, 1889. *J. Conchyl.*: 117. [Localidad tipo: Casablanca, Marruecos].

Material estudiado: Estrecho de Gibraltar: Barbate, 1 c. j., col. SG; Cádiz 1 c. (7,2 × 3,1 mm), col. Gavala en col. Azpeitia, MNCN; Ceuta, La Almadraba, 1 c. (6,5 × 2,9); Ceuta, Punta Almina, 25-40 m, 14 ej. y c. (5,9 × 3,2 – 6,8 × 3,3 mm); Ceuta, Benzú, 1 c. (6,6 × 3,2 mm). Marruecos: Safi, 10 km. sur ciudad, 2 c. (7,2 × 3,0 mm).

Descripción: Concha fusiforme algo pupoide, sólida, con 5-5 $^1/_2$ vueltas de espira y hasta 7,2 mm, y vueltas regularmente convexas con una sutura bastante marcada.

Protoconcha con aproximadamente una vuelta, diámetro máximo de 600-620 μm (núcleo: 330-350 μm, primera media vuelta: 480-500 μm). El núcleo es prominente y tiene cordoncillos espirales bastante marcados, aplanados, algo más anchos que los interespacios, cuyo fondo forma una fila de diminutos puntos excavados. Al final de la segunda media vuelta aparece una escultura de costillas axiales algo sigmoideas y opistoclinas, de anchura similar a los espacios que las separan. En los espacios se pueden apreciar unos cordoncillos espirales que continúan los del núcleo.

Teleoconcha con ornamentación formada por cordones espirales y costi-



Figuras 81-84. *Chauvetia decorata* Monterosato, 1889. 81-83, ejemplar de Punta Almina, Ceuta, 32-40 m (6,0 mm); 84, ejemplar de Cádiz (7,2 mm).
Figures 81-84. Chauvetia decorata *Monterosato, 1889. 81-83, specimen from Punta Almina 32-40 m (6.0 mm); 84, specimen from Cádiz (7.2 mm).*

llas axiales. En la primera vuelta de la teleoconcha aparecen cuatro cordones espirales, los dos abapicales bien marcados, los adapicales (subsuturales) menos prominentes o casi fusionados; a partir de la tercera vuelta, los cordones subsuturales se afirman, de modo que hay cuatro cordones casi iguales en la penúltima vuelta; esta escultura persiste en la última vuelta, que presenta en total 15-16 cordones que decrecen algo en tamaño al acercarse al canal sifonal. En la penúltima vuelta se aprecian 11-13 costillas axiales, que persisten en la última vuelta; a su paso por las costillas axiales, los cordones forman tubérculos redondeados, a modo de perlas.

La última vuelta alcanza el 65% de la altura total, mientras que la abertura ocupa en torno al 45%.

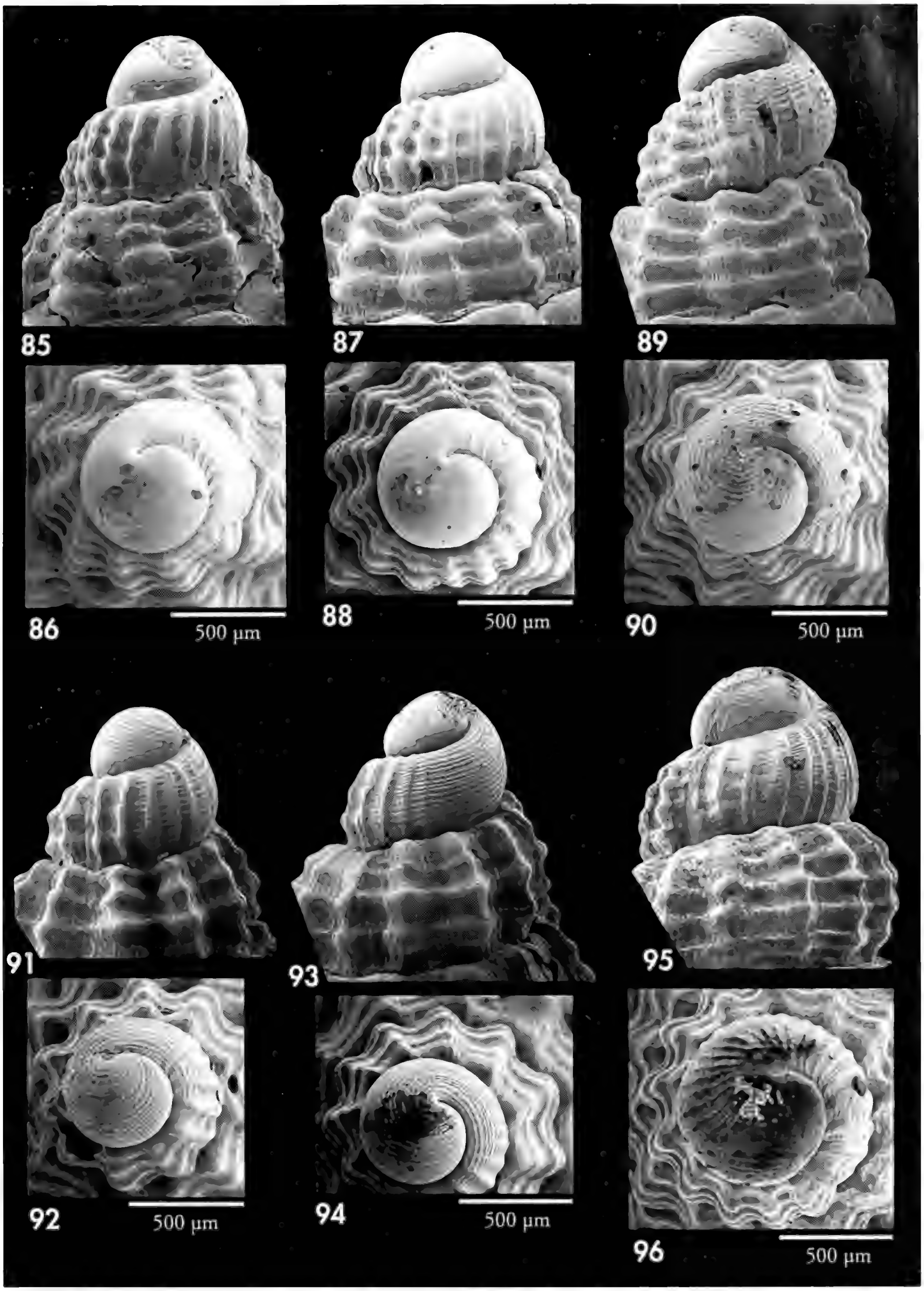
Abertura oval, engrosada en los ejemplares adultos, con un canal sifonal muy corto y ancho. Labio grueso en los ejemplares adultos, particularmente en su parte adapical; el lado externo forma una variz distinta, aunque no delimitada del resto de la vuelta, sobre la cual los cordones están muy atenuados, y son casi inapreciables. En el interior del labio de los ejemplares completamente adultos se observan 4-5 dentículos poco marcados, alargados y situados muy adentro de la abertura; sin embargo, el interior de la abertura de los ejemplares subadultos es frecuentemente liso. El borde del labio en vista lateral forma una curvatura suave, sin proyección ni dentículo.

Protoconcha castaña clara; teleoconcha castaña en la mitad adapical de las vueltas y en la parte abapical de la última vuelta, con una zona blanca en la mitad abapical de las vueltas de espira, continuada como una banda en la mitad de la última vuelta.

Animal desconocido.

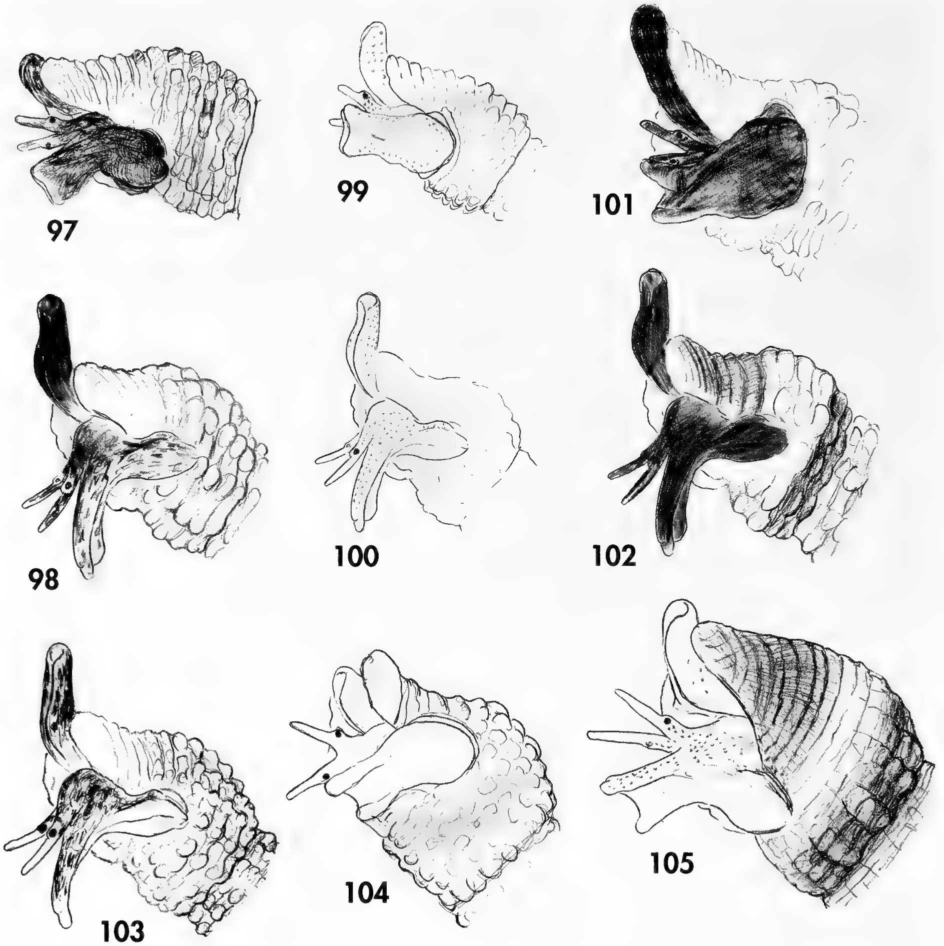
Distribución: Costa atlántica de Marruecos y estrecho de Gibraltar.

Notas: Esta especie es muy parecida a *C. taeniata* spec. nov., pero su espira es más ancha y los cordones se mantienen en toda la superficie y no tienden a aplanarse en las últimas vueltas. Los juveniles se distinguen bien, en las poblaciones simpátricas de Ceuta, por tener la protoconcha más pequeña y las vueltas no tan altas en proporción, regularmente convexas (no aplanadas con un ángulo en la periferia) y con los cordones adapicales pequeños, en lugar de



Figuras 85-96. Protoconchas en vista lateral y apical, todas a la misma escala. 85-88: *Chauvetia dentifera*, Punta Almina, Ceuta, 32-40 m; 89-90: *Chauvetia taeniata*, Punta Almina, Ceuta, 32-40 m; 91-94: *Chauvetia decorata*, Punta Almina, Ceuta, 32-40 m; 95-96: *Chauvetia balgimae*, frente a Rabat, 355 m.

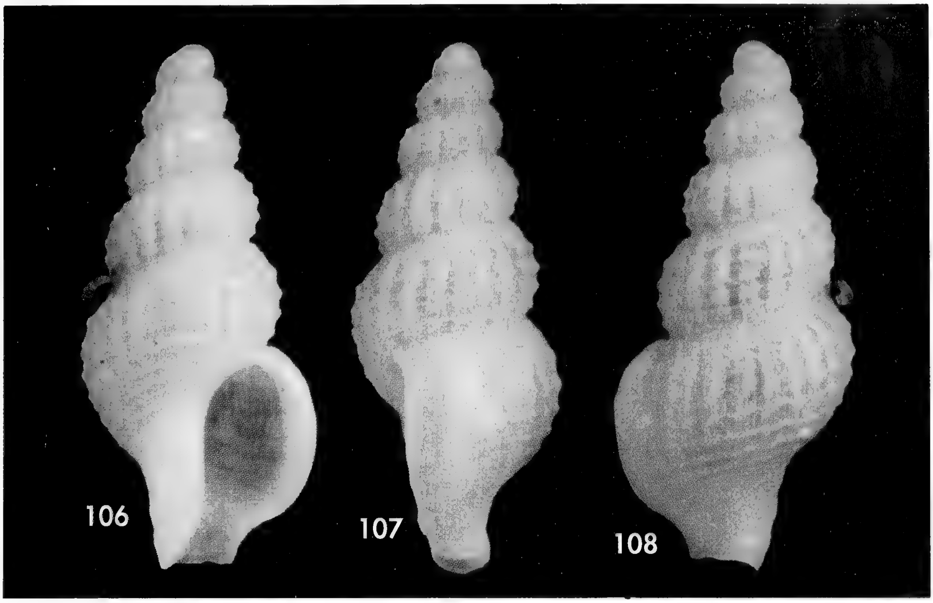
Figures 85-96. Protoconchs in lateral and apical views, all to scale. 85-88: Chauvetia dentifera, *Punta Almina, Ceuta, 32-40 m; 89-90:* Chauvetia taeniata, *Punta Almina, Ceuta, 32-40 m; 91-94:* Chauvetia decorata, *Punta Almina, Ceuta, 32-40 m; 95-96:* Chauvetia balgimae, *off Rabat, 355 m.*



Figuras 97-105. Esquemas de los patrones de coloración de los animales vivos. 97: *Chauvetia mamillata*, Sagres, 5 m; 98: *C. mamillata*, Punta Almina, Ceuta, 32-40 m; 99: *C. brunnea*, Sagres, 5 m; 100: *C. brunnea*, Punta Almina, Ceuta, 32-40 m; 101: *C. procerula* con color de concha uniforme, Sagres, 5 m; 102: *C. procerula* con banda blanca, Punta del Saudiño; 103: *C. recondita*, Punta Almina, Ceuta, a 32-40 m; 104: *C. retifera* juvenil, frente a Salema, Algarve; 105: *C. dentifera*, Sagres, 20 m.

Figures 97-105. Sketches of colour patterns in the living animals. 97: Chauvetia mamillata, *Sagres, 5 m; 98:* C. mamillata, *Punta Almina, 32-40 m; 99:* C. brunnea, *Punta Almina, 32-40 m; 100:* C. brunnea, *Sagres, 5 m; 101:* C. procerula *with uniform shell colour, Sagres, 5 m; 102:* C. procerula *with white band, Punta del Saudiño; 103:* C. recondita, *Punta Almina, 32-40 m; 104: juvenile* C. retifera, *off Salema, Algarve; 105:* C. dentifera, *Sagres, 20 m.*

cuatro cordones casi iguales desde el principio. Entre las cuatro especies que presentan el patrón de color con banda blanca, ésta nos parece la que mejor se ajusta a la breve diagnosis proporcionada por MONTEROSATO (1889), sobre todo porque la incluye en el género *Chauvetia* (en su criterio, junto con *C. granulata* sensu Tiberi, 1868 y con *C. recondita*), y no en *Donovania* (junto con *C. procerula*, descrita en el mismo artículo).



Figuras 106-108. *Chauvetia balgimae* spec. nov., holotipo de BALGIM DR82, frente a Rabat, 355 m (6,3 mm).
Figures 106-108. Chauvetia balgimae spec. nov., holotype from BALGIM DR82, off Rabat, 355 m (6.3 mm).

Chauvetia balgimae spec. nov. (Figs. 95-96, 106-108)

Material tipo: Holotipo [ej., 6,3 × 2,9 mm], MNHN 22874 y 9 paratipos (4 ej. MNHN 22875, 5 ej. MNCN 15.05/53587), todos de la localidad tipo.
Material estudiado: El material tipo y Balgim Sta. DR81 (33° 46′ N, 08° 30′ W), 309 m, 1 ej.
Localidad tipo: Frente a Rabat, Marruecos (33° 45′ N – 08° 32′ W, 355 m), Balgim St. DR82.
Etimología: Del nombre de la campaña Balgim (Bentos del AtLántico, GIbraltar y Mediterráneo), en la cual la especie fue recolectada.

Descripción: Concha fusiforme, no muy sólida, con $4^1/_2$-5 vueltas de espira y hasta 6,8 mm, y vueltas muy convexas, con una sutura bastante marcada.

Protoconcha con aproximadamente una vuelta, diámetro máximo de 850-900 µm (núcleo: 500 µm, primera media vuelta: 700 µm). El núcleo es redondeado y tiene cordoncillos espirales muy tenues, casi inapreciables con microscopía óptica, desiguales entre sí, con interespacios relativamente lisos; desde la primera media vuelta aparece una escultura de numerosas costillas axiales algo sigmoideas y opistoclinas, de anchura similar a los espacios que las separan. En los espacios se puede apreciar la continuación de los cordoncillos espirales, que están atenuados en la parte más saliente de las costillas.

Teleoconcha con ornamentación formada por cordones espirales y costillas axiales. En la primera vuelta de la teleoconcha aparecen cuatro cordones espirales, de los que uno (subsutural) está algo apartado de la sutura; en este intervalo surge un quinto cordón a partir de la segunda vuelta. Esta escultura persiste en la última vuelta, que presenta en total unos 20 cordones que decrecen marcadamente en grosor al acercarse el canal sifonal. Las costillas axiales son algo sigmoideas, ligeramente más estrechas que los interespacios; en la penúltima vuelta se aprecian 17-19 costillas axiales, que se atenúan algo al final de la última vuelta. A su paso por las costillas axiales, los cordones forman pequeños tubérculos redondeados.

La última vuelta alcanza el 62% de la altura total, mientras que la abertura ocupa en torno al 42%

Abertura ovalada, con un canal sifonal largo para el género, y ancho. Labio en los ejemplares adultos con el lado externo formando una variz estrecha y elevada, situada algo separada del borde, que es fino y cortante; los cordones están muy atenuados, y son casi inapreciables sobre la variz. En el interior del labio de los ejemplares completamente adultos no se aprecian dentículos. El borde del labio en vista lateral es sigmoideo.

Color de la concha y del animal completamente blanco.

Notas: La protoconcha de esta especie se parece mucho a la de *Chauvetia edentula* Oliver y Rolán, 2009, descrita de una profundidad similar en el banco sahariano y en la isla de Gran Canaria. Sin embargo, la teleoconcha es marcadamente diferente, siendo *C. edentula* mucho más sólida, con la última vuelta proporcionalmente más compacta y la abertura más pequeña.

CONCLUSIONES

En este trabajo consideramos doce especies válidas del género *Chauvetia* en el litoral ibero-marroquí, situando en el estrecho de Gibraltar y en el sur de la Península Ibérica la máxima diversidad específica del género en Europa. En algunos puntos del Estrecho, como Punta Almina o Benzú, cerca de Ceuta, se han podido recolectar hasta ocho especies en la misma muestra. En otras regiones del Mediterráneo, contando incluso con especies que no se encuentran en el área aquí estudiada, pueden encontrarse hasta siete especies en el entorno de Sicilia, que es el otro "punto caliente" de la riqueza especifica en el Mediterráneo. El máximo absoluto de riqueza específica, sin embargo, sigue centrado en la península del cabo Verde, en Senegal, donde Oliver y Rolán (2008) han encontrado 14 especies, seguido de cerca por la plataforma sahariana, con una docena de especies (Oliver y Rolán, 2009). Luego, más al sur, el género es muy escaso en África occidental, existiendo alguna representación hasta Costa de Marfil, pero con un número de especies muy bajo.

El género *Chauvetia* no está representado en el Atlántico occidental, lo que es explicable considerando el tipo de desarrollo sin fase planctónica que se deduce de la protoconcha de todas las especies estudiadas del género. Tampoco está representado en las islas Azores, poniendo así de manifiesto que las distancias transoceánicas son infranqueables por sus representantes. No siempre las especies con desarrollo directo intracapsular son incapaces de colonizar sitios remotos, mediante, por ejemplo, la flotación de cápsulas ovígeras, pero parece evidente que, en el caso de *Chauvetia*, la capacidad de dispersión es escasa.

Esta capacidad limitada de dispersión hace probablemente que las especies de *Chauvetia* sean propensas a diferenciarse en poblaciones locales con escaso intercambio genético con otras poblaciones de la especie. Quizás ésta sea una razón para que existan tantos problemas taxonómicos sin resolver. En este trabajo hemos puesto de manifiesto algunos de ellos y es obvio que aún faltan datos a lo largo de las costas norteafricanas y en la cuenca oriental para que se pueda llegar a una revisión taxonómica completa del género. También es de esperar que los caracteres de secuencias moleculares aporten nuevos elementos decisivos cuando se conozcan para estas especies.

Las especies litorales incluidas en este estudio están todas claramente vinculadas a fondos rocosos o, a lo sumo, a fondos colindantes de cascajo biógeno.

Quizá por ello no se ha encontrado ningún ejemplar de *Chauvetia* en el amplio muestreo realizado en las lagunas del Algarve, en los alrededores de Faro y Olhão, a pesar de la presencia de extensas praderas de fanerógamas ricas en especies y de un esfuerzo de muestreo equivalente al desplegado en la zona de Sagres. Por la misma razón, los tramos costeros con litoral arenoso y lagunas, como los del suroeste ibérico o del noroeste marroquí, podrían actuar como barreras que convierten en islas los tramos de costa rocosa intercalados y propician la diferenciación de las poblaciones.

AGRADECIMIENTOS

La campaña Ceuta 1986 fue el fruto de un esfuerzo conjunto del MNHN y de la Universidad de Sevilla (José Carlos García Gomez), la del Algarve (1988) y Seamount 1 (1987) fueron dirigidas por Philippe Bouchet (MNHN), y las campañas Fauna Ibérica III (1994) y IV (1996), realizadas en el Proyecto Fauna Ibérica (DGICYT PB92-0121) fueron dirigidas por Ángel Guerra, del Instituto de Investigaciones Marinas (Consejo Superior de Investigaciones Científicas).

Las fotografías de microscopio electrónico de barrido fueron realizadas en su mayoría en los servicios centrales de apoyo a la investigación de la Universidad de Málaga, con la ayuda de Gregorio Martín Caballero; algunas de ellas se realizaron en el laboratorio de microscopía electrónica del Museo Nacional de Ciencias Naturales por Laura Tormo y Marta Furió.

Los autores también agradecen a Ángel Luque (Universidad Autónoma, Madrid) una minuciosa revisión del manuscrito y sugerencias valiosas.

BIBLIOGRAFÍA

ARNAUD P. 1978. Révision des taxa malacologiques méditerranéens introduits par Antoine Risso. *Annales du Muséum d'Histoire Naturelle de Nice*, 5: 101-150.

BUCQUOY E., DAUTZENBERG P. Y DOLLFUS G. 1882-1886. *Les mollusques marins du Roussillon*. Tome Ier. Gastropodes. Paris, J. B. Baillière et fils. 570 pp., 66 lám. [pp. 85-135, pl. 11-15, febrero 1883]

CROSSE H. 1885. Nomenclatura generica e specifica di alcune conchiglie mediterranee, pel Marchese di Monterosato [reseña bibliográfica]. *Journal de Conchyliologie*, 33: 139-142.

HERGUETA H., LUQUE A. Y TEMPLADO J. 2002. On the taxonomy and biology of *Chauvetia mamillata* (Risso, 1826) (Gastropoda: Buccinidae) in south East Spain. *Bollettino Malacologico*, supplemento 4: 135-146.

HORRO J. Y ROLÁN E. 2004. Las especies de *Chauvetia* de Galicia (Mollusca, Muricoidea). *Noticiario SEM*, 41: 27-30.

LOCARD A. 1892. *Les coquilles marines des côtes de France*. J. B. Baillière et fils, Paris, 384 pp.

MAES V.O. 1983. Observations on the systematics and biology of a turrid gastropod assemblage in the British Virgin Islands. *Bulletin of Marine Science*, 33 (2): 305-335.

MICALI P. 1999. Note sulle specie di *Chauvetia* dell'Atlantico nord-orientale. *Bollettino Malacologico*, 34 (5-8): 53-68.

MONTEROSATO T. A. DI 1872. *Notizie intorno alle conchiglie mediterranee*. Palermo, Michele Amenta, 61 pp.

MONTEROSATO T. A. DI 1884. *Nomenclatura generica e specifica di alcune conchiglie mediterranee*. Palermo, Virzi, 152 pp.

MONTEROSATO T. DI 1889. Coquilles marines Marocaines. *Journal de Conchyliologie*, 37: 20-40, 112-121.

NORDSIECK F. 1976. Familia Buccinidae. Il genere *Chauvetia* Monterosato, 1884 nei mari d'Europa. *La Conchiglia*, 89-90: 3-7.

OLIVER J. D. Y ROLÁN E. 2008. Las especies del género *Chauvetia* (Gastropoda, Neogastropoda) del área de Dakar, Senegal, Africa occidental, con la descripción de diez especies nuevas. *Iberus*, 26 (2): 133-175.

OLIVER J. D. Y ROLÁN E. 2009. Las especies de *Chauvetia* Monterosato, 1884 (Mollusca, Neogastropoda) de Canarias y el área Oeste Africana de Mauritania y Sahara. *Iberus*, 27 (2): 113-154.

PALLARY P. 1902. Liste des mollusques testacés de la baie de Tanger. *Journal de Conchyliologie* 50: 1-39, pl. 1

PALLARY P. 1920. *Exploration scientifique du Maroc organisée par la Société de Géographie de Paris et continuée par la Société des Sciences Naturelles du Maroc*. Deuxième fascicule. Malacologie (1912). Larose, Rabat y Paris, 108 pp., 1 lám., 1 mapa.

Peñas A., Rolán E., Luque A.A., Templado J., Moreno D., Rubio F., Salas C., Sierra A. y Gofas S. 2006. Moluscos marinos de la isla de Alborán. *Iberus*, 24 (1): 23-151

Risso A. 1826. *Histoire naturelle des principales productions de l'Europe méridionale et particulièrement de celles des environs de Nice et des Alpes Maritimes*, vol. 4. Paris, Levrault, iv + 439 pp., 12 láms.

Scacchi A. 1836. *Catalogus conchyliorum regni Neapolitani*. Neapoli [Napoles], Typis Filiatre-Sebetii, 18 pp., 1 lám.

Tiberi N. 1868. Des testacés de la Méditerranée qui doivent être compris dans les genres *Lachesis* et *Nesæa* de Risso. *Journal de Conchyliologie*, 16: 68-81, lám. 5.

Vermeeij G. 2001. Innovation and evolution at the edge: origins and fates of gastropods with a labral tooth. *Biological Journal of the Linnean Society*, 72: 461-508.

Woodward S.P. 1899. Some account of the synonymy and affinities of *Donovania minima* (Mont.). *Proceedings of the Malacological Society of London*, 3 (3): 235-238.

© Sociedad Española de Malacología — Iberus, 28 (1): 61-66, 2010

Record of the largest specimen of neon flying squid *Ommastrephes bartramii* (Cephalopoda: Ommastrephidae)

Registro del mayor ejemplar de pota saltadora *Ommastrephes bartramii* (Cephalopoda: Ommastrephidae)

Ángel GUERRA*, Graham J. PIERCE**, María Begoña SANTOS***, Ángel F. GONZÁLEZ*, Gema HERNÁNDEZ-MILIAN***, Carmela PORTEIRO*** and Baltasar PATIÑO***

Recibido el 26-XI-2009. Aceptado el 23-IV-2010

ABSTRACT

We report a record of the largest known specimen of *Ommastrephes bartramii*. It was an almost mature female, with dorsal mantle length (ML) of 1020 mm and weighing around 35 kg, caught by a Spanish fishing vessel in October 2007 on a surface long-line in the Eastern Tropical Pacific. Growth increments on a statolith indicate an age of 492-512 days. The stomach was full and contained beaks of ommastrephid squids and of a small pelagic octopus (*Japetella* spp.), and remains of mackerel (possibly bait from the long-line) and unidentified fish.

RESUMEN

En este trabajo se presenta información sobre el mayor ejemplar de *Ommastrephes bartramii* descrito hasta la actualidad. Se trata de una hembra casi madura, cuya longitud dorsal del manto es de 1020 mm y con un peso total de aproximadamente 35 kg, capturada en octubre de 2007 por un pesquero español utilizando palangre de superficie en el Pacífico Tropical Este. Los incrementos de crecimiento observados en un estatolito indican una edad comprendida entre 492 y 512 días. El estómago estaba lleno y contenía picos de potas (omastréfidos) y de un pulpo pelágico pequeño (*Japatella* spp.), así como restos de caballas (posiblemente cebo del palangre) y de otros peces que no pudieron ser identificados.

INTRODUCTION

The neon flying squid *Ommastrephes bartramii* (LeSueur, 1821) is distributed worldwide in subtropical and temperate oceanic waters (Roper, Sweeney and Nauen, 1984; Nesis, 1987; Dunning, 1998). It has supported major jig and surface driftnet fisheries in the North Pacific since about 1974, and its life history in this area is well known (Bower and Ichii, 2005; Ichii, Mahapatra, Okamura, and Okada 2006). It occurs in the South Pacific where SST

---

* Instituto de Investigaciones Marinas (CSIC), Vigo, Spain. E-mail: angelguerra@iim.csic.es

** Centro Oceanográfico de Vigo, Instituto Español de Oceanografía, P.O. Box 1552, 36200 Vigo, Spain and Institute of Biological and Environmental Sciences, Zoology Building, University of Aberdeen, Tillydrone Avenue, AB24 2TX Aberdeen, U.K.

*** Centro Oceanográfico de Vigo, Instituto Español de Oceanografía, P.O. Box 1552, 36200 Vigo, Spain.

Figure 1. Worldwide distribution of *Ommastrephes bartramii* (AquaMaps, GBIF OBIS) and capture location (●) of this record.
Figura 1. Distribución mundial de Ommastrephes bartramii *(Aqua Maps, GBIF OBIS) y localización del lugar de captura del ejemplar (●).*

ranges from ~ 12° to 26° C and is rarely caught in cooler waters. Adjacent to the continental slope of western South America, *O. bartramii* is replaced in waters warmer than 15° C by the jumbo squid *Dosidicus gigas* (Yatsu and Yamashiro, 1999; Zuev, Nigmatullin, Chesalin, and Nesis, 2002). The Subtropical Convergence (SC) is the southern boundary of its distribution in the South Pacific, generally at about 40-50° S. However, the SC zone is highly variable from year to year and shows significant seasonal latitudinal shifts, occurring as far south as 52° S (Dunning, 1998).

Although this species was identified as a potential fishery resource in the late 1970s, there is still no commercial exploitation in the Southern hemisphere (Dunning, 1998). Nigmatullin, Shchetinnikov and Shukhgalter (2009) sampled 60 specimens of this species, to study the diet and parasites, by jigging in the south-eastern Pacific in the early 1980s. The animals ranged from 16 to 39 cm mantle length (ML). The largest specimen recorded to date was a female of 800 mm mantle length weighing 20-25 kg caught in Argentinean waters (Dunning, 1998). In this paper we describe a new record of a larger specimen caught in the SE Pacific, including information on age, maturity and stomach contents.

MATERIAL AND METHODS

The present specimen was caught by the Spanish fishing vessel *Nuevo Monte Ventoso*, 10/10/07, on a surface long-line at 21° S, 88° W (FAO area 87, Figure 1). It was frozen on board and transported to Vigo (NW Spain). It was defrosted at room temperature, dissected and measured (see Figure 2). We sampled stomach contents, one statolith (the other was not located), beaks, sucker rings, mantle and ovary tissue.

The method applied for ageing involved mounting the statolith on a microscope slide, using Crystalbond, with the anterior concave side upper-

Figure 2. *Ommastrephes bartramii*, view of the mouth, arms and anterior ventral mantle margin of the specimen.
Figura 2. Ommastrephes bartramii, *vista de la boca, brazos y margen ventral anterior del manto del ejemplar.*

most. The statolith was ground, first on the anterior surface, then turned over and ground on the posterior surface. The statolith was then turned over so that the anterior surface was uppermost. This grinding of both surfaces in the sagittal plane results in the production of a relatively thin statolith section. Increments were determined along the axis of maximum statolith growth with a NIS Elements D 2.30 image analysis system interfaced with a Nikon compound microscope (400x magnification). Counts were obtained semi-automatically: putative increments were detected automatically by computer software from an enhanced image but final identification of increments was carried out manually. Increments were not clearly identifiable near the outer margin of the ground surface, and the number of increments missed in this area was estimated by extrapolation from the adjacent area (GONZÁLEZ, DAWE, BECK AND PÉREZ, 2000).

Stomach contents (consisting of semi-digested flesh and hard remains) were washed through a sieve (mesh size 0.355 mm) and all identifiable prey remains (e.g. fish otoliths, bones and cephalopod beaks) extracted and transferred to 75% alcohol. Fish hard parts were later dried. Beaks, otoliths and bones were identified to the lowest possible taxon using guides (e.g. CLARKE 1986, HÄRKÖNEN 1986; BOSCHI, FISCHBACH AND IORIO, 1992; SMALE, WATSON AND HECHT, 1995; WATT, PIERCE AND BOYLE, 1997; TUSET, LOMBARTE, AND ASSIS, 2008) and reference material held by the authors. Original prey size was calculated from standard measurements (lower rostral length for squid beaks) using published regressions (CLARKE,

Table I. Main measurements (mm for linear measurements, g for weights).
Tabla I. Principales medidas del ejemplar (en mm las morfométricas y en g los pesos).

Linear dimensions	mm	Weights	g
Dorsal mantle length	1020	Total weight	Approx. 35000
Ventral mantle length	970	Nidamental gland weight	250 (1 out of 2)
Ventral mantle width	375	Oviduct gland weight	150 (1 out of 2)
Fin length	500	Ovary weight	500
Fin width	925	Digestive gland weight	950
Arm R1 length	580	Stomach contents weight	950
Arm R3 length	630		
Left tentacle	1020		

1986). In the case of the fish remains, the otoliths found were fragmented. Of the intact fish bones identifiable to family we were able to use the dentary length to estimate the approximate size, using an unpublished regression.

RESULTS AND DISCUSSION

The specimen was a female, with dorsal mantle length (ML) of 1020 mm and weighing around 35 kg. It was almost mature, with mature oocytes passing through the oocyte chamber, and was mated (see Table I). Repeat readings of growth increments on the one statolith located indicate an age of 492-512 days.

Age data from the North Pacific suggest a 1-year life cycle whereas this specimen was already 16-17 months old. However, similar discrepancies between reported age and the known seasonality of the life cycle are known from other squids, e.g. *Loligo* spp. (see GONZÁLEZ, OTERO, GUERRA AND PIERCE, In Press). BOWER AND ICHII (2005) reported two seasonal cohorts in the North Pacific. In the loliginid squid *Loligo forbesi*, BOYLE, PIERCE AND HASTIE (1995) proposed that individual growth rate determines whether an animal becomes a winter or summer spawner, and individuals from summer and winter breeding seasons might thus be of mixed age. Thus an apparently annual spawning and recruitment cycle is not necessarily inconsistent with some animals living for up to 2 years. CHEN AND CHIU (2003) recorded maximum mantle lengths of 527 mm for *Ommastrephes bartramii* in the North Pacific between September and December, which would be consistent with the present specimen approaching spawning readiness in October.

The stomach was full (containing 950g of food remains, a mixture of semi-digested flesh and hard prey remains). Table II summarises the information on prey found in the stomachs, including reconstructed lengths and weights. Remains included beaks of ommastrephid squids (as well as fragments of gladius and cephalopod flesh), vertebrae, dentaries and a broken otolith from a fish of the family Scombridae, probably a species of mackerel and remains of unidentified fish (broken otoliths, bones, a post-temporal, and numerous dermal scutes). An intact specimen of alfonsino (*Beryx* sp., probably *B. decadactylus*) was recovered from the mantle cavity of the squid (it had not been eaten).

It was not possible to identify the ommastrephid beaks to species since beaks from species in this family are very similar but it is likely that they belong to the same species, since cannibalism is known to be quite common in cephalopods (IBÁÑEZ AND KEYL, 2010). The other identified remains of cephalopods belonged to the genus *Japetella*. With the exception of *Japetella*,

Table II. Prey species found in the stomachs of the specimen of *Ommastrephes bartramii* taken by a long-liner in the south-eastern Pacific. For all prey species, number of beaks/other remains, estimated number of individuals (N) and estimated prey length (mm) and weight (g) are indicated.
Tabla II. Especies de presas encontradas en el estómago de Ommastrephes bartramii *capturado con un palangre en el Pacífico sureste. Para todas las especies se indica el número de picos/otros restos, el número de individuos estimados (N) y una estimación de la longitud de la presa (mm) y su peso (g).*

Cephalopod prey Family	**Species**	**Remains**	**N**	**Importance Length (mm)**	**Weight (g)**
Ommastrephidae	Unidentified	3 lower + 2 upper beaks, gladius, flesh	3	259-301	536-728
Bolitaenidae	Japatella sp.	1 lower + 1 upper beaks	1	*	*
Fish prey Family	**Species**				
Scombridae	Scomber spp.	Bones + 1 otolith	2	359-385	393-493
Unidentified	Unidentified	broken otoliths, bones, dermal scutes			

which is a small pelagic octopus (specimens of *Japetella* recorded from pygmy sperm whale stomachs in Hawaii averaged 8 g in body weight, West et al. 2009), the estimated size of the prey taken by the squid ranged from 259 to 385 mm in length and 390 to 720 g. The occurrence of mackerel in the diet is at first sight surprising since mackerel is a shelf species, but it may have been used as bait on the long-line (although remains of more than 1 individual mackerel were found in the stomach and bait fish are normally spaced out along a long-line).

There is little information on the diet of the species, NIGMATULLIN, SHCHETINNIKOV AND SHUKHGALTER (2009) reported on the stomach contents of 60 specimens of *O. bartramii* taken by hand-jigging in the southeast Pacific. These squid had taken a wide variety of prey, mainly myctophid fish (*Symbolophorus, Myctophum* and *Hygophum*) and cephalopods (Onychoteuthidae and Enoploteuthidae). The authors also noted the presence in the stomachs of beaks of the family Ommastrephidae (including some remains of *O. bartramii*). Myctophid fish and squid of the families Onychoteuthidae and Enoploteuthidae were also found to be the main prey in a sample of 315 *O. bartramii* from off Hawaii (PARRY, 2006). No myctophid remains were found in the stomach of the present specimen.

The main preys of this species in the Northwest Pacific were myctophids. Secondary important prey items included onychoteuthid and gonatid squids. The study was done using driftnets offshore but *Engraulis japonicus* and Carangidae (as well as other species that could be found in shelf waters) were reported in the diet in low numbers. Chnages in feeding habits of the neon flying squid were found in relation to their seasonal south-north migrations and diel vertical displacements (WATANABE, KUBODERA, ICHII AND KAWAHARA, 2004).

ACKNOWLEDGEMENTS

We would like to thank the skipper and crew of the *Nuevo Monte Ventoso* and Rafael Bañón Díaz who identified the fish found inside the squid mantle. G.J. Pierce was supported by the ANIMATE project (MEXC-CT-2006-042337).

BIBLIOGRAPHY

Boschi E., Fischbach C. and Iorio M. 1992. Catálogo ilustrado de los crustáceos estomatópodos y decápodos marinos de Argentina. *Frente Marítimo,* 10: 56-57.

Bower J.R. and Ichii T. 2005. The red flying squid (*Ommastrephes bartramii*): A review of recent research and the fishery in Japan. *Fisheries Research* 76, 39-55.

Boyle P.R., Pierce G.J. and Hastie L.C. 1995. Flexible reproductive strategies in the squid *Loligo forbesi. Marine Biology,* 121: 501-508.

Chen C.-S. and Chiu T.S. 2003. Variations of life history parameters in two geographical groups of the neon flying squid, *Ommastrephes bartramii,* from the North Pacific. *Fisheries Research,* 63: 349-366.

Clarke M.R. 1986. *A handbook for the identification of Cephalopod beaks.* Clarendon Press. Oxford. 273 p.

Dunning M. 1998. An overview of the fisheries biology and resource potential of *Ommastrephes bartramii* (Cephalopoda: Ommastrephidae) in the Southern Hemisphere. In Okutani, Y. (Ed.): Contributed papers to International Symposium on Large Pelagic Squids. *Japan Marine Fishery Resources Research Center,* Tokyo: 65-76.

González A.F., Dawe E.G., Beck P.C. and Pérez J.A.A. 2000. Bias associated with statolith-based methodologies for ageing squid: a comparative study on *Illex illecebrosus* (Cephalopoda: Ommastrephidae). *Journal of Experimental Marine Biology and Ecology,* 244: 161-180.

González A.F, Otero J., Guerra A., Pierce G. J. (in press) Age, growth and mortality of *Loligo vulgaris* wild planktonic paralarvae in the Ría de Vigo (NE Atlantic Ocean). *ICES Journal of Marine Science.*

Härkönen T. 1986. *Guide to the otoliths of bony fishes of the Northeast Atlantic.* Daubin ApS. Sweden. 256 p.

Ibáñez Ch.M. and Keyl F. 2010. Cannibalism in cephalopods. *Reviews in Fish Biology and Fisheries,* 20: 123-136.

Ichii T., Mahapatra K., Okamura H. and Okada Y. 2006. Stock assessment of the autumn cohort of neon flying squid (*Ommastrephes bartramii*) in the North Pacific based on past large-scale high seas drifnet fishery data. *Fisheries Research,* 78: 286-297.

Nesis K.N. 1987. Cephalopods of the world. Squids, cuttlefishes, octopuse, and allies. T.F.H. Publications, Neptune City. 351 p.

Nigmatullin C.M., Shchetinnikov A.S. and Shukhgalter O.A. 2009. On feeding and helminth fauna of neon flying squid *Ommastrephes bartramii* (Lesueur, 1821) (Cephalopoda: Ommastrephidae) in the southeastern Pacific. *Revista de Biología Marina y Oceanografía,* 44: 227-235.

Parry M. 2006. Feeding behaviour of two ommastrephid squids *Ommastrephes bartramii* and *Sthenoteuthis oualaniensis* off Hawaii. *Marine Ecology Progress Series,* 318: 229–235.

Roper C.F.E., Sweeney M.J. and Nauen C.E. 1984. *FAO species catalogue. Cephalopods of the world. An annotated and illustrated catalogue of species of interest to fisheries.* FAO Fisheries Synopsis, 3 (125): 277 p.

Smale M.J., Watson G. and Hecht T. 1995. *Otolith atlas of Southern African marine fishes (Ichthyological monographs).* J.L.B. Smith Institute of Ichthyology, 1, 253 pp.

Tuset V.M., Lombarte A. and Assis C.A. 2008. Otolith atlas for the western Mediterranean, north and central eastern Atlantic. *Scientia Marina,* 72: 1–203.

Watanabe H., Kubodera T., Ichii T. and Kawahara S. 2004. Feeding habits of neon flying squid *Ommastrephes bartramii* in the transitional region of the central North Pacific. *Marine Ecology Progress Series,* 266: 173-184.

Watt J., Pierce G.J. and Boyle P.R. 1997. A guide to the identification of North Sea fish using premaxillae and vertebrae. Co-operative Research Report No 220, International Council for the Exploration of the Sea, 231 p.

West K.L., Walker W.A., Baird R.W., White W., Levine G., Brown E. and Schofield D. 2009. Diet of pygmy sperm whales (*Kogia breviceps*) in the Hawaiian Archipelago. *Marine Mammal Science,* DOI: 10.1111/j.1748-7692.2009.00295.x

Yatsu A. and Yamashiro C. 1999. *Report of the Kaiyo Maru Cruise for study on the resources of two ommastrephid squids, Dosidicus gigas and Ommastrephes bartrami, in the Pacific Ocean, during September 11 - December 24, 1997.* Fisheries Agency of Japan, 206 p.

Zuev G.V., Nigmatullin Ch.M., Chesalin M.V. and Nesis K.N. 2002. Main results of long-term worldwide studies on tropical nektonic oceanic squid genus *Sthenoteuthis*: an overview of the soviet investigations. *Bulletin of Marine Science,* 71: 1019-1060.

© *Sociedad Española de Malacología* *Iberus*, 28 (1): 67-72, 2010

A new species of *Candidula* (Gastropoda, Hygromiidae) from central Portugal

Una nueva especie de *Candidula* (Gastropoda, Hygromiidae) de Portugal

Geraldine A. HOLYOAK and David T. HOLYOAK*

Recibido el 19-II-2010. Aceptado el 23-IV-2010

ABSTRACT

A new species *Candidula coudensis* is described from Vale da Couda (Almoster, Leiria), in central Portugal. It differs from other species of the genus in combining a large shell with sharp peripheral keel and coarse radial ribs with a penis bearing a long flagellum. The new species lives together with *Candidula* cf. *belemensis* (Servain, 1880) on rocky limestone slopes.

RESUMEN

Se describe la nueva especie *Candidula coudensis* del Vale da Couda (Almoster, Leiria), en la región central de Portugal. Difiere de otras especies del género por presentar una concha grande con fuerte quilla carenal y gruesas costillas radiales, y un pene provisto de un largo flagelo. La nueva especie vive junto con *Candidula* cf. *belemensis* (Servain, 1880) en pendientes calcáreas rocosas.

INTRODUCTION

During fieldwork in the limestone hills above Vale da Couda (district of Leiria, formerly Beira Litoral), central Portugal on 31st January 2008 an unfamiliar "helicellid" (Hygromiidae) was found. Because of its light-coloured, sharply keeled shell with strong radial ribs it was initially thought to be *Candidula setubalensis* (L. Pfeiffer, 1850), known only as an endemic of the Serra da Arrábida near Setúbal (district of Setúbal, Portugal). Subsequent studies have revealed that the genital anatomy of the snail from Vale da Couda is typical of *Candidula* in having only a single large dart sac as in *C. setubalensis* (GITTENBERGER, 1985) but it differs from that species in the much longer flagellum on its penis. Since the shells of *C. setubalensis* also differ in several characters from those of the snail from Vale da Couda the latter is described here as a new species. A fuller review of the species of *Candidula* in Portugal is in preparation.

TAXONOMIC PART

Family HYGROMIIDAE Tryon, 1866
Subfamily HYGROMIINAE Tryon, 1866
Tribe Helicellini Ihering, 1909

---

* Quinta da Cachopa, Barcoila, 6100-014 Cabeçudo, Portugal.

Genus *Candidula* Kobelt, 1871

Type species (by absolute tautonymy): *Helix candidula* Studer, 1818 = *Candidula unifasciata* (Poiret, 1801).

Remarks: Allocation of the genus *Candidula* to the Tribe Helicellini in the Hygromiidae follows Bank, Bouchet, Falkner, Gittenberger, Hausdorf, Proschwitz and Ripken (2001), Bank, Groh and Ripken (2002) and Falkner, Bank and Proschwitz (2001).

Candidula coudensis spec. nov. (Figs. 1-7)

Type locality: Vale da Couda, by N348 road SE. of Almoster (district of Leiria, Portugal), 29S NE498099, *ca* 390 m alt., herb-rich grassland and low shrubs by road.

Type material: Holotype (Figs 1-5; in the BM, reg. no. 20100177) from type-locality collected 12 Dec. 2009, leg. G.A. Holyoak; body in spirit and dry shell kept separately (holotype and several paratypes kept alive until 16 Jan. 2010).

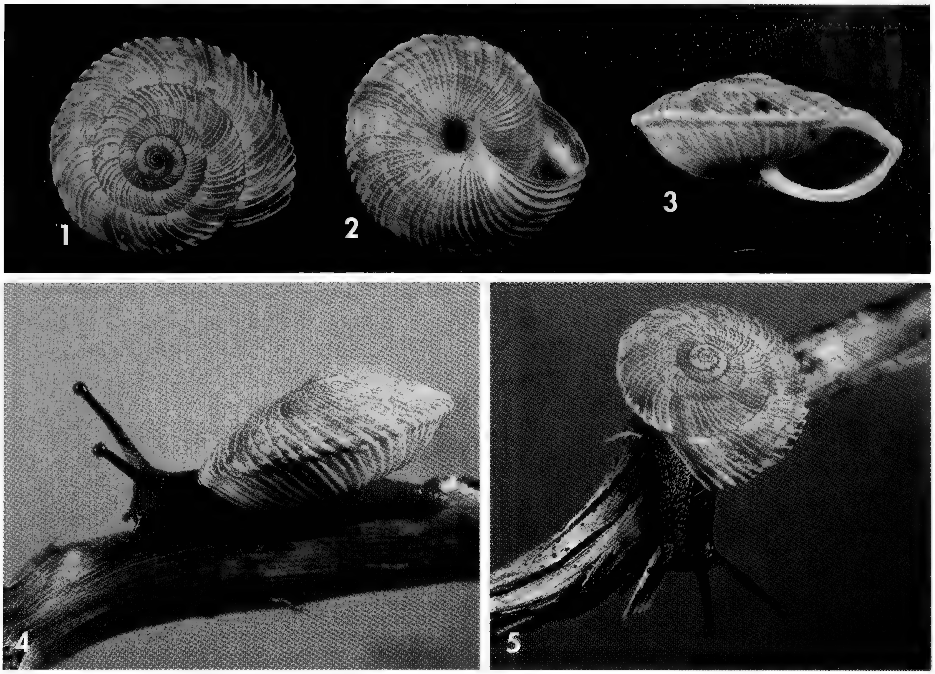
Paratypes: 4 dry shells (BM, reg. no. 20100178) and 4 in spirit (3 shell and body, 1 body only, BM, reg. no. 20100179), 57 dry shells, 2 shells containing bodies kept in spirit and 5 bodies in spirit with dry shells kept separately (Collection of G.A. Holyoak). Additional paratypes from near type-locality, all in Collection of G.A. Holyoak: 10 shells, 1 body in spirit (used for Figs. 6, 7) and dry shell kept separately, collected 31 Jan. 2008 (limestone crags and slopes, 29S NE498099); 31 shells, 1 body in spirit and dry shell kept separately, collected 10 June 2009 (low limestone crags and slopes, 29S NE498099); 44 shells, collected 12 Dec. 2009 (scrub-covered limestone hillside with low walls and scree, 29S NE497096).

Etymology: The specific epiphet *coudensis* is an adjective derived from the name of the type-locality at Vale da Couda. The generic name *Candidula* has been created as a feminine noun, so the termination of the epiphet *coudensis* is therefore feminine in agreement.

Description: Adult shell (Figs. 1-3) dextral, strongly compressed above, with low convex to low-conical spire of 5¼-5½ flattened whorls with shallow sutures and sharp slightly raised keel at periphery. Umbilicus $^{1}/_{5}$ - $^{1}/_{7}$ width of shell, symmetrical, exposing parts of several whorls of spire internally, open or slightly overlapped by peristome. Mouth slightly oblique, oval but somewhat flattened above and below with prominent keel at periphery, thin peristome and white internal rib. Shell opaque, pale cream to light brown (fading to whitish) with very variable broad to narrow bands of dull brown to blackish-brown that are variously distinct, fused, blotched or interrupted, sometimes almost lacking on underside of shell. Shell surface not or slightly glossy, with radial ribs which are pale on top; on lower whorls ribs become strong, evenly spaced, with each rib conspicuously raised and thickened at the peripheral keel; on underside of shell the ribs reach the umbilicus, within which they are reduced to rows of papillae; microsculpture of fine spiral parallel grooves is often present on body whorl, especially on underside. The protoconch appears smooth at ×30 magnification; there is no trace of hairs or hair-pits on the upper whorls.

Exposed parts of body of living animal (Figs. 4, 5) light to rather dark grey, with some brown suffusion and blackish foot fringe. In detail, the skin tubercles are variably suffused with brown and outlined in dark grey.

Genital anatomy (Figs. 6, 7); description based on dissection of four individuals; "proximal" and "distal" in the following account refer to the position in relation to the genital orifice. The right ommatophore retractor muscle runs free, i.e. it does not cross between penis and vagina. Flagellum long (longer than epiphallus), slender, tapering, curved; epiphallus slightly shorter than penis; penial retractor muscle attached to prox-

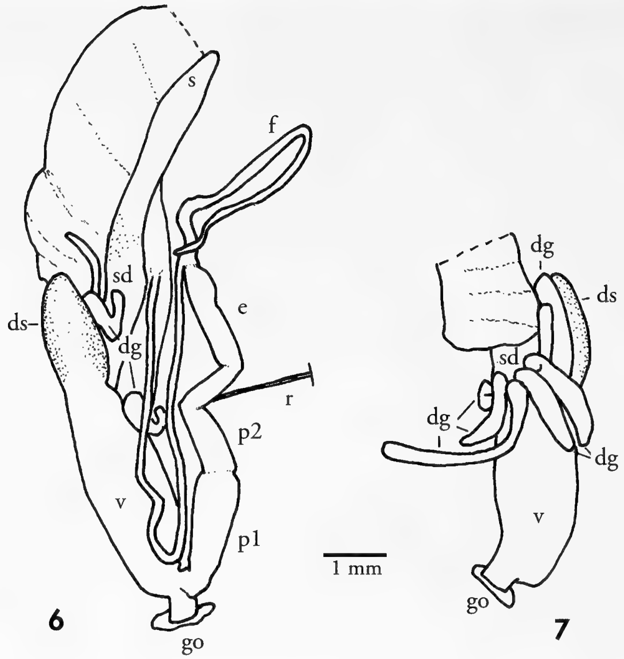


Figures 1-5. *Candidula coudensis* spec. nov. holotype, shell 11.6 mm in width (BM reg. no. 20100177). 1-3: adult shell; 4, 5: holotype photographed alive.
Figuras 1-5. Candidula coudensis *spec. nov. holotipo, anchura de la concha 11,6 mm (BM nº 20100177). 1-3: concha adulta; 4, 5: holotipo fotografiado en vivo.*

imal part of epiphallus; penis thin-walled, internally with conical verge (having small simple apical pore) descending from distal part of penis (p2) into proximal part of penis (p1). Free oviduct moderately long. Dart sac (stylophore) single, moderately large, muscular, united with wall of vagina for about three-quarters of its length, entering proximal part of vagina through conical papilla. Digitiform glands ("mucus glands") two, arising from vagina just distal to its union with dart-sac complex, each gland divided near base into two or three short branches. Spermatheca (bursa-copulatrix) cylindrical-conical, lying on spermoviduct; spermatheca duct rather short and wide.

Dimensions: holotype 11.6 × 5.0 mm, 90 adult paratypes 8.8-11.4 × 4.7-5.4 mm.

Distribution and habitat: *C. coudensis* has been found only in a range less than one kilometre in total extent, near Vale da Couda, by the N348 road SE. of Almoster (district of Leiria), Portugal. This range overlaps the edges of three different 10-km squares of the U.T.M. grid (NE40, NE41 and NE51). *Candidula* cf. *belemensis* lives in the same areas, and also at several other sites within a 5 km radius on the same limestone hills where *C. coudensis* was not found. Within its restricted range *C. coudensis* occurs at *ca* 380-390 m altitude, over Mesozoic limestone that is exposed in crags facing east and north and also as scattered rocks and in stone walls. The largest numbers were found living on 12th December 2009, resting above the ground on herbs, grasses and low bushes on almost flat, rather open, disturbed ground near the roadside (11 living *C. coudensis* were found, with at least 11 living *C.* cf. *belemensis* in similar sites in the same small area). Single *C. coudensis* were also found living under



Figures 6, 7. *Candidula coudensis* spec. nov. Anatomy of genitalia of a paratype (in collection of G.A. Holyoak). 6: general view of anatomy of proximal genitalia; 7: view of vagina and dart sac from other side. Abbreviations, dg: digitiform gland(s); ds: dart sac; e: epiphallus; f: flagellum; go: genital orifice; p1: proximal part of penis; p2: distal part of penis; r: penial retractor muscle; s: spermatheca; sd: spermathecal duct; v: vagina.

Figuras 6, 7. Candidula coudensis *spec. nov. Anatomía de genitales de un paratipo (en colección de G.A. Holyoak). Fig. 6 is Vista anatómica general de la parte proximal del tracto genital, Fig. 7 vista de la vagina y del saco del dardo desde el lado opuesto. Abreviaturas, dg: glándula(s) digitiforme(s); ds: saco del dardo; e: epifalo; f: flagelo; go: orificio genital; p1: parte proxima del pene; p2: parte distal del pene; r: músculo retractor del pene; s: espermateca; sd: conduto de la espermatecas; v: vagina.*

limestone rocks near the sparsely vegetated base of the east-facing crags on 31st January 2008 and 10th June 2009.

Remarks: Among Iberian Helicellini the presence of only a single moderately large clearly visible dart sac is a distinctive feature of *Candidula*, although an externally unnoticeable "accessory sac" lacking a dart may also be present alongside it and sometimes also a trace of an atrophied dart sac within the opposite wall of the vagina (e.g. GITTENBERGER, 1985; HAUSDORF, 1988; ALONSO, IBÁNEZ AND HENRÍQUES, 1996; SCHILEYKO, 2006).

A review of Portuguese species of *Candidula* by GITTENBERGER (1993) recognised six species, largely from shell characters. Of these, *C. intersecta* (Poiret, 1801) and *C. gigaxii* (L. Pfeiffer, 1848) have wide ranges in western Europe, whereas the other four are apparently endemic to Portugal (*C. setubalensis* known only from Serra da Arrábida; *C. belemensis* known from districts of Faro (the Algarve) and Setúbal, and possibly (pers. obs.) northwards to the district of Leiria; *C. olisippensis* (Servain, 1880) known locally from the Algarve northwards to the district of Porto (formerly, Douro Litoral); *C. codia* (Bourguignat, 1859) known only from the Algarve, where additional localities were reported by MENDES SIMÕES, 2006).

C. coudensis differs from all of these except *C. setubalensis* in having a sharply keeled shell. However, the flagellum in *C. setubalensis* is much shorter (less than half length of epiphallus: GITTENBERGER, 1985) than in *C. coudensis* (in which it is longer than epiphallus: Fig. 6). Their shells also differ, comparisons based on 37 adult or nearly adult shells of *C. setubalensis* (in Collection of G.A. Holyoak) revealing that they are on average smaller (largest shell 9.7 × 4.6 mm), with even less convex whorls (so spire often lower, mouth more elliptical, peripheral keel even sharper), and umbilicus larger (averaging *ca* 1/5 of shell width) and exposing more of spire internally; the sculpture and coloration of the shell are similar. All of the five other species of *Candidula* accepted for Portugal by GITTENBERGER (1993) have depressed-globular shells with a rounded body whorl. In all five of these species the sculpture of radial ribs is weaker than in *C. coudensis*, although it is approached by *C. codia*, which otherwise differs markedly in its globular shell with domed spire.

Elsewhere, the genus *Candidula* has been reported over a wide range from Ireland eastwards to southernmost Sweden and southwards to Fuerteventura (Canary Islands) in the west and the Balkan Peninsula in the east, with approximately 23 recognised species (KERNEY AND CAMERON, 1979; HAUSDORF, 1988, 1991; MANGANELLI AND GIUSTI, 1988; PUENTE, 1994; ALONSO, IBÁNEZ AND HENRÍQUES, 1996). Except for *C. setubalensis*, as discussed above, no other species currently assigned to the genus has a sharply keeled shell. However, a relatively long penial flagellum, exceeding one-half of the length of the epiphallus, has been described for the Spanish endemic species *C. camporroblensis* (De Fez, 1944) and *C. rocandioi* (Ortiz de Zárate, 1950) (APARICIO, 1982).

C. coudensis apparently reaches reproductive maturity in winter. A paratype with mature genitalia (Figs 6-7) was collected on 31st January 2008. Five of the snails collected on 12th December 2009 were kept alive indoors and these laid three clusters of eggs on 16th-18th January 2010. The clusters were of 36, 64 and 77 eggs respectively, laid in loosely-adherent rounded-conical heaps, with a few single eggs scattered elsewhere in the box. Individual eggs were spherical, 1.0-1.3 mm in diameter, more or less translucent, whitish, or sometimes with a slight yellow tinge.

ACKNOWLEDGEMENTS

The authors want to thank T.L. Blockeel for advice on nomenclature and the referees for helpful suggestions.

BIBLIOGRAPHY

ALONSO M.R., IBÁÑEZ M. AND HENRÍQUES F.C. 1996. *Candidula ultima* (Mousson, 1872) (Mollusca, Pulmonata, Hygromiidae), a nice case of adaptive convergence. *Journal of Conchology*, 35: 455-465.

APARICIO M.T. 1982. Observations on the anatomy of some Helicidae from central Spain. *Malacologia*, 22 (1-2): 621-626.

BANK R.A., BOUCHET P., FALKNER G., GITTENBERGER E., HAUSDORF B., PROSCHWITZ T. von AND RIPKEN T.E.J. 2001. Supraspecific classification of European non-marine Mollusca (CLECOM Sections I + II). *Heldia*, 4 (1-2): 77-128.

BANK R.A., GROH K. AND RIPKEN T.E.J. 2002. Catalogue and bibliography of the non-marine Mollusca of Macaronesia. *In*: Falkner, M., Groh, K. and Speight, M.C.D. (Eds), *Collectanea Malacologica. Festschrift für Gerhard Falkner*. Hackenheim: ConchBooks. Pp. 89-235.

FALKNER G., BANK R.A. AND PROSCHWITZ T. VON 2001. Check-list of the non-marine molluscan species-group taxa of the states of northern, Atlantic and central Europe (CLECOM I). *Heldia*, 4 (1-2): 1-76.

GITTENBERGER E. 1985. The taxonomic status of *Xeroplexa* Monterosato, 1892 (Pulmonata: Helicidae: Helicellinae), a surprise. *Iberus*, 5: 59-62.

GITTENBERGER E. 1993. Digging in the graveyard of synonymy, in search of Portuguese species of *Candidula* Kobelt, 1871 (Mollusca: Gastropoda Pulmonata: Hygromiidae). *Zoologische Mededelingen*, Leiden, 67 (17): 283-293.

HAUSDORF B. 1988. Zur Kenntnis der systematischen Beziehung einiger Taxa der Helicellinae Ihering 1909 (Gastropoda: Hygromiidae). *Archiv für Molluskenkunde*, 119 (1-3): 9-37.

HAUSDORF B. 1991. Über zwei *Candidula*-Arten von der südlichen Balkanhalbinsel (Gastropoda: Hygromiidae). *Archiv für Molluskenkunde*, 120 (4-6): 119-129.

KERNEY M.P. AND CAMERON R.A.D. 1979. *Land snails of Britain and north-west Europe*. HarperCollins, London.

MANGANELLI G. AND GIUSTI F. 1988. Notulae malacologicae, 38. A new Hygromiidae from the Italian Apenines and notes on the genus *Cernuella* and related taxa (Pulmonata: Helicoidea). *Bollettino Malacologico*, 23 (11-12): 327-380 [for 1987].

MENDES SIMÕES J.M. 2006. Notas sobre a distribuição geográfica de *Candidula codia* (Bourguignat, 1859) (Gastropoda, Pulmonata: Hygromiidae) em Portugal. *Portugala*, 7: 3-4.

PUENTE A.I. 1994. *Estudio taxonómico y biogeográfico de la superfamilia Helicoidea Rafinesque, 1815 (Gastropoda: Pulmonata: Stylommatophora) de la Península Ibérica e Islas Baleares*. Doctoral thesis (unpublished). Bilbao, 970 pp.

SCHILEYKO A.A. 2006. Treatise on recent terrestrial pulmonate molluscs, Part 14, Helicodontidae, Ciliellidae, Hygromiidae. *Ruthenica*, Supplement 2: 1905-2047.

© Sociedad Española de Malacología —— *Iberus*, 28 (1): 73-78, 2010

A new species of *Gibbula* (Mollusca, Archaegastopoda) from Namibia

Una nueva especie de *Gibbula* (Mollusca, Archaegastopoda) de Namibia

Emilio ROLÁN* and Michael L. ZETTLER**

Recibido el 14-XII-2009. Aceptado el 24-IV-2010

ABSTRACT

A new species is described from Namibian waters and compared with the morphologically close species from the study area.

RESUMEN

Se describe una nueva especie de Namibia comparándola con las especies morfológicamente similares del área de estudio.

INTRODUCTION

The Namibian molluscan fauna is very far from being well known. Only few works with information about the molluscs of this area are known (e.g. Penrith and Kinsley, 1970a, 1970b). Usually, it is thought that this fauna is mostly influenced by that of South Africa (Kilburn and Rippey, 1982, Steyn and Lussi, 1998) due to the presence of an oceanic current from the south towards the north that obstructs the dispersion of the West African fauna.

MATERIAL AND METHODS

The Leibniz Institute for Baltic Sea Research from Rostock-Warnemünde, Germany, sampled the macrozoobenthos along the northern Namibian coast in 2008 with the research vessel "Maria Sybilla Merian". Triplicate benthic samples were taken with a 0.1 m^2 van Veen grab at each station. Additional dredge hauls using a net mesh size of 5 mm) were taken for collection of larger, mobile or rare species. All samples were sieved through a 1-mm^2 screen and animals were preserved on board in 4% buffered formaldehyde. Sorting procedures were conducted at the laboratory with a stereomicroscope with 10-40x magnification. For more information on the study area and abiotic characteristics at the sampling station see Zettler, Bochert and Pollehne (2009).

In this material, several samples of a species with conical form were found; since it was apparently undescribed, the purpose of the present paper is to name it.

Abbreviations

MHNS Museo de Historia Natural de la Universidad de Santiago de Compostela, (coll. E. Rolán),

---

* Museo de Historia Natural, Campus Universitario Sur, 15782 Santiago de Compostela, Spain.
** Leibniz-Institute for Baltic Sea Research, Seestr. 15, 18119, Rostock, Germany.

IOW Institute for Baltic Sea Research, Warnemünde,
MNCN Museo Nacional de Ciencias Naturales, Madrid,
WMC collection of Werner Massier, Swakopmund
ZMB Museum für Naturkunde of the Humboldt University, Berlin,

SYSTEMATICS

Family TROCHIDAE Rafinesque, 1815
Subfalily TROCHINAE Rafinesque, 1815
Genus *Gibbula* Risso, 1826

Gibbula massieri spec. nov. (Figs. 1-14)

Type material: Holotype (Figs. 1-3) in ZMB (Moll. 107743). Paratypes in the following collections: MNCN (1, n° 15.05/53490, Fig. 5); IOW (3, IOW-NA-0001-3, Figs. 4, 7-9); MHNS (1); WMC (3, Figs. 6-9).
Other material examined: One specimen was destroyed for radular study; 25 juveniles and some fragments (IOW).
Type locality: Offshore Namibia south of the River Kunene, 30 m depth, 17.390° S 11.724 E (5-03-2008). Shell deposits of the brachiopod *Discinisca tenuis* (Sowerby, 1847).
Etymology: The specific name is after Werner Massier, from Swakopmund, Namibia, for his cooperation in the study of the material.

Description: Shell (Figs. 1-9) conical, solid, with spiral striation and axial threads. Protoconch (Figs. 10-11) with about one smooth whorl and a diameter of about 90 μm. The beginning of the teleoconch has 4 spiral cords, separated by deep interspaces. The subsequent whorls have a straight profile and a similar number of cords, the last whorl having between 5 and 6 cords down to the periphery, which is well angled. Below it, towards the base, there are 7-8 cords, clearly separated, and closer near the umbilical infundibulum. In the interspaces between the cords there are numerous small very close prosocline threads. Aperture rectangular, columella slightly prosocline, straight, external border sharp, slightly undulating as a result of the endings of the spiral cords. The colour of the first whorls (corresponding to the juvenile stages) is brown on the spiral cords and white on its interspaces; in the subsequent whorls, axial dark blotches appear, alternating with white or light colour. On the base, the cords usually are alternate brown and white or cream, but this is very irregular.

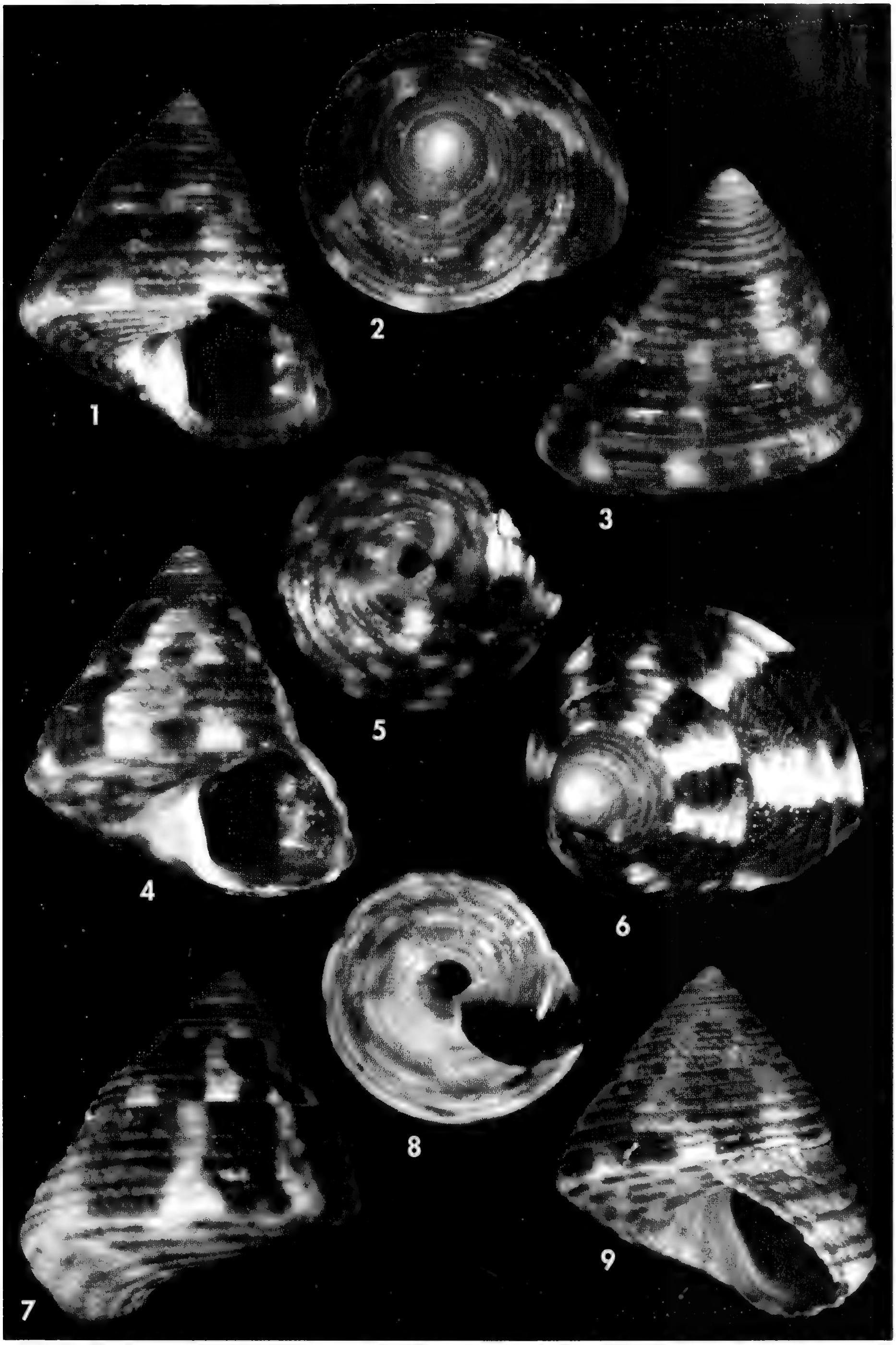
Dimensions: holotype 6.5 mm in height by 6.1 mm in diameter. The paratypes are of a similar size.

The animal, examined in specimens preserved in alcohol, is whitish with isolated dark lines on the head. There are three evident epipodial tentacles on each side. Operculum (Fig. 12) rounded, fine, semitransparent and multispiral, with a central nucleus.

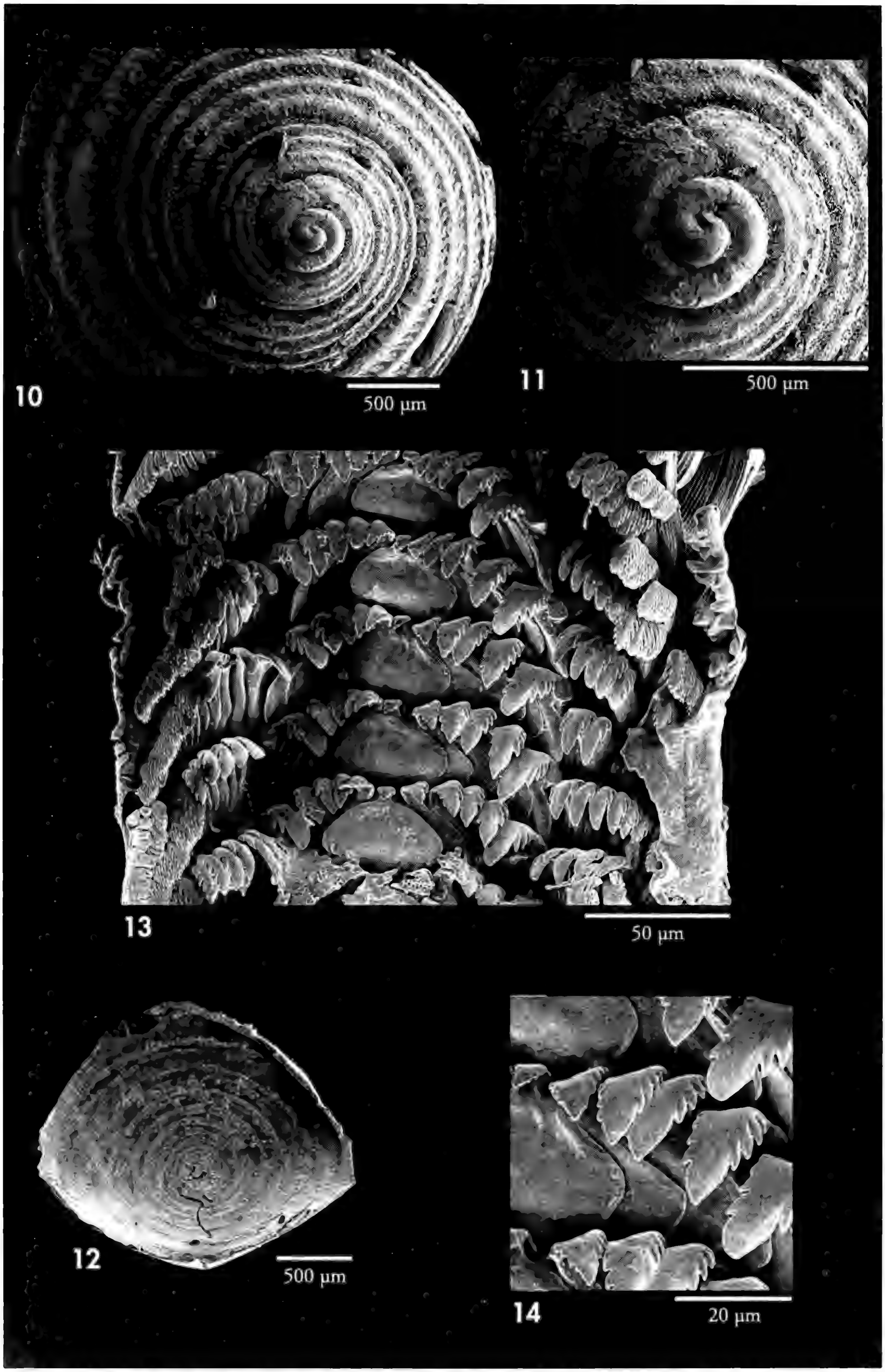
Radula (Figs. 13, 14) rather typical of the genus: rachidian tooth with a reduced shaft, which has only a few small cusps; the lateral teeth 1-5 are similar in form, increasing slightly in size outwards; all of them have a pointed apex and several lateral cusps (up to 6), the external one larger. The marginal ones number about 30 on each side, the 5-6 more internal ones are larger and have 1-2 lateral cusps; going up to the external ones, their size diminishes while the number of their lateral cusps increases.

Distribution: Only known from Namibia.

Remarks: The placement of this species in the genus *Gibbula* is based on the relatively small size of the shell, its conical form, lack of columellar denticle,



Figures 1-9. *Gibbula massieri* spec. nov. 1-3: holotype, 6.5 mm (ZMB); 4-9: paratypes; 4: 5.4 mm (IOW); 5: 5.5 mm (MNCN); 6: 5.0 mm (WMC); 7, 9: 6.4 mm (IOW); 8: 5.0 mm (IOW).
Figuras 1-9. Gibbula massieri *spec. nov. 1-3: holotipo, 6,5 mm (ZMB); 4-9: paratipos; 4: 5,4 mm (IOW); 5: 5,5 mm (MNCN); 6: 5,0 mm (WMC); 7, 9: 6,4 mm (IOW); 8: 5,0 mm (IOW).*



Figures 10-14. *Gibbula massieri* spec. nov. 10-11: protoconch; 12: operculum; 13-14: radula.
Figuras 10-14. Gibbula massieri *spec. nov. 10-11: protoconcha; 12: opérculo; 13-14: rádula.*

presence of an umbilicus, existence of three epipodial tentacles at each side of the body, and radula with a narrow shaft and reduced cusp in the rachidian tooth.

Among the South African species of small size we can separate the new species from the following:

Cantharidus suarezensis (P. Fischer, 1878) is lighter in colour, the umbilicus narrower.

Gibbula beckeri Sowerby, 1901, is more depressed, the whorls convex and slightly shouldered, the sculpture is weaker, the colour is also a combination of dark and light blotches but with a smaller pattern.

Gibbula zonata (Wood, 1828) is more depressed, with convex whorls, spiral cords in low number, and a wider umbilicus.

Gibbula cicer (Menke in Philippi, 1844) has convex whorls, prominent and less numerous spiral cords, the umbilicus usually closed.

Gibbula fultoni (Sobwerby, 1889), according to the description in BARNARD (1963), has a conical form similar to that of the present new species but it has a completely or almost closed umbilicus. The shell is also larger.

Among the Angolan species, comparison must be made with:

Jujubinus fulgor Gofas, 1991, which has an apparently similar shell, but is more solid, smaller, without any umbilicus and having a columellar lengthening on its lower part.

The comparison with species from other areas:

Gibbula verdensis Rolán and Templado, 2001 has a similar form and size, but the colour is usually lighter, the white blotches are very small and the umbilicus is reduced to a small furrow. It is endemic to the Cape Verde islands.

Gibbula joubini Dautzenberg, 1910 is smaller (about 4.5 mm) the peripheral border is more rounded, the dark brown blotches are most frequently opistocline, the aperture is relatively smaller. This is an endemism from Senegal which has not been recorded from other countries.

The species recorded by GOFAS, PINTO AFONSO AND BRANDÃO (1985) from Angola as *Gibbula* aff. *joubini*, may be the species here described or other similar (material not examined).

ACKNOWNLEDGEMENTS

We thank Dr. U. Struck (Berlin), Dr. V. Mohrholz (Rostock), U. Hehl (Rostock), M. Römer (Hamburg) and C. Berg (Rostock) for assistance during sampling at RV Maria S. Merian. We wish also to thank Dr. Ralf Bochert and I. Glockzin (both Rostock) for analysis of benthic samples in the laboratory. To Jesús Méndez of the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) of the University of Vigo for the SEM photographs. And António A. Monteiro for English corrections to the manuscript.

BIBLIOGRAPHY

BARNARD R. H. 1963. Contribution to the knowledge of South African Marine Mollusca. Part IV. Gastropoda: Prosobranchiata: Rhipidoglossa, Docoglossa, Tectibranchiata. Polyplacophora. Solenogastres. Scaphopoda. *Annals of the South African Museum*, 47 (2): 201-360.

DAUTZENBERG P. 1910. Contribution à la faune malacologique de l'Afrique occidentale *Actes de la Société Linnénne de Bordeaux*, 44: 1-174, pl. 1-4

GOFAS S. 1991. Un nouveau *Jujubinus* d'Angola. *Apex*, 6 (1): 21-24.

GOFAS S., PINTO AFONSO J. AND BRANDÃO M. [1985]. Conchas e moluscos de Angola. Universidade Agostinho Neto/Elf Aquitaine Angola, 144 pp.

KILBURN R. AND RIPPEY E. 1982. *Sea Shells of Southern Africa*. Macmillan South Africa, Johanesburg. 249 pp.

PENRITH M. L. AND KENSLEY B. 1970a. The constitution of the intertidal fauna of rocky shores of South West Africa. Part I. Lüderitzbucht. *Cimbebasia*, 1: 191–239.

PENRITH M. L. AND KENSLEY B. 1970b. The constitution of the intertidal fauna of rocky shores of South West Africa. Part II. Rocky Point. *Cimbebasia*, 1: 241–268.

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

STEYN D. G. AND LUSSI M. 1998. *Marine Shells of South Africa*. Ekogilde Publishers, Hartbeespoort. 264 pp.

ZETTLER M.L., BOCHERT R. AND POLLEHNE F. 2009. Macrozoobenthos diversity in an oxygen minimum zone off northern Namibia. *Marine Biology*, 156: 1949-1961.

© *Sociedad Española de Malacología* — *Iberus*, 28 (1): 79-89, 2010

New information on the Caribbean *Rissoina* (Gastropoda, Rissoidae) of the group *R. sagraiana-cancellata* with the description of a new species

Nueva información sobre las *Rissoina* del Caribe (Gastropoda, Rissoidae) del grupo de *R. sagraiana-cancellata*, con la descripción de una nueva especie

Emilio ROLÁN* and Raúl FERNÁNDEZ-GARCÉS**

Recibido el 2-XII-2009. Aceptado el 27-IV-2010

ABSTRACT

Five species of the genus *Rissoina* from Cuba are characterized and illustrated with scanning electron micrographs: *Rissoina sagraiana, R. pulchra, R. labrosa, R. redferni* and *R. cancellina* spec. nov. *Rissoina cancellata* is here placed in synonymy of *R. sagraiana*.

RESUMEN

Se caracterizan e ilustran con micrografías electrónicas de barrido cinco especies del género *Rissoina* de Cuba: *Rissoina sagraiana, R. pulchra, R. labrosa, R. redferni* y *R. cancellina* spec. nov. Se considera *Rissoina cancellata* como un sinónimo de *R. sagraiana*.

INTRODUCTION

Some of the species of the genus *Rissoina* in the Caribbean are poorly known, sometimes only from bibliographic references or from just a few figures. Even species recently described lack good photographs of details, such as the protoconch or microsculpture; this hinders the perfect knowledge of the species as well as the comparison with other species of the group, sometimes forcing other researchers to face problems about synonymy or validity.

Some species of this group were described for the Caribbean in a previous century: D'ORBIGNY (1842), PHILIPPI (1847), ADAMS (1850), etc.

PONDER (1985) revised the family Rissoidae at the generic and subgeneric levels, including among others the subgenus *Phosinella* Mörch, 1876 based on one of the species here studied.

The taxonomy of the species treated herein has been subject to disagreement. DESJARDIN (1949) revised the Cuban species of *Rissoina* and considers *R. pulchra* as a synonym of *R. cancellata*, followed in this by PONDER (1985). Conversely DE JONG AND COOMANS (1988) consider that *R. pulchra* is a synonym of *R. sagraiana*. Other works on the Caribbean malacological fauna have recorded and represented species of this group: WARMKE AND ABBOTT (1961), ABBOTT (1974), DE JONG AND COOMANS (1988), DÍAZ MERLANO AND PUYANA HEGEDUS (1994), RIOS (1994), REDFERN (2001), ESPINOSA AND ORTEA (2002), LEE (2009), among others.

---

* Museo de Historia Natural, Campus Universitario Sur, 15782 Santiago de Compostela, Spain.

** Centro de Estudios Ambientales de Cienfuegos (CEAC), División de Gestión Ambiental (DGA), calle 17, esquina Ave. 46, Cienfuegos, Cuba.

In the present paper, we present information on some characters of five Caribbean species of *Rissoina* which are morphologically very close, although the protoconchs show enough characters for differentiation. The previous papers on this group by the authors were ROLÁN AND FERNÁNDEZ-GARCÉS (2009a, 2009b).

Abbreviations

BMNH	The Natural History Museum, London
CFG	coll. Fernández Garcés, Cienfuegos
CHL	collection of Harry G. Lee, Florida
IES	Intituto de Ecología y Sistemática, La Habana
IGH	Instituto de Oceanología, La Habana
MCZ	Museum of Comparative Zoology, Harvard
MHNS	Museo de Historia Natural, Santiago de Compostela
MNCN	Museo Nacional de Ciencias Naturales, Madrid
MNHN	Museum national d'Histoire naturelle, Paris
ZMB	Zoologisch Museum, Berlin
s	shell
j	juvenile

SYSTEMATICS

Superfamily RISSOIDEA J. E. Gray, 1847
Family RISSOIDEA J. E. Gray, 1847
Subfamily RISSOININAE Stimpson, 1865

Genus *Rissoina* d'Orbigny, 1840

Type species: *Rissoina inca* d'Orbigny, 1840. Original designation.

Rissoina sagraiana d'Orbigny, 1842 (Figs. 1A-F)

Rissoina sagra d'Orbigny, 1842. *Hist. Nat. Cuba*, Atlas pl. 12, figs 4,5.
Rissoina sagraiana d'Orbigny, 1846. *Hist. Nat. Cuba*, vol. 2: 25.
Rissoina cancellata Philippi, 1847. *Zeitsch. Malak.*, 1846: 127.

Type material: *R. sagraiana*: Lectotype, selected in original lot of syntypes by Ángel Luque and hereby designated (Fig. 1A-C) and 3 paralectotypes in BMNH. *R. cancellata*: Holotype in ZMB (coll. Pfeiffer, 2334), 5.8 mm (see Remarks).
Other material examined: Cuba: 12 s, 2 j, Cayo Carenas, Cienfuegos Bay, 5-10 m (CFG); 20 s, 16 j, Rancho Luna, Cienfuegos, 12 m (CFG); 12 s, Faro Luna, Cienfuegos, 40 m (CFG); 8 s, 3 j Mangles Altos, Cienfuegos, 8 m (CFG); 5 s, Rancho Club, Cienfuegos Bay, 2 m (CFG); 10 s, Rancho Luna, Cienfuegos, 10-55 m (MHNS); 10 s, Faro de los Colorados, Cienfuegos, 20 m (MHNS). Nicaragua: 1 s, 1 f, Cayo Witties, 20 m (MHNS).

Description: Shell (Figs. 1A-C, 1E): see the original descriptions (D'ORBIGNY, 1846; PHILIPPI, 1847). Protoconch (Figs. 1D, 1F) with about 2 $^{1}/_{2}$ - 2 $^{3}/_{4}$ whorls, sometimes almost 3 whorls, and with a diameter of about 390-400 μm. It is smooth but on the last whorl (or starting a little before) an evident spiral thread can be observed at the middle of the periphery. At the beginning of the teleoconch there are two spiral cords in the middle of the whorl; in the following whorls, a new spiral cord appears between the two previous ones. The spiral cords are 6-7 on the last whorl, plus some smaller ones near the base.

Holotype of 5.8 mm, other shells from Cuba are slightly larger.

Distribution: This species is well known from many works from all the Caribbean: WARMKE AND ABBOTT (1961) from Puerto Rico; VOKES AND VOKES (1983) from Campeche and Yucatan; DE JONG AND COOMANS (1988) from

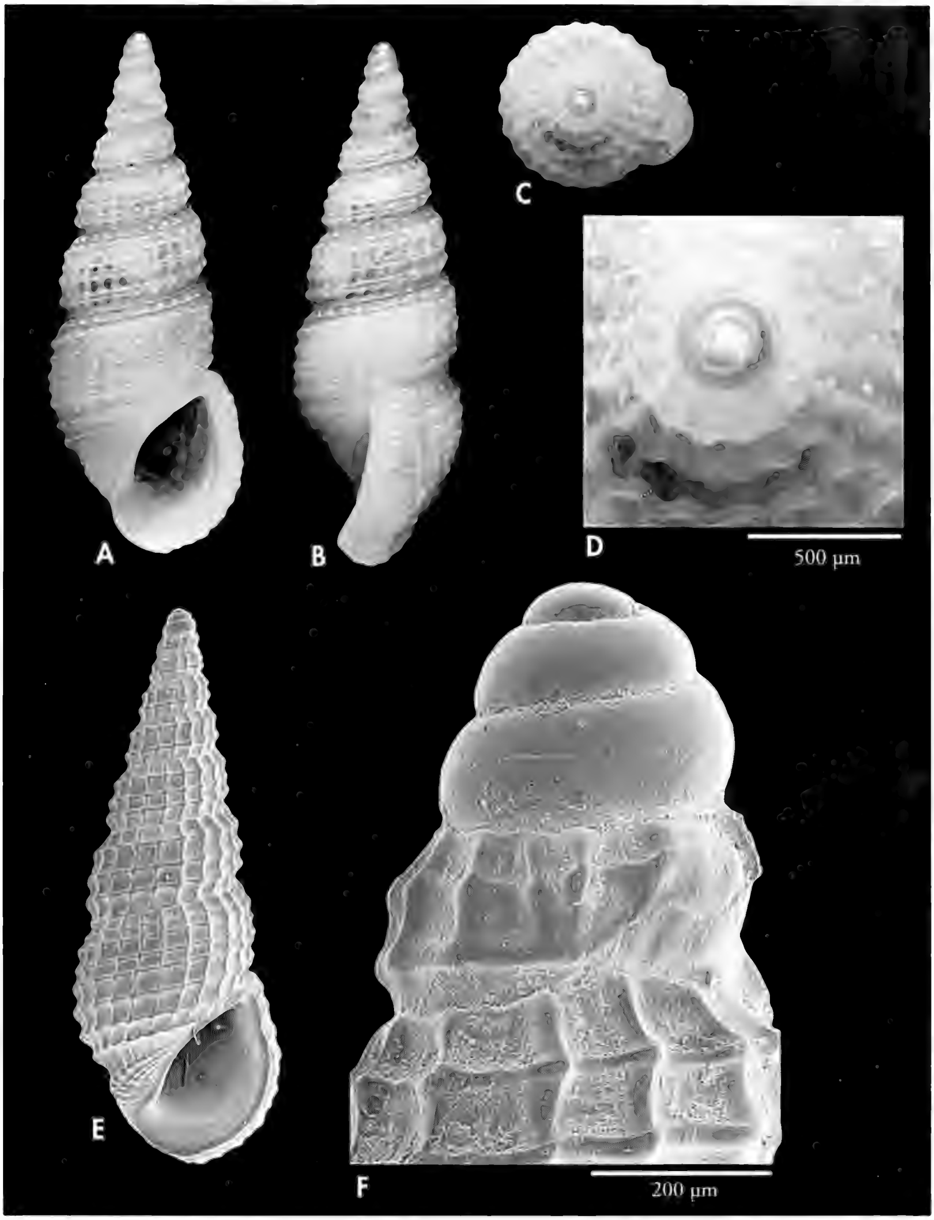


Figure 1. *Rissoina sagraiana* d'Orbigny, 1842. A-C: lectotype, 5.5 mm (BMNH); D: protoconch of the lectotype; E: shell from Cienfuegos, Cuba, 5.7 mm; F: Protoconch, same shell as E.
Figura 1. Rissoina sagraiana *d'Orbigny, 1842. A-C: lectotipo, 5,5 mm (BMNH); D: protoconcha del lectotipo; E: concha de Cienfuegos, Cuba, 5,7 mm; F: Protoconcha, misma concha que E.*

Curaçao, Aruba and Bonaire; DÍAZ MERLANO AND PUYANA HEGEDUS (1994) from Colombia; RIOS (1994) from Brasil; REDFERN (2001) from Abaco (Bahamas) with a good representation of the protoconch; LEE (2009) from Northeast

Florida. Cuba is the type locality and also we have material from Nicaragua.

Remarks: Examining the material from ZMB we found one lot (ZMB, 2334) with only one shell of 5.8 mm from Cuba, which is labelled as *R. cancellata* Philippi (coll. Pfeiffer), in good condition, with multispiral protoconch, with a spiral cordlet on the last whorl. We have no doubt that this shell is the holotype of *R. cancellata* because the locality and collector coincide with the indications given by PHILIPPI (1847) in the original description. It seems to be the same species that we usually call *R. sagraiana* with the characters previously mentioned in the description.

Rissoina sagraiana appears in the literature as the oldest species name for this morphologically similar group, despite the indication by DESJARDIN (1949) listing the name *Rissoina sagraiana* d'Orbigny, as from 1853. The species was first published by D'ORBIGNY (1842) under the name *Rissoina sagra* in the caption of the plate and thereby made available under the provisions of article 12.2.7 of the International Code of Zoological Nomenclature; the complete description was published years later (1846) under the name *R. sagraiana* and the publication in parts was completed only in 1853 (dates as stated in BOUCHET AND ROCROI, 2005). Therefore there are two different spellings of the name, but according to article 32.5.1.1 of the ICZN, correction of the spelling of a name in a later part of a work published in parts constitutes an evidence for an inadverted error and therefore, the species must be cited as *Rissoina sagraiana* d'Orbigny, 1842 having priority over *Rissoina cancellata* Philippi, 1847.

This species is figured under the name *R. cancellata* by PONDER (1985: 83, fig. 135) who considered it as a synonym of *R. pulchra* C. B. Adams, 1850), the type species of subgenus *Phosinella* Mörch, 1876. The protoconch shown therein is typical of *Rissoina sagraiana.*

Rissoina pulchra (C. B. Adams, 1850) (Figs. 2A-E)

Rissoa pulchra C. B. Adams, 1850. *Cont. Conch.*, 7: 114.

Type material: Lectotype (Fig. 2A) in MCZ (156423)(C. B. Adams coll., Acc. 1173), designated by CLENCH AND TURNER (1950) by inference of a holotype.
Other material examined: Cuba: 1 s, Faro Luna, Cienfuegos 40 m (CFG); 1 s, Rancho Luna, 20 m (MHNS); 1 s, Faro de los Colorados, 35 m (MHNS); 1 s, Rancho Club, 10 m (all in Cienfuegos Bay); 1 j, Maria la Gorda, 30 m (MHNS).

Description: See original description (ADAMS, 1850 and CLENCH AND TURNER, 1950). The shell (Figs. 3A-B) seems to be very similar to that of *R. cancellata* even in the protoconch, which is smaller (Fig. 3C), also multispiral, with about 2 $^1/_2$ whorls and a diameter of 270 μm. Under magnification it seems that this protoconch lacks any spiral sculpture.

Dimensions: the lectotype is 5.7 mm. Shells from Cuba may be a little larger (up to 7.0 mm).

Distribution: From Abaco (Bahamas) by REDFERN (2001) showing a protoconch. "Jamaica" in the original description (type locality).

Remarks: This is the type species of the subgenus *Phosinella* Mörch, 1876 (SD Nevilll, 1885). PONDER (1985) considered *R. pulchra* C. B. Adams, 1850 as a synonym of *R. cancellata* and used the latter name because *Rissoa pulchra* is a primary homonym of *Rissoa pulchra* Forbes, 1844, described from the Aegean Sea. As already mentioned the shell figured in PONDER (1985) and presumably also the specimens used for anatomy are *R. sagraiana* = *cancellata* rather than *R. pulchra*. The taxon *Rissoa pulchra* Forbes, 1844 has never been mentioned since its description, and it is uncertain to which species it refers. Conversely, *R. pulchra* Adams, 1850 has been recorded sometimes during the last 50 years: NOWELL-USTICKE (1959), ABBOTT (1974), DÍAZ MERLANO AND PUYANA HEGEDUS (1984), PONDER (1985), DE JONG

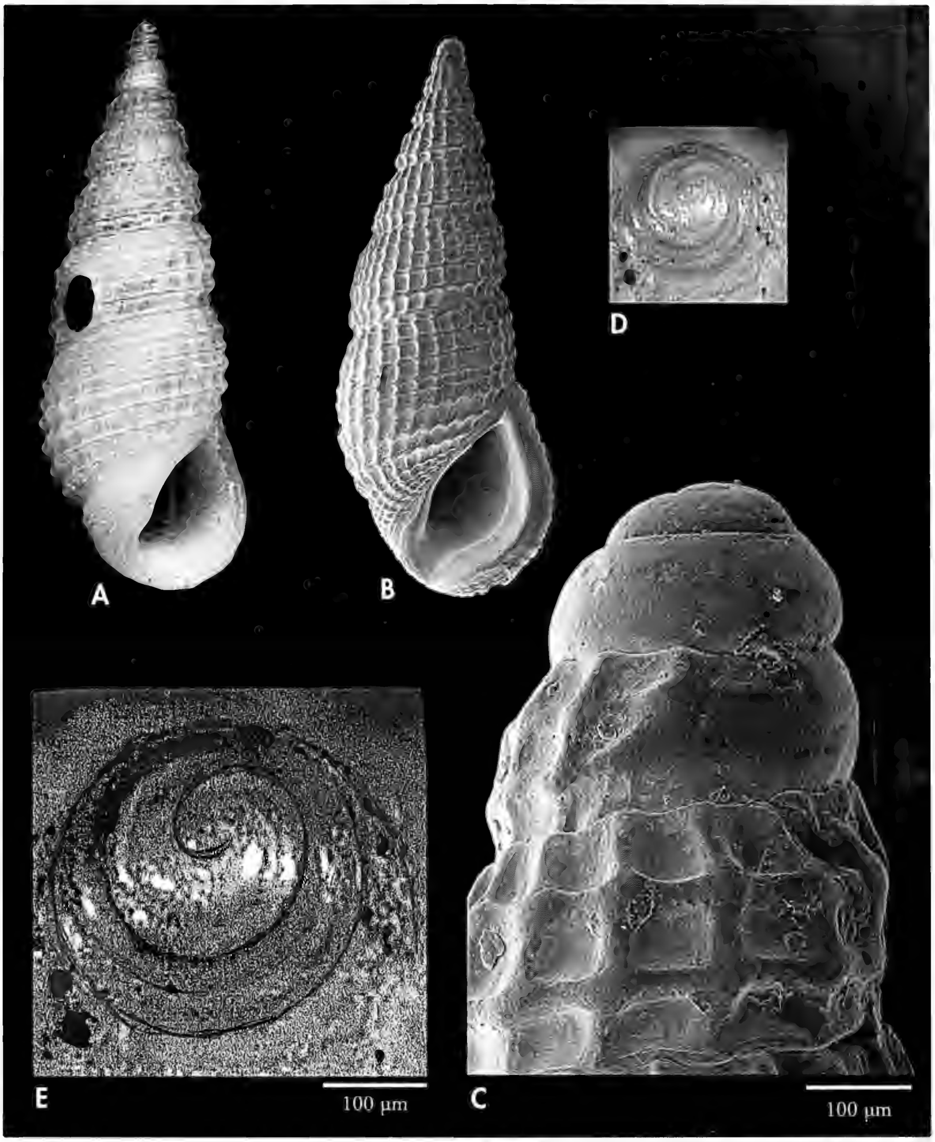


Figure 2. *Rissoina pulchra* (C. B. Adams, 1850). A: Lectotype, 5.7 mm, MCZ (156423). B: shell, 5.6 mm, Cuba (MHNS); C: protoconch, same shell as B; D-E: protoconch of the lectotype.
Figura 2. Rissoina pulchra *(C. B. Adams, 1850). A: Lectotipo, 5,7 mm, MCZ (156423). B: concha, 5,6 mm, Cuba (MHNS); C: protoconcha, misma concha que B; D-E: protoconcha del lectotipo.*

AND COOMANS (1988), RIOS (1994), REDFERN (2001). Although this is probably short of the 25 publications required to make it a *nomen protectum* under the provisions of ICZN, we also consider current usage in leading databases such as Malacolog <http://www.malacolog.org/>, the World Register of Marine species <www.marinespecies.org> and the Encyclopedia of Life <www.eol.org>. For these reasons we propose to keep using the name *R. pulchra* C. B. Adams.

Table I. Schematic comparison of the shells of the *Rissoina sagraiana* group.
Tabla I. Comparación de las conchas del grupo de Rissoina sagraiana.

species	protoconch whorls	µm diameter protoconch	spiral cord in protoconch	spiral cords at first teleoconch whorl
sagraiana	2 1/2 - 2 3/4	390-400	yes	2
pulchra	2 1/2	270	no	2
cancellina	2	320-330	yes	3
labrosa	2	400	yes	2 small, joint
redferni	1 1/4	380	no	3

CLENCH AND TURNER (1950) mentioned and figured the holotype of this taxon: as Adams (1850) did not designate a holotype, the previous mention may be considered as a lectotype designation.

REDFERN (2001) represented the three species *sagraiana-cancellata-pulchra* and described the protoconchs with the difference of their being keeled or not. According to him, *R. pulchra* differs from *R. sagraiana* and *R. cancellata* (actually, from the species described herein as *R. cancellina* spec. nov.) in having a wider protoconch without any spiral cord. We agree with this difference. The details of this comparison are given in Table I.

Rissoina cancellina spec. nov. (Figs. 3A-E)

Type material: Holotype (Fig. 3A) in MNCN (15.05/53590). Paratypes: ZMB (1, nº 115039) (Fig. 3B) labelled as *Rissoina cancellata* Phil. v. *pulchra* C. B. Adams, Jamaica, coll. Paetel; MNHN (1), MHNS (5), IES (1), CFG (10).

Other material examined: Cuba: 8 s, 3 j, Cayo Carenas, Cienfuegos Bay, 5-10 m (CFG); 10 s, Rancho Luna, 20-40 m (CFG); 11 s, 3 j, Faro de los Colorados, Cienfuegos, 15 m (CFG); 2 s, La Concha, Cienfuegos Bay, 3 m (CFG); 2 ej, Guajimico, Cienfuegos, 3 m (CFG); 10 s, 8 j, Rancho Luna, Cienfuegos, 10-55 m (MHNS); 3 s, Faro de los Colorados, Cienfuegos, 20 m (MHNS); 2 s, 3 j, Bajo de Sancho Pardo, 4 m (MHNS); 1 s, Cuba, ZMB (coll. Dunker, 115036). Saint Thomas: 2 s, ZMB (115038). West Indies: 7 s, ZMB (coll. Paetel, 115037). Nicaragua: 5 s, 5j, Cayo Miskitos, 25 m (MHNS).

Type locality: Cienfuegos, Cuba.

Etymology: From the Latin word *cancelli* "lattice gate" alluding to the crossed sculpture, and also due to the similarity with *Rissoina cancellata*, taxon which now is considered in synonymy of *R. sagraiana*.

Description: Shell (Figs. 3A-B) ovoid elongate, pointed, solid and whitish. Protoconch (Figs. 3C, 3D) almost cylindrical and a little depressed, with between 320-330 µm, and about 2 whorls, the first one smooth and the second with a spiral cord at the middle. The beginning of the teleoconch has immediatly three spiral cords. The subsequent whorls also have 3-5 spiral cords crossed by axial ribs. These ribs are 10-13 in the first whorls and 16-19 on the last one. On the body whorl the cords are 9-10. On the subsutural area (Fig. 3E) there are about five very small spiral threads. Under high magnification (Fig. 3F) numerous micro perforations can be seen on the surface of the shell. Aperture ovoid with a typical depression of the genus near the base.

The holotype is 9.3 mm. Other shells are slightly smaller.

Distribution: Probably this species has a large distribution in the Caribbean, but usually it has been recorded under different names, so that confirmation is needed in order to avoid possible confusion with other similar species. REDFERN (2001, as *R. cancellata*) figured the protoconch.

Remarks: The holotype is a shell in good condition and with a good proto-

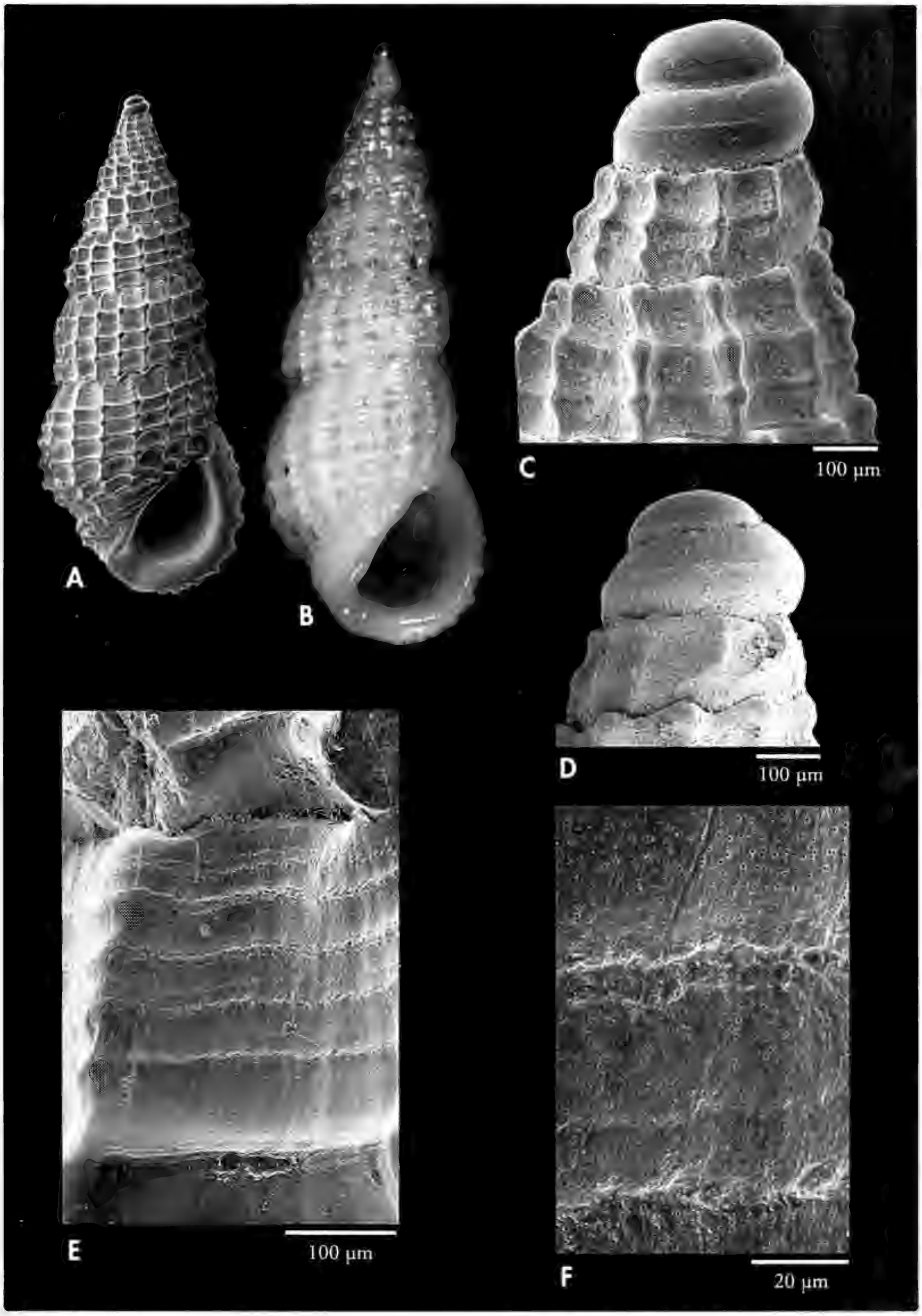


Figure 3. *Rissoina cancellina* spec. nov. A: holotype, 5.7 mm, Cuba (MNCN); B: paratype, 8.5 mm, ZMB (115039); C: protoconch of the holotype; D: protoconch, Cayo Miskitos, Nicaragua; E, F: microsculpture of the holotype.

Figura 3. Rissoina cancellina *spec. nov. A: holotipo, 5,7 mm, Cuba (MNCN); B: paratipo, 8,5 mm, ZMB (115039); C: protoconcha del holotipo; D: protoconcha, Cayo Miskitos, Nicaragua; E, F: microescultura del holotipo.*

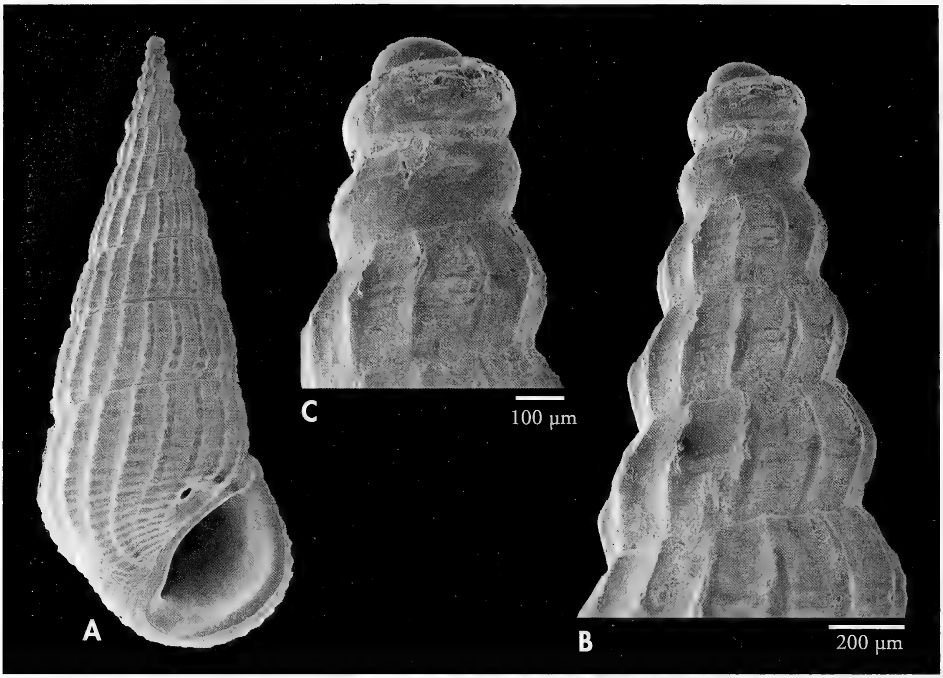


Figure 4. *Rissoina labrosa* Schwartz, 1860. A: Shell, 11.0 mm, Cienfuegos, Cuba; B, C: Protoconch.
Figura 4. Rissoina labrosa *Schwartz, 1860. A: Concha, 11,0 mm, Cienfuegos, Cuba; B, C: Protoconcha.*

conch (Fig. 2A) measuring 9.3 mm (ZMB, 115039) and labelled as *Rissoina cancellata* Phil. v. *pulchra* C. B. Adams, Jamaica, coll. Paetel.

In the material in the ZMB, there are several shells which can belong to this species. One of them (ZMB, 115036) from Cuba, coll. Dunker, has a shell whose protoconch presents excrescences on its upper part and is hence difficult to observe. Six shells more in this lot have lost the protoconch and are badly eroded. Another lot (ZMB, 115037) includes a probable *R. cancellina* but eroded and without protoconch. One more (ZMB, 115038) may also be the same species but is much eroded.

R. cancellina spec. nov. must be compared with the following:

R. sagraiana has a protoconch with more whorls (2 1/2 - 2 3/4) and the first whorls of the teleoconch have only two spiral cords (see Table 1).

R. pulchra has a protoconch with more whorls, lacking any spiral cord, while in the beginning of the teleoconch there are only two cords on the first whorls.

R. redferni has a protoconch with less whorls (1 1/2) but wider, and without any spiral cord.

Rissoina labrosa Schwartz, 1860 (Figs. 4A-B)

Rissoina labrosa Schwartz, 1860. *Über... Die Gattung Rissoina*, pl. 7, fig. 58.
Rissoina sheaferi Mc Ginty, 1962: 42, pl. 3, fig. 5.

Type material: Supposedly in the Vienna Museum. Not examined.
Material examined: Cuba: 1 s, Cayo Carenas, Cienfuegos Bay, 10 m (CFG); 1 s, Faro de los Colorados, Cienfuegos, intertidal (CFG); 3 j, Rancho Luna, Cienfuegos, 12 m (CFG); 1 s, Faro Luna, Cienfuegos,

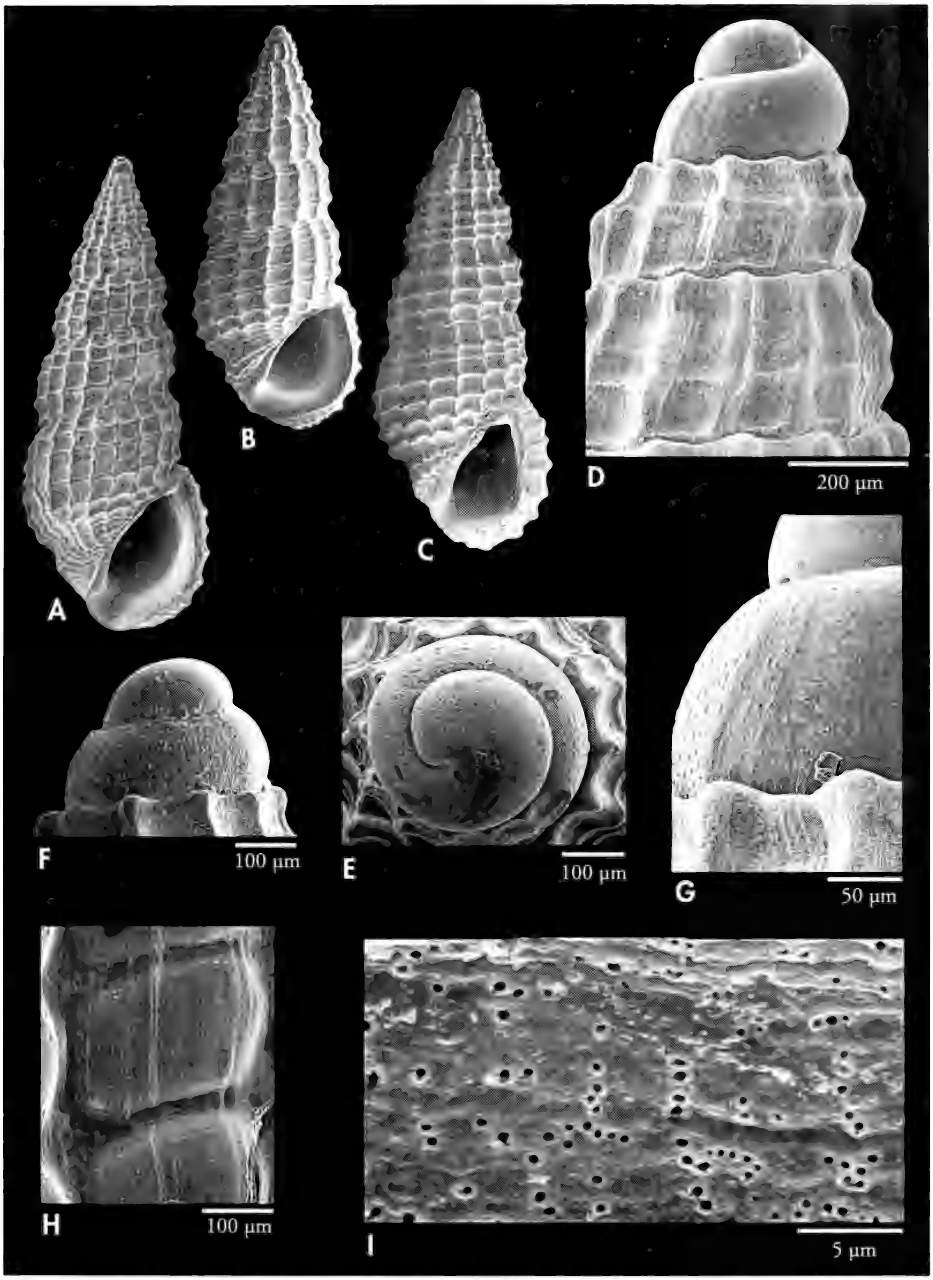


Figure 5. *Rissoina redferni* Espinosa and Ortea, 2002. A: shell, 6.4 mm, Egmond Key, Florida (CHL); B: shell, 4.8 mm, Cienfuegos, Cuba; C: shell, 5.8 mm, Cayo Miskitos, Nicaragua; D, E: protoconch, shell from Florida; F: protoconch, shell from Cuba; G: microsculpture of the protoconch, same shell as D; H, I: microsculpture of the teleoconch, shell from Florida.

Figura 5. Rissoina redferni *Espinosa y Ortea, 2002. A: concha, 6,4 mm, Egmond Key, Florida (CHL); B: concha, 4,8 mm, Cienfuegos, Cuba; C: concha, 5,8 mm, Cayo Miskitos, Nicaragua; D, E: protoconcha, concha de Florida; F: protoconcha, concha de Cuba; G: microescultura de la protoconcha, misma concha que D; H, I: microescultura de la teleoconcha, concha de Florida.*

20 m (MHNS); 2 s, Rancho Luna, Cienfuegos, 22-54 m (MHNS); 1 s, Cable Inglés, Cienfuegos, 20 m (CFG); 5 s, 6 j, Bajo de Sancho Pardo, 3-5 m (MHNS); 2 s, 5 j, María la Gorda, 30 m (MHNS). Mexico: 4 s, Puerto Morelos, Quintana Roo, Yucatán (MHNS). Nicaragua: 3 s, Cayo Los Muertos, 15 m (MHNS).

Description: See SCHWARTZ (1860). The protoconch has a little more than 2 whorls and has a cylindrical profile.

Distribution: Known from Cuba (type locality), Curaçao, Aruba and Bonaire (DE JONG AND COOMANS, 1988). Nicaragua and Mexico, in the present work.

Remarks: This shell may be considered somewhat different from the others included in the group, and was previously mentioned as being larger and more pointed, with a straight profile, with the suture scarcely marked, and the protoconch cylindrical and elevated. We figure a shell (Fig. 4A) and protoconch (Figs. 4B-C) for comparison.

Rissoina redferni Espinosa and Ortea, 2002 (Figs. 5A-H)

Rissoina redferni Espinosa and Ortea, 2002. *Avicennia*, 15: 142.

Type material: Holotype (IGH) not examined.
Other material examined: Cuba: 25 shells, Cienfuegos Bay, 35 m (MHNS); 3 s, Punta Tamarindo, Cienfuegos, 20 m (MHNS); 5 s, de Sagua la Grande, Villa Clara, 3-10 m (CFG); 4 s, Batabanó, Habana, 5-7 m (CFG). Florida: 4 s, Egmond Key (CHL). Nicaragua: 3 s, Cayo Miskitos, 6 m (MHNS); 7 s, Cayo Los Muertos, 12 m (MHNS); 5 s, Cayo Witties, 20 m (MHNS).

Description: Shell (Figs. 5A-C): see ESPINOSA AND ORTEA (2002). This description is short in some aspects referring to micro sculpture: the protoconch (Figs. 5D-F) has 1 $^1/_4$ whorls which have small tubercles spirally aligned, more evident near the end (Fig. 5G). The nucleus has about 160 µm; the first half whorl measures about 270 µm, and the protoconch about 380 µm. The micro sculpture of the teleoconch (Figs. 5H-I) presents spiral lines formed by a rough surface and under very high magnification shows small pits. The comparison of the material from Cuba and from the Bahamas did not show meaningful differences.

Distribution: Known from Bahamas (REDFERN, 2001), Nicaragua and Cuba (type locality: Playa Flamenco, Cayo Coco).

Remaks: We consider *R. redferni* a valid species, different from all similar species previously mentioned. In the original description comparison with *R. pulchra* had not been made; this latter has a more reticulated shell, with more numerous spiral ribs, the protoconch being larger and with more whorls; *R. cancellina* spec. nov. has a similar shell, but its protoconch is larger and has 2 $^1/_4$ whorls instead of 1 $^1/_4$. *R. sagraiana* has a protoconch with 2 $^1/_2$ - 2 $^3/_4$ whorls. On the other hand, comparison with *R. fenestrata* is not necessary, as the shells and protoconchs are rather different (see ROLÁN AND FERNÁNDEZ-GARCÉS, 2009b).

ACKNOWLEDGEMENTS

The authors thank Jesús Méndez and Inés Pazos of the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) of Vigo University for the SEM micrographs of the shells. Thanks also to Matthias Glaubrecht (ZMB) for sending type material for examination; to Adam Baldiger (MCZ) for sending photographs of the type of *R. pulchra* and Amelia MacLellan (BMNH) for the information and the photographs of the types from the type material of *R. sagraiana*; to Antonio A. Monteiro for the English language revision.

BIBLIOGRAPHY

Abbott J.T. 1974. *American Seashells.* Van Nostrand Reinhold Company, New York. 663 pp., 23 pls.

Adams C.B. 1850. Descriptions of supposed new species of marine shells which inhabit Jamaica. *Contributions to Conchology,* 7: 109-123.

Bouchet P. and Rocroi J.P. 2005. Classification and nomenclator of gastropod families. *Malacologia,* 47(1-2): 1-357.

Clench W.J. and Turner R. D. 1950. The western Atlantic marine mollusks described by C. B. Adams. *Occasional Papers on Mollusks* 1(15): 233-403.

Desjardin M. 1949. Les Rissoina de l'Ile de Cuba. *Journal de Conchyliologie,* 89: 193-208, pls. 9-10.

Díaz Merlano J.M. and Puyana Hegedus M. 1994. *Moluscos del Caribe Colombiano.* Un catálogo ilustrado. Colciencias-Fundación Natura-Invemar. Santafé de Bogotá. 291 pp

Espinosa J. and Ortea J. 2002. Descripción de cuatro nuevas especies de la familia Rissoinidae (Mollusca: Gastropoda). *Avicennia,* 15: 141-146.

Jong K.M. de and Coomans H.E. 1988. *Marine gastropods from Curaçao, Aruba and Bonaire.* Studies on the Fauna of Curaçao and other Caribbean Islands, 69. 261 pp, 47 pls.

Lee H.G. 2009. *Marine shells from Northeast Florida.* Jacksonville Shell Club, Jacksonville. 204 pp.

Nevill G. 1885. *Hand list of Mollusca in the Indian Museum, Calcutta.* Part II. Gastropoda, Prosobranchia-Neurobranchia (contd.). Government Printer, calcutta, x + 306 pp.

Mörch O.A.L. 1875-1877. Synopsis molluscorum marinorum Indiarum occidentalium imprimis insularum danicarum. *Malakozoologische Blätter,* 22: 142-184 [1875], 23: 45-58, 87-143 [1876], 24: 14-66, 93-123 [1877].

Nowell-Usticke G.W. 1959. *A check-liat of the marine shells of St. Croix and Virgin Islands.* Christiansted, St. Croix, 90 pp.

Orbigny A. D', 1841-1853. *Mollusques. In: R. de la Sagra, Histoire physique, politique et naturelle de l'île de Cuba.* Arthus Bertrand, Paris.[Volume 2 pp. 1-112, issued 1846 and Atlas pl. 1-28 issued 1842, fide Bouchet and Rocroi, 2005].

Philippi R.A. 1847. Testaceorum novorum centuria. *Zeitschrift für Malakozoologie,* 4: 113-128.

Ponder W.F. 1985. A review pf the Genera of the Rissoidae (Mollusca: Mesogastropoda: Rissoacea). *Records of the Australian Museum,* suppl. 4: 1-221.

Redfern C. 2001. *Bahamian seashells. A thousand Species from Abaco, Bahamas.* Bahamiansehlls.com Inc. Boca Raton, 280 pp, 124 pls.

Rios E.C. 1994. *Seashells of Brazil.* Fundação Cidade do Rio Grande, Rio Grande, 345 pp, 113 pls.

Rolán E. and Fernández-Garcés R. 2009a. Description of a new species of *Rissoina* (Prosobranchia, Rissoidae) from Bermuda. *Gloria Maris,* 48 (1): 17-21.

Rolán E. and Fernández-Garcés R. 2009b. New information on Cuban *Rissoina* (Mollusca: Rissoidae) 1. *Rissoina fenestrata* and *R. vanderspoeli. Novapex,* 10 (2): 59-64.

Schwartz von Mohrenstern G. 1860. Über die Familie der Rissoiden und insbesondere die Gattung Rissoina. *Denkschriften der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften,* 19: 71-188, 11 pls.

Vokes H.E. and Vokes E.H. 1983. *Distribution of shallow-water marine Mollusca, Yucatan Peninsula, Mexico.* Mesoamerican Ecology Institute Monograph 1, Middle American Research Institute Publication, 54: viii, 183 pp, 50 pls.

Warmke G.L. and Abbott J.T. 1961. *Caribbean Seashells.* Livingstone Publishing Co., Pennsylvania. 348 pp.

© *Sociedad Española de Malacología* —————— *Iberus*, 28 (1): 91-96, 2010

A new *Manzonia* (Gastropoda: Rissoidae) from northwestern Morocco

Una nueva *Manzonia* (Gastropoda, Rissoidae) del Noroeste de Marruecos

Serge GOFAS*

Recibido el 10-II-2010. Aceptado el 30-IV-2010

ABSTRACT

A new species of the family Rissoidae is described from the upper slope of Northwestern Morocco. Some characters of this species would relate it to the genus *Manzonia* whereas others are shared with species currently assigned to the genus *Alvania* (subgenus *Alvinia*). Some possible diagnostic characters of *Manzonia* are discussed.

RESUMEN

Se describe una nueva especie de la familia Rissoidae, de la parte superior del talud continental del Noroeste de Marruecos. Algunos caracteres de esta especie sugieren su inclusión en el género *Manzonia*, mientras otros se asemejan a especies que se clasifican actualmente en el género *Alvania* (sugénero *Alvinia*). Se comentan algunos caracteres posiblemente diagnósticos del género *Manzonia*.

INTRODUCTION

Small gastropods belonging to the family Rissoidae are a prominent part of the littoral, shelf and upper bathyal molluscan faunas in the Mediterranean, temperate Western Europe and are particularly species-rich in the north-east Atlantic archipelagos: Canary Islands and Madeira (VAN AARTSEN, 1981; ROLÁN, 1987; MOOLENBEEK AND FABER 1987; MOOLENBEEK AND HOENSELAAR 1989; ROLÁN AND FERNANDES, 1990; AMATI, 1992; HOENSELAAR AND GOUD, 1998; SEGERS AND SWINNEN, 2002), the Azores (GOFAS 1990; BOUCHET AND WARÉN 1993; HOENSELAAR AND GOUD 1998), and the Cape Verde Islands (ROLÁN 1987; MOOLENBEEK AND ROLÁN 1988). There are currently 317 species of this family recognized as valid for the Mediterranean and Northeast Atlantic south to 28° N (CLEMAM database <http://www.somali.asso.fr/clemam/> searched April, 2010) and this inventory may be near completion. However, the species in this family are particularly prone to evolve towards the loss of planktotrophic larval development, therefore giving rise to "pairs" of related species where the non-planktotrophic species is derived and tends to have a restricted geographic range (OLIVERIO, 1994; 1996). For this reason, more discoveries of new species are to be expected.

This paper provides a description of a species encountered in the straits of

---

* Departamento de Biología Animal, Facultad de Ciencias, Universidad de Málaga, E-29071 Málaga, Spain. Correspondence: sgofas@uma.es

Gibraltar, presently known only from two specimens but definitely distinct from those previously known in the area. The species is tentatively assigned to the genus *Manzonia*, and the definitive characters of *Manzonia* are discussed.

SYSTEMATICS

Genus *Manzonia* Brusina, 1870

Type species: *Turbo costatus* J. Adams, 1797, by original designation (= *Turbo crassus* Kanmacher, 1798; non *Turbo costatus* von Salis Marschlins, 1793)

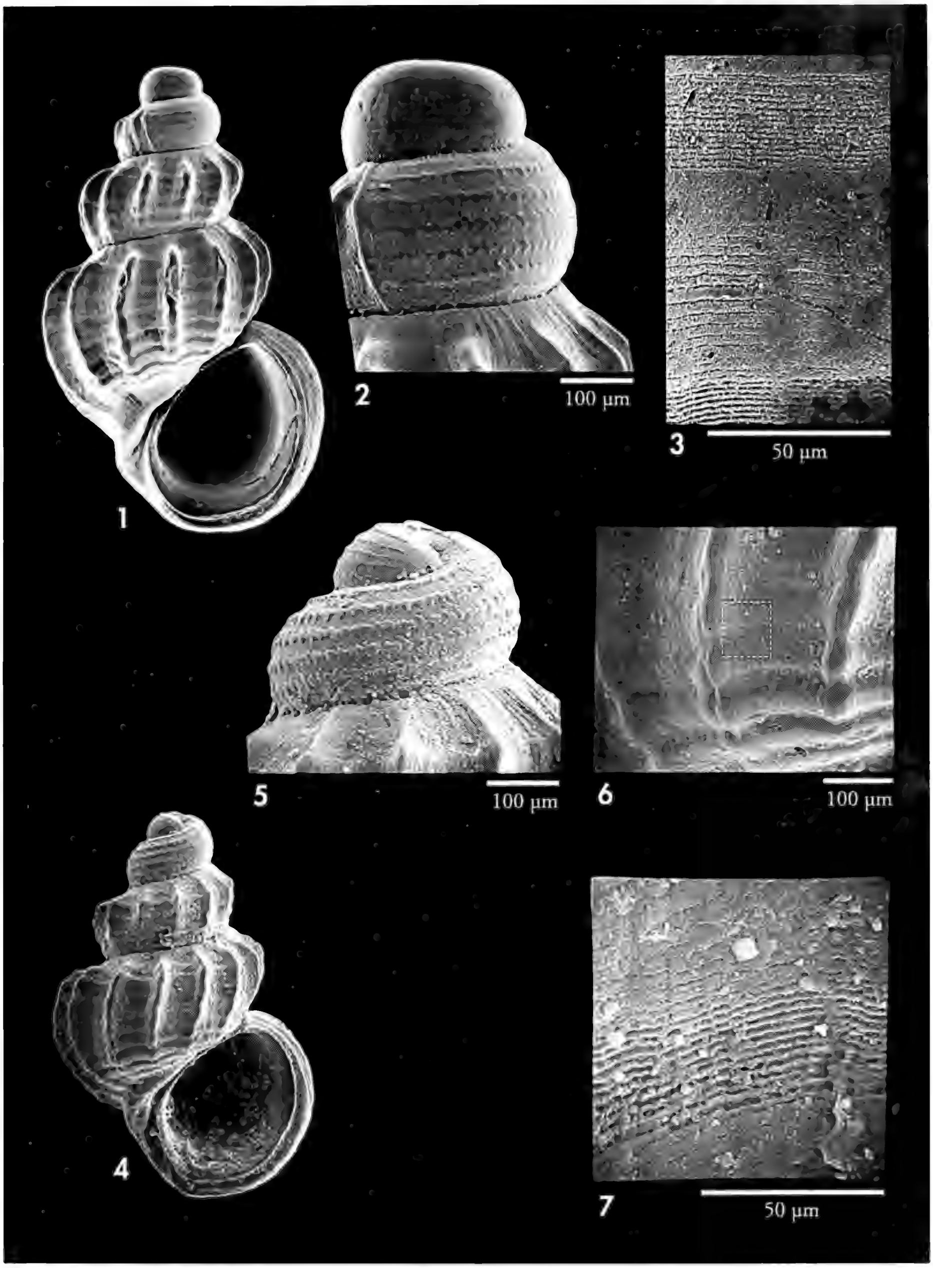
Manzonia alexandrei n. sp. (Figs. 1-7)

Type material: Holotype MNHN 22876 (shell, 1,8 × 1.1 mm) from "Balgim" sta. DW57, and 1 paratype MNHN 22877 (specimen, 1.5 × 1.0 mm) from a sample collected in the vicinity of strait of Gibraltar, from fishermen, 1971. Only known from the type specimens.
Type locality: off NW Morocco, 35° 42' N, 06° 35' W, 548 m.
Etymology: The species is dedicated to my son Alexandre

Description. Shell with a moderately high spire, adults up to 1.8 × 1.1 mm. Protoconch of 1.25 convex whorls, with a sculpture of six rather flat, beaded spiral cords, narrower than the interspaces; the nodes on the cords extend towards the interspaces in which they determine faint axial folds. Teleoconch of 2 $^{1}/_{4}$ to 2 $^{1}/_{2}$ convex whorls, angulated at a distance abapically from suture so as to make the whorls shouldered. Axial sculpture of flexuous, narrow and very elevated folds, highest at the shoulder of whorls, fading out prior to reaching the suture which is not at all undulated, and reaching quite far towards the abapical surface of the body whorl. Spiral sculpture of very flat cords, broader than the interspaces, bearing irregular, very faint grooves along spiral lines forming irregular pits; interspaces with those grooves much more definite, separating ca. 15 raised spiral threads; the spiral cords are more elevated towards the abapical half of the body whorl, below the line prolonging the suture. The base of the body whorl with a rather strong and elevated spiral cord, situated very close to a small umbilical chink and separated from the rest of the whorl by a distinct spiral depression. Outer lip opisthocline, bent in its adapical part and thickened externally by a broad rim sloping gently towards the adjacent surface of body whorl; smooth inside. Inner lip rather thin, slightly detached from the preceding whorl except in the centre of the parietal area. Shell colour white.

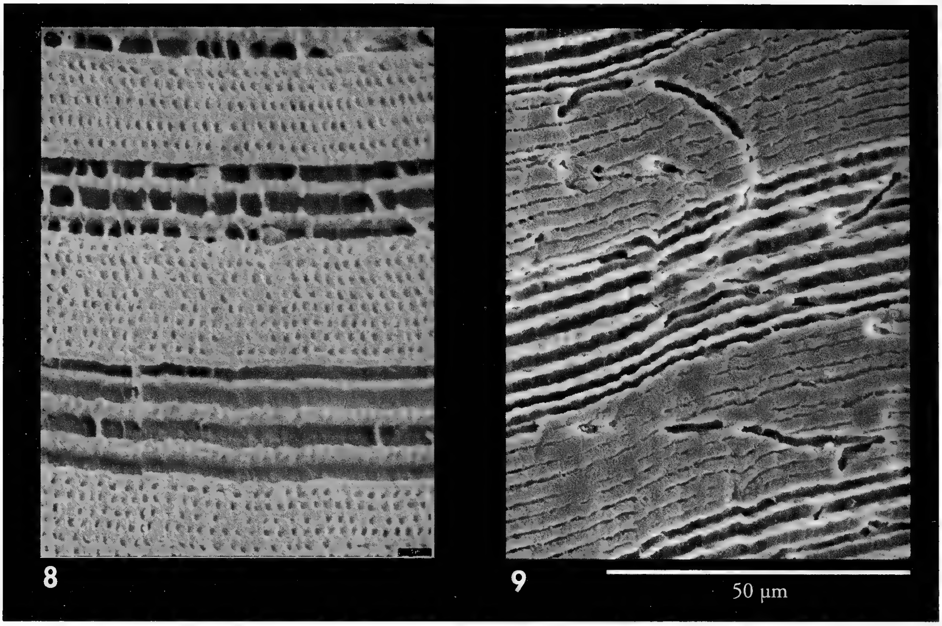
Remarks: This species seems to be living on hard substrate in rather deep-water, which would explain its rarity, or difficulty of collection. The specimen from the strait of Gibraltar was retrieved from a large stone riddled with cavities, together with many specimens of *Alvania zylensis* Gofas and Warén 1982 and other gastropods.

The new species features a combination of character states which are not found together in any of the species described in the eastern Atlantic or Mediterranean. The protoconch with nodose spirals differs drastically from the pattern seen in most species of *Manzonia* with paucispiral protoconch from Macaronesia (see MOOLENBECK AND FABER, 1987) or from the Lusitanian seamounts (see GOFAS, 2007) where the cords, if any, are smooth. It is reminiscent of the kind of protoconch seen in *Alvania weinkauffi* Weinkauff, 1868 (see PONDER, 1985, fig. 102B) and in its sibling *Alvania fischeri* (Jeffreys, 1884) but there, the nodes are even more separated, looking under high magnification like small patches aligned over a minute spiral thread and pasted over the underlying surface.



Figures 1-7. *Manzonia alexandrei* n. sp. 1: holotype from off NW Morocco, 548 m, apertural view (actual size 1.8 mm); 2: protoconch of the holotype; 3: detail of microsculpture of the holotype; 4: paratype from near the strait of Gibraltar, apertural view (actual size 1.5 mm); 5: protoconch of the paratype; 6, 7: detail of microsculpture of the paratype.

Figures 1-7. Manzonia alexandrei *n. sp. 1: holotipo, frente a la costa NO de Marruecos, 548 m, vista apertural (tamaño real 1,8 mm); 2: protoconcha del holotipo; 3: detalle de la microescultura del holotipo; 4: paratipo, cerca del estrecho de Gibraltar, vista apertural (tamaño real 1,5 mm); 5: protoconcha del paratipo; 6, 7: detalle de la microescultura del paratipo.*



Figures 8, 9. Details of microsculpture of *Manzonia*, comparable to Figures 3 and 7. 8: *Manzonia crassa* (Kanmacher, 1798), specimen from Benalmádena, southern Spain; 9: *Manzonia arata* Gofas, 2007, shell from Ampère seamount.

Figuras 8, 9. Detalles de la microescultura de Manzonia, *comparables con las Figuras 3 y 7. 8:* Manzonia crassa *(Kanmacher, 1798), ejemplar de Benalmádena, sur de España; 9:* Manzonia arata *Gofas, 2007, concha del banco Ampère .*

The most similar species with respect to characters of the teleoconch may be *Manzonia arata* Gofas, 2007, described from the Ampère seamount off western Morocco, which shares the general outline and aspect of the spiral sculpture. The latter is nevertheless clearly different in having the ribs protruding against the suture so as to make it strongly undulated; the completely different protoconch, keeled with indistinct and smooth spirals, may indicate that they are unrelated. There is also a superficial resemblance with *Frigidoalvania thalassae* Bouchet and Warén, 1993, described from deep water of Bay of Biscay, but the latter differs in being much larger and in having more numerous and less raised axial ribs. The protoconch of *F. thalassae* is radically different, being rather conical in shape with faint spiral striae.

The generic placement in *Manzonia* is backed by the general build of the shell and the presence of a spiral depression around the base of the body whorl. Nevertheless it must be stressed that the separation between the genera *Manzonia*, *Alvania* s.l. and *Onoba* is not at all clearcut. *Manzonia*, as currently recognized, may form a monophyletic group around its type species *Manzonia crassa*. Its diagnostic character states (Moolenbeek and Faber, 1987) include (1) the presence of a "duplicate" peristome i. e. a strong outer rim on which the sculpture of the outer surface of the body whorl is usually continued, and an inner rim continuing the inner surface of the aperture, (2) the presence of a spiral depression and/or stronger spirals on the abapical part of body whorl, and (3) a peculiar microsculpture where the larger spirals bear spirally aligned rows of minute (ca. 1 μm) pits whereas the intervening spaces are furnished with minute, raised spiral lamellae, and still more minute axial threads abutting between these. The value of this latter character has been treated as doubtful by BOUCHET AND WARÉN (1993: 657)

The microsculpture seen in *Manzonia alexandrei* n. sp. is not as characteristic as that seen in the type species and in many Macaronesian coastal species. It is nevertheless not structurally different, and differs from *Manzonia crassa* (figure 8) in that the spiral elements in the grooves are more closely packed together and the pits are not so neatly demarcated. However such a structure can be seen to be very similar in *Manzonia arata,* which from other characters can be assumed to be phylogenetically related to *Manzonia lusitanica* Gofas 2007, *M. crispa* (Watson, 1897) and to the type species.

PONDER (1985: 48) advocated that the subgenus *Alvinia* Monterosato, 1884 (with *Alvania weinkauffi* as type species) should belong to *Manzonia* rather than to *Alvania,* based on shared characters such as the presence of a duplicated peristome, of stronger spiral cords on the abapical part and the radula with numerous cusps on the inner side of the laterals. This view is also supported by the fact that *Alvinia* has a simple triangular metapodial tentacle like *Manzonia,* and unlike *Alvania* s. str. (see PONDER, 1985: 39) which has a bundle of separate metapodial tentacles.

The combination of characters seen in *Manzonia alexandrei* n. sp. further supports Ponder's view that some species which lack the typical *Manzonia*-microsculpture may nevertheless be more closely related to *Manzonia* than to *Alvania* s. str. More independent characters, including those based on molecular sequences, are needed to assess the value of this morphological character to be held as diagnostic of *Manzonia.*

BIBLIOGRAPHY

AMATI B. 1992. On a new species of *Manzonia* from Selvagens Islands, (Gastropoda, Prosobranchia, Rissoidae). *Publicações Ocasionais da Sociedade Portuguesa de Malacología*, 16: 9-12.

BOUCHET P. AND WARÉN A. 1993. Revision of the Northeast Atlantic bathyal and abyssal Mesogastropoda. *Bollettino Malacologico*, supplement 3: 579–840.

GOFAS S. 1990. The littoral Rissoidae and Anabathridae of São Miguel, Azores. *Açoreana*, supplement: 97–134.

GOFAS S. 2007. Rissoidae (Mollusca: Gastropoda) from northeast Atlantic seamounts. *Journal of Natural History*, 41 (13-16): 779-885

HOENSELAAR H.J. AND GOUD J. 1998. The Rissoidae of the Cancap expeditions, I: the genus *Alvania* Risso, 1826 (Gastropoda Prosobranchia). *Basteria*, 62: 69–115.

MOOLENBEEK R.G. AND FABER M.J. 1987. The Macaronesian species of the genus *Manzonia. De Kreukel*, 23 (1): 1–16, pl. 1; 23 (2-3): 23–31; 23 (10): 166–179, pl. 2–3.

MOOLENBEEK R.G. AND ROLÁN E. 1988. New species of Rissoidae from the Cape Verde Islands (Mollusca, Gastropoda) part 1. *Bulletin, Zoölogisch Museum, Universiteit van Amsterdam*, 11 (14): 121–126.

MOOLENBEEK R.G. AND HOENSELAAR H.J. 1989. The genus *Alvania* on the Canary Islands and Madeira (Mollusca, Gastropoda) part 1. *Bulletin, Zoölogisch Museum, Universiteit van Amsterdam*, 11 (27): 215–228.

OLIVERIO M. 1994. Developmental vs. genetic variation in two Mediterranean rissoid complexes. *Journal of Molluscan Studies*, 60: 461-465.

OLIVERIO M. 1996. Contrasting developmental strategies and speciation in N.E. Atlantic prosobranchs: preliminary analysis. En: *Origin and evolutionary radiation of the Mollusca* (Taylor, J. ed.), Oxford University Press, pp. 261-266.

PONDER W. 1985. A review of the genera of the Rissoidae (Mollusca: Mesogastropoda: Rissoacea). *Records of the Australian Museum*, supplement 4: 1–221.

ROLÁN E. 1987. El género *Manzonia* Brusina, 1870 en el Archipiélago de Cabo Verde. *Publicações Ocasionais da Sociedade Portuguesa de Malacologia*, 9: 27–36.

ROLÁN, E. 1987. Aportaciones al estudio de los Risoaceos de las Islas Canarias: I. Descripción de tres especies nuevas. *Publicações Ocasionais da Sociedade Portuguesa de Malacología*, 8: 1-4.

ROLÁN E. AND FERNANDES F. 1990. Tres nuevas especies del género Manzonia (Mollusca, Gastropoda) para la costa occidental de Africa. *Publicações Ocasionais da Sociedade Portuguesa de Malacología*, 15: 63-68.

SEGERS W. AND SWINNEN F. 2002. *Manzonia bacalladoi*, a new species from the Madeiran archipiélago. *Gloria Maris*, 40 (6): 120-125.

VAN AARTSEN J.J. 1981. *Manzonia overdiepi*, a new marine gastropoda (Rissoidae) from Canary and Madeira Is. *La Conchiglia*, 15 (168-169): 6-7.

© Sociedad Española de Malacología —————— Iberus, 28 (1): 97-114, 2010

Notes on the benthic macrofauna of Agadir Bay (Atlantic Morocco)

Datos sobre la macrofauna bentónica de la Bahía de Agadir (Marruecos Atlántico)

Abdellatif MOUKRIM*, José Enrique GARCÍA RASO** and Serge GOFAS**

Recibido el 16-IV-2010. Aceptado el 30-IV-2010

ABSTRACT

The macrofauna collected in 25 dredge hauls from subtidal soft bottoms (6-25 m) in Agadir Bay, Southern Morocco, is listed. Seventy species are identified, chiefly Mollusca but also some decapods, echinoderms, and polychaetes. The results show four main assemblages with a similarity above 50%. The community of soft bottoms is quite homogeneous within the bay and is comparable to the community of fine sands with *Chamelea striatula* - *Mactra corallina* as described by Glémarec (1969, 1973) and with the shallow well calibrated fine sandy bottoms (SFBC) or 'terrigenous' fine sandy bottoms (Pérès and Picard 1964; Ledoyer, 1968). Towards the deeper part there is an increase of *Ophiura texturata* together with an increase in mud content. A more significantly different community is associated to bottoms with rocks in the northern part of the bay. Almost half of the species identified belong to the temperate European (Atlanto-Mediterranean) faunal province whereas one quarter belong to the tropical West African province. Despite the modest sampling effort, there are five species of molluscs (*Nassarius goreensis, N. argenteus, Cuna gambiensis, Tellina rubicincta, Pandora oblonga*) new to the Moroccan fauna, indicating the need for a more thorough survey in the area.

RESUMEN

Se presenta una lista de las especies de la macrofauna recolectada en 25 dragados en fondos blandos sublitorales (6-25 m) de la Bahía de Agadir, Sur de Marruecos. Se identificaron 70 especies, principalmente moluscos, pero también decápodos, equinodermos y poliquetos. Los resultados de este estudio muestran cuatro grupos de especies con una similitud superior al 50%. La comunidad de fondos blandos es bastante homogénea dentro de la bahía y se corresponde con la comunidad de arenas finas con *Chamelea striatula* - *Mactra corallina* descrita por Glémarec (1969, 1973) y con la de arenas finas bien calibradas poco profundas (SFBC) o arenas finas terrígenas (Pérès and Picard 1964; Ledoyer, 1968). Hacia la parte más profunda se aprecia una mayor abundancia de *Ophiura texturata*, así como un incremento de la proporción de fango. La comunidad más diferente se encuentra en un fondo con rocas en la parte norte de la bahía. Aproximadamente la mitad de las especies pertenecen a la provincia faunística europea templada (Atlanto-Mediterránea) y cerca de una cuarta parte a la provincia tropical del Oeste Africano. A pesar de lo limitado del muestreo, se citan cinco especies de moluscos nuevas para la fauna de Marruecos (*Nassarius goreensis, N. argenteus, Cuna gambiensis, Tellina rubicincta, Pandora oblonga*), lo que pone de manifiesto la necesidad de una prospección más intensa en este área.

---

* Laboratoire Eaux et Environnement, Faculté des Sciences, B.P. 28S, Agadir (Morocco).
** Departamento de Biología Animal, Facultad de Ciencias, E-29071 Málaga (Spain).

INTRODUCTION

The benthic fauna of the Atlantic coast of Morocco is known quite adequately for bathyal environments sampled by deep-sea expeditions (see review in SALAS, 1996 and GARCÍA RASO, 1996) or for the intertidal communities accessible from the shore. The subtidal environments in between have received little attention and their species composition remains largely unknown. Previous data are mainly based on a sampling programme conducted in the years 1924-1925 with the trawler "Vanneau", following the foundation of the Institut Scientifique Chérifien, Morocco's Natural History Museum in 1923 (LIOUVILLE, 1930). However, only a small part of the material obtained was eventually studied.

The geographical situation of the Bay of Agadir falls mid-way within the so-called "Mauretanian region" of EKMAN (1953). Thus, it is important to determine how much of its fauna belongs to the European temperate province, as does most of Atlantic Morocco, and how much belongs to the tropical West African province. The bay marks the end to the north of a very long stretch of coastline with a broad shallow continental shelf clad with sediments, and bordered by long, straight sandy beaches exposed to heavy surf. Northwards, Cape Ghir sets a sharp physiographic limit to a predominantly rocky shore with a narrow platform; a comparable sandy shore resumes only much further to the north along the coastal plains of Bouregreg and Sebou in Northern Morocco. Thus, this physical boundary may contribute to sharpen the northwards boundary of any West African elements likely to occur in the area. The area of Agadir is also coincident with a major area of upwelling (MITTELSTAED, 1983), which makes it potentially species-rich.

The growing concern for conservation and control of water quality has triggered new interest for the benthos in nearshore environments close to the large urban agglomeration of Agadir. The purpose of this paper is to present some results regarding the benthic macrofauna (chiefly Mollusca and Decapoda) of the soft bottoms which constitute most of the bay, and to draw some preliminary conclusions regarding benthic communities and their biogeographic setting.

MATERIAL AND METHODS

A set of samples (Figure 1) was collected in May 1999, using a rectangular dredge with an opening of 50 cm, geared with a net of 10 mm mesh. The dredge was towed by a boat at a speed of approximately one knot, for 15 minutes, parallel to shore at each position on a transect. Three transects were sampled perpendicular to shore, in the vicinity of Oued Souss, which was the target area for an environmental impact study, and within each transect four samples were taken at 10, 15, 20 and 25 m depth. Two other transects and some samples were taken with the same gear at the northern end of the beach (D), inside the harbour (E), and in front of the suburb of Anza (F), just northwest to the harbour. In each of the transects D and F, samples were taken, at 6, 10, 15, 20 and 25 m. Samples were sorted immediately upon return to the lab, and the animals preserved in 70° ethanol for further determination.

The literature used for species identification was not specific to the area. The fauna of both Western Europe and West Africa has been considered. PASTEUR HUMBERT (1962a, b), POPPE AND GOTO (1991, 1993) and the unpublished manuscript on West African Bivalvia by Rudo von Cosel (MNHN) were the basic references for the Mollusca; MONOD (1956), FOREST AND GANTES (1960) and ZARIQUEY ÁLVAREZ (1968), among others for the decapods, TORTONESE (1965) for the echinoderms. The polychaetes were identified by Patrick Gillet (of Institut d'Ecologie Appliquée, Angers, France).

Sediment samples were taken by SCUBA diving along the three transects of Oued Souss (A: 30° 18′ N, B: 30° 20′ N

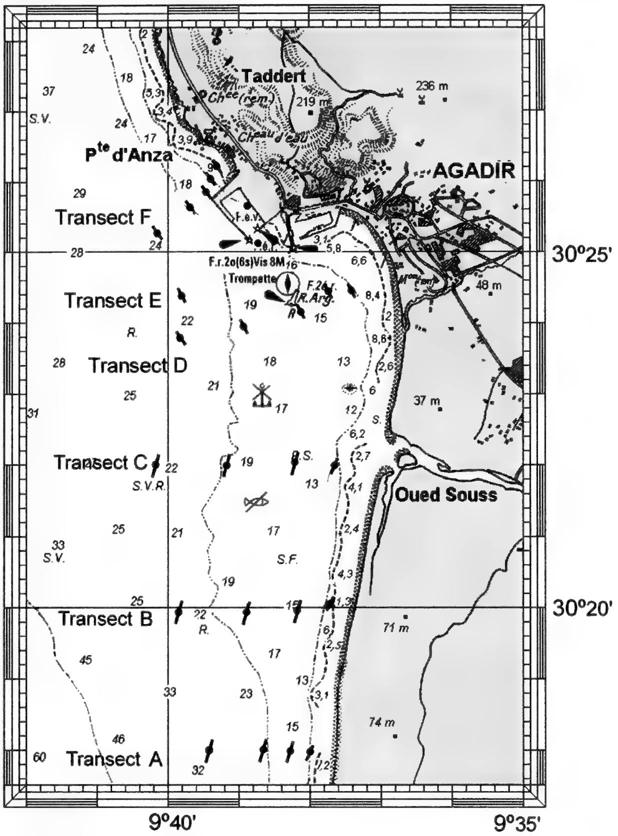


Figure 1. Map of the Bay of Agadir, with location of the sampling stations.
Figura 1. Mapa de la bahía de Agadir, con la ubicación de las estaciones de muestreo.

and C: 30° 22′ N), in order to determine granulometry using a column of standard sieves.

PRIMER software (CLARKE AND WARWICK 1994, CLARKE AND GORLEY, 2001) was used in the study of the structure of the communities and their spatial variations using qualitative data without transformation and standardization. Possible significant differences between transects and depths were assessed using the ANOSIM routine. Samples were grouped according to their faunal composition using the Bray-Curtis similarity index. In the cluster the mode group average was selected. The samples were then plotted with a non-metric multidimensional scaling (MDS routine) and, to know the level of contribution of the different species, the SIMPER routine was applied.

RESULTS

The list of all collected species amounts to 70 (Table I). There is an increase in species richness with distance from shore. Molluscs and decapods are the best represented groups, whereas polychaetes probably were undersampled due to the kind of dredge used, which skims the superficial part of the sediment.

The sediments are essentially fine sands in transects A and C (range of median 0.17-0.32 mm). The pelite content is very low nearshore and

Table I. List of species collected in the dredgings. The * denotes species shared with "sables fins à *Venus gallina - Mactra corallina*" and "sables fins envasés à *Pharus legumen - Ophiura texturata*" or denoted as characteristic of fine sand communities by Glemarec (1969). W: West african species. The abundance of species is coded (1) 1-2 specimens, (2) 3-5 specimens, (3) 6-10 specimens, (4) over 10 specimens.

		Transect 30º 18′ N				**Transect 30º 20′ N**			
depth (m)		10	15	20	25	10	15	20	25
MOLLUSCA GASTROPODA									
Bela sp.									
Bivetiella cancellata (Linné, 1758)	W		2	1					
Bullia miran (Bruguière, 1792)	W	3	4	3		2	4	4	2
Calyptraea chinensis (Linné, 1758)									
Clanculus kraussi (Philippi, 1846)	W								
Cabestana dolaria (Linné, 1767)	W								
Cymbium cucumis Röding, 1798	W	1							
Epitonium turtonis (Turton, 1819)									
Euspira fusca (de Blainville, 1845)			1						
Euspira pulchella (Risso, 1826)			1						
Marginella glabella (Linné, 1758)	W								
Mesalia varia (Kiener, 1844)	W	2	4	3		1			
Mitrella sp.		1							
Nassarius argenteus (Marrat, 1877)	W								
Nassarius elatus (Gould, 1845)	W	2	4	1		1	1	1	
Nassarius goreensis (von Maltzan, 1884)	W								
Nassarius incrassatus (Ström, 1768)									
Nassarius reticulatus (Linné, 1758)		3	2	1					
Nassarius vaucheri (Pallary, 1906)	W	1				1		1	
Ocenebra brevirobusta Houart, 2000									
Philine aperta (Linné, 1758)									1
Stramonita haemastoma (Linné, 1758)									
Solatia piscatoria (Gmelin, 1791)	W	1	2	1	1		2	1	
Tectonatica sagraiana (d'Orbigny, 1844)	W								1
Volvarina sp.	W								
MOLLUSCA BIVALVIA									
Anomia ephippium (Linné, 1758)						1			
Abra alba (Wood, 1802)	*		1	1	4	1	1	2	
Chamelea striatula (da Costa, 1778)	*							1	
Corbula gibba (Olivi, 1792)					2				2
Cuna gambiensis Nicklès, 1955	W								
Donax vittatus (da Costa, 1778)	*	2							
Dosinia lupinus (Linné, 1758)	*	1	1	1				1	
Ensis ensis (Linné, 1758)	*								
Gari fervensis (Gmelin, 1791)									
Macoma cumana (Costa, 1829)		1	1		1				
Mactra corallina (Linné, 1758)	*		1					2	2

*Tabla I. Lista de especies recolectadas en los dragados. El * indica especies que se han citado para las comunidades denominadas "sables fins à* Venus gallina - Mactra corallina*" y "sables fins envasés à* Pharus legumen - Ophiura texturata*", o indicadas como características de comunidades de arena fina por Glemarec (1969). W: Especies Oeste-Africanas. La abundancia de las especies esta anotada como (1) 1-2 ejemplares, (2) 3-5 ejemplares, (3) 6-10 ejemplares, (4) más de 10 ejemplares.*

Transect 30º 22′ N				North of Beach					Harbour			Off Anza				
10	15	20	25	6	10	15	20	25	6	6	25	6	10	15	20	25
				2												
	1									1						
4	3	4		2	4	4	2			4	1	4	1	1	2	4
													1			1
												2				1
										1						
												1				
										1						
																1
															1	1
2	1			4	4	1			1	4	1	4	2		3	2
															1	
	1								1							
				2		1				3		3		1	4	4
															2	
												4	2		1	1
				3	4	1			2	4		4	4	2	3	4
	1			4						4		1				1
										2						
									1							
										1						
	1					1				1						
										1					1	1
										2						
												1	1		1	
	1	1			2	1	1		4		3			1	2	4
				2	2				1	4	1	2	2	4	2	2
					2				1	2					1	4
																1
1				1	1		1			4			1	1		
		1	1		2					4			1	1		
	1				1			1		1			1	1	1	
																1
	1	1				1			4							
	2		1			1		1		2	3			1	1	

Table I. List of species collected in the dredgings. The * denotes species shared with "sables fins à *Venus gallina - Mactra corallina*" and "sables fins envasés à *Pharus legumen - Ophiura texturata*" or denoted as characteristic of fine sand communities by Glemarec (1969). W: West african species. The abundance of species is coded (1) 1-2 specimens, (2) 3-5 specimens, (3) 6-10 specimens, (4) over 10 specimens.

*Tabla I. Lista de especies recolectadas en los dragados. El * indica especies que se han citado para las comunidades denominadas "sables fins à* Venus gallina - Mactra corallina*" y "sables fins envasés à* Pharus legumen - Ophiura texturata*", o indicadas como características de comunidades de arena fina por Glemarec (1969). W: Especies Oeste-Africanas. La abundancia de las especies esta anotada como (1) 1-2 ejemplares, (2) 3-5 ejemplares, (3) 6-10 ejemplares, (4) más de 10 ejemplares.*

		Transect 30º 18' N				Transect 30º 20' N				Transect 30º 22' N				North of Beach					Harbour			Off Anza				
depth (m)		10	15	20	25	10	15	20	25	10	15	20	25	6	10	15	20	25	6	6	25	6	10	15	20	25
MOLLUSCA GASTROPODA																										
Bela sp.														2												
Bivetiella cancellata (Linné, 1758)	W		2	1							1									1						
Bullia miran (Bruguière, 1792)	W	3	4	3		2	4	4	2	4	3	4		2	4	4	2			4	1	4	1	1	2	4
Calyptraea chinensis (Linné, 1758)																							1			1
Clanculus kraussi (Philippi, 1846)	W																					2				1
Cabestana dolaria (Linné, 1767)	W																			1						
Cymbium cucumis Röding, 1798	W	1																								
Epitonium turtonis (Turton, 1819)																						1				
Euspira fusca (de Blainville, 1845)			1																	1						
Euspira pulchella (Risso, 1826)			1																							1
Marginella glabella (Linné, 1758)	W																								1	1
Mesalia varia (Kiener, 1844)	W	2	4	3		1				2	1			4	4	1			1	4	1	4	2		3	2
Mitrella sp.		1																							1	
Nassarius argenteus (Marrat, 1877)	W										1								1							
Nassarius elatus (Gould, 1845)	W	2	4	1		1	1	1						2		1				3		3		1	4	4
Nassarius goreensis (von Maltzan, 1884)	W																								2	
Nassarius incrassatus (Ström, 1768)																						4	2		1	1
Nassarius reticulatus (Linné, 1758)		3	2	1										3	4	1			2	4		4	4	2	3	4
Nassarius vaucheri (Pallary, 1906)	W	1				1		1			1			4						4		1				1
Ocenebra brevirobusta Houart, 2000																				2						
Philine aperta (Linné, 1758)									1										1							
Stramonita haemastoma (Linné, 1758)																				1						
Solatia piscatoria (Gmelin, 1791)	W	1	2	1	1		2	1			1					1				1						
Tectonatica sagraiana (d'Orbigny, 1844)	W								1											1					1	1
Volvarina sp.	W																			2						
MOLLUSCA BIVALVIA																										
Anomia ephippium (Linné, 1758)						1																1	1		1	
Abra alba (Wood, 1802)	*		1	1	4	1	1	2			1	1			2	1	1		4		3			1	2	4
Chamelea striatula (da Costa, 1778)	*							1						2	2				1	4	1	2	2	4	2	2
Corbula gibba (Olivi, 1792)					2				2						2				1	2					1	4
Cuna gambiensis Nicklès, 1955	W																									1
Donax vittatus (da Costa, 1778)	*	2								1				1	1		1			4			1	1		
Dosinia lupinus (Linné, 1758)	*	1	1	1				1				1	1		2					4			1	1		
Ensis ensis (Linné, 1758)	*										1				1			1		1			1	1	1	
Gari fervensis (Gmelin, 1791)																										1
Macoma cumana (Costa, 1829)		1	1		1						1	1				1			4							
Mactra corallina (Linné, 1758)	*		1					2	2		2		1			1		1		2	3			1	1	

Table I. Continuation.
Tabla I. Continuación

Modiolus stultorum (Jousseaume, 1893)	W			1	1				

		Transect 30º 18' N				Transect 30º 20' N			
depth (m)		10	15	20	25	10	15	20	25
Nuculana bicuspidata (Gould, 1845)	W		3		1				
Pandora oblonga (Sowerby,1830)	W								
Pandora inaequivalvis (Linné, 1758)			1	2		1			
Parvicardium exiguum (Gmelin, 1791)									
Pharus legumen (Linné, 1758)	*	1	1	2		2	1	2	1
Phaxas pellucidus (Pennant, 1777)	*							1	
Scacchia zorni van Aartsen & Fehr-de Wal, 1985									
Sinupharus combieri (Fischer-Piette & Nicklès, 1946)	W								
Spisula subtruncata (da Costa, 1778)	*		1		1				
Tellina tenuis (da Costa, 1778)	*	1							
Tellina rubicincta Gould, 1845	W				1				
Tellina fabula Gmelin, 1791	*		2	1				1	1
Thracia papyracea (Poli, 1791)	*		1						
Thyasira flexuosa (Montagu, 1803)					2				
MOLLUSCA CEPHALOPODA									
Sepietta oweniana (d'Orbigny, 1839)				2					
Sepiola rondeleti Leach, 1817			2						
CRUSTACEA DECAPODA									
Diogenes pugilator (Roux, 1829)	*	3		3			4		
Liocarcinus cf. *holsatus* (Fabricius, 1798)	*	2	2	3		1	1	1	1
Liocarcinus depurator (Linné, 1758)									
Macropodia rostrata (Linné, 1761)					2				
Philocheras trispinosus (Hailstone, 1835)	*					3	1		
Polybius henslowii Leach, 1820			1				1		
Scyllarus arctus (Linné, 1758)									1
PYCNOGONIDA									
Nymphon sp.						1			
ECHINODERMATA									
Echinocardium sp.		1							
Ophiura texturata Lamarck, 1816	*			4	4	1		4	4
ANNELIDA POLYCHAETA									
Cirratulus filiformis Keferstein, 1862									
Diopatra neapolitana Delle Chiaje, 1841		1	1	4	4	1	2	3	3
Lugia pterophora (Ehlers, 1864)									
Magellona papillicornis Müller, 1858									
Nepthys sp									1

Table I. Continuation.
Tabla I. Continuación

Transect 30º 22′ N				North of Beach					Harbour			Off Anza				
10	15	20	25	6	10	15	20	25	6	6	25	6	10	15	20	25
									1	4	1	2	2	3	4	
				4												
	1			4	4	3							1	3	3	
									3							
	1	1	1	1	1	1	2	1		1	1	1		1	1	
				1												1
	1															
				2	1					4	1		1	1	1	1
				2						3		1	2	3		
													2			
1			1		1				1	1	1			1		
			2	2					4							
4	3			2								3				
2	2	2	1	2	2	3	1	1		4		3	1	2		2
2																
					1											2
2	3	3														
1		1	1				1	1					1			
							1							1	1	
		4	4				2	4						2		4
															1	
1		3	4	1		3				1	1	1	3	1	3	3
															1	
						1										
									2	1						

Table I. Continuation.
Tabla I. Continuación

Modiolus stultorum (Jousseaume, 1893)	W			1	1

		Transect 30° 18' N				Transect 30° 20' N				Transect 30° 22' N				North of Beach					Harbour			Off Anza				
depth (m)		10	15	20	25	10	15	20	25	10	15	20	25	6	10	15	20	25	6	6	25	6	10	15	20	25
Nuculana bicuspidata (Gould, 1845)	W		3		1														1	4	1	2	2	3	4	
Pandora oblonga (Sowerby,1830)	W													4												
Pandora inaequivalvis (Linné, 1758)			1	2		1					1			4	4	3							1	3	3	
Parvicardium exiguum (Gmelin, 1791)																			3							
Pharus legumen (Linné, 1758)	*	1	1	2		2	1	2	1		1	1	1	1	1	1	2	1		1	1	1		1	1	
Phoxas pellucidus (Pennant, 1777)	*							1																		
Scacchia zorni van Aartsen & Fehr-de Wal, 1985														1												1
Sinupharus combieri (Fischer-Piette & Nicklès, 1946)	W										1															
Spisula subtruncata (da Costa, 1778)	*		1		1									2	1					4	1		1	1	1	1
Tellina tenuis (da Costa, 1778)	*	1												2						3		1	2	3		
Tellina rubicincta Gould, 1845	W				1																		2			
Tellina fabula Gmelin, 1791	*		2	1				1	1	1			1		1				1	1	1			1		
Thracia papyracea (Poli, 1791)	*		1										2	2					4							
Thyasira flexuosa (Montagu, 1803)					2																					
MOLLUSCA CEPHALOPODA																										
Sepietta oweniana (d'Orbigny, 1839)				2																						
Sepiola rondeleti Leach, 1817			2																							
CRUSTACEA DECAPODA																										
Diogenes pugilator (Roux, 1829)	*	3		3			4			4	3			2								3				
Liocarcinus cf. *holsatus* (Fabricius, 1798)	*	2	2	3		1	1	1	1	2	2	2	1	2	2	3	1	1		4		3	1	2		2
Liocarcinus depurator (Linné, 1758)										2																
Macropodia rostrata (Linné, 1761)					2										1											2
Philocheras trispinosus (Hailstone, 1835)	*					3	1			2	3	3														
Polybius henslowii Leach, 1820			1				1			1		1	1				1	1					1			
Scyllarus arctus (Linné, 1758)									1																	
PYCNOGONIDA																										
Nymphon sp.						1																				
ECHINODERMATA																										
Echinocardium sp.		1															1							1	1	
Ophiura texturata Lamarck, 1816	*			4	4	1		4	4			4	4				2	4						2		4
ANNELIDA POLYCHAETA																										
Cirratulus filiformis Keferstein, 1862																									1	
Diopatra neapolitana Delle Chiaje, 1841		1	1	4	4	1	2	3	3	1		3	4	1		3				1	1	1	3	1	3	3
Lugia pterophora (Ehlers, 1864)																									1	
Magellona papillicornis Müller, 1858																1										
Nepthys sp									1										2	1						

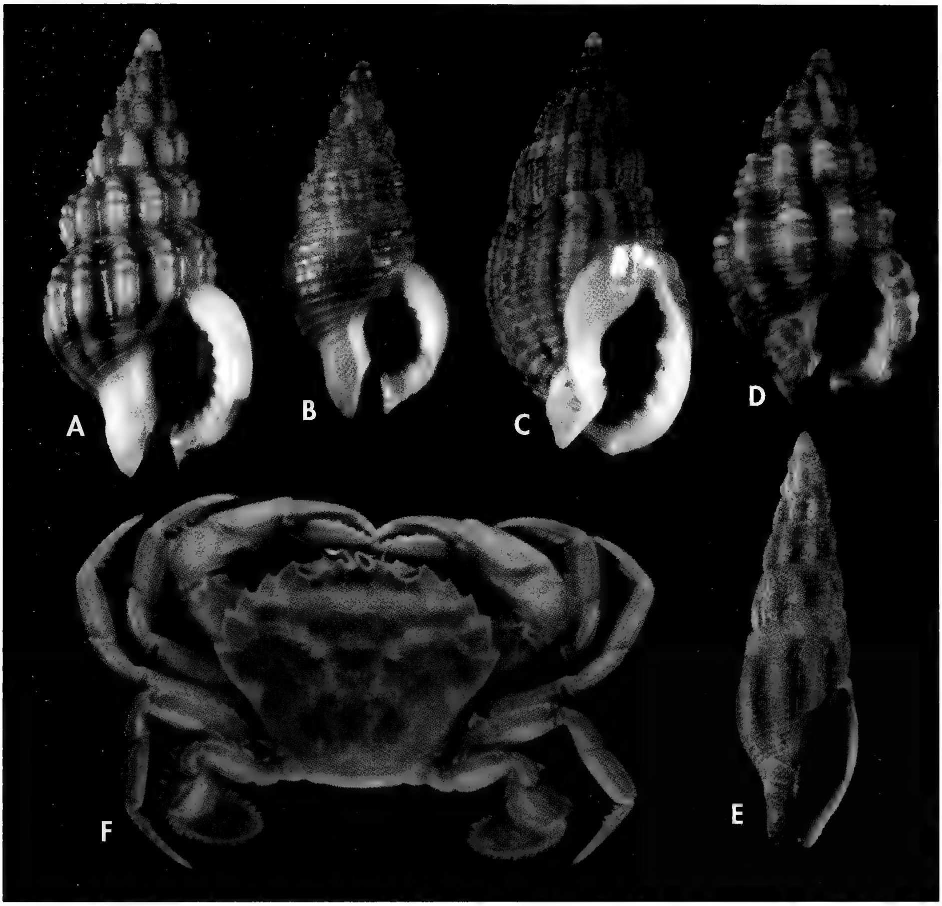


Figure 2 A-E. Gastropods from Agadir Bay. A: *Nassarius vaucheri* (Pallary, 1901), Agadir beach, 6 m (height 12 mm); B: *Nassarius argenteus* (Marrat, 1877), inside harbour, 15 m (height 7.4 mm); C: *Nassarius reticulatus* (Linné, 1758), Agadir beach, 6 m (height 16 mm); D: *Nassarius goreensis* (von Maltzan, 1884), off Anza, 20 m (height 9.3 mm); E: *Bela* cf. *zonata* (Locard, 1892), Agadir beach, 6 m (height 10.5 mm). Figure 2 F. Decapod Crustacean: *Liocarcinus cf. holsatus* (Fabricius, 1798), off Oued Souss, 15 m (breadth of carapace 36 mm).

Figura 2 A-E. Gasterópodos de la bahía de Agadir. A: Nassarius vaucheri *(Pallary, 1901), playa de Agadir, 6 m (altura 12 mm); B:* Nassarius argenteus *(Marrat, 1877), en el puerto, 15 m (altura 7,4 mm); C:* Nassarius reticulatus *(Linné, 1758), playa de Agadir, 6 m (altura 16 mm); D:* Nassarius goreensis *(von Maltzan, 1884), frente a Anza, 20 m (altura 9,3 mm); E:* Bela *cf.* zonata *(Locard, 1892), playa de Agadir, 6 m (altura 10,5 mm). Figura 2 F. Crustáceo Decápodo:* Liocarcinus *cf.* holsatus *(Fabricius, 1798), frente al Oued Souss, 15 m (ancho del caparazón 36 mm).*

increases to ca. 10% at 20 m. The values in transect B, under the influence of Oued Souss, show a higher content of pelites at shallower depths (up to 30% at 10 m depth). The northernmost transects, off the harbour and F, contain also some rocky outcrops.

Taxonomic and biogeographic notes on some species

MOLLUSCA GASTROPODA

Family Turritellidae

Turritellids are represented by one species of *Mesalia*, the same one that extends northwards to the Ibero-Moroc-

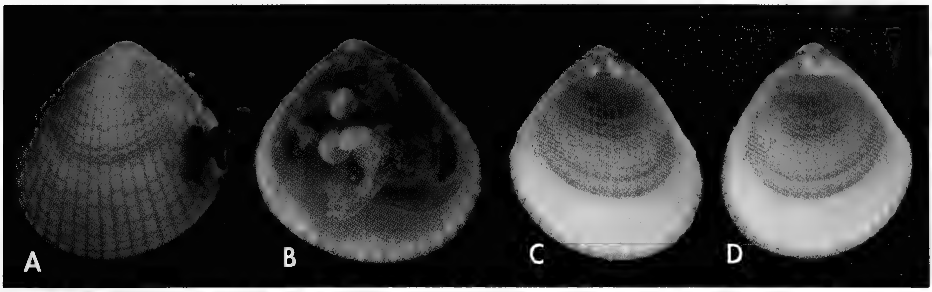


Figure 3. *Cuna gambiensis* Nicklès, 1955 from Agadir Bay, from "Vanneau" sta. 118 (30° 40' N, 09° 55' W, 20 m). A: Outside view of the left valve of a live-collected specimen; note the hydrozoan on posterior edge (actual height of shell 3.0 mm). B. inside view of the same valve with dried soft parts inside, note the four juveniles in prodissoconch stage incubated in the pallial cavity. C-D. Inside of left and right valve of another specimen (actual size 2.9 mm).
Figura 3. Cuna gambiensis *Nicklès, 1955 de la bahía de Agadir, campaña del "Vanneau" est. 118 (30° 40' N, 09° 55' W, 20 m). A: Vista externa de la valva izquierda de un ejemplar recolectado vivo; nótese el hidrozoo asentado en el borde posterior (altura de la concha 3,0 mm); B: vista interna de la misma valva con partes blandas desecadas; nótense los cuatro juveniles en estadio de prodisoconcha, incubados en la cavidad paleal. C-D. interior de las valvas izquierda y derecha de otro ejemplar (altura 2,9 mm).*

can Gulf and to the Alboran Sea and southwards to Senegal. There has been considerable confusion regarding the taxonomy of this species, often misidentified as the Senegalese endemic *Mesalia brevialis* (Lamarck, 1822) (e.g. PASTEUR-HUMBERT, 1962a: 39). We agree with PALLARY (1900) and MARCHE-MARCHAD (1981) in considering that this is a distinct species, correctly named *Mesalia varia* (Kiener, 1844).

Family Nassariidae

This family is represented in our material by seven species, of which two are new to the Moroccan fauna. Nassarids are well represented in West Africa (see Adam and Knudsen, 1984) and are mostly scavengers. *Bullia miran* is one of the largest species and is a conspicuous element of the assemblage. It is a West African species, already mentioned from Agadir Bay by PALLARY (1920: 37, as *Dorsanum miran*) and PASTEUR-HUMBERT (1962a).

Nassarius vaucheri (Fig. 2A) and *Nassarius argenteus* (Fig. 2B) are two very similar species, the former endemic to the Ibero-Moroccan gulf and the latter West African, which could be suspected of being geographical subspecies one of the other. The occurrence at Agadir of *N. argenteus* documents a range extension into Morocco, and supports their treatment as separate species.

Nassarius goreensis (Fig. 2D) is also a West African species new to the Moroccan fauna. Besides this occurrence, there are occasional findings as far north as Asilah and Tangiers (36° N; specimens in Muséum National d'Histoire Naturelle, Paris, collected by S.G.).

Nassarius reticulatus (Fig. 2C) conversely, is a member of the temperate West European fauna which reaches here its southern limit.

Family Muricidae

Ocenebra brevirobusta is a Moroccan endemic, formerly identified as *Ocenebra torosa* (Lamarck, 1816) or *Ocenebra erinaceus* (Linné, 1758) (see PALLARY, 1920; PASTEUR-HUMBERT, 1962a). HOUART (2000) described it as a new species, from material collected at Essaouira, some 100 km north of Agadir.

Family Turridae

There is one species of *Bela* (Fig. 2E) which resembles both morphologically

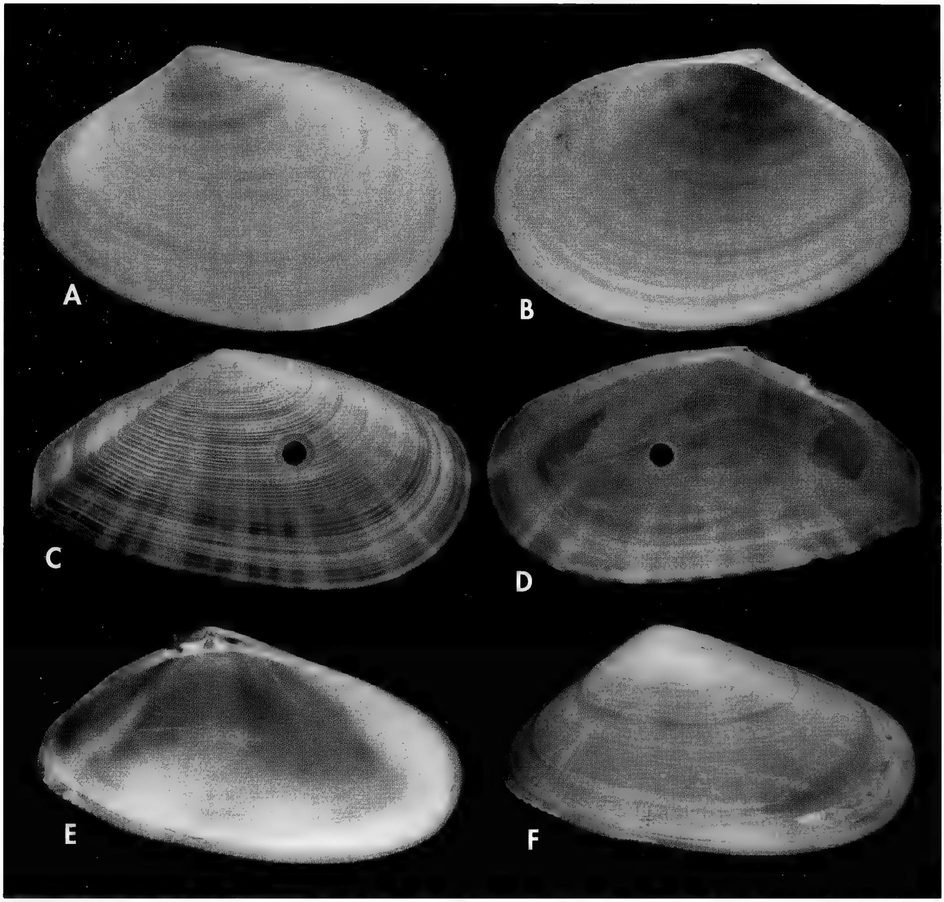


Figure 4 A-F. Bivalves from Agadir Bay. A, B: *Macoma cumana* (Costa, 1829), right valve, South of Oued Souss, 15 m (length 20 mm); C, D: *Tellina rubicincta* Gould, 1845, right valve, off Anza, 25 m. (length 22 mm); E, F: *Donax vittatus* (da Costa, 1778), left and right valves, off Anza, 10 m (length 21 mm).

Figura 4 A-F. Bivalvos de la bahía de Agadir. A, B: Macoma cumana *(Costa, 1829), valva derecha, sur de Oued Souss, 15 m (longitud 20 mm); C, D:* Tellina rubicincta *Gould, 1845, valva derecha, frente a Anza, 25 m. (longitud 22 mm); E, F:* Donax vittatus *(da Costa, 1778), valvas izquierda y derecha, frente a Anza, 10 m (length 21 mm).*

and in habitat the Mediterranean species *Bela zonata* (Locard, 1892), but there is such confusion in the species-level taxonomy of European *Bela* that we prefer not to venture a specific name.

MOLLUSCA, BIVALVIA

Family Condylocardiidae

Cuna gambiensis (Fig. 3) is a small bivalve living in algal turf and thus linked to hard bottom. A few specimens were collected in the transect off Anza, but there are many specimens from Agadir collected in the years 1920 by G. Dollfus with R/V "Vanneau" (unpublished material in Muséum National d'Histoire Naturelle, Paris). This is a tropical West African species, new to the Moroccan fauna. Live-taken specimens showed a small hydrozoan growing on the posterior edge of the valve, and, like other species of the Condylocardiidae

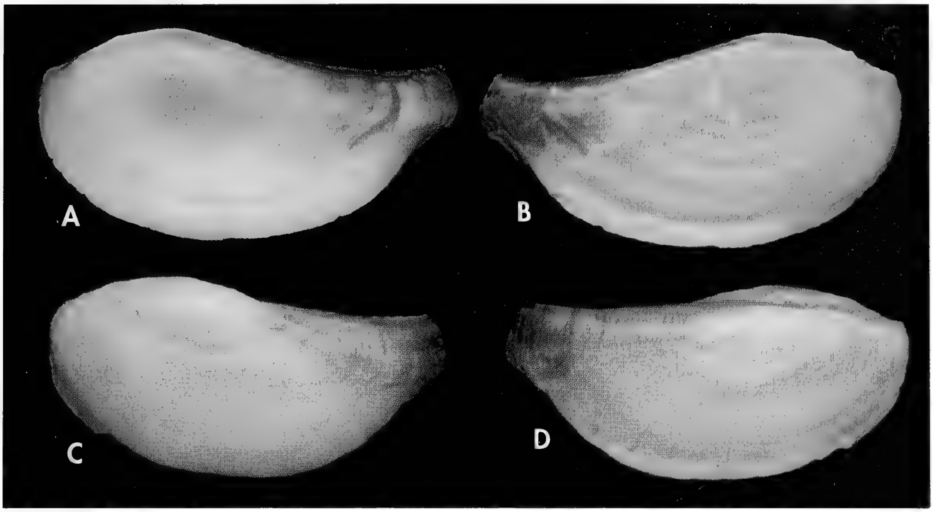


Figure 5 A-D. *Pandora* spp. from Agadir Bay. A-B: *Pandora inaequivalvis* (Linné, 1758), Agadir beach, 6 m (length 24 mm); C-D: *Pandora oblonga* (Sowerby, 1830), Agadir beach, 6 m (length 14 mm).

Figure 5 A-D. Pandora *spp. de la bahía de Agadir. A-B:* Pandora inaequivalvis *(Linné, 1758), Agadir beach, 6 m (length 24 mm); C-D:* Pandora oblonga *(Sowerby, 1830), Agadir beach, 6 m (length 14 mm).*

(SALAS AND ROLÁN, 1990; SALAS AND COSEL, 1991) it was found brooding juveniles.

Family Pharidae

The sand-dwelling razor shells are represented by four species. It is noteworthy that the genus *Ensis*, represented by three species in comparable sandy beaches of the Ibero-Moroccan Gulf, is here only represented by the smaller (and usually rarer) *Ensis ensis*. The West African *Sinupharus combieri* was already recorded (BELLON-HUMBERT, GLÉMAREC AND GOFAS, 1975), but the record of the European *Phaxas pellucidus* is a range extension, the known southern limit being Tangiers.

Family Tellinidae

Macoma cumana (Fig. 4A-B) has its type locality in the Western Mediterranean and is reported to have a West African range (von Cosel, unpublished data), but its distribution is quite puzzling, being replaced in the Alboran Sea by the very similar *Macoma melo* (Sowerby, 1866). The West African species *Tellina rubicincta* (Fig. 4C-D) is new to the Moroccan fauna, the previously known northern limit being in Mauritania (DAUTZENBERG, 1910). It strongly resembles the European *T. distorta* Poli, 1791 but is larger, slenderer and with more distinct comarginal lamellae towards the posterior end.

Family Donacidae

Donax vittatus was quite frequent in the sandy bottom of the shallower part of the transects. The specimens from Agadir (Fig. 4E-F) resemble the Mediterranean *D. venustus* (Poli, 1791) in having sometimes three broad radial bands, but should be assigned to *D. vittatus* on the basis of having striae which are not restricted to the part of the shell between the posterior angle and the posterior margin. The relationships of these species are still unsettled (TIRADO AND SALAS, 1999).

Family Veneridae

BACKELJAU, BOUCHET, GOFAS AND DE BRUYN (1994) have shown that the Atlantic populations formerly called

Venus gallina correspond to *Chamelea striatula*, whereas the real *Chamelea gallina* is restricted to the Mediterranean and southwestern Iberian Peninsula. This is an important point because the Atlantic species is the eponym of "sables fins à *Venus gallina-Mactra corallina*" of GLEMAREC (1969), to be corrected as *Chamelea striatula-Mactra corallina*. It is noteworthy that *C. striatula* is displaced towards more muddy facies where both species are sympatric, whereas, on the European West coast, it occupies facies of fine sand which are similar to the biotope of *C. gallina* in the Mediterranean.

Family Pandoridae

The shallow samples of the Agadir beach yield, in the same habitat, both the European *Pandora inaequivalvis* (Fig. 3D), here at its southern limit (range extension, previously known only from Essaouira northwards) and the West African *P. oblonga* (Fig. 3E), which is here recorded as new to the Moroccan fauna. *Pandora oblonga* is smaller, has a distinctly more convex left valve and more concave right valve, and is less rostrated posteriorly.

CRUSTACEA, DECAPODA

The genus *Diogenes* (Diogenidae) is represented in West Africa by a species complex (FOREST, 1961), but examination of the very large sample from Agadir bay suggests that only one species, *D. pugilator*, is present. The genus *Liocarcinus* (Portunidae) is represented by two species, the widespread *L. depurator*, and another one of doubtful identification (Fig. 2F), tentatively assigned to *L.* cf. *holsatus*, although the contour of the carapace resembles somewhat the Mediterranean *L. vernalis* (Risso, 1826). Nevertheless, specimens from Agadir lack the characteristic velvety surface of the latter. Material from intermediate localities on the Moroccan coast is needed to decide whether this is a geographical variation of one of these two European species, or if a third species must be considered. However, this group of species is in revision (d'Udekem d'Acoz personal communication).

ANNELIDA: POLYCHAETA

There is a species of the genus *Diopatra* (family Onuphidae) which is abundant in all the transects of the bay. This may be *D. marocensis*, described from similar bottoms south of Safi (PAXTON, FADLAOUI AND LECHAPT, 1995). The number of Polychaete species in the samples is low, but this may be a bias due to our sampling gear which does not dig deeply into the sediments.

Characterization of the assemblages

The results of the aggregation and ordination analyses (MDS) using presence-absence data are shown in Figure 6, in which four main groups with a similarity above 50% are defined (stress value 0.18). The analysis of the grouped "stations" by transect shows significant difference (ANOSIM global test, p = 0.003), with highest values between the F and the A, B and C transects (pairwise tests, p = 0.008). In this way, the material collected off Anza and inside the harbour contain, in addition to the other assemblages, several species normally associated with rocky substrates. Among these are *Clanculus kraussi* and *Nassarius incrassatus*, found off Anza, and *Stramonita haemastoma, Ocenebra brevirobusta*, and *Cymatium doliarium* collected inside the harbour. The harbour appears comparatively species-rich (34 species), which can result both from the presence of hard substrates along the piers, and from the shelter of the piers which maintains low wave action.

Along the depth gradient a low significance differences have been found (ANOSIM Global test, p = 0,04).

A semi-quantitative analysis shows similar results (by transects: global test, p = 0.002), with highest values between the F and the A, B and C transects (pairwise tests, p = 0.008); by depth: global test, p = 0,01).

The average similarity within the different transects was around 40.1 (A) – 53.5% (F) (SIMPER) and between 9 (B) to

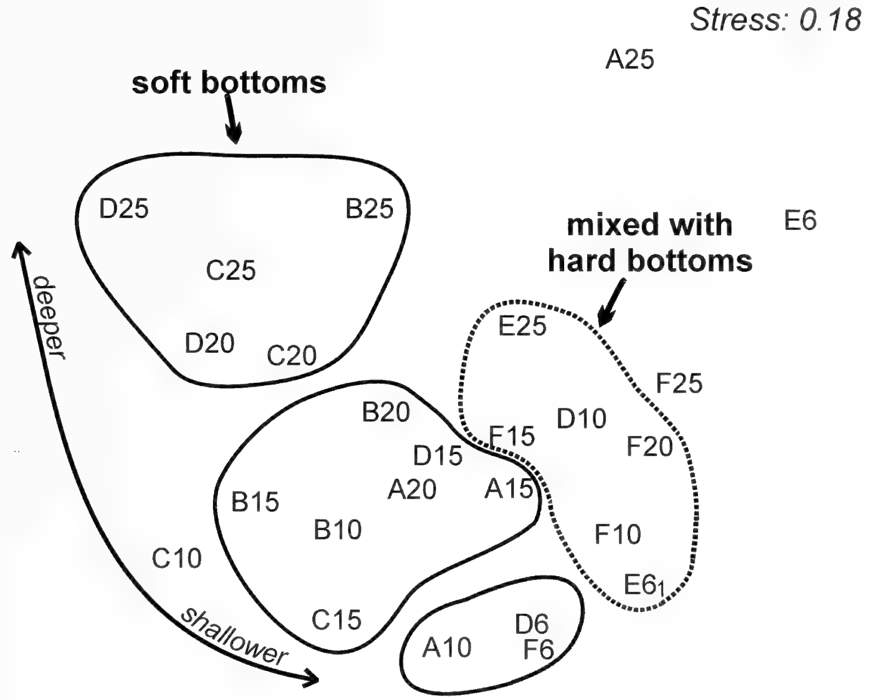


Figure 6. Multi-dimensional scaling (MDS) of the samples. The similarity matrix is based on presence/absence of the species and the Bray-Curtis similarity coefficient. The contours highlight groups of samples which cluster with a similarity coefficient above 50%. The samples are identified by a letter (A: radial of 30°18'N, B: radial of 30°20'N, C: radial of 30°22'N, D: North of Beach; E: Harbour, F: off Anza), and their depth.

Figura 6. Ordenación multidimensional (MDS) de las muestras. La matriz de similitud esta basada en la presencia/ausencia de las especies y en el coeficiente de similitud de Bray-Curtis. Los contornos señalan grupos de muestras que se juntan con un coeficiente superior a 50%. Las muestras están identidficadas por una letra (A: radial de 30°18'N, B: radial de 30°20'N, C: radial de 30°22'N, D: Norte de la playa; E: Puerto, F: frente a Anza) y por su profundidad.

18 (F) species were necessary to get an accumulative contribution of 90-92 %. By depths, 10 (20m) to 14 (10 m) discriminating species are necessary to get a similar accumulative contribution (higher than 90%) with an average similarity between 35.3 (25 m) – 53.9% (15 m).

DISCUSSION

The species collected include some well known as characteristic of fine sands. The assemblages on soft bottoms are quite comparable to those reported by GLEMAREC (1969, 1973) from "sable fin à *Venus gallina - Mactra corallina*" and "sables fins envasés à *Pharus legumen - Ophiura texturata*", where many species (denoted by * on Table I) are shared. Some species collected here are restricted to rather low latitudes so that they have not been mentioned in any of the classical works on benthic bionomy Among these, *Bullia miran, Nassarius elatus* and *Mesalia varia* are dominant and should qualify as characteristic of the fine sand or slightly muddy fine sand communities at the latitude of Agadir. The equivalence with the

Mediterranean community of "sables fins bien calibrés" SFBC (Pérès and Picard, 1964, Augier, 1982) or of 'terrigenous' fine sandy bottoms (Ledoyer, 1968) is not straightforward because of these biogeographic differences, but many of the characteristic Mediterranean species are here replaced in the Atlantic Morocco by ecological vicariants: *Nassarius mutabilis* (Linné, 1758) by *Bullia miran*, *Nassarius pygmaeus* (Lamarck, 1822) by *N. goreensis*, *Chamelea gallina* (Linné, 1758) by *C. striatula*, *Tellina pulchella* Lamarck, 1818 by *T. rubicincta* and *Neverita josephina* Risso, 1826 by other Naticids. The same happens with the decapods, because the characteristic species of the SFBC community of the Mediterranean and southern Spain are *Diogenes pugilator*, *Philocheras trispinosus* and *Liocarcinus vernalis* (Pérès and Picard 1964, Ledoyer, 1968, García Muñoz, Manjón-Cabeza and García Raso, 2008) the latter replaced by *L.* cf. *holsatus* in this study. Such habitats are listed with very little detail, as sublittoral sands (code A5.2) in the European Nature Information System (EUNIS) classification (Davies, Moss and O'Hill, 2004).

The more differentiated assemblage found is that associated with sand and rocky substrate, which also shows the highest specific richness as usual in other areas (García Muñoz *et al*, 2008).

The assemblages also respond to a bathymetric gradient: towards the deeper part of the transects, there is a set of species that prefer slightly muddy sands, the most noteworthy is *Ophiura texturata*. Nevertheless, the community is quite homogeneous along the shore, even where facing the rocky area at Anza. This can be explained by the very flat topography of the sublittoral part of the bay, in which the sandy bottom swamps the rocky outcrops even north of the harbour. Also, the mobility of the macrofauna explains that some species are found across several neighbouring transects on the same kind of bottoms. The same happens in sublittoral bottoms of the Alborán Sea, where the decapod assemblage of coarse sandy bottoms (with high values of organic material) presented practically the same discriminating species as the neighbouring assemblage of muddy fine sandy bottoms, but with different quantitative contribution of the species (García Muñoz *et al*, 2008).

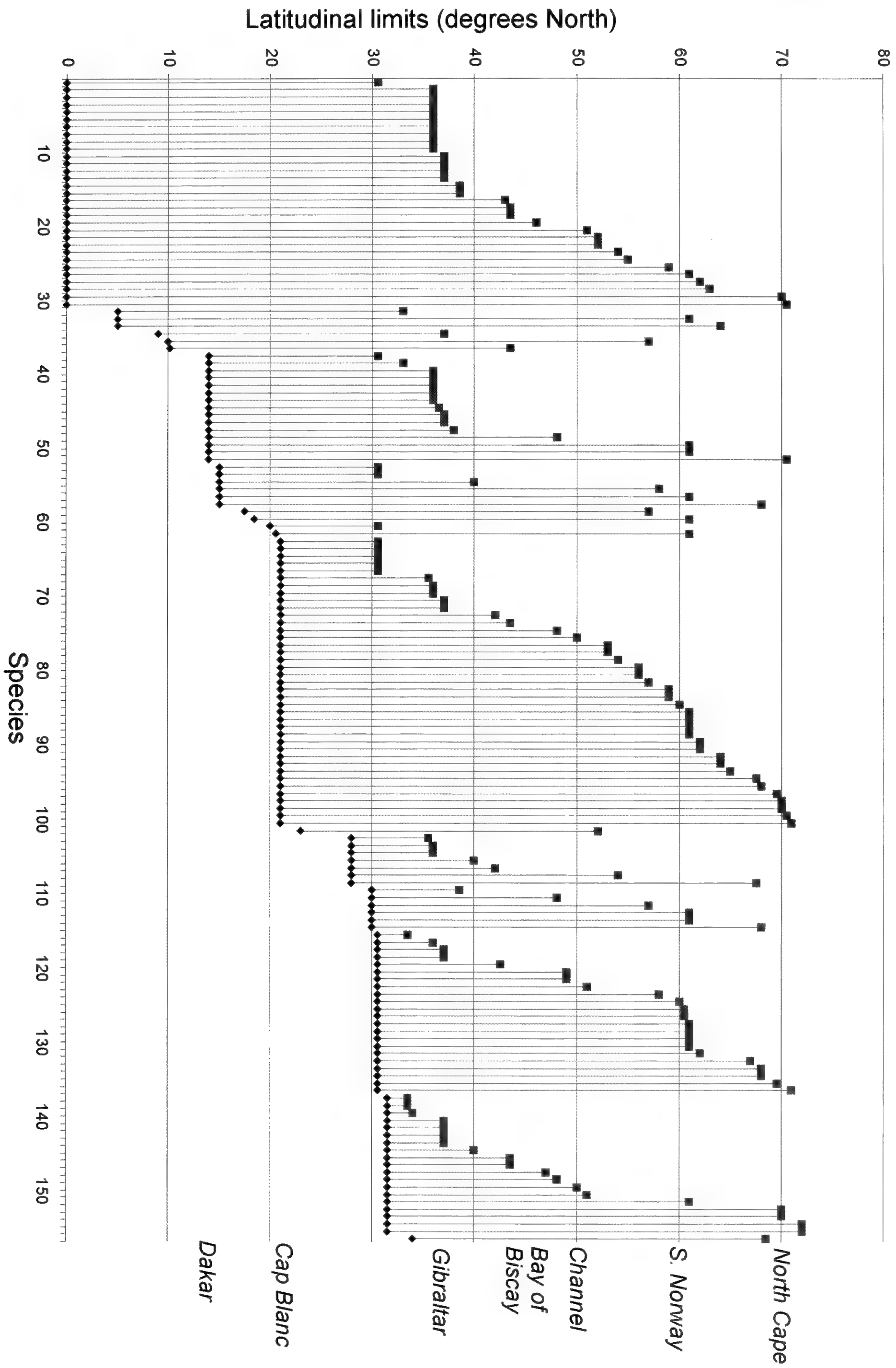
A macrobenthic assemblage from fine sand bottoms in a depth range 16-40 m off Sidi Boulbra (31° 52′ to 31° 58′ N, some 160 km northwards, in the province of Safi), was described by Fadlaoui (1994) in an environmental study for a conventional thermic power plant. This was assigned to "sédiments fin plus ou moins envasés à *Abra alba-Diopatra brevicirris*", referring to a classification of benthic communities derived from Thorson (1957), but is basically similar to the assemblages referred herein. We suspect that the unidentified "terebrid" (Fadlaoui, 1994: 58) reported there with a frequency of 80% is *Bullia miran*, since there are no terebrids in Morocco and shells of *Bullia* are morphologically very terebrid-like.

Biogeographic notes

Among the 70 species collected, 20 (28.5 %) have a predominantly tropical distribution and can be considered as belonging to the West African zoogeo-

(Right page) Figure 7. Plot of the latitudinal ranges of the molluscan species known from Agadir Bay, ordered by southern (◆) and thence by northern (■) distributional limits; ranges in the southern hemisphere not shown and not taken into account for ordering.

(Página derecha) Figura 7. Representación de la extensión latitudinal de las especies conocidas en la Bahía de Agadir, ordenadas por límite sur (◆) y luego por limite norte (■) de distribución; no se muestran, ni se tienen en cuenta para la ordenación, las distribucuiones en el hemisferio sur.


Latitudinal limits (degrees North)
0
10
20
30
40
50
60
70
80
Species
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Dakar
Cap Blanc
Gibraltar
Bay of Biscay
Channel
S. Norway
North Cape

graphic region. This percentage is consistent with the general characterization of the area, which belongs essentially to the Atlanto-Mediterranean province of EKMAN (1953). A survey of the shelled Mollusca, for which good distributional data are available, has been made using the same unpublished dataset as in GOFAS (1999) for latitudinal ranges (Fig. 7). There are ca. 150 species of molluscs known from Agadir bay or from a stretch of coastline which includes Agadir (PALLARY, 1920, PASTEUR-HUMBERT, 1962a,b and this study). Among these, 85 (53%) are temperate Lusitanian species which reach their southern limits at Agadir (30° N) or at Cap Blanc (21° N), whereas 41 (26%) are West African species which reach their northern limit at Agadir, within Morocco or in the Ibero-Moroccan Gulf (up to 36° N). The remainder are species with a broad temperate and tropical range, some of which (e.g. *Venus verrucosa* Linné, 1758) extend to both hemispheres.

The tropical element, however, is overrepresented among the Mollusca from the soft bottoms (i.e. the three southernmost transects). Among the 40 species collected, 15 (37.5%) belong to the West African fauna. This trend is particularly noteworthy among the gastropods, there being 10 of 16 species (62%) which are tropical. This may be a consequence of the overwhelming occurrence of soft bottoms along the tropical West African coast, to which a large number of species have become adapted. Thus, soft bottom littoral communities have a larger pool to draw from to the South than to the North.

There are five species (*Nassarius goreensis, N. argenteus, Cuna gambiensis, Tellina rubicincta, Pandora oblonga*) which are new to the Atlantic coast of Morocco and also to the area covered by CLEMAM (Check List of European Marine Mollusca) and ERMS (European Register of Marine Species, Costello *et al.*, eds. 2002) checklists. This is considerable taking into account the comparatively small sampling effort and highlights the need for a more thorough faunal survey of this area. The number of recorded continental shelf species (156 Mollusca) is also very low compared to other areas (Roscoff, in the Western Entrance of the English Channel: 420 species; Strait of Gibraltar, ca. 1000 species), and it can be speculated that an accurate sampling should at least duplicate this number.

AKNOWLEDGEMENTS

This work would not have been possible without RAMSA, the authority in charge of water supply and sewage for the Agadir urban area. We owe to the collaboration of the authorities of the Harbour of Agadir (ODEP) the possibility to use the towboat "Argoub" and the pilot boat for the dredgings, and extend our special thanks to the Captain for his care in manoevring a very small dredge with a very powerful boat. Special thanks are also expressed to the Muséum National d'Histoire Naturelle (Laboratoire BIMM), Paris, of which the extensive library and collections were indispensable to this work. We are indebted to Dr. Rudo von Cosel (MNHN) for useful advice about the bivalves and to Dr. Patrick Gillet (Université d'Angers) for collaborating with the determination of polychaete species. We also thank Dr. Carmen Salas (University of Málaga) for her interesting remarks and Pr. B. Moumni (Faculty of Science, Tangiers) for help with the granulometry of sediment.

BIBLIOGRAPHY

ADAM W. AND KNUDSEN J. 1984. Révision des Nassariidae (Mollusca: Gastropoda Prosobranchia) de l'Afrique Occidentale. *Bulletin de l'Institut Royal des Sciences Naturelles de Belgique*, 55 (9): 1-95, 5 pl.

AUGIER H. 1982. *Inventaire et classification des biocenoses marines bentiques de la Mediterranée.* Conseil de l'Europe, Collection Sauvegarde de la Nature, 25 Estrasburgo, 59 pp.

BACKELJAU T., BOUCHET P., GOFAS S. AND DE BRUYN L. 1994. Genetic variation, systematics and distribution of the venerid clam *Chamelea gallina*. *Journal of the Marine Biological Association of the United Kingdom,* 74: 211-223.

BELLON-HUMBERT C., GLÉMAREC M. AND. GOFAS S. 1975. *Cultellus combieri* Fischer-Piette et Nicklès (Mollusca, Bivalvia), espèce nouvelle pour la faune atlantique marocaine. *Bulletin de la Société des Sciences naturelles et Physiques du Maroc,* 55: 91-93.

CLEMAM. Unitas Malacologica Check List of European Marine Mollusca. Internet site [current URL <http://www.somali.asso.fr/clemam/>, last searched April 2010].

CLARKE K.R. AND GORLEY R.N. 2001. *PRIMER v5: User Manual/Tutorial.* Primer-E, Plymouth. 91 pp. and computer software package.

CLARKE K. AND WARWICK R. 1994. *Change in marine communities: An approach to statistical analysis and interpretation.* Natural Environment Research Council, Plymouth, U. K., 1-150.

COSTELLO M., EMBLOW C. AND WHITE R. (EDS.) 2002. European Register of Marine Species. *A checklist to the marine species in Europe and a bibliography of guides to their identification.* Muséum National d'Histoire Naturelle, Paris, collection *Patrimoines naturels,* 50: 463 pp.

DAUTZENBERG P. 1910. Contribution à la faune malacologique de l'Afrique Occidentale. *Actes de la Société Linnéenne de Bordeaux,* 64: 47-220, pl. 1-4.

DAVIES C.E., MOSS D. AND O'HILL 2004. *EUNIS Habitat classification revised 2004.* European Topic Centre on Nature Protection and Biodiversity, Paris. 307 p.

EKMAN S. 1953. *Zoogeography of the sea.* Sidgwick and Jackson, London, xiv + 417 pp.

FADLAOUI S. 1994. *Contribution à l'étude de la structure et du fonctionnement des peuplements benthiques de la côte atlantique marocaine (Région de Sidi Boulbra).* Doctoral Thesis, Université de Rennes-I, 1-188.

FOREST J. 1961. Paguridés de l'Afrique Occidentale. *Atlantide Reports,* 6: 203-250.

FOREST J. AND GANTÈS H. 1960. Sur une collection de Crustacés Décapodes marcheurs du Maroc. *Bulletin du Muséum National d'Histoire Naturelle,* 2° sér, 32 (4): 346-358.

GARCÍA RASO J.E. 1996. Crustacea Decapoda (Excl, Sergestidae) from Ibero-moroccan waters. Results of BALGIM-84 Expedition. *Bulletin of Marine Science,* 58 (3): 730-752.

GARCÍA MUÑOZ J.E., MANJÓN-CABEZA M.E. AND GARCÍA RASO J.E. 2008. Decapod crustacean assemblages from littoral bottoms of the Alborán Sea (Spain, west Mediterranean Sea): spatial and temporal variability. *Scientia Marina,* 72 (3): 437-449

GLÉMAREC M. 1969. *Les peuplements benthiques du plateau continental Nord-Gascogne.* Thèse de Doctorat d'Etat, Faculté des Sciences de Paris, 167 pp.

GLÉMAREC M. 1973. The benthic communities of the European North Atlantic continental shelf. *Oceanography and Marine Biology, an Annual Review,* 11: 263-289.

GOFAS S. 1999. Marine molluscs with a very small range in the Strait of Gibraltar. *Diversity and Distributions,* 4: 255-266.

HOUART R. 2000. New species of Muricidae (Gastropoda) from the northeastern Atlantic and the Mediterranean sea. *Zoosystema,* 22 (3): 459-469.

LEDOYER M. 1968. Ecologie de la faune vagile des biotopes méditerranéens accessibles en scaphandre autonome. IV. Synthèse de l'étude écologique. *Recueil des Travaux de la Station Marine d'Endoume,* 60 (Bulletin 44): 1-295.

LIOUVILLE J. 1930. *Liste provisoire des stations du "Vanneau", de la "Dédaigneuse" et du "Lassigny" sur la côte atlantique du Maroc, de 1923 à 1929 (Liste révisée par MM. Rob-Ph. Dollfus, du Muséum, et le lieutenant de vaisseau Jean Spitz, commandant l'unité marine à Casablanca).* Paris, Larose, 24 pp.

MARCHE-MARCHAD I. 1981. Notes sur des representants du genre *Mesalia* Gray, 1847 (Gastropoda, Turritellidae) trouvés dans la Méditerranée. *Bolllettino Malacologico,* 17 (3-4): 41-48.

MITTELSTAED E. 1983. The upwelling area off Northwest Africa. A description of phenomena related to coastal upwelling. *Progress in Oceanography,* 12: 307-331.

MONOD T. 1956. Hippidea et Brachyura Ouest-Africains. *Mémoires de l'Institut Français d'Afrique Noire,* 45: 1-674.

PALLARY P. 1900. Coquilles marines du littoral du Département d'Oran. *Journal de Conchyliologie,* 48: 211-422, pl. 6-8

PALLARY P. 1920. *Exploration Scientifique du Maroc. Malacologie.* Larose, Paris, and Institut Scientifique Chérifien, Rabat. 109 p., 1 pl., 1 map.

PASTEUR-HUMBERT C. 1962a. Les mollusques marins testacés du Maroc. 1. Les Gastéropodes. *Travaux de l'Institut Scientifique Chérifien,* sér. Zoologie, 23: 1- 245.

PASTEUR-HUMBERT C. 1962b. Les mollusques marins testacés du Maroc. 2. Les Lamellibranches et les Scaphopodes. *Travaux de l'Institut Scientifique Chérifien,* sér. Zoologie, 28: 1-184.

PAXTON H., FADLAOUI S. AND LECHAPT J.P. 1995. *Diopatra marocensis,* a new brooding species of Onuphidae (Annelida: Polychaeta). *Journal of the Marine Biological Association of the United Kingdom,* 75, 949-955.

PÉRÈS J.M. AND PICARD J. 1964. Nouveau manuel de bionomie benthique de la Mer Méditerranée. *Recueil des Travaux de la Station Marine d'Endoume*, 47 (Bulletin 31): 1-137.

POPPE G.T. AND GOTO Y. 1991. *European Seashells. Volume I (Polyplacophora, Caudofoveata, Solenogastra, Gastropoda)*, 352 pp. Christa Hemmen, Wiesbaden.

POPPE G.T. AND GOTO Y. 1993. *European Seashells. Volume II (Scaphopoda, Bivalvia, Cephalopoda)*, 221 pp. Christa Hemmen, Wiesbaden.

SALAS C. 1996. The Bivalves from off the Southern Iberian Peninsula collected by the FAUNA I and BALGIM expeditions. *Haliotis*, 25: 33-100.

SALAS C. AND ROLÁN E. 1990. Four new species of Condylocardiidae from Cape Verde Islands. *Bulletin du Muséum National d'Histoire Naturelle*, (4e sér.) 12A (2): 349-363

SALAS C. AND COSEL R. VON 1991. Taxonomy of tropical West African bivalves III. Four new species of Condylocardiidae from the continental shelf. *Bulletin du Muséum National d'Histoire Naturelle* (4e sér.) 13A (3-4): 263-281

THORSON G. 1957. Bottom communities (sublittoral or shallow shelf). In Hedgpeth, J.W. (Ed.): *Treatise on Marine Ecology and Palaeoecology*: 461-534. Geological Society of America.

TIRADO C. AND SALAS C. 1999. Reproduction of *Donax venustus* Poli, 1795, *Donax semistriatus* Poli, 1795 and intermediate morphotypes (Bivalvia: Donacidae) in the littoral of Málaga (Southern Spain). *P.S.Z.N. Marine Ecology*, 20 (2): 111-130.

TORTONESE E. 1965. *Fauna d'Italia, VI. Echinodermata.* Calderini, Bologna. 422 pp.

ZARIQUEY ÁLVAREZ R. 1968. Crustáceos decápodos ibéricos. *Investigación Pesquera*, 32: i-xv, 1-510.

NORMAS DE PUBLICACIÓN

- La revista *Iberus* publica artículos de fondo, notas y monografías que versen sobre cualquiera de los aspectos relacionados con la Malacología. Se entiende por artículo un trabajo de investigación de más de 5 páginas de texto, incluidas láminas, gráficos y tablas. Las notas son trabajos de menor extensión. Las monografías son trabajos sobre un tema único, de extensión superior a las 50 páginas de la revista y que serán publicadas, si procede, como un suplemento de *Iberus*. Los autores interesados en publicar monografías deberán ponerse previamente en contacto con el Editor de Publicaciones. Se entiende que el contenido de los manuscritos no ha sido publicado, ni enviado simultáneamente a otra revista para su consideración.
- Los manuscritos, así como toda la correspondencia relacionada con los mismos, deberán ser remitidos a: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, España y/o al correo electrónico <sgofas@uma.es>.
- El texto del trabajo podrá estar redactado en español, inglés, italiano, francés o portugués.
- Los artículos, notas y monografías deberán presentarse sobre DIN A-4, por una sola cara a doble espacio (incluyendo referencias, pies de figura y tablas), con al menos 3 centímetros de margen por cada lado. Los trabajos se entregarán por triplicado (original y dos copias) y se incluirá una versión en un CD, o bien remitida por correo electrónico, utilizando procesadores de texto en sus versiones de corrientes de Windows (pero no en el formato .docx de Word 2007, el habitual de Windows Vista) o Macintosh. En caso de autoría compartida, uno de los autores deberá hacerse responsable de toda la correspondencia.
- Junto con el trabajo debe incluirse una lista de al menos 4 posibles revisores del mismo, sin perjuicio de los que el propio Editor considere oportunos.
- Los manuscritos se presentarán de acuerdo al siguiente esquema:

Primera página. Deberá incluir un título conciso, pero sugerente del contenido del trabajo, así como una traducción al inglés del mismo (si el artículo no está escrito en inglés). Cuando sea preciso, deberá incluir referencia a familia o taxones superiores. A continuación figurarán, por este orden, el nombre y apellidos completos del autor o autores, las direcciones completas de los mismos, y un resumen del trabajo y su traducción al inglés. Dicho resumen deberá sintetizar, en conjunción con el título, tanto los resultados como las conclusiones del artículo; se sugiere una extensión de 100 a 200 palabras.

Páginas siguientes. Incluirán el resto del artículo, que debe dividirse en secciones precedidas por breves encabezamientos. Siempre que sea posible, se recomienda seguir el siguiente esquema: Introducción, Material y métodos, Resultados, Discusión, Conclusiones, Agradecimientos y Bibliografía. Si se emplean abreviaturas no habituales en el texto, deberán indicarse tras el apartado de Material y Métodos.

- Las notas breves deberán presentarse de la misma forma, pero sin resumen.
- Deberán evitarse notas a pie de página y referencias cruzadas. Deberán respetarse estrictamente los Códigos Internacionales de Nomenclatura Zoológica y Botánica (últimas ediciones). Cuando un taxón aparezca por primera vez deberá citarse su autor y fecha de su descripción. En el caso de artículos sistemáticos, cuando se den las sinonimias de los taxones, éstas deberán citarse COMPLETAS, incluyendo en forma abreviada la publicación donde fueron descritas, y la localidad tipo si es conocida entre corchetes, según el siguiente esquema (préstese especial cuidado a la puntuación):

Dendrodoris limbata (Cuvier, 1804)
Sinonimias
Doris limbata Cuvier, 1804, *Ann. Mus. Hist. Nat. Paris*, 4 (24): 468-469 [Localidad tipo: Marsella].
Doris nigricans Otto, 1823, *Nov. Act. Ac. Caes. Leop.-Car.*, 10: 275.

Dichas referencias no deberán incluirse en la lista de Bibliografía si es la única vez que se nombran en el texto. Si se incluyen una lista completa de referencias de un taxón inmediatamente tras éste, deberá seguirse el mismo esquema (sin incluir en Bibliografía las referencias que no se mencionen en otro lugar del texto).

- Sólo los nombres en latín y los de taxones genéricos y específicos deberán llevar subrayado sencillo o preferentemente ir en cursiva. En ningún caso deberá escribirse una palabra totalmente en letras mayúsculas, ni siquiera el Título. Las unidades a utilizar deberán pertenecer al Sistema Métrico Decimal, junto con sus correctas abreviaturas. En artículos escritos en castellano, en los números decimales sepárese la parte entera de la decimal por una coma inferior (,), NUNCA por un punto (.) o coma superior (ʹ).
- Las referencias bibliográficas irán en el texto con minúsculas o versalitas: Fretter y Graham (1962) o FRETTER Y GRAHAM (1962). Si son más de dos autores se deberán citar todos la primera vez que aparecen en el texto [Smith, Jones y Brown (1970)] empleándose *et al.* las siguientes veces [Smith *et al.* (1970)]. Si un autor ha publicado más de un trabajo en un año se citarán con letras: (Davis, 1989a; Davis, 1989b). No deberá emplearse op. cit. La lista de referencias deberá incluir todas las citas del texto y sólo éstas, ordenadas alfabéticamente. Se citarán los nombres de todos los autores de cada referencia, sea cual sea su número. Los nombres de los autores deberán escribirse, en letras minúsculas o Versalitas. No deberán incluirse referencias a autores cuando éstos aparezcan en el texto exclusivamente como autoridades de un taxón. Los nombres de las publica-

ciones periódicas deberán aparecer COMPLETOS, no abreviados. Cuando se citen libros, dése el título, editor, lugar de publicación, nº de edición si no es la primera y número total de páginas. Deberán evitarse referencias a Tesis Doctorales u otros documentos inéditos de difícil consulta. Síganse los siguientes ejemplos (préstese atención a la puntuación):

Fretter V. y Graham A. 1962. *British Prosobranch Molluscs*. Ray Society, London, 765 pp.

Ponder W.F. 1988. The Truncatelloidean (= Rissoacean) radiation - a preliminary phylogeny. En Ponder, W.F. (Ed.): Prosobranch Phylogeny. *Malacological Review*, suppl. 4: 129-166.

Ros J. 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoológica*, 3 (5): 21-51.

- Las gráficas e ilustraciones deberán ser originales y presentarse preferentemente en formato electrónico al formato de caja de la revista o proporcional a éste. Este formato es de 57 mm (una columna) o 121 mm (dos) de anchura y hasta 196 mm de altura, si bien se recomienda utilizar el formato a dos columnas. Es importante que todas las figuras sean remitidas en su formato original (por ejemplo, las fotografías en .jpg de alta calidad o .tif, las gráficas en hojas de cálculo Excel o documentos de CorelDraw), puesto que las ilustraciones insertadas en el manuscrito WORD son inservibles en la fase de imprenta. Las imágenes digitales deben ser formateadas en su tamaño de impresión con una resolución mínima de 300 ppp para imágenes en color o escala de grises y de 600 ppp para las de blanco y negro. Considérese la reducción que será necesaria a la hora de decidir el tamaño de las escalas o letras en las figuras, que no deberán bajar de los 2 mm. En figuras compuestas, cada parte deberá etiquetarse con letras mayúsculas, el resto de las letras deberán ser minúsculas. Las escalas de dibujos y fotografías deberán ser gráficas, utilizando unidades del sistema métrico decimal; no deberán hacerse referencias a los aumentos de una determinada ilustración, ya que éstos cambian con la reducción. En su caso, se recomienda la utilización de mapas con proyección UTM. Cada figura, gráfica o ilustración deberá presentarse en hojas separadas y con numeración arábiga (1, 2, 3,...), sin separar "Figuras" y "Láminas". Los pies de figura, en una hoja aparte, deberán acompañarse de su traducción al inglés (o español si el inglés es la lengua del trabajo). Utilícese el esquema siguiente:

Figura 1. *Neodoris carvi*. A: animal desplazándose; B: detalle de un rinóforo; C: branquia.

Las abreviaturas empleadas en las ilustraciones deberán incluirse en los pies de figura.

Los autores interesados en incluir láminas en color deberán consultar con el editor y sufragar el sobrecoste con una contribución de 30 € por página. Por lo demás, deberán ajustarse a los mismos requisitos indicados para las figuras.

Si se pretende enviar gráficas o ilustraciones en impresión de papel es imprescindible presentar originales de buena calidad. Las imágenes en semitonos deben estar bien contrastadas y ajustarse al tamaño definitivo de impresión; al componer fotografías sobre una hoja, procúrese que los espacios entre ellas sean regulares y que estén debidamente alineadas. Téngase en cuenta que incluir fotografías de distinto contraste en una misma página conlleva una pobre reproducción final. Las gráficas de ordenador deberán imprimirse con impresora láser sobre papel de buena calidad.

- Las Tablas se presentarán en hojas separadas, siempre con numeración romana (I, II, III,...). Las leyendas se incluirán en una hoja aparte acompañándose de una traducción al inglés. Deberán evitarse las tablas particularmente complejas. Se recomienda reducir el número y extensión de ilustraciones, láminas o tablas al mínimo necesario.
- Los artículos que no se ajusten a las normas de publicación serán devueltos al autor con las indicaciones de los cambios necesarios.
- El Comité Editorial comunicará al autor responsable del trabajo la fecha de recepción del trabajo y la fecha de envío a revisión. Cada original recibido será sometido a revisión por al menos dos investigadores. El Comité Editorial, a la vista de los informes de los revisores decidirá sobre la aceptación o no de cada manuscrito. El autor recibirá en cada caso copia de los comentarios de los revisores sobre su artículo. En caso de aceptación, el mismo Comité Editorial, si lo considera conveniente, podrá solicitar a los autores otras modificaciones que considere oportunas. Si el trabajo es aceptado, el autor deberá enviar una copia impresa del mismo corregida, acompañada por una versión en un CD, utilizando procesadores de texto en sus versiones corrientes de Windows (pero no el formato .docx generado por Word 2007, el habitual de Windows Vista) o Macintosh. La fecha de aceptación figurará en el artículo publicado.
- Las pruebas de imprenta serán enviadas por correo electrónico al autor responsable, exclusivamente para la corrección de erratas, y deberán ser devueltas en un plazo máximo de una semana. Se recomienda prestar especial atención en la corrección de las pruebas.
- De cada trabajo se entregarán gratuitamente 50 separatas, además de una versión electrónica en formato .pdf. Aquellos autores que deseen un número mayor, deberán hacerlo constar al devolver las pruebas de imprenta, y nunca posteriormente. El coste de las separatas adicionales será cargado al autor.

INSTRUCTIONS TO AUTHORS

- *Iberus* publishes research papers, notes and monographs devoted to the various aspects of Malacology. Papers are manuscripts of more than 5 typed pages, including figures and tables. Notes are shorter papers. Monographs should exceed 50 pages of the final periodical, and may be published as Supplements. Authors wishing to publish monographs should contact the Editor. Manuscripts are considered on the understanding that their contents have not been published or simultaneously submitted for publication elsewhere.
- Manuscripts and correspondence regarding editorial matters must be sent to: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, Spain and/or to the e-mail <sgofas@uma.es>.
- Manuscripts may be written in Spanish, English, Italian, French or Portuguese.
- Manuscripts must be typed double spaced (including the references, figure captions and tables) on one side on A-4 (297x210 mm) with margins of at least 3 cm. An original and two copies must be submitted, together with a CD or e-mail remittance containing the article written with a current Windows (but not .docx format generated by Word 2007, mainly used with Windows Vista) or Macintosh word processor. When a paper has joint authorship, one author must accept responsibility for all correspondence.
- The authors must include a list of at least 4 possible referees; the Editor can choose any others if appropriate.
- Papers should conform the following layout:

First page. This must include a concise but informative title, with mention of family of higher taxon when appropriate, and its Spanish translation. It will be followed by all authors' names and surnames, their full address(es), an abstract (and its Spanish translation) not exceeding 200 words which summarizes not only contents but results and conclusions.

Following pages. These should content the rest of the paper, divided into sections under short headings. Whenever possible the text should be arranged as follows: Introduction, Material and methods, Results, Discussion, Conclusions, Acknowledgements and References. Unusual abbreviations used in the text must be grouped in one alphabetic sequence after the Material and methods section.

- Notes should follow the same layout, without the abstract.
- Footnotes and cross-references must be avoided. The International Codes of Zoological and Botanical Nomenclature must be strictly followed. The first mention in the text of any taxon must be followed by its authority including the year. In systematic papers, when synonyms of a taxon are given, they must be cited IN FULL, including the periodical, in an abbreviate form, where they were described, and the type localities in square brackets when known. Follow this example (please note the punctuation):

Dendrodoris limbata (Cuvier, 1804)
Synonyms
Doris limbata Cuvier, 1804, *Ann. Mus. Hist. Nat. Paris*, 4 (24): 468-469 [Type locality: Marseille].
Doris nigricans Otto, 1823, *Nov. Act. Ac. Caes. Leop.-Car.*, 10: 275.

These references must not be included in the Bibliography list, except if referred to elsewhere in the text. If a full list of references of the taxon is to be given immediately below it, the same layout should be followed (also excluding from the Bibliography list those which are not cited elsewhere).

Only Latin words and names of genera and species should be underlined once or be given in italics. No word must be written in UPPER CASE LETTERS. SI units are to be used, together with their appropriate symbols. In Spanish manuscripts, decimal numbers must be separated with a comma (,), NEVER with a point (.) or upper comma (').

- References in the text should be written in small letters or Small capitals: Fretter and Graham (1962) or FRETTER AND GRAHAM (1962). The first mention in the text of a paper with more than two authors must include all of them [Smith, Jones and Brown (1970)], thereafter use *et al.* [Smith *et al.* (1970)]. If an author has published more than one paper per year, refer to them with letters: (Davis, 1989a; Davis, 1989b). Avoid op. cit.

The references in the reference list should be in alphabetical order and include all the publications cited in the text but only these. ALL the authors of a paper must be included. These should be written in small letters or Small capitals. The references need not be cited when the author and date are given only as authority for a taxonomic name. Titles of periodicals must be given IN FULL, not abbreviated. For books, give the title, name of publisher, place of publication, indication of edition if not the first and total number of pages. Keep references to doctoral theses or any other unpublished documents to an absolute minimum. See the following examples (please note the punctuation):

Fretter V. and Graham A. 1962. *British Prosobranch Molluscs*. Ray Society, London, 765 pp.

Ponder W.F. 1988. The Truncatelloidean (= Rissoacean) radiation - a preliminary phylogeny. In Ponder W.F. (Ed.): Prosobranch Phylogeny. *Malacological Review*, suppl. 4: 129-166.

Ros J. 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoológica*, 3 (5): 21-51.

- Figures must be original and provided preferably in electronic format and adjusted to page format and column size. These should be one column (57 mm) or two columns (121 mm) wide and up 196 mm high, or be proportional to these sizes. Two columns format is recommended. It is essential that all figures be supplied in their original format (e.g. photographs as high-grade .jpg or as .tif files, graphs as Excel spreadsheets or Corel-Draw files), as the files inserted into WORD documents cannot be used for printing. Digital images must be given their final printing size with a resolution at least 300 dpi for colour and halftones, and at least 600 dpi for black/white.

Take into account possible reduction in lettering drawings; final lettering must be at least 2 mm high. In composite drawings, each figure should be given a capital letter; additional lettering should be in lower-case letters. A scale line, labelled with SI units, must be used to indicate size; magnification ratio must be avoided as it may be changed during printing. UTM maps are to be used if necessary. Figures must be submitted on separate sheets, and numbered with consecutive Arabic numbers (1, 2, 3,...), without separating 'Plates' and 'Figures'. Legends for Figures must be typed in numerical order on a separate sheet, and a Spanish translation must be included. Follow this example (please note the punctuation):

Figure 1. *Neodoris carvi*. A: animal crawling; B: rhinophore; C: gills.

If abbreviations are to be used in illustrations, they should be included in the figure captions.

Authors wishing to publish illustrations in colour should consult with the editor and will be charged a contribution of 30 € per page. They should otherwise follow the same standards as black and white prints.

If the authors want to send Figures in printed format, it is essential to supply good quality originals. Half-tone images must be of good contrast, and should be submitted in the final printing size. When mounting photographs in a block, ensure spacers are of uniform width. Remember that grouping photographs of varied contrast results in poor reproduction. Computer graphics must be printed on high quality white paper with a laser printer.

- Tables must be numbered with Roman numbers (I, II, III,...) and each typed on a separate sheet. Headings should be typed on a separate sheet, together with their English translation. Complex tables should be avoided. As a general rule, keep the number and extension of illustrations and tables as reduced as possible.
- Manuscripts that do not conform to these instructions will be returned for correction before reviewing.
- Authors submitting manuscripts will receive an acknowledgement of receipt, including receipt date, and the date the manuscript was sent for reviewing. Each manuscript will be critically evaluated by at least two referees. Based of these evaluations, the Editorial Board will decide on acceptance or rejection. Anyway, authors will receive a copy of the referees' comments. If a manuscript is accepted, the Editorial Board may indicate additional changes if desirable. Acceptable manuscripts will be returned to the author for consideration of comments and criticism; a finalized manuscript must then be returned to the Editor, together with a CD containing the article written with current Windows (but not a .docx format generated by Word 2007, mainly used under Windows Vista) or Macintosh word processor. Dates of reception and acceptance of the manuscript will appear in all published articles.
- Proofs will be e-mailed to the author for correcting errors and must be returned corrected within one week. At this stage no stylistic changes will be accepted. Pay special attention to references and their dates in the text and the Bibliography section, and also to numbers of Figures and Tables appearing in the text.
- Fifty reprints per article and a .pdf file will be supplied free of charge. Additional reprints must be ordered when the page proofs are returned, and will be charged at cost. NO LATER orders will be accepted.

La Sociedad Española de Malacología

Junta Directiva desde el 11 de octubre de 2005

Presidente	José Templado González
Vicepresidente	Emilio Rolán Mosquera
Secretaria	María Carmen Salas Casanovas
Tesorero	Luis Murillo Guillén
Editor de Publicaciones	Serge Gofas
Bibliotecario	Rafael Araujo Armero
Vocales	Ramon M. Álvarez Halcon Benjamín Gómez Moliner Alberto Martínez Ortí Diego Moreno Lampreave José Ramón Arrébola Burgos

La *Sociedad Española de Malacología* se fundó el 21 de agosto de 1980. La sociedad se registró como una asociación sin ánimo de lucro en Madrid (Registro Nº 4053) con unos estatutos que fueron aprobados el 12 de diciembre de 1980. Esta sociedad se constituye con el fin de fomentar y difundir los estudios malacológicos mediante reuniones y publicaciones. A esta sociedad puede pertenecer cualquier persona o institución interesada en el estudio de los moluscos.

SEDE SOCIAL: Museo Nacional de Ciencias Naturales, c/ José Gutierrez Abascal 2, 28006 Madrid, España.

CUOTAS PARA 2010:

Socio numerario	(en España):	40 euros
	(en Europa)	40 euros
	(fuera de Europa):	48 euros
Socio estudiante	(en España):	23 euros
	(en el extranjero):	29 euros
Socio Familiar:	(sin recepcion de revista)	4 euros
Socio Protector:	(mínimo)	48 euros
Socio Corporativo	(en Europa):	48 euros
	(fuera de Europa):	54 euros

INSCRIPCIÓN: 6 euros, además de la cuota correspondiente.

A los socios residentes en España se les aconseja domiciliar su cuota. Todos los abonos deberán enviarse al Tesorero (dirección reseñada anteriormente) el 1 de enero de cada año. Los abonos se harán sin recargos para la sociedad y en favor de la *Sociedad Española de Malacología* y no de ninguna persona de la junta directiva. Aquellos socios que no abonen su cuota anual dejarán de recibir las publicaciones de la Sociedad. Los bonos de inscripción se enviarán junto con el abono de una cuota anual al Tesorero.

A los residentes en el extranjero se les ruega que abonen su cuota mediante giro postal en euros (international postal money orders in euros sent to the Treasurer). Members living in foreing countries can deduce 6 euros if paid before 15 April.

Cada socio tiene derecho a recibir anualmente los números de *Iberus, Reseñas Malacológicas* y *Noticiarios* que se publiquen.

ÍNDICE

Iberus 28 (1) 2010

Dubois C. et Martínez-Ortí A. Reproduction du mollusque envahisseur *Corbicula fluminea* (O. F. Müller, 1774) (Bivalvia: Corbiculidae) et recrutement et distribution de ses juvéniles dans un canal de la région toulousaine (France)
Reproducción del molusco invasor Corbicula fluminea *(O. F. Müller, 1774) (Bivalvia: Corbiculidae) y reclutamiento y distribución de sus juveniles en un canal la región de Toulouse (France)* 1-11

Bejega García V., González Gómez de Agüero E. y Fernández Rodríguez C. La Arqueomalacología: una introducción al estudio de los restos de moluscos recuperados en yacimientos arqueológicos
Archaeomalacology: an introduction to the analysis of shellfish remains from archaeological sites 13-22

Gofas S. y Oliver J.D. Las especies del género *Chauvetia* (Gastropoda, Neogastropoda, Buccinidae) del área ibero-marroquí, con descripción de cuatro especies nuevas
The species of the genus Chauvetia *(Gastropoda, Neogastropoda, Buccinidae) in the Ibero-moroccan area, with the description of four new species* 23-60

Guerra A., Pierce G.J., Santos, Mª.B., González A.F., Hernández-Milian G., Porteiro C. and Patiño B. Record of the largest specimen of neon flying squid *Ommastrephes bartramii* (Cephalopoda: Ommastrephidae)
Registro del mayor ejemplar de pota saltadora Ommastrephes bartramii *(Cephalopoda: Ommastrephidae)* 61-66

Holyoak G.A. and Holyoak, D.T. A new species of *Candidula* (Gastropoda, Hygromiidae) from central Portugal
Una nueva especie de Candidula *(Gastropoda, Hygromiidae) de Portugal* 67-72

Rolán E. and Zettler M.L. A new species of *Gibbula* (Mollusca, Archaegastopoda) from Namibia
Una nueva especie de Gibbula *(Mollusca, Archaegastopoda) de Namibia* 73-78

Rolán E. and Raúl Fernández-Garcés R. New information on the Caribbean *Rissoina* (Gastropoda, Rissoidae) of the group *R. sagraiana-cancellata* with the description of a new species
Nueva información sobre las Rissoina *del Caribe (Gastropoda, Rissoidae) del grupo de* R. sagraiana-cancellata, *con la descripción de una nueva especie* 79-89

Gofas S. A new *Manzonia* (Gastropoda: Rissoidae) from nothwestern Morocco
Una nueva Manzonia (Gastropoda, Rissoidae) del Noroeste de Marruecos 91-96

Moukrim A., García Raso J.E. and Gofas S. Notes on the benthic macrofauna of Agadir Bay (Atlantic Morocco)
Datos sobre la macrofauna bentónica de la Bahía de Agadir (Marruecos Atlántico) ... 97-114

ISSN 0212-3010

Iberus

Vol. 28 (2)

REVISTA DE LA SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

Oviedo, diciembre 2010

Iberus

Revista de la

SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

COMITÉ DE REDACCIÓN *(BOARD OF EDITORS)*

EDITOR DE PUBLICACIONES *(EDITOR-IN-CHIEF)*

Serge Gofas	Universidad de Málaga, España

DIRECTOR DE REDACCIÓN *(EXECUTIVE EDITOR)*

Gonzalo Rodríguez Casero	Apdo. 156, Mieres del Camino, Asturias, España

EDITORA EJECUTIVA *(MANAGING EDITOR)*

Eugenia Mª Martínez Cueto-Felgueroso	Apdo. 156, Mieres del Camino, Asturias, España

EDITORES ADJUNTOS *(ASSOCIATE EDITORS)*

Francisco Javier Conde de Saro	Embajada de España, Japón
Benjamín Gómez Moliner	Universidad del País Vasco, Vitoria, España
Ángel Antonio Luque del Villar	Universidad Autónoma de Madrid, Madrid, España
Emilio Rolán Mosquera	Universidad de Vigo, Vigo, España
José Templado González	Museo Nacional de Ciencias Naturales, CSIC, Madrid, España
Jesús S. Troncoso	Universidad de Vigo, Vigo, España

COMITÉ EDITORIAL *(BOARD OF REVIEWERS)*

Kepa Altonaga Sustacha	Universidad del País Vasco, Bilbao, España
Eduardo Angulo Pinedo	Universidad del País Vasco, Bilbao, España
Rafael Araujo Armero	Museo Nacional de Ciencias Naturales, Madrid, España
Thierry Backeljau	Institut Royal des Sciences Naturelles de Belgique, Bruselas, Bélgic
Rüdiger Bieler	The Field Museum, Chicago, Estados Unidos
Sigurd v. Boletzky	Laboratoire Arago, Banyuls-sur-Mer, Francia
Jose Castillejo Murillo	Universidad de Santiago de Compostela, Santiago de Compostela, España
Karl Edlinger	Naturhistorisches Museum Wien, Viena, Austria
Antonio M. de Frias Martins	Universidade dos Açores, Açores, Portugal
José Carlos García Gómez	Universidad de Sevilla, Sevilla, España
Gonzalo Giribet de Sebastián	Harvard University, EE.UU.
Edmund Gittenberger	National Natuurhistorisch Museum, Leiden, Holanda
Ángel Guerra Sierra	Instituto de Investigaciones Marinas, CSIC, Vigo, España
Gerhard Haszprunar	Zoologische Staatssammlung München, München, Alemania
Yuri I. Kantor	A.N. Severtzov Institute of Ecology and Evolution, Moscú, Rusia
María Yolanda Manga González	Estación Agrícola Experimental, CSIC, León, España
Jordi Martinell Callico	Universidad de Barcelona, Barcelona, España
Ron K. O'Dor	Dalhousie University, Halifax, Canada
Takashi Okutani	Nihon University, Fujisawa City, Japón
Marco Oliverio	Universitá di Roma "La Sapienza", Roma, Italia
Pablo E. Penchaszadeh	Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina
Winston F. Ponder	Australian Museum, Sydney, Australia
Carlos Enrique Prieto Sierra	Universidad del País Vasco, Bilbao, España
Mª de los Ángeles Ramos Sánchez	Museo Nacional de Ciencias Naturales, CSIC, Madrid, España
Francisco Javier Rocha Valdés	Instituto de Investigaciones Marinas, CSIC, Vigo, España
Paul G. Rodhouse	British Antarctic Survey, Cambridge, Reino Unido
Joandomènec Ros i Aragones	Universidad de Barcelona, Barcelona, España
María Carmen Salas Casanovas	Universidad de Málaga, Málaga, España
Gerhard Steiner	Institut für Zoologie der Universität Wien, Viena, Austria
Victoriano Urgorri Carrasco	Universidad de Santiago de Compostela, Santiago de Compostela, España
Anders Warén	Swedish Museum of Natural History, Estocolmo, Suecia

PORTADA DE *Iberus*

Iberus gualtieranus (Linnaeus, 1758), una especie emblemática de la península Ibérica, que da nombre a la revista. Dibujo realizado por José Luis González Rebollar "Toza".

Iberus

REVISTA DE LA
SOCIEDAD ESPAÑOLA
DE MALACOLOGÍA

Vol. 28 (2) **Oviedo, diciembre 2010**

Iberus

Revista de la
SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

Iberus publica trabajos que traten sobre cualquier aspecto relacionado con la Malacología. Se admiten también notas breves. *Iberus* edita un volumen anual que se compone de dos o más números.

INSTRUCCIONES PARA LOS AUTORES

Los manuscritos deben remitirse a: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, España.

Los trabajos se entregarán por triplicado (original y dos copias). Se recomienda a los autores leer cuidadosamente las normas de publicación que se incluyen en cada número de la revista.

SUBCRIPCIONES

Iberus puede recibirse siendo socio de la Sociedad Española de Malacología, en cualquiera de sus formas, o mediante intercambio. Aquellos socios que deseen adquirir números atrasados deberán dirigirse al bibliotecario.

Los no socios deberán ponerse en contacto con BACKHUYS PUBLISHERS, P.O. Box 321, 2300 AH Leiden, The Netherlands. Tel.: +31-71-51 70 208, Fax: +31-71-51 71 856, Correo Electrónico: backhuys@euronet.nl

Los resumenes de los artículos editados en esta revista se publican en Aquatic Science and Fisheries Abstracts (ASFA) y en el Zoological Records, BIOSIS.

Contents list published in Aquatic Science and Fisheries Abstracts and Zoological Records, BIOSIS.

Dep. Leg. B-43072-81
ISSN 0212-3010
Diseño y maquetación: Gonzalo Rodríguez
Impresión: LOREDO, S. L. - Gijón

Haedropleura ryalli, a new species from São Tomé Island (Gastropoda, Turridae)

Haedropleura ryalli, nueva especie de la isla de São Tomé (Gastropoda, Turridae)

Juan HORRO*, Sandro GORI** and Emilio ROLÁN***

Recibido el 10-III-2010. Aceptado el 31-VIII-2010

ABSTRACT

A new species of the genus *Haedropleura* Bucquoy, Dautzenberg and Dollfus, 1883 from the island of São Tomé, West Africa, is described and figured.

RESUMEN

Se describe e ilustra una nueva especie del género *Haedropleura* Bucquoy, Dautzenberg y Dollfus, 1883 recolectada en la isla de São Tomé, África occidental.

INTRODUCTION

The genus *Haedropleura* Bucquoy, Dautzenberg and Dollfus, 1883 is mentioned in POWELL (1966) who describes the shell, operculum and radula and refers that this genus has species from the European Miocene and Pliocene and also Recent from Europe and West Africa down to South Africa.

The introduction of scuba diving as a sampling technique in recent times along several areas of the West African coast where it had scarcely been used before has led to the availability of material from waters deeper than previously studied ones, bringing a number of interesting new species to the attention of malacologists. That happened in particular in São Tomé Island, a place characterised by the abundance of endemic species.

While studying the material collected by the second author by scuba diving in that island, the authors have identified a new species of *Haedropleura* which is described and illustrated in this paper.

Abbreviations:

MNHM Muséum national d'Histoire naturelle, Paris
MNCN Museo Nacional de Ciencias Naturales, Madrid
MNHN Muséum national d'Histoire naturelle, Paris
ZMB Zoologisches Museum, Berlin
CJH collection Juan Horro, Vigo
CPR collection of Peter Ryall, Maria Rain
CSG collection Sandro Gori, Livorno
s shell collected empty

---

* Montero Rios 30-3°, 36201 Vigo, Spain; juanhorro@telefonica.net
** Via Semesi, 7, 57123, Livorno, Italy; sandrogori@fastwebnet.it
*** Museo de Historia Natural, Campus Universitario Sur, 15782 Santiago de Compostela, Spain; erolan@emiliorolan.com

TAXONOMIC PART

Family TURRIDAE Swainson, 1840
Subfamily CRASSISPIRINAE Morrison, 1966
Genus *Haedropleura* Bucquoy, Dautzenberg and Dollfus, 1883

Type species (o. d.): *Pleurotoma septangularis* Montagu, 1803

Haedropleura ryalli spec. nov. (Figs. 1-7)

Type material: Holotype (Figs. 1-2) in MNHN (22883). One paratype (Figs. 3, 4) in MNCN (15.05/53578, 1 s) from type locality. Other paratypes from Minerio Reef, São Tomé, 00° 23′ 01.6″ N, 06° 46′ 22.8″ E, 41 m, in the following collections: MHNS (1 s), CSG (4 s), CJH (1 s), CPR (2 s).

Other material examined: 1 fragment, Minerio, São Tomé (MHNS).

Type locality: Lagoa Azul "Fundão", 36 m, São Tomé.

Etymology: Named after our colleague and friend Peter Ryall, who was the first to call our attention to the singularity of these shells.

Description: Shell (Figs. 1-6) fusiform rhomboid, elongate and solid with a high spire. Protoconch (Fig. 7) with about 1 $^1/_4$ whorls, with a diameter between 500 and 650 µm, placed in an oblique position, the nucleus not situated at the apex.

Teleoconch of the holotype with 4 ½ convex whorls, each one having 7-8 prominent and thick axial ribs which go from suture to suture without any subsutural rib or smooth area, and are mostly aligned with those of the following whorl. Ribs becoming thinner and somewhat s-shaped on the last whorl. Suture deep and sinuous. Last whorl representing 65/70% of total shell height. Spiral sculpture formed by very fine and numerous striae on the whole surface, which pass over the axial ribs, extend down to the base and cover also the outer lip. Aperture oval elongate, with an evident parietal callus and smooth columella; siphonal canal short and wide; outer lip very much thickened. Background coloration light cream, with a dark brown subsutural band below which there are irregular and interrupted spiral lines of the same colour; in the middle of the body whorl these lines tend to form another broad band; lower base and mouth almost white.

Dimensions: The holotype is 5.7 mm; the paratypes measure from 5.6 to 6.2 mm.

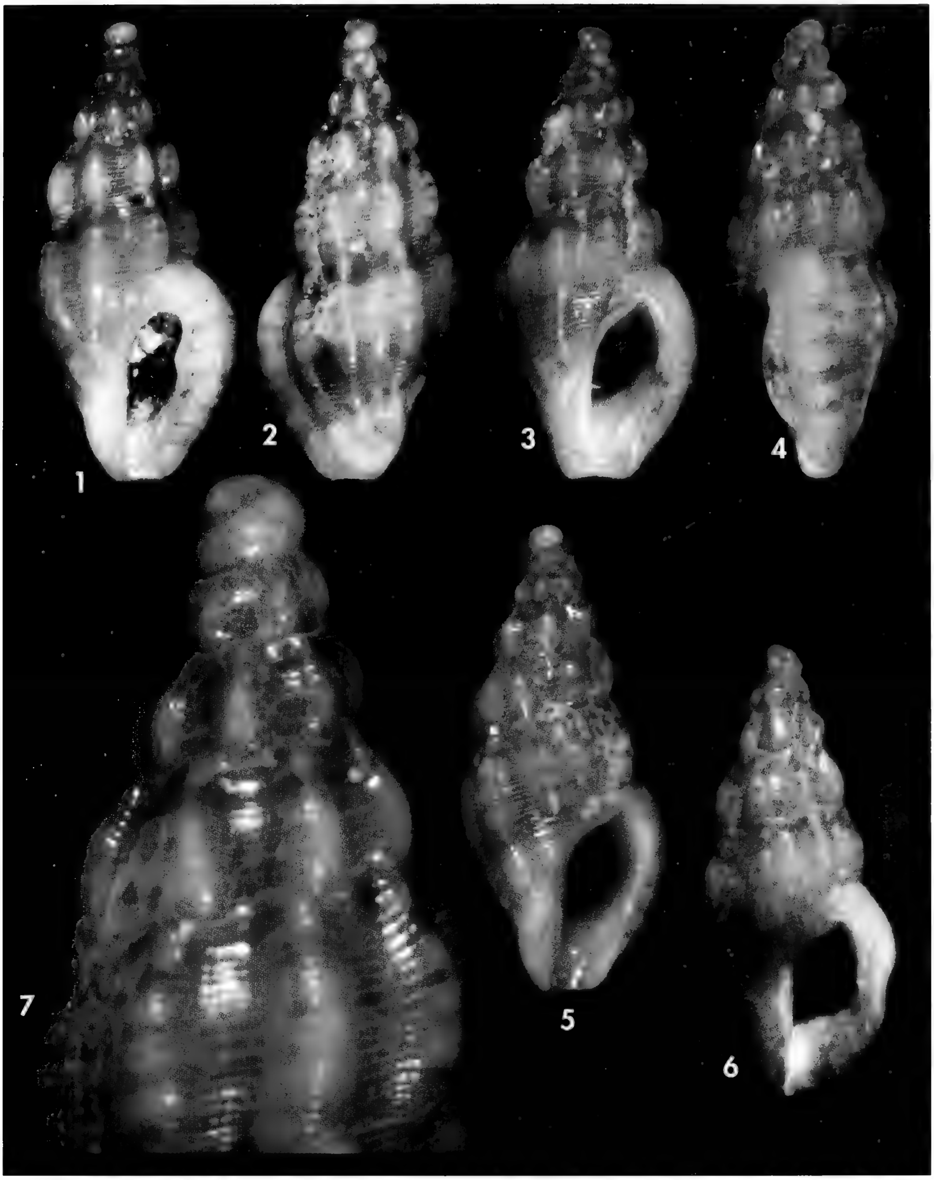
Animal: Not studied.

Distribution: Only known from the two mentioned locations in São Tomé Island, from which we suppose it to be endemic. So far it has not been found in the closeby Príncipe Island, although material from this island available for study, from similar depths, has been scarce so far.

Remarks: Although the generic placement of this new species in the genus *Haedropleura* must be considered a tentative assignation, due to the lack of soft parts, it seems clear from a conchological perspective, because it presents a shape and micro sculpture typical of this genus.

Specially after the introduction of the genus *Anacithara* Hedley, 1922, for west african fauna (HORRO, RYALL AND ROLÁN, 2010), we are aware of the close relationship between these two genera. These can only be certainly separated using radular characters, according to KILBURN (1994) with whom we agree this point. It must be noted that *H. ryalli* shows the spiral sculpture of finer and numerous spiral striae which is typical of *Haedropleura*, instead of more distant incised grooves present in *Anacithara* and that it also presents a larger and different protoconch.

It must also be remembered that genus *Bellaspira* Conrad, 1868 has sometimes been considered as a senior



Figures 1-7. *Haedropleura ryalli* spec. nov. 1, 2: holotype, 5.7 mm, Lagoa Azul (MNHN); 3, 4: paratype, 5.7 mm, Lagoa Azul (MNCN); 5: paratype, 6.1 mm, Minerio (CSG); 6: paratype, 5.8 mm, Minerio (CPR); 7: protoconch of the holotype.
Figuras 1-7. Haedropleura ryalli *spec. nov. 1, 2: holotipo, 5,7 mm, Lagoa Azul (MNHN); 3, 4: paratipo, 5,7 mm, Lagoa Azul (MNCN); 5: paratipo, 6,1 mm, Minerio (CSG); 6: paratipo, 5,8 mm, Minerio (CPR); 7: protoconcha del holotipo.*

synonym of *Haedropleura*, but GIANNUZZI-SAVELLI AND PUSATERI (1986) have already solved this question, showing conchological and radular differences between both genera and concluding that *Bellaspira* species is restricted to the Caribbean and Panamic provinces, while the appropriate genus for European species is *Haedropleura*.

There is great confusion regarding the genus *Haedropleura* in Eastern Atlantic and Mediterranean waters and a general revision of the genus is very much needed, especially for West African waters. Recently MICALI (2010) referring only to Mediterranean species, shows three different ones and calls them *H. septangularis*, *H. secalina* (Philippi, 1844) and *H. flexicosta* Monterosato, 1884. It is not the aim of this paper to start on such a revision, which, at least in Atlantic waters, would include more species and should include information on the types. However, we must state that *Haedropleura ryalli* sp. nov. is easy to separate from all other European and West African *Haedropleura* species due to its unique protoconch. This does not appear on any other species of this genus, even in those with paucispiral protoconchs such as *H. secalina* and *H. flexicosta* mentioned by MICALI (2010), or such as the one figured by NORDSIECK (1977: 75, plate 1, nº 8) under the genus name *Bellaspira*, which are clearly larger, with a more flattened top and does not show the typical position of the nucleus of *H. ryalli*. The constant pattern of *H. ryalli* which is not found in specimens from other locations also confirms its valid specific status.

ACKNOWLEDGEMENTS

We are grateful to the Department of Genetics of the University of Vigo for their help with photography, and to Dr. S. Gofas, editor of Iberus who made important suggestions for this paper.

BIBLIOGRAPHY

GIANNUZI-SAVELLI R. AND PUSATERI F. 1986. Ripristino validitá del taxon generico *Haedropleura* Monterosato in B.D.D., 1883 (Mollusca: Gastropoda). *Lavori, Società Italiana di Malacologia, 22,* Atti Congreso Palermo 13-16 sett 1984: 163-168.

HORRO J., RYALL P. AND ROLÁN E. 2010. *Anacithara* (Conoidea, Turridae) a new genus to West Africa. *Gloria Maris*, 49 (1): 14-22.

KILBURN R.N. 1988. Turridae (Mollusca: Gastropoda) of southern Africa and Mozambique, Part 4. Drilliinae, Crassispirinae and Strictispirinae. *Annals of the Natal Museum*, 29 (1): 167-320.

KILBURN R.N. 1994. Turridae [s. l.] (Mollusca: Gastropoda) of southern Africa and Mozambique. Part. 7. Subfamily Crassispirinae, section 2. *Annals of the Natal Museum*, 35: 177-228.

MICALI P. 2010. Nota sul genere *Haedropleura* B.B.D., 1883 nel Mediterraneo. *Malacologia Mostra Mondiale*, 67: 3-5.

NORDSIECK F. 1977. *The Turridae of the European Seas*. Rome, La Piramide. 131 pp.

POWELL A.W.B. 1966. The Molluscan families Speightiidae and Turridae. *Bulletin of the Auckland Institute and Museum*, 5: 1-184, 23 pls.

© Sociedad Española de Malacología —————— *Iberus*, 28 (2): 5-21, 2010

Ultrastructural study of oogenesis in the African mussel, *Perna perna* (Bivalvia: Mytilidae)

Estudio ultraestructural de la ovogénesis en el mejillón africano, *Perna perna* (Bivalvia: Mytilidae)

Soumya BENOMAR*, Oum Keltoum BELHSEN**, Michel MATHIEU** and Abdellatif MOUKRIM*

Recibido el 15-IV-2010. Aceptado el 7-X-2010

ABSTRACT

Transmission electron microscopy of female gonads in *Perna perna* (Mytilidae) was carried out to study the fine structure of the different developmental stages during oogenesis and to examine the functions of the follicular cells. The gonad is composed of acini, each containing oogoniae and oocytes surrounded by follicular cells, and of an interacinar connective tissue with vesicular cells. Groups of primary oogoniae, surmounted by secondary oogoniae, were found along the inner wall of each acinus. Previtellogenesis of oocytes was characterized by a great increase of these cells in volume, the accumulation of numerous organelles, and the formation of the first yolk granules at the end of this phase. The period of vitellogenesis involved both autosynthetic and heterosynthetic pathways, and was marked by the accumulation of cortical granules and of yolk granules. Numerous lipid droplets (two types), several inclusions resulting from the heterosynthetic uptake of exogenous substances by pinocytosis, and droplets showing two types of electron-lucent materials in the cytoplasm of mature oocytes could also be observed. In the atretic ovocytes, a vacuolization progressively developed in their cytoplasm, with the subsequent rupture of the vitelline membrane and the release of oocyte remnants in the lumen of the acinus. At the end of vitellogenesis, the follicular cells became detached from the oocyte and contained numerous lipid droplets and glycogen inclusions. In *P. perna*, the formation of female gametes was mostly similar to the oogenesis described in other species of bivalvia. The only difference concerned the composition of the yolk in the mature oocyte, as it was constituted of several endogenous substances (lipoproteins mainly) and also of exogenous materials intaken by the oocyte via pinocytosis.

RESUMEN

Las gónadas femeninas en *Perna perna* (Mytilidae) se observaron por microscopía electrónica de transmisión para estudiar la estructura fina de las diferentes etapas de desarrollo durante la ovogénesis y examinar las funciones de las células foliculares. La gónada está formada por acinos, cada uno de ellos conteniendo oogonias y ovocitos rodeados por células foliculares, y por un tejido conectivo interacinar con células vesiculares. Grupos de oogonias primarias, a los que se sobreponen oogonias secundarias, se encuentran a lo largo de la pared interna de cada acino. La previtelogénesis de los ovocitos se caracterizó por un gran aumento de volumen en estas células, por la acumulación de

---

* Laboratory Aquatic Ecosystems : Marine and Continental Field, Biology Department, Sciences Faculty, Ibn Zohr University, BP 8106, 80000, Agadir, Morocco. e-mail: moukrim@univ-ibnzohr.ac.ma.
** Laboratory Marine Biology and Biotechnology, I. B. B. A., Caen University, France.

numerosos orgánulos y por la formación de los primeros gránulos de vitelo al final de esta fase. El período de vitelogénesis implica ambas vías autosintética y heterosintética y se caracteriza por la acumulación de gránulos corticales y de los gránulos de vitelo. En el citoplasma de los ovocitos maduros, se observaron también numerosas gotitas de lípidos (de dos tipos), varias inclusiones resultando de la absorción heterosintética de sustancias exógenas por pinocitosis, así como gotitas con dos tipos de materiales electrón lúcidas. En los ovocitos atrésicos, una vacuolización se desarrolló progresivamente en su citoplasma, con la posterior ruptura de la membrana vitelina y la liberación de los restos de ovocitos en el lumen de los acinos. Al final de la vitelogénesis, las células foliculares se desprendían del ovocito y contenían numerosas gotitas de lípidos y inclusiones de glucógeno. En *P. perna*, la formación de gametos femeninos fue muy similar a la ovogénesis descrita en otras especies de bivalvos. La única diferencia se refiere a la composición del vitelo en el ovocito maduro, ya que está constituido por varias sustancias endógenas (lipoproteínas, principalmente), así como por materiales exógenos absorbidos por el ovocito, mediante pinocitosis.

INTRODUCTION

The African mussel: *Perna perna*, is a worldwide species (Berry, 1978; Hicks , Tunnell and McMahon, 2001a). However, the studies performed on the biology of this mussel only concerned its reproductive cycles, as there was an intraspecific variability in the reproduction. Indeed, in the South African populations of *P. perna*, two main spawning periods between April and October, and several minor and scarcer spawning events after October were reported by Berry (1978) and Lasiak (1986). By contrast, in other *Perna* populations from the same country, Schurink and Griffiths (1991) found a single prolonged spawning period along the year, with spawning activity every month. In the Gulf of Mexico, three spawning periods with one extended and two discrete events in spring or summer were described by Hicks, Tunnell and McMahon (2001) and Hicks, McMahon and Ingrao (2001). In view of this variability in reproductive cycles, it was useful to study gametogenesis in local populations of *P. perna*.

As *P. perna* lives along the southern Atlantic coasts of Morocco, a research programme was carried out to determine the spawning episodes of these local mussels and to analyse the characteristics of their gametogenesis. A first histological study (Id Halla, Bouhaimi, Zekhnini, Narbonne, Mathieu and Moukrim, 1997) demonstrated a single spawning period along the year, with a major event in spring, and this work was completed by ultrastructural studies on spermatogenesis in the same Moroccan population of *P. perna* (Benomar, Belhsen, Goux, Mathieu and Moukrim, 2007). The main aim of the present paper is to describe the ultrastructural stages of female gamete formation and of oocyte degeneration in *P. perna*. The follicular cells and their function are also examined.

MATERIALS AND METHODS

Samples of five mussels each (3-4 cm long) were collected in December 1999, January, March, June and July 2000 from the mid-tide level at Cap Ghir (50 km north of Agadir town). Small portions of female gonad (1-3 mm^3 each) were fixed for 60 min in 2% glutaraldehyde (0.4 M sodium cacodylate buffer, pH 7.2) at 4°C. The tissue was then washed in 0.4 M cacodylate buffer (3 x 10 min) and postfixed for 90 min in 1% osmium tetroxyde (in 0.4 M cacodylate buffer) at 4°C. After dehydration through a gradual ethanol series, the tissue was directly embedded in Epon resin at 37 °C for 60 min and was subsequently

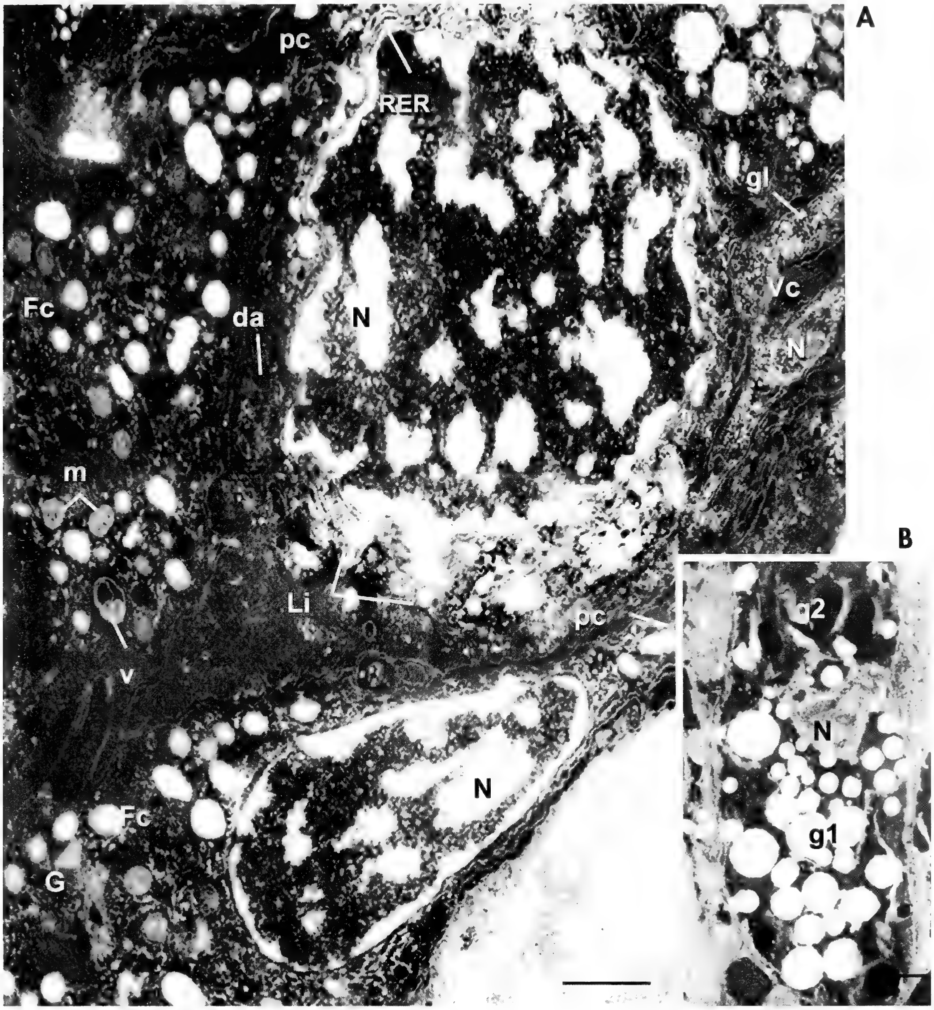


Figure 1. A. Primary oogonia (Og) and follicular cells (Fc) of *Perna perna*, along the inner side of the acinar wall. Some vesicular cells (Vc) were located along the outer side. da, dense aggregates; G, Golgi apparatus; gl, glycogen; Li, lipid droplets; m, mitochondria; N, nucleus, RER, rough endoplasmic reticulum; pc, cytoplasmic projections of follicular cells; v, vacuoles. B. Interacinar vesicular cells showing two types of granules (g1, and g2). Scale bars, 2 µm.

Figura 1. A. Oogonia primaria (Og) y células foliculares (Fc) de Perna perna, *sobre el lado interno de la pared acinar. Algunas células vesiculares (Vc) se ubicaron en el lado externo. da, agregados densos; G, Aparato de Golgi; gl, glucógeno; Li, gotitas de lípidos; m, mitocondria; N, núcleo, RER, retículo endoplasmático rugoso; pc, proyecciones citoplasmáticas de células foliculares; v, vacuolas. B. Células vesiculares interacinares mostrando dos tipos de gránulos (g1, and g2). Escalas, 2 µm.*

placed at room temperature during the following 12 hours. Semi-thin sections of each gonad portion were stained at room temperature with 0.5% toluidine blue in 2.5% Na_2CO_3. Ultrathin sections were collected on copper grids and were stained for 20 min with uranyl acetate, followed by lead citrate for 5 min. Sections were examined using a Siemens 102 electron microscope.

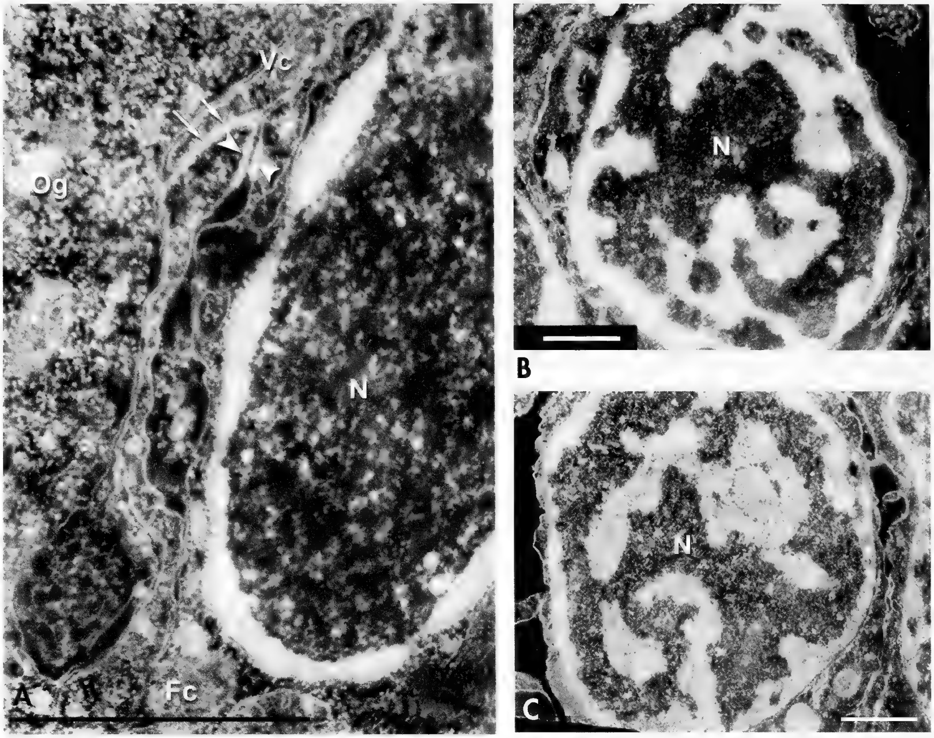


Figure 2. Oogoniae of *Perna perna*. A. Zonula occludens (arrows) and zonula adherens (arrow heads) between an oogonia (Og), a follicular cell, and a spindle-shaped cell. B-C. Nuclei of two oogoniae in metaphasis (first meiotic division). Scale bars, 2 µm.

Figura 2. Oogonias de Perna perna. *A. Zonula occludens (flechas) y zonula adherens (puntas de flecha) entre una oogonia (Og), una célula folicular, y una célula fusiforme. B-C. Núcleos de dos oogonias en metáfase (primera división meiótica). Escalas, 2 µm.*

Different measurements for each cell stage of ovogenesis (a least of 10 cells per stage) were also performed. Individual values recorded for each measurement and each cell stage were averaged.

RESULTS

Numerous acini, surrounded by connective tissue and an external ciliated epithelium, constituted each gonad (Fig. 1A). Along the inner side of each acinar wall, the different developmental stages of oogenesis, from oogoniae up to the first stages of the first meiotic division, could be easily observed. All of them were surrounded by follicular cells and spindle-shaped cells containing glycogen inclusions (Fig. 1A). In the interacinar connective tissue, other vesicular cells, each containing two types of granules, were found (Fig.1B). Along the outer side of the acinus, several muscular fibers were sometimes observed (Fig. 3A).

Oogoniae: Groups of primary oogoniae (primordial cells), each constituted by 2 or 4 cells, were found along the inner side of each acinar wall (Fig. 1A, B). Follicular cells characterized by their cytoplasmic extensions were close to these cell groups. The primary oogoniae were round or elongated, measured 5 to 8 mm in size, and were characterized by a high nucleo-cytoplasmic ratio. They were interconnected by zonulae occludens and zonulae adherens (Fig. 2A). Their nuclei (3-6 µm) contained small

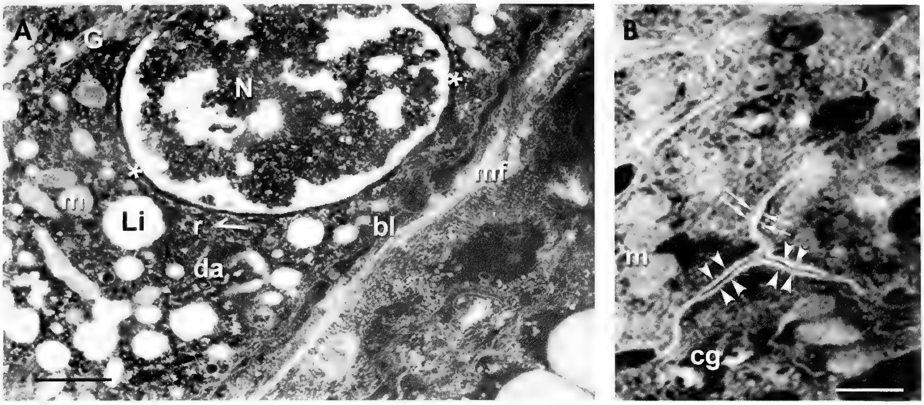


Figure 3. Previtellogenic oocyte of *Perna perna*. A. Early previtellogenic oocyte. The nucleus (N) showed a wide perinuclear cisterna (*) and is positioned near the basal lamina (bl) of the acinus. G, Golgi apparatus; Li, lipid droplets; m, elongated mitochondria; mf, muscular fibers; r, ribosomes. B. Late previtellogenic oocyte. Zonula occludens (double arrows) and zonula adherens (arrow heads) between one oocyte and two follicular cells. Scale bars, A: 1 µm; B: 0.2 µm.

Figura 3. Ovocitos previtelogénicos de Perna perna. *A. Ovocito previtelogénico temprano. El núcleo (N) presentaba una cisterna perinuclear (*) ancha y se sitúa cerca de la lámina basal (bl) del acino. G, Aparato de Golgi; Li, gotitas de lípidos; m, mitocóndria alargada; mf, fibras musculares; r, ribosomas. B. Ovocito previtelogénico tardío. Zonula occludens (flechas dobles) y zonula adherens (puntas de flecha) entre un ovocito y dos células foliculares. Escalas, A: 1 µm; B: 0,2 µm.*

patches of chromatin. In several cells, the chromatin formed a thin border along the inner side of the nuclear envelope, a single or two nucleoli could be observed, and the nuclear envelope was indented. Numerous ribosomes, spherical mitochondria, some cisternae of endoplasmic reticulum, several lipid droplets with no membrane, and membrane-bounded dense vesicles were found in the cytoplasm (Figs. 1-2).

The secondary oogoniae measured 5 to 6 µm in size, and the diplotene stages of the first meiotic division (Fig. 2B, C) were easily recognizable in their voluminous nuclei (4.5-5.5 µm). However, synaptonemal complexes were not found in these nuclei. These cells contained the same organelles as described for primary oogoniae.

Previtellogenic oocytes: The early previtellogenic oocytes (Fig. 3A) were connected together and to follicular cells via zonulae occludens and zonulae adherens (Fig. 3B). They were round or elongated, with irregular outlines, and their size ranged from 9 to 15 µm. Their cytoplasm was more voluminous than that of oogoniae and was increased by the addition of ribosomes, of often elongated mitochondria, and of smooth or rough endoplasmic reticulum (ER). Several vacuoles around the Golgi apparatus could be observed. Their nucleus became elongated, with scattered chromatin and a thicker nuclear envelope, showing a clearly wider perinuclear cisterna and the presence of ribosomes along the outer side of the outer nuclear membrane.

At a later stage (Fig. 4A-E), the oocytes were elongated and their size reached up to 18 µm. Their nuclei became irregular, multilobulated, and were eccentrically positioned. Numerous pores through both membranes of the nuclear envelope could be seen and the nucleolus was often in an eccentric position. At the same time, dense aggregates with no membrane appeared in the cytoplasm, near the nucleus. The rough ER increased in size and some

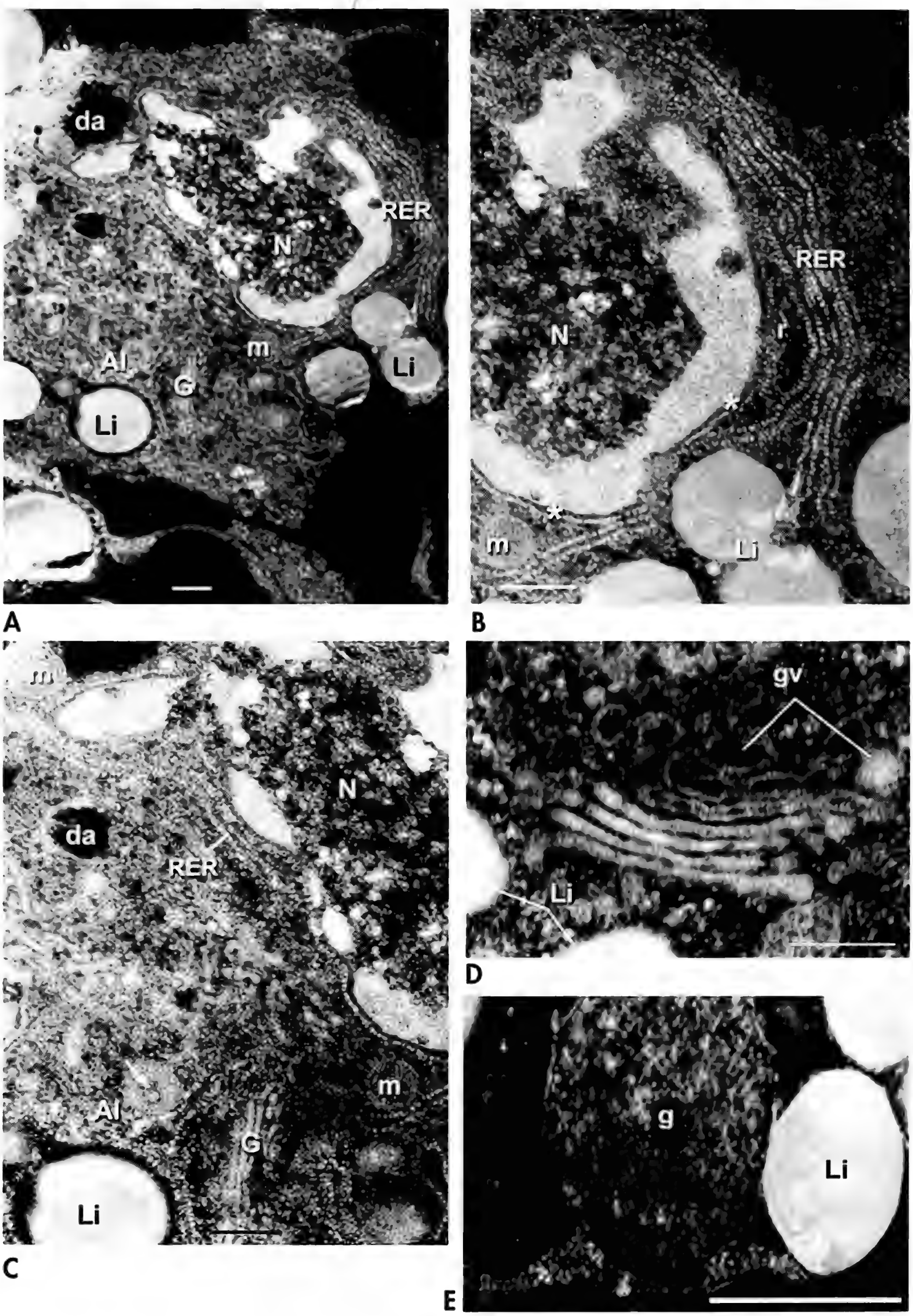


Figure 4 A-E. Late previtellogenic oocytes of *Perna perna*. Al, annulate lamellae; da, dense aggregates; G, Golgi apparatus with a vesicle (gv): g, granule; Li, lipid droplets; m, mitochondria; N, nucleus; RER, rough endoplasmic reticulum; arrow, yolk granule. Scale bars, 1 µm.

Figura 4 A-E. Ovocitos previtelogénicos tardíos de Perna perna. *Al, laminillas anulares; da, agregados densos; G, Aparato de Golgi con una vesícula (gv): g, gránulo; Li, gotitas de lipidos; m, mitocóndria; N, núcleo; RER, retículo endoplasmático rugoso; flecha, gránulo de vitelo. Escalas, 1 µm.*

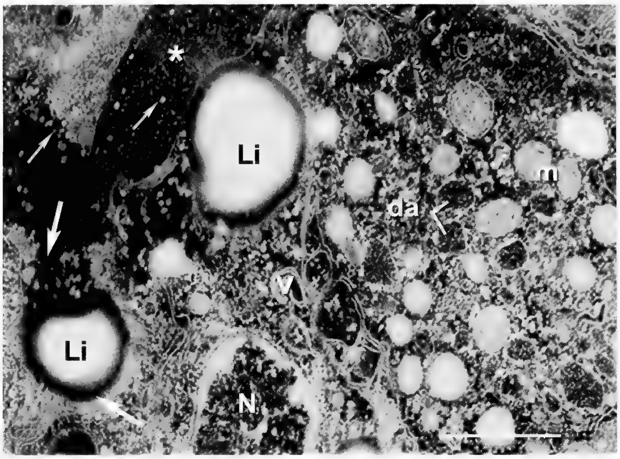


Figure 5. Pinocytosis vesicle (large arrow) with a lipid droplet and glycogen particles (small arrows). *, glycogen deposit in a spindle-shaped cell. Zonula occludens (double arrows) and zonula adherens (arrow heads) between one oocyte and two follicular cells. Scale bar, 1 µm.

*Figure 5. Vesícula de pinocitosis (flecha grande) con una gotita de lípidos y partículas de glucógeno (flechas pequeñas). *, depósito de glucógeno en una célula fusiforme. Zonula occludens (flechas dobles) y zonula adherens (puntas de flecha) entre un ovocito y dos células foliculares. Escala, 1 µm.*

lipid vesicles became bigger in its vicinity. In close proximity, elongated granules containing a dense granular material were sometimes observed. Lamellar structures of ER and the first yolk granules appeared near the Golgi apparatus (Fig 4C). In the basal part of the ooplasm and particularly in the zones of contact between the oocyte and its surrounding cells (follicular cells, and spindle-shaped cells), some pinocytosis vacuoles, each containing lipid droplets and several deposits probably of glycogen, could be seen (Fig. 5).

Vitellogenic oocytes: Their development within the gonad can be arbitrarily divided into four stages, from A the youngest, to D the oldest. Each early vitellogenic oocyte (A stage) kept contact with the acinar wall by cytoplasmic projections (Fig. 6A, B) and was surrounded by follicular cells which are apically connected by desmosome-like junctions. Measuring 30 µm in size, this oocyte contained an elongated nucleus (9 µm) with a very dense nucleolus. In the zone of attachment of the oocyte with the acinar wall, and particularly in cytoplasmic projections, some cisternae of rough ER could be observed. Several microvilli appeared on the outer surface of the apical oolemma (Fig. 6A). At a later stage in vitellogenesis (B stage), the nucleus became spherical and increased in size (Fig. 6C). The nucleolus was in an eccentric position and was surrounded by an electron-lucent material, while the nucleoplasm was constituted by moderately dense patches of heterochromatin and scattering euchromatin. A previtelline space was forming between the apex of the oocyte and the surrounding follicular cells, and an amorphous electron-lucent material, originating from the oocyte, settled into this space between the numerous apical microvilli formed by the oolemma. Progressively, this previtelline space extended along the lateral sides of the oocyte and the microvilli became coated by the amorphous material. Concurrently, there was an increase in the number of saccules forming the Golgi apparatus and in the number of mitochondria (mainly in the attachment zone of the oocyte) (Fig. 6A). The rough ER greatly increased in volume and showed circular lamellae, surrounded by numer-

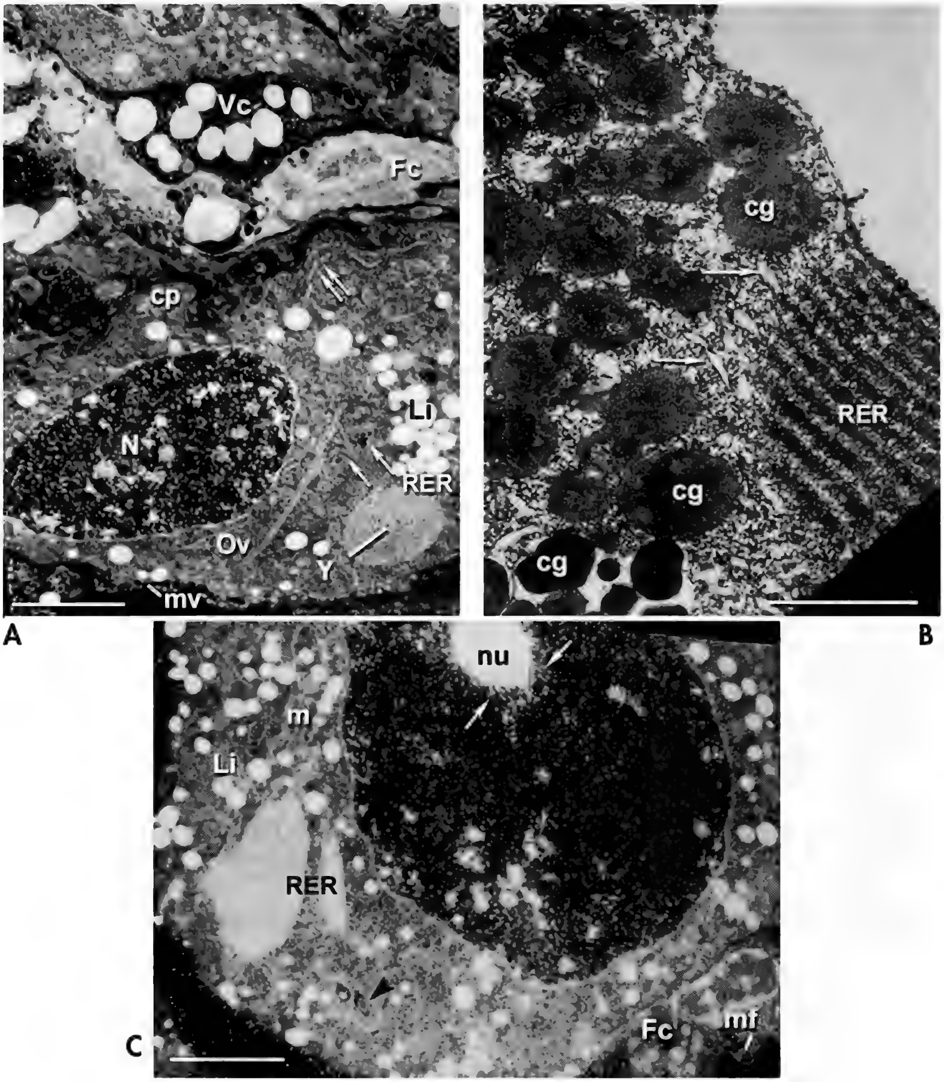


Figure 6. Vitellogenic oocytes of *Perna perna*. A. A-stage oocytes, with cytoplasmic projections (cp) and microvilli (mv) developing at the apex of cells. Flattened rough ER cisternae (RER) were positioned near the nucleus or in cytoplasmic projections (cp). A ring of rough ER surrounded a yolk granule (Y). Li, lipid droplets; arrow head, a Balbiani's body. B. cortical granules (cg) near several cisternae of rough ER (arrows). C. B-stage oocytes. Their nucleolus (nu) was in an eccentric position and was surrounded by an electron-lucent nuclear material (arrows). A myelin-like figure (mf) in a follicular cell can be observed. Flattened cisternae of rough ER were located in the vicinity of the nucleus. Scale bars, A, C: 2 µm; B: 1 µm.

Figura 6. Ovocitos vitelogénicos de Perna perna. *A. Ovocitos de estadio A, con proyecciones citoplasmáticas (cp) y microvellosidades (mv) desarrollandose en el ápice de las células. Cisternas aplanadas del RE rugoso (RER) eran situadas cerca del núcleo o en proyecciones citoplasmáticas (cp). Un anillo de RE rugoso rodeaba un gránulo de vitelo (Y). Li, gottas de lípidos; punta de flecha, un cuerpo de Balbiani. B. gránulos corticales (cg) cerca de varias cisternas de RE rugoso (flechas). C. Ovocitos de estadio B. Su nucleolo se situaba en posición excéntrica y era rodeado por un material electrón lúcido del núcleo (flechas). Se puede observar una figura parecida con mielina (mf) en una célula folicular. Algunas cisternas aplanadas de RE rugoso se situaban en las inmediaciones del núcleo. Escalas, A, C: 2 µm; B: 1 µm.*

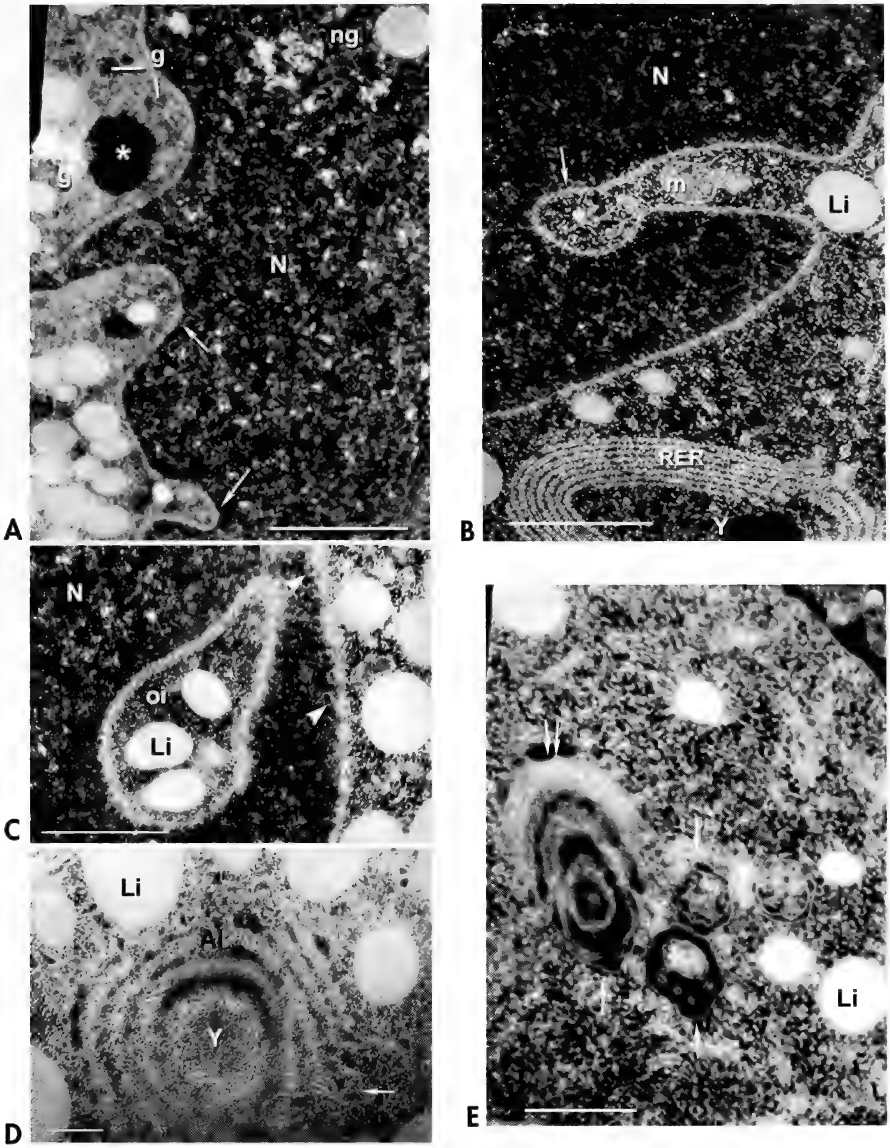


Figure 7. Vitellogenic oocytes of *Perna perna*. A-E. C-stage oocytes showing cytoplasmic indentations (oi, or arrows) in their nuclei. g, granules located in the ooplasm; Li, lipid droplets; *, a dense granule with no membrane. See also an electron-lucent patch (ng) in the nucleus (in A), a yolk granule (Y) surrounded by a ring of rough ER (in B), the presence of numerous pores (arrow heads) through the nuclear envelope (in C), that of annulate lamellae (Al) surrounding a yolk granule (in D), and Balbiani's vitelline bodies (arrows) near cisternae of rough ER (double arrow) (in E). Scale bars, A, B: 5 µm; C-E: 1 µm.
Figura 7. Ovocitos vitelogénicos de Perna perna. *A-E. Ovocitos de estadio Cmostrando indentaciones citoplasmáticas (oi, o flechas) en sus nucleos. g, gránulos situados en el ooplasma; Li, gotitas de lipidos; *, a gránulo densosin membrana. Nótese también una mancha electron lúcida (ng) en el núcleo (en A), un gránulo de vitelo (Y) rodeado por un anillo de RE rugoso (en B), la presencia de numerosos poros (puntas de flecha) atravesando la membrana nuclear (en C), la de laminillas anulares (Al) rodeando un gránulo de vitelo (en D), así como los cuerpos vitelinos de Balbiani (flechas) cerca de cisternas del RE rugoso (flechas dobles) (en E). Escalas, A, B: 5 µm; C-E: 1 µm.*

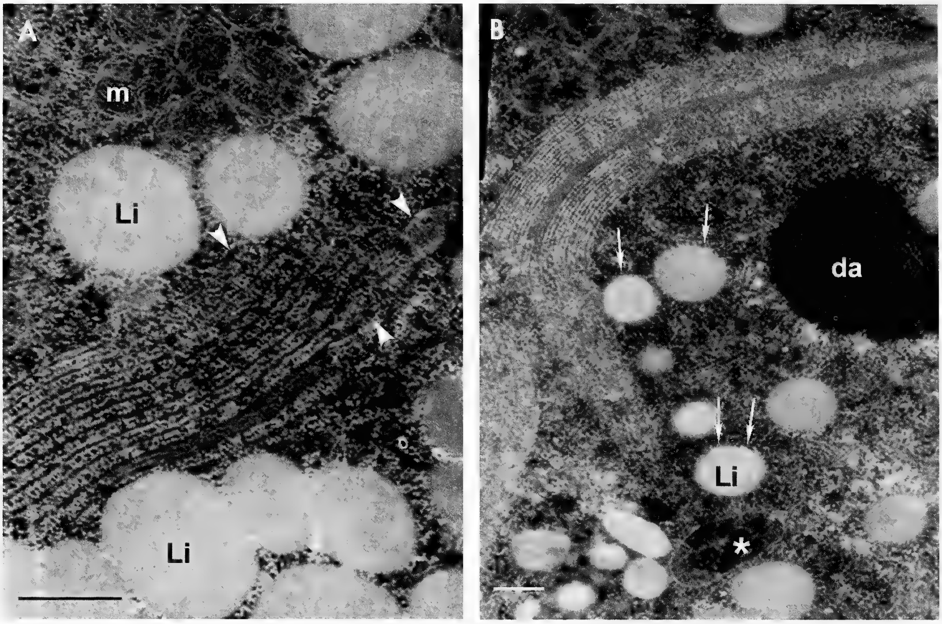


Figure 8. Vitellogenic oocytes (D stage) of *Perna perna*. A-B. Different shapes of the rough ER, with a proliferation of lipid droplets near mitochondria (m) and rough ER cisternae (arrow heads). da, dense granules; arrows, glycogen particles linked to lipid droplets; *, cortical granules (in B). Scale bars, 1 µm.

Figura 8. Ovocitos vitelogénicos (estadio D) de Perna perna. *A-B. Distintas formas del RE rugoso, con proliferación de gotitas de lípidos cerca de una mitocóndria (m) y cisternas del RE rugoso (puntas de flecha). da, gránulos densos; flechas, partículas de glucógeno ligadas a gotitas de lípido; *, gránulos corticales (en B). Escalas, 1 µm.*

ous lipid vesicles. Some cortical granules (Fig. 6B) limited by an undulating membrane, each containing a thin granular material (probably of glycoproteinic origin), were also observed near the rough ER and the Golgi apparatus. They are formed by an autosynthetic way from these organelles. They became progressively denser and were localized at the periphery of the oocyte.

The mature oocytes (C stage) reached 70 mm in size (Fig. 7A-E), while their shape became pedunculate. They were connected to follicular cells by zonulae occludens and zonulae adherens. In their nuclei (30 mm), the ring- or crescent-shaped nucleolus was dense and in an eccentric position, while numerous pores through the nuclear envelope could be observed. Deep cytoplasmic indentations (Fig. 7A-C) could be seen in the nucleus, each containing membrane-bounded lipid droplets and other dense granules with no membrane. The microvilli and the amorphous material constituted a vitelline membrane, which became detached later from the oocyte and thus created a dense perivitelline space between the oocyte and the vitelline membrane. The lamellae of rough ER (Figs. 6-8) were of variable forms (annulate, circular, ovoid, flattened, or crescent-shaped) and were often positioned near the nucleus. The C oocytes contained the same organelles as described for B cells. However, four other structures, often positioned in the vicinity of the rough ER and mitochondria, could be noted. First, membrane-bound lipid vesicles (0.8 mm) became larger via their fusion (Fig. 9A). Secondly, other lipid inclusions (0.5 mm)

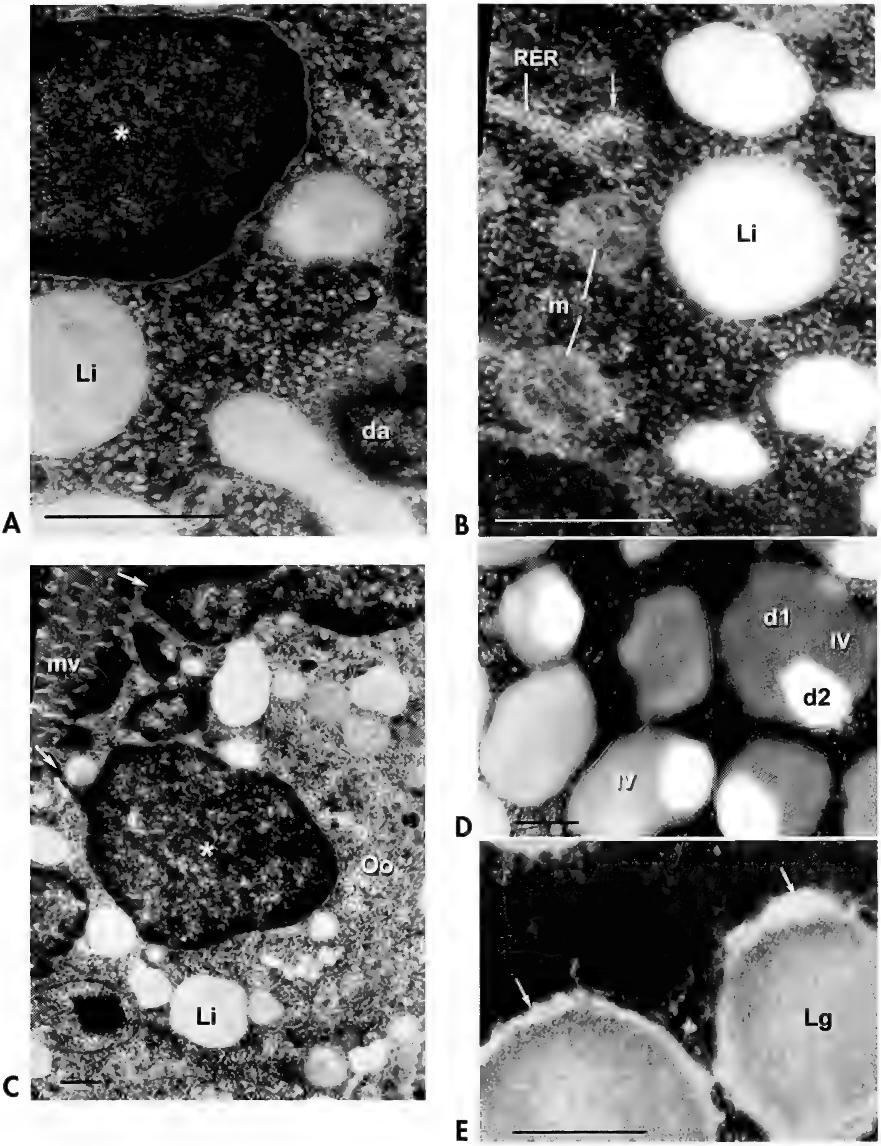


Figure 9 A-E. Vitellogenic oocytes (D stage) of *Perna perna*, different types of granules. See the single membrane-bounded lipid (Li) droplets (in A), several lipid inclusions with no membrane, near mitochondria (m) and cisternae of rough ER (in B), some membrane-bounded inclusions containing a granular material (*) and resulting from pinocytosis at the periphery of the ooplasm (arrow) (in A and C), several electron-lucent granules (IV), each showing two zones of different densities (d1, and d2) (in D), lipid droplets, each linked to a particle of glycogen (arrows) (in E, see also Fig. 8B). Scale bars, 1 µm.
Figura 9 A-E.. Ovocitos vitelogénicos (estadio D) de Perna perna, *distintos tipos de gránulos. Nótense las gotitas de lípidos delimitadas por una membrana sencilla (Li) (en A), varias inclusiones de lípidos sin membrana, cerca de mitocondrias (m) y cisternas de RE rugoso (en B), algunas inclusiones delimitadas por membranas, conteniendo material granular (*) y resultando de pinocitosis a la periferia del ooplasma (flecha) (en A y C), varios gránulos electrón lucidos (IV), cada uno con dos zonas de densidad diferente (d1 y d2) (in D), gotitas de lípidos, cada uno ligado a una partícula de glucógeno (flechas) (en E, véase también Fig. 8B). Escalas, 1 µm.*

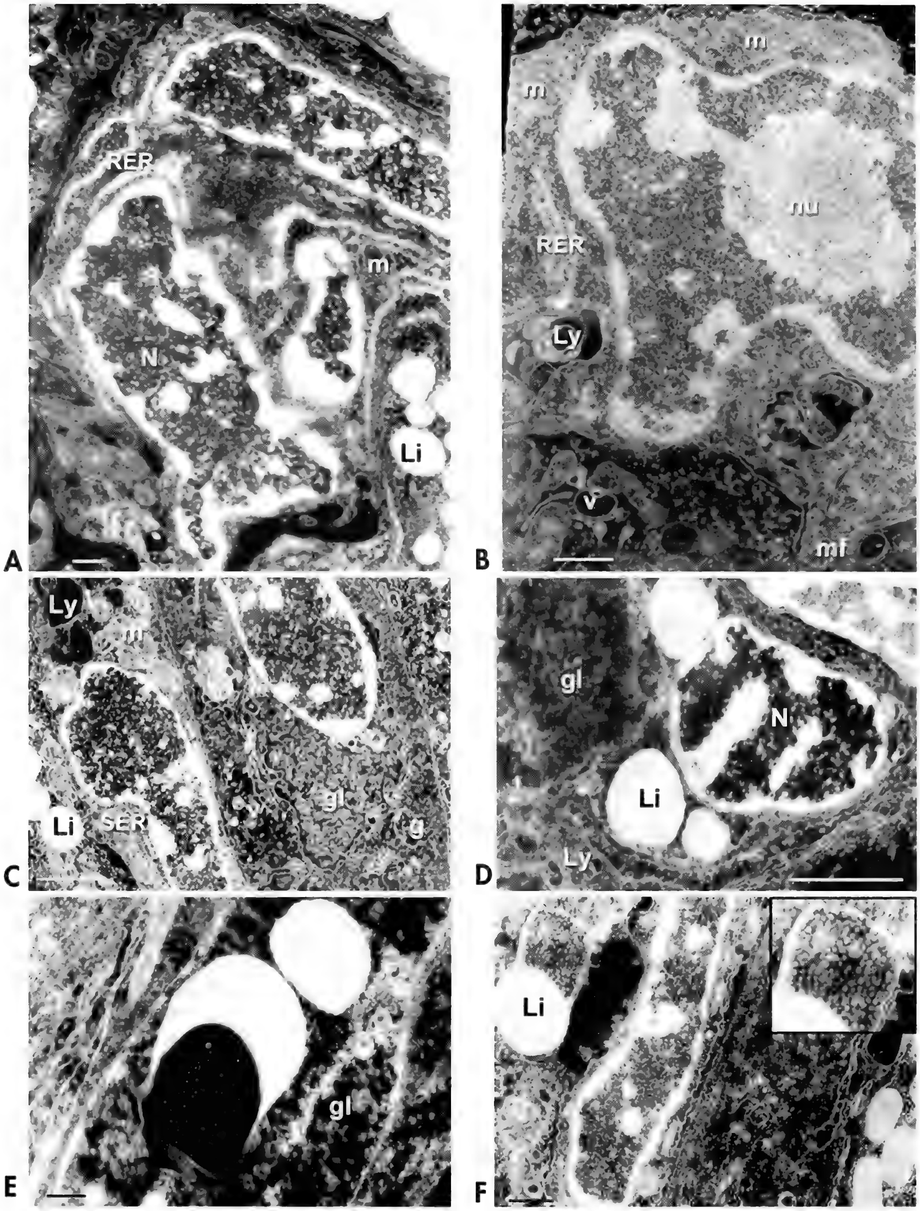


Figure 10. Follicular cells of *Perna perna*. A-F. Irregularly-shaped nuclei. g, granules; gl, particles of glycogen; Li, lipid droplets; Ly, lysosomes; m, mitochondria; mf, myelin-like figures; N, nucleus; nu, nucleolus; RER, cisternae of rough ER; SER, smooth ER. See also lipid droplets in the follicular cells (in D), the presence of granules with two type of electron-lucent materials (in E), and a single inclusion containing a lipid droplet and several glycogen particles forming a rosette (in F). Scale bars, A, B, E: 1 µm; C, D: 5 µm.

Figura 10. Células foliculares de Perna perna. *A-F. Núcleos con forma irregular. g, gránulos; gl, partículas de glucógeno; Li, gotitas de lípidos; Ly, lisosomas; m, mitocóndria; mf, figuras con aspecto de mielina; N, núcleo; nu, nucleolo; RER, cisternas del RE rugoso; SER, RE liso. Nótense también gotitas de lípidos en las células foliculares (en D), la presencia de gránulos con dos clases de materiales electrón lucidos (en E), y una inclusión aislada conteniendo una gotita de lípido y varias partículas de glucógeno formando una roseta (en F). Escalas, A, B, E: 1 µm; C, D: 5 µm.*

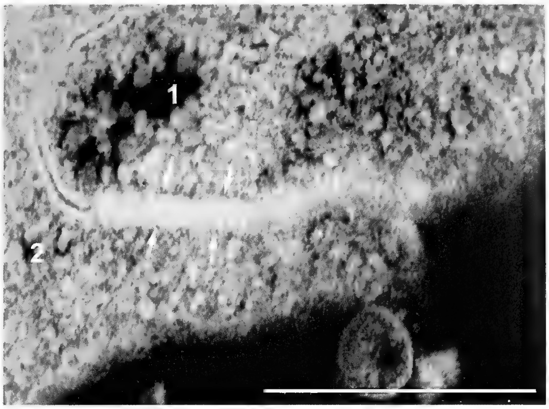


Figure 11. Septate desmosome (arrows) between two follicular cells of *Perna perna*. Scale bar, 1 µm.
Figura 11. Desmosoma septado (flechas) entre dos células foliculares de Perna perna. *Escala, 1 µm.*

with no membrane and showing a denser peripheral condensation (Fig. 9B) could be observed. Thirdly, membrane-bound inclusions (Fig. 9C), containing a granular material generally denser at their periphery, resulted from pinocytosis in the periphery of the ooplasm at the end of vitellogenesis. These last granules, which resulted from material extracellular endocytosis contained thin glycogen particles and were different from the cortical granules, described in the late previtellogenic oocytes. Lastly, some granules contained two granular materials, the first being more electron-lucent than the other (Fig. 9D). All these types of inclusions acted in the formation of yolk. Ringed lamellae, probably deriving from the rough ER, surrounded a big yolk granule or several smaller vesicles sometimes with several mitochondria, and developed in the vicinity of lipid droplets (Fig. 7E). They corresponded to Balbiani's vitelline bodies (PIPE, 1987).

In spite of their polyhedral shape, the D oocytes (postvitellogenic oocytes) were deformed by the presence of other oocytes in the lumen of the acinus. The nuclear envelope showed numerous pores and was very indented, while the ring- or crescent-shaped nucleolus was in an eccentric position. Numerous cortical granules, numerous regular yolk vesicles of variable density, and some glycogen deposits linked to lipid droplets (Fig. 9E) were found. In several zones of the cytoplasm, are stacks of rough ER parallel lamellae.

Follicular cells: During previtellogenesis, each oocyte was completely surrounded by small and irregularly-shaped follicular cells (Fig. 10A-D). Each of these last cells contained a big nucleus, of variable form, and projected cytoplasmic extensions into the lateral part of the oocyte. The follicular cells were interconnected together by septate desmosomes (Fig. 11). Their cytoplasm also contained numerous stacks of rough ER cisternae (or annulate lamellae), a smaller zone of smooth ER, numerous mitochondria, well-developed lysosomes, multivesicular bodies, myelin-like figures, and small single or clumped granules of glycogen, sometimes linked to lipid droplets (Fig. 10F). Some other inclusions, each containing a dense material and another more lucent (Fig. 10E), were also present near lipid droplets. The peripheral part of their cytoplasm also contained some pinocytosis vesicles, each containing a lipid droplet and/or a glycogen granule (Fig. 5). When the oocyte was at the B stage of vitellogenesis, the follicular cells became detached from the apex of the oocyte, which bulged freely into the acinar lumen and became pedunculate, as it was still attached to the inner wall of the acinus. At the C stage of vitellogenesis, the follicular cells were reduced to their basal part and, finally, became completely detached from the oocyte.

In the spaces between the follicular cells and the spindle-shaped cells, free particles of glycogen were frequently observed, particularly during previtellogenesis (Fig. 5).

DISCUSSION

The female gamete formation in *P. perna* was similar to that described in other bivalvia, such as *Brachidontes vigiliae* (BERNARD, DAVIES AND HODGSON, 1988), *Crassostrea virginica* (ECKELBARGER AND DAVIS, 1996), *Mytilus edulis* (ALBERTINI, 1985; PIPE 1987), *Pecten maximus* (DORANGE AND LE PENNEC, 1989), *Pinctada margaritifera* (THIELLEY, 1993), or *Pinna nobilis* (GAULEJAC, HENRY AND VICENTE, 1995). The accumulation of ribosomes and the presence of numerous nuclear pores in previtellogenic oocytes indicated a great synthesis of proteins and an increased transport of material. The perinuclear dense aggregates present in the cytoplasm of these oocytes might correspond to extruded nucleolar material (especially ribonucleoproteins), as described by several authors (ALBERTINI, 1985; DORANGE AND LE PENNEC, 1989; THIELLEY, 1993; GAULEJAC *ET AL.*, 1995). The presence of mitochondria in the stalk of the previtellogenic oocyte suggested a transfer of material. However, the present study did not allow us to observe microtubules in this stalk, such as described in the previtellogenic oocyte of *Pinna nobilis* (GAULEJAC *ET AL.*, 1995), or in that of *Anodonta* (BEAMS AND SEKHON, 1966).

In the vitellogenic oocytes, the growth of cytoplasm in volume was mostly due to the accumulation of inclusions. Among them, the cortical granules were found during all stages of vitellogenesis and this finding agreed with the report by GAULEJAC *ET AL.* (1995) in *Pinna nobilis*. The nature of their contents can only be speculated upon based on morphological investigations. However, evidence for a glycoproteinic content is recognized in oocytes of most bivalve species (e.g. ALBERTINI, 1985; GAULEJAC *ET AL.*, 1995). According to PIPE (1987), the number of these cortical granules might increase via their division. The formation of these cortical granules involved the synthesis of yolk materials by the proteosynthetic organelles of the oocyte. This autosynthetic-type formation has been described in some molluscan species (DE JONG-BRINK, BOER AND JOOSSE, 1983; MEDINA, GARCIA, MORENO AND LOPEZ-CAMPOS, 1986). The production of yolk appears to involve the collaboration of Golgi complexes and RER, as these organelles were observed in close association with yolk bodies, as observed in several mollusc species (ECKELBARGER AND DAVIS, 1996; ECKELBARGER AND YOUNG, 1997). The other types of inclusions found in mature oocytes warrant special comment. First, the two types of lipid droplets, i.e. small inclusions with no membrane and bigger, membrane-bound inclusions, recorded in *P. perna* might correspond to two successive stages in the formation of these lipids via the action of smooth ER, of Golgi apparatus, of mitochondria, and of Balbiani's bodies (DE JONG-BRINK *ET AL.*, 1983). Thus, in the caenogastropod *Colus stimpsoni*, WEST (1983) reported that lipid formation derived from the autosynthetic activities of the oocyte via the endoplasmic reticulum. Secondly, the granules, observed at the C stage of vitellogenesis and containing two types of electron-lucent materials, have not been reported in the literature on bivalvia. To explain this last finding, the most likely hypothesis was to admit that their contents would be of lipoproteinic origin via the fusion of lipid droplets and of proteins originating from rough ER. Lastly, the inclusions resulting from pinocytosis at the end of vitellogenesis were also reported by several authors in other species of molluscs (WEST, 1981, 1983; DE JONG-BRINK *ET AL.*, 1983; ECKELBARGER AND BLADES-ECKELBARGER, 1989; ECKELBARGER AND YOUNG, 1997). Heterosynthetic process involved the Golgi complex and RER on the one hand, and endocytosis of extracellular material on the other hand, so that lipid reserves would be produced by the oocyte and glycogen would be endocytosed (WEST, 1981,1983). In fact, in *P. perna*, the inclusions might originate, either from spindle-shaped cells, which contained glycogen deposits, or from interacinar vesicular cells, which had two types of granules. As free glycogen particles could be seen in the intercellular spaces between the oocyte, the follicular, and the spindle-shaped cells, it might be hypothesized that the free particles would be pinocytosed by the cytoplasm of the vitellogenic oocyte, or by that of follicular cells. Yolk synthesis in *P. perna* was similar to that described in other molluscs species (WEST, 1983; ECKELBARGER AND YOUNG, 1997). However, this massive intake of exogenous substances in the ooplasm was probably not the single way for the formation of yolk. Indeed, the presence of glycogen particles, linked to lipid droplets, in the ooplasm suggested that they might form lipid-carbohydrate complexes, as those described in the oocytes of *Mytilus edulis* (ALBERTINI, 1985). Another way in *P. perna* might be the direct transformation of mitochondria into yolk granules, as reported in the oocytes of many bivalve species (GAULEJAC *ET AL.*, 1995).

The formation of the vitelline membrane occurred during the B and C stages of vitellogenesis, and the material constituting it originated from the oocyte (e.g. PIPE, 1987), the follicular cells (DORANGE AND LE PENNEC, 1989), or both. A part of this material might be composed of the contents of cortical granules, as ALBERTINI (1985) noted the release of mucus from these granules in the vitelline membrane surrounding the oocyte of *Mytilus edulis*. The results noted in the present study indicated the material constituting the vitelline membrane was produced by the oocyte. Our results agreed with those of WOURMS (1987) on the fact that electron microscopy reveals both microvilli and an extracellular coat in the overwhelming majority of invertebrate oocytes.

The ultrastructural changes noted in the atretic oocytes of *P. perna* were similar to those noted in other species of bivalvia, even though the outcome of reserves in *P. perna* was different. The accumulation of yolk granules constituted a dense mass, which is released in the lumen of the acinus, and this oosorption allowed the turn over of nutrients to assure the energetic needs for the bivalve basal metabolism (HOUTTEVILLE, 1974). Another way for re-using oocyte remnants in *P. perna* was constituted by the epithelial cells bordering the gonoducts, as that reported by PIPE (1987) in *Mytilus edulis*, and also by the follicular cells (see the review by DE JONG-BRINK *ET AL.*, 1983).

Some reports were already performed on the relationship between the follicular cells and the maturation of oocytes in bivalvia. The presence of follicular cells completely surrounding the young oocyte and their detachment from it in later stages were already reported in many species (e.g. BERNARD *ET AL.*, 1988; GAULEJAC *ET AL.*, 1995) and this finding underlined the important role of these cells in the growth of oocytes, and their nutrition (DE JONG-BRINK ET AL., 1983). Owing to their organelles, the follicular cells had the capacity to participate in the synthesis of many substances and to phagocytose materials originating from atretic or degenerating oocytes. The exogenous substances, which are intaken by the oocyte of *P. perna* during vitellogenesis via pinocytosis, might originate from the secretions of these follicular cells. The capacity of these last cells to phagocytose the remnants of oocytes in *P. perna* is reflected by the presence of their well-developed lysosomes and of deposits of lipid and glycogen deposits in their cytoplasm. It is possible that products originating from atretic oocytes permitted a transfer of precursors necessary for the vitellogenesis of other developing oocytes, and the synthesis and storage of lipid and glycogen inclusions which can be used later for vitellogenesis, as suggested by GAULEJAC *ET AL.*

(1995) in *Pinna nobilis*. According to West (1983), the follicular cells synthesiz-ed glycogen and the oocytes sequestered it through an endocytotic process.

The studies made by Id Halla *et al.* (1997) on the gonad of *P. perna* demonstrated the presence of a single type of reserve cells. However, in the present work, lipid droplets and inclusions of glycogen were present in reserve cells, so that further studies are necessary to determine if different types of reserve cells exist in the gonad of *P. perna* or if the cell found in the present study shows different cellular stages which succeed in relation to the reproductive cycle of *P. perna*.

In conclusion, the formation of female gametes in *P. perna* was greatly similar to the oogenesis described in other species of bivalvia and particularly in Mytilidae. The only difference concerned the composition of the yolk in the mature oocyte, as it was constituted of several endogenous substances (lipoproteins mainly) and also of exogenous materials intaken by the oocyte via pinocytosis. In *P. perna*, vitellogenesis combined both autosynthetic and heterosynthetic processes, and involved the Golgi complex and RER on the one hand, and endocytosis of extracellular material on the other hand. Further studies are necessary to investigate the composition of vitelline granules in the oocytes using cytochemical methods and transmission electron microscopy.

ACKNOWLEDGEMENTS

The authors are grateful to Ms. A.M. Renou and Mr. D. Goux for the realization of ultrathin sections and Mr. J.L. Herblot for photographic services.

BIBLIOGRAPHY

Albertini L. 1985. *Recherches cytologiques et expérimentales sur l'ovogénèse chez la moule, (*Mytilus edulis *L., mollusque bivalve)*. Doctoral thesis, University of Caen, 147 p.

Beams H.W. and Sekhon S.S.1966. Electron microscope studies on the oocyte of the fresh-water mussel (*Anodonta*), with special reference to the stalk and mechanism of yolk deposition. *Journal of Morphology*, 119: 477-502.

Benomar S., Belhsen O.K., Goux D., Mathieu M. and Moukrim A. 2007. Ultrastructural studies on the spermatogenesis of the African mussel *Perna perna* (Bivalvia: Mytilidae). *Iberus*, 26(2): 1-14.

Bernard R.T.F., Davies B.R. and Hodgson A.N. 1988. Reproduction in a brackish-water mytilid: gametogenesis and embryonic development. *The Veliger*, 30: 278-290.

Berry P.F. 1978. Reproduction, growth, and production in the mussel *Perna perna*, on the east coast of South Africa. *Investigational Reports of the Oceanography Research Institute*, Durban, 48: 1-28.

de Jong-Brink M., Boer H.H. and Joosse J. 1983. Mollusca. Chapter 14. In: Adiyodi KG, Adiyodi RG, (eds.). Reproductive biology of invertebrates. I. Oogenesis, oviposition, and oosorption, John Wiley and Sons, New York, pp. 297-355.

Dorange G. and Le Pennec M. 1989. Ultrastructural study of oogenesis and oocytic degeneration in *Pecten maximus* from the Bay of St. Brieux. *Marine Biology*, 103: 339-348.

Eckelbarger K.J. and Blades-Eckelbarger P.I. 1989. Structure of the ovotestis and evidence for hetero synthetic incorporation of yolk precursors in the oocytes of the nudibranch Mollusc, *Spurilla neapolitana*. *Journal of Morphology*, 201: 105-118.

Eckelbarger K.J. and Davis C.V. 1996. Ultrastructure of the gonad and gametogenesis in the eastern oyster, *Crassostrea virginica*. I. Ovary and oogenesis. *Marine Biology*, 127: 79-87.

Eckelbarger K.J and Young C.M. 1997. Ultrastructure of the ovary and oogenesis in the dmethane-seep mollusc *Bathynerita naticoidea* (Gastropoda: Neritidae) from the Louisiana slope. *Invertebrate Biology*, 116 (4): 299-312.

Gaulejac B. de, Henry M. and Vicente N. 1995. An ultrastructural study of gametogenesis of the marine bivalve *Pinna nobilis* (Linnaeus 1758). I. Oogenesis. *Journal of Molluscan Studies*, 61: 375-392.

Hicks D.W., Tunnell J.W. jr and McMahon R.F. 2001a. Population dynamics of the nonindigenous brown mussel, *Perna perna* (Linnaeus 1758), in the Gulf of Mexico compared to other world-wide populations. *Marine Ecology Progress Series*, 211: 181-192.

HICKS D.W., MCMAHON R.F. AND INGRAO D.A. 2001b. Two invasive mussels in the genus *Perna* in the Gulf of Mexico. In: Virtual Proceedings for the State of the Bay Symposium V, 31 January-2 February 2001. Texas Natural Resource Conservation Commission, Austin, Texas, pp. 159-170.

HOUTTEVILLE P. 1974. Contribution à l'étude cytologique et expérimentale du cycle du tissu de réserve du manteau de *Mytilus edulis*. Doctoral thesis, University of Caen.

ID HALLA M., BOUHAIMI A., ZEKHNINI A., NARBONNE J.F., MATHIEU M. AND MOUKRIM A. 1997. Etude du cycle de reproduction de deux espèces de moules *Perna perna* (Linné, 1758) et *Mytilus galloprovincialis* Lamarck, 1819 dans la baie d'Agadir (Sud du Maroc). *Haliotis*, 26: 51-62.

LASIAK T. 1986. The reproductive cycles of the intertidal bivalves *Crassostrea cucullata* (Born, 1778) and *Perna perna* (Linnaeus, 1758) from Transkei coast, Southern Africa. *The Veliger*, 29: 226-230.

MEDINA A., GARCIA J.C., MORENO F.J. AND LOPEZ-CAMPOS J.P. 1986. Comparative studies on the histology of the ovotestis in *Hypselodoris tricolor* and *Godiva banyulensis* (Gastropoda, Opistothobranchia), with special reference to yolk formation. *Journal of Morphology*, 186: 105-118.

PIPE R.K. 1987. Oogenesis in the marine mussel *Mytilus edulis*: an ultrastructural study. *Marine Biology*, 95: 405-414.

SCHURINK C.E. AND GRIFFITHS C.L. 1991. A comparison of reproductive cycle s and reproductive output in four Southern African mussel species. *Marine Ecology Progress Series*, 76: 123-134.

THIELLEY M. 1993. Etude cytologique de la gamétogenèse, de la sex-ratio et du cycle de reproduction chez l'huître perlière *Pinctada margaritifera* (L) var. *cumingii* (Jameson), (Mollusque, bivalves). Comparaison avec le cycle de *Pinctada maculata* (Gould). Doctoral thesis, Université Française du Pacifique, 233p..

WEST D.L. 1981. Reproductive biology of *Colus stimpsoni* (Prosobranchia: Buccinidae). IV. Oogenesis. *The Veliger*, 24: 28-38.

WEST D.L. 1983. Reproductive biology of *Colus stimpsoni* (Prosobranchia: Buccinidae). V. Nutritive egg formation. *The Veliger*, 25: 299-306.

WOURMS J.P. 1987. Oogenesis. In Giese A.C., Pearse J.S. and Pearse V.B. (Eds.): *Reproduction of marine Invertebrates*, Vol. IX, General aspects: seeking unity in diversity: 50-157. Blackwell Scientific Publications and Boxwood Press, Pacific Grove, California.

© *Sociedad Española de Malacología* ——— *Iberus*, 28 (2): 23-38, 2010

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

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

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

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

ABSTRACT

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

RESUMEN

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

INTRODUCTION

During the Spanish expedition Bentart-2006 for the study of Antarctic benthos to the Antarctic Peninsula and Bellingshausen Sea, a small collection of Mollusca Solenogastres was made. In the area of the Antarctic Peninsula and its adjacent islands some research had already been done regarding these Mollusca, with the result of about 30 described species, whereas the know-

---

* Estación de Bioloxía Mariña da Graña. Universidade de Santiago de Compostela. A Graña. 15590 Ferrol. Spain. ogarcia.alvarez@edu.xunta.es

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

ledge of the Solenogastres fauna in the Bellingshausen Sea is very poor, with only four known species (García-Álvarez and Urgorri, 2003a, b; García-Álvarez, Zamarro and Urgorri, 2009; Salvini-Plawen, 1978).

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

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

One of the greatest difficulties which hampers the study of Solenogastres is the scarcity of research material, as can be observed in most publications about this topic and as also happens in the study of the Bentart collection. It is very common to have only very few specimens available or even a single specimen for the characterization of the new species. This is due to the fact that a high percentage of the samples of Solenogastres come from studies directed to the knowledge of the general marine benthos, for which the sampling methods used are not the most appropriate for the collection of small-sized fauna. When the capture systems used while sampling are more appropriate for the study of meiofauna, as for example epibenthic sleds, the results are different. These sampling systems are being systematically used, both in the expeditions for the study of the Atlantic abyssal basin and in the expeditions we are carrying out off the northwest coast of Spain. In both projects, in which a priority objective is the knowledge of the deep-sea biodiversity, the results obtained in the collection of small fauna are very satisfactory and a large number of specimens of Solenogastres were collected (Gil-Mansilla, García-Álvarez and Urgorri, 2008, 2009).

MATERIAL AND METHODS

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

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

Order NEOMENIAMORPHA Salvini-Plawen, 1978
Family NEOMENIIDAE Ihering, 1876
Genus *Neomenia* Tullberg, 1875

Neomenia expleta sp. nov. (Figs. 1, 2)

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

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

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

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

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

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

Digestive system (Fig. 1C). The mouth opens into the atrium, which is provided with papillae arranged in bundles. Three regions can be distinguished lengthwise in the pharynx. The first one bears 2 to 4 dorsal folds with folded walls; one of these folds separates mediofrontally the mouth from the anterior part of the atrium and a ventral fold is separated from the ventral wall of the digestive tract by a cleft. The folds make this first region of the pharynx laterally narrow and form small lateral caeca. The pharynx is internally covered in this region with a thin cuticle that continues in the second pharyngeal region; all walls are folded and it lacks glands. It has no defined buccal tube and lacks a buccal sphincter. In the second region, the pharynx narrows dorsoventrally and lacks glands, frontally two caeca come out from it: a dorsoanterior one and a ventral one. In this area it has a dorsal wall without folds and with a very soft musculature, its ventral wall is folded and provided with a thick muscular layer; this ventral muscular layer becomes very weak posteriorly. The third region is characterized by presenting a strong sphincter and a folded interior wall, it opens frontally into the intestine, which it clearly penetrates. It lacks a radular system and ventral foregut glandular organs. The intestine has a short dorsoanterior caecum and a strong serial fold due to the dorsoventral musculature. Posteriorly, a pair of short ventrolateral caeca come out from the intestine; each of them surround a pair of copulatory stylets (Figs. 2E, F). The rectum is short and tubular; its interior wall is folded and ciliated. The anus opens dorsally on the frontal wall of the pallial cavity, flanked by respiratory folds.

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

Reproductive system (Fig. 1D) A pair of tubular and narrow gonads is located on both sides of the dorsal blood sinus, no oocytes are observed, but they present spermatozoids in the posterior part close to the pericardium; in this region the gonads are provided with some small ventrolateral pouches, in which spermatozoids can be observed and which can be interpreted as seminal vesicles. The pericardium is voluminous and contains a very large heart joined to the pericardium wall only through its anterior and posterior ends; the heart is divided into two parts, a ventricle and an auricle. The pericardioducts come out ventrolaterally from the posterior part of the pericardium, they consist of a pair of narrow and internally folded ducts that run ventrolaterally to the pericardium and the digestive duct and present a pair of small seminal vesicles almost spherical (Fig. 2C) with spermatozoids, before joining the spawning ducts. The pair of spawning ducts is narrow and sinuous, not very glandular and come out dorsolaterally and separately into a ventral genital pouch of the pallial cavity (Fig. 2B). Each spawning duct has a narrow and sinuous seminal receptacle, located in the opening area of the pericardioducts into the spawning ducts as well as a spawning duct gland with glandular epithelium that comes out into the medial area of the spawning duct.

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

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

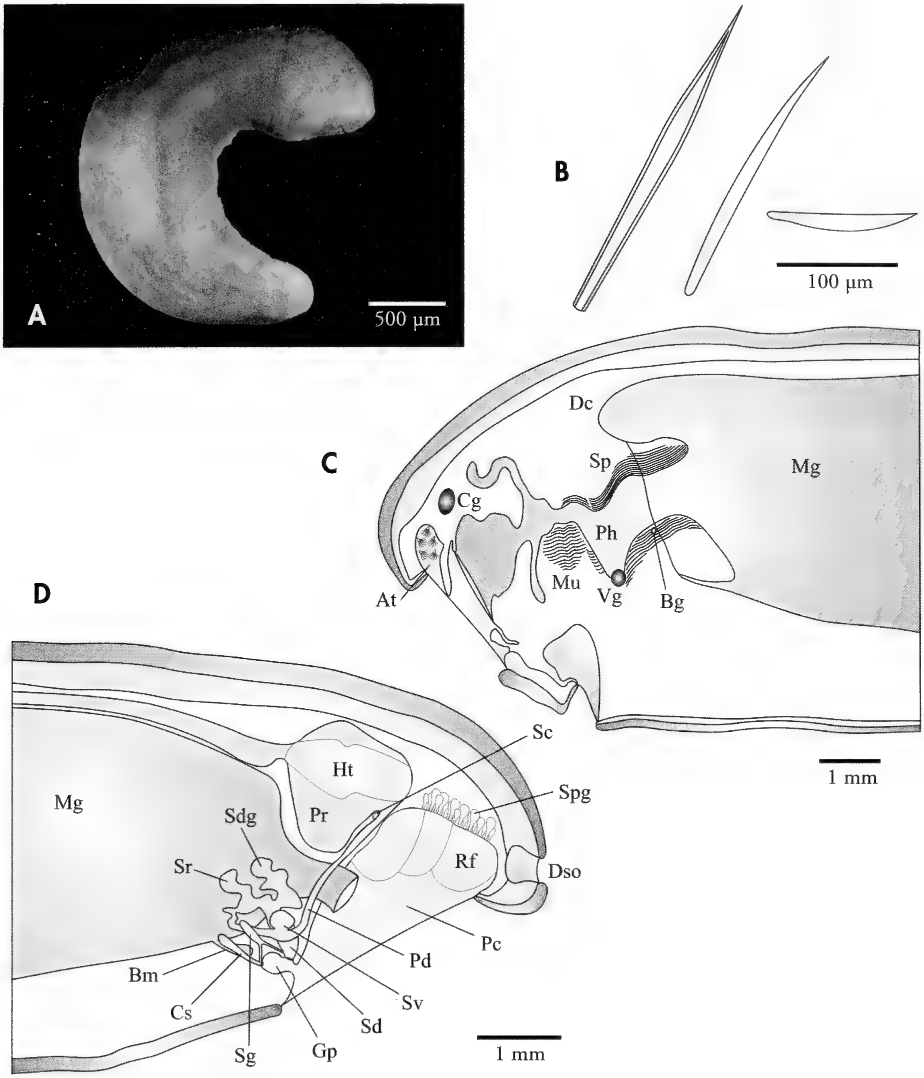


Figure 1. *Neomenia expleta* sp. nov. A: habitus; B: mantle sclerites; C: schematic organization of the anterior body; D: schematic organization of the posterior body. Abbreviations, At: atrial sense organ; Bg: buccal ganglion; Bm: posterior caecum of midgut; Cg: cerebral ganglion; Cs: copulatory stylet; Dc: dorsal caecum; Dso: dorsoterminal sense organ; Gp: genital pouch; Ht: heart; Mg: midgut; Mu: musculature; Pc: pallial cavity; Pd: pericardioduct; Ph: pharynx; Pr: pericardium; Rf: respiratory folds; Sc: suprarectal commissure; Sd: spawning duct; Sdg: spawning duct gland; Sg: copulatory stylet gland; Sp: sphincter; Spg: suprapallial gland; Sr: seminal receptacle; Sv: seminal vesicle; Vg: ventral ganglion.
Figura 1. Neomenia expleta *sp. nov. A: habitus; B: escleritos del manto; C: esquema de la organización de la parte anterior del cuerpo; D: esquema de la organización de la parte posterior del cuerpo. Abreviaturas, At: órgano sensitivo atrial; Bg: ganglio bucal; Bm: ciego posterior del intestino; Cg: ganglio cerebral; Cs: estilete copulador; Dc: ciego dorsal; Dso: órgano sensitivo dorsoterminal; Gp: bolsa genital; Ht: corazón; Mg: intestino; Mu: musculatura; Pc: cavidad paleal; Pd: pericardioducto; Ph: faringe; Pr: pericardio; Rf: pliegues respiratorios; Sc: comisura suprarrectal; Sd: conducto de desove; Sdg: glándula del conducto de desove; Sg: glándula del estilete copulador; Sp: esfínter; Spg: glándula suprapaleal; Sr: receptáculo seminal; Sv: vesícula seminal; Vg: ganglio ventral.*

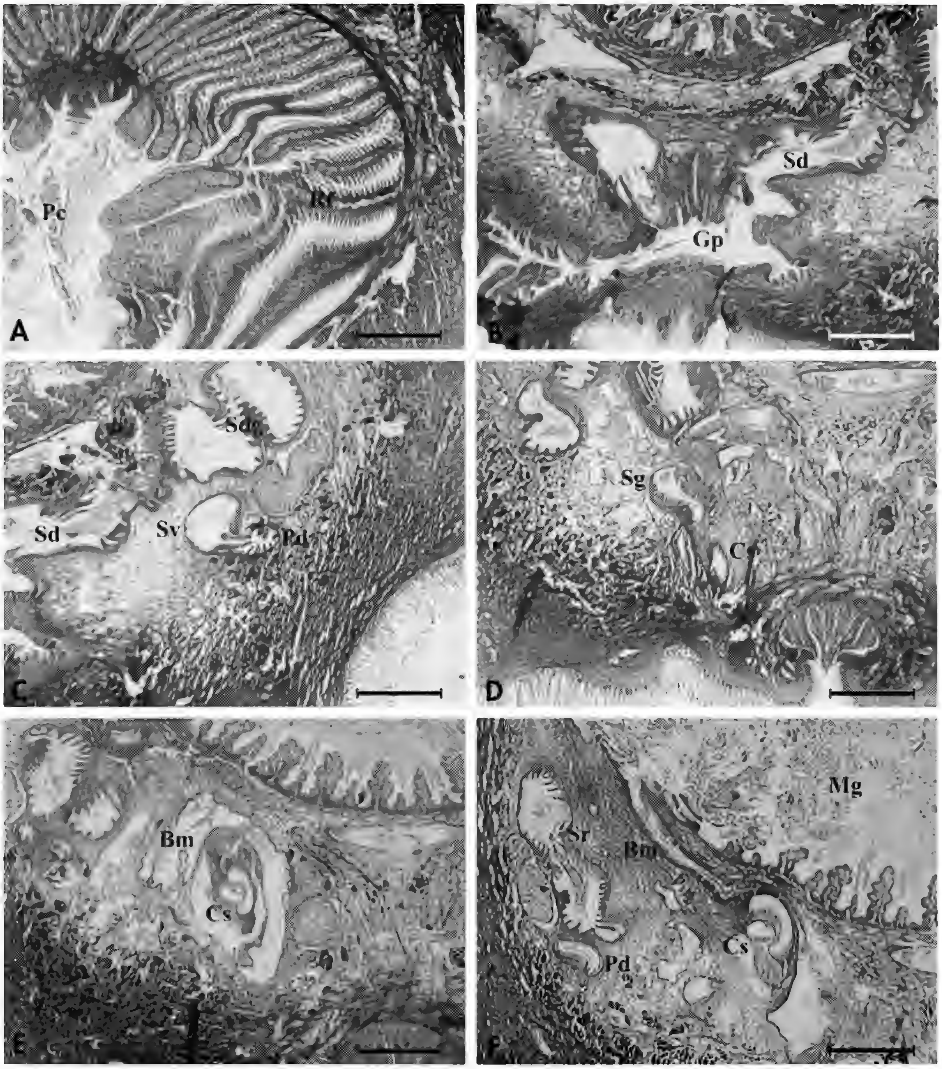


Figure 2. *Neomenia expleta* sp. nov. A: respiratory folds; B: spawning duct opening; C: seminal vesicle; D: copulatory stylet gland; E: copulatory stylet; F: posterior caecum of midgut. Abbreviations, Bm: posterior caecum of midgut; Cs: copulatory stylet; Gp: genital pouch; Mg: midgut; Pc: pallial cavity;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

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

1875, *N. labrosa* Salvini-Plawen, 1978, *N. trapeziformis* Salvini-Plawen, 1978, *N. megatrapezata* Salvini-Plawen and Paar-Gausch, 2004 and *N. trivialis* Salvini-Plawen and Paar-Gausch, 2004); lacking distally spear-shaped sclerites (having

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

	Phyllomenia	*Harpagoherpia*	*Lituiherpia*	*Ocheyoherpia*	*Plicaherpia* gen.nov.
Acicular sclerites	+	+	+	+	+
Paddle-shaped sclerites	+	-	+	+	+
Hook-shaped sclerites	-	-	+	+	+
Groove-shaped scales	-	-	-	-	+
Atrio-buccal oppening	Separated	Separated	Common	Common	Common
Midgut constrictions	+	-	+	+	+
Gonoducts	+	-	-	-	-
Genital oppening	Paired	Unpaired	Unpaired	Unpaired	Unpaired
Genital papilla	-	-	-	-	+
Copulatory stylets	+	-	-	+	-
Copulatory stylets gland	-	-	-	+	-
Cammera pallial cavity	One	One	One	One	Two
Respitary organs	-	-	-	-	+
Dorsoterminal sense organ	-	+	-	-	-

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

Five species of the genus *Neomenia* can be found in the same biogeographical range (García-Álvarez and Urgorri, 2003a; Salvini-Plawen, 1978, 2006), Antarctic Peninsula and adjacent islands, together with *Neomenia expleta* sp nov.. These are *N. labrosa* Salvini-Plawen, 1978; *N. laminata* Salvini-Plawen, 1978; *N. monolabrosa* Salvini-Plawen, 2006; *N. megatrapezata*; and *N. trivialis*. Each of these species has a series of characteristics that clearly distinguish them from *Neomenia expleta* sp nov.

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

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

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

N. megatrapezata (South Shetland Islands, 640-670 m deep) can reach 18 cm long and has 4 well-marked longitudinal ridges; it possesses an anterior cleft in the lateral pharynx, 4 foregut regions and lacks a midgut caecum; the opening of the spawning duct is unpaired; it has prepallial spines and genital papilla and has neither seminal vesicles nor suprapallial glands (SALVINI-PLAWEN, 2006).

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

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

Phyllomenia sp. (Figs. 3, 4)

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

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

Mantle. The cuticle is thin, 30-40 mm thick in the lateral areas of the body and 50-60 mm thick in the dorsal area, with several layers of interwoven tangential sclerites. Five types of sclerites can be seen (Fig. 3B): solid acicular with pointed distal end and rounded proximal end slightly sigmoid (200 mm long x 15 mm wide); narrow solid paddle-shaped sclerites (230 mm long x 15 mm wide); wide solid paddle-shaped sclerites (200 mm long x 32 mm wide). Both types of solid paddle-shaped sclerites are abundant in the ventral area on both sides of the pedal groove; elongated and wide scales with a very pointed distal end and a straight proximal one (100 mm long x 30 mm wide) located above all in its anterior end, atriobuccal cavity and pedal groove; blade-shaped scales (75 mm long x 13 mm wide).

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

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

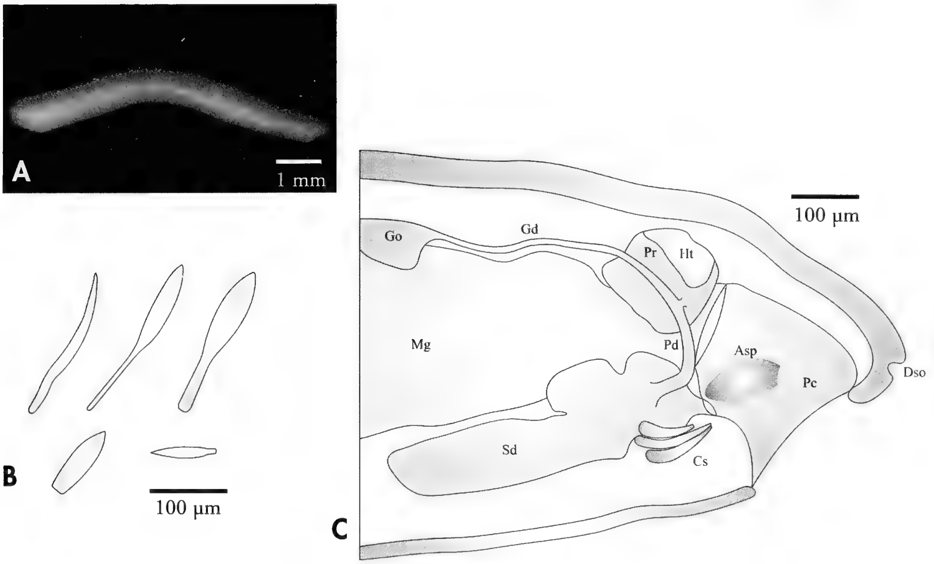


Figure 3. *Phyllomenia* sp. A: habitus; B: mantle sclerites; C: schematic organization of the posterior body. Abbreviations, Asp: Abdominal spicules pouch; Cs: copulatory stylet; Dso: dorsoterminal sense organ; Gd: gonoduct; Go: gonad; Ht: heart; Mg: midgut; Pc: pallial cavity; Pd: pericardioduct; Pr: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

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

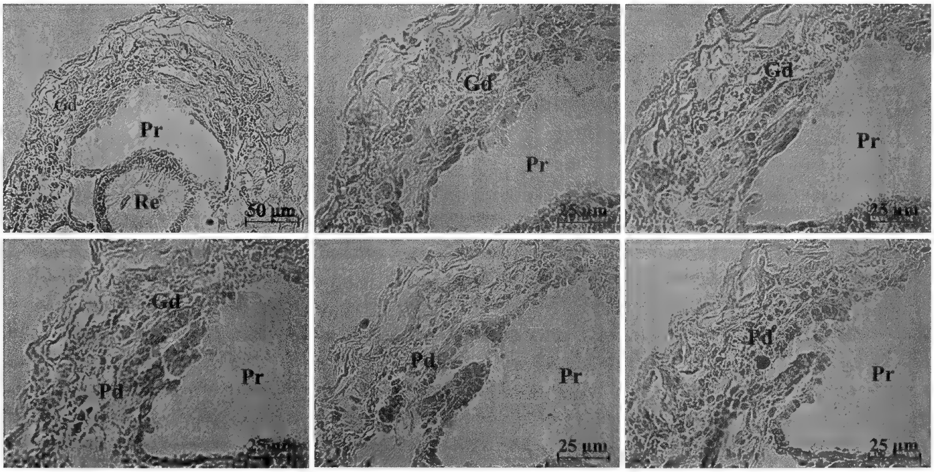


Figure 4.- *Phyllomenia* sp. Union of gonoduct and pericardioduct. Gd – gonoduct; Pd – pericardioduct; Pr - pericardium; Re – rectum.

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

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

Remarks. The organization of the anterior part of the body is unknown. However, its size (8 mm long, 0.85 mm thick) and the combination of sclerites and caracters of the posterior part of the body identify the specimen hereby studied as a juvenile individual of genus *Phyllomenia*. Two species are described in the genus *Phyllomenia* Thiele, 1913 (GARCÍA-ÁLVAREZ AND SALVINI-PLAWEN, 2007): *Phyllomenia austrina* present in different locations of the Antarctic Ocean (South Sandwich Island, Bransfield Strait, Ross Sea and Davis Sea), 148-465 m deep; and *Phyllomenia cornuadentata* Salvini-Plawen, 1978, present in Tierra del Fuego (South America), 384-903 m deep. Both species have a complex and very similar organization of the pallial cavity and a gonopericardial system that changes as specimens become mature. In young specimens, the organization of the posterior part of the body is very similar to the rest of species of Solenogastres (SALVINI-PLAWEN, 1978), while adults develop from the pallial cavity and the spawning duct, a set of pouches, of which the function and relationship to the structures they originate from, are only partially known (SALVINI-PLAWEN, 1970, 1978; THIELE, 1913).

Genus ***Plicaherpia*** gen. nov.

Diagnosis. Solid acicular sclerites combined with hook-shaped solid sclerites and elongated groove-shaped scales in a layer. With common atrio-buccal opening. Midgut with constrictions. Unpaired genital opening with genital papilla. Pallial cavity with two chambers. Coputatory stylets absent. Respiratory organs present. Dorsoterminal sense organ absent.

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

Plicaherpia papillata sp. nov. (Fig. 5)

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

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

Diagnosis. Specimen 2 mm x 0.77 mm, without longitudinal keels or swellings. Cuticle 10-20 mm thick. Four types of solid sclerites: slightly curved acicular; hook-shaped; long and narrow groove-shaped scales, with a very pointed distal end, and long and wide groove-shaped scales. Pedal groove with a fold that does not reach into the pallial cavity. Radula with 2 medial den-

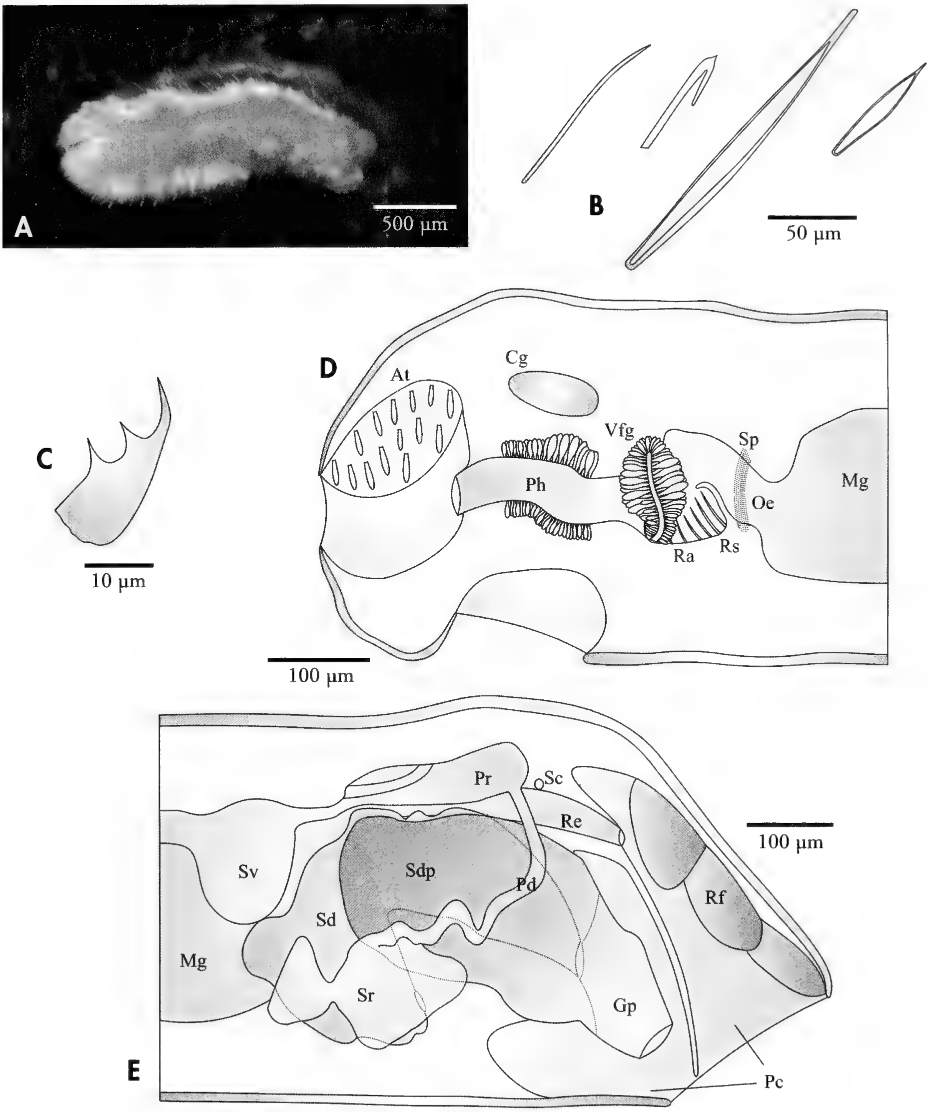


Figure 5. *Plicaherpia papillosa* gen. and sp. nov. A: habitus; B: mantle sclerites; C: radular tooth; D: schematic organization of the anterior body; E: schematic organization of the posterior body. Abbreviations, At: atrial sense organ; Cg: cerebral ganglion; Gp: genital papilla; Mg: midgut; Oe: oesophagus;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

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

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

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

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

Pedal groove and pallial cavity. The pedal groove bears a ciliated fold that does not get into the pallial cavity. The pallial cavity has a subterminal position and bears two chambers divided by a septum (Fig. 5E): a dorsal chamber that extends anterodorsally, where there are 15 short and wide respiratory folds with a radial arrangement and into which the rectum opens; the second chamber is ventral, it extends anteroventrally and the unpaired spawning duct opens into it through a genital papilla. It lacks copulatory stylets and abdominal spicles.

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

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

Reproductive system (Fig. 5E). There is a tubular and narrow pair of gonads. In the posterior area, the gonads present a pair of large seminal vesicles full of spermatozoids. A short pair of gonopericardioducts of circular section open anteriorly into the pericardium. The tubular heart is joined to the dorsal wall of the anterior part of the pericardium only through its anterior and posterior ends. The pericardioducts come out from the ventroposterior part of the pericardium and open dorsally into the seminal receptacles. The pair of seminal receptacles are located laterally in the anterior half of the spawning duct and comprise two pouches (a smaller anterior one and a posterior one) divided by a constriction. The posterior pouch of seminal receptacle opens laterally into the spawning duct. The spawning duct is unpaired along its entire extension; in its anterior half, its section cut is higher that wide due to the fact that a ventral pouch comes out from it, posteriorly it gets narrower till becoming tubular and opens unpaired in the centre of the genital papilla. The genital papilla is encircled by soft musculature and extends ventroposteriorly till it opens into the ventral chamber of the pallial cavity. Two pouches open directly into the genital papilla. Their section cut is high and narrow and extends anteriorly on both sides of the spawning duct to the medial area of the seminal receptacles.

Discussion. The set of features present in *Plicaherpia* gen. nov. defines it clearly as a new genus within the family Phyllomeniidae Salvini-Plawen, 1978, of the order Sterrofustia Salvini-Plawen, 1978, which is characterized by the combination of solid sclerites (with hook-shaped elements), distichous radula and ventrolateral foregut glandular organs with subepithelially arranged gland cell bodies (type A). (GARCÍA-ÁLVAREZ AND SALVINI-PLAWEN, 2007; SALVINI-PLAWEN, 1978). This family is hitherto composed of four genera: *Phyllomenia* Thiele, 1913, *Harpagoherpia* Salvini-Plawen, 1978, *Lituiherpia* Salvini-Plawen, 1978 and *Ocheyoherpia* Salvini-Plawen, 1978.

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

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

Amboherpia sp. (Fig. 6)

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

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

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

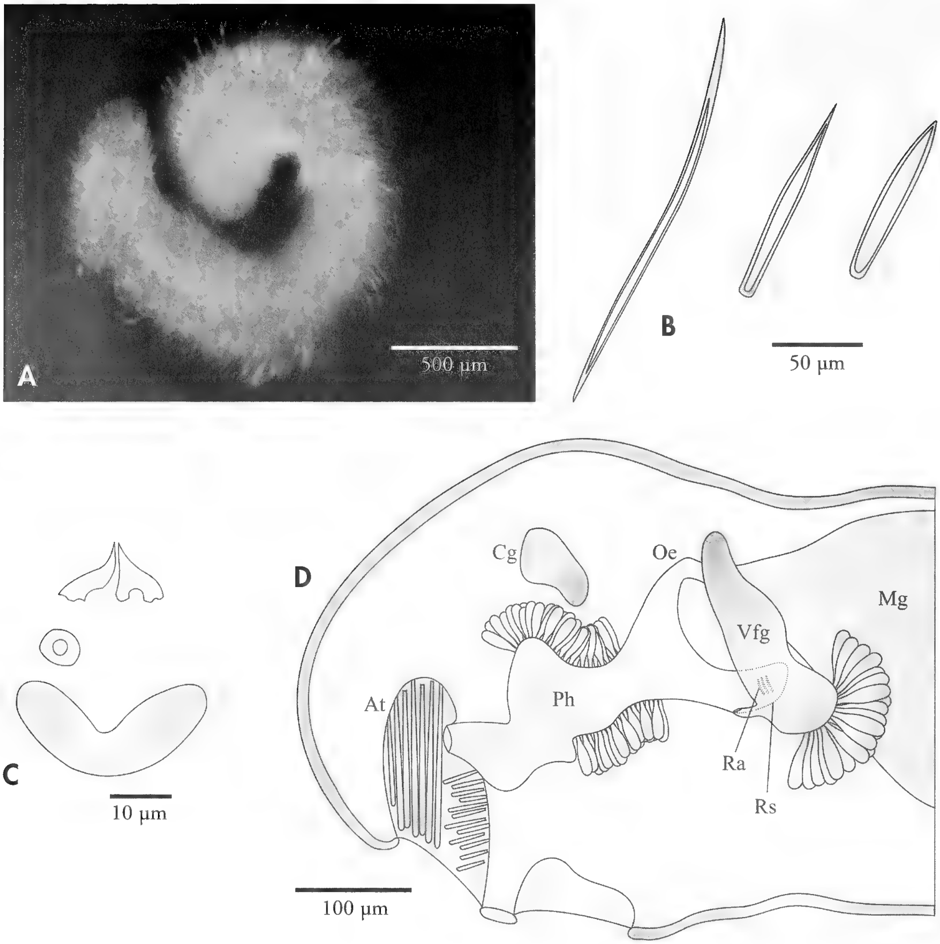


Figure 6. *Amboherpia* sp. A: habitus; B: mantle sclerites; C: radular teeth; D: schematic organization of the anterior body. Abbreviations, At: atrial sense organ; Bg: buccal ganglion; Cg: cerebral ganglion; Mg: midgut; Oe: oesophagus; Ph: pharynx; Ra: radula; Rs: radular sac; Vfg: ventrolateral foregut glandular organs.
Figure 6. Amboherpia *sp. A: habitus; B: escleritos del manto; C: dientes radulares; D: esquema de la organización de la parte anterior del cuerpo. Abreviaturas, At: órgano sensitive atrial; Bg: ganglio bucal; Cg: ganglio cerebral; Mg: intestino; Oe: esófago; Ph: faringe; Ra: rádula; Rs: saco radular; Vfg: órgano glandular ventrolateral del intestino.*

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

Pedal groove and pallial cavity. The pedal groove bears a ciliated fold that does not get into the pallial cavity. The pallial cavity is very small, has a subterminal position and lacks both respiratory folds and copulatory stylets. The unpaired opening of the spawning duct into the pallial cavity could be observed.

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

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

Remarks. At present three genera of the family Acanthomeniidae Salvini-Plawen, 1978 are known: *Acanthomenia* Thiele, 1913; *Amboherpia* Handl and Salvini-Plawen, 2002 and *Veromenia* Gil-Mansilla, García-Álvarez and Urgorri, 2008. The three genera differ in the combination of several characteristics: organization of the atrio-buccal cavity; presence/absence of radula, presence/absence of respiratory folds and presence/absence of a dorsoterminal sense organ (GIL-MANSILLA *ET AL.*, 2008 see table 2; HANDL AND SALVINI-PLAWEN, 2002; SALVINI-PLAWEN, 1978). The specimen is to be clearly included within the genus *Amboherpia* as it has a common atriobuccal cavity, monoserial radula, it lacks respiratory folds and has, despite some reservations, a dorsoterminal sense organ. Two species are described in the genus *Amboherpia*: *A. heterotecta* Handl and Salvini-Plawen, 2002, Bergen (Norway), 610 m deep and *A. dolicopharyngeata* Gil-Mansilla, García-Álvarez and Urgorri, 2008, Angola Basin, 5415 m deep. Although the structure of its reproductive system is still unknown *Amboherpia* sp., has a combination of characteristics that enable us to distinguish it from the known species of the genus (GIL-MANSILLA *ET AL.*, 2008 HANDL AND SALVINI-PLAWEN, 2002). *Amboherpia* sp. differs from *A. heterotecta* in the fact that: it lacks a preradular sphincter, it is provided with an oesophagus, and the ventrolateral foregut glandular organs have short ducts and a glandular association restricted to the terminal part. It differs from *A. dolicopharyngeata* in: having only groove-shaped scales, the pharynx is shorter and not divided in two regions, the oesophagus is shorter and lacks an intestinal dorso-anterior caecum.

ACKNOWLEDGEMENTS

This paper is part of the research projects: Bentart (MEC-Spanish Government REN2003-01881/ANT) and Diva-Artabria II (MEC-Spanish Government CTM-2004-00740; Xunta de Galicia PGIDIT07PXIB000120PR).

BIBLIOGRAPHY

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

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

GARCÍA-ÁLVAREZ O. AND URGORRI V. 2003b. A new species of Phyllomeniidae (Mollusca Solenogastes: Sterrofustia) from the South Shetland Islands, Antarctica. *Iberus*, 21 (2): 99-107.

GARCÍA-ÁLVAREZ O., ZAMARRO M. AND URGORRI V. 2009. Proneomeniidae (Solenogastres, Cavibelonia) from the Bentart-2006 Expedition, with description of a new species. *Iberus*, 27 (1): 67-78.

GIL-MANSILLA E., GARCÍA-ÁLVAREZ O. AND URGORRI V. 2008. New Acanthomeniidae (Solenogastres, Cavibelonia) from the abyssal Angola Basin. *In*: Martínez Arbizu, P. and Brix, S. (Eds). Bringing Light into Deep-sea Biodiversity. *Zootaxa*, 1866: 175-186.

GIL-MANSILLA E., GARCÍA-ÁLVAREZ O. AND URGORRI V. 2009. A new genus and two new species of Simrothiellidae (Solenogastres, Cavibelonia) from the Abyssal Angola Basin. *Journal of the Marine Biological Association of the United Kingdom*, 89 (7): 1507-1515.

HANDL C. AND TODT C. 2005. Foregut Glands of Solenogastres (Mollusca): Anatomy and Revised Terminology. *Journal of Morphology*, 265: 28-42.

HANDL C. AND SALVINI-PLAWEN L.V. 2002. New records of Solenogastres-Cavibelonia (Mollusca) from Norwegian fjords and shelf waters including three new species. *Sarsia*, 87: 423-450.

SALVINI-PLAWEN L.V. 1970. *Phyllomenia austrina* ein Phylogenetisch bedeutsamer Solenogaster (Mollusca, Aculifera). *Zeitschrift für Zoologie, Systematik u. Evolutionsforschung*, 8: 297-309.

SALVINI-PLAWEN L.V. 1978. Antarktische und subantarktische Solenogastres-Eine Monographie: 1898-1974. *Zoologica, Stuttgart*, 128: 1-315.

SALVINI-PLAWEN L.V. 2006. Five new Iberian Neomeniamorpha (Mollusca, Solenogastres). *Iberus*, 24 (2): 1-26.

SALVINI-PLAWEN L.V. AND PAAR-GAUSCH I. 2004. Three new species of *Neomenia* (Mollusca, Solenogastres) from the Southern Hemisphere. *New Zealand Journal of Marine and Freshwater Research*, 38: 137-162.

THIELE J. 1913. Antarktische Solenogastren. Deutsche Südpolar Expedition, 14, *Zoologie*, 6 (1): 35-65.

© *Sociedad Española de Malacología* — *Iberus*, 28 (2): 39-50, 2010

Fauna Malacológica da cidade de Coimbra (Beira Litoral). Moluscos "urbanos" de Portugal. 1

Malacological Fauna from Coimbra (Beira Litoral). Portuguese "urban" Molluscs. 1

Álvaro DE OLIVEIRA*

Recibido el 21-VII-2010. Aceptado el 31-X-2010

RESUMO

É listada a fauna malacológica da cidade de Coimbra (Beira Litoral, Portugal), comparando resultados da pesquisa bibliográfica com registos próprios decorrentes de trabalho de campo efectuado no decorrer dos últimos dois anos e meio. 197 espécies nominais foram citadas, das quais 100 são aqui consideradas válidas. Sessenta e uma espécies são reportadas como ocorrendo actualmente na cidade, uma diversidade considerável, tendo em conta o confinamento a que estão votadas, e a constante e ininterrupta transformação do seu espaço vital.

ABSTRACT

The malacological fauna from Coimbra (Beira Litoral, Portugal) is listed, the results of bibliographic research compared with own records of field work done in the last two and a half years. 197 nominal species were cited, 100 of which here considered as valid ones. Sixty-one species are reported as presently living in the town, a notable diversity having in mind their confinement, and the constant and uninterrupted transformation of their own vital space.

INTRODUÇÃO

Nas margens do Rio Mondego e a cerca de 45 km da sua foz, a cidade de Coimbra, capital da província de Beira Litoral, está situada no limite oriental da Bacia Lusitânica, caracterizada pela natureza sedimentar, calcária, dos seus terrenos. A sua localização estabelece a transição entre o curso superior do Rio, alcantilado e serrano, e o início do extenso e amplo vale, seu remoto estuário.

A fauna malacológica terrestre e aquática é reportada, confrontados registos clássicos com resultados de trabalho de campo efectuado pelo autor nos anos de 2008, 2009 e 1° semestre de 2010.

"Arredores de..." ou "environs de...", expressões frequentemente usadas na bibliografia antiga, apontam sítios actualmente absorvidos pelo crescimento da cidade: as espécies estão hoje em dia contidas em pequenos "ghettos" urbanos, jardins e parques públicos, dominados pelo exotismo da sua Flora. Em alguma medida este é um relato de extinções.

---

* Av. Lagos, 219-Y, 4405-658 Gulpilhares, Portugal. deoliveira1004@sapo.pt

MATERIAL E MÉTODOS

O trabalho de campo foi efectuado no decorrer dos últimos dois anos e meio (2008, 2009, 1° semestre de 2010), em oito sítios caracterizados na Tabela I, na qual é mostrada a distribuição das espécies na cidade. Três desses sítios (Jardim Botânico, Jardim de Santa Cruz e Quinta das Lágrimas, Figs. 1-2), pela diversidade faunística inicialmente detectada, foram objecto de um maior esforço de amostragem: durante o ano de 2009, para além da amostragem directa, foram colhidas amostras mensais de manta morta e camada superficial do solo, sujeitas a imediata triagem.

Todas as amostras (excepções apontadas) estão depositadas na colecção do autor. A sua determinação específica foi baseada em caracteres conquiliológicos, e, no caso das lesmas, na sua morfologia externa. Particularmente quanto a estas últimas, a sua classificação, não baseada em estudo anatómico, foi necessariamente conservadora (exemplos: o conceito de ambas *Deroceras laeve* (Müller O. F., 1774) e *Arion nobrei* Pollonera, 1889 poderá acolher mais do que um *taxon*).

Foi também estudado material museológico, quase em exclusivo proveniente das colecções depositadas no Museu de História Natural da Universidade de Coimbra, com vista à confirmação de alguns registos.

Paralelamente foi realizado um extenso trabalho de compilação bibliográfica, tendo como base, essencialmente, cinco obras de referência: MORELET (1845), HIDALGO (1875), LOCARD (1899), NOBRE (1885, 1930). Estes registos são apontados na Tabela II (colunas 1 a 4). Na mesma Tabela são reportados os registos próprios (coluna 5) e os primeiros registos para Coimbra (coluna 6) quando posteriores a NOBRE (1930).

Na Tabela III é dada a lista de sinonímias, particularmente pertinente para compreender os registos de LOCARD (1899), que para Coimbra cita 113 espécies, das quais apenas 58 são aqui consideradas válidas.

RESULTADOS E DISCUSSÃO

Moluscos de Coimbra

(i) São 197 as espécies nominais de moluscos terrestres e aquáticos citadas para Coimbra (Tabelas II e III), desde meados do séc. XIX até à actualidade.

(ii) 100 espécies são consideradas válidas (Tabela II), das quais 61 (61%) foram detectadas pelo autor (Tabela I).

(iii) Do conjunto dos registos clássicos (colunas 1-4, Tabela II) são reconhecidas 76 espécies, 41 (54%) encontradas no presente estudo. Áquelas acrescem 24 registos posteriores, nove dos quais aqui apontados como novos para Coimbra: *Ferrissia fragilis, Carychium minimum, Spermodea lamellata, Vertigo pygmaea, Zonitoides nitidus, Lehmannia valentiana, Microxeromagna lowei, Otala lactea, Corbicula fluminea.*

(iv) O grupo no qual é mais patente o número de espécies entretanto desaparecidas é sem dúvida os Bivalvia. Das oito espécies apontadas apenas uma (13%) foi encontrada pelo autor: a espécie exótica *Corbicula fluminea* (conchas e valvas roladas).

(v) Entre os Gastropoda o grupo mais afectado é o dos caracóis aquáticos: apenas 10 (42%) das 24 espécies foram detectadas. Na Superfamilia Planorboidea o cenário é ainda mais preocupante: das 13 espécies citadas apenas quatro (31%) foram recentemente observadas, das quais três exóticas: *Planorbella duryi, Ferrissia fragilis, Physa acuta.*

(vi) Quanto aos Gastropoda terrestres é de notar o aparente desaparecimento dos dois representantes da Familia Chondrinidae, *Granopupa granum* e *Chondrina lusitanica*, particularmente esta última, endemismo da Bacia Lusitânica, em franca regressão em toda a área de distribuição (registos próprios não publicados).

(vii) Das 61 espécies detectadas no presente estudo (Tabela I), 10 (16%) foram observadas num único sítio: *Theodoxus* cf. *fluviatilis, Belgrandia lusitanica, Planorbella duryi, Vallonia* cf. *enniensis, Spermodea lamellata, Balea heydeni, Limacus flavus, Microxeromagna lowei, Otala lactea, Corbicula fluminea.*

Figuras 1, 2. Coimbra. 1: Margem direita do Rio Mondego e Mata do Jardim Botânico, 21-IV-2009. 2: Rio Mondego e Quinta das Lágrimas (margem esquerda), 10-XII-2009.
Figures 1, 2. Coimbra. 1: Right bank of Mondego River and Wood of the Botanical Garden, 21-IV-2009. 2: Mondego River and Quinta das Lágrimas (left bank), 10-XII-2009.

Tabela I. Lista das espécies observadas/colhidas em Coimbra (registos próprios). X. Presença. (X). Apenas conchas. Sítios [UTM 1km]: 1. Jardim Botânico [NE4950]. 2. Jardim de Santa Cruz [NE4951]. 3. Penedo da Saudade [NE4950]. 4. Vale da Ribeira de Coselhas [NE4752-4852]. 5. Margens do Mondego [NE4849-4949-4850-4950-4851-5148]. 6. Instituto Geofísico [NE5051]. 7. Penedo da Meditação [NE5052]. 8. Quinta das Lágrimas [NE4849].

Table I. List of species noticed/collected in Coimbra (own records). X. Presence. (X). Shells only. Sites [UTM 1km]: 1. Botanical Garden [NE4950]. 2. Santa Cruz Garden [NE4951]. 3. Penedo da Saudade [NE4950]. 4. Ribeira de Coselhas Valley [NE4752-4852]. 5. Mondego River banks [NE4849-4949-4850-4950-4851-5148]. 6. Instituto Geofísico [NE5051]. 7. Penedo da Meditação [NE5052]. 8. Quinta das Lágrimas [NE4849].

Espécies	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Theodoxus cf. *fluviatilis* (Linnaeus, 1758)								X
Pomatias elegans (Müller O. F., 1774)	X	X						X
Potamopyrgus antipodarum (Gray J. E., 1843).	X	X		X			(X)	X
Mercuria tachoensis (Frauenfeld, 1865)		X						X
Belgrandia lusitanica (Paladilhe, 1867)								X
Galba truncatula (Müller O. F., 1774)	X	X	X		(X)			X
Radix balthica (Linnaeus, 1758).	(X)							(X)
Planorbella duryi (Wetherby, 1879)	X							
Ferrissia fragilis (Tryon, 1863)	X				X			X
Ancylus fluviatilis (Müller O. F., 1774)		X		X				
Physa acuta Draparnaud, 1805	X			X	X			X
Carychium ibazoricum Bank e Gittenberger, 1985	X	X	X				X	X
Carychium minimum Müller O. F., 1774	X							X
Oxyloma elegans (Risso, 1826)		X		X	X		X	X
Cochlicopa lubrica (Müller O. F., 1774)		X						X
Cochlicopa lubricella (Rossmässler, 1834)	X	X		X			X	
Lauria cylindracea (da Costa, 1778)	X	X	X	X		X	X	X
Leiostyla anglica (Férussac, 1821)	X	X	X			X	X	X
Vallonia costata (Müller O. F., 1774)		X				X		
Vallonia cf. *enniensis* (Gredler, 1856)		X						
Vallonia pulchella (Müller O. F., 1774)		X		X	X			X
Plagyrona placida (Shuttleworth, 1852)	X	X						X
Acanthinula aculeata (Müller O. F., 1774)	X	X	X			X	X	X
Spermodea lamellata (Jeffreys, 1830)							X	
Truncatellina cylindrica (Férussac A., 1807)						X		X
Vertigo pygmaea (Draparnaud, 1801)				X				X
Clausilia bidentata (Ström, 1765)	X	X	X	(X)			X	X
Balea heydeni Maltzan, 1881							(X)	
Rumina decollata (Linnaeus, 1758)	X		(X)	X	(X)	X	X	X
Testacella maugei (de Férussac, 1819)	X	X	(X)			X	X	X
Punctum pygmaeum (Draparnaud, 1801)	X	X	X			X	X	X
Paralaoma servilis (Shuttleworth, 1852)	X	X		X	X	(X)	X	X
Discus rotundatus (Müller O. F., 1774)	X	X						X
Vitrea contracta (Westerlund, 1871)	X	X	X			X	X	X
Euconulus fulvus (Müller O. F., 1774)	X		X	(X)			X	
Zonitoides nitidus (Müller O. F., 1774)					X			X
Oxychilus cellarius (Müller O. F., 1774)	X	X						(X)
Oxychilus draparnaudi (Beck, 1837)	X	X	(X)	(X)		(X)	X	X
Aegopinella nitidula (Draparnaud, 1805)	X	X	X			X	X	X

Tabela I. Continuação.
Table I. Continuation.

Espécies	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Milax gagates (Draparnaud, 1801)			X	X	X	X		
Limax maximus (Linnaeus, 1758)							X	X
Limacus flavus (Linnaeus, 1758)	X							
Lehmannia valentiana (Férussac, 1822)				X			X	X
Deroceras laeve (Müller O. F., 1774)	X	X	X		X			X
Deroceras reticulatum (Müller O. F., 1774)	X		X	X	X		X	X
Arion ater (Linnaeus, 1758)					X		X	
Arion intermedius Normand, 1852	X	X	X	X		X	X	X
Arion nobrei Pollonera 1889	X	X	X					X
Cochlicella barbara (Linnaeus, 1758)		X		X	X		X	
Oestophora barbula (Rossmässler, 1838)	X	X	X	X		X	X	X
Oestophora lusitanica (Pfeiffer, 1841)							X	(X)
Ponentina subvirescens (Bellamy, 1839)		X	X			X	X	
Candidula olisippensis (Servain, 1880)	X	X		X	X	X	X	
Cernuella virgata (da Costa, 1778)				X			X	
Microxeromagna lowei (Potiez e Michaud, 1838)							X	
Theba pisana pisana (Müller O. F., 1774)	X			X	X	(X)	X	X
Cepaea nemoralis (Linnaeus, 1758)	X	X	X	X		(X)	X	X
Otala lactea (Müller O. F., 1771)								(X)
Portugala inchoata (Morelet, 1845)					X	X		X
Cornu aspersum (Müller O. F., 1774)	X	X	(X)	X	X	X	X	X
Corbicula fluminea (Müller O. F., 1774)					(X)			
61 spp.	35	34	22	24	18	21	33	44

(viii) De quatro das espécies apenas foram detectados vestígios (conchas roladas): *Radix balthica, Balea heydeni, Otala lactea, Corbicula fluminea.*

Comentários sobre algumas espécies

Assiminea eliae: É surpreendente o registo de Locard (1899) desta espécie de águas salobras. No entanto, uma outra espécie que compartilha o mesmo habitat, *Myosotella myosotis*, é citada para Coimbra por Carvalho (1945) [ver "Material museológico" abaixo]. Recentemente o autor encontrou *M. myosotis* associada a *Assiminea* cf. *grayana* Fleming, 1828 na Ria de Aveiro, a cerca de 20 km do mar (registos próprios não publicados).

Mercuria tachoensis: Foi detectada uma colónia inédita deste endemismo português na Fonte da Sereia (Jardim de Santa Cruz). A sua identidade foi confirmada por estudo anatómico (seis espécimes na *coll.* Emilio Rolán).

Ferrissia fragilis: Registo novo para Coimbra desta espécie exótica recentemente referenciada para Portugal (Holyoak, 2009). Foram entretanto detectadas mais duas colónias da espécie: No Vale do Baixo Mondego, numa nascente em Vila Nova da Barca, Beira Litoral; e num jardim público de Faro, Algarve (registos próprios não publicados).

Vallonia cf. *enniensis*: Esta forma foi detectada num único local da cidade, Jardim de Santa Cruz, associada a *Vallonia costata* e *Vallonia pulchella*. Apenas foram encontrados dois exemplares de *V.* cf. *enniensis* em oito colheitas com representantes do *genus* (58 exemplares de *V. costata*, sete de *V. pulchella*); não foram detectados exemplares intermédios.

Tabela II. Lista das espécies citadas para Coimbra. X. Presença. (X). Apenas conchas. (+). Registos novos. * Espécies comentadas em "Resultados". Registos: 1. Morelet (1845). 2. Hidalgo (1875). 3. Locard (1899). 4. Nobre (1885, 1930). 5. Registos próprios (espécies inscritas a negrito). 6. Primeiros registos posteriores a Nobre (1930): (a) Boeters (1988). (b) De Oliveira (2009a). (c) Carvalho (1945). (d) De Oliveira (2009b). (e) Martínez-Ortí (2006). (f) Castillejo (1990b). (g) Carvalho (1944). (h) Castillejo (1990a).

Table II. List of species noticed/collected in Coimbra. X. Presence. (X). Shells only. (+). New records. (*) Species commented under "Resultados". Records: 1. Morelet (1845). 2. Hidalgo (1875). 3. Locard (1899). 4. Nobre (1885, 1930). 5. Own records (species inscribed in bold). 6. First records after Nobre (1930): (a) Boeters (1988). (b) De Oliveira (2009a). (c) Carvalho (1945). (d) De Oliveira (2009b). (e) Martínez-Ortí (2006). (f) Castillejo (1990b). (g) Carvalho (1944). (h) Castillejo (1990a).

Espécies	**1**	**2**	**3**	**4**	**5**	**6**
Theodoxus cf. _fluviatilis_ (Linnaeus, 1758)	X		X	X	X	
Pomatias elegans (Müller O. F., 1774)	X	X	X	X	X	
Bithynia tentaculata (Linnaeus, 1758)			X	X		
Assiminea eliae Paladilhe, 1875 *			X			
Potamopyrgus antipodarum (Gray J. E., 1843)					X	X (a)
Mercuria tachoensis (Frauenfeld, 1865) *			X	X	X	
Belgrandia lusitanica (Paladilhe, 1867)	X		X	X	X	
Valvata piscinalis (Müller O. F., 1774)	X		X	X		
Galba truncatula (Müller O. F., 1774)			X	X	X	
Radix balthica (Linnaeus, 1758)			X	X	(X)	
Radix auricularia (Linnaeus, 1758)			X	X		
Bulinus truncatus contortus (Michaud, 1829)	X		X	X		
Planorbarius metidjensis (Forbes, 1838) *			X	X		
Planorbella duryi (Wetherby, 1879)					X	X (b)
(+) **_Ferrissia fragilis_** (Tryon, 1863)*					X	
Planorbis planorbis (Linnaeus, 1758)			X			
Planorbis carinatus (Müller O. F., 1774)	X		X	X		
Anisus spirorbis (Linnaeus, 1758)	X		X	X		
Gyraulus albus (Müller O. F., 1774)			X	X		
Gyraulus laevis (Alder, 1838)			X			
Gyraulus crista (Linnaeus, 1758)			X	X		
Hippeutis complanatus (Linnaeus, 1758)			X	X		
Ancylus fluviatilis (Müller O. F., 1774)			X	X	X	
Physa acuta Draparnaud, 1805			X	X	X	
Myosotella myosotis (Draparnaud, 1801) *						X (c)
Carychium ibazoricum Bank e Gittenberger, 1985	X	X	X	X	X	
(+) **_Carychium minimum_** Müller O. F., 1774					X	
Oxyloma elegans (Risso, 1826)			X	X	X	
Cochlicopa lubrica (Müller O. F., 1774)			X	X	X	
Cochlicopa lubricella (Rossmässler, 1834)					X	X (d)
Lauria cylindracea (da Costa, 1778)		X	X	X	X	
Leiostyla anglica (Férussac, 1821)			X		X	
Vallonia costata (Müller O. F., 1774)					X	X (d)
Vallonia cf. _enniensis_ (Gredler, 1856) *					X	X (d)
Vallonia pulchella (Müller O. F., 1774)					X	X (d)
Plagyrona placida (Shuttleworth, 1852) *			X		X	
Acanthinula aculeata (Müller O. F., 1774)			X	X	X	

Tabela II. Continuação.
Table II. Continuation.

Espécies	**1**	**2**	**3**	**4**	**5**	**6**
(+) ***Spermodea lamellata*** (Jeffreys, 1830) *					X	
Pupilla muscorum (Linnaeus, 1758)			X			
Pyramidula rupestris (Draparnaud, 1801) *			X	X		
Granopupa granum (Draparnaud, 1801)			X	X		
Chondrina lusitanica (Pfeiffer, 1848) *			X	X		
Truncatellina cylindrica (Férussac A., 1807)				X	X	
(+) ***Vertigo pygmaea*** (Draparnaud, 1801) *					X	
Merdigera obscura (Müller O. F., 1774)			X	X		
Clausilia bidentata (Ström, 1765)	X	X	X	X	X	
Balea heydeni Maltzan, 1881					(X)	X (e)
Balea perversa (Linnaeus, 1758) *		X	X	X		
Ferussacia folliculus (Gmelin, 1791)			X	X		
Cecilioides acicula (Müller O. F., 1774)				X		
Rumina decollata (Linnaeus, 1758)		X	X	X	X	
Testacella maugei (de Férussac, 1819)	X	X	X	X	X	
Punctum pygmaeum (Draparnaud, 1801)				X	X	
Paralaoma servilis (Shuttleworth, 1852)			X		X	
Discus rotundatus (Müller O. F., 1774)					X	X (d)
Vitrea contracta (Westerlund, 1871)			X		X	
Vitrea crystallina (Müller O. F., 1774)				X		
Euconulus fulvus (Müller O. F., 1774)					X	X (d)
(+) ***Zonitoides nitidus*** (Müller O. F., 1774) *					X	
Oxychilus cellarius (Müller O. F., 1774)		X	X	X	X	
Oxychilus draparnaudi (Beck, 1837)			X		X	
Aegopinella nitens (Michaud, 1831)			X			
Aegopinella nitidula (Draparnaud, 1805)				X	X	
Parmacella valenciennii (Webb e Van Beneden, 1836 *						X (c)
Milax gagates (Draparnaud, 1801)				X	X	
Limax maximus (Linnaeus, 1758)				X	X	
Limacus flavus (Linnaeus, 1758)				X	X	
(+) ***Lehmannia valentiana*** (Férussac, 1822)					X	
Deroceras agreste (Pollonera, 1891)				X		
Deroceras laeve (Müller O. F., 1774)				X	X	
Deroceras lombricoides (Morelet, 1845)				X		
Deroceras reticulatum (Müller O. F., 1774)					X	X (f)
Arion ater (Linnaeus, 1758)				X	X	
Arion nobrei Pollonera 1889					X	X (h)
Arion intermedius Normand, 1852				X	X	
Cochlicella acuta (Müller O. F., 1774)			X	X		
Cochlicella barbara (Linnaeus, 1758)				X	X	
Oestophora barbula (Rossmässler, 1838)			X	X	X	
Oestophora lusitanica (Pfeiffer, 1841)			X	X	X	
Ponentina subvirescens (Bellamy, 1839)		X	X	X	X	
Xerotricha apicina (Lamarck, 1822)		X	X	X		
Xerotricha conspurcata (Draparnaud, 1801)		X	X	X		
Candidula belemensis (Servain, 1880)			X			
Candidula intersecta (Poiret, 1801)		X	X	X		

Tabela II. Continuação.
Table II. Continuation.

Espécies	1	2	3	4	5	6
Candidula olisippensis (Servain, 1880)			X		X	
Cernuella virgata (da Costa, 1778)				X	X	
(+) ***Microxeromagna lowei*** (Potiez e Michaud, 1838)					X	
Theba pisana pisana (Müller O. F., 1774)		X	X	X	X	
Cepaea nemoralis (Linnaeus, 1758)			X	X	X	
(+) ***Otala lactea*** (Müller O. F., 1771)					(X)	
Portugala inchoata (Morelet, 1845)			X	X	X	
Cornu aspersum (Müller O. F., 1774)			X	X	X	
Potomida littoralis (Cuvier, 1798) *						X (g)
Unio delphinus Spengler, 1793 *	X			X		
Anodonta anatina (Linnaeus, 1758) *	X		X	X		
(+) ***Corbicula fluminea*** (Müller O. F., 1774)					(X)	
Sphaerium corneum (Linnaeus, 1758) *			X	X		
Musculium lacustre (Müller O. F., 1774)				X		
Pisidium amnicum (Müller O. F., 1774) *						X (g)
Pisidium casertanum (Poli, 1791)			X	X		
100 spp.	12 spp.	13 spp.	58 spp.	64 spp.	61 spp.	15 spp.
			76 spp.			

V. cf. *enniensis* foi também colhida num jardim da cidade do Porto, Douro Litoral, associada a *V. pulchella* [registos próprios não publicados]. Aqui, numa amostra de nove exemplares, três são atribuíveis a *V.* cf. *enniensis*. Dos restantes seis exemplares, atribuíveis a *V. pulchella*, pelo menos um apresenta caracteres intermédios: as primeiras voltas da espira com estriação axial típica de *V. pulchella*, que se vai gradualmente espaçando, até que no último quarto de volta é patente já a estriação axial típica de *V. enniensis*.

Giusti e Manganelli (1992) põem em causa a validade da maior parte das espécies europeias de *Vallonia* (entre as quais *V. enniensis*), considerando: (1) estão baseadas apenas em caracteres conquiliológicos; (2) as populações de quase todas as espécies são completamente desprovidas de complexo penial; (3) o facto de várias "espécies" ocorrerem associadas no mesmo local [p. ex. Beckmann (2007) reporta *V. pulchella*, *V. enniensis* e *V. costata* associadas em dois locais da ilha de Mallorca, Baleares], apresentada por vários autores como prova suficiente da sua validade taxonómica, pode não bastar: poderá tratar-se de populações de diferentes estirpes genéticas ou clones da mesma espécie, perpetuadas por autofecundação ou partenogênese.

Plagyrona placida: Uma das espécies terrestres mais raras na cidade [raramente obtido mais que um exemplar em qualquer das amostragens realizadas nos três sítios onde foi encontrada (Tabela I)].

Spermodea lamellata: Registo novo para Coimbra desta espécie rara da fauna portuguesa, da qual apenas são conhecidas mais três populações, contidas na Bacia Lusitânica, províncias de Beira Litoral e Estremadura (Gittenberger, 1989; De Oliveira, 2007).

Vertigo pygmaea: Registo novo para Coimbra e para a província de Beira Litoral. Conhecida apenas das províncias de Minho e Douro Litoral nos registos clássicos, foi recentemente encontrada em Bragança, província de Trás-os-Montes (registos próprios não publicados).

Zonitoides nitidus: Registo novo para Coimbra e para a província de Beira Litoral. Desta espécie, até agora apenas conhecida da província de Douro Litoral (De Oliveira, 2008), foram entretanto detectadas populações em Valença (prov. Minho) e Bragança (prov. Trás-os-Montes) [registos próprios não publicados].

Material museológico

Em Fevereiro de 2010 foram estudados vários lotes de Gastropoda e Bivalvia não-marinhos provenientes de Coimbra depositados no Museu de História Natural da Universidade de Coimbra (MHNC) reportados no Catálogo da Colecção de Invertebrados de Portugal (Carvalho, 1944, 1945). Nenhuma das amostras possui data de colheita e apenas quatro apontam o nome do autor:

Planorbarius metidjensis: Dois lotes, um dos quais (131b) identificado como "*Planorbis corneus* (L.)", o outro (132) como "*Planorbis corneus* (L.) var. *metidjensis* Forbes", compostos por, respectivamente, cinco e duas conchas. Biometria (em mm; conchas maiores de cada uma das amostras): altura – 6,6-7,3; diâmetro – 14,0-16,3; n° de voltas – 3,8-4,4. A ocorrência em Portugal continental de *Planorbarius corneus* (Linnaeus, 1758) não foi confirmada. O estudo da população reportada do Jardim Botânico da Universidade de Coimbra revelou tratar-se de *Planorbella duryi* (Wetherby, 1879), espécie exótica de origem neárctica (De Oliveira, 2009a).

Myosotella myosotis: Este é o único vestígio da ocorrência em Coimbra desta espécie de águas salobras. O lote estudado (117a) é composto por três conchas com os restos secos do animal. Biometria: altura – 6,9-7,8; diâmetro – 3,2-3,6; n° de voltas – 7,0.

Pyramidula rupestris: O único lote (49b) procedente de Coimbra é composto por sete conchas, cinco das quais em muito mau estado de conservação. O estudo das duas conchas em melhor estado revelou tratar-se de *Plagyrona placida* [ver também "Registos duvidosos ou errados" abaixo]. Biometria (concha maior): altura – 1,6; diâmetro – 2,2; n° de voltas – 3,1.

Chondrina lusitanica: O lote estudado (92a), identificado como "*Abida secale* (Drap.)" é composto por duas conchas. Biometria: altura – 7,6-8,1; diâmetro – 2,8-3,0; n° de voltas – 7,0-7,5.

Balea perversa: A amostra (98c) é composta por sete conchas pertencentes a juvenis de *Clausilia bidentata*! Biometria (concha maior): altura – 4,8; diâmetro – 2,0; n° de voltas – 8,0. A ocorrência de *Balea perversa* em Portugal continental é apenas suportada por material conquiliológico depositado no Museo de Ciencias Naturales de Madrid [uma amostra (*pars*) procedente de Coimbra na coll. Azpeitia (Martínez-Ortí, 2006)] e no Museu de História Natural da Universidade do Porto [uma amostra proveniente da Serra de Montesinho, prov. de Trás-os-Montes, na *coll.* Nobre (registos próprios não publicados)].

Parmacella valenciennii: A amostra (17a) não foi encontrada. A espécie é classicamente reportada em Portugal do Vale do Tejo para sul (Morelet, 1845; Nobre, 1930). Mais recentemente, a sua área de distribuição é ampliada para norte, até ao Vale do Mondego (Rodríguez, Hermida e Outeiro, 1993). No entanto, a sua ocorrência actual em Coimbra não foi confirmada.

Potomida littoralis: O lote (431) é composto por três conchas. Biometria (concha maior): altura – 37,8; comprimento – 55,6; espessura – 21,8. Este é o único registo conhecido para Coimbra.

Unio delphinus: A amostra (430) identificada como "*Unio pictorum* (L.)" é constituído por cinco conchas. Biometria (concha maior): altura – 36,3; comprimento – 72,0; espessura – 25,7.

Anodonta anatina: A amostra (432) identificada como "*Anodonta cygnea* (L.)" é constituído por uma concha. Biometria: altura – 51,0; comprimento – 94,3; espessura – 28,5.

Pisidium amnicum: A amostra (485) identificada como "*Pisidium amnicum* (Müller)" é constituída por três conchas, as duas menores pertencentes a *Sphaerium corneum*. Biometria: *P. amnicum*: altura – 8,9; comprimento – 11,0; espessura – 6,2; *S. corneum*: altura – 6,7-7,1; comprimento – 7,7-8,5; espessura – 4,8-

Tabela III. Lista de sinonímias: (1). MORELET (1845). (2). HIDALGO (1875). (3). LOCARD (1899). (4). NOBRE (1885, 1930).

Table III. Sinonymy list: (1). MORELET (1845). (2). HIDALGO (1875). (3). LOCARD (1899). (4). NOBRE (1885, 1930).

Espécies	**Sinónimos**
Theodoxus cf. *fluviatilis* (Linnaeus, 1758)	*Neritina violacea* (1, 4), *Theodoxia elongatula* (3), *Neritina fluviatilis* (4)
Pomatias elegans (Müller O. F., 1774)	*Cyclostoma elegans* (1, 2, 3, 4)
Bithynia tentaculata (Linnaeus, 1758)	*Bythinia tentaculata* (3, 4), *B. decipiens, B. matritensis* (3)
Assiminea eliae Paladilhe, 1875	*Assimina eliae* (3)
Mercuria tachoensis (Frauenfeld, 1865)	*Amnicola lanceolata, A. castroiana* (3), *A. similis, Hydrobia similis* (4)
Belgrandia lusitanica (Paladilhe, 1867)	*Paludina gibba* (1), *Belgrandia gibba, Hydrobia gibba* (4)
Valvata piscinalis (Müller O. F., 1774)	*Valvata tolosana, V. eximia* (3)
Galba truncatula (Müller O. F., 1774)	*Limnaea truncatula* (3, 4)
Radix balthica (Linnaeus, 1758)	*Limnaea acutalis, L. acronica, L. limosa, L. angustana, L. paulinoi, L. rubella, L. lusitanica* (3), *L. peregra, L. ovata* (4)
Radix auricularia (Linnaeus, 1758)	*Limnaea auricularia* (3, 4), *L. intermedia* (3)
Bulinus truncatus contortus (Michaud, 1829)	*Physa contorta* (1), *P. brondeli, P. paulinoi, P. castroi* (3), *Bulinus contortus* (4)
Planorbarius metidjensis (Forbes, 1838)	*Planorbis metidjensis, P. algericus, P. aclopus, P. lusitanus, P. rosai* (3), *P. dufouri* (3, 4), *P. corneus* var. *metidjensis* (4)
Planorbis planorbis (Linnaeus, 1758)	*Planorbis umbilicatus, P. intermedius* (3)
Planorbis carinatus (Müller O. F., 1774)	*Planorbis complanatus* var. *carinata* (4)
Anisus spirorbis (Linnaeus, 1758)	*Planorbis leucostoma* (1, 4), *P. rotundatus* (3), *P. spirorbis* (4)
Gyraulus albus (Müller O. F., 1774)	*Planorbis albus* (3, 4)
Gyraulus laevis (Alder, 1838)	*Planorbis glaber* (3)
Gyraulus crista (Linnaeus, 1758)	*Planorbis imbricatus* (3), *P. crista, P. nautileus* (4)
Hippeutis complanatus (Linnaeus, 1758)	*Planorbis fontanus* (3, 4), *P. complanatus* (4)
Ancylus fluviatilis (Müller O. F., 1774)	*Ancylus strictus, A. gibbosus* (3), *A. striatus* (4)
Physa acuta Draparnaud, 1805	*Physa subopaca* (3)
Carychium ibazoricum Bank e Gittenberger, 1985	*Auricula gracilis* (1), *Carychium gracile* (2, 3, 4)
Oxyloma elegans (Risso, 1826)	*Succinea longiscata* (3), *S. elegans, S. pfeifferi* (4)
Cochlicopa lubrica (Müller O. F., 1774)	*Zua subcylindrica* (3), *Cionella subcylindrica* (4)
Lauria cylindracea (da Costa, 1778)	*Pupa umbilicata* (2, 4), *Pupilla umbilicata* (3)
Leiostyla anglica (Férussac, 1821)	*Pupilla paulinoi* (3)
Plagyrona placida (Shuttleworth, 1852)	*Helix debauxiana* (3)
Acanthinula aculeata (Müller O. F., 1774)	*Helix aculeata* (3, 4)
Pyramidula rupestris (Draparnaud, 1801)	*Helix rupestris* (3, 4)
Granopupa granum (Draparnaud, 1801)	*Pupa graniformis* (3), *P. granum* (4)
Chondrina lusitanica (Pfeiffer, 1848)	*Pupa lusitanica* (3), *P. avenacea* var. *lusitanica* (4)
Truncatellina cylindrica (Férussac A., 1807)	*Vertigo muscorum* (4)
Merdigera obscura (Müller O. F., 1774)	*Bulimus obscurus* (3), *Buliminus obscurus* (4)
Clausilia bidentata (Ström, 1765)	*Clausilia rugosa* (1, 2, 4), *C. moniziana* (3)
Balea perversa (Linnaeus, 1758)	*Balia perversa* (3)
Ferussacia folliculus (Gmelin, 1791)	*Ferussacia vescoi, F.amblya* (3)
Cecilioides acicula (Müller O. F., 1774)	*Caecilianella acicula* (4)
Rumina decollata (Linnaeus, 1758)	*Bulimus decollatus* (2)
Punctum pygmaeum (Draparnaud, 1801)	*Helix pygmaea* (4)
Paralaoma servilis (Shuttleworth, 1852)	*Helix poupillieri* (3)
Vitrea contracta (Westerlund, 1871)	*Hyalinia vitreola* (3)
Oxychilus cellarius (Müller O. F., 1774)	*Helix cellaria* (2), *Hyalinia chersa, H. lusitanica, H. blidahensis* (3), *H. cellaria* (4)
Oxychilus draparnaudi (Beck, 1837)	*Hyalinia raterana, H. kraliki* (3)

Tabela III. Continuação.
Table III. Continuation.

Espécies	Sinónimos
Aegopinella nitens (Michaud, 1831)	*Hyalinia nitens, H. castroi* (3), *Zonites nitens* (4)
Aegopinella nitidula (Draparnaud, 1805)	*Hyalinia nitidula* (4)
Milax gagates (Draparnaud, 1801)	*Amalia gagates* (4)
Deroceras agreste (Pollonera, 1891)	*Agriolimax agrestis* (4)
Deroceras laeve (Müller O. F., 1774)	*Agriolimax laevis* (4)
Arion intermedius Normand, 1852	*Arion hessei* (4)
Cochlicella acuta (Müller O. F., 1774)	*Cochlicella barbara* (3), *Helix barbara* (4)
Cochlicella barbara (Linnaeus, 1758)	*Helix acuta, H. ventrosa* (4)
Oestophora barbula (Rossmässler, 1838)	*Helix barbula* (3, 4), *H. barbella, H. despicta* (3)
Oestophora lusitanica (Pfeiffer, 1841)	*Helix lusitanica* (3, 4)
Ponentina subvirescens (Bellamy, 1839)	*Helix occidentalis* (2, 3, 4), *H. villula, H. atachypora, H. conimbricensis, H. rosai* (3)
Xerotricha apicina (Lamarck, 1822)	*Helix apicina* (2, 3, 4)
Xerotricha conspurcata (Draparnaud, 1801)	*Helix conspurcata* (2, 3), *H. moricola* (3)
Candidula belemensis (Servain, 1880)	*Helix absidiata* (3)
Candidula intersecta (Poiret, 1801)	*Helix caperata* (2), *H. intersecta* (3, 4), *H. herbarum* (3)
Candidula olisippensis (Servain, 1880)	*Helix defectiva, H.unifasciata, H. olisippensis* (3)
Cernuella virgata (da Costa, 1778)	*Helix virgata, H. variabilis* (4)
Theba pisana pisana (Müller O. F., 1774)	*Helix pisana* (2, 3, 4), *H. pisanella, H. pisanopsis, H. carpiensis, H. djerbanica* (3)
Cepaea nemoralis (Linnaeus, 1758)	*Helix nemoralis* (3, 4)
Portugala inchoata (Morelet, 1845)	*Helix inchoata* (3, 4), *H. paulinoi, H. nobrei, H. goltzi, H. pochi* (3)
Cornu aspersum (Müller O. F., 1774)	*Helix aspersa* (3, 4)
Unio delphinus Spengler, 1793	*Unio pictorum* (1, 4), *U. oeschrus, U. amblyus* (3)
Anodonta anatina (Linnaeus, 1758)	*Anodonta macilenta* (1, 3, 4), *A. acyrta, A. silvae, A. embiella, A. bocageana, A. rosai* (3)
Sphaerium corneum (Linnaeus, 1758)	*Sphaerium lusitanicum, S. nucleatum* (3)
Musculium lacustre (Müller O. F., 1774)	*Sphaerium lacustris* (4)

5,6. Este é o único registo conhecido de *P. amnicum* para Coimbra.

Registos duvidosos ou errados

Recentemente De Oliveira (2009b) cita para Coimbra *Pyramidula pusilla* (Gittenberger e Bank, 1996). Este registo, após análise mais detalhada, é errado e corresponde a *Plagyrona placida*.

CONCLUSÃO

Pelo menos 61 espécies de moluscos continentais sobrevivem ainda na cidade de Coimbra. Uma diversidade ainda assim notável dados (i) o isolamento e a exiguidade dos habitats actualmente disponíveis e (ii) a continua manutenção e artificialização desses mesmos espaços (limpeza, recolha de manta morta, obras de "beneficiação", eventual uso de moluscicidas...), que periódica e sistematicamente vão sendo responsáveis por fenómenos de mortalidade.

AGRADECIMENTOS

Material bibliográfico e malacológico foi disponibilizado para consulta e estudo na Biblioteca de Zoologia e no Museu de História Natural da Universidade de Coimbra. No Museu de Histó-

ria Natural da Universidade do Porto foram estudadas as amostras da Familia Clausiliidae depositadas na *coll.* Nobre.

Emilio Rolán estudou anatomicamente a colónia de *Mercuria* da Fonte da Sereia confirmando a sua identidade.

BIBLIOGRAFIA

Beckmann K.-H., 2007. *Die Land- und Süsswassermollusken der Balearischen Inseln.* Conchbooks, Wiesbaden. 255 p.

Boeters H. D. 1988. Moitessieriidae und Hydrobiidae in Spanien und Portugal (Gastropoda: Prosobranchia). *Archiv für Molluskenkunde,* 118 (4-6): 181-261.

Carvalho R. N. 1944. Catálogo da Colecção de Invertebrados de Portugal existentes no Museu Zoológico da Universidade de Coimbra. Mollusca. 2ª Parte: A. Classe Pelecypoda Goldfuss (Acephala Cuv. Lamellibranchiata Blv.). *Memórias e Estudos do Museu Zoológico da Universidade de Coimbra,* 162: 1-22.

Carvalho R. N. 1945. Catálogo da Colecção de Invertebrados de Portugal existentes no Museu Zoológico da Universidade de Coimbra. Mollusca. 2ª Parte: B. Classe Gastropoda Cuvier. *Memórias e Estudos do Museu Zoológico da Universidade de Coimbra,* 167: 1-50.

Castillejo J., 1990a. Babosas de la Peninsula Iberica. I. Los Arionidos. Catalogo critico y mapas de distribucion (Gastropoda, Pulmonata, Arionidae). Comunicaciones del VIII Congreso Nacional de Malacologia, Valencia, Octubre de 1990, *Iberus,* 9 (1-2): 331-345.

Castillejo J. 1990b. Babosas de la Peninsula Iberica. II. Los Agriolimacidos. Catalogo critico y mapas de distribucion (Gastropoda, Pulmonata, Agriolimacidae). Comunicaciones del VIII Congreso Nacional de Malacologia, Valencia, Octubre de 1990, *Iberus,* 9 (1-2): 347-358.

De Oliveira A., 2007. *Spermodea lamellata* (Jeffreys, 1830) (Pulmonata: Valloniidae, Acanthinulinae): novos dados sobre a sua distribuição em Portugal. *Noticiario de la Sociedad Española de Malacologia,* 47: 29-31.

De Oliveira A., 2008. Materiais para o estudo da Malacofauna não-marinha de Portugal. 1. Seis gastrópodes (Pulmonata, Stylommatophora) não citados na obra de Augusto Nobre. 2. *Monacha cartusiana* (Müller O. F., 1774) e *Helicigona lapicida* (Linnaeus, 1758) (Pulmonata, Helicoidea). *Noticiario de la Sociedad Española de Malacologia,* 49: 40-45. 51: 48 [errata].

De Oliveira A. 2009a. Materiais para o estudo da Malacofauna não-marinha de Portugal. 4. Revisão das espécies aquáticas introduzidas. *Noticiario de la Sociedad Española de Malacologia,* 52: 31-37.

De Oliveira A. 2009b. Materiais para o estudo da Malacofauna não-marinha de Portugal. 5. *Cochlicopa lubricella* (Rossmässler, 1834) (Pulmonata, Cochlicopidae). *Noticiario de la Sociedad Española de Malacologia,* 51: 55-58.

Gittenberger E., 1989. Additional data concerning the systematics and the remarkable ranges of three species of landsnails, known from Sintra. *Publicações Ocasionais da Sociedade Portuguesa de Malacologia,* 13: 13-16, fig. 1-5.

Giusti F. e Manganelli G., 1992. The problem of the species in Malacology after clear evidence of the limits of morphological systematics. In Gittenberger E. e Goud J. (Eds.): *Proceedings of the Ninth International Malacogical Congress, Edinburgh, 1986.* Unitas Malacologica, Leiden: 153-172.

Hidalgo J. G. 1875. *Catálogo iconográfico y descriptivo de los moluscos terrestres de España, Portugal y las Baleares.* Madrid. pp. 223, lam. A, 1-44, pp. 46.

Holyoak G. A. 2009. *Ferrissia fragilis* (Gastropoda: Planorbidae) in Portugal. *Noticiario de la Sociedad Española de Malacologia,* 52: 41-42.

Locard A. 1899. *Conchyliologie Portugaise. Les coquilles terrestres des eaux douces et saumatres. Archives du Muséum d'Histoire Naturelle de Lyon,* 7 (1): i-iv, 1-303.

Martínez-Ortí A. 2006. *Balea heydeni* Von Maltzan, 1881 (Gastropoda, Clausilidae) en España: características conquiológicas y distribucción. *Noticiario de la Sociedad Española de Malacologia,* 45: 30-37.

Morelet A. 1845. *Description des Mollusques terrestres et fluviatiles du Portugal.* J.-B. Baillière, Paris. 115 pp., 14 pl.

Nobre A., 1885. Catalogue des Mollusques des environs de Coïmbre (Portugal). *Annales de la Societé Royale Malacologique de Belgique,* 20: 45-62.

Nobre A. 1930. *Moluscos terrestres, fluviais e das águas salobras de Portugal.* Companhia Editora do Minho, Barcelos. 259 pp., 18 pl.

Rodríguez T., Hermida J. e Outeiro A. 1993. La Superfamilia Zonitoidea Mörch, 1864 en Portugal. *Revista da Academia Galega de Ciencias,* 12: 57-66.

© Sociedad Española de Malacología *Iberus*, 28 (2): 51-62, 2010

Notes on Mediterranean *Dizoniopsis* (Gastropoda: Cerithiopsidae), with the description of two new species

Apuntes sobre los *Dizoniopsis* (Gastropoda: Cerithiopsidae) del Mediterráneo, con la descripción de dos especies nuevas

Philippe BOUCHET*, Serge GOFAS** and Anders WARÉN***

Recibido el 8-XI-2010. Aceptado el 10-XI-2010

ABSTRACT

Species-level taxonomy is reviewed for the Mediterranean Cerithiopsidae with a sculpture formed by two rows of beads. The two previously known species are assigned respectively to *Dizoniopsis coppolae* (Aradas, 1870) and *D. concatenata* (Conti, 1864) and are held as distinct from the fossil type species *Dizoniopsis bilineata* (Hörnes, 1848). Two additional species, which are found sympatrically with these in the Strait of Gibraltar, are described as new. *Dizoniopsis micalii* Cecalupo and Villari 1997 is reassigned to the genus *Cerithiopsis*.

RESUMEN

Se revisa la taxonomía de las especies mediterráneas de Cerithiopsidae con escultura formada por dos filas de gránulos. Las dos especies previamente conocidas se asignan respectivamente a *Dizoniopsis coppolae* (Aradas, 1870) y *D. concatenata* (Conti, 1864) y se consideran distintas de la especie tipo fósil *Dizoniopsis bilineata* (Hörnes, 1848). Dos especies adicionales, que se encuentran en el estrecho de Gibraltar en simpatría con las anteriores, se describen como nuevas. *Dizoniopsis micalii* Cecalupo y Villari 1997 se reubica en el género *Cerithiopsis*.

INTRODUCTION

The Cerithiopsidae are a family of small gastropods, distributed worldwide in tropical and temperate shelf environments. There are many genera and species, difficult to recognize because there is very little differentiation in shell morphology. All may be characterized by small (3 to 10 mm) size, brown to dark colour, high spire and usually a spiral sculpture of beaded cords. Cerithiopsidae are specialized for feeding on sponges and this feature is shared with the Triphoridae, another family in which differentiation at generic level is not reflected in shell characters. The question of the relationship between the two families remains beyond the scope of this paper.

---

* Muséum National d'Histoire Naturelle, Département Systématique et Evolution USM 603/UMR 7138 " Systématique, Adaptation, Evolution", Equipe "Exploration de la Biodiversité", Case Postale 51, 55, Rue Buffon, F-75231 Paris Cedex 05, France.

** Departamento de Biología Animal, Facultad de Ciencias, Universidad de Málaga, Campus de Teatinos - E-29071 Málaga, Spain.

*** Department of Invertebrate Zoology, Swedish Museum of Natural History, Box 50007, SE-10405 Stockholm, Sweden.

The genus-level taxonomy of the Cerithiopsidae remains to be worked out in most areas of the world, including Europe. The most relevant contribution is that of MARSHALL (1983) based on New Zealand species. The Mediterranean species have been described in numerous papers, scattered in the literature and usually dealing with one or two species at a time. It was our intention, many years ago, to provide a revision of all European species known to date. For this we accumulated substantial data, but the revision was not completed and, meanwhile, most of the species then undescribed were named by other authors.

Among European cerithiopsids, a noteworthy and easily recognized morphological group is composed by species in which the teleoconch sculpture is composed of only two rows of beads until at least the penultimate whorl. In most of the other Mediterranean species of the family, there are two (rarely three) cords on the first teleoconch whorl and a third one is added very early, adapically along the suture.

SACCO (1895) introduced *Dizoniopsis* as a subgenus of *Cerithiopsis*, for Neogene fossils which were said to differ by having two rows of granules per whorl only. This character is shared by some Recent Mediterranean representatives, for which the name of the Miocene type species has been repeatedly used. There are two clearly different Recent species, long recognized by Mediterranean authors, but much confusion has arisen regarding which name should be used for one or another of them.

This report is mostly based on material collected around Ceuta, in the westernmost part of the Mediterranean, during a workshop organized by Philippe Bouchet (Muséum National d'Histoire Naturelle, Paris) and José Carlos Garcia Gómez (Universidad de Sevilla), in May 1986. We here summarize published records on the two previously known species, and describe two additional species from the Strait of Gibraltar.

Abbreviations:

MNHN	Muséum National d'Histoire Naturelle, Paris
sh.	shell(s)
spm	live taken specimen(s)

Genus *Dizoniopsis* Sacco, 1895

Type species: *Cerithium bilineatum* Hörnes, 1848, by original designation (Steinebrunn, Middle Miocene, Vienna Basin)

The type species of *Dizoniopsis* has been illustrated by LANDAU, LA PERNA AND MARQUET (2006) who designated a lectotype. The illustrated protoconch is incompletely preserved but conserves nearly two whorls, and therefore is presumably multispiral with nearly three whorls if complete. The sculpture of this protoconch consists of two moderate spiral keels on the penultimate whorl, the abapical one becoming concealed by the suture on the last whorl, and of flexuose axial riblets forming a reticulate pattern with the keels.

This protoconch morphology differs radically from that of the two Recent Mediterranean species, adequately illustrated and discussed by PALAZZI AND VILARI (2001). Conversely, it is quite similar to the protoconch of the Recent *Dizoniopsis apexclarus* Rolán, 2007, described from the islands of the Gulf of Guinea, which differs in having a single keel on the penultimate whorl and hardly more than two whorls in total.

The outcome is that the name *Dizoniopsis bilineata* cannot be used for a Recent Mediterranean species. Other available names which have been used for this group of species, viz. *Cerithiopsis clarkii* Forbes and Hanley, 1851, *Cerithium concatenatum* Conti, 1864 and

Cerithiopsis coppolae Aradas, 1870, are discussed hereafter.

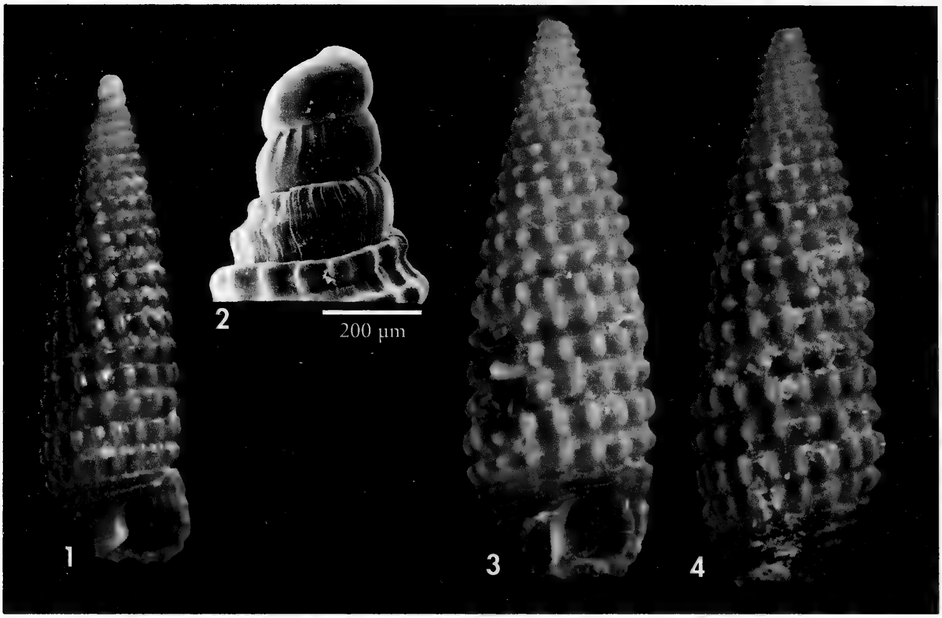
An additional Mediterranean species was originally described as *Dizoniopsis micalii* by Cecalupo and Villari (1997) and is still currently held in this binomen. It differs from the species discussed herein in both the protoconch and teleoconch characters, and we consider it better assigned to *Cerithiopsis* s. l. Its protoconch has axial ribs resembling *Cerithiopsis scalaris* Locard, 1892 whereas the teleoconch starts with two rows on granules on the early whorls as most *Cerithiopsis* species, but later completes three rows like in the type species *Cerithiopsis tubercularis*.

Dizoniopsis coppolae (Aradas, 1870) (Figs. 1-4)

Cerithiopsis coppolae Aradas, 1870: *Atti Accad. Gioenia Sc. Nat.*, (3) 4: 263-268 [Ognina near Catania, Sicilia] – Pallary, 1920, *Expl. Scient. Maroc*: 45 .
Cerithiopsis bilineata var. *ventricosa* Brusina, 1871, *Bull. Malac. Ital.*, 4: 5-7 [Croatia]
Cerithiopsis bilineata [non (Hörnes, 1848)] – Monterosato, 1877, *J. Conchyl.*, 25: 41; Monterosato, 1878, *Giorn. Sc. Nat. Econ. Palermo*, 99; Kobelt, 1908, *Iconogr.* vol. 4: 118, pl. 120, fig. 14-15.
Cerithiopsis (Dizoniopsis) bilineata [non (Hörnes, 1848)] – Nordsieck, 1968, *Europ. Meeres-Gehäuseschnecken*: 70, pl. 11 fig. 43.10.
Dizoniopsis euxinica haifensis Nordsieck, 1972, *Arch. Molluskenk.*, 102: 234 [Shiqmona, Israel].
Cerithiopsis (Dizoniopsis) bilineata [non (Hörnes, 1848)] and var. *concatenata* [non (Conti, 1864)] – Fekih and Gougerot, 1974, *Bull. Inst. Océanogr. Pêche Salammbô*: 184-185, 207-208.
Cerithiopsis (Dizoniopsis) coppolae Aradas, 1870 – Nordsieck, 1976, *La Conchiglia* 87-88: 7 – Palazzi and Villari, 2001, *La Conchiglia*, 297, suppl.: 15-18, 38-40.
Dizoniopsis coppolae (Aradas, 1870) – Oliver Baldoví, 2007, *Iberus* 25(2): 32.

Type material: *C. coppolae,* whereabouts unknown. *C. bilineata* var. *ventricosa*: 61 syntypes from mixed Dalmatian localities (Otok, Lapad, Lokrum) in Croatian Natural History Museum, Zagreb, reg. n° 1295, and 13 syntypes in Jeffreys collection ex Brusina, USNM 187810. *D. euxinica haifensis*: 7 syntypes SMF 239381/1 (the shell figured by Nordsieck) and 239382/6.
Material examined: Portugal. - Sagres, Ponta da Baleeira, 37° 00.3′ N – 08° 55.5′ W, 17-23 m, 2 sh. (4.0 × 1.5 to 4.8 × 1.8 mm without protoconch), Mission Algarve 1988 (MNHN). Morocco.- Asilah, from beach drift, 4 sh. (up to 3.5 × 1.3 mm without protoconch). Strait of Gibraltar. – Ceuta, Punta Almina, 35° 54.1′ N – 05° 16.5′ W, submarine cliff 25-40 m, 2 sh. (4.4 × 1.7 mm, 5.1 × 1.8 mm, MNHN). Ceuta, Punta del Desnarigado, 35° 53.6′ N – 05° 16.8′ W, 16-20 m, 1 old sh. (4.8 × 1.8 mm, MNHN). Italy, Sicily. - Acitrezza, 1 sh. (3.9 × 1.3 mm), Mission Sicile 1990 (MNHN). Brucoli, 1 sh. (4.7 × 1.4 mm), Mission Sicile 1990 (MNHN). Tunisia. – Djerba, 78 sh. (3.5 × 1.2 to 4.7 × 1.4 mm), col. Bouchet and Warén, 1982 (MNHN).

Description: Shell up to a little more than 5 mm, high conical, solid, with about 2 $^{1}/_{4}$ protoconch whorls and 10-12 teleoconch whorls. Protoconch narrow and styliform, easily broken off, with convex whorls and a sculpture of flexuous axial riblets which start from the adapical suture and gradually fade out; these are irregularly distributed on the last protoconch whorls and vary in strength among individuals. Sculpture of teleoconch composed by two spiral cords, approximately as broad as the intervening space, crossed by axial ribs which form very distinct beads at their intersection with the cords. On the first teleoconch whorl, the abapical cord is more prominent than the other one and the axial ribs are not very conspicuous. On the following whorls, the adapical cord progressively takes over as the thickest one. On the last whorl, the beads of the adapical cord become slightly more elongated but do not split. The abapical part of the body whorl bears one cord, slightly ragged but not beaded, in prolongation of the suture, and two more similar cords between this and the siphonal canal; these cords are markedly narrower than the beaded cords on the ribs and the spaces between them are crossed by raised



Figures 1-4. ***Dizoniopsis coppolae*** (Aradas, 1870). 1: shell from Djerba, Tunisia (actual size 4.4 mm); 2: protoconch of another specimen from the same locality (scanning electron micrograph; 3, 4: shell from Ceuta, Strait of Gibraltar, Punta Almina 25-40 m (actual size 5.1 mm).
Figuras 1-4. Dizoniopsis coppolae *(Aradas, 1870). 1: concha de Djerba, Túnez (tamaño real 4,4 mm); 2: protoconcha de otro ejemplar de la misma localidad (micrografía electrónica de barrido); 3, 4: concha de Ceuta, estrecho de Gibraltar, Punta Almina 25-40 m (tamaño real 5,1 mm).*

threads parallel to the growth lines. Aperture oval, with a broad and short siphonal canal and a smaller channel at the opposite end. Adult shells have a rounded, but not thickened edge to the outer lip. Colour brown, grading to paler or even white towards the apical whorls; the nodes are paler with a greyish hue contrasting with the dark brown on spaces between nodes on the cords, and the abapical cords are also somewhat darker than the intervening spaces. Animal unknown.

Remarks: It is strange that ARADAS (1870) dedicated a special paper to the description of this species whereas a few years later ARADAS AND BENOIT (1876: 239) do not list it as valid, mentioning instead that some authors hold it as a variety of *Cerithium tuberculare*, and do not even retain *Cerithiopsis* as distinct from *Cerithium*. Most Mediterranean authors subsequently used the name *Cerithiopsis bilineata* for this species, following the lead by MONTEROSATO (1878).

This species has been adequately figured and discussed by PALAZZI AND VILLARI (2001) who noted the variability in the protoconch sculpture. The distribution of this species seems to be restricted. It is widespread in the Eastern and Central Mediterranean, but there are hardly any records from the coasts of France and Spain in the Western basin, and it is represented in our material from the Strait of Gibraltar by only three old shells. It is nevertheless cited by OLIVER BALDOVÍ (2007) in shell grit surrounding *Posidonia* grounds in the bay of Valencia, and by PALLARY (1920) from the Atlantic coast of Morocco. The specimens collected in the Strait of Gibraltar and in the Algarve are somewhat larger and broader than those from Tunisia and Sicily, and all lack a protoconch.

Dizoniopsis concatenata (Conti, 1864) (Figs. 5-12)

Cerithium concatenatus Conti, 1864, *Il Monte Mario..*: 51. – Landau, La Perna and Marquet, 2006, *Palaeontos* 10: 11, 15-16.

Cerithiopsis clarkii [non Forbes and Hanley, 1851] – Monterosato, 1877, *J. Conchyl.*, 25: 41; Monte[illegible]378, *Giorn. Sc. Nat. Econ. Palermo*, 99; Kobelt, 1908, *Iconogr.* vol. 4: 126-127, pl. 120, fig. 11-12.

Cerithiposis bilineata var. *concatenata* (Conti, 1864) - Cerulli-Irelli, 1912, *Palaeontogr. Ital.*, 18: 149, pl. 23 fig. 50-51.

Cerithiopsis bilineata var. *ventricosa* [non Brusina, 1871] – Bucquoy, Dautzenberg and Dollfus, 1884, *Moll. Roussillon*, vol. 1: 205-206, pl. 27 fig. 10-12.

Cerithiopsis (Cerithiopsida) clarki [non Forbes and Hanley, 1851] – Nordsieck, 1968, *Europ. Meeres-Gehäuseschnecken*: 70, pl. 11 fig. 43.31.

Cerithiopsis (Dizoniopsis) clarkii [non Forbes and Hanley, 1851] – Fekih and Gougerot, 1974, *Bull. Inst. Océanogr. Pêche Salammbô* 3: 184-185, 207-208.

Cerithiopsis (*Dizoniopsis*) *bilineata* [non (Hörnes, 1848)] – Nordsieck, 1976, *La Conchiglia* 87-88: 7, 18 (en parte) – Ros and Altimira 1977: 53 "de color pardo oscuro en los individuos recolectados vivos"

Cerithiopsis bilineata [non (Hörnes, 1848)] – Giannuzzi Savelli et al., 1999: 44-45, fig. 76 a,b. – Oliver Baldoví, 2007, *Iberus*, 25 (2): 49, fig. 34-35.

Cerithiopsis (Dizoniopsis) concatenata (Conti, 1864) – Palazzi and Villari, 2001, *La Conchiglia*, 297, suppl.: 15-18, 38-40.

Type material: Lectotype (Landau, La Perna and Marquet, 2006) in coll. Cerulli-Irelli, Museo di Paleontologia dell'Università di Roma "La Sapienza" (see remarks below).
Material examined: Portugal. - Sagres, Bay of Baleeira, 37° 00.7′ N – 08° 55.0′ W, 3-15 m, 1 spm. drawing AL 132. (3.6 × 1.4 mm without protoconch), Mission Algarve 1988 (MNHN). Strait of Gibraltar. - Ceuta, Punta del Saudiño, 35° 54.1′N – 05° 18.0′W, submarine cliff 17-35 m; drawing CE 38, 2 spm. (4.1 × 1.4, 4.0 × 1.4 mm); Punta del Desnarigado, 35° 53.6′ N – 05° 16.8′ W, 16-20 m, 1 old sh. (MNHN). Mediterranean France. - Le Dramont 22-30 m, 3 sh. (up to 3.7 × 1.2 mm), leg. Pelorce (MNHN). Iles d'Hyères, Grande Passe 112-113 m, 2 sh. (3.8 × 1.2, 5.2 × 1.7 mm) leg. Picard 1956 (MNHN). Cap Morgiou, Calanque de la Triperie 22 m, 1 sh. juv., leg. Zibrowius 1996 (MNHN). Unknown origin, possibly Roussillon, 2 spm. figured in Bucquoy, Dautzenberg and Dollfus (1884), pl. 27 fig. 10-11 as *C. bilineata* var. *ventricosa* (3.9 × 1. 3 mm). Corsica. - Calvi, 1 spm. (4.5 × 1.5 mm, MNHN). Italy. - Camogli, Genova, 42 m, 1 sh. (3.0 × 1.2 mm). Capraia, Le Formiche, 3 sh. (3.1 × 1.1 to 4 × 1.2 mm), leg. Palazzi (MNHN); Livorno 7-17 m, 2 spm. (4.2 × 1.2), leg. Palazzi (MNHN). Sicily, Acitrezza 36 m, 4 sh. (full grown 3.2 × 1.1 to 4.0 × 1.4 mm), leg. Spada (SMNH). Acitrezza, 1 sh. (4.3 × 1.3 mm), Mission Sicile 1990 (MNHN).

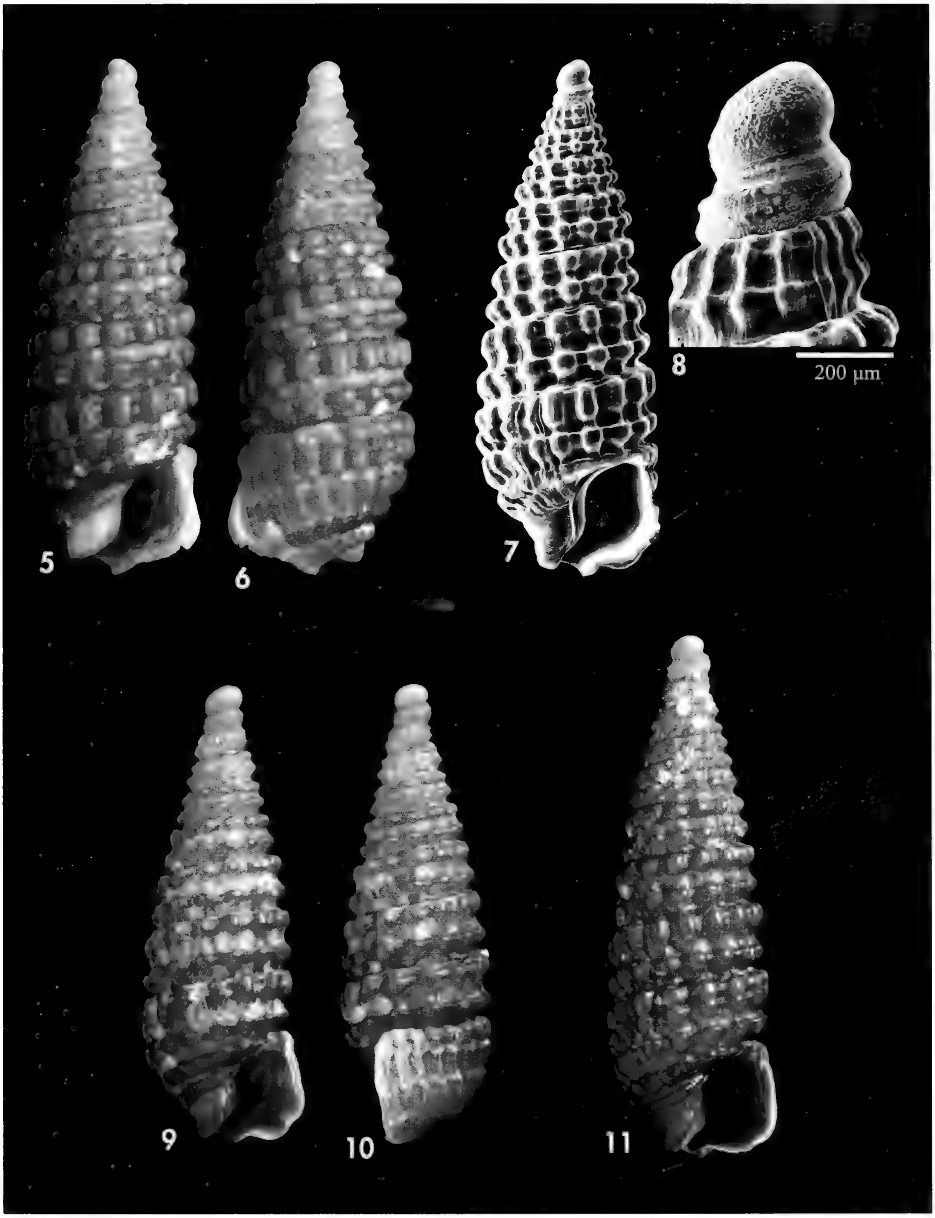
Description: Shell up to a little more than 5 mm, high conical, solid, with about 2 $^1/_4$ protoconch whorls and 7 to 8 $^1/_2$ teleoconch whorls. Protoconch narrow and styliform, easily broken off, the first whorl rounded with a frosted surface, the following with two well-defined keels appearing progressively and running rather close together along the middle part of the whorl, more or less connecting to the start of the beaded cords on the first teleoconch whorl. Limit protoconch-teleoconch not very distinct. Sculpture of teleoconch composed by two spiral cords, approximately as broad as the intervening space, crossed by axial ribs which form very distinct beads at their intersection with the cords. On the first teleoconch whorl, the abapical cord is markedly more prominent than the other one and overhangs the suture of the following whorl; the axial ribs are there comparatively more apparent and more crowded than on the second teleoconch whorl. On the following whorls, the adapical cord progressively takes over as the thickest one. On the last whorl, the beads of the adapical cord become elongated in the axial direction and, on the section preceding the aperture of adult specimens, this cord tends to split and form two contiguous rows of beads, which become still more narrow and elongate. The abapical part of the body whorl bears one thick beaded cord in prolongation of the suture and another one, flatter and not distinctly beaded, in the intervening space between this and the siphonal canal. Aperture oval, with a broad and short siphonal canal and a smaller channel at the opposite end. Adult shells have a rounded, but not thickened edge to the outer lip. Colour brown, grading to paler or even white towards the apical whorls.

Animal with an elongated foot, with propodium truncated in front and bordered anteriorly by a mentum, the median part rather narrowing, and the metapodium broadly ovate. Opening of the pedal gland conspicuous at the anterior end of metapodium, prolonged towards the posterior end by an axial groove on the sole. Head devoid of snout, provided with two elongate cephalic tentacles which are not separated at their base by any rim or swelling, and form a V-shape when extended. Eyes black, rounded, situated within the base of the tentacles without forming a distinct swelling, not surrounded by any opaque granular material. Opercular lobe rather thick, not containing any opaque granular material. Mantle with a smooth edge.

Remarks: This species is clearly separated from *Dizoniopsis coppolae* and *D. bilineata* by both protoconch and teleoconch characters. The protoconch lacks axial sculpture, whereas on *D. coppolae* it is covered with flexuous axial ribs and lacks spiral keels (see PALAZZI AND VILLARI, 2001: figs 65-69); its two peripheral keels remain on the median part of the whorl contrary to the fossil *D. bilineata* in which the abapical keel is concealed by the suture on the last protoconch whorl. The teleoconch differs from *D. coppolae* in several clearcut characters of the body whorl. The subsutural cord definitely splits before reaching the outer lip of the aperture, and there accounts for more than one-third of the height of the whorl, whereas in *D. coppolae* this cord does not split and does not exceed one-quarter of the height of the whorl. The most obvious distinguishing feature is that there are only two abapical cords on the base (one in prolongation of the suture, and one more) whereas there are three (one in the prolongation of the suture and two more) in *D. coppolae*. The colour pattern is also different. Although grading from lighter to darker from apex to later whorls, it is uniformly brown on one particular whorl whereas in *D. coppolae* the nodes have a greyish hue contrasting with the dark brown on spaces between nodes on the cord, and with an intermediate light brown in the intervening spaces between cords; it is clear from this that ROS AND ALTIMIRA (1977) observed this species, and not *D. coppolae*, on the Catalan coast.

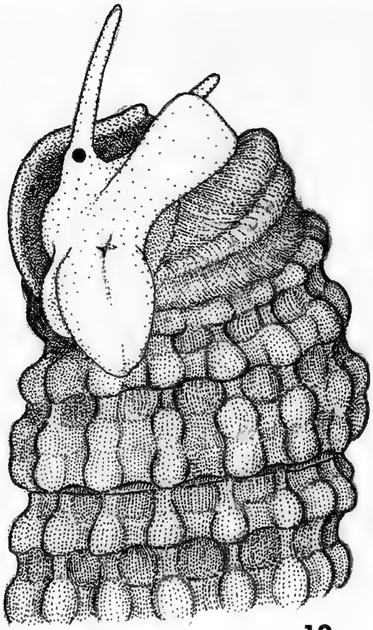
The areas behind the eyes and beneath the operculum are translucent and similar in texture to the remaining surface of the body, contrary to most cerithiopsids we have observed and particularly to *Cerithiopsis tubercularis*, where these areas are densely furnished with whitish or yellowish granules. The animal was observed alive in two different localities (Ceuta and Algarve) which rules out that this difference is accidental.

MONTEROSATO (1877, 1878) was the first to distinguish two species among Mediterranean cerithiopsids having two rows of granules, and used for them respectively the names *Cerithiopsis bilineata* (considering *C. coppolae* as a synonym) and *C. clarkii*. *Cerithiopsis clarkii* Forbes and Hanley, 1851 (vol. 3 p. 368, vol. 4 pl. 103 fig. 6) was introduced conditionally, based on a specimen collected at Exmouth, in the English Channel. All the species of Cerithiopsidae found in Britain, including the type species *Cerithiopsis tubercularis* (Montagu, 1803), have normally three rows of granules on the whorls but may occasionally display two or four rows, usually after an accident in shell growth. Therefore JEFFREYS (1867: 267) was definitely correct in his interpretation of the specimen as a teratological "Monstr. *Clarkii*" of *Cerithiopsis tubercu-*

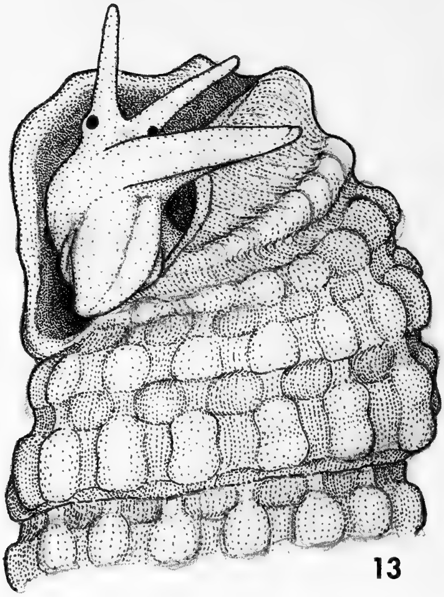


Figures 5-11. *Dizoniopsis concatenata* (Conti, 1864). 5, 6: specimen from Ceuta, Strait of Gibraltar, Punta del Saudiño 17-35 m (actual size 4.1 mm, same specimen as fig. 12); 7: another specimen from the same locality (scanning electron micrograph, actual size 4.1 mm); 8: protoconch, same specimen; 9, 10: shell from Le Dramont, Mediterranean coast of France, 22-30 m (actual size 3.6 mm); 11: shell from Aci Trezza near Catania, Sicily (actual size 4.1 mm).

Figuras 5-11. Dizoniopsis concatenata *(Conti, 1864). 5, 6: ejemplar de Ceuta, estrecho de Gibraltar, Punta del Saudiño 17-35 m (tamaño real 4,1 mm, mismo ejemplar que fig. 12); 7: otro ejemplar de la misma localidad (micrografía electrónica de barrido, tamaño real 4,1 mm); 8: protoconcha, mismo ejemplar; 9, 10: concha de Le Dramont, costa mediterránea de Francia, 22-30 m (tamaño real 3,6 mm); 11: concha de Aci Trezza cerca de Catania, Sicilia (tamaño real 4,1 mm).*



12



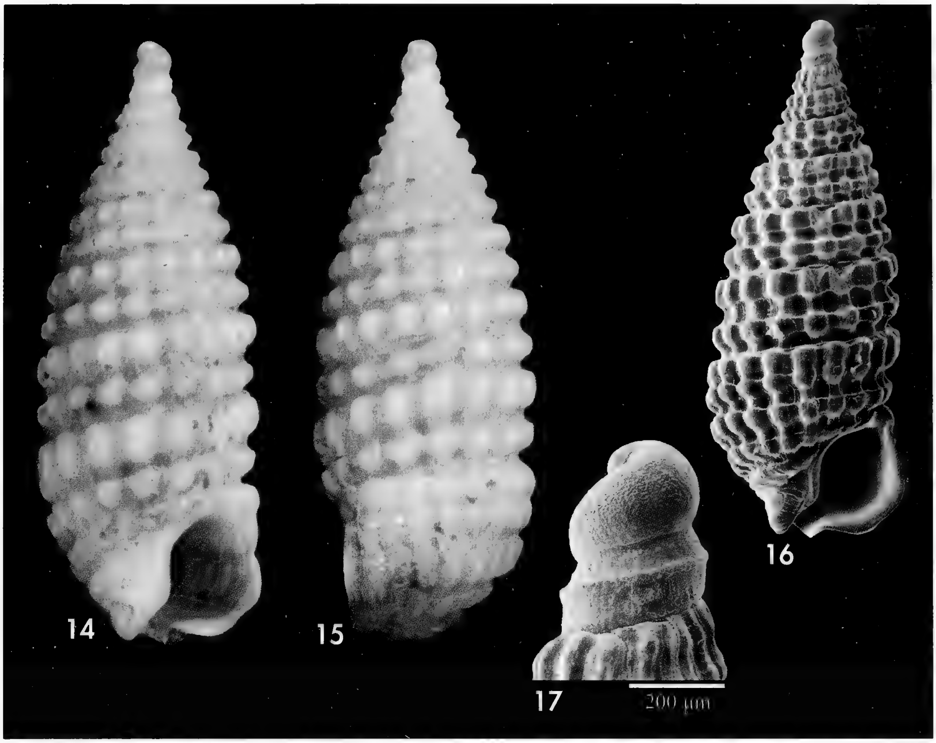
13

Figure 12. *Dizoniopsis concatenata* (Conti, 1864), living animal from Ceuta, Strait of Gibraltar, Punta del Saudiño 17-35 m (same specimen as fig. 5-6). Figure 13. *Dizoniopsis aspicienda* spec. nov., living animal of the holotype from Ceuta, Strait of Gibraltar, Punta Almina 25-40 m (same specimen as fig. 14-15).

Figura 12. Dizoniopsis concatenata *(Conti, 1864), animal vivo de Ceuta, estrecho de Gibraltar, Punta del Saudiño 17-35 m (mismo ejemplar que fig. 5-6). Figura 13.* Dizoniopsis aspicienda *spec. nov., animal vivo del holotipo de Ceuta, estrecho de Gibraltar, Punta Almina 25-40 m (mismo ejemplar que fig. 14-15).*

laris, noting that the early whorls have the usual three rows, and this was also the view of Marshall (1911). Nordsieck (1968) first used the name *Cerithiopsis (Cerithiopsida) clarki* (written with one "i") for this species, but later (Nordsieck, 1976) assigned it to *C.bilineata* and considered *C. clarki* (based on the figure of Forbes and Hanley) to occur only in the Atlantic. His figure of *C. bilineata* on p. 18 is nevertheless *C. coppolae*.

Cerulli-Irelli (1912) used the name *C. bilineata* var. *concatenata* (Conti, 1864) and illustrated a specimen from the type locality, the lower Pleistocene strata of Monte Mario near Rome, which is definitely the species considered here. The same shell is again figured by Landau, La Perna and Marquet (2006) and designated as lectotype of *Cerithium concatenatus* Conti, 1864. Cerulli-Irelli stated to have identified his specimens by comparison with Conti's type material. This interpretation was also that of Palazzi and Villari (2001) but contradicts Monterosato (1884: 134; 1890: 163) and Marshall (1895: 38) who considered that *Cerithium concatenatus* was the same as *Cerithiopsis pulchella* Jeffreys, 1858 (= *C. jeffreysi* Watson, 1885). However, both are somewhat at odds with Conti's original description (reproduced in van Aartsen, Menkhorst and Gittenberger, 1984: 29), which mentions three rows of granules on the whorls and four on the body whorl of which there is one smaller next to the



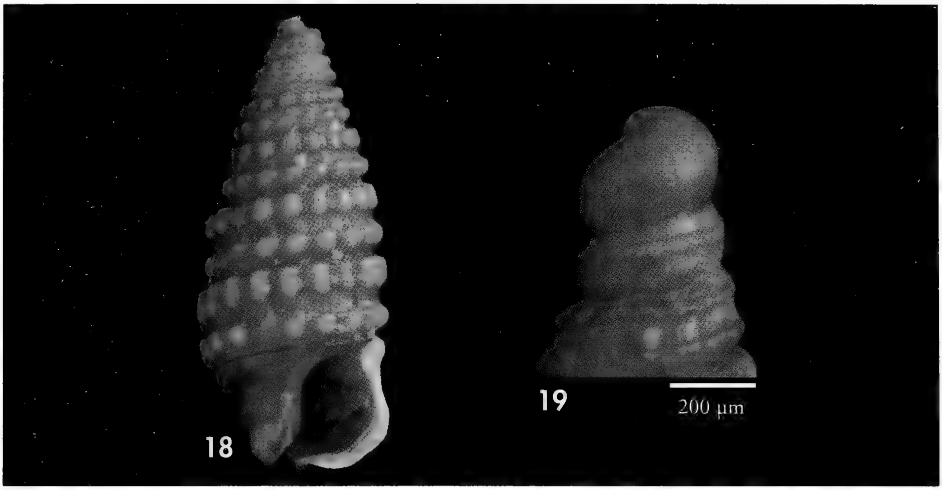
Figures 14-17. *Dizoniopsis aspicienda* spec. nov. 14, 15: holotype, specimen from Ceuta, Strait of Gibraltar, Punta Almina 25-40 m (actual size 4.9 mm); 16: paratype, specimen from Ceuta, Benzú, 24 m (scanning electron micrograph, actual size 4.2 mm); 17: protoconch, same specimen.
Figuras 14-17. Dizoniopsis aspicienda *spec. nov. 14, 15: holotipo, ejemplar de Ceuta, estrecho de Gibraltar, Punta Almina 25-40 m (tamaño real 4,9 mm); 16: paratipo, ejemplar de Ceuta, Benzú, 24 m, (micrografía electrónica de barrido, tamaño real 4,2 mm); 17: protoconcha, mismo ejemplar.*

suture and the two on the middle of the whorl merging into a single one (hence the name).

Our understanding of the taxon is here based on the lectotype illustrated by LANDAU, LA PERNA AND MARQUET (2006). This specimen may not be eligible as such because of not forming part of Conti's original material, the whereabouts of which are unknown. It is not desirable as a neotype either, because it lacks a protoconch. Therefore, if it is demonstrated that this is not Conti's species, it may have to be named as a new species but we nevertheless consider it more parsimonious, for the stability of nomenclature, to continue usage of this name instead of leaving *Cerithium concatenatus* as a *nomen dubium*.

Dizoniopsis aspicienda spec. nov. (Figs. 13-17)

Type material: Holotype, live-collected specimen, Ceuta, Punta Almina, 35° 54.1′ N – 05° 16.5′ W, 38-40 m, drawing CE 18 (4.9 × 1.8 mm), MNHN 23283. Paratype, Ceuta, Benz, 35° 55.0′ N, 05° 22.5′ W, 24-26 m (4.2 × 1.6 mm), MNHN 23284.
Etymology: meaning "worth looking at", alluding to the handsome aspect of the species.



Figures 18, 19. *Dizoniopsis abylensis* spec. nov. 18: holotype, shell from Ceuta, Strait of Gibraltar, Punta del Saudiño 17-35 m (actual size 3.8 mm); 19: protoconch of a juvenile shell from Ceuta, Punta Bermeja, 27-32 m.

Figuras 18, 19. Dizoniopsis abylensis *spec. nov. 18: holotipo, concha de Ceuta, estrecho de Gibraltar, Punta del Saudiño 17-35 m (tamaño real 3,8 mm); 19: protoconcha de una concha juvenil de Ceuta, Punta Bermeja, 27-32 m.*

Description: Shell up to nearly 5 mm, definitely cyrtoconoid, solid, with about 2 protoconch whorls and 7 to 7 $^1/_2$ teleoconch whorls. Protoconch narrow and styliform, easily broken off, the first whorl with a frosted surface, the following with one well-defined keel appearing progressively and running at about two-thirds of the whorl, closer to the adapical suture, and a less pronounced one situated more abapically; both more or less connecting to the start of the beaded cords on the first teleoconch whorl. Limit protoconch-teleoconch not very distinct. Sculpture of teleoconch composed of two spiral cords, approximately as broad as the intervening space, crossed by axial ribs which form very distinct beads at their intersection with the cords. On the first teleoconch whorl, the abapical cord is markedly more prominent than the other one and overhangs the suture of the following whorl. On the following whorls, the adapical cord progressively takes over as slightly thicker. On the last whorl, the beads of the adapical cord become elongated in the axial direction and, on the section preceding the aperture of adult specimens, this cord tends to split and form two contiguous rows of beads. The abapical part of the body whorl bears one thick beaded cord in prolongation of the suture and another one, flatter and not distinctly beaded, in the intervening space between this and the siphonal canal. Aperture oval, with a broad and short siphonal canal and a smaller channel at the opposite end. Adult shells have a rounded, but not thickened edge to the outer lip. Colour white to very pale tan.

Animal essentially like in *D. concatenata*, but markedly smaller in relation to the shell and with cephalic tentacles broader and flatter.

Remarks: This species is only represented by these two specimens, but is clearly separable from sympatric *D. concatenata* by having a pale, nearly white shell, by the cyrtoconoid, rather pupoid teleoconch which is markedly broader at the same height, and by lacking the paired keels on the later larval whorls. Like *D. concatenata*, it has been observed to lack the granular masses behind the eyes and beneath the operculum.

Dizoniopsis abylensis spec. nov. (Figs. 18-19)

Type material: Holotype, shell, Ceuta, Strait of Gibraltar, Punta del Saudiño, 35° 54.1′ N – 05° 18.0′ W, submarine cliff 17-35 m; m (3.8 × 1.6 mm), MNHN 23285. Paratype, juvenile shell from Ceuta, Punta Bermeja, 35° 54.6′ N – 05° 20.3′ W, 27-32 m (1.8 mm), MNHN 23286.
Etymology: from Abyla, the name of Ceuta in classical Antiquity.

Description: Shell up to nearly 4 mm, slightly cyrtoconoid, solid, with about 2 protoconch whorls and 7 teleoconch whorls. Protoconch narrow and styliform, easily broken off, the first whorl rounded with a frosted surface, the following with two well-defined keels appearing progressively and running along the middle part of the whorl, more or less connecting to the start of the beaded cords on the first teleoconch whorl. Limit protoconch-teleoconch not very distinct. Sculpture of teleoconch composed by two spiral cords, approximately as broad as the intervening space, crossed by axial ribs which form very distinct beads at their intersection with the cords. On the first teleoconch whorl, the abapical cord is markedly more prominent than the other one and overhangs the suture of the following whorl. On the last two whorls, the adapical cord progressively takes over as slightly thicker. On the last whorl, this cord tends to split and form two contiguous rows of beads. The abapical part of the body whorl bears one well defined, smooth cord in prolongation of the suture and the intervening space between this and the siphonal canal is smoothish and excavated, with a weak spiral swell which is too poorly defined to be taken as a cord. Aperture oval, with a broad and short siphonal canal and a smaller channel at the opposite end. Adult shells have a rounded, but not thickened edge to the outer lip. Colour pale brown, with the beads on the spiral cords lighter, the intervening spaces between beads on the cords and the smooth cord on the base darker. Animal unknown.

Remarks: Although represented by only one adult specimen and a juvenile, this species is so strikingly different from the other two sympatric species of *Dizoniopsis* that we venture its description as new. The shell is stouter than *D. concatenata* and *D. aspicienda*, but the most noteworthy character is the configuration of the base with one smooth cord in prolongation of the suture (distinctly beaded in the other two species) and an excavated surface between this and the suture (furnished with a distinct cord in the other two species); this character is held as significant since the holotype is a completely adult individual with a well-formed aperture. The colour pattern is also different, and reminiscent of *D. coppolae* with lighter beads contrasting on cords which are darker than the intervening spaces; however the latter differs in having three cords on the base and a very different protoconch, with axial ribs.

BIBLIOGRAPHY

ARADAS A. 1870. Descrizione di una specie malacologica nuova. *Atti dell'Accademia Gioenia di Scienze Naturali*, (3) 4: 263-268.

ARADAS A. AND BENOIT L. 1872-1876. Conchigliologia vivente marina della Sicilia. *Atti dell'Accademia Gioenia di Scienze Naturali*, (3) 6: 1-112 + pl. 1-2 [1872]; 113-226 + pl. 3-4 [1874]; 227-324 + pl. 5 [1876] (dates of publication according to Bouchet P. 1982, *Bollettino Malacologico* 18: 177-180).

CECALUPO A. AND VILLARI A. 1997. *Dizoniopsis micalii*. Una nuova specie per il Mediterraneo (Mesogastropoda: Cerithiopsidae). *Bollettino Malacologico*, 32 (1-4): 41-44.

CERULLI-IRELLI S. 1912. Fauna Malacologica Mariana. Parte 6. Gastropoda: Cerithiidae Cerithiopsidae, Triforidae, Diastomidae, Vermetidae, Turritellidae, Mathildidae, Caecidae. *Palaeontographia Italica*, 18: 141-169. pl. 23-25.

Conti A. 1864. *Il Monte Mario ed i suoi fossili subappennini raccolti e descritti dallo scultore e paleontologo*. Roma, G. Cesaretti, 57 pp.

Fekih M. and Gougerot L. 1974. Liste commentée des gastéropodes testacés marins recueillis dans les dépots littoraux actuels du Golfe de Tunis. *Bulletin de l'Institut National Scientifique et Technique d'Océanographie et de Pêche de Salammbo*, 3 (1-4): 185-232

Forbes E. and Hanley S.C. 1848-1853. *A history of British Mollusca and their shells*. London, van Voorst. Vol. 1: 1-486 (1848). Vol. 2: 1-480 (1 dec. 1849); 481-557 (1850). Vol. 3: 1-320 (1850) 321-616 (1851). Vol. 4: 1-300 (1852). Introduction, plates I-LXXX [1853].

Giannuzzi-Savelli R., Pusateri F., Palmeri A. and Ebreo C. 1999. *Atlante delle conchiglie marine del Mediterraneo, vol. 3 : Caenogastropoda (parte 2: Ptenoglossa)*. Evolver, Roma. 127 p.

Jeffreys J. G. 1862-1869. *British Conchology*. London, van Voorst. Vol. 1: pp. CXIV + 341 [1862]. Vol. 2: pp. 479 [1864]. Vol. 3: pp. 394 [1865]. Vol. 4: pp. 487 [1867]. Vol. 5: pp. 259 [1869].

Kobelt W. 1906-1908. *Iconographie der schalentragende europäischen Meeresconchylien*. Part 4: 1-80, pl. 99-114 [1906]; 81-172, pl. 115-126 [1908]. Wiesbaden, C.W. Kreidel.

Landau B., La Perna R. and Marquet R. 2006. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain, Part 6: Triphoroidea, Epitonioidea, Eulimoidea. *Palaeontos*, 10: 1-96, pl. 1-22.

Marshall B.A. 1978. Cerithiopsidae (Mollusca: Gastropoda) of New Zealand, and a provisional classification of the family. *New Zealand Journal of Zoology*, 5: 47-120.

Marshall J.T. 1895. Alterations in 'British Conchology'. [Part III.]. *Journal of Conchology* 8: 24-41 [January 1895].

Marshall J.T. 1911-1912. Additions to British Conchology. Part VII. *Journal of Conchology* 13: 179-190 [April 1911]; 192-209 [July 1911]; 223-231 [October 1911]; 294-306 [April 1912], 324-338 [July 1912].

Monterosato T. A. di 1877. Note sur quelques coquilles provenant des côtes d'Algérie. (Trad. di H. Crosse). *Journal de Conchyliologie*, 25 (1): 24-49, pl. 2, 3.

Monterosato T. A. di 1878. Enumerazione e sinonimia delle Conchiglie mediterranee. *Giornale di Scienze Naturali ed Economiche di Palermo*, 13: 61-115.

Nordsieck F. 1976. Il genere *Cerithiopsis* Forbes & Hanley, 1849 nei mari d'Europa. *La Conchiglia*, 87-88: 3-7.

Oliver Baldoví J.D. 2007. Catálogo de los Gasterópodos testáceos marinos de la parte Sur del Golfo de Valencia (España). *Iberus*, 25 (2): 29-61.

Palazzi S. and Villari A. 2001. Molluschi e Brachiopodi delle grotte sottomarine del Taorminense. *La Conchiglia*, 297, suppl., 56 pp.

Pallary P. 1920. *Exploration scientifique du Maroc organisée par la Société de Géographie de Paris et continuée par la Société des Sciences Naturelles du Maroc*. Deuxième fascicule. Malacologie (1912). 108 p., 1 pl., 1 map. Rabat and Paris, Larose.

Rolán E. 2007. A new species of *Dizoniopsis* (Prosobranchia, Cerithiopsidae) from the Gulf of Guinea Islands. *Iberus*, 25 (1): 33-36.

Ros J.D. and Altimira C. 1977. Comunidades bentónicas de sustrato duro del litoral NE español. V. Sistemática de moluscos. *Miscel·lània Zoològica*, 4 (1): 43-55.

Sacco F. 1895. *I Molluschi dei terreni terziarii del Piemonte e della Liguria. Parte XVII (Cerithiidae, Triforidae, Cerithiopsidae e Diastomidae)*. 83 p, 3 pl. Torino, Carlo Clausen.

van Aartsen J.J., Menkhorst H.P.M.G. and Gittenberger E. 1984. The marine Mollusca of the Bay of Algeciras, Spain, with general notes on *Mitrella*, Marginellidae and Turridae. *Basteria*, supplement 2: 1-135.

© Sociedad Española de Malacología —— Iberus, 28 (2): 63-72, 2010

Spawn and early development of NE Atlantic species of *Hypselodoris* (Gastropoda: Opisthobranchia)

Puesta y desarrollo de especies del género *Hypselodoris* del Atlántico nororiental (Gastropoda: Opisthobranchia)

Rita COELHO*, ** and Gonçalo CALADO***

Recibido el 23-X-2010. Aceptado el 24-XI-2010

SUMMARY

Despite an existing review of the Atlantic species of the family Chromodorididae (Mollusca: Nudibranchia), little is known about early development patterns of these species due to the difficulty of collecting data from living animals. Six species of the genus *Hypselodoris* inhabit the Portuguese continental coasts: *H. bilineata*, *H. cantabrica*, *H. fontandraui*, *H. picta*, *H. tricolor* and *H. villafranca*. This paper is based on new data and extensive studies made under laboratory conditions and aims to describe several aspects of their reproduction, namely egg mass type, egg size and colour, duration of embryonic development and development patterns. The data here obtained and existing developmental data for Atlantic *Hypselodoris* from the literature are also compared.

RESUMEN

A pesar de que existe una revisión de las especies atlánticas de la familia Chromodorididae (Mollusca: Nudibranchia), muy poco se conoce acerca de la biología y patrones de desarrollo de estas especies debido a la dificultad de obtener datos a partir de ejemplares vivos. Seis especies del género *Hypselodoris* habitan en las costas continentales portuguesas: *H. bilineata*, *H. cantabrica*, *H. fontandraui*, *H. picta*, *H. tricolor* y *H. villafranca*. En el presente trabajo de aportan nuevos datos obtenidos de estudios en condiciones de laboratorio con el objetivo de describir algunos aspectos de la biología reproductora de estas especies, como el tipo de puesta, tamaño del huevo y color, duración del desarrollo embrionario y patrón de desarrollo. Los datos obtenidos en el presente trabajo se (sintetizan y) comparan con los existentes en la bibliografía.

INTRODUCTION

The Family Chromodorididae (Mollusca: Nudibranchia) comprises one of the most fantastic coloured Nudibranch groups of the Iberian Peninsula East coast. Despite a review (ORTEA, VALDÉS AND GARCÍA-GÓMEZ, 1996) of the Atlantic species of the family Chromodorididae Bergh, 1891 (Mollusca: Nudibranchia), studies specifically devoted to their reproductive biology, from egg

---

* Instituto Português de Malacologia, Zoomarine, E.N. 125, Km 65 Guia; 8201-864 Albufeira; Portugal. E-mail: ipmalac@gmail.com

** Center of Marine Science-CCMAR, University of Algarve, Faro, Portugal.

*** Universidade Lusófona de Humanidades e Tecnologias, Av. do Campo Grande, 376 1749 - 024 Lisboa, Portugal.

to metamorphosis are absent. General data on egg mass shapes, egg size or egg-to-juvenile periods are scarce, scattered or absent. Quite often available data come from one single specimen. Furthermore, dispersion measures or confidence intervals are mostly absent.

Like with most aspects of nudibranch biology, there is no general rule concerning their life history and life span. Most species seem to live for about one year, although the tropical Sea hare *Dolabella auricularia* has been reported to live for six years in an aquarium (HADFIELD AND SWITZER-DUNLAP, 1984) and the cephalaspidean *Philine aperta* can live for up to four years in nature (LANCASTER, 1983). On the other hand, there are small nudibranchs, especially those that live and feed on short-lived cnidarian colonies which can complete a life cycle in a few weeks. For example, both the European aeolid *Tenellia pallida* (Alder and Hancock, 1842) [= *T. adspersa* (Nordmann, 1845)] and the coral-eating tropical aeolid *Cuthona poritophages* Rudman, 1979 can mature in three weeks (RASMUSSEN, 1944; RUDMAN, 1979) and probably die within two or three months. In the case of these very short-lived species, they need to complete their life-cycle before the colony they live and feed on dies. If they are too slow then they will themselves die from starvation before they can breed.

Six species of the nudibranch genus *Hypselodoris* inhabit the Atlantic coast of Portugal (CERVERA, CALADO, GAVAIA, MALAQUIAS, TEMPLADO, BALLESTEROS, GARCÍA-GÓMEZ AND MEGINA, 2006): *Hypselodoris billineata* (Pruvot-Fol 1953), *Hypselodoris cantabrica* (Bouchet and Ortea, 1980), *Hypselodoris fontandraui* (Pruvot-Fol, 1951), *Hypselodoris picta webbi* (D'Orbigny, 1839), *Hypselodoris tricolor* (Cantraine, 1835), and *Hypselodoris villafranca* (Risso, 1818).

In this paper we report for the first time data on the spawn and early development of six sympatric *Hypselodoris* species from Portuguese continental coasts maintained under similar laboratory conditions. Several aspects were considered, namely egg mass type, egg size and colour, duration of embryonic development and development type.

MATERIAL AND METHODS

Specimens studied were collected on subtidal surveys using scuba diving in Arrábida (West Coast – 38° 30′ 18″ N, 8° 55′ 18″ W) and the Algarve (South coast- 37° 00′ 08″ N, 7° 49′ 20″ W), Portugal, from April 2004 to June 2005. After collection, the animals were brought to the laboratory and placed in closed-circuit 40 L aquaria, where water quality was monitored daily for temperature, pH and salinity, and weekly for the presence of nitrites, nitrates and phosphates. Individuals were kept at a constant temperature (18±1°C), as similar as possible to that of their natural environment, because egg development timing is known to be strongly affected by temperature; this parameter was kept constant in order to make developmental comparisons. Adults of the same species were kept together and fed with one of their natural prey items, the corneous demosponge *Dysidea fragilis* (Montagu, 1818), which is very common along the Portuguese coasts.

Egg masses were generally laid on the glass walls of the aquaria. The oviposition was considered complete when the adult abandoned the egg mass. Then, the egg masses were carefully removed from the aquaria, incubated individually in 500 L beakers at a constant temperature (18°C±1) and checked periodically until larval hatching. Extensive observations during embryonic development were made with an optical microscope at regular periods (4-5 times a day) in the centre of the egg mass, in order to register the main development stages before hatching. Daily inspection of all aquaria was necessary to ensure the measurement of zygote diameters before first cleavage since in these planktotrophic species initial development is very fast.

The classification followed for *Hypselodoris* egg masses is the one pro-

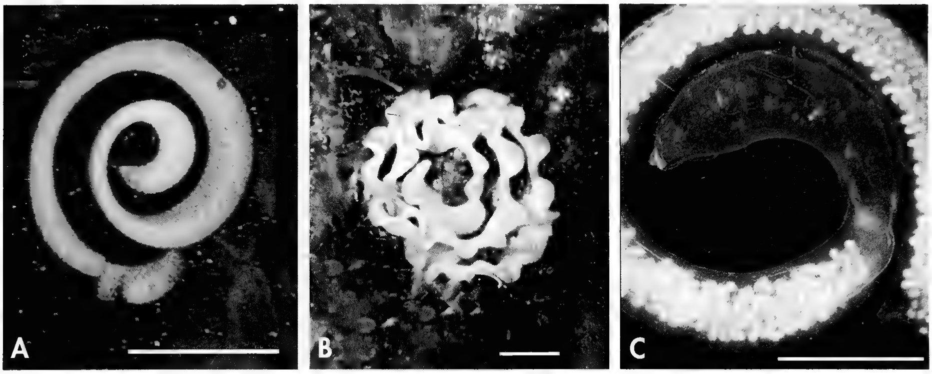


Figure 1. Egg ribbons of *H. bilineata* (A), *H. picta webbi (B)*, and *H. villafranca (C)*. Scale bars, 2 cm.
Figura 1. Puesta de H. bilineata *(A),* H. picta webbi *(B) y* H. villafranca *(C). Escalas, 2 cm.*

posed by WILSON (2002), which deals exclusively with the family Chromodorididae. According to this author, *Hypselodoris* egg masses are grouped in the following types: A) flat egg masses attached to the substratum by the broad side of the ribbon; B) egg masses with a free edge, shorter or equal than the attached edge causing the ribbon to slope toward the centre or stand upright respectively; C) egg masses with a free edge, slightly longer or much longer than the attached edge, causing the ribbon to slope away from the centre of the spiral or causing ondulations/waves, with an outward slope.

The criteria used to classify the species larval development were those outlined by THOMPSON (1967, 1976): Type 1) planktotrophic development, with a free veliger stage that can be pelagic for an extended period of time and that feeds obligatorily on plankton; Type 2) development with lecitotrophic larvae, with a short-life pelagic veliger that can dispense with plankton feeding due to their large yolk reserves; type 3) direct development, without a free pelagic larval phase.

RESULTS

Egg masses produced in the laboratory by these nudibranchs are identical to those collected in the field. All *Hypselodoris* spp. egg masses are shaped like a spiral ribbon attached to the substratum along one edge and consisting of embryos embedded in a gelatinous matrix (Fig. 1).

Hypselodoris egg masses found are grouped in two types: *H. billineata, H. cantabrica, H. fontandraui, H. picta, H. tricolor* have egg masses corresponding to type C of WILSON (2002), whereas *H. villafranca* have type A ones. Developmental characteristics of the studied species are summarized in Table I.

H. villafranca is the only species studied with direct development. All observed egg masses from this species had embryos passing through a suppressed veliger stage before hatching as benthic juveniles. This form of direct development has been categorized by BONAR (1978) as ametamorphic direct development, which means that this species does not fully develop into a veliger before undergoing metamorphosis.

All other five *Hypselodoris* species studied present a free living planktotrophic veliger, which have similar developmental characteristics. Despite the differences in egg dimensions (Table I), hatching times were also very similar (Fig. 2).

Right after complete oviposition we could often observe two to three different stages of development in the same spawn. The first part to be released could show second cleavage (4 cells), by

Table I. Comparative table of developmental characteristics of species of the genus *Hypselodoris* of the Portuguese Coast, at 18±1°C. When appropriate, mean measures are given ± standard deviation.
Tabla I. Tabla comparativa de las características del desarrollo en especies del género Hypselodoris *en las costas portuguesas, a 18±1°C.*

	Geographic range	Egg diameter (μm)	Capsule diameter (μm)	Eggs per capsule	Developmental type	Embryonic period (days)	Length at hatching (μm)	Number of specimens studied
H. bilineata	Eastern Atlantic	73.07±7.19	123.16±9.89	1	Planktotrophic	7,75±0,25	139,5±4,4	10
H. cantabrica	Eastern Atlantic	95.73±8.41	126.96±0.28	1	Planktotrophic	8.25±0.35	161.5±6.0	10
H. fontandraui	Eastern Atlantic	86.41±4.10	135.61±22.15	1	Planktotrophic	7.50±0.14	156.9±5.8	10
H. picta webbi	Caribbean and Eastern Atlantic	171.16±10.52	314.73±41.73	1-2	Planktotrophic	8.04±0.13	219.2±8.3	10
H. tricolor	Eastern Atlantic	85.65±6.97	147.93±25.74	1	Planktotrophic	7.71±0.17	143.2±2.8	10
H. villafranca	Eastern Atlantic, except Canary Islands. Madeira and Azores	243.69±46.06	389.60±45.32	1	Direct	28.00±0.82	515±23	10

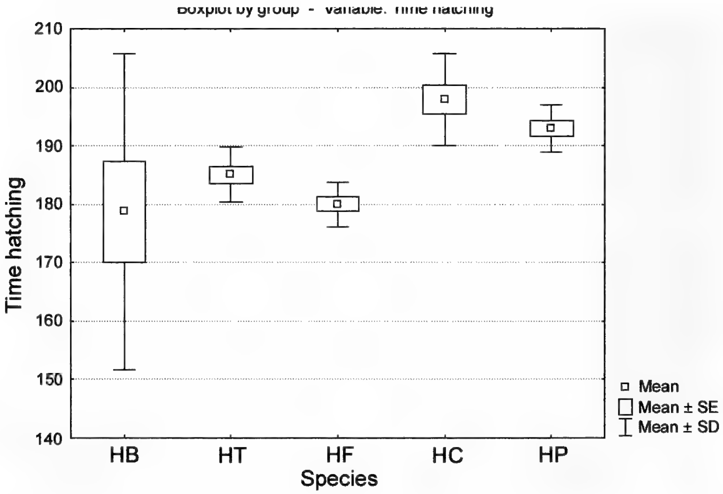


Figure 2- Time hatching duration for all planktotrophic *Hypselodoris* species studied (HB= *H. bilineata*, HT= *H. tricolor*, HF= *H. fontandraui*, HC= *H. cantabrica*, HP= *H. picta*).
Figura 2- Tiempo hasta la eclosión de las especies plAde Hypselodoris estudiadas (HB= H. bilineata, HT= H. tricolor, *HF=* H. fontandraui, *HC=* H. cantabrica, *HP=* Hypselodoris picta*).*

Table II. Overview and timing of embryonic development in species of the genus *Hypselodoris* of the Portuguese Coast, at 18±1°C.
Tabla II. Resumen de la cronología del desarrollo embrionario *desarrollo en especies del género* Hypselodoris *en las costas portuguesas, a 18±1°C.*

	1st Cleavage (hours)	2nd Cleavage (hours)	3rd Cleavage (hours)	Morula (hours)	Blastula (hours)	Gastrula (days; hours)	1st Organs (days; hours)	Veliger stage(days; hours)	Hatching (days; hours)
H. bilineata	2h	4h	7h	12h	17h	1d; 14h	2d; 19h	5d; 20h	7d; 18h
H. cantabrica	2h	4h	8h	13h	20h	1d; 18h	3d; 13h	6d; 4h	8d; 1h
H. fontandraui	2h	5h	7h	14h	17h	1d; 15h	2d; 17h	6d; 1h	7d; 12h
H. picta	2h	3h 30′	8h	13h	25h	1d; 21h	3d; 18h	6d; 6h	8d; 6h
H. tricolor	2h	5h	7h	13h	20h	1d; 14h	2d; 19h	6 d; 1h	7d; 17h
H. villafranca	2h	24h	42h	72h	168h	9 d	11d; 6h	—	28d

the time the later eggs were emerging from the oviduct, still undivided. The stages from morula to blastula were observed during day 0 for all species except *H. villafranca*.

Gastrulation was seen during day 1 except in *H. villafranca*, where it was only observed by day 9. Only after day 5/6 could we designate larvae as true veligers because a shell and a bilobed velum could be clearly seen. In this stage veligers were very active inside the capsules. Duration of the embryonic period from egg to gastrula of all species is presented in Figure 3. The hatching stage occurred between days 7 and 8 after oviposition for planktotrophic species.

The general pattern of cleavage, gastrulation and early embryogenesis of all species examined is typical of that described for other Opisthobranch gastropods (GOHAR AND SOLIMAN, 1967a,b,c). The main embryonic development stages and timings are presented in Table II. Most planktotrophic species of *Hypselodoris* studied present a veliger with a size within the range of 139.5 µm to 161.5 µm. Exception is made for *Hypselodoris picta webbi* veliger which reaches 219.2 µm in length at hatching time. Juveniles of *Hypselodoris villafranca* are dorid-like in shape. They measure 515±23 µm in length at hatching and present a translucent mantle with bright yellow random spots. A structural spicular-like network can be seen in the mantle tissue. This network is maintained in adults of many dorids but is lost in most chromodorids. No eyes or rhinophores buds are visible (Fig. 4). During the first 10-12h post-hatching juveniles crawl on top of the gelatinous matrix of the spawn, sometimes seeming to graze on it.

In Table III we summarise the available information on the developmental characteristics of the studied species.

DISCUSSION

In this study several aspects of the spawn and development of six species of the genus *Hypselodoris* Stimpson, 1855 are described.

The type of egg mass presented by *H. villafranca* is quite remarkable, since it is to our knowledge the first observation of direct development among chromodorids.

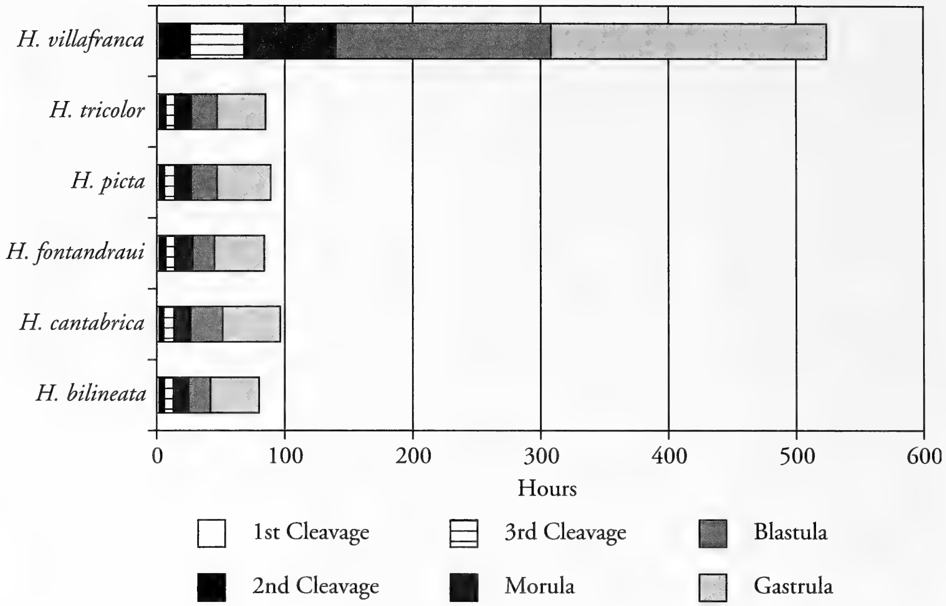


Figure 3. Embryonic period duration from egg to gastrula in all species studied of *Hypselodoris*.
Figura 3. Duración del desarrollo embrionario hasta el estado de gástrula.

Concerning egg size, the mean diameter in *H. bilineata, H. cantabrica, H. fontandraui* and *H. tricolor* is below 100 µm, within the range reported for most Nudibranchia species (Hadfield and Miller, 1987) and consistent with the planktotrophy exhibited. Egg and capsule sizes are classically considered to be good predictors of development type (Hadfield and Switzer-Dunlap, 1984) and used for comparative purposes (Hadfield and Miller, 1987). In the case of the Atlantic *Hypselodoris picta*, however, this extrapolation clearly predicts direct development, as in *H. villafranca*, but fails to predict pelagic-lecithotrophy which should be the case of *H. picta webbi* if one follows Hadfield and Switzer-Dunlap's (1984) predictions. The same situation was reported by Thompson (1967) for *Archidoris pseudoargus*, a planktotrophic developer whose eggs are 170 µm in diameter. A free-swimming, planktotrophic veliger can emerge from eggs of very different sizes, from 73 µm in *H. bilineata* (average adult length 30mm), to 171 µm in *H. picta webbi* (average adult length 100mm). The latter is the largest planktotrophic egg size reported so far among nudibranchs (see Todd, Lambert and Davies, 2001 for a review). Clearly the amount of energy packed into each ovum is very different. Nevertheless, survivorship and time to competence in these larvae remains unknown. The difference in hatching time between species with planktotrophic larvae and the one with direct development is certainly due to developmental constraints. Even so, the total egg-to-juvenile period is generally longer and variable in the planktotrophic strategy since it is dependent of an external source of energy to undergo metamorphosis (Todd, 1983; Havenhand, 1993).

One of the reasons for supporting egg size with capsule size data, in order to have a more accurate development extrapolation (Clark and Jensen, 1981; Hadfield and Miller, 1987) is the fact that there are species with lecithotrophic or even direct development although

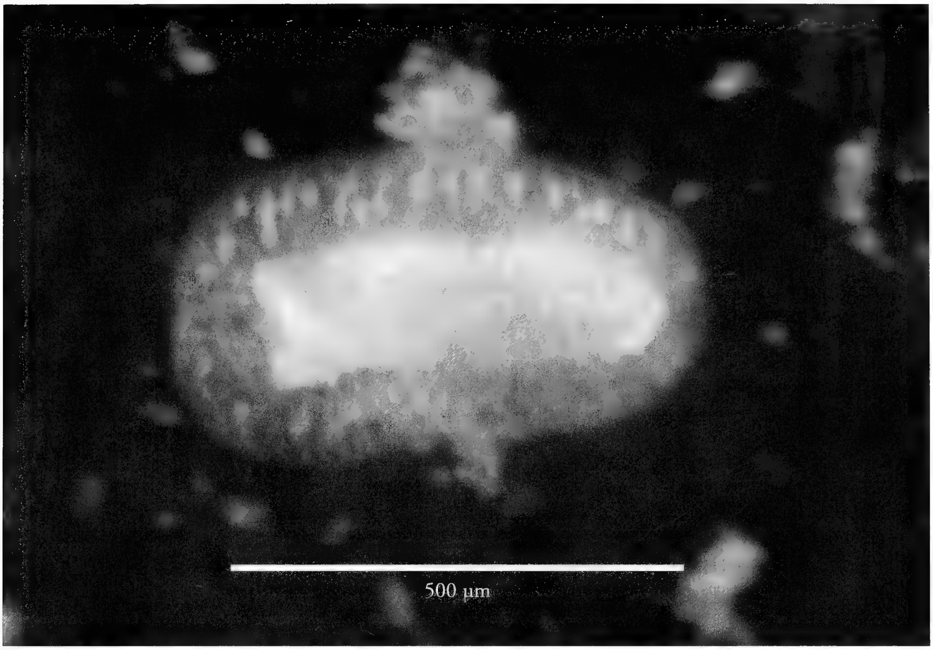


Figure 4. Newly hatched juvenile of *H. villafranca.*
Figura 4. Juvenil recién eclosionado de H. villafranca.

having small eggs. This is common among Sacoglossa species as stated by JENSEN (2001). The situation can be explained based on the presence of albumen, an intracapsular substance rich in proteins and very common in Opisthobranchia spawns (CLARK AND JENSEN, 1981) and the existence of extracapsular yolk in some species, which gives additional nutritional support for embryos, larvae and juveniles (MARIN AND ROS, 1993).

All studied species show a holoblastic and spiral cleavage, typical of the Gastropoda group (BIGGELAAR AND HASZPRUNAR, 1996). With the exception of *H. villafranca* with its slower direct development, all species reach morula stage 12-14h after oviposition and gastrula stage before the 48h mark. Both planktotrophic and direct development species gastrulate by emboly, as described for *Dendrodoris and Chromodoris* by GOHAR AND SOLIMAN (1967a,b) and for *Platydoris* by SOLIMAN, (1978).

The development from gastrula stage to veliger, with all typical structures present lasts between 102-107h.

It is obvious that Opisthobranch life-cycle and developmental strategies are inextricably linked to adult food specificity. Species that feed on transient food organisms are usually small and present a short life cycle, with a very rapid embryonic development. On the other hand, species, like the *Hypseloris* here presented, that depend on large long-living colonies such as sponges, are often bigger in size and have longer life cycles with slower embryonic development (RUDMAN AND WILLAN, 1998).

Although some developmental timetables have been reported for a number of opisthobranch species, it is often difficult to use them to make comparisons due to uncontrolled husbandry conditions or severe differences in water culture temperature, which is known to be one of the key factors affecting embryonic development.

Table III. Summary of developmental characteristics of Atlantic species of the genus *Hypselodoris* from available literature and present study.

SPECIES	Type of egg mass	Egg mass color	Egg mass width (mm)	No. of specimens	Type of capsule
H. bilineata	1 whorl spiral ribbon	White	3	-	-
	Spiral ribbon	White	-	-	-
	3 whorls ribbon	Red-orange	5	1	-
	2 Whorls spiral ribbon	White	4		
	2-2,5 Whorls Spiral ribbon	White	3	7	Oval
	2 Whorls spiral ribbon	White		8	Spherical
H. cantabrica	4 whorls spiral ribbon	White	-	-	-
	Spiral ribbon	White	-	1	Oval
	Spiral ribbon	White		1	
	4 whorls spiral ribbon	White		10	Oval
H. fontandraui	Spiral ribbon	White	-	-	-
	Spiral ribbon	White	-	-	-
	Spiral ribbon	White	-	1	-
	2 Whorls spiral ribbon	White	-	10	-
H. picta webbi	Waved spiral ribbon	Red-orange	6	-	-
	Smoothly waved spiral ribbon	Orange	-	-	-
	5 Whorls waved spiral ribbon		10	1	-
	4 Whorls waved spiral ribbon	Pink-orange	-	-	-
H. tricolor	3 whorls spiral ribbon	White	2	-	-
	Spiral ribbon	White	-	3	Spherical
	2.5 Whorls Spiral ribbon	White	3	5	-
	2 Whorls spiral ribbon	White	-	-	-
H. villafranca	2 Whorls spiral ribbon	Orange	2.5mm	-	-
	Spiral ribbon	Orange	-	2	Oval or spherical
	1 whorl spiral ribbon	Orange			Spherical

The studies on development presented by Martínez-Pita, Sánchez-Espanña and García (2006) on species of *Polycera*, conducted at 19°C, report similar embryonic stage timings to those presented for planktotrophic species of *Hypselodoris* in the current study. Yonow (1996) cultured *Acteon tornatilis* at 12°C water temperature and noted that the 4-cell stage was reached about 24h after oviposition and the gastrula stage within 4.9-6d. Although there are no significant differences in development pattern between compared species, these last data report a much slower embryonic development than our study, which is probably due to the 6°C difference in water temperature.

All *Hypselodoris* planktotrophic species exhibit a similar embryonic growth pattern and despite differences in egg size no differences are registered for hatching times. *Hypselodoris picta webbi* presents the biggest veliger (219.2±8.3 µm) but this size discrepancy with other planktotrophic species seems to be more related to adult size (approximately 100mm length) than to any developmental pattern. Nevertheless, survivorship and time to competence in these larvae remains unknown.

When hatching, morphological resemblance of *Hypselodoris villafranca* crawling juveniles to adult specimens is very limited and no rhinophores are visible. The crawling behaviour that the juvenile exhibits for 10-12h on top of the gelatinous matrix of the spawn, seeming to graze on it, leads us to think that matrix nutrients are not only important during embryonic development but

Tabla III. Resumen de las principales aspectos del desarrollo de las especies atlánticas del género Hypselodoris *obtenidas a partir de la bibliografía y del presente estudio.*

Capsule diameter (µm)	No. of eggs per capsule	Egg diameter (µm)	Embryonic period in days	SOURCE
100-120	-	79-109	-	Ortea *et al* (1996)
110-120	1	-	-	Garcia Gómez (2002)
-		175-208	-	Bouchet and Ortea (1980)
120	1		11 (18-20ºC)	Gantes (1962)
158(±3,5)l	1	85-100	9 (21ºC)	Sánchez-Tocino *et al* (2007)
100-133	1	67-100	7.75±0.25	Current Study
-	-	95-125	7 (22ºC)	Ortea *et al* (1996)
90-140	1	-	-	Garcia Goméz (2002)
95-125	1	80-85		Sánchez-Tocino *et al* (2007)
117-144	1	75-120	8.25±0.35	Current Study
150-180	-	110-120	-	Ortea *et al.* (1996)
150-180	1	-	-	Garcia-Gómez (2002)
145-180	1	110	13 (18ºC)	Sánchez-Tocino *et al.* (2007)
95-233	1	80-100	7.50±0.14	Current Study
-	-	175-208	-	Ortea *et al* (1996)
160-190	1	-	-	Garcia-Gómez (2002)
170x200	1-2	130-135	-	Sánchez-Tocino *et al.* (2007)
240-453	1-2	141-210	8.04±0.13	Current Study
90-120	-	85-100	13 (20-22ºC)	Ortea *et al.* (1996)
90-120	1	-	-	Garcia-Gómez (2002)
170x200	1-2	130-135	-	Sánchez-Tocino *et al.* (2007)
85-181	1	71-90	7.71±0.17	Current Study
300-400	-	Bit smaller than capsules	-	Ortea *et al.* (1996)
320-360	1	-	-	Garcia-Gómez (2002)
300-599	1	173-430	28.00±0.82	Current Study

serve as first food for juveniles after hatching (GIBSON AND CHIA, 1991).

Although some work is still required to understand some of the differences here recognized in development patterns between these species, the data presented in this work with a systematised character and controlled husbandry conditions of specimens, will certainly be useful regarding potential taxonomic or phylogenetic discussions.

ACKNOWLEDGMENTS

This work was carried out under a research project funded by Prémio Milénio Sagres/Expresso 2002. R.C. holds a grant from the Fundação para a Ciência e Tecnologia, Portugal (BDE 15577/2005). António Monteiro, and Manuel Malaquias, read an early version of the manuscript and helped to improve it.

BIBLIOGRAPHY

BIGGELAAR J. M. AND HASZPRUNAR G. 1996. Cleavage patterns and mesentoblast formation in the Gastropoda: An evolutionary perspective. *Evolution*, 50 (4): 1520-1540

BONAR D. B. 1978. Morphogenesis at metamorphosis in opisthobranch molluscs. In Chia F.S. and Rice M.E. (Eds.): *Settlement and metamorphosis of marine invertebrate larvae.* Elsevier North-Holland, New York: 177-196.

CERVERA J.L., CALADO G., GAVAIA C., MALAQUIAS M.A.E., TEMPLADO J., BALLESTEROS M., GARCÍA-GÓMEZ J.C. AND MEGINA C. 2006. An annotated and updated checklist of the opisthobranchs (Mollusca: Gastropoda) from Spain and Portugal (including islands and archipelagos). *Boletin del Instituto Español de Oceanografía*, 20 (1-4): 5-111.

CLARK K.B. AND JENSEN K.R. 1981. A comparison of egg size, capsule size, and development patterns in the order Ascoglossa (Sacoglossa) (Mollusca: Opisthobranchia). *International Journal of Invertebrate Reproduction* 3: 57–68

GIBSON G.D. AND CHIA F. 1991. Contrasting reproductive modes in two sympatric species of *Haminaea* (Opisthobranchia: Cephalaspidea). *Journal of Molluscan Studies*, 57: 49-60.

GOHAR H.A.F. AND SOLIMAN G.N. 1967a. The biology and development of *Dendrodoris (Doriopsis) fumata* (Rüpp. and Leuck.) (Gastropoda, Nudibranchia). *Publications of the Marine Biological Station, Al-Ghardaqa, Egypt*, 14: 31-54.

GOHAR H.A.F. AND SOLIMAN G.N. 1967b. The biology and development of *Chromodoris inornata* Pease (Gastropoda, Nudibranchia). *Publications of the Marine Biological Station, Al-Ghardaqa, Egyp*t, 14: 78-95.

GOHAR H.A.F. AND SOLIMAN G.N. 1967c. The biology and development of *Chromodoris tinctoria* (Rüpp. and Leuck.) (with reference to the taxonomic value of spawning characters). *Publications of the Marine Biological Station, Al-Ghardaqa, Egypt*, 14: 95-108.

HADFIELD M.G. AND MILLER S.E. 1987. On developmental patterns of Opisthobranchs. *American Malacological Bulletin*, 5 (2): 197-214.

HADFIELD M. AND SWITZER-DUNLAP M. 1984. Opisthobranchs. In Wilbur K. (Ed.): *The Mollusca, 7: Reproduction*. Academic Press, New York: 209-350.

HAVENHAND J. 1993. Egg to juvenile period, generation time, and the evolution of larval type in marine invertebrates. *Marine Ecology Progress Series*, 97: 247-260.

JENSEN K.R. 2001. Review of reproduction in the Sacoglossa (Mollusca, Opisthobranchia). *Bollettino Malacologico*, 37, 81–98

LANCASTER S.M. 1983. The biology and reproductive ecology of Philine aperta (Opisthobranchia: Bullomorpha) in Oxwich Bay. *Journal of Molluscan Studies, Suppl 12A:* 82-88

MARIN A. AND ROS J.D. 1993. Ultrastructural ecological aspects of the development of chloroplast retention in the sacoglossan *Elysia timida*. *Journal of Molluscan Studies*, 59: 95-104.

MARTÍNEZ-PITA I.; SÁNCHEZ-ESPANÑA A.I. AND GARCÍA F.J. 2006. Some aspects of the reproductive biology of two Atlantic species of *Polycera* (Mollusca: Opisthobranchia) *Journal of the Marine Biological Association of the U.K.* 86 (2): 391-399.

MCDONALD, G. AND NYBAKKEN J. 1997. A List of the Worldwide Food Habits of Nudibranchs. http://people.ucsc.edu/~mcduck/nudifood.htm (viewed October 2005)

ORTEA J., VALDÉS A. AND GARCÍA-GÓMEZ J.C. 1996. Revisión de las especies atlánticas de la familia Chromodorididae (Mollusca: Nudibranchia) de grupo cromático azul. *Avicennia, Suppl. 1*: 1-165.

RASMUSSEN E. 1944. Faunistic and biológical notes on marine invertebrates. *Videnskabelige Meddelelserfra Dansk Naturhistorisk Forening*, 107: 207-33.

RUDMAN, W.B. 1979. The ecology and anatomy of a new species of aeolid opisthobranch mollusc: a predator of the reef-forming coral Porites. *Zoological Journal of the Linnean Society, 65*: 339-359.

RUDMAN W.B. AND WILLAN R.C. 1998. Opisthobranchia. In Beesley P.L., Ross G.J.B. and Wells, A. (Eds.): *Mollusca: The Southern synthesis*. Fauna of Australia. CSIRO, Melbourne, pp. 915–1035.

SOLIMAN G.N. 1978. The redescription, reproduction and development of the dorid nudibranch *Platydoris Scabra* (Cuvier) from the Northwestern Red Sea, *Journal of Molluscan Studies*, 44 (2): 151-165.

STRATHMANN R.R. 1978. The evolution and loss of feeding larval stages of marine invertebrates. *Evolution*, 32: 894-906.

THOMPSON T.E. 1967. Direct development in the nudibranch *Cadlina laevis*, with a discussion of developmental processes in Opisthobranchia. *Journal of Marine Biological Association of the United Kingdom*, 47: 1-22.

THOMPSON T.E. 1976. *Biology of Opistobranch molluscs* I. London: The Ray Society

TODD C.D. 1983. Reproductive and trophic ecology of nudibranch molluscs. In Russel-Hunter W.D. (Ed.): *The Mollusca. 6: Ecology*. Academic Press, New York, 6: 225-259.

TODD C.D., LAMBERT W.J. AND DAVIES J. 2001. Some perspectives on the biology and ecology of nudibranch molluscs: generalisations and variations on the theme that prove the rule. *Bollettino Malacologico*, 37: 105-120.

YONOW N. 1996. Gametogenesis, egg production and development in *Acteon tornatilis* (Opisthobranchia: Cephalaspidea). *Malacological Review*, Supplement 6: 31-52.

WILSON N. 2002. Egg masses of chromodorid nudibranchs (Mollusca: Gastropoda: Opisthobranchia). *Malacologia*, 44 (2): 289-305.

ERRATA en Rolán y Fernández-Garcés (*Iberus,* 28 (1) p. 84-86) sobre *R. cancellina* spec. nov.

Sustituir el primer párrafo de "Remarks" por el siguiente:

Remarks: The holotype is a shell in good conditions and good protoconch (Fig. 3A) with 5.7 mm; one paratype is a shell with 8.5 mm (ZMB 115039) and labelled as *Rissoina cancellata* Phil. v. *pulchra* C. B. Adams, Jamaica, coll. Paetel (Fig. 3B).

NORMAS DE PUBLICACIÓN

- La revista *Iberus* publica artículos de fondo, notas y monografías que versen sobre cualquiera de los aspectos relacionados con la Malacología. Se entiende por artículo un trabajo de investigación de más de 5 páginas de texto, incluidas láminas, gráficos y tablas. Las notas son trabajos de menor extensión. Las monografías son trabajos sobre un tema único, de extensión superior a las 50 páginas de la revista y que serán publicadas, si procede, como un suplemento de *Iberus*. Los autores interesados en publicar monografías deberán ponerse previamente en contacto con el Editor de Publicaciones. Se entiende que el contenido de los manuscritos no ha sido publicado, ni enviado simultáneamente a otra revista para su consideración.
- Los manuscritos, así como toda la correspondencia relacionada con los mismos, deberán ser remitidos a: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, España y/o al correo electrónico <sgofas@uma.es>.
- El texto del trabajo podrá estar redactado en español, inglés, italiano, francés o portugués.
- Los artículos, notas y monografías deberán presentarse sobre DIN A-4, por una sola cara a doble espacio (incluyendo referencias, pies de figura y tablas), con al menos 3 centímetros de margen por cada lado. Los trabajos se entregarán por triplicado (original y dos copias) y se incluirá una versión en un CD, o bien remitida por correo electrónico, utilizando procesadores de texto en sus versiones de corrientes de Windows (pero no en el formato .docx de Word 2007, el habitual de Windows Vista) o Macintosh. En caso de autoría compartida, uno de los autores deberá hacerse responsable de toda la correspondencia.
- Junto con el trabajo debe incluirse una lista de al menos 4 posibles revisores del mismo, sin perjuicio de los que el propio Editor considere oportunos.
- Los manuscritos se presentarán de acuerdo al siguiente esquema:

Primera página. Deberá incluir un título conciso, pero sugerente del contenido del trabajo, así como una traducción al inglés del mismo (si el artículo no está escrito en inglés). Cuando sea preciso, deberá incluir referencia a familia o taxones superiores. A continuación figurarán, por este orden, el nombre y apellidos completos del autor o autores, las direcciones completas de los mismos, y un resumen del trabajo y su traducción al inglés. Dicho resumen deberá sintetizar, en conjunción con el título, tanto los resultados como las conclusiones del artículo; se sugiere una extensión de 100 a 200 palabras.

Páginas siguientes. Incluirán el resto del artículo, que debe dividirse en secciones precedidas por breves encabezamientos. Siempre que sea posible, se recomienda seguir el siguiente esquema: Introducción, Material y métodos, Resultados, Discusión, Conclusiones, Agradecimientos y Bibliografía. Si se emplean abreviaturas no habituales en el texto, deberán indicarse tras el apartado de Material y Métodos.

- Las notas breves deberán presentarse de la misma forma, pero sin resumen.
- Deberán evitarse notas a pie de página y referencias cruzadas. Deberán respetarse estrictamente los Códigos Internacionales de Nomenclatura Zoológica y Botánica (últimas ediciones). Cuando un taxón aparezca por primera vez deberá citarse su autor y fecha de su descripción. En el caso de artículos sistemáticos, cuando se den las sinonimias de los taxones, éstas deberán citarse COMPLETAS, incluyendo en forma abreviada la publicación donde fueron descritas, y la localidad tipo si es conocida entre corchetes, según el siguiente esquema (préstese especial cuidado a la puntuación):

Dendrodoris limbata (Cuvier, 1804)
Sinonimias
Doris limbata Cuvier, 1804, *Ann. Mus. Hist. Nat. Paris*, 4 (24): 468-469 [Localidad tipo: Marsella].
Doris nigricans Otto, 1823, *Nov. Act. Ac. Caes. Leop.-Car.*, 10: 275.

Dichas referencias no deberán incluirse en la lista de Bibliografía si es la única vez que se nombran en el texto. Si se incluyen una lista completa de referencias de un taxón inmediatamente tras éste, deberá seguirse el mismo esquema (sin incluir en Bibliografía las referencias que no se mencionen en otro lugar del texto).

- Sólo los nombres en latín y los de taxones genéricos y específicos deberán llevar subrayado sencillo o preferentemente ir en cursiva. En ningún caso deberá escribirse una palabra totalmente en letras mayúsculas, ni siquiera el Título. Las unidades a utilizar deberán pertenecer al Sistema Métrico Decimal, junto con sus correctas abreviaturas. En artículos escritos en castellano, en los números decimales sepárese la parte entera de la decimal por una coma inferior (,), NUNCA por un punto (.) o coma superior (').
- Las referencias bibliográficas irán en el texto con minúsculas o versalitas: Fretter y Graham (1962) o FRETTER Y GRAHAM (1962). Si son más de dos autores se deberán citar todos la primera vez que aparecen en el texto [Smith, Jones y Brown (1970)] empleándose *et al.* las siguientes veces [Smith *et al.* (1970)]. Si un autor ha publicado más de un trabajo en un año se citarán con letras: (Davis, 1989a; Davis, 1989b). No deberá emplearse op. cit. La lista de referencias deberá incluir todas las citas del texto y sólo éstas, ordenadas alfabéticamente. Se citarán los nombres de todos los autores de cada referencia, sea cual sea su número. Los nombres de los autores deberán escribirse, en letras minúsculas o Versalitas. No deberán incluirse referencias a autores cuando éstos aparezcan en el texto exclusivamente como autoridades de un taxón. Los nombres de las publica-

ciones periódicas deberán aparecer COMPLETOS, no abreviados. Cuando se citen libros, dése el título, editor, lugar de publicación, nº de edición si no es la primera y número total de páginas. Deberán evitarse referencias a Tesis Doctorales u otros documentos inéditos de difícil consulta. Síganse los siguientes ejemplos (préstese atención a la puntuación):

Fretter V. y Graham A. 1962. *British Prosobranch Molluscs*. Ray Society, London, 765 pp.

Ponder W.F. 1988. The Truncatelloidean (= Rissoacean) radiation - a preliminary phylogeny. En Ponder, W.F. (Ed.): Prosobranch Phylogeny. *Malacological Review*, suppl. 4: 129-166.

Ros J. 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoológica*, 3 (5): 21-51.

- Las gráficas e ilustraciones deberán ser originales y presentarse preferentemente en formato electrónico al formato de caja de la revista o proporcional a éste. Este formato es de 57 mm (una columna) o 121 mm (dos) de anchura y hasta 196 mm de altura, si bien se recomienda utilizar el formato a dos columnas. Es importante que todas las figuras sean remitidas en su formato original (por ejemplo, las fotografías en .jpg de alta calidad o .tif, las gráficas en hojas de cálculo Excel o documentos de CorelDraw), puesto que las ilustraciones insertadas en el manuscrito WORD son inservibles en la fase de imprenta. Las imágenes digitales deben ser formateadas en su tamaño de impresión con una resolución mínima de 300 ppp para imágenes en color o escala de grises y de 600 ppp para las de blanco y negro. Considérese la reducción que será necesaria a la hora de decidir el tamaño de las escalas o letras en las figuras, que no deberán bajar de los 2 mm. En figuras compuestas, cada parte deberá etiquetarse con letras mayúsculas, el resto de las letras deberán ser minúsculas. Las escalas de dibujos y fotografías deberán ser gráficas, utilizando unidades del sistema métrico decimal; no deberán hacerse referencias a los aumentos de una determinada ilustración, ya que éstos cambian con la reducción. En su caso, se recomienda la utilización de mapas con proyección UTM. Cada figura, gráfica o ilustración deberá presentarse en hojas separadas y con numeración arábiga (1, 2, 3,...), sin separar "Figuras" y "Láminas". Los pies de figura, en una hoja aparte, deberán acompañarse de su traducción al inglés (o español si el inglés es la lengua del trabajo). Utilícese el esquema siguiente:

Figura 1. *Neodoris carvi*. A: animal desplazándose; B: detalle de un rinóforo; C: branquia.

Las abreviaturas empleadas en las ilustraciones deberán incluirse en los pies de figura.

Los autores interesados en incluir láminas en color deberán consultar con el editor y sufragar el sobrecoste con una contribución de 30 € por página. Por lo demás, deberán ajustarse a los mismos requisitos indicados para las figuras.

Si se pretende enviar gráficas o ilustraciones en impresión de papel es imprescindible presentar originales de buena calidad. Las imágenes en semitonos deben estar bien contrastadas y ajustarse al tamaño definitivo de impresión; al componer fotografías sobre una hoja, procúrese que los espacios entre ellas sean regulares y que estén debidamente alineadas. Téngase en cuenta que incluir fotografías de distinto contraste en una misma página conlleva una pobre reproducción final. Las gráficas de ordenador deberán imprimirse con impresora láser sobre papel de buena calidad.

- Las Tablas se presentarán en hojas separadas, siempre con numeración romana (I, II, III,...). Las leyendas se incluirán en una hoja aparte acompañándose de una traducción al inglés. Deberán evitarse las tablas particularmente complejas. Se recomienda reducir el número y extensión de ilustraciones, láminas o tablas al mínimo necesario.
- Los artículos que no se ajusten a las normas de publicación serán devueltos al autor con las indicaciones de los cambios necesarios.
- El Comité Editorial comunicará al autor responsable del trabajo la fecha de recepción del trabajo y la fecha de envío a revisión. Cada original recibido será sometido a revisión por al menos dos investigadores. El Comité Editorial, a la vista de los informes de los revisores decidirá sobre la aceptación o no de cada manuscrito. El autor recibirá en cada caso copia de los comentarios de los revisores sobre su artículo. En caso de aceptación, el mismo Comité Editorial, si lo considera conveniente, podrá solicitar a los autores otras modificaciones que considere oportunas. Si el trabajo es aceptado, el autor deberá enviar una copia impresa del mismo corregida, acompañada por una versión en un CD, utilizando procesadores de texto en sus versiones corrientes de Windows (pero no el formato .docx generado por Word 2007, el habitual de Windows Vista) o Macintosh. La fecha de aceptación figurará en el artículo publicado.
- Las pruebas de imprenta serán enviadas por correo electrónico al autor responsable, exclusivamente para la corrección de erratas, y deberán ser devueltas en un plazo máximo de una semana. Se recomienda prestar especial atención en la corrección de las pruebas.
- De cada trabajo se entregarán gratuitamente 50 separatas, además de una versión electrónica en formato .pdf. Aquellos autores que deseen un número mayor, deberán hacerlo constar al devolver las pruebas de imprenta, y nunca posteriormente. El coste de las separatas adicionales será cargado al autor.

INSTRUCTIONS TO AUTHORS

- *Iberus* publishes research papers, notes and monographs devoted to the various aspects of Malacology. Papers are manuscripts of more than 5 typed pages, including figures and tables. Notes are shorter papers. Monographs should exceed 50 pages of the final periodical, and may be published as Supplements. Authors wishing to publish monographs should contact the Editor. Manuscripts are considered on the understanding that their contents have not been published or simultaneously submitted for publication elsewhere.
- Manuscripts and correspondence regarding editorial matters must be sent to: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, Spain and/or to the e-mail <sgofas@uma.es>.
- Manuscripts may be written in Spanish, English, Italian, French or Portuguese.
- Manuscripts must be typed double spaced (including the references, figure captions and tables) on one side on A-4 (297x210 mm) with margins of at least 3 cm. An original and two copies must be submitted, together with a CD or e-mail remittance containing the article written with a current Windows (but not .docx format generated by Word 2007, mainly used with Windows Vista) or Macintosh word processor. When a paper has joint authorship, one author must accept responsibility for all correspondence.
- The authors must include a list of at least 4 possible referees; the Editor can choose any others if appropriate.
- Papers should conform the following layout:

First page. This must include a concise but informative title, with mention of family of higher taxon when appropriate, and its Spanish translation. It will be followed by all authors' names and surnames, their full address(es), an abstract (and its Spanish translation) not exceeding 200 words which summarizes not only contents but results and conclusions.

Following pages. These should content the rest of the paper, divided into sections under short headings. Whenever possible the text should be arranged as follows: Introduction, Material and methods, Results, Discussion, Conclusions, Acknowledgements and References. Unusual abbreviations used in the text must be grouped in one alphabetic sequence after the Material and methods section.

- Notes should follow the same layout, without the abstract.
- Footnotes and cross-references must be avoided. The International Codes of Zoological and Botanical Nomenclature must be strictly followed. The first mention in the text of any taxon must be followed by its authority including the year. In systematic papers, when synonyms of a taxon are given, they must be cited IN FULL, including the periodical, in an abbreviate form, where they were described, and the type localities in square brackets when known. Follow this example (please note the punctuation):

Dendrodoris limbata (Cuvier, 1804)
Synonyms
Doris limbata Cuvier, 1804, *Ann. Mus. Hist. Nat. Paris*, 4 (24): 468-469 [Type locality: Marseille].
Doris nigricans Otto, 1823, *Nov. Act. Ac. Caes. Leop.-Car.*, 10: 275.

These references must not be included in the Bibliography list, except if referred to elsewhere in the text. If a full list of references of the taxon is to be given immediately below it, the same layout should be followed (also excluding from the Bibliography list those which are not cited elsewhere).

Only Latin words and names of genera and species should be underlined once or be given in italics. No word must be written in UPPER CASE LETTERS. SI units are to be used, together with their appropriate symbols. In Spanish manuscripts, decimal numbers must be separated with a comma (,), NEVER with a point (.) or upper comma (').

- References in the text should be written in small letters or Small capitals: Fretter and Graham (1962) or FRETTER AND GRAHAM (1962). The first mention in the text of a paper with more than two authors must include all of them [Smith, Jones and Brown (1970)], thereafter use *et al.* [Smith *et al.* (1970)]. If an author has published more than one paper per year, refer to them with letters: (Davis, 1989a; Davis, 1989b). Avoid op. cit.

The references in the reference list should be in alphabetical order and include all the publications cited in the text but only these. ALL the authors of a paper must be included. These should be written in small letters or Small capitals. The references need not be cited when the author and date are given only as authority for a taxonomic name. Titles of periodicals must be given IN FULL, not abbreviated. For books, give the title, name of publisher, place of publication, indication of edition if not the first and total number of pages. Keep references to doctoral theses or any other unpublished documents to an absolute minimum. See the following examples (please note the punctuation):

Fretter V. and Graham A. 1962. *British Prosobranch Molluscs*. Ray Society, London, 765 pp.

Ponder W.F. 1988. The Truncatelloidean (= Rissoacean) radiation - a preliminary phylogeny. In Ponder W.F. (Ed.): Prosobranch Phylogeny. *Malacological Review*, suppl. 4: 129-166.

Ros J. 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoológica*, 3 (5): 21-51.

- Figures must be original and provided preferably in electronic format and adjusted to page format and column size. These should be one column (57 mm) or two columns (121 mm) wide and up 196 mm high, or be proportional to these sizes. Two columns format is recommended. It is essential that all figures be supplied in their original format (e.g. photographs as high-grade .jpg or as .tif files, graphs as Excel spreadsheets or Corel-Draw files), as the files inserted into WORD documents cannot be used for printing. Digital images must be given their final printing size with a resolution at least 300 dpi for colour and halftones, and at least 600 dpi for black/white.

Take into account possible reduction in lettering drawings; final lettering must be at least 2 mm high. In composite drawings, each figure should be given a capital letter; additional lettering should be in lower-case letters. A scale line, labelled with SI units, must be used to indicate size; magnification ratio must be avoided as it may be changed during printing. UTM maps are to be used if necessary. Figures must be submitted on separate sheets, and numbered with consecutive Arabic numbers (1, 2, 3,...), without separating 'Plates' and 'Figures'. Legends for Figures must be typed in numerical order on a separate sheet, and a Spanish translation must be included. Follow this example (please note the punctuation):

Figure 1. *Neodoris carvi*. A: animal crawling; B: rhinophore; C: gills.

If abbreviations are to be used in illustrations, they should be included in the figure captions.

Authors wishing to publish illustrations in colour should consult with the editor and will be charged a contribution of 30 € per page. They should otherwise follow the same standards as black and white prints.

If the authors want to send Figures in printed format, it is essential to supply good quality originals. Half-tone images must be of good contrast, and should be submitted in the final printing size. When mounting photographs in a block, ensure spacers are of uniform width. Remember that grouping photographs of varied contrast results in poor reproduction. Computer graphics must be printed on high quality white paper with a laser printer.

- Tables must be numbered with Roman numbers (I, II, III,...) and each typed on a separate sheet. Headings should be typed on a separate sheet, together with their English translation. Complex tables should be avoided. As a general rule, keep the number and extension of illustrations and tables as reduced as possible.
- Manuscripts that do not conform to these instructions will be returned for correction before reviewing.
- Authors submitting manuscripts will receive an acknowledgement of receipt, including receipt date, and the date the manuscript was sent for reviewing. Each manuscript will be critically evaluated by at least two referees. Based of these evaluations, the Editorial Board will decide on acceptance or rejection. Anyway, authors will receive a copy of the referees' comments. If a manuscript is accepted, the Editorial Board may indicate additional changes if desirable. Acceptable manuscripts will be returned to the author for consideration of comments and criticism; a finalized manuscript must then be returned to the Editor, together with a CD containing the article written with current Windows (but not a .docx format generated by Word 2007, mainly used under Windows Vista) or Macintosh word processor. Dates of reception and acceptance of the manuscript will appear in all published articles.
- Proofs will be e-mailed to the author for correcting errors and must be returned corrected within one week. At this stage no stylistic changes will be accepted. Pay special attention to references and their dates in the text and the Bibliography section, and also to numbers of Figures and Tables appearing in the text.
- Fifty reprints per article and a .pdf file will be supplied free of charge. Additional reprints must be ordered when the page proofs are returned, and will be charged at cost. NO LATER orders will be accepted.

LA SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

Junta Directiva desde el 11 de octubre de 2005

Presidente	José Templado González
Vicepresidente	Emilio Rolán Mosquera
Secretaria	María Carmen Salas Casanovas
Tesorero	Luis Murillo Guillén
Editor de Publicaciones	Serge Gofas
Bibliotecario	Rafael Araujo Armero
Vocales	Ramon M. Álvarez Halcon Benjamín Gómez Moliner Alberto Martínez Ortí Diego Moreno Lampreave José Ramón Arrébola Burgos

La *Sociedad Española de Malacología* se fundó el 21 de agosto de 1980. La sociedad se registró como una asociación sin ánimo de lucro en Madrid (Registro Nº 4053) con unos estatutos que fueron aprobados el 12 de diciembre de 1980. Esta sociedad se constituye con el fin de fomentar y difundir los estudios malacológicos mediante reuniones y publicaciones. A esta sociedad puede pertenecer cualquier persona o institución interesada en el estudio de los moluscos.

SEDE SOCIAL: Museo Nacional de Ciencias Naturales, c/ José Gutierrez Abascal 2, 28006 Madrid, España.

CUOTAS PARA 2010:

Socio numerario	(en España):	40 euros
	(en Europa)	40 euros
	(fuera de Europa):	48 euros
Socio estudiante	(en España):	23 euros
	(en el extranjero):	29 euros
Socio Familiar:	(sin recepcion de revista)	4 euros
Socio Protector:	(mínimo)	48 euros
Socio Corporativo	(en Europa):	48 euros
	(fuera de Europa):	54 euros

INSCRIPCIÓN: 6 euros, además de la cuota correspondiente.

A los socios residentes en España se les aconseja domiciliar su cuota. Todos los abonos deberán enviarse al Tesorero (dirección reseñada anteriormente) el 1 de enero de cada año. Los abonos se harán sin recargos para la sociedad y en favor de la *Sociedad Española de Malacología* y no de ninguna persona de la junta directiva. Aquellos socios que no abonen su cuota anual dejarán de recibir las publicaciones de la Sociedad. Los bonos de inscripción se enviarán junto con el abono de una cuota anual al Tesorero.

A los residentes en el extranjero se les ruega que abonen su cuota mediante giro postal en euros (international postal money orders in euros sent to the Treasurer). Members living in foreing countries can deduce 6 euros if paid before 15 April.

Cada socio tiene derecho a recibir anualmente los números de *Iberus, Reseñas Malacológicas* y *Noticiarios* que se publiquen.

ÍNDICE

Iberus 28 (2) 2010

HORRO J., GORI S. AND ROLÁN E. *Haedropleura ryalli*, a new species from São Tomé Island (Gastropoda, Turridae)
Haedropleura ryalli, *nueva especie de la isla de São Tomé (Gastropoda, Turridae)* 1-4

BENOMAR S., BELHSEN O.K., MATHIEU M. AND MOUKRIM A. Ultrastructural study of oogenesis in the African mussel, *Perna perna* (Bivalvia: Mytilidae)
Estudio ultraestructural de la ovogénesis en el mejillón africano, Perna perna *(Bivalvia: Mytilidae)* 5-21

GARCÍA-ÁLVAREZ O., ZAMARRO Mª AND URGORRI V. New species of Mollusca Solenogastres from the Bellingshausen Sea and the Antarctic Peninsula (Bentart-2006 Expedition)
Nuevas especies de Moluscos Solenogastres del Mar de Bellingshausen y Península Antártica (Expedición Bentart-2006) 23-38

DE OLIVEIRA A. Fauna Malacológica da cidade de Coimbra (Beira Litoral). Moluscos "urbanos" de Portugal. 1
Malacological Fauna from Coimbra (Beira Litoral). Portuguese "urban" Molluscs. 1 ... 39-50

BOUCHET P., GOFAS S. AND WARÉN A. Notes on Mediterranean *Dizoniopsis* (Gastropoda: Cerithiopsidae), with the description of two new species
Apuntes sobre los Dizoniopsis *(Gastropoda: Cerithiopsidae) del Mediterráneo, con la descripción de dos especies nuevas* 51-62

COELHO R. AND CALADO G. Spawn and early development of NE Atlantic species of *Hypselodoris* (Gastropoda: Opisthobranchia)
Puesta y desarrollo de especies del género Hypselodoris *del Atlántico nororiental (Gastropoda: Opisthobranchia)* 63-72

ISSN 0212-3010

Iberus

Vol. 29 (1)

REVISTA DE LA SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

Oviedo, junio 2011

Iberus

Revista de la

SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

COMITÉ DE REDACCIÓN *(BOARD OF EDITORS)*

EDITOR DE PUBLICACIONES *(EDITOR-IN-CHIEF)*

Serge Gofas	Universidad de Málaga, España

DIRECTOR DE REDACCIÓN *(EXECUTIVE EDITOR)*

Gonzalo Rodríguez Casero	Mieres del Camino, Asturias, España

EDITORA EJECUTIVA *(MANAGING EDITOR)*

Eugenia Mª Martínez Cueto-Felgueroso	Mieres del Camino, Asturias, España

EDITORES ADJUNTOS *(ASSOCIATE EDITORS)*

Francisco Javier Conde de Saro	Embajada de España, Japón
Benjamín Gómez Moliner	Universidad del País Vasco, Vitoria, España
Ángel Antonio Luque del Villar	Universidad Autónoma de Madrid, Madrid, España
Emilio Rolán Mosquera	Universidad de Vigo, Vigo, España
José Templado González	Museo Nacional de Ciencias Naturales, CSIC, Madrid, España
Jesús S. Troncoso	Universidad de Vigo, Vigo, España

COMITÉ EDITORIAL *(BOARD OF REVIEWERS)*

Kepa Altonaga Sustacha	Universidad del País Vasco, Bilbao, España
Eduardo Angulo Pinedo	Universidad del País Vasco, Bilbao, España
Rafael Araujo Armero	Museo Nacional de Ciencias Naturales, Madrid, España
Thierry Backeljau	Institut Royal des Sciences Naturelles de Belgique, Bruselas, Bélgica
Rüdiger Bieler	The Field Museum, Chicago, Estados Unidos
Sigurd v. Boletzky	Laboratoire Arago, Banyuls-sur-Mer, Francia
Jose Castillejo Murillo	Universidad de Santiago de Compostela, Santiago de Compostela, España
Karl Edlinger	Naturhistorisches Museum Wien, Viena, Austria
Antonio M. de Frias Martins	Universidade dos Açores, Açores, Portugal
José Carlos García Gómez	Universidad de Sevilla, Sevilla, España
Gonzalo Giribet de Sebastián	Harvard University, EE.UU.
Edmund Gittenberger	National Natuurhistorisch Museum, Leiden, Holanda
Ángel Guerra Sierra	Instituto de Investigaciones Marinas, CSIC, Vigo, España
Gerhard Haszprunar	Zoologische Staatssammlung München, München, Alemania
Yuri I. Kantor	A.N. Severtzov Institute of Ecology and Evolution, Moscú, Rusia
María Yolanda Manga González	Estación Agrícola Experimental, CSIC, León, España
Jordi Martinell Callico	Universidad de Barcelona, Barcelona, España
Ron K. O'Dor	Dalhousie University, Halifax, Canada
Takashi Okutani	Nihon University, Fujisawa City, Japón
Marco Oliverio	Universitá di Roma "La Sapienza", Roma, Italia
Pablo E. Penchaszadeh	Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina
Winston F. Ponder	Australian Museum, Sydney, Australia
Carlos Enrique Prieto Sierra	Universidad del País Vasco, Bilbao, España
Mª de los Ángeles Ramos Sánchez	Museo Nacional de Ciencias Naturales, CSIC, Madrid, España
Francisco Javier Rocha Valdés	Instituto de Investigaciones Marinas, CSIC, Vigo, España
Paul G. Rodhouse	British Antarctic Survey, Cambridge, Reino Unido
Joandomènec Ros i Aragones	Universidad de Barcelona, Barcelona, España
María Carmen Salas Casanovas	Universidad de Málaga, Málaga, España
Gerhard Steiner	Institut für Zoologie der Universität Wien, Viena, Austria
Victoriano Urgorri Carrasco	Universidad de Santiago de Compostela, Santiago de Compostela, España
Anders Warén	Swedish Museum of Natural History, Estocolmo, Suecia

PORTADA DE *Iberus*

Iberus gualtieranus (Linnaeus, 1758), una especie emblemática de la península Ibérica, que da nombre a la revista. Dibujo realizado por José Luis González Rebollar "Toza".

Iberus

REVISTA DE LA
SOCIEDAD ESPAÑOLA
DE MALACOLOGÍA

Vol. 29 (1) Oviedo, junio 2011

Iberus

Revista de la
SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

Iberus publica trabajos que traten sobre cualquier aspecto relacionado con la Malacología. Se admiten también notas breves. *Iberus* edita un volumen anual que se compone de dos o más números.

INSTRUCCIONES PARA LOS AUTORES

Los manuscritos deben remitirse a: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, España.

Los trabajos se entregarán por triplicado (original y dos copias). Se recomienda a los autores leer cuidadosamente las normas de publicación que se incluyen en cada número de la revista.

SUBCRIPCIONES

Iberus puede recibirse siendo socio de la Sociedad Española de Malacología, en cualquiera de sus formas, o mediante intercambio. Aquellos socios que deseen adquirir números atrasados deberán dirigirse al bibliotecario.

Los no socios deberán ponerse en contacto con BACKHUYS PUBLISHERS, P.O. Box 321, 2300 AH Leiden, The Netherlands. Tel.: +31-71-51 70 208, Fax: +31-71-51 71 856, Correo Electrónico: backhuys@euronet.nl

Los resumenes de los artículos editados en esta revista se publican en Aquatic Science and Fisheries Abstracts (ASFA) y en el Zoological Records, BIOSIS.

Contents list published in Aquatic Science and Fisheries Abstracts and Zoological Records, BIOSIS.

Dep. Leg. B-43072-81
ISSN 0212-3010
Diseño y maquetación: Gonzalo Rodríguez
Impresión: LOREDO, S. L. - Gijón

© Sociedad Española de Malacología —————— Iberus, 29 (1): 1-7, 2011

Cima apicisbelli Rolán, 2003 (Gastropoda: Cimidae): nuovo immigrante in Mediterraneo o specie autoctona?

Cima apicisbelli Rolán, 2003 (Gastropoda: Cimidae): ¿nuevo inmigrante en el Mediterraneo o especie autoctona?

Danilo SCUDERI* e Francesco CRISCIONE**

Recibido el 11-III-2010. Aceptado el 21-I-2011

ABSTRACT

The recovery of several living specimens of *Cima apicisbelli* Rolán, 2003 is reported in the coast of Acitrezza (Ionian Sea, E Sicily) within a marine protected area. This is the first citation in Italian waters, and the second ever for the Mediterranean, but of primary importance as based on abundant material found alive. This finding opened a taxonomic issue regarding its actual validity as a distinct species. The resemblance of their shells with that of the autochthonous *C. cylindrica* (Jeffreys, 1856), re-proposes an old question regarding the alien species entering the Mediterranean via Gibraltar strait: are they really aliens or are they just rare and/or overlooked native species to be better understood taxonomically? Based on observations on fresh material of *C. apicisbelli* and comparison with shells of the native congener we here support the validity of both taxa, therefore considering our record a real case of new finding of a species of Atlantic origin.

RIASSUNTO

Si segnala il ritrovamento di 26 esemplari viventi della specie alloctona *Cima apicisbelli* Rolán, 2003 nelle acque di Acitrezza (Mar Ionio, Sicilia Orientale), all'interno di un'area marina protetta: si tratta del primo rinvenimento per le acque italiane, e del secondo in assoluto per il Mediterraneo, ma di primaria importanza poiché quello presente si basa su abbondante materiale rinvenuto vivente. Insieme ai dettagli del ritrovamento, viene di seguito riportata una discussione circa la reale consistenza tassonomica di questa specie: la congenere autoctona *C. cylindrica* (Jeffreys, 1856) risulta avere una conchiglia morfologicamente molto simile. Viene esplorata la possibilità che le due specie possano essere solo sinonimi: dal confronto tra individui di *C. cylindrica*, rispondenti all'attuale concetto della specie, e *C. apicisbelli*, rinvenute ad Acitrezza, sono emerse differenze a supporto della distinzione delle due specie che conducono a riferire il presente rinvenimento come una nuovo reperimento in Mediterraneo di una specie aliena di provenienza atlantica.

RESUMEN

Se señala la recolección de 26 ejemplares vivos de la especie alóctona *Cima apicisbelli* Rolán, 2003 en aguas de Acitrezza (mar Jónico, este de Sicilia), dentro de un área marina protegida. Este es l primera cita de la especie para aguas italianas , y la segunda para el Mediterráneo, pero de suma importancia por tratarse de un abundante material

---

* Dipartimento di Biologia Animale, Laboratorio di Biologia Marina, Università di Catania, Via Androne, 81 - 95124 Catania, Italy. E-mail: danscu@tin.it

** Australian Museum, 6 College Street Sydney NSW - 2010 Sydney, Australia. E-mail: cicciocriscione@gmail.com

recolectado vivo. En esta ocasión comparamos esta especie con el congénere mediterráneo *C. cylindrica* (Jeffreys, 1856), que tiene una concha muy similar morfológicamente y podría ser sinónimo. Comparando ejemplares de *C. cylindrica* correspondiendo al concepto actual de la especie, y los *C. apicisbelli* de Acitrezza, las diferencias respaldan la distinción de las dos especies, lo cuál nos lleva a considerar este descubrimiento como una nueva ocurrencia en el Mediterráneo de una especie exótica de origen atlántico.

INTRODUZIONE

Durante questi ultimi dieci anni, l'ingresso in Mediterraneo di specie di molluschi non autoctone è apparso essere un fenomeno particolarmente frequente ed in crescita. Ciò sia perché tale fenomeno viene più spesso rimarcato ed enfatizzato in quanto ricollegabile al fenomeno più generale del cambiamento del clima su scala globale e della tropicalizzazione più in particolare, sia anche perché la bibliografia e gli studi prodotti relativamente alla malacofauna mediterranea sono ormai estremamente approfonditi, cosicché la individuazione di nuove entità all'interno di questo bacino risulta maggiormente facilitata.

Secondo Galil (2008), la consistenza del fenomeno di invasione del Mediterraneo può essere spiegata come un effetto della sinergia tra fattori antropici (inquinamento, eutrofizzazione, degrado degli habitats, sovrapesca, maricoltura, cambiamento climatico e traffico marittimo) e la peculiare storia geofisica e climatica dell'area. Una delle modalità con cui le specie aliene si diffondono sembra essere la normale dispersione larvale e ciò è particolarmente vero per le specie cosiddette "lessepsiane", che transitano attraverso il canale di Suez per poi attestarsi lungo le coste prossime ad esso, quelle levantine o egiziane (Oliverio, 1995). In questo caso, la diffusione segue una successione temporale e direzionale ("stepping stones"), che si rispecchia nelle segnalazioni scientifiche. Ovviamente, nulla esclude che meccanismi di mediazione antropica possano essere in alcuni casi prime responsabili del trasporto di queste specie attraverso il canale o di una loro secondaria diffusione in Mediterraneo. Rimorchiatori o chiatte ormeggiate per lungo tempo ad una estremità per poi passare all'altro lato del canale possono aver costituito un ottimo substrato per specie aliene (Fox, 1926). Navi che fanno la spola tra il bacino di Levante e di Ponente possono essere un veicolo di diffusione per specie sessili, come nel caso di *Brachidontes pharaonis* (Fischer, 1870) (Di Geronimo, 1971) e *Pinctada radiata* (Leach, 1814) (in Zibrowius, 1992). Per quest'ultima, anzi, il veicolo di trasporto può dipendere anche da substrati naturali, come ad esempio il carapace di rettili marini (Oliverio, Gerosa e Cocco, 1993). Il trasporto mediato da mezzi di navigazione marittima è probabilmente la maggiore causa di importazione di specie aliene *sensu stricto*, cioè specie introdottesi in Mediterraneo direttamente dal luogo d'origine (Oliverio, 1995). Questo è particolarmente vero per quei mezzi con ridotta velocità o per quelle strutture che operano in condizioni di frequente ancoraggio, come le piattaforme di esplorazione dei fondali. Dodici specie di Molluschi originari dell'Australia vennero per la prima volta segnalate nel nostro mare in prossimità della piattaforma "*Southern Cross*" ancorata presso le coste israeliane (Mienis, 2004). L'altra importante modalità con la quale si realizza l'"invasione aliena" è certamente legata alla maricoltura, attività che è cresciuta esponenzialmente nelle ultime due decadi. Da non trascurare è, inoltre, l'introduzione che si realizza tramite le cosiddette *ballast water*, o acque di zavorra, riversate dalle navi da carico nelle località di destinazione assieme al loro contenuto in larve (Streftaris, Zenetos e Papathanassiou, 2005). L'introduzione intenzionale dell'ostrica del Pacifico, *Crassostrea gigas* (Thunberg, 1793), e della vongola filippina *Ruditapes philippinarum* (Adams e Reeve, 1850), oltre ad aver messo in pericolo le popolazioni delle specie autoctone corrispondenti (Bodoy, Maitre-Allain e Riva, 1981; Madhioub e Zaouali, 1988), fu seguita da quella delle specie aliene ad esse associate (Ribera e Boudouresque, 1995).

Se da una parte la fauna proveniente dall'area indopacifica risulta piuttosto semplice da distinguere da quella autoctona, quella, invece, di provenienza atlantica offre maggiori problemi per l'evidente somiglianza morfologica delle sue specie con quelle del Mediterraneo. Inoltre, poiché la malacofauna del Mediterraneo risulta composta prevalentemente da specie provenienti dall'area lusitanica, risulta spesso difficile stabilire se una specie sia entrata nel nostro mare solo recentemente oppure sia stata sempre presente e male interpretata o non ben identificata o ancora geograficamente distribuita con popolazioni circoscritte nello spazio o nel tempo. Un'ulteriore complicazione deriva, infatti, da quelle specie lusitaniche che, tuttora presenti in Mediterraneo, potrebbero averlo colonizzato a più riprese nel tempo, come ad esempio *Panopea glycymeris* (Born, 1778), per le quali un'indagine approfondita deve partire dallo studio delle conchiglie fossili. Molte specie atlantiche, per questo, sono state escluse dalla lista delle specie alloctone della CIESM (Zenetos, Gofas, Russo e Templado, 2004).

In questi ultimi anni in certe aree della Sicilia orientale si sono susseguiti numerosi rinvenimenti di specie aliene: in particolare ad Acitrezza, piccolo villaggio poco a nord di Catania, che vive di pesca e della commercializzazione del pesce, ospitando uno dei maggiori mercati ittici siciliani, il fenomeno della presenza di specie non autoctone si è recentemente amplificato, portando a peculiari segnalazioni (Scuderi e Russo, 2003; 2005) e giustificando la realizzazione di specifici lavori di ricerca, solo in parte conclusi (Pane, 2008).

Il recente rinvenimento nella stessa località di numerosi individui viventi determinati come *Cima apicisbelli* Rolán, 2003 (Cimidae), ha offerto la possibilità di investigare meglio la tassonomia di questa specie ed i rapporti tra malacofauna atlantica e quella mediterranea. Questa specie, descritta per le coste del Senegal, è stata rinvenuta per la prima volta in Mediterraneo nel 2007 lungo le coste di Denia, Valencia, Spagna meridionale, dove un'unica conchiglia vuota è stata ritrovata in un detrito raccolto a bassa profondità, in un fondale misto di sabbia e roccia, con presenza della fanerogama *Posidonia oceanica* (L.) Delile, 1813 e di alghe fotofile (Oliver Baldovì, 2007).

Il rinvenimento qui descritto costituisce il primo per le acque italiane e il secondo in assoluto per il Mediterraneo. Non e' da trascurare anche il fatto che sia avvenuto all'interno dei confini di un'area protetta.

La disponibilita' di abbondante materiale vivente ha consentito un esame approfondito, dal quale è emersa una grande somiglianza di *C. apicisbelli* con la congenerica autoctona *C. cylindrica* (Jeffreys, 1856). Tale rimarchevole somiglianza non era stata discussa all'atto della istituzione di *C. apicisbelli*.

Il presente lavoro affronta una breve disamina tassonomica introduttiva sulle due specie di *Cima* per arrivare ad una soluzione logica circa il ritenere, e quindi segnalare, la specie di recente descrizione come alloctona.

MATERIALI E METODI

C. apicisbelli. Acitrezza (Catania, NE Sicilia), Marzo 2006, profondità -0,20/1 m su un substrato costituito in prevalenza da *Caulerpa racemosa*, 21 individui. Altri 5 individui a nord di Acitrezza, estate 2006, profondità -1/2 m, fotofilo roccioso.

C. cylindrica. Ganzirri (Messina, NE Sicilia), 1995, profondità -0,20/1 m su un substrato costituito in prevalenza da *Caulerpa taxifolia*, 3 individui. Is Linosa (Agrigento, Canale di Sicilia), 1995, profondità -25 m in detrito, 2 conchiglie. Vendicari (Siracusa, SE Sicilia), 1994, detrito spiaggiato, 2 conchiglie.

DISCUSSIONE

C. apicisbelli è caratterizzata da una conchiglia minuta, fragile, con scultura delicata (Figs. 1, 2). La caratteristica che immediatamente la fa distinguere dalle altre congeneri mediterranee, *C. minima*, *C. cylindrica*, è la scultura della conchiglia, che non è liscia, ma presenta sottili costicine assiali intersecate a linee spirali a formare un reticolo; tale trama può ricordare la scultura delle varie specie di *Graphis* presenti in Mediterraneo, dalle quali si distingue agevolmente per l'apice non liscio. Come già evidenziato in letteratura (van Aartsen, 1981), la conchiglia di *C. cylindrica* risulta liscia, solcata da deboli strie spirali solo negli ultimi giri: anche se non riportato esplicitamente, l'apice risulta pressoché liscio.

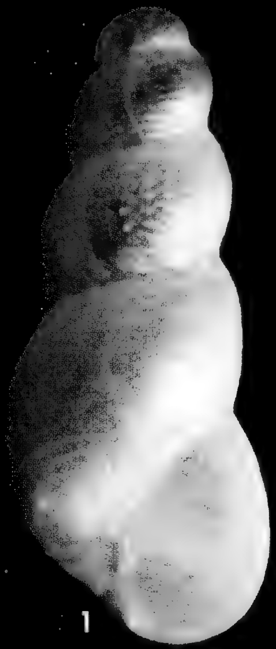
Sono stati posti a confronto gli individui di *C. apicisbelli* rinvenuti nell'area jonica sopra indicata e alcuni individui di *C. cylindrica* conservati nella collezione di uno degli autori (D.S.), che confrontano perfettamente con la descrizione di van Aartsen (1981): sono stati confrontati tra loro individui di pari dimensioni. Dal confronto degli individui delle due specie, riportati in materiali e metodi e di cui si da un'immagine in Figs. 1 e 4, si evidenziano differenze morfologiche, sia a carico della teleoconca che della protoconca. Infatti la conchiglia adulta di *C. apicisbelli*, a parità di dimensioni (circa 1 mm), rispetto a *C. cylindrica*, appare più inflata, con meno giri e più arrotondati con sutura più netta; la scultura appare molto marcata su tutta l'altezza di ogni giro, compresi quelli apicali; inoltre la bocca appare più aperta ed ampia (si veda il disegno schematico di Fig. 9). Circa la protoconca, invece, in *C. apicisbelli* risulta ornata da scultura consistente di linee assiali rade e spirali più marcate, che sul nucleo, piuttosto grosso, divengono ortogonali a causa dell'iperstrofia protoconcale (Figs. 3 e 7). In *C. cylindrica*, invece, la protoconca appare liscia (Figs. 5 e 6), con solo qualche linea d'accrescimento appena rintracciabile: il nucleo è più piccolo (0,057 mm contro 0,071 mm di *C. apicisbelli*). Sul nucleo embrionale di entrambe è visibile un cingolo apicale (Figs. 6 e 7) che va poi a fondersi con la sutura già del primo giro di protoconca.

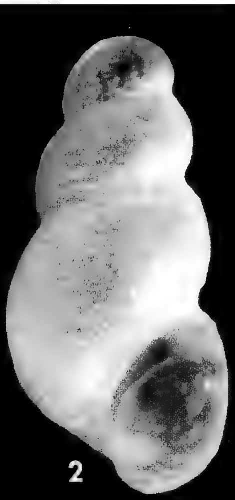
Le differenze morfologiche rilevate, quindi, se da un lato potrebbero essere viste come lievi e rientrare nell'ambito della variabilità intraspecifica di *C. cylindrica*, che del resto risulta tuttora specie scarsamente rinvenuta ed affatto investigata tassonomicamente, come già denunciato da van Aartsen (1981), dall'altro sono sufficienti a discriminare le due entità tassonomiche: esistono, infatti, gruppi di specie (vedi nel genere *Turbonilla* o *Chrysallida* ad esempio) che sono divergenti in maniera più lieve e differiscono per un più esiguo numero di caratteri.

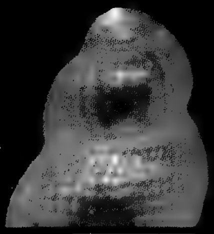
Per tale motivo *C. apicisbelli* e *C. cylindrica* vengono qui considerate specie diverse, sulla base di tali differenze morfologiche.

(Pagina destra) Figuras 1-3, 7, 9. *Cima apicisbelli*, Acitrezza (Catania, Sicilia); 1, 2: interi individui (0,95 mm e 0,70 mm); 3: protoconca; 7: disegno della protoconca; 9: disegno schematico del profilo conchiliare. Figuras 4, 5, 6, 8. *Cima cylindrica*, Ganzirri (Messina, Sicily); 4: intero individuo (1,05 mm); 5: protoconca; 6: disegno della protoconca; 8: disegno schematico del profilo conchiliare.

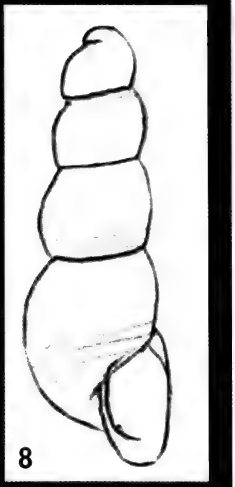
(Right page) Figuras 1-3, 7, 9. Cima apicisbelli, *Acitrezza (Catania, Sicilia); 1, 2: individuos enteros (0,95 mm y 0,70 mm); 3: protoconcha; 7: dibujo de la protoconcha; 9: dibujo esquemático del perfil de la concha. Figuras 4, 5, 6, 8.* Cima cylindrica, *Ganzirri (Messina, Sicily); 4: individuo entero (1,05 mm); 5: protoconcha; 6: dibujo de la protoconcha; 8: dibujo esquemático del perfil de la concha.*

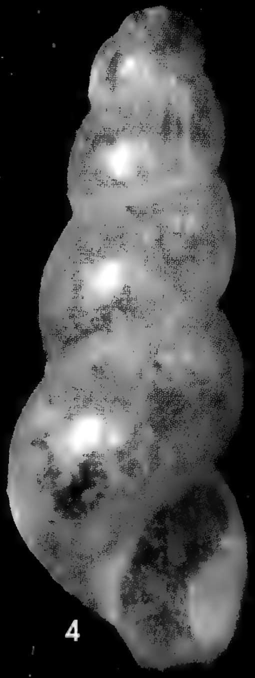

1

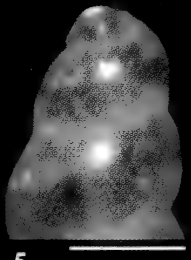

2



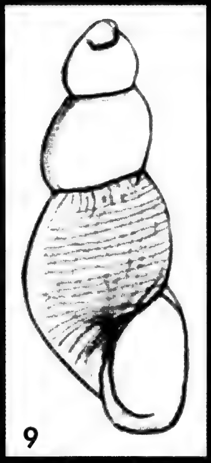
3

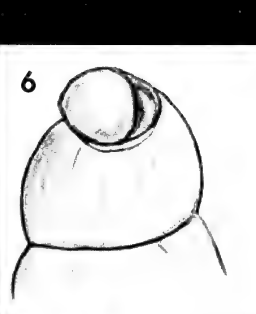

8

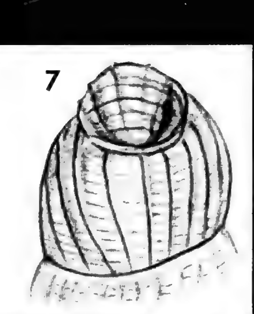

4



5


9


6


7

Il dubbio che si possa trattare di forme estreme della stessa specie, comunque, permane, non prefiggendosi il presente lavoro la loro investigazione puramente tassonomica, ed apre una finestra sulle polemiche che descrizioni troppo affrettate, senza operare le dovute comparazioni con materiale tipico di specie molto vicine portano a rilevare: un monito, quindi, va necessariamente profuso affinchè non si prosegua con superficialità alla descrizione di nuovi taxa che, una volta istituiti, è lavoro duro e improbo, poi, andare a confrontare e revisionare.

Essendo quindi maggiormente propensi alla validità di *C. apicisbelli*, possiamo qui dire che quello presente risulta essere il primo rinvenimento per le acque italiane e per il Mediterraneo orientale, mentre risulta essere il secondo in ordine cronologico per l'intero Mediterraneo dopo quello di Valencia (Oliver Baldovì, 2007). Quest'ultimo, però, è stato fondato su un unico individuo rinvenuto morto, da cui l'importanza assunta dalla presente segnalazione di numerosi individui viventi che accertano con sicurezza la presenza in Mediterraneo di popolazioni di questa specie.

Rimangono ancora da stabilire le modalità di ingresso nel Mare Nostrum.

Rispetto a quello di Valencia, infatti, il rinvenimento siciliano non sembra rappresentare una tappa di colonizzazione naturale del nostro mare, sia per i tempi con cui si è attuata (contemporanea rispetto al rinvenimento spagnolo), sia anche per il numero di individui, svariati e tutti viventi. Va inoltre osservato che, come già precedentemente notato per altre specie alloctone, rinvenute nelle medesime condizioni (Scuderi & Russo, 2003; 2005), risulta piuttosto anomalo rinvenire in tempi brevi ed al centro del Mediterraneo popolazioni già ben acclimatate altrove assenti: ciò risulta contrario alle dinamiche di invasione naturale conosciute (Oliverio, 1995) e sembra piuttosto conforme ad un modello d'invasione mediato dall'uomo.

Inoltre, i diversi precedenti rinvenimenti di specie aliene (Scuderi e Russo, 2003; 2005) nella stessa area, nonché la presenza a ridosso di quest'ultima di uno dei più fiorenti mercati ittici siciliani, ha suggerito l'idea che tali specie possano arrivare all'interno delle cassette di pesce, non a caso proveniente spesso dalle aree geografiche di origine delle stesse. In particolare la presente specie è stata descritta solo molto recentemente, per il Senegal: la richiesta di pescato "non autoctono", particolarmente del Senegal, è cresciuta enormemente durante questi ultimi anni (osserv. pers.). Questo perviene ai nostri mercati sempre meno in condizioni di congelamento e sempre più in condizioni di ottima freschezza, grazie anche ai moderni ed efficienti canali di approvvigionamento (spedizioni aeree). Per questo motivo, esiste a nostro parere la possibilità che individui di specie aliene arrivino in buono stato di conservazione e riescano poi a sopravvivere e adattarsi, una volta accidentalmente reimmesse in mare. Questo meccanismo potrebbe spiegare anche altri fenomeni di colonizzazione da parte delle specie alloctone avvenuto in altre aree del Mediterraneo. Ulteriori studi di comparazione tra il materiale biologico che accompagna il pescato importato e quello rinvenuto nelle indagini sul campo, potrebbero avvalorare tale ipotesi.

RINGRAZIAMENTI

Gli autori desiderano qui ringraziare la prof.ssa Grazia Cantone del Dip. di Biologia Animale dell'Università di Catania per l'appoggio e gli utili pareri al riguardo. I ringraziamenti vanno anche al Direttore (Dott. Emanuele Mollica) e allo staff dell'AMP "Isole Ciclopi" per avere consentito e facilitato il campionamento. Un ringraziamento particolare va al prof. S. Gofas (UMA) per le utili critiche al manoscritto e le sempre opportune, puntuali e precise disquisizioni scaturite.

BIBLIOGRAFIA

BODOY A., MAITRE-ALLAIN T. E RIVA A. 1981. Croissance comparée de la palourde européenne *Ruditapes decussatus* et de la palourde japonaise *Ruditapes philippinarum* dans un écosystème artificiel méditerranéen. *Vie Marine*, 2: 39–51.

DI GERONIMO I. 1971. Prima segnalazione sulle coste italiane di *Brachiodontes variabilis* Krauss. *Bollettino delle Sedute dell'Accademia Gioenia di Scienze Naturali in Catania*, 10: 847–852.

FOX H.M. 1926. Zoological results of the Cambridge expedition to the Suez Canal, 1924. 1. General part. *Transactions of the Zoological Society of London*, 22: 1–64.

GALIL B.S. 2008. Alien species in the Mediterranean Sea - which, when, where, why? *Hydrobiologia*, 606: 105–116.

MADHIOUB M.N. E ZAOUALI J. 1988. Captage de l'huître *Crassostrea gigas* dans le lac Ichkeul. *Bulletin de l'Institut National Scientifique et Technique d'Océanographie et de Pêche de Salammbô*, 15: 47–60.

MIENIS H.K. 2004. New data concerning the presence of Lessepsian and other Indo-Pacific migrants among the molluscs in the Mediterranean Sea with emphasize on the situation in Israel. In B. Öztürk & A. Salman (Eds.): Proceedings 1st National Malacology Congress, 1-3 September 2004, Izmir. *Turkish Journal of Aquatic Life*, 2 (2): 117-131.

OLIVER BALDOVÌ J.D. 2007. Catalogo de los Gasteròpodos testàceos marinos de la parte Sur del Golfo de Valencia (España). *Iberus*, 25 (2): 29-61.

OLIVERIO M. 1995. The status of the living Mediterranean *Strombus*, or: what is a lessepsian migrant. *Notiziario CISMa*, 16[1994]: 35-40.

OLIVERIO M., GEROSA G. E COCCO M. 1993. First record of *Pinctada radiata* (Bivalvia, Pteriidae) epibiont on the loggerhead sea turtle *Caretta caretta* (Chelonia, Cheloniidae). *Bollettino Malacologico*, 28 (5-12): 149-152.

PANE F. 2008. *Malacofauna associata ad alghe fotofile in un sito dell'AMP "Is. Ciclopi" Acitrezza, con particolare riferimento alle specie aliene.* Tesi di laurea, Università di Catania, 54 pp.

RIBERA M.A. E BOUDOURESQUE C.F. 1995. Introduced marine plants with special reference to macroalgae: mechanisms and impacts. *Progress in Phycological Research*, 11: 187–268.

ROLÁN E. 2003. A new species of the genus *Cima* (Gastropoda, Cimidae) from Senegal. *Novapex*, 4 (1): 21-23.

SCUDERI D. E RUSSO G.F. 2003. Due nuovi Gasteropodi per le acque italiane: *Melibe fimbriata* Alder & Hancock, 1864 e *Tricolia tingitana* Gofas, 1982 (Mollusca: Gastropoda). Atti XXXV Congr. SIBM, *Biologia Marina Mediterranea*, 12 (1): 618-621.

SCUDERI D. E RUSSO G.F. 2005. Prima segnalazione di *Aplysia dactylomela* Rang, 1828 e probabile presenza di *Syphonota geographica* (Adams e Reeve, 1850) (Gastropoda: Opisthobranchia: Anaspidea) per le acque del Mediterraneo. Atti XXXV Congr. SIBM, *Biologia Marina Mediterranea*, 12 (1): 338-341.

STREFTARIS N., ZENETOS A. E PAPATHANASSIOU E. 2005. Globalisation in marine ecosystems: the story of non-indigenous marine species across european seas. *Oceanography and Marine Biology: An Annual Review*. 43, 419-453.

VAN AARTSEN J.J. 1981. European marine mollusca: notes on less well-known species II. The genus *Cima* Chaster, 1896. *Basteria*, 45: 117-119.

ZENETOS A., GOFAS S., RUSSO G. E TEMPLADO J. 2004. CIESM Atlas of Exotic Species in the Mediterranean, Vol.3. Molluscs, 376 p. (http://www.ciesm.org/atlas/molluscsintro.html).

ZIBROWIUS H. 1992. Ongoing modifications of the Mediterranean marine fauna and flora by the establishment of exotic species. *Mesogee*, 51: 83–107.

© Sociedad Española de Malacología ——————— *Iberus*, 29 (1): 9-33, 2011

The family Tornidae (Gastropoda, Rissooidea) in the East Atlantic, 2. Circulinae

La familia Tornidae (Gastropoda, Rissooidea) en el Atlántico oriental, 2. Circulinae

Joan Daniel OLIVER* and Emilio ROLÁN**

Recibido el 23-I-2011. Aceptado el 17-III-2011

ABSTRACT

The species of the subfamily Circulininae from the East Atlantic belonging to the genus *Circulus* are studied. There is a total of 8 species, of which 2 are previously undescribed. The shell morphology is ilustrated for all the species with scanning electron micrographs which show the protoconch and, in some cases, the microsculpture.

RESUMEN

Se estudian las especies del género *Circulus* de la subfamilia Circulininae del Atlántico occidental. En total son 8 especies, de las cuales 2 son nuevas para la ciencia. De todas ellas se ilustra la morfología de la concha con microscopía electrónica de barrido, incluyendo la protoconcha y, en algunos casos, la microescultura.

INTRODUCTION

In their 1969 paper, ADAM AND KNUDSEN (1969) studied the small discoid species then scarcely known from the West African coast. Subsequently, new species were described (ROLÁN AND RUBIO, 1991, 1996; RUBIO AND ROLÁN, 1991; ROLÁN, RUBIO AND RYALL, 2000; ROLÁN AND RYALL, 2002). ROLÁN AND RUBIO (2002) published a paper on the species of the family Tornidae Sacco 1986, from West Africa reviewing and illustrating 39 species of which 23 were new to science.

More recently, BOUCHET AND ROCROI (2005) recorded the Gastropod taxa of family level and listed as accepted the family Tornidae with the following subfamilies: Torninae Sacco, 1884; Circulinae Fretter and Graham, 1962; Teinostomatinae Cossmann, 1917; Vitrinellinae Bush, 1897.

In the above mentioned work on the Tornidae from West Africa (ROLÁN AND RUBIO, 2002), the family had been studied somewhat incompletely because some of these subfamilies were not included in Tornidae at that time but in other taxonomic groups. The genus *Circulus* Jeffreys, 1865, was treated by FISCHER (1887: 824) as a subgenus of *Gibbula* Risso, 1826; later DALL (1927) placed it in synonymy with *Lydiphnis* Melville, 1906 and THIELE (1929) as a genus within *Cyclostrematidae*. Most of them were placed in Archaeogastropoda, and this remained so until FRETTER (1956) researched the anatomy of *Circulus striatus* (Philippi, 1836), type

---

* c/Alcorisa 83, 12-C 28043, Madrid.

** Museo de Historia Natural, Campus Universitario sur, 15782 Santiago de Compostela.

species of *Circulus*, and noticed that the radula of this species was taenioglossate, not rhipidoglossate.

For this reason we have resumed the study of the family Tornidae with the intention of reviewing the subfamilies not included in the previous study. In the present work we begin with subfamily Circulinae.

In the present work, as well as in the previous ones, we intend to show a complete iconography of the species pointing out the differential morphological characters which allow a clear placement of each taxon.

MATERIAL AND METHODS

The material studied comes from several collections made by the authors, mainly in the Mediterranean, Morocco, Mauritania, Senegal, São Tomé and Principe, Annobón and Angola. Other material collected by other malacologists such as Francisco Fernandes, Anselmo Peñas, Peter Ryall and José María Hernández was also examined. There is also some material from the Muséum National d' Histoire Naturelle of Paris (MNHN).

The material was collected mainly from sediments from the intertidal level to 8-10 m, while diving with snorkel and SCUBA diving, and also by dredging from a boat. The material from the MNHN was collected in several expeditions to Guinea Conakry, Ivory Coast and Congo with R/V "André Nizery" and "Antea Benchaci I", and in Angola (coll. Serge Gofas) through manual dredging.

The sediments were sieved and examined under a binocular microscope either by the collectors or the authors.

The numbering of the protoconch whorls was made following the method of VERDUIN (1976) in which the whorls are counted following an initial nucleus.

Abbreviations

AMNH	American Museum of Natural History, New York
MNCN	Museo Nacional de Ciencias Naturales, Madrid
MNHN	Muséum national d'Histoire naturelle, Paris
MHNS	Museo de Historia Natural, Universidad, Santiago de Compostela
NHMUK	The Natural History Museum, London
RBINS	Royal Belgian Institute of Natural Sciences, Bruxelles
ZMB	Zoologisch Museum für Naturkunde, Berlin
CAP	collection of Anselmo Peñas, Vilanova i la Geltrú
CDO	collection of Daniel Oliver, Madrid
CPR	collection of Peter Ryall, Maria Rain
CJH	collection of José María Hernández, Gáldar
sp	specimen with soft parts
s	shell empty
f	fragment

RESULTS

Family TORNIDAE
Subfamily CIRCULINAE Fretter and Graham, 1962

Genus *Circulus* Jeffreys, 1865

Circulus Jeffreys, 1865. *Brit. Conch.*, vol 3: 315 [established as a subgenus of *Trochus*; type species: *Delphinula duminyi* Requien, 1848 = *Circulus striatus*].

General characters of the shell: Protoconch: multispiral without any sculpture. The transition to the teleoconch is difficult to observe, because the separation is scarcely apparent. The beginning of the teleoconch may be observed by looking at the beginning of the spiral cords, although sometimes these are eroded.

Teleoconch: circular, flat, with a wide deep umbilicus. Spiral ornamentation formed by spiral cords. Some of them are prominent, forming keels. They lack any axial sculpture except for growth lines.

In order to describe more easily the sculpture of the shell in view of its taxonomic importance, we can represent the apertural peristome as a hexagon (Fig. 1) (even though its shape is frequently irregular, tending sometimes to be rectangular or circular):

1: Adapical insertion of the external lip with the shell
1-2: Subsutural cords
2: Cord / upper keel
2-3: Lateral upper cords
3: Cord / peripheral keel
3-4: Lateral lower cords
4: Cord / basal keel
4-5: Basal cords
5: periumbilical cord (change of direction)
5-6: Umbilical cords
6: Abapical insertion of the external lip in the shell
6-1: Callus: the callus is a simple prolongation of the inner part on the columella.

It is important to mention that the border of the external lip touches the teleoconch a little above the peripheral keel (3) while the internal border does it a little above the basal keel (4).

Some species may lack some of these cords-keels, or additional cord-keels may appear. Also some intraspecific variability can be observed.

Dichotomous key of *Circulus*:

1. - Shell with smooth spire. There are only umbilical cords . . . . *C. senegalensis*
- Shell with spiral cords / or keels 2

2 - Shell without keels 3
- Shell with keels 4

3 - Shell with evident spiral and basal cords . . . . *C. congoensis*
- Shell with lateral and basal areas without spiral cords or cords only appreciable under magnification . . . . *C. striatus*

4 - Peripheral keel clearly more developed than the basal keel 5
- Shell with the basal keel as developed or more than the peripheral keel 6

5 - Shell with vitreous aspect, without basal keel and without subsutural cords . . . . *C. pseudopraecedens*
- Shell of white color with basal cord / keel less developed that the peripheral one and with subsutural clear cords . . . . *C. ryalli*

6 - Shell lacking lower lateral cords with a basal keel more developed than the peripheral one . . . . *C. stephani*
- Lower lateral cords present 7

7 - Peristome tending to be rectangular and having microsculpture under magnification . . . . *C. microsculpturatus*
- Peristome subcircular, lower lateral cords, tending to form subperipheral keels . . . . *C. smithi*

Circulus striatus (Philippi, 1836) (Figs. 2A-G, 3A-G, 4A-G)

Valvata striata Philippi, 1836, p. 147, pl. IX, fig. 3A-C. [Type locality: Cefalù near Catania, Sicily, Pleistocene]
Adeorbis tricarinatus Wood, 1848. *Ann. Mag. Nat. Hist.* 9: 530.
Delphinula duminyi Requien, 1848. *Cat. Coq. Corse*: 64 [Type locality: Ajaccio, Corsica]. .

Delphinula triangulata Rayneval and Ponzi, 1854. *Cat. Monte Mario*: 18 [Type locality: Monte Mario near Rome, Italy, Pleistocene]
Skenea striatula Weinkauff, 1862. *J. Conch.* 10: 343 [incorrect subsequent spelling of *striata* Philippi, 1836].
Circulus costulatus Locard, 1889. *Bull. Soc. Mal. France*, 6: 297. [Type locality: France: Brest, Morbihan and Vendée].
Circulus carinulatus Locard, 1889. *Bull. Soc. Mal. France*, 6: 300. [Regions armoricaine and aquitaine; Provence].
Circulus striatus bicarinatus Altimira, 1977: 25. [Type locality: Sant Pol de Mar, Barcelona].
Delphinula costata Danilo and Sandri, 1856.

Type material: Probably in ZMB.
Other material examined: Usual form: Spain: 1 s, Santander (MHNS); 2 s, Ria de Vigo, 10 m (MHNS); 2 s, Tarragona (CAP); 5 s, Denia (beached) (MHNS); 133 s, 11 f, Cullera (beached) (CDO); 16 s, Denia (beached) (CDO); 18 s, Oliva (beached) (CDO); 6 s, Jávea (beached) (CDO); 2 s, Ibiza (CDO). Morocco: 3 s, Agadir (MHNS). Carinate form: Spain: 7 s, Cullera (beached) (CDO). Tricarinate form: Spain: 3 s, Cullera (beached) (CDO).

Description: Shell (Figs. 2A-E, 3A-E): the best description can be seen in FRETTER AND GRAHAM (1978). Shell flat with about 4 whorls (including protoconch) reaching 1.6 mm in diameter and 0.8 mm in height; shells with five whorls reaching 2.75 mm diameter and 1.25 mm height respectively (GRAHAM, 1988).

The protoconch (Figs. 2F, 3F, 4F-G) is multispiral, has a little less than 2.25 whorls, and is about 390 μm in width. It is smooth without any ornamentation and its end is barely marked with a light line coincident with the beginning of the spiral cords of the teleoconch.

The shell with typical morphology has spiral cords not forming keels. Apically 6-7 spiral cords can be observed whose width is approximately half that of the corresponding interspaces. The subsutural adapical one is weak, a little deep and limited on both sides by granules. Below, there are three more similar cords; the lowest one situated on the upper keel. Below these, there are four more cords (upper laterals) the fourth being in the emplacement of the peripheral keel.

Examined from the umbilical side, the shell has very weak low lateral cords, which in some shells give the impression that there are no cords, up to an isolated cord, situated in the position of the basal keel and which may sometimes be double. Apparently, there are no basal cords between the basal keel and the umbilical cords, the latter being always present and evident under magnification of the umbilicus. The lack of basal cords may be caused by erosion or they may decrease as the shell grows.

There are four or five umbilical cords, separated by sulci and crossed by an axial irregular and granulose sculpture. The aperture is circular.

The operculum is corneous and rounded.

The animal of *C. striatus* has been figured in FRETTER AND GRAHAM (1962: 284)

Distribution: The species is known from Ireland and the British Isles (FRETTER AND GRAHAM, 1978; GRAHAM, 1982, 1988), Atlantic Iberian Peninsula (ROLÁN, 1983); Portugal (NOBRE, 1940); Mediterranean (HIDALGO, 1917; POPPE AND GOTO, 1991). The record from São Tomé and Príncipe (FERNANDES AND ROLÁN, 1993), refers to another species with which it was confused at the time.

Remarks: *Adeorbis tricarinatus* Wood, 1848 was described as a species distinct from *C. striatus*. The description of this species was based on fossil shells and authors like JEFFREYS (1865) considered it, as well as *C. supranitidus* (Wood, 1848), a fossil variety of *C. striatus*. In spite of this opinion, even recently some authors, such as TERRENI (1981) consider it valid. AARTSEN, MENHORST AND GITTENBERGER (1984, fig. 57) indicate that this taxon as dubious, but admit that it could be valid and compare it to other similar fossil species. COPPINI, CUNEO, MARGELLI AND CAMPANI (2005, fig. 2c) present a similar shell and consider that it is a valid species

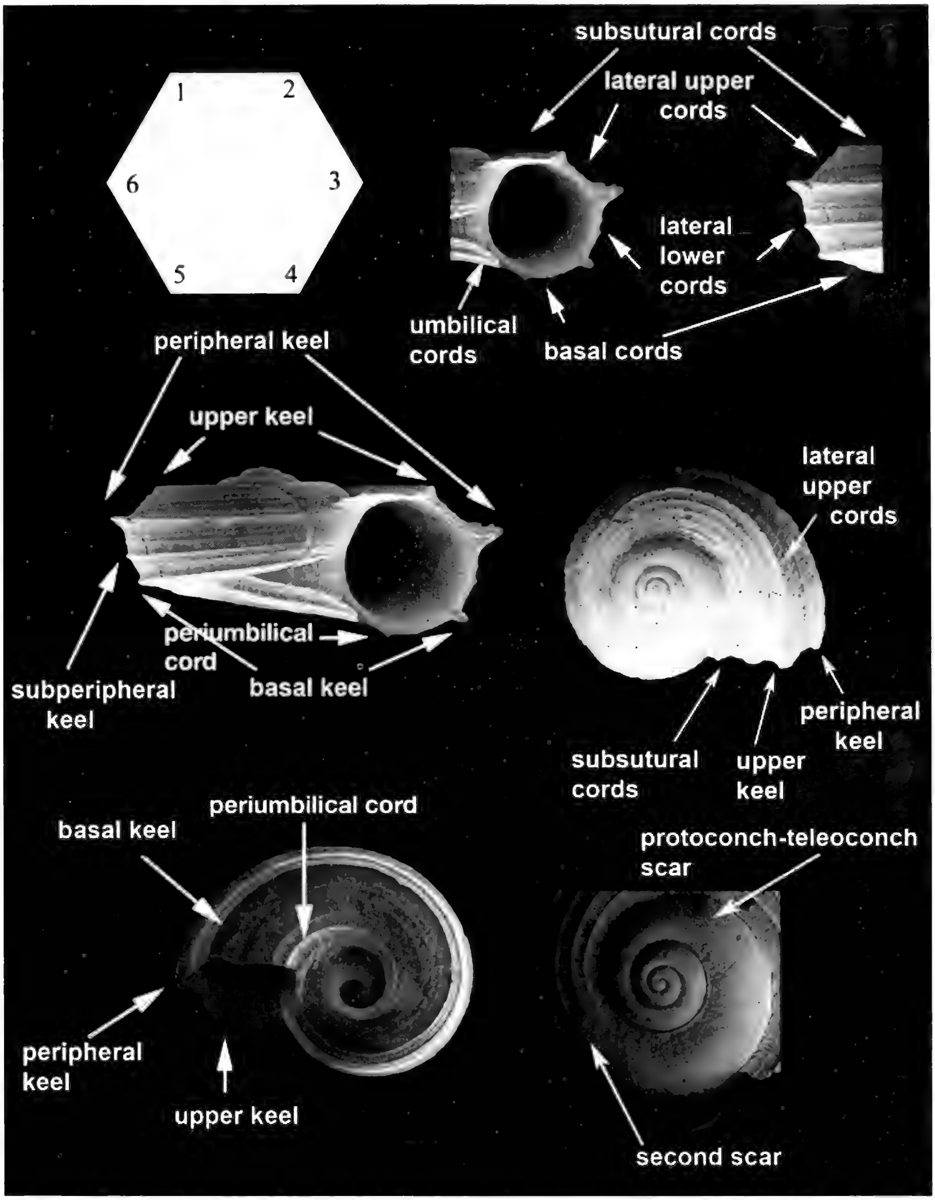


Figure 1. Schematic images showing the different sculpture and the terms employed for these characters.

Figura 1. Imágenes esquemáticas mostrando los distintos tipos de escultura y la terminología empleada para estos caracteres.

which is called *Circulus tricarinatus*. This is reflected in the CLEMAM web page where this name is also mentioned as valid.

In Cullera (Valencia, East Spain), a great quantity of material of *Circulus striatus* has been collected. In this material, there were many shells which do not represent exactly the typical form of the species, but have some peculiar characters instead: a form, which is carinate

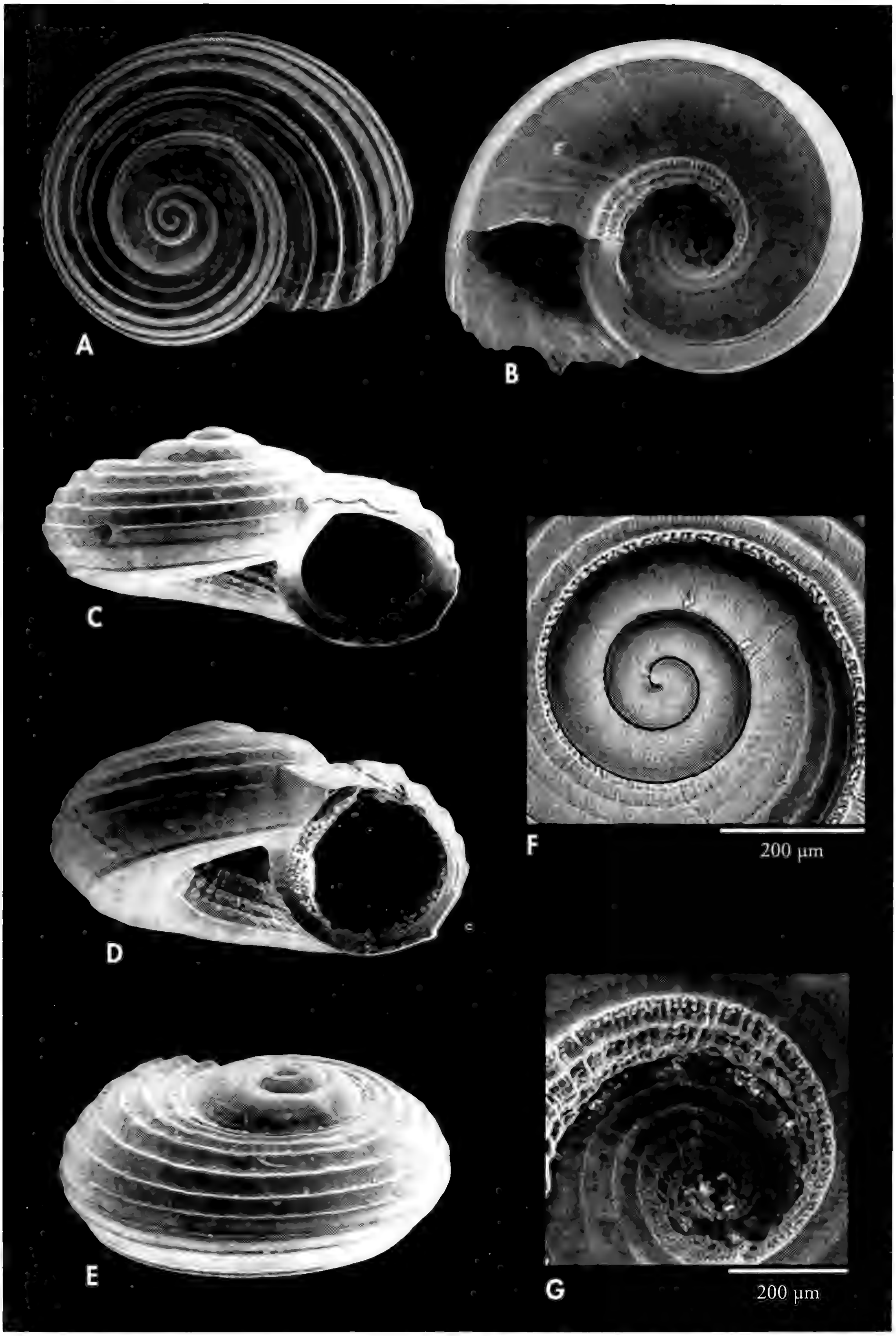


Figure 2. *Circulus striatus* (Philippi, 1836). A-E: shells, 1.6, 1.6, 1.5, 1.2, 1.2 mm, Cullera, Valencia; F: protoconch; G: detail of the umbilicus.

Figura 2. Circulus striatus *(Philippi, 1836). A-E: conchas, 1,6; 1,6; 1,5; 1,2; 1,2 mm, Cullera, Valencia; F: protoconcha; G: detalle del ombligo.*

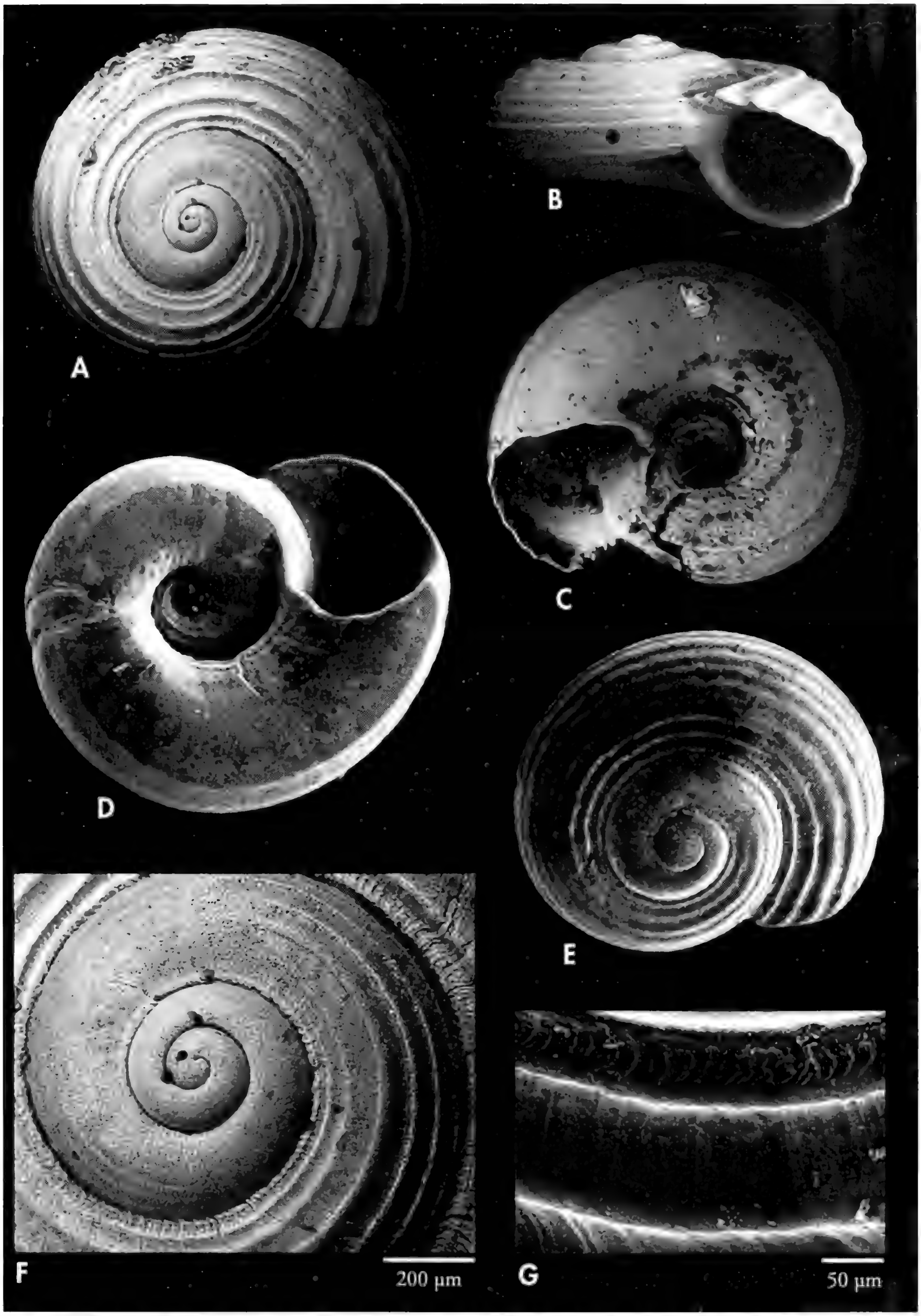


Figure 3. *Circulus striatus* (Philippi, 1836). A-C: shells, 1.68, 1.7, 1.9 mm, Agadir, Morocco (MHNS); D, E: shells, 1.9, 2.1 mm, from Tarragona (CAP); F: protoconch, Agadir; G: detail of the microsculpture, Tarragona.

Figura 3. Circulus striatus *(Philippi, 1836). A-C: conchas, 1,68; 1,7; 1,9 mm, Agadir, Marruecos (MHNS); D, E: conchas, 1,9; 2,1 mm, de Tarragona (CAP); F: protoconcha, Agadir; G: detalle de la microescultura, Tarragona.*

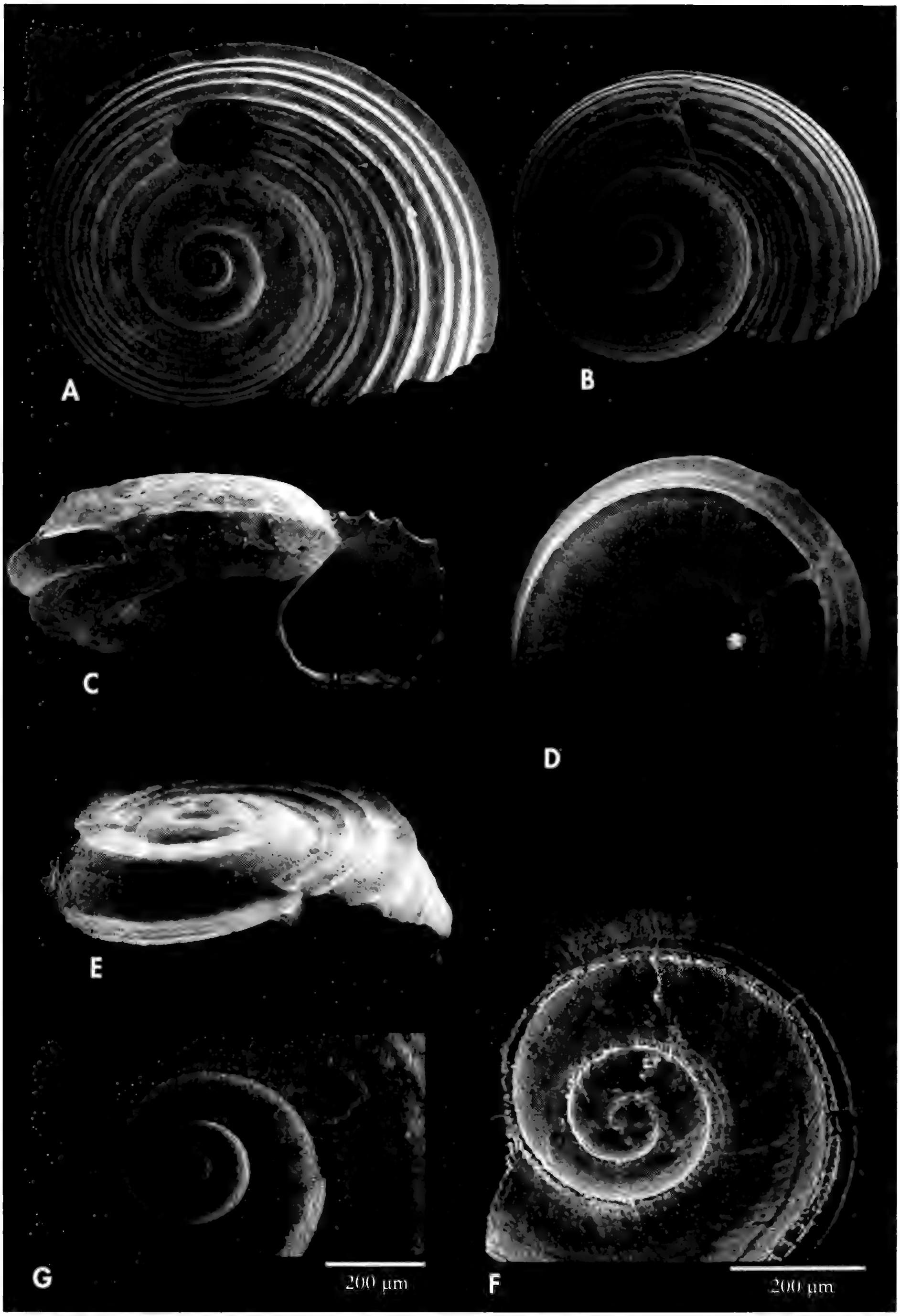


Figure 4. *Circulus striatus* (Philippi, 1836). A, B: shells of carinate form 1.24, 1.4 mm (CDO); C-E: shells of tricarinate form, 1.9, 1.5, 1.7 mm, Cullera, Valencia (CDO); F, G: protoconchs.
Figura 4. Circulus striatus *(Philippi, 1836). A, B: conchas de la forma con quilla, 1,24; 1,4 mm (CDO); C-E: conchas de la forma con tres quillas, 1,9; 1,5; 1,7 mm, Cullera, Valencia (CDO); F, G: protoconchas.*

(Fig. 4A-B), has a more developed peripheral cord/keel; another form, is tricarinate (Figs. 4C-E) presenting three cords more developed in the shape of a keel. These cords are placed in the upper position (2), peripheral position (3) and basal position (4). The presence of these different forms in only a small area suggests to us that they are simply extreme forms or variants of one species, *Circulus striatus* with variable development of the keels.

Circulus smithi Bush, 1897 (Figs. 5A-E, 6A-F, 7A-D)

Cyclostrema tricarinata Smith, E. A., 1871. p. 737, pl.75, fig. 26. [Type locality: Whydah, Dahomey].
Circulus smithi Bush, 1897. New name for *Cyclostrema tricarinatus* Smith 1871, non *Adeorbis tricarinatus* Wood 1842. p. 126.

Type material: Probably in BMNH. Not examined.
Other material examined: Western Sahara: 4 s, 3 j, Dakhla, 50-60 m, (MHNS). Mauritania: 8 s, Nouakchott, 80-100 m (CJH). Ivory Coast: 1 j, off Grand Bassam, R/V "Antea Benchaci I", 5° 11,3′ N, 3° 46′ W, (MNHN); 3 s, off Grand Bassam R/V "Antea Benchaci I" I, 30 m, 5° 09,2′ N, 3° 47,1′ W (MNHN). Ghana: 30 s, 13 j, 8 f, Miamia, 38-40 m (MHNS); 8 j, 8 f, Miamia, 45-55 m (MHNS). Angola: 1 s, Luanda, 50 m (MHNS); 22 s, 1 f, Luanda, 20-100 m (MHNS).

Description: Shell (Figs. 5A-C, 6A-D, 7A-D) flat reaching 1.8 mm in diameter, with 4.1 whorls (protoconch included) and height of about 0.86 mm. In lateral view, the first whorls barely extend beyond the level of the last whorl, although this character is somewhat variable.

The protoconch (Figs. 5D, 6E-F) is smooth with 2 ½ whorls, and about 560 μm in diameter. Well preserved protoconchs may show very fine slightly sinusoidal growth lines. The teleoconch begins with a not very noticeable line, slightly sinusoidal, and with the onset of the spiral cords. In some shells the protoconch seems to have more whorls due to the fact that the first whorl of the teleoconch is practically smooth. In such shells, the transition to the protoconch is not clear, but can be seen as the subsutural cord continues parallel to the suture and the other cords appear progressively below, sometimes after a new interruption as a scar, where they are more evident.

As in other *Circulus*, the shell sculpture consists of spiral cords which are narrower than their interspaces (Fig. 5E). Growth lines can be seen in these interspaces. The umbilicus is wide and may present 2-3 umbilical cords in the interior, but sometimes these may be transformed into 8-9 very fine and closely set cords.

Distribution: From Western Sahara south to Angola.

Remarks: This species presents some variability, but most of the shells have three cords which are more developed, forming keels: the upper one in position 2 (upper keel), 3 (peripheral keel) and 4 (basal keel) (see Fig. 1 for these positions). The external lip is inserted on the previous whorls a little above the peripheral keel, while the internal lip begins at the level of the lower keel. Between the suture and the upper keel there are 4-5 cords, the first one of which is very close to the suture. Between the upper keel and the peripheral one there are two cords; and between this latter and the lower one there are three or four. Occasionally, one of these cords can be more developed forming a keel above the basal one. In basal view, five basal cords can be seen.

The separation with those *C. striatus* which present more prominent peripheral keels is based mainly on the umbilical axial striation present between the umbilical cords, while *C. smithi* lacks this sculpture completely, only showing spiral cords. Furthermore, the cords of *C. striatus* have more volume than those of *C. smithi*.

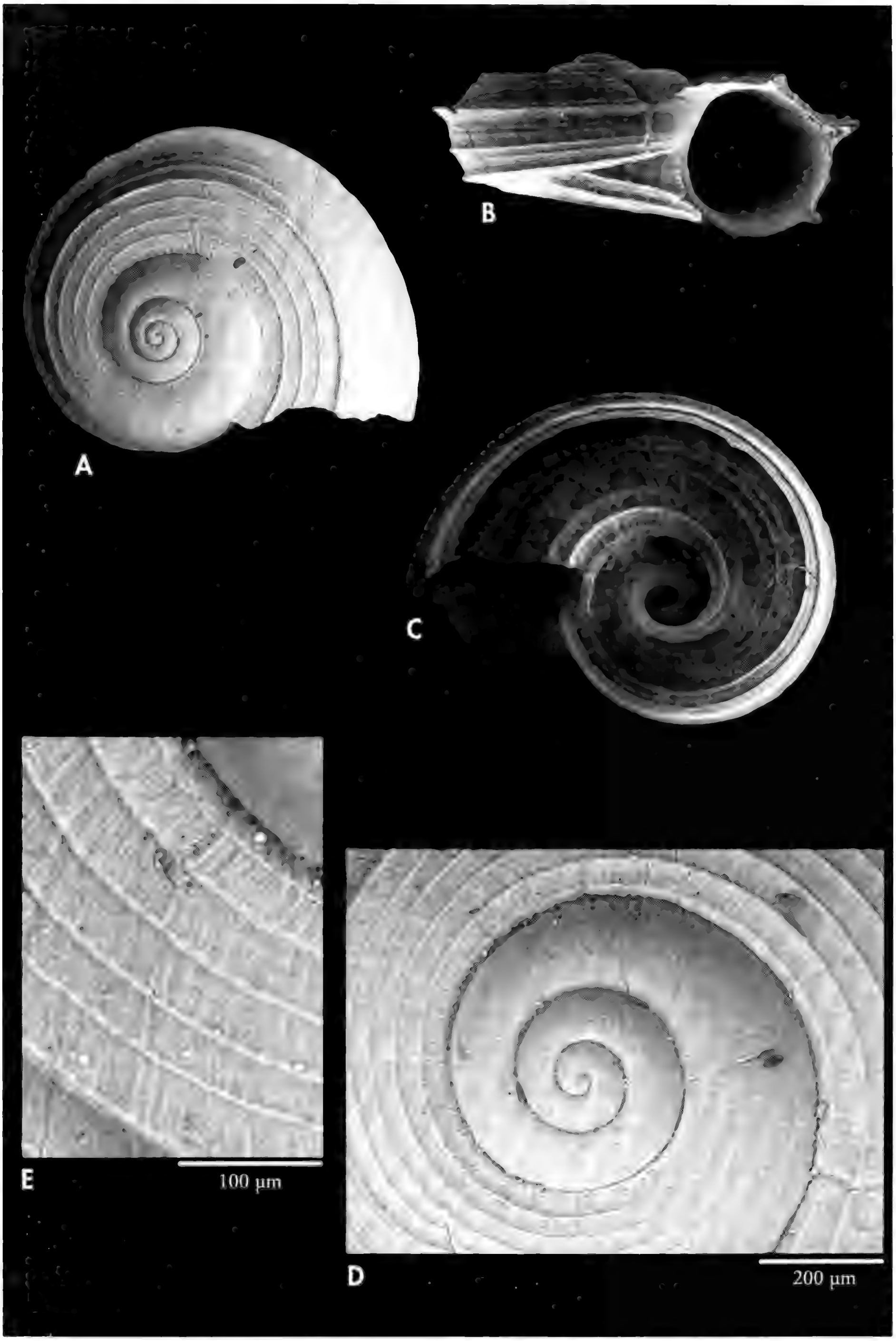


Figure 5. *Circulus smithi* Bush, 1897. A-C: shells, 1.7, 1.89, 1.92 mm, Miamia, Ghana (MHNS); D: protoconch; E: details of the microsculpture.

Figura 5. Circulus smithi *Bush, 1897. A-C: conchas, 1,7; 1,89; 1,92 mm, Miamia, Ghana (MHNS); D: protoconcha; E: detalles de la microescultura.*

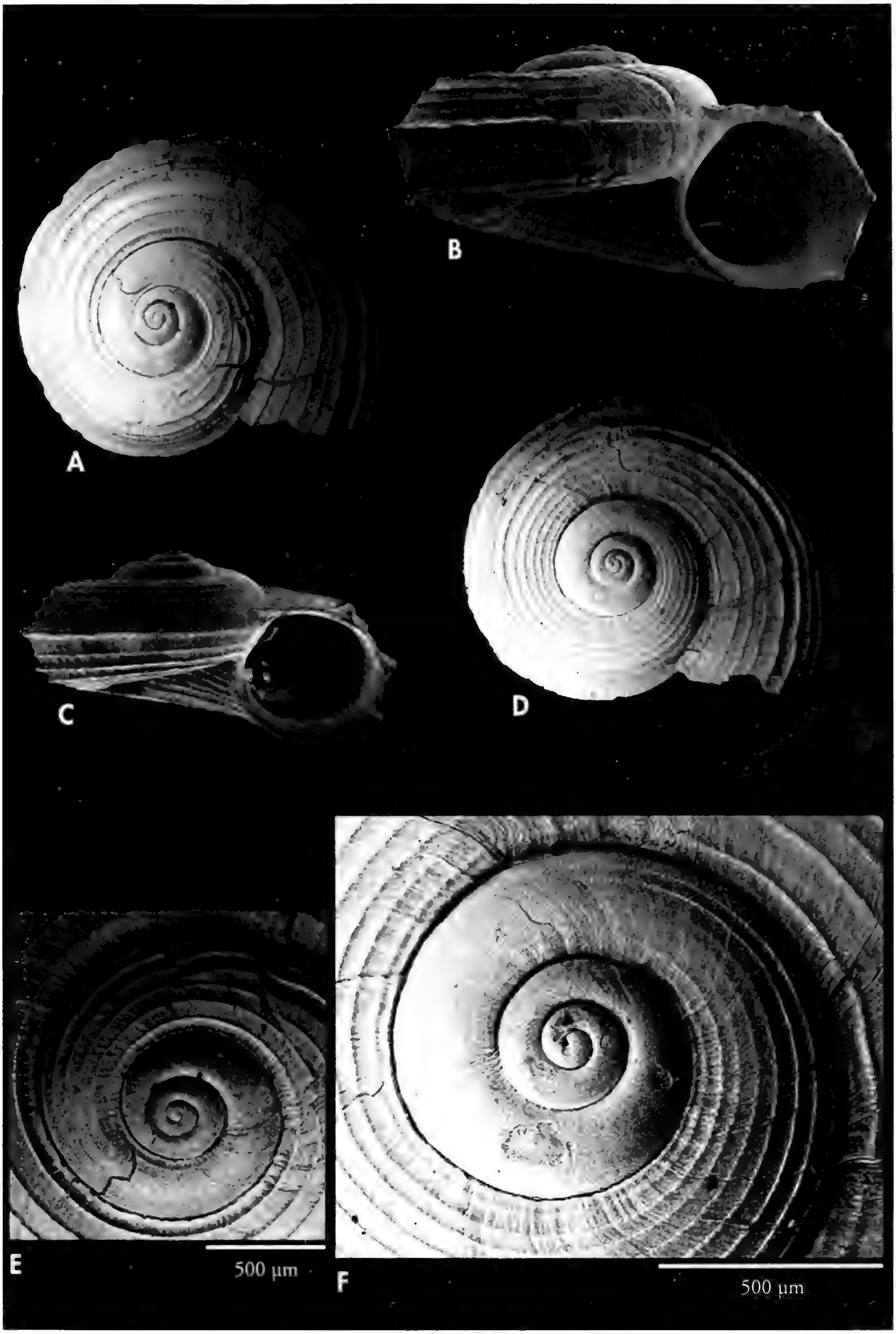


Figure 6. *Circulus smithi* Bush, 1897. A-D: shells, 2.9, 3.2, 2.3, 2.6 mm, Congo (MNHN); E, F: protoconchs.

Figure 6. Circulus smithi *Bush, 1897. A-D: conchas, 2,9; 3,2; 2,3; 2,6 mm, Congo (MNHN); E, F: protoconchas.*

Circulus congoensis (Thiele, 1925) (Figs. 8A-D, 9A-I)

Vitrinella congoensis Thiele, 1925. *Gast. Deut. Tiefsen Expedition*: 147, pl.9, fig. 3A-C. [Type locality: Congo mouth].
Circulus striatus in ADAM AND KNUDSEN (1969): 10, fig. 5.

Type material: Holotype (Figs. 8A-C) in ZMB.
Other material studied: Western Sahara: 1 c, Dakhla (50-60 m) (MHNS); Senegal: 1 s, Casamance 12° 20,7′ N, 16° 53,1′ W (MNHN). Ghana: 14 s, Miamia, 38-40 m (MHNS). Guinea Conakry: 1 s, 1 j, W Ile Quito, R/V "André Nizery" Sedigui II, 10° 00′ N,15° 46′ W, 28 m (MNHN); 3 s, 1 j, W Ile Quito, R/V "André Nizery" Sedigui II, 10°00′N, 15° 58′ W, 34 m (MNHN); 3 s, W Ile Quito, 10° 00′ N, 15° 43′ W, 26 m (MNHN); 1 s, Río Yomponi 10° 24′ N, 14° 50′ W, 22 m (MHNS); 3 s, Río Nuñez 10° 35,5′ N, 15° 26′ W 9 m (MNHN). Guinea Bissau: 1 s, Bissau II 10° 45′ N, 15° 44,5′ W, 25 m (MHNS); Angola: 3 s, Luanda, 20-100 m (MHNS).

Description: Shell (Figs. 8A-C, 9A-D) with 4.3 whorls (protoconch included) reaching 1.7 mm in diameter and 0.9 mm in height.

The protoconch (Figs. 8D, 9F-G) is smooth and reaches nearly three whorls and about 660-710 μm in diameter. The spiral cords begin after a small scar.

The teleoconch is ornamented with spiral cords which are clearly narrower than the corresponding interspaces. All cords are similar in size; none of them is more developed and so they do not form any keel. Only the subsutural cord (Fig. 9H-I) is clearly narrower than the others just when it appears at the end of the protoconch, and is only visible under strong magnification. After this first whorl, this cord increases in size, its width subsequently approaching that of the other cords.

The shell has a little more than 20 spiral cords: 7-8 from the suture to the place where the basal keel (which does not exist) would be; about ten in the basal area and 5-6 more inside the umbilicus. The cords are a little more flat at the base than at the dorsal area.

The larger shells, like the holotype, may have fewer cords or they may be less apparent.

Distribution: This species is known from the Western Sahara south to Angola.

Remarks: When ADAM AND KNUDSEN (1969) reviewed the taxon *Circulus striatus* from West Africa, they mixed up more than one species. They studied 21 shells from 7 localities, 14 of which from Cotonou (Dahomey). They described and figured as *C. striatus* the only shell from Iles de Los, West of Crawford Banc, which in our opinion does not belong to this species but to another that we will describe below. They compared the shells from Cotonou, which were also illustrated, commenting that they could correspond to *Vitrinella congoensis* Thiele, 1925, but considering it as a variety of *C. striatus*. After examining the photographs of the holotype of *Vitrinella congoensis* Thiele in ZMB, we confirm that the shell of *V. congoensis* is really very similar to the shells represented by Adam and Knudsen as *C. striatus* from Cotonou, but in our opinion it is different from the true *C. striatus*. For this reason we consider that *V. congoensis* Thiele is a valid species of *Circulus*, different from *C. striatus*.

Probably, the confusion of Adam and Knudsen could be due to the study of a large lot of *Circulus* (approximately 150 shells) from Arcachon in the Dautzenberg collection. The shells in this lot (not examined by us) were apparently recent and showed great variability: some of them had a smooth base, which is usual in the typical European *C. striatus*, whereas others had a striated base and even intermediate grades appeared. Therefore, the decision of Adam and Knudsen to consider all of them (those from Arcachon and those from West Africa) as *C. striatus* is understandable in view of the low number of shells examined from some areas, their similarity and small size, and the lack of electronic microscopy.

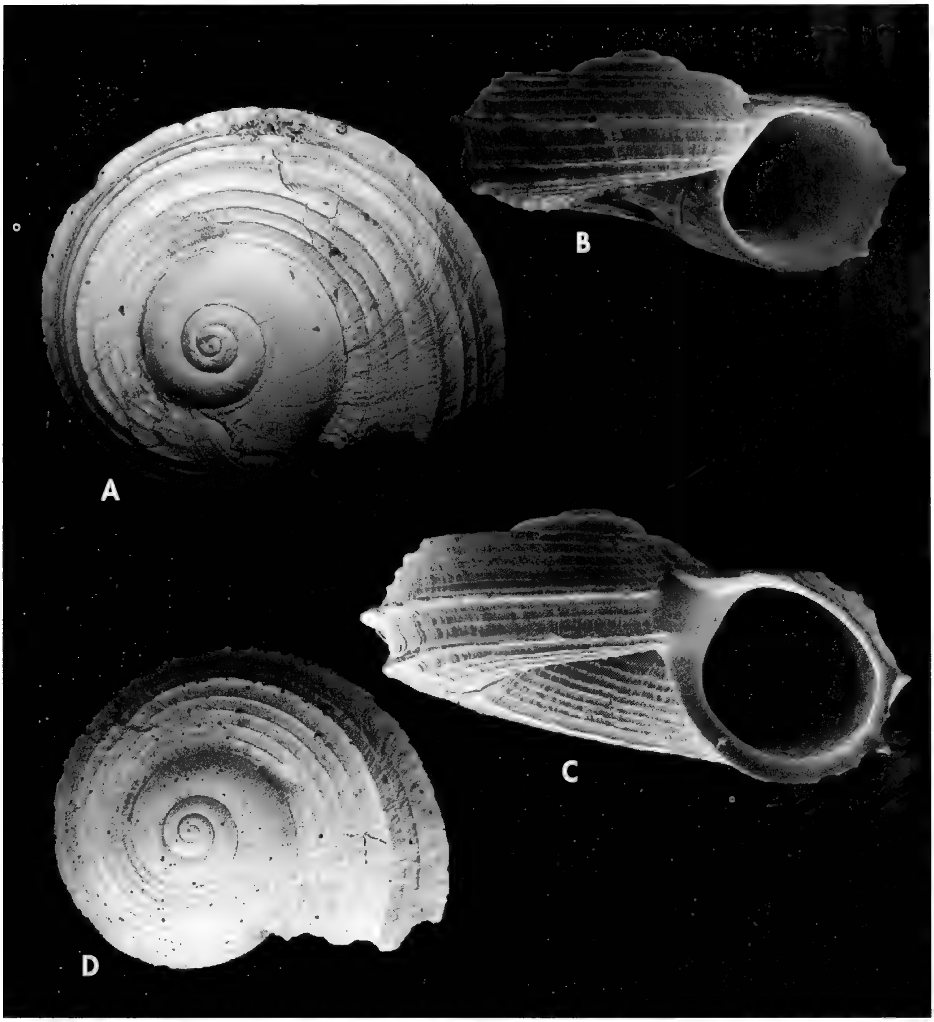


Figure 7. *Circulus smithi* Bush, 1897. A, B: shells, 2.7, 2.7 mm, Nouakchott, Mauritania (CJH); C, D: shells, 2.2, 2.9 mm, Dakar, Senegal.
Figure 7. Circulus smithi *Bush, 1897. A, B: conchas, 2,7; 2,7 mm, Nouakchott, Mauritania (CJH); C, D: conchas, 2,2; 2,9 mm, Dakar, Senegal.*

The use of electronic microscopy allowed us to evaluate that the variability in *C. striatus* could occasionally lead to consider different species (like *C. tricarinatus*). The study of many shells of *C. striatus* from the Mediterranean (Cullera, Valencia) and the Atlantic (Galicia, Morocco) showed us that those typical characters are constant and different from other species.

The most important differences between *C. striatus* and *C. congoensis* are:

1- The presence on the entire shell of a light subsutural sculptured cord in *C. striatus*. In *C. congoensis* this cordlet is barely sculptured, and it is only found at the beginning in the teleoconch, later changing into a normal cord.

2- The cords in the lateral low area and basal area in *C. congoensis* are

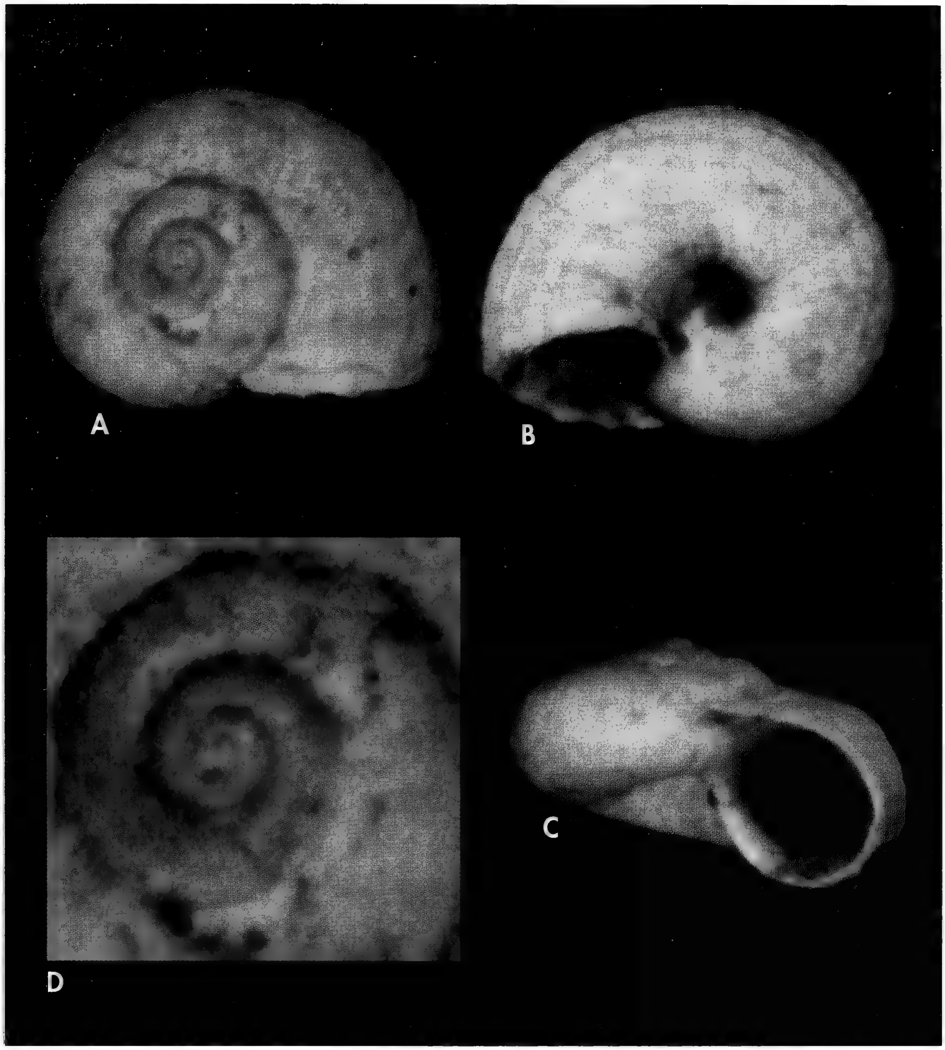


Figure 8. *Circulus congoensis* (Thiele, 1925). A-C: holotype, 1.93 mm, Congo mounth (ZMB); D: protoconch.
Figura 8. Circulus congoensis *(Thiele, 1925). A-C: holotipo, 1,93 mm, desembocadura del Congo (ZMB); D: protoconcha.*

evident and have the same size as the dorsal ones, but are a little flatter on the base. In *C. striatus* the base area apparently lacks any cord and has a very light and almost smooth aspect, which can be seen under strong magnification. It is possible that in the material from Arcachon studied by Adam and Knudsen some shells of *C. striatus* with basal cords were present, due to the great variability of the species. These shells never have stronger marked cords as does *C. congoensis*.

3- The umbilicus of *C. striatus* is more open than that of *C. congoensis*.

4- *C. striatus* is proportionally flatter than *C. congoensis*.

5- The umbilical cords in *C. striatus* are more axially sculptured than those of *C. congoensis*.

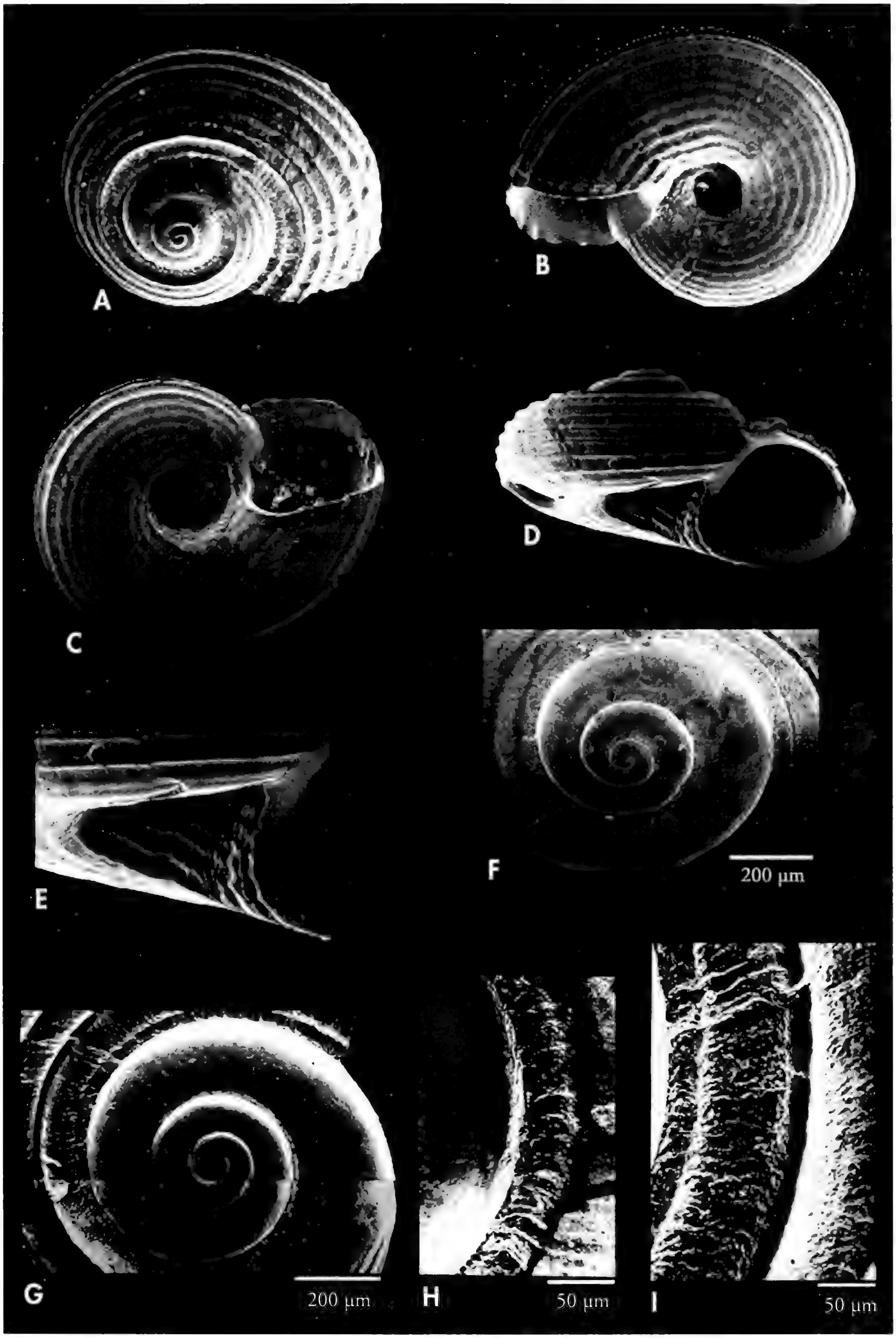


Figure 9. *Circulus congoensis* (Thiele, 1925). A-D: shells: 1.7, 1.7, 1.6, 1.6 mm, Miamia, Ghana (MHNS); E: detail of the umbilicus; F, G: protoconchs; H, I: microsculpture.

Figura 9. Circulus congoensis *(Thiele, 1925). A-D: conchas: 1,7; 1,7; 1,6; 1,6 mm, Miamia, Ghana (MHNS); E: detalle del ombligo; F, G: protoconchas; H, I: microescultura.*

Circulus senegalensis Adam and Knudsen, 1969 (Figs. 10A-F)

Circulus senegalensis Adam and Knudsen, 1969: 13, fig. 6. [Type locality: Senegal, 60 m].

Type material: Holotype and 29 paratypes in RBINS.
Other material examined: Western Sahara: Dakhla: 1 s, beach sediments (MHNS). Mauritania: 1 s, Nouakchott, fishermen dredgings, 80-100 m (CJH). Ivory Coast: 11 s, Centre Oceanografique, Abdijan, stn 13, (MNHN); 1 s, Radiale Grand Bassam R/V "Antea Benchaci I", 5° 05′ N, 3° 46.6′ W, 55 m (MNHN): 1 s, Radiale Gd. Bassam R/V "Antea Benchaci I", 5° 06′ N, 3° 46.6′ W, 50 m (MNHN). Ghana: 2 s, Miamia, 50 m (MHNS); 31 s, Miamia, 45-50 m (MHNS); 4 s, 38-40 m (MHNS); 12 s, Cap Three points, 35-65 m (MHNS). Congo: 1 s, Sta. 964, R/V André Nizery, 5° 25′ S, 12° 01′ E, 70 m (MNHN); 1 s, Sta. 949, R/V André Nizery, 5° 23′ S, 11° 48′ E, 40 m (MNHN); 5 s, Sta. 916, R/V André Nizery, 3° 4′ S, 10° 13.5′ E, 100 m (MNHN); 1 s, Sta. 1031, R/V André Nizery, 3° 15′ S, 10° 22′ E, 30 m (MNHN). Angola: 2 s, Cabinda, W Landana 5° 07′ S, 12° 01′ E, 9 m (MNHN); 32 s, 5 j, Mussulo, Luanda, 20-100 m (MNHN); 25 s, 50 j, Luanda, 50-70 m (MNHN); 4 s, Luanda, 100 m (MHNS).

Description: See ADAM AND KNUDSEN (1969). Shell (Figs. 10A-D) flat, with 4.5 whorls, solid, whitish, reaching up to 2.8 mm in width and 1.7 mm in height.

Protoconch (Fig. 10E) multispiral with almost two whorls and a diameter of about 540 μm. The transition to the teleoconch is difficult to see because of the lack of sculpture on this part of the surface.

The teleoconch is smooth except for the presence of three (sometimes four) umbilical cords separated by sulci, the innermost one being more developed. Axial ornamentation formed by little sinusoidal growth lines, which when crossing the umbilical cords give them an undulating aspect only visible under strong magnification.

Aperture circular. At those points where keels appear in other species, a sinusoidal profile may be observed.

Distribution: This species is found all along the African coast from Western Sahara south to Angola.

Remarks: This species is very distinct because it is smooth on the dorsum and thus quite different from other species occurring in the area studied.

Circulus pseudopraecedens Adam and Knudsen, 1969 (Figure 11A-D)

Circulus pseudopraecedens Adam and Knudsen, 1969: 14, fig. 7. [Type locality: Grand Cess, Liberia].

Type material: Holotype and 7 paratypes in RBINS. Holotype figured in ADAM AND KNUDSEN (1969).
Other material examined: Senegal: 2 j, Dakar, 20 m (MHNS); 2 s, Casamance, 12° 20,7′ N, 16° 53,1′ W, 15 m (MNHN); 1 s, Le Tacoma, 15 m (CJP). Ghana: 22 s, 50 j, 3 f, Miamia, 35-40 m (MHNS); 8 s, 1 j, Miamia, 40-55 m (MHNS). Equatorial Guinea: 2 s, Río Núñez, 1° 35′ N, 15° 26′ W, 9 m (MHNS); 1 s, W Ile Quito, R/V "André Nizery" Sedigui II, 10° 00′ N, 15° 46′ W, 28 m (MNHN). Angola: 7 s, Luanda, 20-100 m (MHNS).

Description: Shell (Figs. 11A-C): see ADAM AND KNUDSEN (1969).

Shell circular, depressed, with 4.8 whorls (protoconch included) which reaches 3.3 mm in diameter and 1.3 mm in height. Protoconch (Fig. 11D), with a little less than 3 whorls and about 800 μm in width. The transition to the teleoconch is difficult to see, but appears at the beginning of the upper cord. The shell has a vitreous, slightly transparent aspect. It has a clear peripheral keel and a spiral cord like an upper keel. In most of the shells there is no basal keel but ADAM AND KNUDSEN (1969) mention that they found a shell from Rufinesque Bay with this keel.

The subsutural area is flat and smooth without subsutural cords. The upper lateral area can present some scarcely prominent narrow cords. A

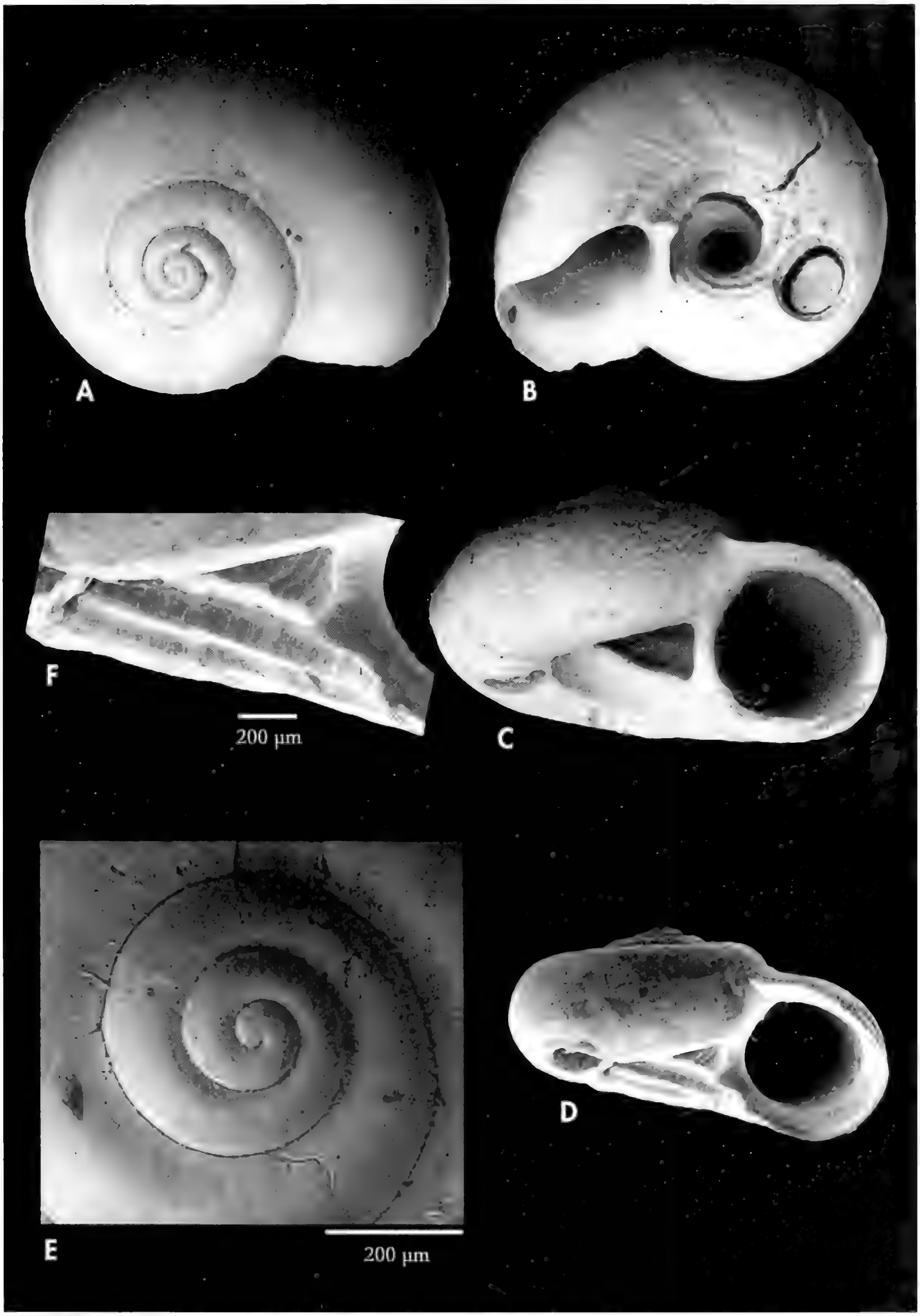


Figure 10. *Circulus senegalensis* Adam and Knudsen, 1969. A, B: shells, 1.9, 2.0 mm, Abidjan, Ivory Coast (MHNS); C, D: shells, 2.1, 1.3 mm, Luanda, Angola (MNHN); E: protoconch; F: detail of the umbilical sculpture.

Figura 10. Circulus senegalensis *Adam y Knudsen, 1969. A, B: conchas, 1,9; 2,0 mm, Abidjan, Costa de Marfil (MHNS); C, D: conchas, 2,1; 1,3 mm, Luanda, Angola (MNHN); E: protoconcha; F: detalle de la escultura umbilical.*

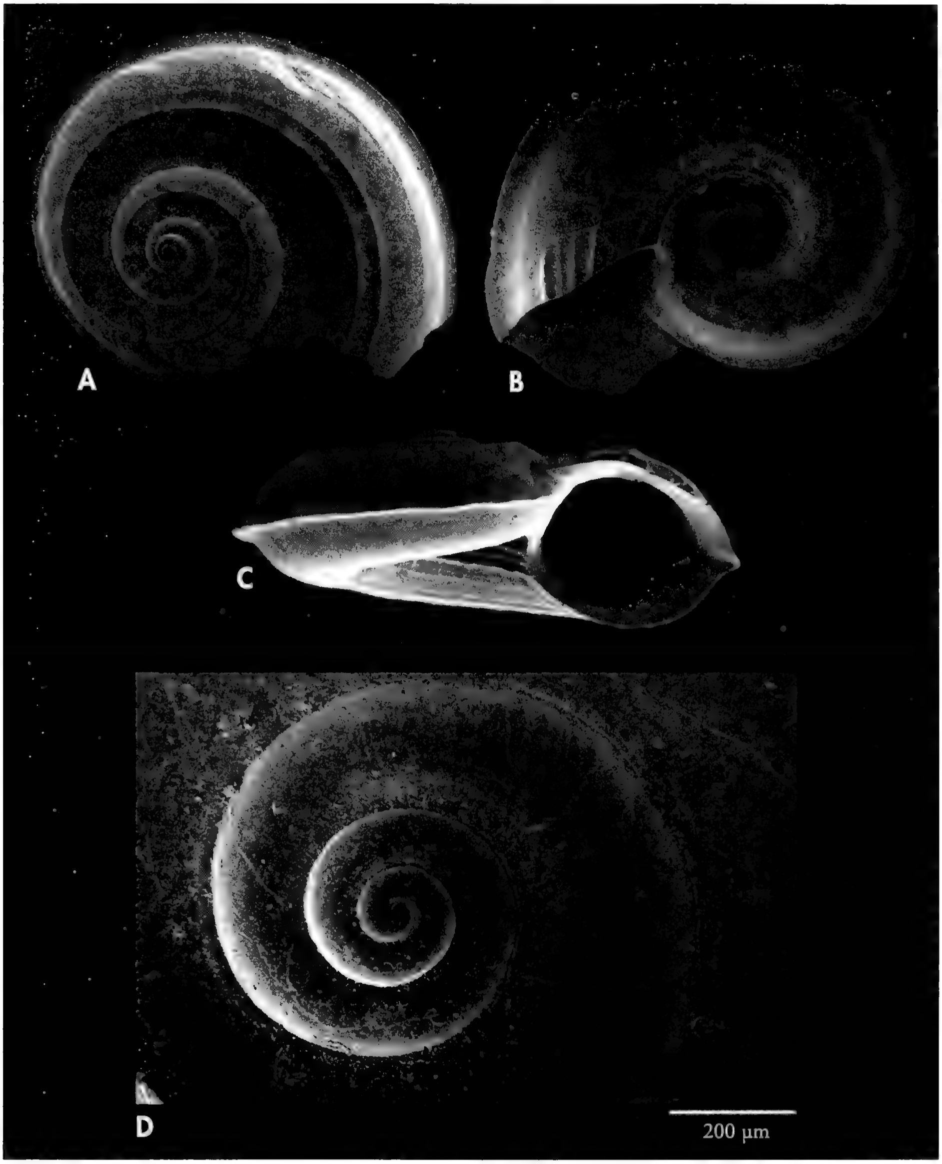


Figure 11. *Circulus pseudopraecedens* Adam and Knudsen, 1969. A-C: shells, 3.2, 2.8, 3.1 mm, Miamia, Ghana (MHNS); D: protoconch.

Figura 11. Circulus pseudopraecedens *Adam y Knudsen, 1969. A-C: conchas, 3,2; 2,8; 3,1 mm, Miamia, Ghana (MHNS); D: protoconcha.*

cord, placed at $^1/_3$ between the suture and the peripheral cord appears at the beginning of the teleoconch and represents the upper keel. Below, other small cords may appear but are barely noticeable.

The peripheral keel is the most outstanding feature of the sculpture. The lateral low cords, the basal keel and the basal cords are absent or are very slight in juvenile shells. On the contrary, in adult shells, after some scars they can appear more evidently. From a basal view the shell shows a wide and deep umbilicus. In its interior there are 5-6 umbilical cords.

When it comes to the axial microsculpture, only sinusoidal growth lines can be found.

The aperture is circular and prosocline, and from a basal view the upper part of the external lip clearly extends beyond the lower part.

Distribution: Known from Senegal to Angola.

Remarks: The characteristic shape with constant and prominent keels and lacking other intermediate cords separates this species from other congeners in the studied area.

Circulus stephani Rolán and Ryall, 2002 (Figure 12A-F)

Circulus stephani Rolán and Ryall, 2002. *Iberus*, 20 (1): 95, figs. 1-6. [Type locality: Mimia, Ghana, 38-40 m].

Type material: Holotype (Fig. 12A) in MNCN and paratypes in several museums (MNHN, MHNS, etc.) mentioned in the original description.
Other material examined: Ivory Coast: 1 s, Abdijan Grand Bassan (col. Leboeuf Ortson) (MNHN). Ghana: 8 s, 38-40 m; (MHNS); 4 s, Cap Three Points, 35-65 m (MHNS). Angola: Cabinda: 1 s, W. Luanda 10° 05′ S, 11° 59′ E, 25 m; R/V André Nizery (col. MNHN) (also that mentioned in the original description).

Description: Shell (Figs. 12A-E): see ROLÁN AND RYALL (2002). Shell circular, depressed, with about 4.5 whorls reaching 2.1 mm in diameter. Protoconch (Fig. 12F) with almost 2.75 whorls and 740 μm in width. *Circulus stephani* presents three evident keels: upper, peripheral and basal. The upper one is the least developed, while the basal one is the strongest, reaching the maximum width of the shell.

The subsutural cords appear at the beginning of the teleoconch. They are clearly narrower than the corresponding interspaces. The first one to appear will be the upper keel. Later, on the subsutural area the other four cords appear. As the shell grows in size, more cords appear, while the largest shells can have up to 10 subsutural cords.

Distribution: Known from Ivory Coast to Angola.

Remarks: See ROLÁN AND RYALL (2002) for differentiation from other species of the genus in West Africa.

Circulus microsculpturatus spec. nov. (Figures 13A-F)

Type material: Holotype in MNHN (23687) (Figs. 13A-B). Paratype; 1 s, Dakhla, 50 m, Western Sahara in MNCN (15.05/55052).
Type locality: Sediments trawled at 50 m, Guinea Conakry.
Etymology: The specific name alludes to the microsculpture characteristic of the present species.

Description: Shell (Fig. 13A-B) circular, depressed, solid, with almost 4.5 whorls, reaches 3.5 mm in diameter and 1.5 mm in height. Protoconch (Fig. 13C) with 2 whorls and 510 μm in diameter. The main sculpture is formed by spiral cords, narrower than the corresponding interspaces. In these interspaces appears a granular microsculpture which is characteristic of this species (Figs. 13D-F). Three of the cords are more developed forming keels: upper, peripheral and basal. The basal one is particularly developed, giving a rectangular appearance to the peristome. Between the suture and the upper keel there are 5-6 spiral cords. Between the upper and the peripheral keels there are 23 cords, of which the upper one is nearly as large as the keel itself.

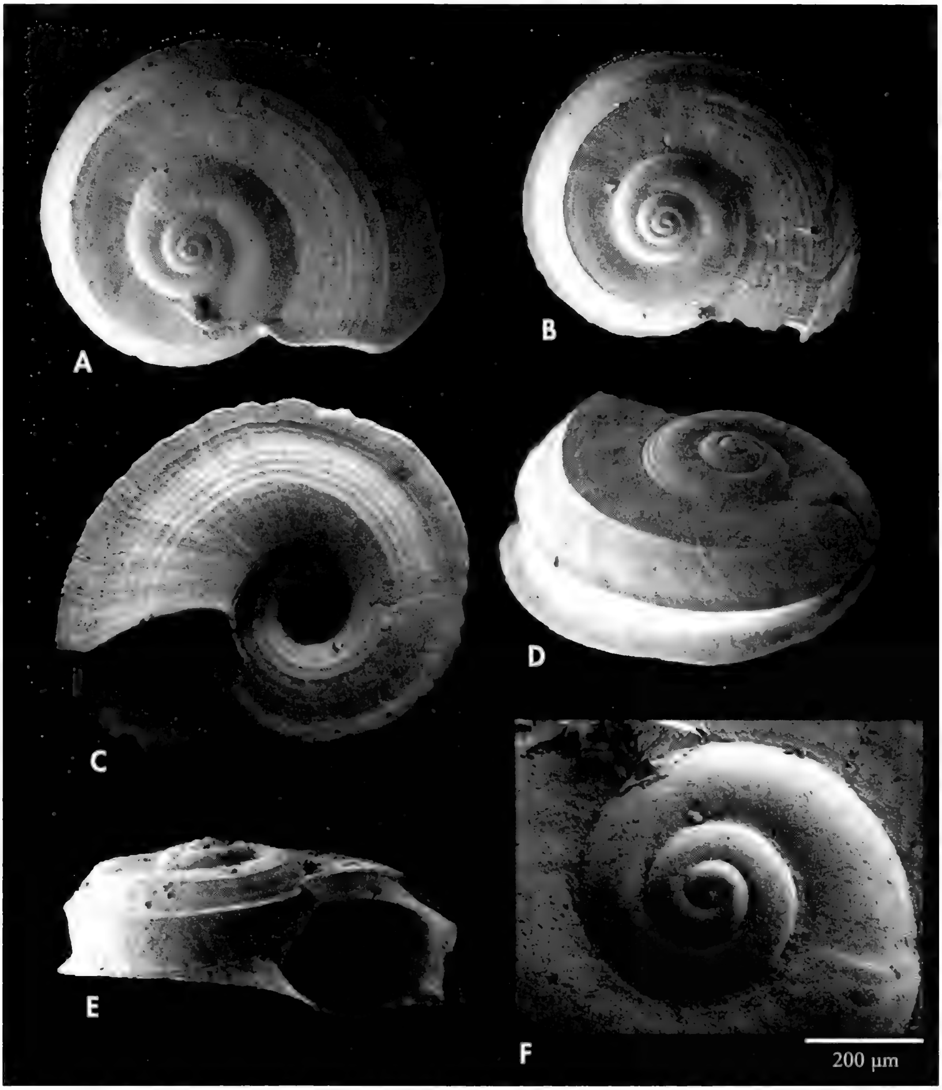


Figure 12. *Circulus stephani* Rolán and Ryall, 2002. A: holotype, 2.1 mm (MNCN); B: paratype, 1.7 mm (MNHN); C: paratype, 2.0 mm (AMNH); D: paratype, 1.6 mm (NHMUK); E: paratype, 2.1 mm (MHNS); F: protoconch of the holotype.
Figura 12. Circulus stephani *Rolán y Ryall, 2002. A: holotipo, 2,1 mm (MNCN); B: paratipo, 1,7 mm (MNHN); C: paratipo, 2,0 mm (AMNH); D: paratipo, 1,6 mm (NHMUK); E: paratipo, 2,1 mm (MHNS); F: protoconcha del holotipo.*

Between the peripheral and the basal keels there are four cords. There is not a clear basal cord, the base being occupied by about 14 cordlets with a width similar to that of the interspaces. They go into the umbilicus.

Distribution: Only known from the type material (From Sahara to Guinea Conakry).

Remarks: The microsculpture of the present species differentiates it from the other congeneric species in the studied area.

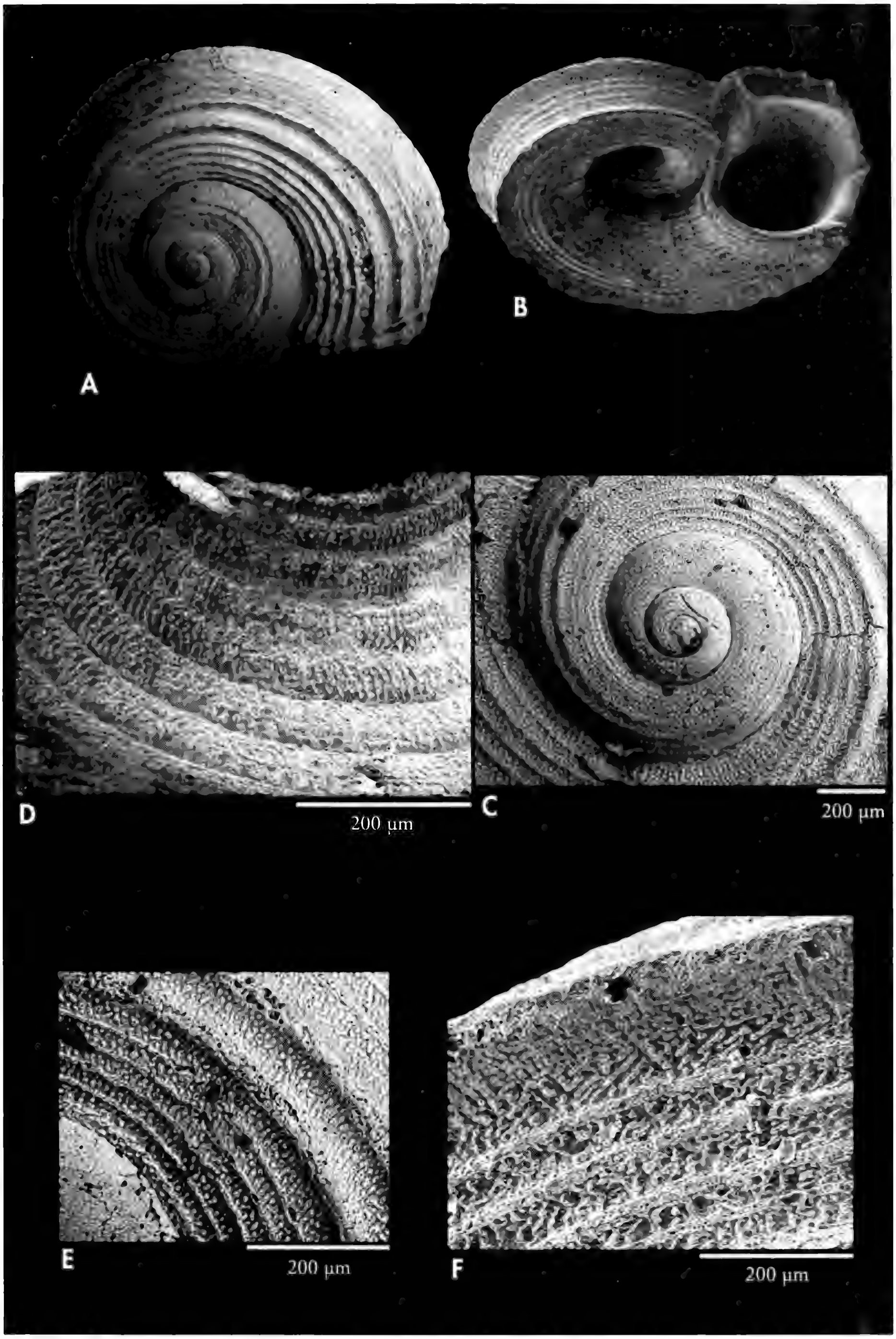


Figure 13. *Circulus microsculpturatus* spec. nov. A, B: holotype, 3.4 mm, Guinea Conakry (MNHN); C: protoconch of the holotype; D-F: microsculpture.

Figura 13. Circulus microsculpturatus *spec. nov. A, B: holotipo, 3,4 mm, Guinea Conakry (MNHN); C: protoconcha del holotipo; D-F: microescultura.*

Circulus ryalli spec. nov. (Figure 14A-D)

Circulus striatus in Adam and Knudsen (1969): 10, fig. 4.

Type material: Holotype (Fig. 14A) in MNCN (15.05/55053). Paratypes in the following: MNHN (23688) (1 s, Fig. 14B), MHNS (5 s, 1 j, Fig. 14C), CPR (1 s).
Type locality: Miamia, Ghana, in sediments dredged in 38-45 m.
Etymology: The species is named after Peter Ryall, a malacologist who lived for many years in Ghana and helped us during the collection of the type material.

Description: Shell (Figs. 14A-C) circular, depressed, with 4.6 whorls (protoconch included), reaching 1.9 mm in diameter and 0.9 mm in height. Protoconch (Fig. 14D) smooth, with 2 ½ whorls, and about 510 μm in diameter. Teleoconch with slightly prosocline spiral cords and axial growth lines which cross the interspaces, giving them a striated appearance. The shell has a clear peripheral keel, and in the places which would correspond to the other keels there are somewhat developed cords; as the shell increases in size the basal cord progressively becomes keel-shaped. The subsutural area is flat with six or seven cords which appear after the protoconch scar. These cords are wider than their interspaces at the beginning, but subsequently the interspaces increase in size while the cords continue the same, so that at the end of the spire the cords are clearly narrower than their interspaces. Among the subsutural cords, the adapical one is a little wider and placed in the position of the upper keel. The upper lateral area is flat and so the transition has an angled aspect (about 100°). Between the upper cord/keel and the peripheral keel, there are 6-7 cords and, with the shell in lateral view, they seem to be flatter and wider than the corresponding interspaces. In the upper lip one or two cords are inserted on the peripheral keel. The lateral lower area does not have cords and is slightly concave. The basal area is flat with 4-5 cords, two of which are more developed, in the position of the periumbilical cord/keel and 2-3 lighter, in the transition with the umbilical area. Between these two groups of cords there is a wide space. The umbilicus is open and in its interior there are about 7-8 spiral cords as wide as the interspaces, crossed by growth lines which give them a striated aspect.

Dimensions: the holotype is 1.97 mm.

Distribution: Only known from the type material.

Remarks: This species appears to be that which ADAM AND KNUDSEN (1969) considered as *C. striatus* from Iles de Los, to the W of Crawford Bank.

Circulus striatus lacks true cords at the base which is smooth; in the umbilical cords, there is a typical microsculpture while in *C. ryalli* there only appear fine axial growth lines; the protoconch of *C. striatus* has between 2 and a little more whorls, with 390 μm in diameter, while *C. ryalli* has a protoconch with 2 ½ whorls and about 510 μm. The beginning of the teleoconch in *C. ryalli* shows evident cords, all similar, while those in *C. striatus* are generally more attenuate and the subsutural one has constantly visible microsculpture.

Circulus senegalensis has a smooth shell lacking keels and cords.

Circulus pseudopraecedens has keels but not spiral cords between them.

Circulus smithi has fewer cords on the dorsal part, the space between the keels being more occupied by cords.

Circulus microsculpturatus spec. nov. has a more evident microsculpture over the entire shell.

REMARKS AND FINAL DISCUSSION

Eight species of the genus *Circulus* from the East Atlantic area have been studied in the present work. Most of the species have a tropical distribution,

Figure 14. *Circulus ryalli* spec. nov. A: holotype, 1.97 mm, Miamia, Ghana (MNC); B: paratype, 1.9 mm (MNHN); C: paratype, 1.9 mm (MHNS); D: protoconch of the holotype.
Figura 14. Circulus ryalli *spec. nov. A: holotipo, 1,97 mm, Miamia, Ghana (MNC); B: paratipo, 1,9 mm (MNHN); C: paratipo, 1,9 mm (MHNS); D: protoconcha del holotipo.*

from West Sahara south to Angola, which seems to be an area in common to all of them although not all (mainly the ones of which less material is available) have been collected throughout the entire area.

Of those, the oldest and type species of the genus is *C. striatus*. This species extends from the cold waters of northern Europe south to the temperate waters of the Mediterranean and northern and western Morocco. It is not present in the rest of the African west coast but has been erroneously confused with other species on several occasions.

As is usual in species with a wide dispersal area, all of them have multispiral protoconchs (between 2 and 3 spiral whorls).

Some European taxa which have been included in *Circulus* and do not belong there are the following:

Adeorbis subcarinatus Montagu, 1803, now considered as a species of the genus *Tornus*.

Circulus jeffreysii Monterosato, 1872: according to WARÉN (1992) it is a Skeneid species, not a *Circulus*.

Circulus formossisimus Brugnone, 1873. Synonymized with *Circulus jeffreysii*.

ACKNOWLEDGEMENTS

The authors want to express their thanks to Philippe Bouchet of the MNHN for the loan of numerous samples from this museum. Jesús Méndez and Inés Pazos of the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) of the University of Vigo and to Ramiro Barreiro Pérez of the Centro de Apoyo Científico y Tecnológico of the University of Santiago de Compostela (CACTUS) for the microphotographs of the material studied in this work. Other SEM photographs were made by Marta Furió, Laura Tormo and Alberto Jorge in the MNCN. Also to José María Hernández (†) from Gran Canaria, Anselmo Peñas from Vilanova i la Geltrú and Peter Ryall, from Maria Rain, for the loan of material. António A. Monteiro of Lisbon made the corrections to the language.

BIBLIOGRAPHY

AARTSEN J.J. VAN, MENKHORST H.P.M.G. AND GITTENBERGER E. 1984. The marine Mollusca of the Bay of Algeciras, Spain, with general notes on Mitrella, Marginellidae and Turridae. *Basteria*. Suppl. 2: 1-135.

ADAM W. AND KNUDSEN J. 1969. Quelques genres de Mollusques prosobranches marins inconnus ou peu connus de l'Afrique occidentale. *Bulletin Institut Royal des Sciences Naturelles de Belgique*, 44 (27): 1-69.

BOUCHET P. AND ROCROI J.P. (Ed.); Frýda J., Hausdorf B., Ponder W., Valdés Á. and Warén A. 2005. Classification and nomenclator of gastropod families. *Malacologia: International Journal of Malacology*, 47 (1-2): 397 pp. ConchBooks, Hackenheim, Germany.

COPPINI M., CUNEO F., MARGELLI A. AND CAMPANI E. 2005. Gastropoda e Scaphopoda del porto de Livorno. *Bollettino Malacologico*, 41 (5-8): 1-8.

DALL W.H. 1927. Small shells from dredgings off the southeast coast of the United States by the United States Fisheries steamer *Albatross* in 1885 and 1886. *Proceedings of the United States National Museum*, 70 (2667): 1-134.

FERNANDES F. AND ROLÁN E. 1993. Moluscos marinos de São Tomé y Principe: actualización bibliográfica y nuevas aportaciones. *Iberus*, 11 (1): 31-47.

FISCHER P. 1887. Manuel de conchyliologie et de paléontologie conchyliologique : ou, Histoire naturelle des mollusques vivants et fossiles. Paris, Savy. xxiv + 1369 p., 23 pl.

FRETTER V. AND GRAHAM A. 1962. *British prosobranch molluscs: their functional anatomy and ecology*. Ray Society, London, xvi + 755 pp.

FRETTER V. AND GRAHAM A. 1978. The prosobranch molluscs of Britain and Denmark. Part 4 - Marine Rissoacea. *Journal of Molluscan Studies, supplement* 6: 153-241.

GRAHAM A. 1982. *Tornus subcarinatus* (Prosobranchia, Rissoacea) anatomy and relationships. *Journal of Molluscan Studies*, 48: 144-147.

GRAHAM A. 1988. Molluscs: Prosobranch and Pyramidellid Gastropods. *Synopses of the British Fauna, 2*. Linnean Society of London, 662 pp.

HIDALGO J.G. 1917. *Fauna malacológica de España, Portugal y las Baleares*. Trabajos del Museo Nacional de Ciencias Naturales, 30, Madrid. 752 pp.

JEFFREYS J.G. 1865. *British conchology, or an account of the Mollusca which now inhabit the British Isles and the surrounding seas. Vol. 111. Marine shells, comprising the remaining Conchifera, the Solenoconchia, and Gasteropoda as far as Littorina*. J. van Noorst, London, 393 (+ 1) p., 8 pls.

LOCARD A. 1889. Matériaux pour servir l'histoire de la malacologie française. VIII. Note sur les espèces françaises appartenant au genre *Circulus*. *Bulletin de la Société Malacologique de France*, 6: 283-307.

NOBRE A. 1938-40. *Fauna malacológica de Portugal. Moluscos marinhos e das aguas salobras*. Companhia Editora do Minho, Barcelos. 807 pp, 87 láms.

POPPE G.T. AND GOTO Y. 1991. *European Seashells*. vol 1. Christa Hemmen, Darmstadt. 352 pp.

ROLÁN E. 1983. Moluscos de la Ría de Vigo, 1 Gasterópodos. *Thalassas*, 1 (1), supl. 1: 1-383 pp.

ROLÁN E. AND RUBIO F. 1991 "1990". Aportaciones a los conocimientos sobre los micromoluscos de África Occidental. 1. Tornidae de São Tomé y Principe. *Iberus*, 9 (1-2): 181-186, 1 lám.

ROLÁN E. AND RUBIO F. 1996. Un nuevo vitrinélido (Mollusca, Gastropoda, Vitrinellidae) de la isla de São Tomé (África occidental). *Iberus*, 14 (2): 143-146.

ROLÁN E. AND RUBIO F. 2002. The family Tornidae (Gastropoda, Rissooidae) in the east Atlantic. *Reseñas Malacologicas*, suppl.: 1-98.

ROLÁN E., RUBIO F. and RYALL P. 2000. A new species of *Teinostoma* (Mollusca, Gastropoda, Vitrinellidae) from Ghana (W. Africa). *Argonauta*, 13 (2): 81-82.

ROLÁN E. AND RYALL P. 2002. A new species of the genus *Circulus* (Gastropoda, Adeorbidae) from West Africa. *Iberus*, 20 (1): 95-98.

RUBIO F. AND ROLÁN E. 1991 "1990". Aportaciones a los conocimientos sobre los micromoluscos de África Occidental. 2 Archaegastropoda de São Tomé y Principe. *Iberus*, 9 (1-2): 209-219, 5 lám.

TERRENI G. 1981. *Molluschi conchiferi del mare antistante la costa Toscana*. 1-102 pp. Livorno.

THIELE J. 1929-1935. *Handbuch der Systematischen Weichtierkunde*. 2 vols. 1154 p., 584 figs.

VERDUIN A. 1976. On the systematic of recent *Rissoa* of the subgenus *Turboella* Gray, 1847, from the Mediterranean and European Atlantic coasts. *Basteria*, 40: 21-73.

WARÉN A. 1992. New and little known "Skeneimorph" gastropods from the Mediterranean Sea and the adjacent Atlantic Ocean. *Bollettino Malacologico*, 27 (10-12): 149-248.

WOOD S.V. 1848. *A Monograph of the Crag Mollusca*. I. Univalves. Paleontological Society, London. 208 pp, 21 pls.

© Sociedad Española de Malacología ——————— Iberus, 29 (1): 35-38, 2011

First Mediterranean record of *Diaphana marshalli* (Sykes, 1904) (Gastropoda, Diaphanidae) - a rare bathyal species

Primera cita para el Mediterráneo de *Diaphana marshalli* (Sykes, 1904) (Gastropoda, Diaphanidae) - una especie rara del batial

Enzo CAMPANI*, Cesare BOGI** and Bella S. GALIL***

Recibido el 4-II-2011. Aceptado el 20-III-2011

ABSTRACT

The rare bathyal gastropod *Diaphana marshalli* (Sykes, 1904), previously known only for the Atlantic, is reported for the first time in the Mediterranean. The specimens, collected off Hadera, Israel, are photographed and compared with its Mediterranean congener, *D. jonica* Di Geronimo, 1974

RESUMEN

Se cita por primera vez en el Mediterráneo el gasterópodo *Diaphana marshalli* (Sykes, 1904), una especie rara del batial, previamente conocida solamente en el Atlántico. La cita se basa en ejemplares recogidos frente a Hadera, Israel, que se ilustran y se comparan con su congénere del Mediterráneo, *D. jonica* Di Geronimo, 1974

INTRODUCTION

The bathyal molluscs of the Levantine Sea are scarcely known. Nearly a century passed from STUARNY's (1896) publication of the specimens collected during the voyages of the "POLA" (1890-1893), JANSSEN's (1989) report of those collected by "METEOR" [cruise 5] (1987) and Bogi's account of the few specimens collected by "POSEIDON" [cruise 201/2] (1994) from Eratosthenes Seamount (GALIL AND ZIBROWIUS, 1998). A total 42 species were identified from material collected during a series of cruises conducted between 1994 and 1999 as part of pollution monitoring surveys by the Israel Oceanographic and Limnological Research (IOLR) off the northern coast of Israel (BOGI AND GALIL, 2004). Of these, five species constituted new records for the eastern Mediterranean, and 8 were newly recorded from the Levantine Sea. Two specimens, earlier considered juveniles of an unidentified gastropod, have been recently re-examined and recognized as *Dipahana marshalli* (Sykes, 1904).

MATERIALS AND METHODS

The area investigated is located off the coast of Israel, at depths between 1227 and 1454 m. The material was collected during monitoring surveys of a

---

* Corso G. Mazzini 299, 57126 Livorno, Italy, E-mail enzo.campani@fastwebnet.it
** Via delle Viole 7, 57124 Livorno, Italy, E-mail bogicesare@tiscali.it
*** Israel Oceanographic and Limnological Research, National Institute of Oceanography, P.O.B. 8030, Haifa 31080, E-mail bella@ocean.org.il

deepwater coal fly ash disposal site off Hadera (between 32° 38′ N 34° 02′ E and 32° 36′ N 34° 16′ E). The samples were collected aboard the R/V *Shikmona*, using a 45 ft Marinovich type deep water trawl (codend mesh 6 mm) with a 0.5 mm plankton net secured atop. The samples were preserved in 10% buffered formalin aboard ship. In the laboratory, the samples were washed and sieved through a 250 μm mesh, preserved in 70% alcohol, stained in Rose Bengal and sorted. Two specimens (with soft parts) were collected at a depth of 1400 m in September 1997 [1,5 x 0,91 mm (fig. 2); 1,3 x 0,8 mm (figs. 3 – 5)]. The smaller specimen was damaged, the larger one is preserved in the Bogi collection.

TAXONOMY

OPISTHOBRANCHIA Milne-Edwards, 1848
CEPHALASPIDEA P. Fischer, 1883
DIAPHANIDAE Odhner, 1914
Diaphana Brown, 1827

Diaphana marshalli (Sykes, 1904)

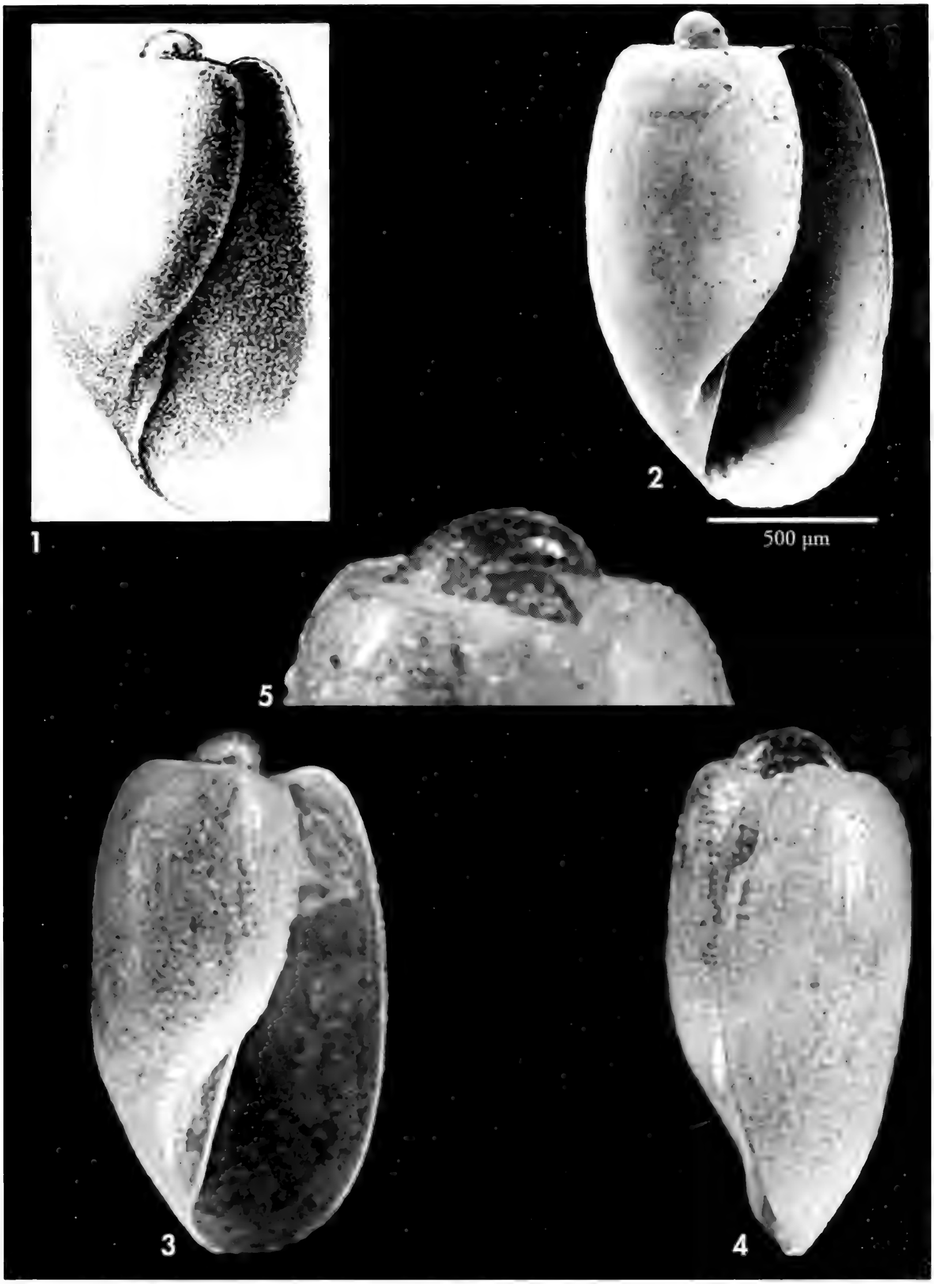
Discussion: *Diaphana marshalli* is an exceedingly rare species. Aside from the type series collected off Portugal, only two additional specimens are known: a shell collected by the "THALASSA" Expedition (station Z 447, 48° 47′, 11° 12′, 1450 – 1500 m) and cited as *Retusa* (?) *marshalli* by BOUCHET (1975), and a 2.1 mm high specimen with soft parts, collected by the "INCAL" Expedition 1976 (station CP08, 50° 15′ N, 13° 14′ W, 2644 m) (SCHIØTTE, 1999).

Retusa marshalli was described and illustrated (SYKES, 1904: 31, figs. 5, 6, 6a, b) from specimens collected by the "PORCUPINE" Expedition of 1870, off Portugal, at station 17, at 600-1095 fathoms. Only a single specimen was measured ("Alt. 2, diam. max. 1.1 mm", there, p. 32), though the author refers to another, larger specimen (*"one specimen, broken, is larger than the type"*, there, p. 32). SYKES' illustration (1904, fig. 6) is reproduced (fig. 1).

BOUCHET (1975: 334) expressed doubt on the species' generic placement: *"Des caractères tels que la présence d'un ombilic ou la conformation du sommet semblent très originaux pour une* Retusa *et il est vraisemblable que lorsque l'animal sera connu, une séparation générique deviendra nécessaire"*. BOUCHET AND WARÉN (1979) examined Sykes' material, illustrated the shell and referred to it as "holotype" (there, fig. 18 i), though that shell, at 2.45 mm, was rather larger that the specimen measured by Sykes. These authors declared *'Retusa' marshalli* "probably a *Diaphana*" (there, p. 237). Schiøtte (1999) reported that the type material consisted of a "holotype" 2.45 mm high (BMNH1922122) and *"pieces of 4 or 5 additional specimens, labelled as syntypes, all dry shells"* (there, p. 87).

Few species of *Diaphana* Brown, 1827 have been recorded from the Mediterranean Sea, but the only one resembling *D. marhalli* is *D. jonica* Di Geronimo, 1974. The latter has been considered a junior synonym of *D. lactea* (Jeffreys, 1877) by BOUCHET AND WARÉN (1979) who examined the type. SCHIØTTE (1999: 124) who compared illustrations of both species declared "*... there is a very good resemblance between the shells of* D. lactea *and* D. jonica.*"*.

BOUCHET AND WARÉN (1979: 237) separated *'Retusa' marshalli* from its congener *D. lactea* as the former has "*... a whitish unsculptured shell with an umbilical chink, but the larval shell is white, not brown as in lactea, and the broadest part of the aperture is at the lower third of the shell, instead of the middle of the shell. In* 'R'. marshalli *the larval shell is completely visible even in adult specimens when seen*



Figures 1-5. *Diaphana marshalli* (Sykes, 1904). 1: Sykes' illustration, reproduced, height 2.45 mm; 2: Scanning electron micrograph of the larger Levantine specimen, height 1.5 mm; 3: adapertural view of smaller Levantine specimen, height 1.3 mm; 4: side view of the same specimen; 5: detail of the apex of the same specimen.

Figuras 1-5. Diaphana marshalli *(Sykes, 1904). 1: Reproducción de la ilustración de Sykes, altura 2,45 mm; 2: Micrografía electrónica de barrido del mayor ejemplar levantino, altura 1,5 mm, 3: Vista adapertural del menor ejemplar levantino, altura 1,3 mm, 4: vista lateral del mismo ejemplar; 5: detalle del ápice del mismo ejemplar.*

from the adapertural side, while in lactea only the topmost part of the larval shell protrudes above the top of the body whorl. 'R'. marshalli *is smaller, being only 2.45 mm when adult".*

On comparing Di Geronimo's (1974) description and SEM image of the holotype of *D. jonica* with the Levantine specimens of *D. marshalli* it was apparent that the shell of the former is more cylindrical and slender than the shell of the latter species, its height-to-width ratio being 1,84 compared with 1,6-1,65 in *marshalli*; the columella differently set and the umbilicus narrower; the apex of *D. jonica* is described as *"più o meno sporgente"*, but is similar to that of *D. lactea* as figured in Bouchet and Warén (1979) with only the topmost part of the larval shell protruding above the body whorl.

The reproductive biology of *D. marshalli* is unknown, but the size of its larval shell indicates planktotrophic larval development (Bouchet and Warén, 1979: 231). Schiøtte (1999: 133) agrees *"... interestingly, deep-water species usually seem to have planktotrophic development"*. This may explain the occurrence of a rare Atlantic bathyal diaphanid gastropod in the Levantine Sea. The common mollusks at depths greater than 1000 m off the Israeli coast are eurybathic Atlanto-Mediterranean and Boreal species with an upper bathymetric range enabling them to overcome the barriers posed by the shallow Gibraltar Straits and the Siculo-Tunisian sill (< 400 m), or stenobathic species with epipelagic larvae. Indeed, the present record of *D. marshalli* agrees with the distribution patterns of the Levantine deep water benthos (Galil, 2004).

ACKNOWLEDGEMENTS

We thank Dr. A. Warén, for the SEM images and Mr. S. Bartolini for the digital photographs.

BIBLIOGRAPHY

Bogi C. and Galil B., 2004. The bathybenthic and pelagic molluscan fauna off the Levantine coast, eastern Mediterranean. *Bollettino Malacologico*, 39: 79-91

Bouchet P., 1975. Opisthobranches de profondeur de l'Ocean Atlantique. I Cephalaspidea. *Cahiers de Biologie Marine*, 16: 317-365

Bouchet P. and Warén A., 1979. The abyssal molluscan fauna of the Norwegian Sea and its relation to other faunas. *Sarsia*, 64: 211-243

Di Geronimo L, 1974. Molluschi bentonici in sedimenti recenti batiali e abissali dello Jonio. *Conchiglie*, 10 (7-8): 133-172.

Galil B.S. 2004. The limit of the sea: the bathyal fauna of the Levantine Sea. *Scientia Marina*, 68 (Suppl.3): 63-72.

Galil B.S. and Zibrowius H. 1998. First benthos samples from Eratosthenes seamount, Eastern Mediterranean. *Senckenbergiana maritima*, 28(416): 111- 121.

Janssen R., 1989. Benthos-Mollusken aus dem Tiefwasser des östlichen Mittelmeeres, gesammelt während der "METEOR"- Fahrt 5 (1987). *Senckenbergiana maritima*, 20 (5/6): 265-276.

Schiøtte T. 1999. A taxonomic revision of the genus *Diaphana* Brown, 1827, including a discussion of the phylogeny and zoogeography of the genus (Mollusca: Opisthobranchia) *Steenstrupia*, 24: 77-140

Sturany R. 1896. Berichte der Commission für Tiefsee-Forschungen XVIII. Zoologische Ergebnisse VII. Mollusken I (Prosobranchier und Opisthobranchier; Scaphopoden; Lamellibranchier) gesammelt von S.M. Schiff "Pola" 1890-1894. *Denkschriften der Kaiserlichen Akademie der Wissenschaften, Mathematische-Naturwissenschaftlischen Classe*, 63: 1-36, pl.1-2

Sykes E.R. 1904. On the Mollusca procured during the "Porcupine" Expeditions 1869-1870. Supplemental notes, part I. *Proceedings of the Malacological Society of London*, 6: 23-40, pl.

© Sociedad Española de Malacología — *Iberus*, 29 (1): 39-46, 2011

Otala punctata (O.F. Müller, 1774) (Stylommatophora: Helicidae) in Italy

Otala punctata (O.F. Müller, 1774) (Stylommatophora: Helicidae) en Italia

Willy DE MATTIA* and Francesco MASCIA**[1]

Recibido el 2-X-2010. Aceptado el 24-III-2011

ABSTRACT

A living population of *Otala punctata* (O.F. Müller, 1774) has been found for the first time in Sardinia, Italy. In the island the species was previously recorded by several authors, but only finding badly preserved shells, often considered of doubtful origin. An anatomical and conchological description is given, and a comparison with other populations of the species and *O. lactea* (Müller, 1774) from the W-Mediterranean region is carried out. The species distribution is limited to a coastal sector of NW-Sardinia characterized by Mediterranean maquis and rural environments. Conservation status of the population is discussed, and its presumable origin from the Iberian peninsula through active human transportation is proposed.

RESUMEN

Una población viva de *Otala punctata* (O.F. Müller, 1774) se ha encontrado por primera vez en Cerdeña, Italia. Existen citas anteriores por parte de varios autores, pero sólo basadas en conchas mal conservadas y a menudo de procedencia dudosa. Se hace una descripción anatómica y conquiliológica, y se compara con otras poblaciones de la especie y con *O. lactea* (Müller, 1774) de la región W-Mediterráneo. La distribución de la especie se limita a un sector costero del noroeste de Cerdeña, un medio rural caracterizado por matorral mediterráneo. Se examina el estado de conservación de la población y se sugiere su presumible origen desde de la península Ibérica a través de transporte antrópico.

INTRODUCTION

In Italy *O. punctata* was recorded for the first time (as *Archelix apalopena* (Bourguignat, 1867)) by MALATESTA AND SETTEPASSI (1954) from Alghero (N-W Sardinia). Its presence in the same area has been confirmed later by CARRADA, PARISI AND SACCHI (1967). Significantly, both papers reported finding badly preserved shells only and no living specimen was ever found. Paulucci (1886) reported *O. lactea* (Müller, 1774) from the Tuscan Archipelago (Argentarola island). This record, based on a single, badly preserved shell, could be referred to *O. punctata*, but *Eobania vermiculata* (O.F. Müller, 1774) cannot be excluded

---

* Via di Monte San Giovanni 8, I 34147 Muggia, Italy; wdemattia@gmail.com
** Via Oreste Salomone 32, I 09030 Elmas, Italy; fr.maxia@gmail.com

[1] Corresponding author

(Giusti, 1976; Bodon, Favilli, Giusti and Manganelli, 1995).

O. punctata has a Western-Mediterranean distribution. It is found in northwest Algeria, eastern Spain and the Baleares, south-western France and Malta (Falkner, 1990; Clanzig and Bertrand, 2001; Falkner, Ripken, and Falkner, 2002; Barbara and Schembri, 2008). The species is widely raised in heliciculture and thus present also in North and South America, and South Africa (Herbert and Sirgel, 2001; Cowie, Dillon, Robinson and Smith, 2009). The aim of this work is to clarify the Status of *Otala punctata* in Sardinia.

MATERIAL AND METHODS

The snails were killed in water and then fixed in 75% ethanol. Bodies were isolated from the shell and then dissected under an optical microscope. Anatomical details were drawn using a camera lucida. Empty shells were measured (n=20 for each population). The material is kept in the collections of the Authors.

RESULTS

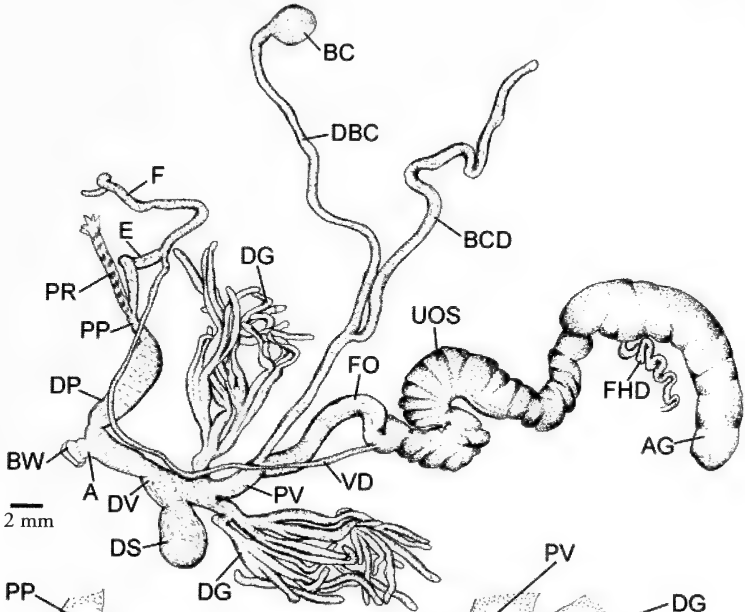
Otala punctata (O.F. Müller, 1774)

Material examined [dsp, dissected specimen(s)]. — Italy: Sardinia, Alghero, Sorgente Lu Cantar, 40° 32′ 18″ N 8° 19′ 30″ E, 30 m alt., 07. ii. 2008, 3 dsp. F. Mascia leg.; Sardinia, Alghero, Cala Bona, 20 m alt., 40° 32 ′40″ N 8°19′ 20″ E, 07. ii. 2008, 2 dsp. F. Mascia leg.; Malta: Mosta, 80 m alt., 35° 54′ 34″ N 14° 25′ 05″ E, 17. i. 2010, 2 dsp, N. Barbara leg. Spain, Málaga, El Tarajal, 30 m alt., 36° 70′ 20″ N 4° 50′ 23″ E, 12. xi. 2008, 2 dsp., J.S. Torres leg.

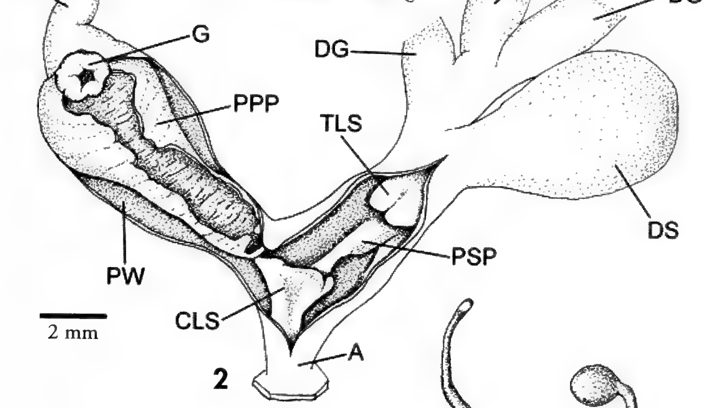
Shell (Figs 9-10): The protoconch is dark violet-brown to dark brown. The teleoconch is thick and robust, globose to subglobose, conical above and convex below. There are up to 5 main, dark brown to light brown, variably wide bands, which are fused with a superimposed pattern of whitish reticulation. Sometimes the main bands abruptly fade becoming barely visible and the shell becomes almost uniformly creamy in colour. The polished external surface shows irregular, fine growth lines and very fine, dense spiral lines. The spire is conical and not much raised with 4-5 regularly growing whorls. The last

(Right page) Figures 1-3. *Otala punctata* (O.F. Müller, 1774). Italy: Sardinia, Alghero, Sorgente Lu Cantar. 1, 3: genitalia (ovotestis excluded); 2: inner walls of atrium and penis. Abbreviations, A: atrium; AG: albumen gland; BC: bursa copulatrix; BCD: diverticulum of the bursa copulatrix; BW: body wall; CLS: crest-like structure; DBC: duct of the bursa copulatrix; DG: digitiform glands; DP: distal penis; DS: dart sac; dsp: dissected specimen[s]; DV: distal vagina; E: epiphallus; F: flagellum; FHD: first hermaphrodite duct; FO: free oviduct; G: glans or penial papilla; PP: proximal penis; PPP: pseudo-penial papilla; PR: penial retractor muscle; PSP: pilaster-shaped pleat; PV: proximal vagina; PW: penial wall; TLS tongue-like structure; UOS: uterine ovispermiduct; VD: vas deferens.

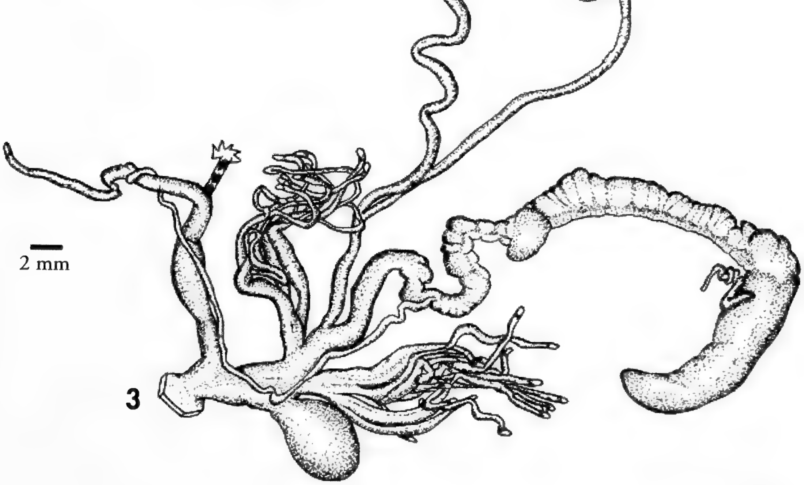
(Página derecha) Figuras 1-3. Otala punctata *(O.F. Müller, 1774). Italia: Cerdeña, Alghero, Sorgente Lu Cantar. 1, 3: órganos genitals (ovotestis excludo); 2: paredes internas del atrio y del pene. Abreviaturas, A: atrio; AG: glándula del albumen ; BC: bursa copulatrix; BCD: divertículo de la bursa copulatrix; BW: pared del cuerpo; CLS: estructura en forma de cresta; DBC: conduto de la bursa copulatrix; DG: glándulas digitiformes ; DP: pene distal ; DS: saco del dardo; DV: vagina distal ; E: epifalo; F: flagelo; FHD: primer conducto hermafrodita; FO: oviducto libre; G: glans o papila penial ; PP: pene proximal ; PPP: papilla pseudo-penial; PR: músculo retractor penial; PSP: pliegue en forma de pilastra; PV: vagina proximal ; PW: pared del pene; TLS estructura linguiforme; UOS: oviespermiducto uterino; VD: vas deferens.*


BC
DBC
F
E
BCD
DG
PR
PP
UOS
FO
DP
FHD
AG
BW
A
DV
PV
VD
2 mm
DS
DG

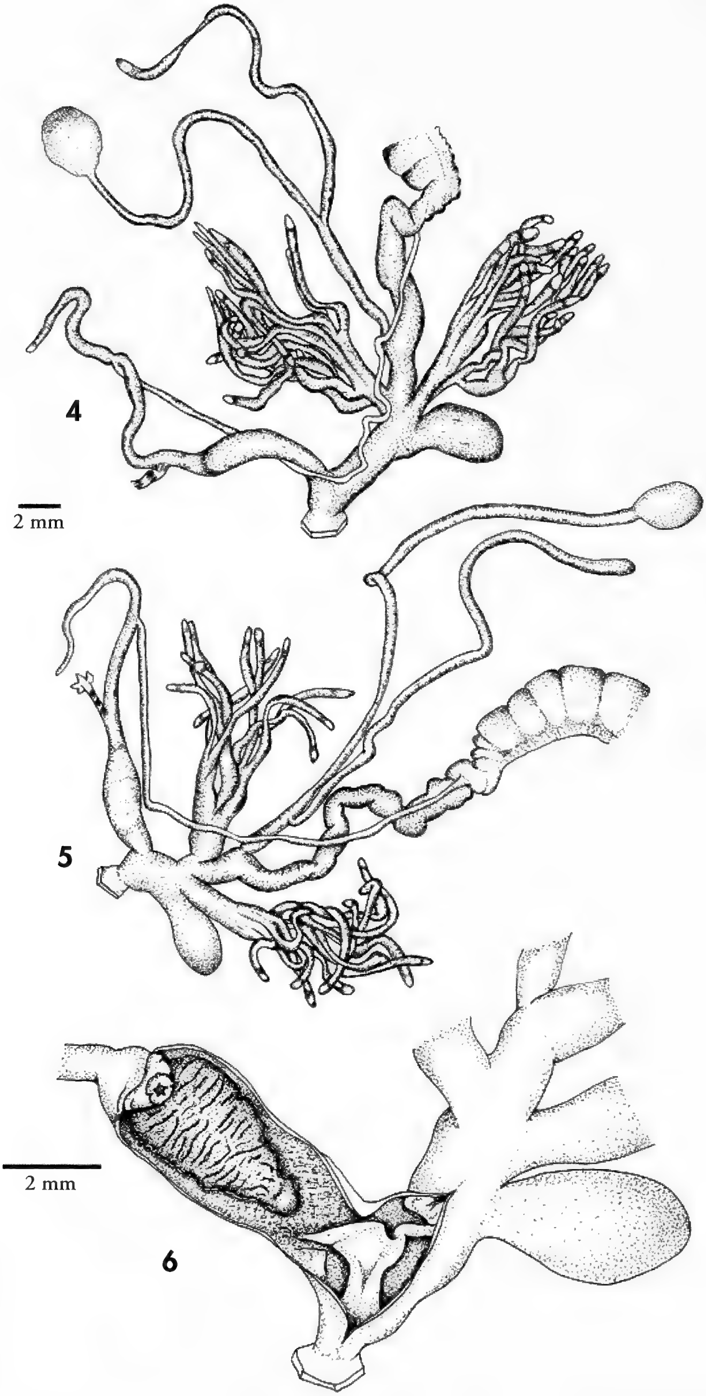
1


PV
PP
DG
G
DG
PPP
TLS
DS
PSP
PW
2 mm
CLS
A

2


2 mm

3



Figures 4-6. *Otala punctata* (O.F. Müller, 1774). 4: Spain, Málaga, El Tarajal, genitalia (ovotestis excluded); 5, 6: Malta, Mosta; 5: genitalia (ovotestis excluded); 6: inner walls of atrium and penis.
Figures 4-6. Otala punctata *(O.F. Müller, 1774). 4: España, Málaga, El Tarajal, genitalia (ovotestis excluído); 5, 6: Malta, Mosta; 5: genitalia (ovotestis excluído); 6: paredes internas del atrio y del pene.*

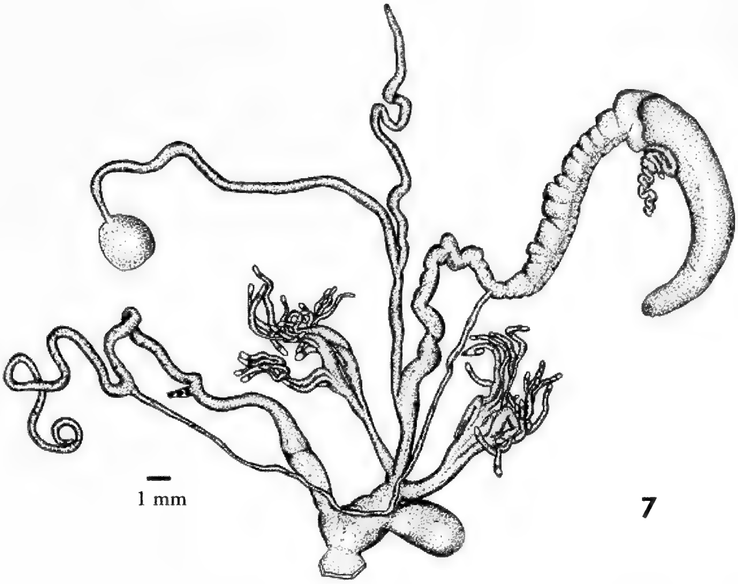


Figure 7. *Otala lactea* (Müller, 1774). Spain, Menorca, Mahon, genitalia (ovotestis excluded).
Figura 7. Otala lactea *(Müller, 1774). España, Menorca, Mahón, órganos genitales (ovotestis excluído).*

whorl is very large (70% of shell height), well rounded and markedly descending where approaching the aperture. The sutures are moderately deep and the umbilicus is closed. The aperture is markedly oblique and oval. The peristoma is interrupted, thick and reflected and is whitish in colour. A columellar tooth, more or less evident, is often present. The columellar part of aperture, palatum and parietum are always dark brown in colour.

Diagnostic characters of genitalia (Figs 1-6): Proximal part of the vagina with two digitiform glands. Each gland consists of a short base which bifurcates into three or four main branches. Each main branch gives rise to numerous long digitiform appendices. A single, very large dart-sac enters about midway along the vagina. The dart-sac contains a single, straight long dart with four lateral wings and a spear-like head; it opens into the vagina with a tongue-like structure. Along the inner wall of vagina there is a huge pilaster-shaped pleat which reaches the large crest-like structure in the atrium. A moderately short copulatory (5-7 mm) duct divides into a diverticulum of bursa copulatrix and a duct of bursa copulatrix. Diverticulum and duct have almost the same length. The bursa copulatrix is usually oval or round. The vagina enters the atrium side by side with the penis. A moderately short (8-10 mm) penial flagellum arises where the vas deferens enters the penial complex. A rather short epiphallus (6-8-mm) enters the penis (8-10 mm) where the penial retractor meets the penial wall. The penis has a proximal widened portion (almost twice as long as the distal) and enveloped in a thin penial sheath. The short penial papilla is surrounded by a solid and long pseudopenial papilla with a grooved surface.

Dimensions of Sardinian specimens: Shell diameter: 29 ± 1.7 mm (range: 27 - 32 mm) Shell height: 18 ± 1.1 mm (range: 16-20 mm) (average value ± standard deviation).

Anatomical and conchological investigation allowed to easily distinguish *Otala punctata* from *O. lactea* (Müller, 1774) and *Eobania vermiculata*. *Otala lactea* has a smaller shell (average diam-

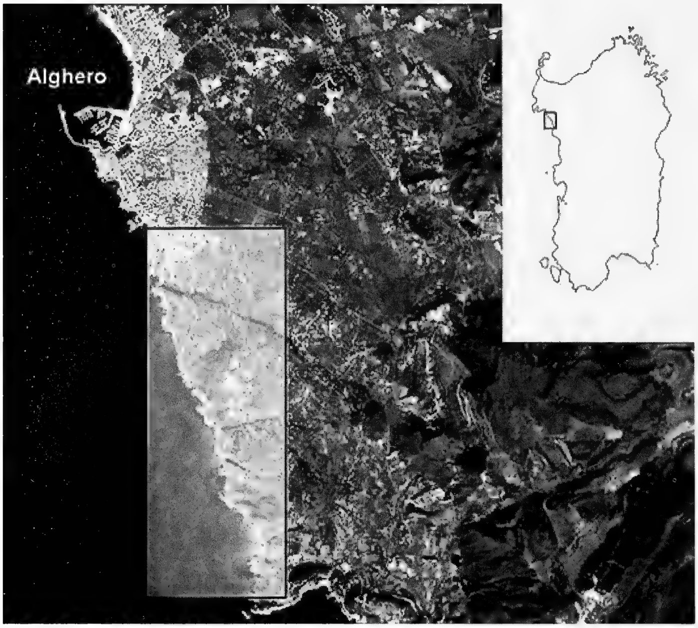
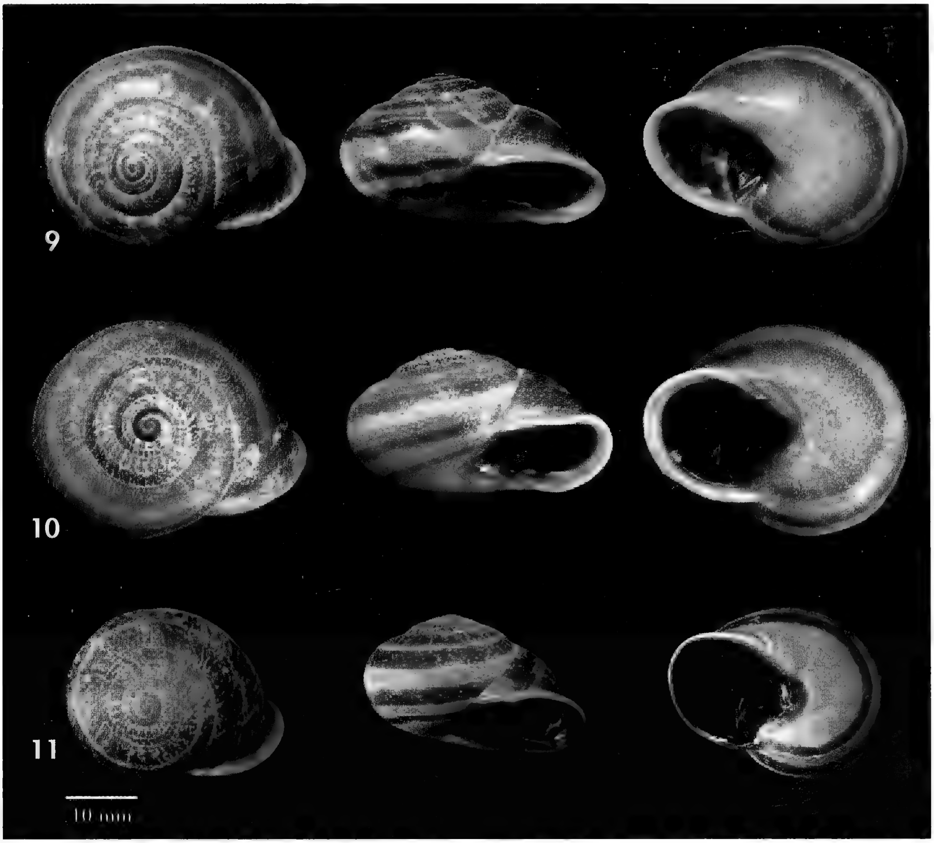


Figure 8. Distribution of *Otala punctata* (Müller, 1774) in Sardinia, Italy.
Figura 8. Distribución de *Otala punctata* (Müller, 1774) en Cerdeña, Italia.

eter of 20 mm) and the inner part of the aperture (peristome, parietum and palatum) is uniformly dark brown in colour (Fig. 11). *E.vermiculata* has a spire somewhat more elongated and the inner part of the aperture is uniformly creamy white in colour (BODON *ET AL.*, 1995). *Eobania vermiculata* and *O. lactea* can be easily distinguished from *O. punctata* by the anatomy of the genitalia. *Eobania vermiculata* has a much longer flagellum and vagina, while the free oviduct is markedly shorter. The diverticulum of the bursa copulatrix is 6-10 times longer than the duct of bursa copulatrix. On the distal penis, a slender false penial papilla is present, which originates from the penial wall and does not surround the penial papilla. *Otala lactea* can be distinguished mainly in virtue of the much longer epiphallus and penial flagellum (Fig. 7).

The present investigation allows us to confirm the presence of *O. punctata* in Italy. The species occurs exclusively in the southern surroundings of the town of Alghero (Sassari, Sardinia), along the southern rocky shore area of the town (Fig. 8), from sea level to 40 meters in altitude. Population cover an area of approximately 0.4 km^2. In the same area, the population density of *Eobania vermiculata* (O.F. Müller, 1774) and *Cornu aspersum* (O.F. Müller, 1774) is markedly higher than that of *O. punctata*. This area belongs to the Mediterranean upper thermomediterranean thermotype (BACCHETTA, BAGELLA, BIONDI, FARRIS AND FILIGHEDDU, 2009). Geologically the area is characterized by marine and continental Quaternary deposits (BARCA, CARMIGNANI, OGGIANO, PERTUSAT, SALVADORI, CONTI, ELTRUDIS, FUNEDDA AND PASCI, 1996) and is mainly covered by Mediterranean coastal maquis, belonging to the western-Sardinian, calcicole, thermomediterranean *Chamaerops humilis-Juniperetum turbinatae* (BACCHETTA *ET AL.*, 2009; BIONDI, FILIGHEDDU AND FARRIS, 2001; BLASI, ANGIUS AND BACCHETTA, 2009). Mediterranean coastal maquis alternates with rural landscape principally represented by grazing fields and cultivated lands.



Figures. 9-11. Shells of *Otala* spp. 9-10, *Otala punctata* (O.F. Müller, 1774). 9: Sardinia, Alghero, Sorgente Lu Cantar; 10: Spain, Málaga, El Tarajal; 11: *Otala lactea* (Müller, 1774), Spain, Menorca, Mahon.

Figures. 9-11. Shells of Otala *spp. 9-10,* Otala punctata *(O.F. Müller, 1774). 9: Cerdeña, Alghero, Sorgente Lu Cantar; 10: España, Málaga, El Tarajal; 11:* Otala lactea *(Müller, 1774), España, Menorca, Mahón.*

DISCUSSION

Carrada *et al.* (1967) stressed the presence of fossil shells of *O. punctata* in travertines from Alghero but this has not been confirmed. Preliminary field research revealed that in the surroundings of Alghero, quaternary deposits do not show the presence of *O. punctata*. Baldino, Carenti, Grassi, Orgolesu, Secchi and Wilkens (2008) and Wilkens (2004) did not cite the species from the archaeological sites of north-western Sardinia. Also Paulucci (1882) did no mentions for *O. punctata* in Sardinia.

Most probably *O. punctata* is not autochthonous to Sardinia. The introduction of *O. punctata* could be referred to the Aragonese occupation during the 14th. The traditional local denomination of this species, which is "Caragol español" (Spanish snail), could support the hypothesis. Nowadays snail farming is a common practice in Sardinia, but not in the surroundings of Alghero. In the island *O. punctata* and *O. lactea* were commonly used for heliciculture in the past, but less frequently at present.

The population of *O. punctata* shows a very low density of specimens which could be referred to its alien origin. Probably a feeding competition occurs with the native syntopic Helicidae species, such as *Cantareus apertus* (Born, 1778), *Cornu aspersum* (O.F. Müller, 1774) and *Eobania vermiculata* (O.F. Müller, 1774). Moreover, because of its culinary interest, the species is frequently collected by people. The very limited distribution of *O. punctata* is a clear risk factor. Destruction of habitat by city expansion, mostly related to tourism facility development and collecting as a food item represent the main threats. Further investigations are actually in progress in order to clarify the origin of the Sardinian population of *O. punctata*.

AKNOWLEDGEMENTS

The Authors are grateful to N. Barbara, P. Schembri (Zabbar, Malta) and J.S. Torres (Málaga, Spain) for providing alcohol-preserved material and E. Zallot (Monster, Holland) for advice and critical comments.

BIBLIOGRAPHY

Bacchetta G., Bagella S., Biondi E., Farris E., Filigheddu R.S. and Mossa L. 2009. Vegetazione forestale e serie di vegetazione della Sardegna (con rappresentazione cartografica alla scala 1:350.000). *Fitosociologia,* 46, suppl. 1(1): 3-82.

Baldino B., Carenti G., Grassi E., Orgolesu T., Secchi F. and Wilkens B. 2008. L'economia animale dal Medioevo all'Età moderna nella Sardegna nord occidentale. *Sardinia, Corsica et Baleares Antiquae,* 6: 103-155.

Barbara N. and Schembri P.J. 2008. The status of *Otala punctata* (Müller, 1774), a recently established terrestrial gastropod in Malta. *Bollettino Malacologico,* 44(5-8): 101-107.

Barca S., Carmignani L., Oggiano G., Pertusat I P.C., Salvadori I., Conti P., Eltrudis A., Funedda A. and Pasci S. 1996. *Carta geologica della Sardegna (scala 1:200.000).* Servizio Geologico d'Italia, Firenze.

Biondi E., Filigheddu R. and Farris E. 2001. Il paesaggio vegetale della Nurra. *Fitosociologia,* 38(2), suppl. 2: 3-105.

Blasi C., Angius R. and Bacchetta G. 2009. Clima e Bioclima. *In*: Bacchetta G., Bagella S., Biondi E., Farris E., Filigheddu R., Mossa L. 2009. Vegetazione forestale e serie di vegetazione della Sardegna (con rappresentazione cartografica alla scala 1:350.000). *Fitosociologia,* 46(1), suppl. 1: 3-82.

Bodon M., Favilli L., Giusti F. and Manganelli G. 1995. Gastropoda pulmonata. In: Minelli A. Ruffo S. & La Posta S. (Ed.), *Checklist delle specie della fauna d'Italia,* 16: 60 pp.

Carrada G., Parisi V. and Sacchi C.F. 1967. Dati per una biogeografia dei molluschi continentali in Sardegna. *Atti Società Italiana Scienze Naturali Museo Civico Storia Naturale, Milano,* 105: 377-388.

Clanzig S. and Bertrand A. 2001. *Otala punctata* (O.F. Müller, 1774) en France. *Documents Malacologiques,* 2: 47-48.

Cowie R.H., Dillon R.T. jr, Robinson D.G. and Smith J.W. 2009. Alien non-marine snails and slugs of priority quarantine importance in the United States: A preliminary risk assessment. *American Malacological Bulletin,* 27(1-2):113-132.

Falkner G. 1990. Binnenmollusken. In: R. Fechter & G. Falkner, *Weichtiere,* 112-280. Munchen.

Falkner G., Ripken T.E.J. and Falkner M. 2002. *Mollusques continentaux de France. Liste de référence annotée et bibliographie.* Muséum national d'Histoire naturelle, Patrimoines naturels 52, Paris, 350 pp.

Giusti F. 1976. I Molluschi terrestri, salmastri e di acqua dolce dell'Elba, Giannutri e scogli minori dell'Arcipelago toscano. *Lavori, Società Italiana di Biogeografia, Siena,* 5 (1974): 99-355.

Malatesta A. and Settepassi F. 1954. Risultati del rilevamento del foglio 192 (Alghero-Isola di Sardegna). III. Fossili delle formazioni continentali quaternarie. *Bollettino Servizio Geologico Italaliano,* 76: 33-39.

Herbert D.G. and Sirgel W.F. 2001. The recent introduction of two potentially pestiferous alien snails into South Africa and the outcomes of different pest management practices: an eradication and a colonization research in action. *South African Journal of Science,* 97: 301-304.

Paulucci M. 1882. Note malacologiche sulla fauna terrestre e fluviale dell'isola di Sardegna. *Bullettino della Società Malacologica Italiana,* 8: 139-381.

Paulucci M. 1886. Conchiglie terrestri e d'acqua dolce del M. Argentario e delle isole circostanti. *Bullettino della Società malacologica Italiana,* 12: 5-64, pl. 1, 2.

Wilkens B. 2004. La fauna sarda durante l'Olocene: le conoscenze attuali. *Sardinia, Corsica et Baleares Antiquae,* 1 (2003): 181-197.

© Sociedad Española de Malacología ——— Iberus, 29 (1): 47-57, 2011

Reproduction of *Donax trunculus* in the littoral of Huelva (southern Atlantic Spain): is there any difference with the Mediterranean population from the Andalusian coast?

Reproducción de *Donax trunculus* en el litoral de Huelva (suroeste Atlántico de España): ¿hay diferencias con la población mediterránea de la costa andaluza?

Cristina TIRADO, José Luis RUEDA and Carmen SALAS*

Recibido el 13-IV-2011. Aceptado el 11-V-2011

ABSTRACT

The reproductive cycle of *D. trunculus* L., 1758 was studied using histology and changes in flesh dry weight, in the littoral of Huelva (southern Atlantic Spain) from June 1990 to May 1991. The spawning period is essentially synchronic, and extends from February to August, with different individual intensity. Three peaks of spawning have been recorded, April, June and July. The resting period ranges from September to December, with the whole population in cytolized stage in October. The favourable environmental variables, such as high levels of chlorophyll *a* and relatively mild seawater temperatures allow this extensive reproductive period. This cycle shows a diphase of the spawning period with the Mediterranean population from Málaga, which should imply a different close season for each population.

RESUMEN

Se estudia el ciclo reproductor de *D. trunculus* L., 1758 mediante histología y cambios en la biomasa, en el litoral de Huelva (sur de España Atlántico) entre junio de 1990 y mayo de 1991. El periodo de puesta es básicamente sincrónico y se extiende desde febrero hasta agosto, con intensidad variable según los individuos. Se han registrado tres picos de puesta: abril, junio y julio. El periodo de reposo ocurre entre septiembre y diciembre, con toda la población en la fase citolítica en octubre. Las variables ambientales favorables, tales como los altos niveles de clorofila *a* y las temperaturas relativamente templadas del agua permiten un periodo reproductor largo. Este ciclo muestra un desfase del período de puesta con relación a la población mediterránea de Málaga, por lo que se recomienda un periodo de veda diferente para cada población.

INTRODUCTION

The overexploitation, for many years, of some marketable shellfish species in southern Spain has mainly been due to an incorrect management of the fisheries. Until 2003, the law in Andalusia (autonomous region including eight southern provinces of Spain) ruled an extensive close season (over six

---

* Departamento de Biología Animal, Facultad de Ciencias, Universidad de Málaga, E-29071 Málaga, España.

months) for most of the marketable bivalves of this area. Because of the incompatibility of these extensive periods with a profitable economic activity, it was not enforced. The study of the reproduction of the populations of Donacidae in the Mediterranean littoral of Málaga (Tirado and Salas, 1998, 1999) pointed out the possibility of establishing an effective rule with a reduced close season that would still be compatible with profitable fishery activities. These results led regional fishery authorities to promote a research project for the study of reproductive cycles of the most important shellfish, aimed at adjusting the close season to the biology of each species and consequently to improve the management of these fisheries (Tirado and Rodriguez de la Rua, 2000).

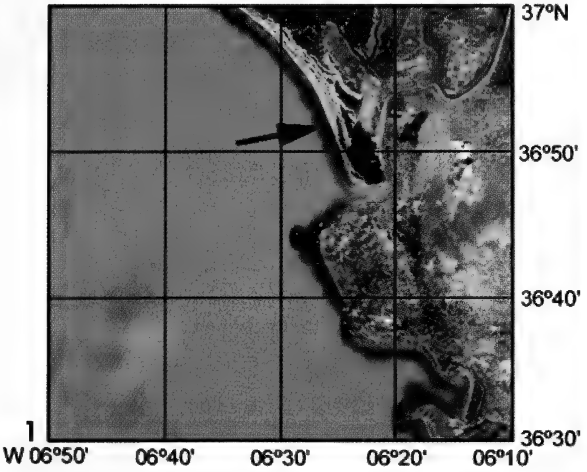
One of the studied species was *Donax trunculus* L. 1785 ("coquina") with a very important consumer market, mostly in the province of Huelva (southwest coast). The reproduction of this species was studied in the Mediterranean littoral of Andalusia (Tirado and Salas, 1998), but it is well known that reproduction in bivalves is strongly related to environmental variables, such as temperature, availability of food or type of beach, among others (Bayne 1976; Brown and McLahlan, 2006). The environmental characteristics of the Atlantic shallow littoral are very different from those of the Mediterranean. The fishing methods are also different, in the Mediterranean littoral the fishery is made by authorized boats, whereas in the Atlantic littoral the fishermen use individual dredges drawn backwards in shallow water. For these reasons, the study of the *Donax trunculus* population from the Atlantic littoral of Huelva was undertaken.

Donax trunculus is a littoral species widely distributed from Brittany (French coast) (Lucas, 1965; Ansell and Lagardère, 1980; Guillou and le Moal, 1980) to Southern Morocco (Pasteur Humbert, 1962) and in the Mediterranean (Sabelli, Gianuzzi-Savelli and Bedulli, 1990). As a commercial species, *D. trunculus* has been intensively studied for fisheries management (Baldaccini and Bianucci, 1984, Fischer, Bauchot and Scheneider, 1987), parasitism and predation (Ramón, Gracenea and González-Moreno, 1999, Salas, Tirado and Manjón-Cabeza, 2001), population dynamics (Mouëza and Chessel, 1976; Guillou and Le Moal, 1980; Bayed and Guillou 1985; Mazé and Laborda 1988; Neuberger-Cywiak, Achituv and Mizrahi, 1990; Zeichen, Agnesi, Mariani, Maccaroni and Ardizzone, 2002) and growth and reproduction at different places of the distribution area (Lucas, 1965; Badino and Marchioni 1972; Mouëza and Frenkiel-Renault, 1973; Bayed 1990; Neuberger-Cywiak *et al.* 1990; Tirado and Salas 1998; Gaspar, Ferreira and Monteiro, 1999; Deval 2009). All this research has revealed a biological and physiological variability of the populations in relation to environmental factors. Therefore, the aim of this paper is to study the reproductive cycle of *D. trunculus* from Huelva, and to point out the differences between the Atlantic and the Mediterranean populations in order to request the authorities to take into account the biology of the species in a particular area for a better management of the resources.

MATERIAL AND METHODS

The sampling area is located in the littoral of Doñana (Southwest Spain) (36° 52′N - 6° 26′W) (Fig. 1), in an extensive beach, more than 20 km long and 100-200 m wide, with a tidal range which can reach 3.6 m in spring tides. The beach is of fine grain and gentle slope that can be considered as a dissipative beach (Schlacher, Schoeman, Dugan, Lastra and Jones, 2008). The samples were collected, on a sandy bottom at 0.4 m depth, from June 1999 to May 2000, with monthly frequency from October to February and twice a month during the spring and summer months. The specimens were captured

1



2

Figure 1. Sampling area. Figure 2. Gear used for commercial collecting of *Donax trunculus*.
Figura 1. Área de muestreo. Figura 2. Rastro usado para la pesca de Donax trunculus.

with a dredge of 45 cm width, with 9 cm long teeth. The mesh was 1.75 cm, usual among the fishermen of the area (Fig 2).

A total of 4333 specimens of *D. trunculus*, between 13 and 44 mm in length, were examined; of these 3798 were used for the analysis of the flesh dry weight variation (about 200 individuals/sample) and 535 specimens for histological study (usually 30 per month).

The length (L) of every specimen was measured to the nearest millimetre, and the soft parts were dried in an oven at 100 °C for 24 h, and weighed to the nearest milligram (flesh dry weight, FDW). Two different indices of condition were applied, FDW/L^3 variation, and that proposed by Crosby and Gale (1990) as FDW*1000/volume of the internal cavity of the shell (considering the millilitres of water as milligrams) which is referred to as CI. The regression of flesh dry weight on the length was calculated for each sample to estimate the variation in biomass of a standard individual, based on the logarithmic transformation of Ricker's function $W= aL^b$ (RICKER, 1975), where *W* is the weight, *L* is the length, *a* is the ordinate at origin, and *b* is the slope. To minimize the bias introduced by the somatic growth of individuals during the cycle and by the variation of the size of the specimens between successive samples, the variation of flesh dry weight was estimated for an individual of 29 mm length (mean size of the population studied). For that we took into account the regression lines for every sample.

For histological processing, specimens were anaesthetized with $MgCl_2$, fixed in 10% formaldehyde, embedded in paraffin, sectioned at 10 μm and stained with haematoxylin of Carazzi and eosin, and a trichromic staining (VOF according to GUTIÉRREZ (1967)) of haematoxylin of Carazzi, light green, orange G and acid fuchsine. The stages of development of the gonad were scored according to the scale proposed by DE VILLIERS (1975) for *D. serra* Röding, 1798 in South Africa, who proposed five stages:

Cytolized. The alveoli are very small and wide apart. Some clams can be sexed when a few gametes are present.

Preactive. The alveoli have clearly defined alveolar walls. They are intersected by broad, continuous transverse fascicles. Most clams can be sexed.

Active. The alveoli are large and usually adjacent. The alveolar walls are always complete. Germ cells in various stages of development fill the alveoli and are both actively increasing and enlarging.

Spawning. The alveolar pattern is disturbed and the alveolar walls are often broken. The alveoli are often flattened and show an orientation towards the centre of the gonad.

Postactive. The amount of germ cells varies, depending on the intensity of spawning and the time that has elapsed since spawning took place. Phagocitic cells are common.

The species showed a sexual differentiation during the time of sexual activity. During the active period, the ovaries of *D. trunculus* are dark blue whereas the testes have a viscous aspects and a whitish-orange colour, which makes possible to identify the sex macroscopically of most of the specimens.

To evaluate the possible influence of environmental factors on the cycle, the temperature of sea water at the surface was measured simultaneously with the collection of the individuals. Samples of water (1l) were taken for determination of chlorophyll *a*. Pigment analyses were carried out by filtering the water through Whatman GF/C glass filters. The pigments of the retained cells were then extracted with acetone for 12 h in cool, dark conditions, following the recommendations of LORENZEN AND JEFFREY (1980). Concentrations of chlorophyll *a* were calculated using the trichromatic equations of JEFFREY AND HUMPHREY (1975).

The test of Kolmogorov-Smirnov and Kendal and Pearson's rank correlations included in the program SPSS 8.0, were used to check the distribution of the data. Cross correlation between both condition indexes and percentage of spawning with temperature and chlorophyll *a* levels were calculated to asses their influence on the reproductive cycle.

RESULTS

Environmental factors

The monthly temperature data showed important fluctuations (Fig. 3), with the maximum value in the second half of September (23 °C) and the minimum (12.5 °C) in December. The most important decrease was recorded from October to November (9.5 °C), and conversely, the highest increase (4.5 °C) was observed from February to the first half of March.

The chlorophyll *a* levels were higher than 2 μg/l throughout the cycle, showing an irregular pattern, with two important peaks, in September (24.3 μg/l) and March (16.1 μg/l).

Sex ratio

The sex ratio was determined on specimens with shell length ranging from 13 to 44 mm. In the samples from December to the end of July it is possible to identify the sex of the whole population according to the colour and external aspect of the gonad. A total of 2564 specimens were examined for sex-ratio study (all the specimens from histology and those of biomass study from December to July), of which 1268 were males (49.45%) and 1296 females (50.55%) (Fig. 4). The sex ratio for all them can be considered as 1:1 (χ^2= 0.7, P>0.95). The smallest specimen examined with gonad differentiated was a female of 13.8 mm.

Sexual cycle

Flesh dry weight: The variation of flesh dry weight –length ratio (FDW/L^3) during the annual cycle is shown in Figure 5. The mean monthly values of both variables, flesh dry weight (FDW) and size (L^3) were considered in 3798 specimens. The standard deviations range between 10 and 21%, being larger than the standard deviations observed in the monthly mean size (between 6 and 15%) (Fig. 6) There is also a broad weight range in most of the samples (Fig. 7), with standard deviation between 23 and 45%.

According to flesh dry weight–length ratio (FDW/L^3), the population showed low values during summer and autumn, with an increase from December to February. From February, the flesh dry weight- length ratio decreases until summer, with a

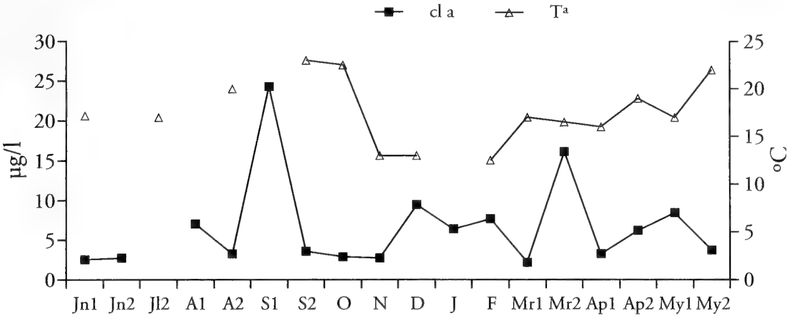


Figure 3. Sea water temperature and concentration of chlorophyll *a* in sea water at the sampling site through the year.

Figura 3. Temperatura del agua de mar y concentración de clorofila a *en el agua del mar en el sitio de muestreo durante todo el año.*

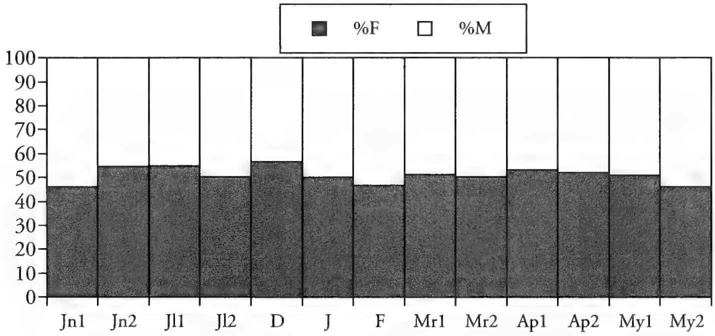


Figure 4. Relative frequency (%) of sexes during the year of study. F: females. M: males.

Figura 4. Frecuencia relativa (%) de los sexos durante el año de estudio. F: hembras. M: machos.

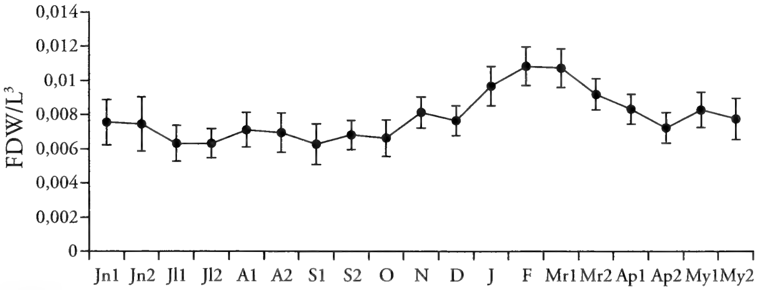


Figure 5. Flesh dry weight (FDW)/ Length (L^3) ratio during the year of study. Bars show standard deviation.

Figure 5. Relación de peso seco de biomasa (FDW)/ Longitud (L^3) durante el año de estudio. Las barras muestran la desviación estándar.

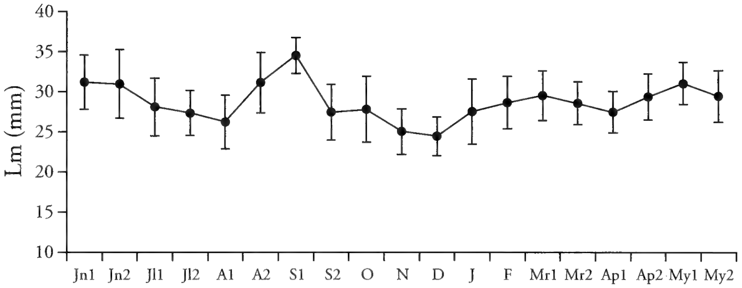


Figure 6. Monthly mean length of shells (L) during the year of study. Bars show standard deviation.

Figura 6. Media mensual de la longitud de las conchas (L) durante el año de estudio. Las barras muestran la desviación estándar.

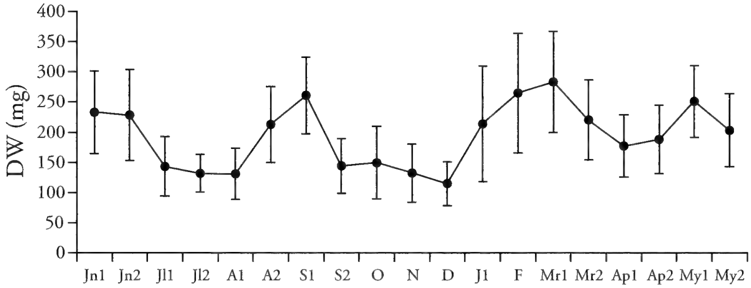


Figure 7. Monthly mean flesh dry weight (DW) during the year of study. Bars show standard deviation.

Figura 7. Media mensual del peso seco de biomasa (DW) durante el año de estudio. Las barras muestran la desviación estándar.

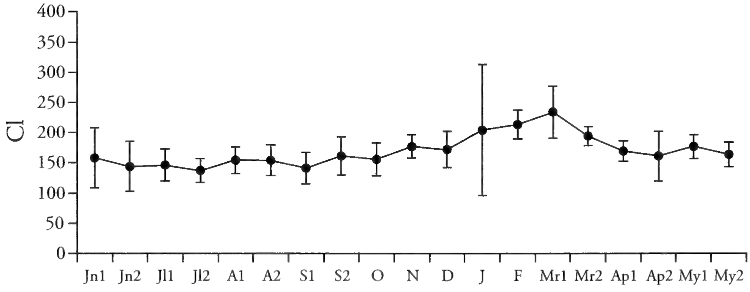


Figure 8. Index of condition of Crosby and Gale (CI): flesh dry weight × 1,000 / volume of the internal cavity of the shell, during the year of study.

Figura 8. Índice de condición de Crosby y Gale (CI): Peso seco de la biomasa × 1000 / volumen de la cavidad interna de la concha, durante el año de estudio.

Table I. Linear regression calculated for each sample. Lm: mean length; flesh dry weight for a standard individual; R^2: coefficient of determination; R: coefficient of correlation; N: number of specimens; W: monthly flesh dry weight for a standard individual of 29 mm.

Tabla I. Regresión linear calculada para cada muestra. Lm: longitud media; R^2: coeficiente de determinación; L: coeficiente de correlación; N: número de individuos; W: peso seco de biomasa mensual para un individuo estándar de 29 mm.

	Lm	Regression lines	R^2	R	N	W(L=29 mm)
Jn1	31.22	y=2.3423 x -1.1468	0.7171	0.8468	200	66.78
Jn2	31	y = 2.2581x - 1.0283	0.8105	0.9003	199	64.46
Jl1	28.15	y=2.3057 x -1.201	0.8062	0.8979	198	67.15
Jl2	27.37	y=2.0405 x -0.8224	0.7073	0.8410	200	58.35
A1	26.27	y = 2.3454x -1.2257	0.8452	0.9193	199	66.79
A2	31.19	y=2.2428 x -1.0357	0.7991	0.8939	197	64.00
S1	34.57	y=2.5491 -1.5168	0.4281	0.6543	202	72.41
S2	27.51	y=2.3769 x -1.2753	0.9006	0.9490	201	67.65
O	27.81	y=2.6152x -1.6298	0.8392	0.9161	199	74.21
N	25.1	y=2.7123 x -1.6903	0.8741	0.9349	200	76.97
D	25.40	y=2.701 x - 1.7035	0.8329	0.9126	200	76.62
J	27.58	y = 2.8042 - 1.7363	0.9229	0.9607	200	79.58
F	28.69	y = 2.8714x - 1.7802	0.9071	0.9524	200	81.49
Mr1	29.49	y = 2.605 x - 1.3919	0.8814	0.9388	199	74.15
Mr2	28.62	y = 2.8325x - 1.7953	0.8816	0.9389	200	80.35
Ap1	27.52	y =2.785x -1.7727	0.862	0.9284	199	78.99
Ap2	29.43	y = 2.3754x - 1.2251	0.7727	0.8790	200	67.66
My1	31.09	y = 2.4862x - 1.3195	0.7618	0.8728	202	70.78
My2	29.54	y = 2.4818x - 1.3567	0.8038	0.8965	199	70.62

small peak in May. The CI index showed a similar pattern (Fig. 8). The most important decrease was recorded from March to April.

The monthly regression lines for weight-length relationship are shown in Table I, and the monthly variation of flesh dry weight for a standard individual (W) is represented in Figure 9. According to these data the population from Huelva had a relatively synchronous reproductive pattern, with 18 samples (from a total of 19) explaining 70% of the variations of weight by the length. The pattern of the standard individual was similar to that of CI index.

According to the test of Kolmogorov Smirnov, only the temperature and FDW/L^3 data showed a normal distribution. The coefficients of correlation of Pearson and Kendall have been calculated. According to these data, the temperature is inversely correlated with FDW/L^3 ($r=0.541 p<0.05$) and with the FDW of the standard individual ($tau=0.438$, $p<0.01$). No other correlations were significant.

Gametogenic cycle

The data from the histological study are presented in Figure 10. Activation of gonads started in January while the regression began in the second half of August with more than 66% of the population in postactive and cytolized stages. In October, the whole population was in cytolized stage.

During the active period, the histological data showed continuous spawning, with percentages higher than 55% from February to July with three peaks: first half of April (96.67%), June (100%) and second half of July (96.67%), while only 13% of the individuals at the end of August were spawning. Different stages in the same gonad and new activation

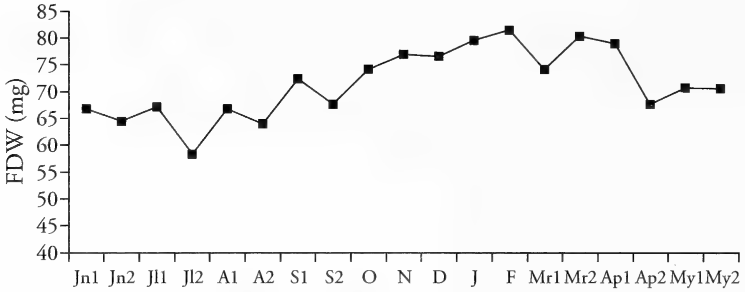


Figure 9. Variation in flesh dry weight in a standard *Donax trunculus* animal 29 mm long.
Figura 9. Variación del peso seco biomasa en un animal estándar de Donax trunculus *de 29 mm de longitud.*

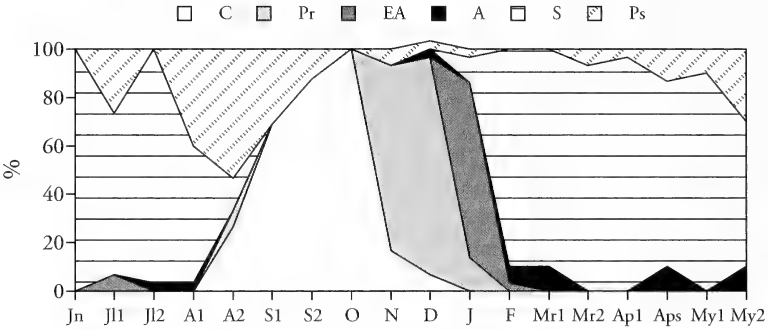


Figure 10. Monthly cumulative frequency of different stages of development of the gonads in *D. trunculus*. C: cycolized; Pr: preactive; EA: early active; A: active; S: spawning; Ps: postactive.
Figura 10. Frecuencia mensual acumulada de los diferentes estados de desarrollo de las gónadas en D. trunculus. *C: cicolizado; Pr: preactivo; EA: activo temprano; A: activo; S: en puesta; Ps: postactivo.*

without a total regression of the gonad have been observed in many individuals.

The resting period started in September and finished in December. At the beginning of this period, it was impossible to identify the sex of 36% of the individuals, and in October all the individuals were in cytolized stage and it was impossible to identify the sex of 50% of the sample.

DISCUSSION

Sex ratio

The sex-ratio of the population of *Donax trunculus* from Huelva agrees with observations of other authors regarding this species (LUCAS, 1965; MOUEZA AND FRENKIEL-RENAULT 1973, TIRADO AND SALAS, 1998, DEVAL, 2009, LA VALLE, 2006), but disagrees with the results obtained in the neighbour population of southern Portugal, where GASPAR *ET AL.* (1999) found a higher proportion of males in all size classes.

According to the macroscopic identification of the gonads, the active period is more extensive in the Atlantic population, in which it is possible to identify the sex of the whole population from February to the end of July (Fig 3), while in the Mediterranean population, the gonads are coloured in the whole sample only in May and June. Percentages of specimens with non coloured gonads higher than 70% were observed from October to February (TIRADO AND SALAS, 1998)

Sexual cycle

Condition index: The wide range of the standard deviation was partially related to the presence of different stages of development of the gonads. The data for the different condition indexes of this Atlantic population showed a long reproductive period, from December to September, very similar to those found by BAYED (1990) in the Atlantic coast of Morocco and by GASPAR *ET AL.* 1999 in the South of Portugal, although in the latter there was a continuous decrease of the index of condition from February to August.

However, there are differences with the Mediterranean population of Málaga, in which the most important and continuous decrease of the index of condition was observed from April to June, with an important increase in July. In the population from Huelva, the major decrease was recorded from March to April, with a slight increase in May, but with continuous decrease during the summer.

In Turkey, the population studied by DEVAL (2000) had a shorter reproductive period; the spawning occurred from April to July with a peak between May and June. This reproductive cycle is coincident with that of the population of Málaga. The duration of the reproductive period of the Turkish and Málaga populations was similar to that found in other Mediterranean populations (ANSELL AND BODOY 1979 in Camargue, French Mediterranean coast; MÖUEZA AND FRENKIEL-RENAULT 1973 in Algeria), although these were not coincident in time, due to differences in the environmental variables.

Gametogenic cycle: The data obtained point to continuous spawning for almost the whole population from April to August, coincident with the decrease of the index of condition during this period. The coexistence of different stages in the same gonad, together with a direct transformation from a postactive stage to an active one without the intermediate step of a cytolized stage, have been reported for other donacids (DE VILLIERS, 1975, for *D. serra*; TIRADO AND SALAS 1998 for *D. trunculus* in Málaga; GASPAR *ET AL.* 1999 in *D. trunculus* in Faro (Portugal) Tirado and Salas, 1999 for *D. venustus* and *Donax semistriatus*), or other species, such as *Tapes rhomboides* (see MORVAN AND ANSELL, 1988), *Callista chione* (see TIRADO, SALAS AND LÓPEZ, 2002) and *Venus verrucosa* (see TIRADO, SALAS AND MÁRQUEZ, 2003). This renewed activation of the gonad seems to be at the origin of the fluctuations of the indexes of condition during this period. After the most important release of gametes at the beginning of spring, there was new but less intense spawning by the same individuals in the same cycle. The occurrence of successive individual spawnings has also been described in the population of the Adriatic Sea (ZEICHEN *ET AL.* 2002).

The most important drop of the indexes of condition occurred between March and April, with 100% of the population in spawning, and after an important increase of chlorophyll *a* in March. The strong regression of the gonad from September to October (100% of the population in postactive or cytolized stage) could be related to the strong decrease of the temperature (9.5ºC). An inverse correlation has been obtained between temperature and flesh dry weight (FDW/L and FDW of a standard individual). The availability of food in September at the same time as a maximum of clorophyll *a* could be advantageous for the storage of reserves, after an extensive spawning period. This result is also described in the Algerian population (MOUEZA AND FRENKIEL-RENAULT, 1973). On the other hand, the increase of chlorophyll *a* in March could be advantageous for the larva after the highest peak of spawning of the population from March to April.

According to the histological data, the Moroccan population of *D. trunculus* have three months of resting period (BAYED, 1990), whereas in the population of Huelva there is only one month (October). Moreover, the percentages of spawning in the population of Huelva are around 100%, whereas in the population of Morocco the percentages never reach 50%. The data of the population from Faro (Portugal) are more similar to those found in the population of Huelva, although the whole population is never in spawning (maximum 80% in August, Gaspar *et al.*, 1999).

According to Schlacher *et al.* (2008) and Brown and McLachlan (2006) the populations from dissipative beaches have a more extensive reproductive cycle than those from reflective ones. However, our data on the reproduction of *D. trunculus* from the littoral of Málaga, collected in reflective beaches (Tirado and Salas, 1998) showed a similar extension of the reproductive cycle to that of the population of Huelva, which lives in a dissipative beach, but with an offset of three months between the beginning of the spawning period in each population. These results justify the necessity of taking into account the biology of the species in a particular area for a better management of the resources by ruling different close seasons for the Atlantic and the Mediterranean populations, from March to April in the Atlantic populations and from May to June in the Mediterranean ones.

BIBLIOGRAPHY

Ansell A.D. and Bodoy A. 1979. Comparison of events in the seasonal cycle for *Donax vittatus* and *Donax trunculus*. In Naylor, E. and R. G. Hartnoll (Ed.): Cyclic phenomena in marine plants and animals. *Proceedings of the 13th European Marine Biology Symposium*. Pergamon Press, Oxford and New York: 191-198.

Ansell A.D. and Lagardère F. 1980. Observations on the biology of *Donax trunculus* and *Donax vittatus* at Ile d'Oléron (French Atlantic coast). *Marine Biology*, 57: 287-300.

Badino G. and Marchionni V. 1972. Neurosecretion and gonad maturation in a population of *Donax trunculus* L. from Leghorn (Italy). *Bollettino di Zoologia, 39*: 321-326.

Baldaccini G. and Bianucci P. 1984. Contributo alla conoscenza di *Donax trunculus* (Bivalvia) del litorale versiliese: aspetti tecnologici, commerciali e statistici della raccolta. *Nova Thalassia*, 6: 441-449.

Bayed A. 1990. Reproduction de *Donax trunculus* sur la côte Atlantique marocaine. *Cahiers de Biologie Marine*, 31: 159-169.

Bayed A. and Guillou J. 1985. Contribution à l'étude des populations du genre *Donax*: la population de *D. trunculus* L. (Mollusca, Bivalvia) de Mehdia (Maroc). *Annales de l'Institut Océanographique*, Paris, 61 (2): 139-147.

Bayne B.L. 1976. *Marine mussels, their ecology and physiology*. International Biological Programme. Ed. Cambridge University Press, 441 pp.

Brown A.C. and McLahlan A. 2006. *Ecology of sandy beaches* (2nd). Elsevier, Amsterdam: 373 pp.

Crosby M.P. and Gale L. 1990. A review and evaluation of bivalve condition index methodologies with a suggested standard method. *Journal of Shellfish Research,* 9 (1): 233-237.

De Villiers G. 1975. Reproduction of the sand mussel *Donax serra* Röding. *Investigational Reports of the Sea Fisheries Branch of South Africa*, 109: 1-31.

Deval M.C. 2009. Growth and reproduction of the wedge clam *Donax trunculus* in the sea of Marmara, Turkey. *Journal of Applied Ichthyology*, 25 (5): 551-558.

Fischer W., Bauchot M.L. and Scheneider M. 1987. Fiches FAO d'identification des espèces pour les besoins de la pêche. (Révision 1). Méditerranée et mer Noire. Zone de pêche 37. Vol. I.Vegetaux et Invertébrés, 760 pp.

Gaspar M.B., Ferreira R. and Monteiro C.C. 1999. Growth and reproductive cycle of *Donax trunculus* L., (Mollusca:Bivalvia) off Faro, southern Portugal. *Fisheries Research*, 41: 309-316.

Guillou J. and Le Moal Y. 1980. Aspects de la dynamique des populations de *Donax vittatus* et *D. trunculus* en baie de Douarnenez. *Annales de l'Institut Océanographique, Paris*, 56 (1): 55-64.

Gutiérrez M. 1967. Coloración histológica para el ovario de peces, crustáceos y moluscos. *Investigación Pesquera*, 31 (2): 265-271.

Jeffrey S.W. and Humphrey G.T. 1975. New spectrophotometric equation for determining chlorophylls a, b, c^1 and c^2 in higher plants, algae and natural phytoplankton. *Biochemie und Physiologie der Pflanzen*, 167: 191-194.

LA VALLE P. 2006. *Donax trunculus* (Bivalvia: Donacidae) quale indicatore biologico degli equilibri costieri e del bilancio sedimentario. Doctoral thesis, Università degli studi di Roma "La Sapienza". pp. 1-148, i-xv and appendix, 1-44.

LORENZEN C.J. AND JEFFREY S.W. 1980. Determination of chlorophyll in seawater. *UNESCO Technical Papers in Marine Science*, 35: 1-20.

LUCAS A. 1965. Recherches sur la sexualité des Mollusques Bivalves. *Bulletin Biologique de la France et de la Belgique*, 99: 115-247

MAZÉ R.A. AND LABORDA A.J. 1988. Aspectos de la dinámica de población de *Donax trunculus* (Linnaeus, 1758) (Bivalvia: Donacidae) en la ría de El Barquero (Lugo, NO España). *Investigación Pesquera*, 52 (3): 299-312.

MORVAN C. AND ANSELL A.D. 1988. Stereological methods applied to reproductive cycle of *Tapes rhomboides*. *Marine Biology*, 97: 355-364.

MOUËZA M. AND FRENKIEL-RENAULT L. 1973. Contribution à l'étude de la biologie de *Donax trunculus* L. (Mollusques Lamellibranches) dans l'Algérois: la reproduction. *Cahiers de Biologie Marine*, 14 (3): 261-283.

MOUËZA M. AND CHESSEL D. 1976. Contribution a l´étude de la biologie de *Donax trunculus* L. (Mollusque, Lamellibranche) dans l'Algerois: analyse statistique de la dispersion le long d'une plage en Baie du Bou-Ismaïl. *Journal of Experimental Marine Biology and Ecology*, 21: 211-221.

NEUBERGER-CYWIAK L., ACHITUV Y. AND MIZRAHI L. 1990. The ecology of *Donax trunculus* Linnaeus and *Donax semistriatus* Poli from the Mediterranean coast of Israel. *Journal of Experimental Marine Biology and Ecology*, 134: 203-220.

PASTEUR-HUMBERT C. 1962. Les Mollusques marins testacés du Maroc. Vol. II. Les Lamellibranches et les Scaphopodes. *Travaux de l'Institut Scientifique Chérifien*, Série Zoologie, 28, 188 pp.

RAMÓN M., GRACENEA M. AND GONZÁLEZ-MORENO O. 1999. *Bacciger bacciger* (Trematoda, Fellocistomidae) infection in commercial clams *Donax trunculus* (Bivalvia, Donacidae) from the sandy beaches of the Western Mediterrranean. *Diseases of Aquatic Organisms*, 35: 37-46.

RICKER W. 1975. Computation and interpretation of biological statistics of fish population. *Bulletin of the Fisheries Research Board of Canada*, 191: 1-382.

SABELLI B, GIANUZZI-SAVELLI R. AND BEDULLI D. 1990. *Catalogo annotato dei Molluschi marini del Mediterraneo*. Società Italiana dei Malacologia, vol 1, 348 pp.

SALAS C., TIRADO C. AND MANJÓN-CABEZA M.E. 2001. Sublethal foot-predation on Donacidae (Mollusca, Bivalvia). *Journal of Sea Research*, 46: 43-56.

SCHLACHER T.A., SCHOEMAN D.S., DUGAN J., LASTRA M. AND JONES A. 2008. Sandy beach ecosystems: key features, sampling issues, management challenges and climate change impacts . *Marine Ecology*, 29 (Suppl. 1) 70–90

TIRADO C. AND RODRÍGUEZ DE LA RÚA A. 2000. *Estudio del ciclo reproductor de los moluscos bivalvos y gasterópodos del litoral andaluz.* Informe Técnico. Consejería de Agricultura y Pesca, Junta de Andalucía, 357 pp.

TIRADO C. AND SALAS C. 1998. Reproduction and fecundity of *Donax trunculus* L., 1758 (Bivalvia: Donacidae) in the littoral of Málaga (Southern Spain). *Journal of Shellfish Research*, 17 (1): 169-176.

TIRADO C. AND SALAS C. 1999. Reproduction of *Donax venustus* Poli 1795, *Donax semistriatus* Poli 1795 and intermediate morphotypes (Bivalvia: Donacidae) in the littoral of Málaga (Southern Spain). *P.S.Z.N.: Marine Ecology*, 20 (2): 111-130.

TIRADO C., SALAS C. AND LÓPEZ J.I. 2002. Reproduction of *Callista chione* (L., 1758) (Bivalvia: Veneridae) in the littoral of Málaga (Southern Spain). *Journal of Shellfish Research*, 21 (2): 643-648.

TIRADO C., SALAS C. AND MÁRQUEZ I. 2003. Reproduction of *Venus verrucosa* L., 1758 (Bivalvia: Veneridae) in the littoral of Málaga (southern Spain). *Fisheries Research*, 63: 437-445.

ZEICHEN M.M., AGNESI S., MARIANI A., MACCARONI A AND ARDIZZONE D. 2002. Biology and Population Dynamics of *Donax trunculus* L., (Bivalvia: Donacidae) in the South Adriatic Coast (Italy). *Estuarine; Coastal and Shelf Science*, 54: 971-982.

© Sociedad Española de Malacología ——————— Iberus, 29 (1): 59-74, 2011

Bittium nanum (Gastropoda, Cerithiidae), una especie válida de las islas Azores

Bittium nanum (Gastropoda, Cerithiidae), a valid species from the Azores Islands

Diego MORENO*

Recibido el 20-IV-2011. Aceptado el 19-V-2011

RESUMEN

Se hace una redescripción de la especie del género *Bittium* Gray, 1847 que constituye uno de los elementos más abundantes del zoobentos de la zona litoral rocosa en las islas Azores. La especie ha sido confundida por casi todos los autores con las especies europeas *B. reticulatum* (da Costa, 1778) o *B. latreillii* (Payraudeau, 1826) pero se diferencia suficientemente para considerarse un endemismo del archipiélago. Se propone usar para ella el binomen *Bittium nanum* (Mayer, 1864), un nombre olvidado pero nomenclaturalmente válido y basado en fósiles de una terraza de edad Pleistoceno en Prainha, isla de Santa María. Éste (introducido originalmente en el binomen *Cerithiopsis nana* Mayer, 1864) es un homónimo primario de *Cerithiopsis tubercularis* var. *nana* Jeffreys, 1867, por lo cual esta última especie debería de ser renombrada o redescrita.

ABSTRACT

A redescription is given for the species of the genus *Bittium* Gray, 1847 which is one of the most abundant components of the zoobenthos on rocky shores of the Azores. The species has been confused by almost all authors with the European species *B. reticulatum* (da Costa, 1778) or *B. latreillii* (Payraudeau, 1826) but differs enough to be considered a species endemic to the archipelago. It is proposed to use for this species the binomen *Bittium nanum* (Mayer, 1864), a forgotten but nomenclaturally valid name based on fossils of a terrace of Pleistocene age in Prainha, Island of Santa Maria. This name (first introduced in the binomen *Cerithiopsis nana* Mayer, 1864) is a primary homonym of *Cerithiopsis tubercularis* var. *nana* Jeffreys, 1867, which should be renamed or better described anew.

INTRODUCCIÓN

En las islas Azores vive una especie del género *Bittium* Gray, 1847 que constituye uno de los elementos más abundantes del zoobentos de la zona litoral rocosa. Sin embargo, no existe un consenso acerca del estatus taxonómico de esta especie, la cual ha sido generalmente confundida con otras similares que viven en el litoral de Europa continental.

El *Bittium* de las Azores ha recibido generalmente el nombre de *Bittium reticulatum* (Da Costa, 1778), la especie tipo del género y el representante del mismo más ampliamente distribuido y más común en las costas continentales europeas, por parte de numerosos autores, siguiendo en ello a Mac ANDREW (1857: 124 y 150). Este nombre se siguió utilizando durante muchos años por otros

---

* c/ Araña, apartamentos Las Dunas 2, 04150 – Cabo de Gata, Almería (España)

autores, como JEFFREYS (1885: 57), DAUTZENBERG (1889: 41), NOBRE (1924: 79; 1930: 55), MORTON (1990: 12 y 17), BULLOCK, TURNER Y FRALICK (1990: 43), AZEVEDO (1991: 23), HOUBRICK (1993: 274), MORTON, BRITTON Y MARTINS (1998: 64 y 97). Posteriormente, se citó provisionalmente como *Bittium* cf. *reticulatum* por ÁVILA Y AZEVEDO (1997: 326). También ha sido utilizado el nombre *B. reticulatum* para los fósiles del Cuaternario de la isla de Santa María por ZBYSZEWSKY Y FERREIRA (1962: 215), GARCÍA-TALAVERA (1990: 440) y CALLAPEZ Y SOARES (2000: 314). También, ha sido considerada como *Bittium depauperatum* (Watson, 1897) por NORDSIECK (1976: 7) y NORDSIECK Y GARCÍA-TALAVERA (1979: 90).

El nombre *Bittium latreillii* (Payraudeau, 1826), ha sido sugerido para la especie de Azores por VERDUIN (1976: 135) y, más recientemente, por ÁVILA, AMEN, AZEVEDO, CACHÃO Y GARCÍA-TALAVERA (2002: 349), ÁVILA, CARDIGOS Y SANTOS (2004: 77; 2007: 46-47) y ÁVILA, SANTOS, PENTEADO, RODRIGUES, QUINTINO Y MACHADO (2005: 73). Por último, MARTINS, BORGES, ÁVILA, COSTA, MADEIRA Y MORTON (2009: 58) mencionan la especie como *Bittium* cf. *latreillii*, y citan también a *B. latreillii* como muy raro frente a Vila Franca do Campo en la isla de São Miguel a 180 m de profundidad. La dudas en la asignación de un nombre a la especie han hecho que se haya quedado como *Bittium* sp. por algunos autores, como ÁVILA (1998: 483; 2000: 102), ÁVILA, AZEVEDO, GONÇALVES, FONTES Y CARDIGOS (1998: 493; 2000: 144) y COSTA Y ÁVILA (2001: 120, 124).

El objeto de este trabajo es aportar una descripción detallada del *Bittium* de las Azores y de mostrar que se trata de una especie distinta a las que viven en las costas europeas. En un principio se había contemplado su descripción como especie nueva (MORENO, 1998, no publicado en el sentido de la CINZ). En una posterior revisión bibliográfica realizada en el Muséum National d'Histoire Naturelle de París (MNHN) se pudo hallar para la misma un nombre disponible, aunque caído en el olvido, basado en un fósil del Cuaternario de la isla de Santa María y originalmente publicado en el binomen *Cerithiopsis nana* Mayer, 1864. La descripción de Mayer es explícita y la figura es suficiente para reconocer la especie, que ÁVILA, AMEN, AZEVEDO, CACHÃO Y GARCÍA-TALAVERA (2002) han vuelto a encontrar en su localidad tipo aunque identificada como *Bittium latreillii*. El nombre ha sido ignorado por autores posteriores, con la única excepción de GARCÍA-TALAVERA (1990) quien se limita a repetir la cita original de Mayer sin relacionarla con el *Bittium* de su propio material (identificado p. 440 como *Bittium reticulatum*).

Pese a ello, se considera que la falta de uso para este nombre se debe a la falta de atención para la especie o a su confusión con otras especies, no al uso acostumbrado de un sinónimo frente al nombre nomenclaturalmente válido. Tampoco ha sido rechazado como "nomen oblitum" durante el periodo de vigencia de dicho concepto (1961-1973, artículo 23b de la edición de 1961 del CINZ). Por lo tanto, se propone la nueva combinación *Bittium nanum* (Mayer, 1864) como el nombre válido para el *Bittium* de las Azores.

Cerithiopsis nana Mayer, 1864 es un homónimo primario con respecto a *Cerithiopsis tubercularis* var. *nana* Jeffreys, 1867, un nombre en uso para una especie taxonómicamente válida del género *Cerithiopsis* (familia Cerithiopsidae). Recientemente, CECALUPO Y ROBBA (2010), designaron *Cerithiopsis nana* Jeffreys, 1867 como especie tipo de un género nuevo, *Nanopsis* Cecalupo y Robba. Los mismos autores anuncian su intención de solicitar a la CINZ que suprima el nombre más antiguo de Mayer (1864). Esta acción no parece deseable al tratarse del nombre potencialmente válido de otra especie y, como solución alternativa para el problema nomenclatural, se debería contemplar el renombrar o redescribir *Cerithiopsis nana* Jeffreys, 1867.

El nombre *Cerithiopsis nana* Mayer, 1864 es homónimo secundario de *Cerithium tuberculare* var. *nanum* Wood, 1848, actualmente considerado como una especie del género *Cerithiopsis* (Marquet, 1997). Sin embargo, al no haberse reemplazado y al no considerarse especies congenéricas en la actualidad, se aplica el artículo 59.2 del CINZ según el cual bajo estas circunstancias "el nombre más moderno no debe rechazarse, incluso si uno de los nombres de nivel especie se propuso originalmente en el género actual del otro".

Resulta sorprendente que un nombre específico tan trivial como *nanum* no resulte preocupado en combinación con el nombre genérico *Bittium*, pero este parece ser el caso. En la misma familia hallamos a *Cerithium nanum* C.B. Adams, 1850, actualmente considerado como perteneciente en la familia Triphoridae y sin uso como nombre válido, por lo tanto ni homónimo primario ni secundario; este nombre preocupa a *Cerithium nanum* Pallary, 1912 (un *Cerithium* del grupo de *C. vulgatum* Bruguière, 1792).

SISTEMÁTICA

Bittium nanum (Mayer, 1864) *comb. nov.* (Figs. 1-32)

Cerithiopsis nana Mayer, 1864. *Syst. Verz. der foss.*: 66-67, lám.6, fig. 46 [citado por error fig. 49 en el texto].

Material estudiado: se han estudiado un total de 6.358 ej., todos procedentes de las islas Azores: Banco João do Castro: St. 1, 1971, 7 ej., máx. 5,0 mm, MNHN, mission Biaçores, 40-50 m; Faial: Castelo Branco, jul-79, 5 ej., máx. 3,5 mm, MNHN, col. Zibrowius, 28 m; Castelo Branco, St. P-11, 1971, 15 ej., máx. 3,0 mm, MNHN, mission Biaçores, 5-7 m; Horta, St. 29, 1971, 34 ej., máx. 2,5 mm, MNHN, mission Biaçores, 2-3 m; Horta, St.L-9, 1971, 5 ej., máx. 2,0 mm, MNHN, mission Biaçores, 3 m; Horta, St. P-13, 1971, 10 ej., máx. 5,0 mm, MNHN, mission Biaçores, 17 m; Monte da Guia, jul-79, 6 ej., máx. 4,5 mm, MNHN, Zibrowius, 47-60 m; Monte da Guia, St.P-19, 1971, 17 ej., máx. 4,5 mm, MNHN, mission Biaçores, 4 m; St. L- 8, 1971, 1 ej., máx. 5,8 mm, MNHN, mission Biaçores, 8 m; St. L-11, 1971, 12 ej., máx. 8,0 mm, MNHN, mission Biaçores, 2-4 m; St. P-13, 1971, 4 ej., máx. 2,0 mm, MNHN, mission Biaçores, 3-4 m; Flores: I. Muda, St. P-24, 1971, 8 ej., máx. 4,0 mm, MNHN, mission Biaçores, 24 m; S. Cruz de Flores, 1989, 300 ej., máx. 4,0 mm, MNHN, Exp. Flores, col. Gofas, 20 m; S. Cruz de Flores, 1989, 1 ej., máx. 7,0 mm, MNHN, Exp. Flores, col. Gofas, 1 m; S. Cruz de Flores, 1989, 1000 ej., máx. 6,0 mm, MNHN, Exp. Flores, col. Gofas, 20 m; S. Cruz de Flores, 1989, 1000 ej., máx. 7,0 mm, MNHN, Exp. Flores, col. Gofas, 20 m; Formigas: (E) St. P-44, 1971, 3 ej., máx. 4,0 mm, MNHN, mission Biaçores, 35-45 m; (E) St. P-44, 1971, 13 ej., máx. 4,5 mm, MNHN, mission Biaçores, 43 m; (W) St. P-43, 1971, 4 ej., máx. 5,5 mm, MNHN, mission Biaçores, 15 m; Pico: Lajes do Pico, 04/07/1995, 6 ej., máx. 9,5 mm, col. D. Moreno, 1 m; Lajes do Pico, 04/07/1995, 18 ej., máx. 8,5 mm, col. D. Moreno, 1 m; Lajes do Pico, 04/07/1995, 7 ej., col. D. Moreno, 1 m; Lajes do Pico, 04/07/1995, 10 ej., máx. 9,5 mm, col. D. Moreno, 1 m; Lajes do Pico, 04/07/1995, 41 ej., máx. 9,0 mm, col. D. Moreno, 1 m; S. Roque, 02/07/1995, 15 ej., col. D. Moreno, 6 m; S. Maria: P. Malbusca, 01/10/1971, 2 ej., máx. 5,5 mm, MNHN, mission Biaçores, 12-25 m; P. Malbusca, St.P-3, 1971, 5 ej., máx. 3,5 mm, MNHN, mission Biaçores, 30 m; Ponta Marvão, jun-90, 41 ej., máx. 7,5 mm, MNHN, col. S. y C. Gofas, 0-1 m; Praia Formosa, jun-90, 300 ej., máx. 7,0 mm, MNHN, col. S. y C. Gofas, 0 m; Vila do Porto, jun-90, 3 ej., máx. 6,5 mm, MNHN, col. S. y C. Gofas, 0-1 m; Vila do Porto, jun-90, 52 ej., máx. 6,0 mm, MNHN, col. Gofas y Azevedo, 9 m; Vila do Porto, jun-90, 300 ej., máx. 9,0 mm, MNHN, col. Gofas y Azevedo, 6 m; São Miguel: Agua d'Alto, jul-88, 9 ej., MNHN, col. Gofas, 50 m; Caloura, B. Areia, jul-88, 111 ej., máx. 7,0 mm, MNHN, col. Gofas, 15 m; Caloura, Pta. Galera, jul-79, 3 ej., máx. 4,0 mm, MNHN, col. Zibrowius, 15 m; Caloura, Pta. Galera, 10/07/1983, 8 ej., máx. 4,0 mm, MNHN, col. Bouchet et al., 20 m; Caloura, Pta. Galera, 10/07/1983, 300 ej., máx. 6,3 mm, MNHN, col. Bouchet et al., 20 m; Caloura, Pta. Galera, jul-88, 500 ej., máx. 7,0 mm, MNHN, Gofas, 13-18 m; Caloura, Pta. Galera, 29/06/1995, 58 ej., máx. 5,0 mm, col. D. Moreno, 20 m; Capelas, St. P-5, 1971, 8 ej., máx. 3,0 mm, MNHN, mission Biaçores, 12 m; Capelas, M. St.P-41, 1971, 40 ej., máx. 5,5 mm, MNHN, mission Biaçores, 29 m; Feteiras, jul-88, 500 ej., máx. 6,0 mm, MNHN, col. Gofas, 15-24 m; Lagoa, jul-88, 500 ej., máx. 6,5 mm, MNHN, col. Gofas, Infralitoral; Ponta Delgada, 09/07/1983, 300 ej., máx. 6,0 mm, MNHN, col. Bouchet, et al., 10-20 m; Ponta Delgada, jul-88, 53 ej., máx. 8,0 mm, MNHN, col. Gofas, 0 m; Ponta Delgada, St.P-29, 1971, 3 ej., máx. 3,5 mm, MNHN, mission Biaçores, 12 m; Ponta Piramide, jul-88, 300 ej., máx. 5,0 mm, MNHN, col. Gofas, 13 m; St. P-32, 1971, 12 ej., máx. 4,3 mm, MNHN, mission Biaçores, 7 m; Vila Franca, jul-88, 100 ej., máx. 4,0 mm, MNHN, col. Gofas, 10 m; Vila Franca, jul-88, 57 ej., máx. 8,0 mm, MNHN, col. Gofas, 0-5 m; Vila Franca, Ilheu, jul-88, 113 ej., máx. 7,5 mm, MNHN, col. Gofas, 0-1 m; Vila Franca, Ilheu, 29/06/1995, 88 ej., máx. 4,5 mm, col. D. Moreno, 15 m; Vila Franca, St.P-36, 1971, 21 ej., máx. 6,0 mm, MNHN, mission Biaçores, 24 m; Terceira: P. Diego, St. P-7, 1971, 22 ej., máx. 5,0 mm, MNHN, mission Biaçores, 40 m; St. P-7, 1971, 7 ej., máx. 4,3 mm, MNHN, mission Biaçores, 39-40.

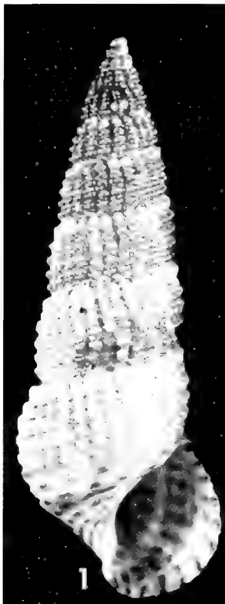
Redescripción: La concha (figs. 1-7) es pequeña, de unos 6 a 9 mm en los adultos, 9,5 mm es el máximo medido en el material estudiado (6.358 ejemplares). Sin embargo, existen ejemplares aislados que superan los 10 mm (S. ÁVILA, com. pers.). Los adultos tienen unas 10 vueltas de espira. La superficie está surcada por numerosas costillas espirales y axiales que, al encontrarse, forman un pequeño tubérculo. El número de costillas espirales es de 5 ó 6. Los adultos más pequeños tienen 5, pero los más grandes tienen 6 en la vuelta del cuerpo o en la anterior.

La formación de las costillas espirales es muy similar a la conocida para *B. latreillii* (VERDUIN, 1976) pero algo más rápida, por ello tienen una 6ª costilla. El origen de las distintas costillas espirales es el siguiente. La 3ª costilla (en el tiempo, no por su posición) se forma en posición subsutural, aproximadamente en la primera o segunda vuelta de la teleoconcha, y rápidamente alcanza en tamaño a las anteriores. Posteriormente, la 4ª costilla comienza a formarse por debajo de la 3ª costilla o subsutural, aproximadamente en la tercera vuelta de espira (Figs. 5 y 6), antes que en *B. latreillii*. La 5ª costilla nace por debajo de la 3ª o subsutural, aproximadamente en la sexta vuelta de espira de la teleoconcha (Fig. 6). Por último, la 6ª costilla espiral nace igual que las anteriores, por debajo de la 3ª o subsutural, aproximadamente en la novena o décima vuelta de espira. La microescultura de la superficie de la concha es similar a la conocida para *B. reticulatum* y *B. latreillii*, con microtubérculos en los espacios intercostales (espirales) y pequeñas cavidades en las costillas (Fig. 7).

El número de costillas axiales, que también es más numeroso que en *B. latreillii*, es de 24 a 28 en la vuelta del cuerpo o en la anterior. Las costillas son finas, ortoclinas en las primeras vueltas de la teleoconcha y prosoclinas u opistocirtas en las últimas. Los tubérculos que se forman al cruzarse las costillas axiales con las espirales son brillantes, redonde-

(Página derecha) Figuras 1-11. *Bittium nanum*. Conchas, microescultura al MEB y opérculo. 1, 2: conchas de Lajes do Pico, Is. Pico, Azores (4/VII/1995) (8,1 y 7,4 mm de longitud); 3, 4: conchas de Marvão, Is. Santa María, Azores (VI/1990) (8 y 7 mm); 5: formación de la 4ª costilla espiral (flecha) y microescultura, S. Roque do Pico, Is. Pico (2/VII/1995); 6: concha juvenil mostrando la formación de la 4ª y 5ª costillas espirales (flechas), S. Roque do Pico, Is. Pico (2/VII/1995); 7: detalle de la microescultura de la concha, S. Roque do Pico, Is. Pico (2/VII/1995); 8, 9: conchas con pérdida de la escultura, Lajes do Pico, Is. Pico (4/VII/1995) (6 y 5,7 mm); 10: concha juvenil mostrando la pérdida de escultura, S. Roque do Pico, Is. Pico (2/VII/1995); 11: opérculo, Lajes do Pico, Is. Pico (4/VII/1995).

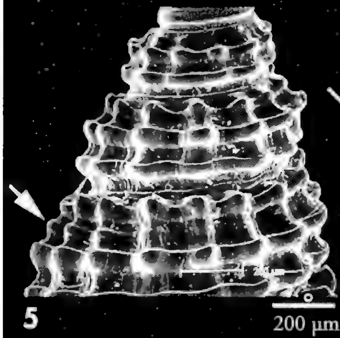
(Right page) Figures 1-11. Bittium nanum. *Shells, SEM of microsculpture and operculum. 1, 2: shells from Lajes do Pico, Pico Is., Azores (4/VII/1995) (8.1 and 7.4 mm in length); 3, 4: shells from Marvão, Santa Maria Is., (VI/1990) (8 and 7 mm); 5: formation of the 4th spiral rib (arrow) and microsculpture, S. Roque do Pico, Pico Is. (2/VII/1995); 6: juvenile shell showing the formation of the 4th and 5th ribs spirals (arrows), S. Roque do Pico, Pico Is. (2/VII/1995); 7: detail of shell microsculpture, S. Roque do Pico, Pico Is. (2/VII/1995); 8, 9: shells with loss of sculpture, Lajes do Pico, Pico Is., (4/VII/1995) (6 and 5.7 mm); 10: juvenile shell showing loss of sculpture, S. Roque do Pico, Pico Is. (2/VII/1995); 11: operculum, Lajes do Pico, Pico Is. (4/VII/1995).*

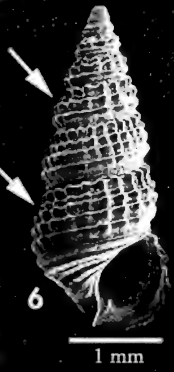

1

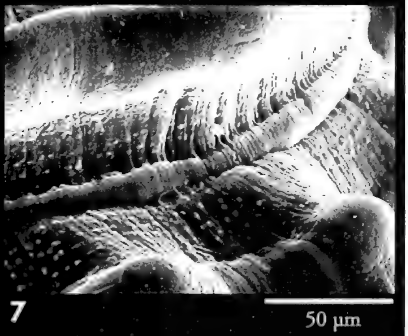

2

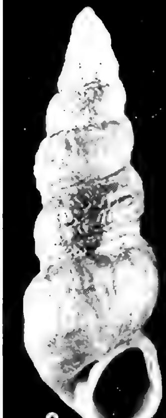

3

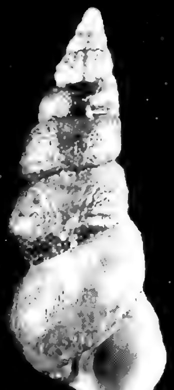

4

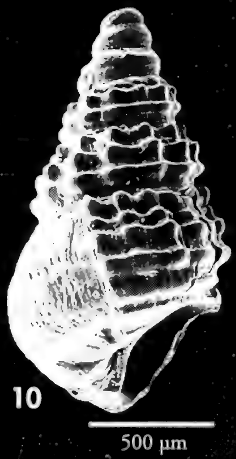

5

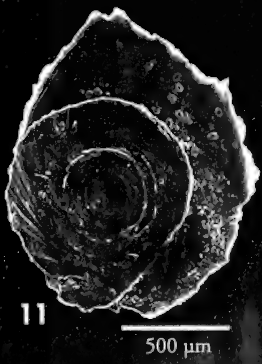

6


7


8


9


10


11

ados, se encuentran muy próximos unos a otros y son muy uniformes. Como en las demás especies del género, las costillas axiales no continúan en la base.

Las costillas espirales de la base son lisas, unas 6 ó 7 en los adultos. Las dos adapicales suelen ser más fuertes, seguidas de una 3ª más débil que la 4ª. Las últimas van haciéndose más débiles hasta la columela.

Con respecto a la escultura de la concha, una característica que hay que destacar, por ser muy peculiar, es la existencia de numerosos ejemplares que la pierden totalmente en alguna fase de su crecimiento o en la mayor parte de la teleoconcha (Figs. 8, 9, 10, 24, 29, 30 y 32). Estas espiras suelen desviarse con frecuencia del eje de la columela, con lo que el perfil de la concha se hace irregular. Dicho crecimiento deforme, que no parece afectar al normal desarrollo del animal, no se encuentra aislado en determinadas poblaciones, puesto que se ha encontrado en numerosas localidades de distintas islas y podría estar presente en todo el archipiélago (es muy frecuente, al menos, en las islas de Pico, S. Miguel y S. María). HOUBRICK (1993) no hace referencia en ningún momento a esta alteración en el crecimiento, que parece ser propio de *B. nanum*, y no se ha observado o no se conoce en otras especies del género.

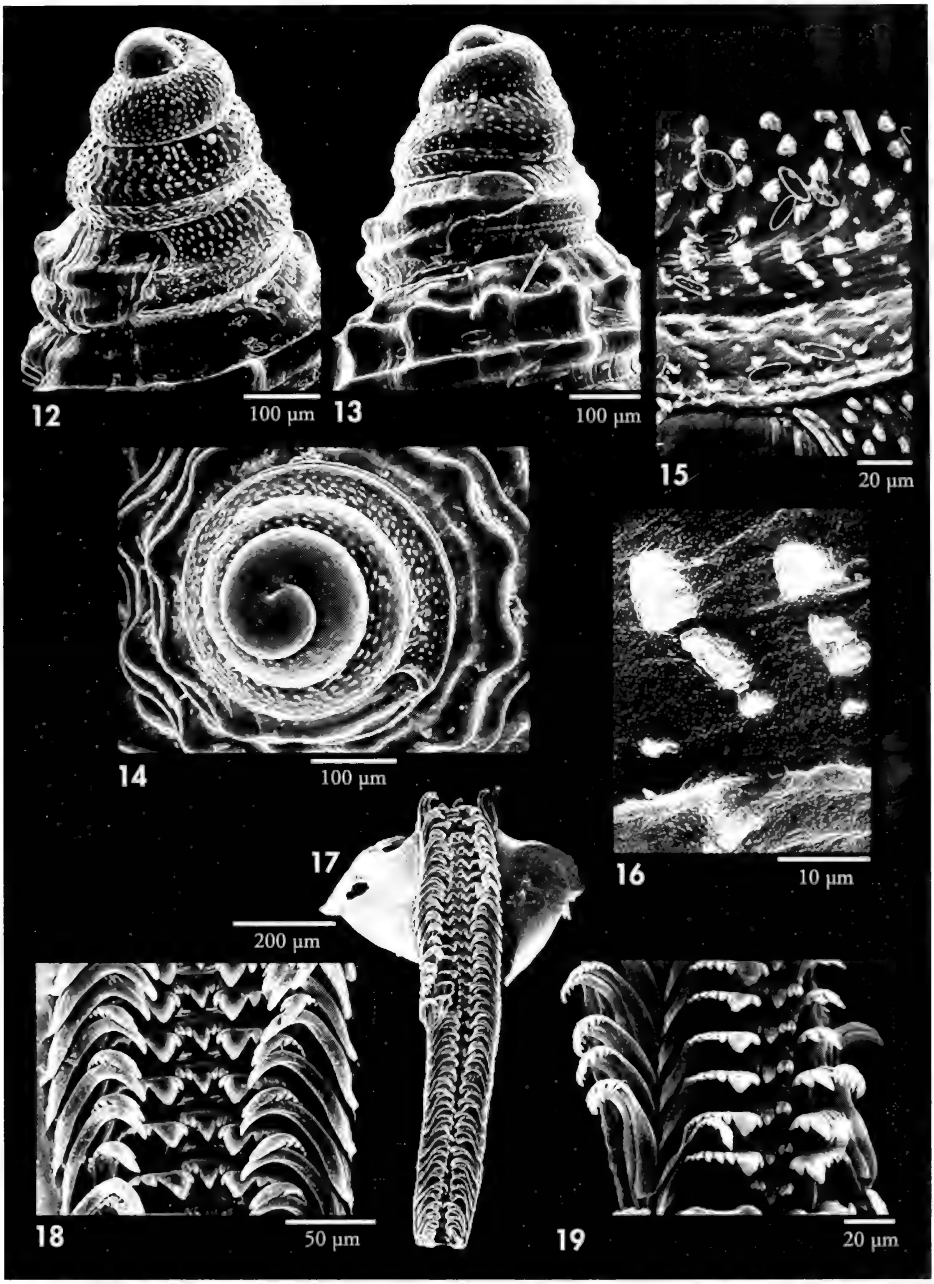
Cuando la escultura se pierde, las conchas aparecen más o menos lisas, sin costillas espirales, costillas axiales ni microescultura, y con aspecto deforme, muy tosco (Figs. 8, 9 y 29). En primer lugar podría pensarse que se trata de conchas rodadas, pero no es así al haberse observado en individuos vivos y en conchas frescas. También se podría pensar que se trata de una degeneración o de alguna malformación, debida quizás al aislamiento genético que sufre la especie en su conjunto o cada una de sus distintas poblaciones insulares, pero no parece ser así, puesto que muchos individuos que sufren esta pérdida de escultura vuelven a recuperarla en fases sucesivas. Así, encontramos ejemplares con concha normal, seguida por unas vueltas de espira (1-3 vueltas) sin escultura, y, de nuevo, vueltas con escultura normal (Figs. 24 y 30). Probablemente se trate de un morfo más, que se presenta en un número elevado de individuos y que es favorable en ciertas circunstancias para el camuflaje del animal. Estos ejemplares deformes presentan un ombligo incipiente (Figs. 8, 9 y 10), que no se encuentra en las conchas de crecimiento normal.

El perfil general de las vueltas de espira en las conchas de crecimiento normal con escultura es bastante recto, pero no tan marcado como en *B. latreillii*. El perfil general de la concha no es tan triangular como en *B. latreillii*, sino ligeramente pupoide, con las primeras vueltas de bordes divergentes y las últimas con bordes cada vez más paralelos. La periferia de la concha en los ejemplares que han perdido la escultura espiral, como ya se ha comentado, es totalmente irregular.

La abertura es ligeramente ovalada, con el labio externo apenas engrosado en los adultos, aunque aumenta en dimensiones y vuelo, pero de forma menos marcada que en *B. latreillii*. La especie posee varices, sobre todo los ejemplares de mayor tamaño en la vuelta del cuerpo

El color de fondo de la concha es uniforme, pardo claro o castaño (Figs. 26-30 y 32). Los tubérculos suelen distinguirse muy bien, pues son de color claro, ya sea su tono natural o acentuado por una ligera erosión de los puntos más sobresalientes de la concha. Es frecuente que, como en *B. latreillii*, algunos tubérculos estén pigmentados de blanco, principalmente a lo largo del cordón subsutural, aunque también en todos los tubérculos que constituyen una costilla axial determinada o en tubérculos sueltos en cualquier posición. Las costillas espirales de la base suelen estar pigmentadas de blanco y castaño, intermitente, muy marcado en las dos costillas adapicales.

La protoconcha de *B. nanum* (Figs. 12-16) es muy similar a la *B. latreillii*, lo que confirma el estrecho parentesco entre ambas especies, ya observado al estudiar la teleoconcha. Tanto las



Figuras 12-19. *Bittium nanum*. Protoconcha y rádula al MEB. 12-16: S. Roque do Pico, Is. Pico, Azores (2/VII/95); 17-19: Lajes do Pico, Is. Pico (4/VII/1995). 12: protoconcha con borde sinusígero roto; 13, 14: protoconcha completa; 15, 16: microescultura y detalle; 17: rádula completa; 18, 19: varias filas de la rádula con los dientes marginales cerrados y abiertos.

Figures 12-19. Bittium nanum. *SEM of protoconch and radula. 12-16: S. Roque do Pico, Pico Is., Azores (2/VII/95); 17-19: Lajes do Pico, Pico Is. (4/VII/1995). 12: protoconch with broken sinusigera rim; 13, 14: complete protoconch; 15, 16: microsculpture and detail; 17: complete radula; 18, 19: several rows of the radula with closed and open marginal teeth.*

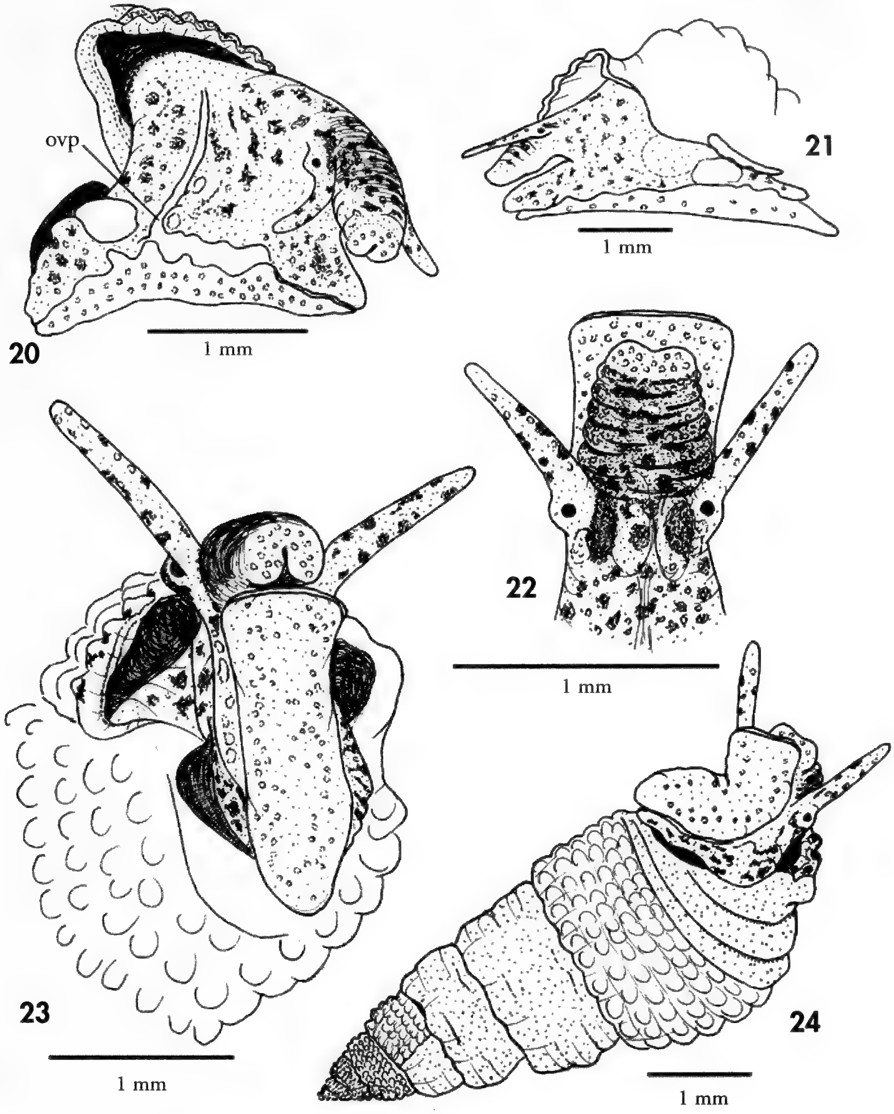
dimensiones de la protoconcha en su conjunto (385 µm: n= 4), como la presencia de dos costillas espirales en la última vuelta de la protoconcha II y una microescultura con tubérculos patentes, es prácticamente igual a la observada de *B. latreillii*. Sin embargo, existen algunas ligeras diferencias. La anchura de la protoconcha es algo mayor en esta especie (media de 289 µm: n= 4) que en *B. latreillii* (media de 260 µm; n= 7). Los tubérculos son de base ovalada, de entre 7 y 9 µm de diámetro mayor (Figs. 15 y 16), algo más grandes que los de *B. latreillii*. Entre estos tubérculos hay otros diminutos, de unos 0,2 µm (Fig. 16), que están también presentes en *B. latreillii*.

El animal de *B. nanum* (Figs. 20-24, 26, 28 y 32) es similar al de otras especies del género, tanto en forma como en pigmentación. Los tentáculos cefálicos son más largos que el morro y el borde del manto posee papilas. Las hembras en la época de reproducción presentan un ovopositor desarrollado (Fig. 20: ovp). El color de fondo es pardo claro, sobre el que se disponen manchas de color pardo oscuro, principalmente en la cabeza y dorso, y puntos de color blanco opaco, dispersos por toda la superficie (Figs. 26, 28, 32). Los tentáculos tienen manchitas oscuras y blancas en los bordes y centro, con frecuencia, de color rojizo, como en *B. latreillii*. El extremo de los tentáculos tiene manchas blancas. Existe una mancha amarillenta detrás del ojo, oculta por manchas oscuras más superficiales. En la base del morro, que es la zona más oscura, se distingue con dificultad, por transparencia, el bulbo bucal, que es anaranjado. Los labios son de color claro con puntos blancos. El propodio está poco pigmentado de oscuro en el dorso y posee pequeñas manchas en el centro. Los bordes laterales del propodio tienen pequeñas papilas redondeadas pigmentadas de blanco. El surco ciliado derecho es más pálido que las áreas próximas. El borde del manto tiene manchitas de color pardo entre las papilas, que no poseen manchas blancas. Más internamente, el manto tiene una banda amarilla paralela al borde. Los lóbulos del opérculo, a ambos lados del animal, poseen una gran mancha de color blanco, como en *B. latreillii*. El pie es blanquecino con puntos blancos y la suela es de color crema con dos bandas internas amarillentas paralelas junto a los bordes y numerosos puntos blancos por toda su superficie.

La rádula de *B. nanum* (Figs. 17-19) es muy similar a la de *B. reticulatum* y a la de *B. latreillii*. Su longitud, en ejemplares adultos de entre 8 y 9 mm de longitud de concha, es de poco más de 900 µm y tiene unas 40 filas de dientes. El diente raquídeo tiene entre 2 y 3 dentículos a cada lado del diente central. El diente lateral tiene entre 1 y 2 cúspides en la cara interna y entre 3 y 7 en la externa. El diente marginal externo tiene entre 3 y 5 dentículos en la cara interna y entre 3 y 7 en la externa. Por último, el diente marginal externo tiene entre 3 y 9 cúspides en el lado interno, mientras que el externo es liso. .

Comentarios: *Bittium latreillii* es una especie de amplia distribución en las costas europeas, desde el Golfo de Vizcaya hasta el Sahara Occidental, incluyendo Madeira y Canarias, y todo el Mediterráneo, que vive en fondos infra- y circalitorales. Es similar a *B. latreillii*, pero posee una concha más pequeña (hasta unos 10 mm), con un perfil más redondeado, a veces cirtoconoide. La protoconcha de *B. nanum* es más ancha y con tubérculos más grandes que la de *B. latreillii*. No es de extrañar que en las islas Azores, además de la especie endémica y de amplia distribución en el archipiélago, *B. nanum* se pueda encontrar alguna población aislada de *B. latreillii*, como parecen haber demostrado MARTINS *et al.* (2009) que podría provenir de Madeira o de la costa europea continental, gracias a las larvas planctotróficas que pueden recorrer grandes distancias en el mar.

Otros autores, como NORDSIECK (1976) y NORDSIECK Y GARCÍA-TALAVERA (1979), han utilizado para esta especie el nombre *Bittium depauperatum* (Watson, 1897). Sin embargo, *B. depauperatum* fue descrito por WATSON (1897) para Madeira. Se han consultado 3 sintipos de *Bittium depauperatum*



Figuras 20-24. ***Bittium nanum***. Anatomía externa. 20-22. Lajes do Pico, Is. Pico, Azores (4/VII/1995). 20: hembra mostrando el ovopositor (ovp); 21: animal visto desde el lado izquierdo; 22: pigmentación de la cabeza, de los tentáculos cefálicos y del propodio; 23: pigmentación del animal, vista ventralmente. S. Cruz, Is. Flores, Azores (1989, MNHN) (Dibujo de S. Gofas); 24: ejemplar con concha que ha perdido la escultura y que ha vuelto a recuperarla. Ponta Piramide, Is. S. Miguel, Azores (VII/88, MNHN) (dibujo de S. Gofas con algunas modificaciones).

Figures 20-24. Bittium nanum. *External anatomy. 20-22. Lajes do Pico, Pico Is., Azores (4/VII/1995). 20: female showing the ovipositor (ovp); 21: animal viewed from the left side; 22: pigmentation of the head, cephalic tentacles and propodium; 23: pigmentation of the animal, ventral view. S. Cruz, Flores Is., Azores (1989, MNHN) (Drawing by S. Gofas); 24: specimen with shell sculpture interrupted and later recovered. Ponta Piramide, S. Miguel Is., Azores (VII/88, MNHN) (drawing by S. Gofas with some modifications).*

(Watson, 1897) del Natural History Museum de Londres, y se trata de una especie con protoconcha pauciespiral, no multiespiral como la especie de Azores.

Datos anteriores: La única descripción previa conocida de la concha es la de Houbrick (1993: 274, fig. 3, A, B y C), pero al considerar todas las especies de *Bittium* del Atlántico oriental y Mediterráneo como una sola (*B. reticulatum*), parte de la descripción y algunas de las ilustraciones se refieren a la especie de Azores, mientras que otros datos e ilustraciones están basados en otras poblaciones del continente. Así, sus figuras 3 A, B y C, corresponden a la especie de Azores (S. Miguel), mientras que las figuras 3 D, E y H, corresponden a *B. reticulatum*, las dos primeras fotografías a un ejemplar procedente de Túnez, mientras que la última se trata de un juvenil del que no da la localidad. En los datos de su descripción, la talla que señala corresponde, probablemente a datos bibliográficos, puesto que da 15 mm de longitud máxima, cuando la especie de Azores no suele superar los 10. Sin embargo, los datos sobre las costillas espirales sí coinciden con la especie de Azores ("5 costillas espirales principales en la vuelta del cuerpo").

El material que utilizó Houbrick (1993: 281) en su revisión de la subfamilia Bittiinae para estudiar la anatomía del género *Bittium* era de las islas Azores, y por tanto corresponde con la especie que aquí nos ocupa. Este autor, aunque conocía la variabilidad de *Bittium reticulatum*, y que algunos autores consideraban a las poblaciones de las islas Azores como distinta a *B. reticulatum*, y que por tanto en aguas europeas existe un complejo de especies, consideró a todas ellas en sentido amplio (*sensu lato*) como una sola: *B. reticulatum*. Houbrick (1993: 282) utilizó como argumento para considerar el complexo de especies de *B. reticulatum* como una única especie el hecho de que la anatomía conocida hasta ahora de otras poblaciones, como la de Johansson (1947) o los bocetos realizados por Ponder de ejemplares de Suecia (Ponder, *in litt.*) correspondían básicamente con las observaciones realizadas sobre su material de Azores.

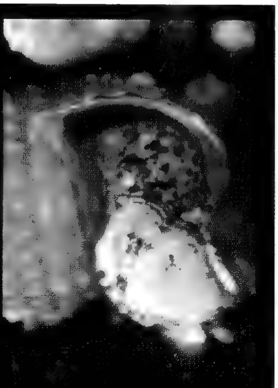
Las conchas que seleccionó Houbrick (1993) para ilustrar a *B. reticulatum* tenían distintas procedencias y correspondían a diferentes especies. En concreto, las figuras 3 A, B y C corresponden a *Bittium nanum* y proceden de la isla de São Miguel (Azores), mientras que el resto son de *Bittium reticulatum* y son de Túnez (fig. 3 D y E), o no se indica procedencia (fig. 3 H).

La protoconcha que describe e ilustra Houbrick (1993: 274, Fig. 3 G) para *B. reticulatum* corresponde realmente a esa especie. Aunque dicho autor trabajó material de Azores donde no vive *B. reticulatum*, el ejemplar que utilizó para describir e ilustrar la protoconcha (sin detallar localidad), procede sin duda del continente, pues posee una superficie lisa. Además, la protoconcha ilustrada por reste autor no se observa

(Página derecha) Figuras 25-32. *Bittium nanum*. Hábitat y animales vivos. 25-30. Lajes do Pico, Is. Pico, Azores (4/VII/1995). 25: laguna costera en Lajes do Pico; 26-28: animales vivos; 29: ejemplar con concha de escultura normal (abajo) y ejemplar con concha sin escultura (arriba); 30: ejemplar con concha que ha perdido la escultura normal y la ha vuelto a recuperar posteriormente; 31: hábitat en arena gruesa junto a *Ervilia castanea*, -15 m, Ilheu de Vila Franca, Is. São Miguel (29/VI/1995); 32: ejemplar con concha que ha perdido la escultura, Ilheu de Vila Franca, Is. São Miguel (29/VI/1995).

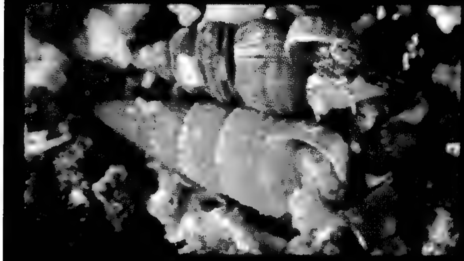
(Right page) Figures 25-32. Bittium nanum. *Living animals and habitats. 25-30. Lajes do Pico, Pico Is., Azores (4/VII/1995). 25: coastal lagoon in Lajes do Pico; 26-28: living animals; 29: specimen with normal shell sculpture (below) and other with no shell sculpture (above); 30: specimen in which normal shell sculpture has been lost and later recovered; 31: habitat in coarse sand with* Ervilia castanea, *-15 m, Ilheu de Vila Franca, São Miguel Is. (29/VI/1995); 32: Specimen in which normal shell sculpture has been lost, Ilheu de Vila Franca, São Miguel Is. (29/VI/1995).*

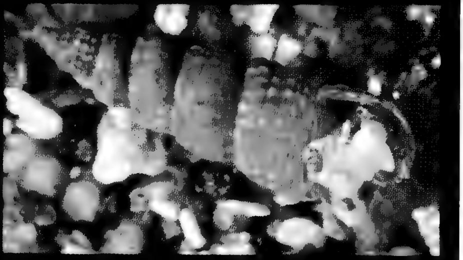

25

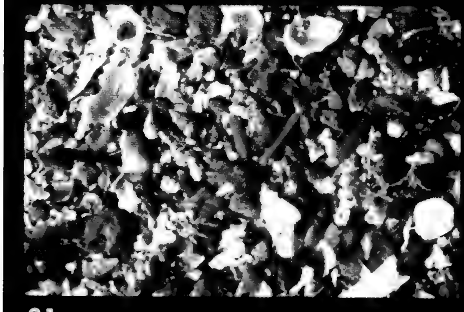

26


27


28


29


30


31


32

en su totalidad, debido a que la abertura de la misma queda oculta por la concha.

El animal de *B. nanum* (Figs. 20-24, 26, 28 y 32) fue descrito e ilustrado con mucho detalle por HOUBRICK (1993: 276, fig. 4). El opérculo ilustrado por HOUBRICK (1993: 276, fig. 3 f) para *B. reticulatum*, podría corresponder a *B. nanum*, aunque de nuevo este autor no detalla la localidad. En base a material procedente de las islas Azores recogido durante el presente estudio, el opérculo (Fig. 11) es muy similar al conocido para otras especies del género, con forma ligeramente ovalada, núcleo excéntrico, superficie lisa y última vuelta más estrecha que el resto del opérculo. La impresión muscular es algo más larga que la mitad de la longitud del opérculo.

La anatomía descrita en detalle por HOUBRICK (1993) para *B. reticulatum* corresponde realmente a *B. nanum*. Esta fundamental aportación de dicho autor se basa en disecciones y cortes histológicos de material recogido vivo por él durante el "Workshop" celebrado en São Miguel (Azores) en julio de 1988. Las observaciones realizadas para esta tesis coinciden plenamente con las realizadas por dicho autor. De la descripción de HOUBRICK (1993) destaca el detallado estudio del sistema reproductor. El oviducto paleal está compuesto por dos láminas gruesas. En la lámina media se encuentran la bursa y el receptáculo seminal, y en la lámina lateral se encuentra el surco de lamelas ciliadas y el receptáculo del espermatóforo (que él llama bursa). Todo es muy similar a lo descrito para *B. reticulatum* por JOHANSSON (1947). La completa descripción de la especie realizada por HOUBRICK (1993) coincide en casi todo con las observaciones efectuadas en el presente trabajo. Dicho autor ilustra (Fig. 4 d) los ganglios bucales en posición dorsal respecto al bulbo bucal, lo que debe tratarse de un error ya que su posición real es ventral.

HOUBRICK (1993: 276-278, Tabla. 2 y Fig. 5) ofrece datos contradictorios sobre la rádula; no coincide lo que describe con lo que se ve en las fotografías que presenta, aunque los valores indicados entran dentro de la variabilidad del material propio, procedente de la isla Pico.

Las puestas fueron descritas por HOUBRICK (1993), se supone que basándose en el material obtenido por él en julio de 1988 en Azores. Nosotros no las hemos observado. HOUBRICK (1993: 279) dice: "Puesta constituida por un cordón gelatinoso fino (de unos 25 mm de longitud estirado) en ajustada espiral en el sentido de la agujas del reloj o doblado sobre sí mismo de forma irregular y fijada al sustrato. Cordón gelatinoso que contiene muchos huevos opacos pequeños (de 0.65 μm de diámetro) [*sic*, por 65 μm] cada uno dentro de una fina, transparente y hialina cápsula (de 110 μm de diámetro). Toda la puesta contiene unos 800 huevos".

Hábitat y distribución: El hábitat de *B. nanum* es preferentemente infralitoral. La especie es muy abundante en todo el archipiélago de Azores donde vive desde fondos muy someros hasta 50 m de profundidad (ejemplares recogidos vivos). Algunas conchas estudiadas proceden de hasta 60 m, pero no corresponden con material fresco. En la bibliografía se indica que se ha encontrado vivo hasta una profundidad de 38 m y conchas hasta 360 m (MARTINS *ET AL.*, 2009). Ocupa todo tipo de fondos rocosos infralitorales, siendo poco frecuente en el cinturón de algas del mesolitoral y en las pequeñas lagunas costeras de las islas como la de Lajes do Pico, en Pico (Fig. 25). Sin embargo, es una de las especies más abundantes en Azores en las algas fotófilas infralitorales (AZEVEDO, 1991: 23, 30-33); COSTA Y ÁVILA (1998) la consideran dominante sobre *Halopteris*. También se encuentra en enclaves de arena gruesa, constituidos por un detrito de origen volcánico, al menos en zonas situadas entre grandes bloques o en la base de acantilados rocosos. Este hábitat marginal lo comparte con el bivalvo *Ervilia castanea*, también abundantísimo en las islas (Fig. 31). Este tipo de hábitat es diferente al observado en *B. reticulatum* y *B. latreillii*, que aunque abundan en la arena retenida por las algas que cubren piedras o bloques rocosos, nunca se encuentran vivos en los detritos que quedan entre ellos, que tienen cúmulos de conchas y el sedimento está suelto. Este último tipo de hábitat es más parecido al de *B. submamillatum*. Se desconoce si la especie vive también en fondos detríticos o de cascajo, aunque es muy posible dado el amplio rango batimétrico que posee. MORTON (1990: 17, como *B. reticulatum*) cita a la especie en una plataforma rocosa cubierta de arena en el interior del islote de Vila Franca (S. Miguel, Azores). En la misma isla BULLOCK, TURNER Y FRALICK (1990: 47 y 54, como *B. reticulatum*) la citan sobre *Codium adhaerens* y sobre algas feofíceas.

La distribución de *B. nanum* se encuentra restringida exclusivamente a las islas Azores. Existen citas de todas las islas del archipiélago; ÁVILA (1998: 483) aporta una extensa recopilación de citas de las distintas islas. Para este trabajo se han estudiado muestras de casi todas ellas, en concreto de S. María, S. Miguel, Terceira, Pico, Faial y Flores, e incluso de los pequeños islotes llamados Formigas, situados entre S. Miguel y S. María, y en el Banco João de Castro que se encuentra entre las islas orientales (S. María y S. Miguel) y las centrales (Terceira, Graciosa, S. Jorge, Faial y Pico), donde ya había sido citada por ÁVILA Y AZEVEDO (1997) y por ÁVILA ET AL. (2004), respectivamente. Se creía que era la único representante del género *Bittium* presente en las islas Azores, pero recientemente MARTINS *et al.* (2009) ilustran un material profundo que parece corresponder al auténtico *B. latreillii*, especie que consideran muy rara, procedente de 180 m de profundidad frente a Vila Franca do Campo en la isla de São Miguel.

Lo más probable es que *B. nanum* sea una especie formada a partir de una antigua población de *B. latreillii* que quedara aislada en Azores. El origen europeo de la especie se ve apoyado por el estudio de GOFAS (1990: 123) sobre las familias Rissoidae y Anabathridae en Azores, en el que demuestra que la afinidad de la fauna de las islas es casi completa con la de las costas europeas, mientras no existen apenas elementos pertenecientes a la fauna norteamericana. Lo mismo ocurre con el resto de la flora y fauna del archipiélago según observaciones personales. Las islas Azores deben considerarse parte de la región biogeográfica Lusitana (BRIGGS, 1974: 208).

B. latreillii debió colonizar en épocas pasadas las islas Azores, gracias, probablemente a una circulación de corrientes superficiales diferente de la actual, quizá en esa época las islas se encontraran más cerca de Europa de lo que lo están ahora. Esta población, muy alejada del continente, debió sufrir un prolongado aislamiento reproductivo, acentuado en la actualidad por unas corrientes superficiales que impiden el contacto entre las poblaciones del continente y las de las islas Azores, en ambos sentidos. Este aislamiento ha producido la divergencia específica.

Según GOFAS (1990b: 123, fig. 13), los movimientos actuales de aguas superficiales de la zona están dominados por la corriente del Golfo, con dirección oeste-este que llega a las Azores y continúa hacia el norte de Europa. Las corrientes procedentes de las costas europeas tienen dirección sur hasta Madeira y Canarias, donde giran en dirección oeste pasando muy al sur de las Azores. El archipiélago queda en una zona central rodeado por corrientes que giran a su alrededor en el sentido de las agujas del reloj (anticiclón). Este movimiento del agua superficial es similar al atmosférico. Es muy conocido el anticiclón de las Azores, centrado sobre las islas, que con frecuencia se traduce en calmas de varios días, a pesar de estar en medio del océano.

Nota nomenclatural acerca de *Cerithiopsis tubercularis* var. *nana* Jeffreys, 1867

Como se ha mencionado anteriormente, *Cerithiopsis nana* Mayer, 1864 es homónimo primario de *Cerithiopsis tubercularis* var. *nana* Jeffreys, 1867 y, pese a ello, este último nombre está actualmente en uso para una especie taxonómicamente válida de la familia Cerithiopsidae. CECALUPO Y ROBBA

(2010) citan un buen número de referencias (entre ellas, VAN AARTSEN MENKHORST Y GITTENBERGER, 1984: 29, fig. 133; PALAZZI, 1994:. 79-80; CACHIA, MIFSUD Y SAMMUT, 1996: p. 132, pl. 14,fig. 1; GIRIBET Y PEÑAS, 1997: 50, fig. 25, 29) y es previsible que se reúnan las condiciones requeridas en el artículo 23.9 del CINZ sobre "inversión de precedencia", o sea al menos 25 citas del nombre por parte de al menos 10 autores en un espacio de tiempo no menor de 10 años en los últimos 50 años.

No obstante, aunque se contemple la inversión de precedencia, el nombre es a su vez homónimo secundario de *Cerithium tuberculare* var. *nanum* Wood, 1848 (*Crag Mollusca,* 1: 70, pl. 8, fig.5c), como ya ha sido notado por parte de varios autores anteriores (CECALUPO Y BUZZURRO, 2005: 134; LANDAU, LA PERNA Y MARQUET, 2006: 13). El nombre de Wood está en uso (SACCO, 1895: 66; REGTEREN ALTENA, BLOKLANDER Y POUDEROYEN, 1955: 30, pl. 6, fig. 64; MARQUET, 1997: 82; CLEVERINGA, MEIJER, VAN LEEUWEN, DE WOLF, POUWER, LISSENBERG Y BURGER, 2000: 204-205). Una solución más satisfactoria al problema nomenclatural, pero que se sale del ámbito del pesente trabajo, sería que *Cerithiopsis nana* Jeffreys fuera renombrada o, mejor, descrita como nuevo taxón.

AGRADECIMIENTOS

Mi más sincero agradecimiento a todas las personas que han colaborado de una forma u otra en el presente trabajo, como a José Templado, director de Tesis que me animó y ayudó en todo momento en el estudio del género *Bittium;* a Serge Gofas que siempre me apoyó y permitió realizar mis estancias en París, a Philippe Bouchet, Bernard Métivier, Pierre Lozouet y Virginia Héros del Muséum National d'Histoire Naturelle de París que facilitaron en todo momento los trabajo en el Laboratorio de Malacologie; a Sergio P. Ávila por su amistad y el envío de numerosa bibliografía e información sobre las islas Azores; a Mª Ángeles Ramos y Josefo Bedoya (tristemente fallecido) por su colaboración y obtención de las fotografías de Scanning en el Museo Nacional de Ciencias Naturales de Madrid; y a Nuria Martín Herrero por todo su apoyo y ayuda en los muestreos, incluido Lajes do Pico, en un viaje de bodas malacológico inolvidable. También se agradece a dos revisores anónimos las sugerencias y correcciones realizadas que han mejorado sustancialmente el trabajo.

BIBLIOGRAFÍA

ÁVILA S.P. 1998. Zonação intertidal de uma comunidade malacológica na "Poça de Barra", uma lagoa localizada na plataforma costeira da vila das Lajes do Pico, Açores. *Açoreana,* 8 (4): 457-485.

ÁVILA S.P. 2000. Shallow-water marine molluscs of the Azores: biogeographical ralationships. *Arquipélago. Life and Marine Sciences,* Suppl. 2 (Part A): 99-131.

ÁVILA S.P., AMEN R., AZEVEDO J.M.N., CACHÃO M. Y GARCÍA-TALAVERA F. 2002. Checklist of the Pleistocene marine mollusks of Praínha and Lagoínhas (Santa Maria Island, Azores). *Açoreana,* 9 (4): 343-370.

ÁVILA S.P. Y AZEVEDO J. M. N. 1997. Shallow-Water molluscs from the Formigas islets, Azores, collected during the 'Santa Maria e Formigas 1990' scientific expedition. *Açoreana,* 8 (3): 323-330.

ÁVILA S.P., AZEVEDO J.M.N., GONÇALVES J.M., FONTES J. Y CARDIGOS F. 1998. Checklist of the shallow-water marine molluscs of the Azores: 1- Pico, Faial, Flores and Corvo. *Açoreana,* 8 (4): 487-523.

ÁVILA S.P., AZEVEDO J.M.N., GONÇALVES J.M., FONTES J. Y CARDIGOS F. 2000. Checklist of the shallow-water marine molluscs of the Azores: 2- São Miguel Island. *Açoreana,* 9 (2): 139-173.

Ávila S.P., Cardigos F. y Santos R.S. 2004. D. João de Castro Bank, a shallow water hydrotermal-vent in the Azores: checklist of the marine molluscs. *Arquipélago.* Life and Marine Sciences, 21 (A): 75-80.

Ávila S.P., Cardigos F. y Santos R.S. 2007. Comparison of the community structure of the marine mollusks of the "Banco D. João de Castro" seamount (Azores, Portugal) with that of typical inshore habitats on the Azores archipelago. *Helgoland Marine Research*, 61: 43-53.

Ávila S.P., Santos A.C., Penteado A.M., Rodrigues A.M., Quintino I. y Machado M.I. 2005. The molluscs of the intertidal algal turf in the Azores. *Iberus,* 23 (1): 67-76.

Azevedo J.N. 1991. *Estudo das comunidades malacológicas fitais do litoral em São Miguel, Açores.* Universidade dos Açores, 75 pp.

Briggs J.C. 1974. *Marine zoogeography.* McGraw Hill, Inc. New York, 475 pp.

Bullock R.C., Turner R.D. y Fralick R.A. 1990. Species richness and diversity of algal-associated micromolluscan communities from São Miguel, Açores. En: Martins A.M.F. (Ed.). *The marine fauna and flora of the Azores. Açoreana Suplemento.* (Proceedings of the First International Workshop of Malacology, São Miguel, Azores, 1988): 39-58.

Cachia C., Mifsud C. y Sammut P.M. 1996. *The marine Mollusca of the Maltese Islands (Part Two: Neotaenioglossa).* Leiden, Backhuys Publishers, 228 pp.

Callapez P. y Soares A.F. 2000. Late Quaternary warm marine mollusks from Santa Maria (Azores) paleoecologic and paleobiogeographic considerations. *Ciencias da Terra,* 14: 313-322.

Cecalupo A. y Buzzurro G. 2005. *Cerithiopsis annae*: una nuova specie di Cerithiopsidae per le coste tunisine. *Bollettino Malacologico,* 40 (9-12): 132-135

Cecalupo A. y Robba E. 2010. The identity of *Murex tubercularis* Montagu, 1803 and description of one new genus and two new species of the Cerithiopsidae (Gastropoda: Triphoroidea). *Bollettino Malacologico,* 46 (2): 45-64.

Cleveringa P., Meijer T., van Leeuwen R.J.W., de Wolf H., Pouwer R., Lissenberg T. y Burger A.W. 2000. The Eemian stratotype locality at Amersfoort in the central Netherlands: a reevaluation of old and new data. *Geologie en Mijnbouw,* 79 (2/3): 197-216.

Costa A.C. y Avila S.P. 2001. Macrobenthic mollusc fauna inhabiting *Halopteris* spp. subtidal fronds in São Miguel island, Azores. *Scientia Marina,* 65 (2): 117-126.

Dautzenberg P. 1889. Contribution a la faune malacologique des Iles Açores. Résultats des dragages effectués par le yacht l'Hirondelle. *Résultats des Campagnes Scientifiques accomplies sur son yatch par Albert I de Monaco,* Fascicule 1, 112.

García-Talavera F. 1990. Fauna tropical en el Neotirreniense de Santa Maria (I. Azores). *Lavori S.I.M.,* 23: 439-443.

Giribet G. y Peñas A. 1997. Fauna malacológica del litoral del Garraf (NE de la Península Ibérica). *Iberus,* 15 (1): 41-93.

Gofas S. 1990. The littoral Rissoidae and Anabathridae of São Miguel, Azores. En Martins A.M.F. (Ed.): *The marine fauna and flora of the Azores. Açoreana Suplemento.* (Proceedings of the First International Workshop of Malacology, São Miguel, Azores, 1988): 97-134.

Houbrick R.S. 1993. Phylogenetic relationships and generic review of the Bittiinae (Prosobranchia: Cerithioidea). *Malacologia,* 35: 261-313.

Jeffreys J.G. 1885. On the mollusca procured during the *Lightning and Porcupine* expeditions. *Proceedings of the Zoological Society of London*: 27-63.

Johansson J. 1947. Über den offenen Uterus bei einigen Monotocardiern ohne Kopulationsorgan. *Zoologiska Bidrag fran Uppsala,* 25 102-110.

Landau B., La Perna R. y Marquet R. 2006. The Early Pliocene Gastropoda (Mollusca) of Estepona, southern Spain, Part 6: Triphoroidea, Epitonioidea, Eulimoidea. *Palaeontos,* 10: 1-96, pl. 1-22.

Mac Andrew R. 1857. Report on the marine testaceous Mollusca of the North-east Atlantic and neighbouring Seas, and the physical conditions affecting their development. *Report of the British Association for the Advancement of Science,* (1856): 101-158.

Marquet R. 1997. Pliocene gastropod faunas from Kallo (oost-Vlaanderen, Belgium) - Part 3. Caenogastropoda: Aporrhaidae to Muricidae, and Part 4. Buccinidae to Helicidae. *Contributions to Tertiary and Quaternary Geology,* 34: 69–149.

Martins A.M.F., Borges J.P., Ávila S.P., Costa A.C., Madeira P. y Morton B. 2009. Illustrated checklist of the infralittoral mollusks off Vila Franca do Campo. *Açoreana,* Suplemento 6 (Setembro): 15-103.

Mayer K. 1864. *Systematisches Verzeichniss der fossilen Reste von Madeira, Porto Santo und Santa Maria, nebst Beschreibung der neuen Arten.* Zürich (Reedition Brill/Backhuys, Leiden, 1988), I-VI, 109 pp.

Moreno D. 1998. *Sistemática y biología del género* Bittium *(Gastropoda, Prosobranchia) en la Península Ibérica.* Tesis Doctoral, Universidad Complutense de Madrid, inédita, 473 pp.

Morton B. 1990. The intertidal ecology of Ilheu de Vila Franca - a drowned volcanic crater in the Azores. En Martins A.M.F. (Ed.): *The marine fauna and flora of the Azores. Açoreana Suplemento.* (Proceedings of the First International Workshop of Malacology, São Miguel, Azores, 1988): 3-20.

MORTON B., BRITTON J.C. Y MARTINS A.M.F. 1998. *Ecologia Costeira dos Açores*. Sociedade Afonso Chaves, Ponta Delgada, x + 249 pp.

NOBRE A. 1924. Contribuçoes para a fauna dos Açores. *Anais do Instituto de Zoologia da Universidade do Porto*, 1: 41-90.

NORDSIECK F. 1976. Il genere *Bittium* Leach, 1847 nei mari d'Europa. *La Conchiglia*, 8 (93-94): 6-9.

NORDSIECK F. Y GARCÍA-TALAVERA F. 1979. *Moluscos marinos de Canarias y Madera (Gastropoda)*. Aula de Cultura Tenerife, 208 pp.

PALAZZI S. 1994. *Cerithiopsis nana* (Jeffreys, 1867) vivente su *Suberites*. *Bollettino Malacologico*, 30: 79-80.

REGTEREN ALTENA C.O. VAN, BLOKLANDER A. Y POUDEROYEN L.P. 1955. De fossile schelpen van de Nederlandse stranden en zeegaten, 2. *Basteria*, 19: 2736.

SACCO F. 1895. *I Molluschi dei terreni terziarii del Piemonte e della Liguria. Parte XVII (Cerithiidae, Triforidae, Cerithiopsidae e Diastomidae)*. Torino, Carlo Clausen, 83 pp, 3 pls.

VAN AARTSEN J.J.; MENKHORST H.P.M.G. Y GITTENBERGER E. 1984. The marine Mollusca of the Bay of Algeciras, Spain, with general notes on *Mitrella*, Marginellidae and Turridae. *Basteria*, supplement 2: 1-135.

VERDUIN A. 1976. On characters, variability, and distribution of the Europaean marine gastropods *Bittium latreillii* (Payraudeau) and *Bittium lacteum* (Philippi). *Basteria*, 40: 133-142.

WATSON R.B. 1897. On the Marine Mollusca of Madeira. *Linnean Journal of Zoology*, 26: 233-329, 2 pls.

WOOD S.V. 1848. *A monograph of the Crag Mollusca, with descriptions of shells from the upper Tertiaries of the British Isles*. The Palaeontographical Society Monographs, London, 1-208 pp., 21 Pls.

ZBYSZEWSKY G. Y FERREIRA O.V. 1962. Étude géologique de l'île de Santa Maria (Açores). *Comunicações dos Serviços Geológicos de Portugal*, 46, 209–245.

NORMAS DE PUBLICACIÓN

- La revista *Iberus* publica artículos de fondo, notas y monografías que versen sobre cualquiera de los aspectos relacionados con la Malacología. Se entiende por artículo un trabajo de investigación de más de 5 páginas de texto, incluidas láminas, gráficos y tablas. Las notas son trabajos de menor extensión. Las monografías son trabajos sobre un tema único, de extensión superior a las 50 páginas de la revista y que serán publicadas, si procede, como un suplemento de *Iberus*. Los autores interesados en publicar monografías deberán ponerse previamente en contacto con el Editor de Publicaciones. Se entiende que el contenido de los manuscritos no ha sido publicado, ni enviado simultáneamente a otra revista para su consideración.
- Los manuscritos, así como toda la correspondencia relacionada con los mismos, deberán ser remitidos a: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, España y/o al correo electrónico <sgofas@uma.es>.
- El texto del trabajo podrá estar redactado en español, inglés, italiano, francés o portugués.
- Los artículos, notas y monografías deberán presentarse sobre DIN A-4, por una sola cara a doble espacio (incluyendo referencias, pies de figura y tablas), con al menos 3 centímetros de margen por cada lado. Los trabajos se entregarán por triplicado (original y dos copias) y se incluirá una versión en un CD, o bien remitida por correo electrónico, utilizando procesadores de texto en sus versiones de corrientes de Windows (pero no en el formato .docx de Word 2007, el habitual de Windows Vista) o Macintosh. En caso de autoría compartida, uno de los autores deberá hacerse responsable de toda la correspondencia.
- Junto con el trabajo debe incluirse una lista de al menos 4 posibles revisores del mismo, sin perjuicio de los que el propio Editor considere oportunos.
- Los manuscritos se presentarán de acuerdo al siguiente esquema:

Primera página. Deberá incluir un título conciso, pero sugerente del contenido del trabajo, así como una traducción al inglés del mismo (si el artículo no está escrito en inglés). Cuando sea preciso, deberá incluir referencia a familia o taxones superiores. A continuación figurarán, por este orden, el nombre y apellidos completos del autor o autores, las direcciones completas de los mismos, y un resumen del trabajo y su traducción al inglés. Dicho resumen deberá sintetizar, en conjunción con el título, tanto los resultados como las conclusiones del artículo; se sugiere una extensión de 100 a 200 palabras.

Páginas siguientes. Incluirán el resto del artículo, que debe dividirse en secciones precedidas por breves encabezamientos. Siempre que sea posible, se recomienda seguir el siguiente esquema: Introducción, Material y métodos, Resultados, Discusión, Conclusiones, Agradecimientos y Bibliografía. Si se emplean abreviaturas no habituales en el texto, deberán indicarse tras el apartado de Material y Métodos.

- Las notas breves deberán presentarse de la misma forma, pero sin resumen.
- Deberán evitarse notas a pie de página y referencias cruzadas. Deberán respetarse estrictamente los Códigos Internacionales de Nomenclatura Zoológica y Botánica (últimas ediciones). Cuando un taxón aparezca por primera vez deberá citarse su autor y fecha de su descripción. En el caso de artículos sistemáticos, cuando se den las sinonimias de los taxones, éstas deberán citarse COMPLETAS, incluyendo en forma abreviada la publicación donde fueron descritas, y la localidad tipo si es conocida entre corchetes, según el siguiente esquema (préstese especial cuidado a la puntuación):

Dendrodoris limbata (Cuvier, 1804)
Sinonimias
Doris limbata Cuvier, 1804, *Ann. Mus. Hist. Nat. Paris*, 4 (24): 468-469 [Localidad tipo: Marsella].
Doris nigricans Otto, 1823, *Nov. Act. Ac. Caes. Leop.-Car.*, 10: 275.

Dichas referencias no deberán incluirse en la lista de Bibliografía si es la única vez que se nombran en el texto. Si se incluyen una lista completa de referencias de un taxón inmediatamente tras éste, deberá seguirse el mismo esquema (sin incluir en Bibliografía las referencias que no se mencionen en otro lugar del texto).

- Sólo los nombres en latín y los de taxones genéricos y específicos deberán llevar subrayado sencillo o preferentemente ir en cursiva. En ningún caso deberá escribirse una palabra totalmente en letras mayúsculas, ni siquiera el Título. Las unidades a utilizar deberán pertenecer al Sistema Métrico Decimal, junto con sus correctas abreviaturas. En artículos escritos en castellano, en los números decimales sepárese la parte entera de la decimal por una coma inferior (,), NUNCA por un punto (.) o coma superior (').
- Las referencias bibliográficas irán en el texto con minúsculas o versalitas: Fretter y Graham (1962) o FRETTER Y GRAHAM (1962). Si son más de dos autores se deberán citar todos la primera vez que aparecen en el texto [Smith, Jones y Brown (1970)] empleándose *et al.* las siguientes veces [Smith *et al.* (1970)]. Si un autor ha publicado más de un trabajo en un año se citarán con letras: (Davis, 1989a; Davis, 1989b). No deberá emplearse op. cit. La lista de referencias deberá incluir todas las citas del texto y sólo éstas, ordenadas alfabéticamente. Se citarán los nombres de todos los autores de cada referencia, sea cual sea su número. Los nombres de los autores deberán escribirse, en letras minúsculas o Versalitas. No deberán incluirse referencias a autores cuando éstos aparezcan en el texto exclusivamente como autoridades de un taxón. Los nombres de las publica-

ciones periódicas deberán aparecer COMPLETOS, no abreviados. Cuando se citen libros, dése el título, editor, lugar de publicación, nº de edición si no es la primera y número total de páginas. Deberán evitarse referencias a Tesis Doctorales u otros documentos inéditos de difícil consulta. Síganse los siguientes ejemplos (préstese atención a la puntuación):

Fretter V. y Graham A. 1962. *British Prosobranch Molluscs*. Ray Society, London, 765 pp.

Ponder W.F. 1988. The Truncatelloidean (= Rissoacean) radiation - a preliminary phylogeny. En Ponder, W.F. (Ed.): Prosobranch Phylogeny. *Malacological Review*, suppl. 4: 129-166.

Ros J. 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoológica*, 3 (5): 21-51.

- Las gráficas e ilustraciones deberán ser originales y presentarse preferentemente en formato electrónico al formato de caja de la revista o proporcional a éste. Este formato es de 57 mm (una columna) o 121 mm (dos) de anchura y hasta 196 mm de altura, si bien se recomienda utilizar el formato a dos columnas. Es importante que todas las figuras sean remitidas en su formato original (por ejemplo, las fotografías en .jpg de alta calidad o .tif, las gráficas en hojas de cálculo Excel o documentos de CorelDraw), puesto que las ilustraciones insertadas en el manuscrito WORD son inservibles en la fase de imprenta. Las imágenes digitales deben ser formateadas en su tamaño de impresión con una resolución mínima de 300 ppp para imágenes en color o escala de grises y de 600 ppp para las de blanco y negro. Considérese la reducción que será necesaria a la hora de decidir el tamaño de las escalas o letras en las figuras, que no deberán bajar de los 2 mm. En figuras compuestas, cada parte deberá etiquetarse con letras mayúsculas, el resto de las letras deberán ser minúsculas. Las escalas de dibujos y fotografías deberán ser gráficas, utilizando unidades del sistema métrico decimal; no deberán hacerse referencias a los aumentos de una determinada ilustración, ya que éstos cambian con la reducción. En su caso, se recomienda la utilización de mapas con proyección UTM. Cada figura, gráfica o ilustración deberá presentarse en hojas separadas y con numeración arábiga (1, 2, 3,...), sin separar "Figuras" y "Láminas". Los pies de figura, en una hoja aparte, deberán acompañarse de su traducción al inglés (o español si el inglés es la lengua del trabajo). Utilícese el esquema siguiente:

Figura 1. *Neodoris carvi*. A: animal desplazándose; B: detalle de un rinóforo; C: branquia.

Las abreviaturas empleadas en las ilustraciones deberán incluirse en los pies de figura.

Los autores interesados en incluir láminas en color deberán consultar con el editor y sufragar el sobrecoste con una contribución de 30 € por página. Por lo demás, deberán ajustarse a los mismos requisitos indicados para las figuras.

Si se pretende enviar gráficas o ilustraciones en impresión de papel es imprescindible presentar originales de buena calidad. Las imágenes en semitonos deben estar bien contrastadas y ajustarse al tamaño definitivo de impresión; al componer fotografías sobre una hoja, procúrese que los espacios entre ellas sean regulares y que estén debidamente alineadas. Téngase en cuenta que incluir fotografías de distinto contraste en una misma página conlleva una pobre reproducción final. Las gráficas de ordenador deberán imprimirse con impresora láser sobre papel de buena calidad.

- Las Tablas se presentarán en hojas separadas, siempre con numeración romana (I, II, III,...). Las leyendas se incluirán en una hoja aparte acompañándose de una traducción al inglés. Deberán evitarse las tablas particularmente complejas. Se recomienda reducir el número y extensión de ilustraciones, láminas o tablas al mínimo necesario.
- Los artículos que no se ajusten a las normas de publicación serán devueltos al autor con las indicaciones de los cambios necesarios.
- El Comité Editorial comunicará al autor responsable del trabajo la fecha de recepción del trabajo y la fecha de envío a revisión. Cada original recibido será sometido a revisión por al menos dos investigadores. El Comité Editorial, a la vista de los informes de los revisores decidirá sobre la aceptación o no de cada manuscrito. El autor recibirá en cada caso copia de los comentarios de los revisores sobre su artículo. En caso de aceptación, el mismo Comité Editorial, si lo considera conveniente, podrá solicitar a los autores otras modificaciones que considere oportunas. Si el trabajo es aceptado, el autor deberá enviar una copia impresa del mismo corregida, acompañada por una versión en un CD, utilizando procesadores de texto en sus versiones corrientes de Windows (pero no el formato .docx generado por Word 2007, el habitual de Windows Vista) o Macintosh. La fecha de aceptación figurará en el artículo publicado.
- Las pruebas de imprenta serán enviadas por correo electrónico al autor responsable, exclusivamente para la corrección de erratas, y deberán ser devueltas en un plazo máximo de una semana. Se recomienda prestar especial atención en la corrección de las pruebas.
- De cada trabajo se entregarán gratuitamente 50 separatas, además de una versión electrónica en formato .pdf. Aquellos autores que deseen un número mayor, deberán hacerlo constar al devolver las pruebas de imprenta, y nunca posteriormente. El coste de las separatas adicionales será cargado al autor.

INSTRUCTIONS TO AUTHORS

- *Iberus* publishes research papers, notes and monographs devoted to the various aspects of Malacology. Papers are manuscripts of more than 5 typed pages, including figures and tables. Notes are shorter papers. Monographs should exceed 50 pages of the final periodical, and may be published as Supplements. Authors wishing to publish monographs should contact the Editor. Manuscripts are considered on the understanding that their contents have not been published or simultaneously submitted for publication elsewhere.
- Manuscripts and correspondence regarding editorial matters must be sent to: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, Spain and/or to the e-mail <sgofas@uma.es>.
- Manuscripts may be written in Spanish, English, Italian, French or Portuguese.
- Manuscripts must be typed double spaced (including the references, figure captions and tables) on one side on A-4 (297x210 mm) with margins of at least 3 cm. An original and two copies must be submitted, together with a CD or e-mail remittance containing the article written with a current Windows (but not .docx format generated by Word 2007, mainly used with Windows Vista) or Macintosh word processor. When a paper has joint authorship, one author must accept responsibility for all correspondence.
- The authors must include a list of at least 4 possible referees; the Editor can choose any others if appropriate.
- Papers should conform the following layout:

First page. This must include a concise but informative title, with mention of family of higher taxon when appropriate, and its Spanish translation. It will be followed by all authors' names and surnames, their full address(es), an abstract (and its Spanish translation) not exceeding 200 words which summarizes not only contents but results and conclusions.

Following pages. These should content the rest of the paper, divided into sections under short headings. Whenever possible the text should be arranged as follows: Introduction, Material and methods, Results, Discussion, Conclusions, Acknowledgements and References. Unusual abbreviations used in the text must be grouped in one alphabetic sequence after the Material and methods section.

- Notes should follow the same layout, without the abstract.
- Footnotes and cross-references must be avoided. The International Codes of Zoological and Botanical Nomenclature must be strictly followed. The first mention in the text of any taxon must be followed by its authority including the year. In systematic papers, when synonyms of a taxon are given, they must be cited IN FULL, including the periodical, in an abbreviate form, where they were described, and the type localities in square brackets when known. Follow this example (please note the punctuation):

Dendrodoris limbata (Cuvier, 1804)
Synonyms
Doris limbata Cuvier, 1804, *Ann. Mus. Hist. Nat. Paris*, 4 (24): 468-469 [Type locality: Marseille].
Doris nigricans Otto, 1823, *Nov. Act. Ac. Caes. Leop.-Car.*, 10: 275.

These references must not be included in the Bibliography list, except if referred to elsewhere in the text. If a full list of references of the taxon is to be given immediately below it, the same layout should be followed (also excluding from the Bibliography list those which are not cited elsewhere).

Only Latin words and names of genera and species should be underlined once or be given in italics. No word must be written in UPPER CASE LETTERS. SI units are to be used, together with their appropriate symbols. In Spanish manuscripts, decimal numbers must be separated with a comma (,), NEVER with a point (.) or upper comma (').

- References in the text should be written in small letters or Small capitals: Fretter and Graham (1962) or FRETTER AND GRAHAM (1962). The first mention in the text of a paper with more than two authors must include all of them [Smith, Jones and Brown (1970)], thereafter use *et al.* [Smith *et al.* (1970)]. If an author has published more than one paper per year, refer to them with letters: (Davis, 1989a; Davis, 1989b). Avoid op. cit.

The references in the reference list should be in alphabetical order and include all the publications cited in the text but only these. ALL the authors of a paper must be included. These should be written in small letters or Small capitals. The references need not be cited when the author and date are given only as authority for a taxonomic name. Titles of periodicals must be given IN FULL, not abbreviated. For books, give the title, name of publisher, place of publication, indication of edition if not the first and total number of pages. Keep references to doctoral theses or any other unpublished documents to an absolute minimum. See the following examples (please note the punctuation):

Fretter V. and Graham A. 1962. *British Prosobranch Molluscs*. Ray Society, London, 765 pp.

Ponder W.F. 1988. The Truncatelloidean (= Rissoacean) radiation - a preliminary phylogeny. In Ponder W.F. (Ed.): Prosobranch Phylogeny. *Malacological Review*, suppl. 4: 129-166.

Ros J. 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoológica*, 3 (5): 21-51.

- Figures must be original and provided preferably in electronic format and adjusted to page format and column size. These should be one column (57 mm) or two columns (121 mm) wide and up 196 mm high, or be proportional to these sizes. Two columns format is recommended. It is essential that all figures be supplied in their original format (e.g. photographs as high-grade .jpg or as .tif files, graphs as Excel spreadsheets or Corel-Draw files), as the files inserted into WORD documents cannot be used for printing. Digital images must be given their final printing size with a resolution at least 300 dpi for colour and halftones, and at least 600 dpi for black/white.

Take into account possible reduction in lettering drawings; final lettering must be at least 2 mm high. In composite drawings, each figure should be given a capital letter; additional lettering should be in lower-case letters. A scale line, labelled with SI units, must be used to indicate size; magnification ratio must be avoided as it may be changed during printing. UTM maps are to be used if necessary. Figures must be submitted on separate sheets, and numbered with consecutive Arabic numbers (1, 2, 3,...), without separating 'Plates' and 'Figures'. Legends for Figures must be typed in numerical order on a separate sheet, and a Spanish translation must be included. Follow this example (please note the punctuation):

Figure 1. *Neodoris carvi*. A: animal crawling; B: rhinophore; C: gills.

If abbreviations are to be used in illustrations, they should be included in the figure captions.

Authors wishing to publish illustrations in colour should consult with the editor and will be charged a contribution of 30 € per page. They should otherwise follow the same standards as black and white prints.

If the authors want to send Figures in printed format, it is essential to supply good quality originals. Half-tone images must be of good contrast, and should be submitted in the final printing size. When mounting photographs in a block, ensure spacers are of uniform width. Remember that grouping photographs of varied contrast results in poor reproduction. Computer graphics must be printed on high quality white paper with a laser printer.

- Tables must be numbered with Roman numbers (I, II, III,...) and each typed on a separate sheet. Headings should be typed on a separate sheet, together with their English translation. Complex tables should be avoided. As a general rule, keep the number and extension of illustrations and tables as reduced as possible.
- Manuscripts that do not conform to these instructions will be returned for correction before reviewing.
- Authors submitting manuscripts will receive an acknowledgement of receipt, including receipt date, and the date the manuscript was sent for reviewing. Each manuscript will be critically evaluated by at least two referees. Based of these evaluations, the Editorial Board will decide on acceptance or rejection. Anyway, authors will receive a copy of the referees' comments. If a manuscript is accepted, the Editorial Board may indicate additional changes if desirable. Acceptable manuscripts will be returned to the author for consideration of comments and criticism; a finalized manuscript must then be returned to the Editor, together with a CD containing the article written with current Windows (but not a .docx format generated by Word 2007, mainly used under Windows Vista) or Macintosh word processor. Dates of reception and acceptance of the manuscript will appear in all published articles.
- Proofs will be e-mailed to the author for correcting errors and must be returned corrected within one week. At this stage no stylistic changes will be accepted. Pay special attention to references and their dates in the text and the Bibliography section, and also to numbers of Figures and Tables appearing in the text.
- Fifty reprints per article and a .pdf file will be supplied free of charge. Additional reprints must be ordered when the page proofs are returned, and will be charged at cost. NO LATER orders will be accepted.

La Sociedad Española de Malacología

Junta Directiva desde el 11 de octubre de 2005

Presidente	José Templado González
Vicepresidente	Emilio Rolán Mosquera
Secretaria	María Carmen Salas Casanovas
Tesorero	Luis Murillo Guillén
Editor de Publicaciones	Serge Gofas
Bibliotecario	Rafael Araujo Armero
Vocales	Ramon M. Álvarez Halcon Benjamín Gómez Moliner Alberto Martínez Ortí Diego Moreno Lampreave José Ramón Arrébola Burgos

La *Sociedad Española de Malacología* se fundó el 21 de agosto de 1980. La sociedad se registró como una asociación sin ánimo de lucro en Madrid (Registro Nº 4053) con unos estatutos que fueron aprobados el 12 de diciembre de 1980. Esta sociedad se constituye con el fin de fomentar y difundir los estudios malacológicos mediante reuniones y publicaciones. A esta sociedad puede pertenecer cualquier persona o institución interesada en el estudio de los moluscos.

Sede social: Museo Nacional de Ciencias Naturales, c/ José Gutierrez Abascal 2, 28006 Madrid, España.

Cuotas para 2011:

Socio numerario	(en España):	40 euros
	(en Europa)	40 euros
	(fuera de Europa):	48 euros
Socio estudiante	(en España):	23 euros
	(en el extranjero):	29 euros
Socio Familiar:	(sin recepcion de revista)	4 euros
Socio Protector:	(mínimo)	48 euros
Socio Corporativo	(en Europa):	48 euros
	(fuera de Europa):	54 euros

Inscripción: 6 euros, además de la cuota correspondiente.

A los socios residentes en España se les aconseja domiciliar su cuota. Todos los abonos deberán enviarse al Tesorero (dirección reseñada anteriormente) el 1 de enero de cada año. Los abonos se harán sin recargos para la sociedad y en favor de la *Sociedad Española de Malacologia* y no de ninguna persona de la junta directiva. Aquellos socios que no abonen su cuota anual dejarán de recibir las publicaciones de la Sociedad. Los bonos de inscripción se enviarán junto con el abono de una cuota anual al Tesorero.

A los residentes en el extranjero se les ruega que abonen su cuota mediante giro postal en euros (international postal money orders in euros sent to the Treasurer). Members living in foreing countries can deduce 6 euros if paid before 15 April.

Cada socio tiene derecho a recibir anualmente los números de *Iberus, Reseñas Malacológicas* y *Noticiarios* que se publiquen.

ÍNDICE

Iberus 29 (1) 2011

SCUDERI D. E CRISCIONE F. *Cima apicisbelli* Rolán, 2003 (Gastropoda: Cimidae): nuovo immigrante in Mediterraneo o specie autoctona?
Cima apicisbelli *Rolán, 2003 (Gastropoda: Cimidae): ¿nuevo inmigrante en el Mediterraneo o especie autoctona?* 1-7

OLIVER J.D. AND ROLÁN E. The family Tornidae (Gastropoda, Rissooidea) in the East Atlantic, 2. Circulinae
La familia Tornidae (Gastropoda, Rissooidea) en el Atlántico oriental, 2. Circulinae .. 9-33

CAMPANI E., BOGI C. AND GALIL B.S. First Mediterranean record of *Diaphana marshalli* (Sykes, 1904) (Gastropoda, Diaphanidae) - a rare bathyal species
Primera cita para el Mediterráneo de Diaphana marshalli *(Sykes, 1904) (Gastropoda, Diaphanidae) - una especie rara del batial* 35-38

DE MATTIA W. AND MASCIA F. *Otala punctata* (O.F. Müller, 1774) (Stylommatophora: Helicidae) in Italy
Otala punctata *(O.F. Müller, 1774) (Stylommatophora: Helicidae) en Italia* 39-46

TIRADO C., RUEDA J.L. AND CARMEN SALAS C. Reproduction of *Donax trunculus* in the littoral of Huelva (southern Atlantic Spain): is there any difference with the Mediterranean population from the Andalusian coast?
Reproducción de Donax trunculus *en el litoral de Huelva (suroeste Atlántico de España): ¿hay diferencias con la población mediterránea de la costa andaluza?* 47-57

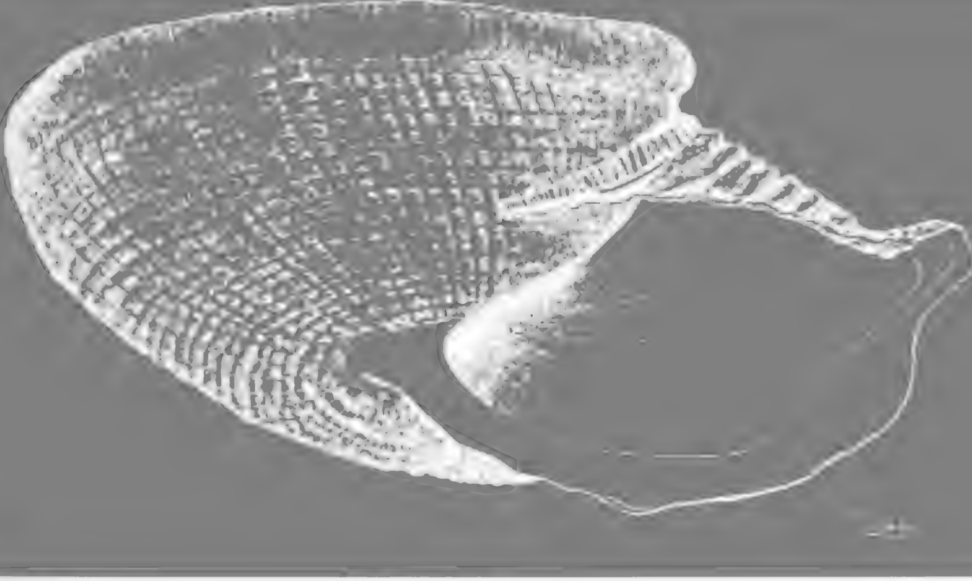
MORENO D. *Bittium nanum* (Gastropoda, Cerithiidae), una especie válida de las islas Azores
Bittium nanum *(Gastropoda, Cerithiidae), a valid species from the Azores Islands* 59-74

ISSN 0212-3010

Iberus

Vol. 29 (2)

REVISTA DE LA
SOCIEDAD ESPAÑOLA DE MALACOLOGÍA



Vigo, diciembre 2011

Iberus

Revista de la
SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

COMITÉ DE REDACCIÓN *(BOARD OF EDITORS)*

EDITOR DE PUBLICACIONES *(EDITOR-IN-CHIEF)*

Serge Gofas	Universidad de Málaga, España

DIRECTOR DE REDACCIÓN *(EXECUTIVE EDITOR)*

Gonzalo Rodríguez Casero	Mieres del Camino, Asturias, España

EDITORA EJECUTIVA *(MANAGING EDITOR)*

Eugenia Mª Martínez Cueto-Felgueroso	Mieres del Camino, Asturias, España

EDITORES ADJUNTOS *(ASSOCIATE EDITORS)*

Francisco Javier Conde de Saro	Embajada de España, Japón
Benjamín Gómez Moliner	Universidad del País Vasco, Vitoria, España
Ángel Antonio Luque del Villar	Universidad Autónoma de Madrid, Madrid, España
Emilio Rolán Mosquera	Universidad de Vigo, Vigo, España
José Templado González	Museo Nacional de Ciencias Naturales, CSIC, Madrid, España
Jesús S. Troncoso	Universidad de Vigo, Vigo, España

COMITÉ EDITORIAL *(BOARD OF REVIEWERS)*

Kepa Altonaga Sustacha	Universidad del País Vasco, Bilbao, España
Eduardo Angulo Pinedo	Universidad del País Vasco, Bilbao, España
Rafael Araujo Armero	Museo Nacional de Ciencias Naturales, Madrid, España
Thierry Backeljau	Institut Royal des Sciences Naturelles de Belgique, Bruselas, Bélgica
Rüdiger Bieler	The Field Museum, Chicago, Estados Unidos
Sigurd v. Boletzky	Laboratoire Arago, Banyuls-sur-Mer, Francia
Jose Castillejo Murillo	Universidad de Santiago de Compostela, Santiago de Compostela, España
Karl Edlinger	Naturhistorisches Museum Wien, Viena, Austria
Antonio M. de Frias Martins	Universidade dos Açores, Açores, Portugal
José Carlos García Gómez	Universidad de Sevilla, Sevilla, España
Gonzalo Giribet de Sebastián	Harvard University, EE.UU.
Edmund Gittenberger	National Natuurhistorisch Museum, Leiden, Holanda
Ángel Guerra Sierra	Instituto de Investigaciones Marinas, CSIC, Vigo, España
Gerhard Haszprunar	Zoologische Staatssammlung München, München, Alemania
Yuri I. Kantor	A.N. Severtzov Institute of Ecology and Evolution, Moscú, Rusia
María Yolanda Manga González	Estación Agrícola Experimental, CSIC, León, España
Jordi Martinell Callico	Universidad de Barcelona, Barcelona, España
Ron K. O'Dor	Dalhousie University, Halifax, Canada
Takashi Okutani	Nihon University, Fujisawa City, Japón
Marco Oliverio	Universitá di Roma "La Sapienza", Roma, Italia
Pablo E. Penchaszadeh	Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina
Winston F. Ponder	Australian Museum, Sydney, Australia
Carlos Enrique Prieto Sierra	Universidad del País Vasco, Bilbao, España
Mª de los Ángeles Ramos Sánchez	Museo Nacional de Ciencias Naturales, CSIC, Madrid, España
Francisco Javier Rocha Valdés	Instituto de Investigaciones Marinas, CSIC, Vigo, España
Paul G. Rodhouse	British Antarctic Survey, Cambridge, Reino Unido
Joandomènec Ros i Aragones	Universidad de Barcelona, Barcelona, España
María Carmen Salas Casanovas	Universidad de Málaga, Málaga, España
Gerhard Steiner	Institut für Zoologie der Universität Wien, Viena, Austria
Victoriano Urgorri Carrasco	Universidad de Santiago de Compostela, Santiago de Compostela, España
Anders Warén	Swedish Museum of Natural History, Estocolmo, Suecia

PORTADA DE *Iberus*

Iberus gualtieranus (Linnaeus, 1758), una especie emblemática de la península Ibérica, que da nombre a la revista. Dibujo realizado por José Luis González Rebollar "Toza".

Iberus

REVISTA DE LA
SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

Vol. 29 (2) **Vigo, diciembre 2011**

Iberus

Revista de la

SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

Iberus publica trabajos que traten sobre cualquier aspecto relacionado con la Malacología. Se admiten también notas breves. *Iberus* edita un volumen anual que se compone de dos o más números.

INSTRUCCIONES PARA LOS AUTORES

Los manuscritos deben remitirse a: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, España.

Los trabajos se entregarán por triplicado (original y dos copias). Se recomienda a los autores leer cuidadosamente las normas de publicación que se incluyen en cada número de la revista.

SUBCRIPCIONES

Iberus puede recibirse siendo socio de la Sociedad Española de Malacología, en cualquiera de sus formas, o mediante intercambio. Aquellos socios que deseen adquirir números atrasados deberán dirigirse al bibliotecario.

Los no socios deberán ponerse en contacto con BACKHUYS PUBLISHERS, P.O. Box 321, 2300 AH Leiden, The Netherlands. Tel.: +31-71-51 70 208, Fax: +31-71-51 71 856, Correo Electrónico: backhuys@euronet.nl

Los resumenes de los artículos editados en esta revista se publican en Aquatic Science and Fisheries Abstracts (ASFA) y en el Zoological Records, BIOSIS.

Contents list published in Aquatic Science and Fisheries Abstracts and Zoological Records, BIOSIS.

Dep. Leg. B-43072-81
ISSN 0212-3010

THE FAMILY TORNIDAE (GASTROPODA, RISSOOIDEA) IN THE CARIBBEAN AND NEIGHBORING AREAS

LA FAMILIA TORNIDAE (GASTROPODA, RISSOOIDEA) EN EL CARIBE Y ÁREAS VECINAS

Federico RUBIO
Pintor Ribera, 4-16ª
46930 Quart de Poblet
(Valencia), Spain
e-mail: federubio@ono.com

Raúl FERNÁNDEZ-GARCÉS
Centro de Estudios Ambientales de Cienfuegos (CEAC),
División de Gestión Ambiental (DGA),
calle 17, esquina Ave. 46,
Cienfuegos, Cuba

&

Emilio ROLÁN
Museo de Historia Natural,
Campus Universitario Sur,
15782, Santiago de Compostela, Spain
e-mail: erolan@emiliorolan.com

INDEX OF SPECIES:

Iberus 29 (2) 2011

FAMILY TORNIDAE

GENUS *CIRCULUS*

PLATES	SPECIES	PAGE
1	*Circulus semisculptus* (Olsson & McGinty, 1958)	6
2	*Circulus orbignyi* Fischer, 1857	8
3	*Circulus liratus* (A.E. Verrill, 1882)	10
4	*Circulus texanus* (Moore, 1965)	11

GENUS *TEINOSTOMA*

PLATES	SPECIES	PAGE
5	*Teinostoma ciskae* Faber, 1995	15
6	*Teinostoma goniogyrus* Pilsbry & McGinty, 1945	16
7	*Teinostoma lenticulare* (H. C. Lea, 1846)	19
8, 9	*Teinostoma reclusum* (Dall, 1889)	21
10	*Teinostoma baldingeri* spec. nov	24
11	*Teinostoma incertum* Pilsbry & McGinty, 1945	24
12	*Teinostoma anastomosis* spec. nov. Rubio, Rolán & Lee	27
13	*Teinostoma panamense* spec. nov. Rubio, Rolán & Lee	29
14	*Teinostoma biscaynense* Pilsbry & McGinty, 1945	29
15	*Teinostoma obtectum* Pilsbry & McGinty, 1945	33
16	*Teinostoma expansum* spec. nov	34
17	*Teinostoma nesaeum* Pilsbry & McGinty, 1945	36
18, 19	*Teinostoma semistriatum* (d'Orbigny, 1842)	38
20	*Teinostoma minusculum* (Bush, 1897)	41
21	*Teinostoma lerema* Pilsbry & McGinty, 1945	43
22	*Teinostoma umbilicatum* (H. C. Lea, 1843)	44
23	*Teinostoma altum* Pilsbry, 1953	46
24	*"Teinostoma" solidum* (Dall, 1889)	48
25	*Teinostoma lunense* spec. nov.	50
26	*Teinostoma cocolitoris* Pilsbry & McGinty, 1945	50
27	*Teinostoma helicinum* spec. nov.	53
28	*Teinostoma megastoma* (C.B. Adams, 1850)	54
29	*Teinostoma cienfuegosense* spec. nov.	56
30	*Teinostoma parvicallum* Pilsbry & McGinty, 1945	57
31	*Teinostoma megacallum* spec. nov.	59
32	*Teinostoma carinicallus* Pilsbry & McGinty, 1946	61
	Teinostoma lituspalmarum Pilsbry & McGinty, 1945	61

GENUS *TORNUS*

PLATES	SPECIES	PAGE
33	*Tornus caraboboensis* (Weisbord, 1962)	63
34	*Tornus schrammii* (P. Fischer, 1857)	64

GENUS *ANTICLIMAX*

PLATES	SPECIES	PAGE
35	*Anticlimax crassilabris* (Aguayo & Borro, 1946)	68
36	*Anticlimax glabra* spec. nov. Rubio, Rolán & Pelorce	70
37	*Anticlimax decorata* Rolán, Fernández-Garcés & Rubio, 1997	70

37 *Anticlimax proboscidea* (Aguayo, 1949) 73
38 *Anticlimax pilsbryi* (McGinty, 1945) 73
39 *Anticlimax locklini* Pilsbry & Olsson, 1950 74
40 *Anticlimax annae* Pilsbry & Olsson, 1950 76
41 *Anticlimax hispaniolensis cratera* Pilsbry & Olsson, 1950 78

GENUS *AOROTREMA*

42 *Aorotrema cistronium* (Dall, 1889) 80
Aorotrema pontogenes (Schwengel & McGinty, 1942) 81

GENUS *CYCLOSTREMISCUS*

43 *Cyclostremiscus beauii* (P. Fischer, 1857) 84
44 *Cyclostremiscus multiliratus* spec. nov. Rubio, Rolán & Garcia 86
45 *Cyclostremiscus dalli* (Bush, 1897) 88
46 *Cyclostremiscus pentagonus* (Gabb, 1873) 88
47 *Cyclostremiscus trilix* (Bush, 1885) 91
48 *Cyclostremiscus hendersoni* (Dall, 1927) 93
49 *Cyclostremiscus bartschi* (Mansfield, 1936) 95
50 *Cyclostremiscus jeannae* Pilsbry & McGinty, 1946 97
51 *Cyclostremiscus suppressus* (Dall, 1889) 97
52 *Cyclostremiscus vanbruggeni* de Jong & Coomans, 1988 100
53 *Cyclostremiscus diminutus* spec. nov. Rubio, Rolán & Pelorce 100
54 *Cyclostremiscus cubanus* (Pilsbry & Aguayo, 1933) 103
55 *Cyclostremiscus euglyptus* Aguayo & Borro, 1946 105
56 *Cyclostremiscus microstriatus* spec. nov. Rubio, Rolán & Lee 105

GENUS *COCHLIOLEPIS*

57 *Cochliolepis adamsii* (Fischer, 1857) 108
58 *Cochliolepis holmesii* (Dall, 1889) 109
59 *Cochliolepis nautiliformis* (Holmes, 1859) 112
60, 61, 62 *Cochliolepis parasitica* Stimpson, 1858 112
63 *Cochliolepis striata* Dall, 1889 118
64 *Cochliolepis planispiralis* spec. nov. 118
65 *Cochliolepis patricioi* spec. nov. Rubio, Rolán & Lee 120
66 *Cochliolepis differens* spec. nov. Rubio, Rolán & Lee 123
67 *Cochliolepis* sp 123

GENUS *EPISCYNIA*

68 69 *Episcynia inornata* (d'Orbigny, 1842) 126

GENUS *PARVITURBOIDES*

70, 71 *Parviturboides interruptus* (C.B. Adams, 1850) 129

GENUS *PLEUROMALAXIS*

72 *Pleuromalaxis balesi* (Pilsbry & McGinty, 1945) 133

GENUS *SOLARIORBIS*

73 *Solariorbis antillensis* de Jong & Coomans, 1988 135
73 *Solariorbis guianensis* Altena, 1966 135
74 *Solariorbis blakei* (Rehder, 1944) 137
75 *Solariorbis elegans* (Olsson & McGinty, 1958) 139
76, 77 *Solariorbis infracarinatus* (Gabb, 1881) 139
78 *Solariorbis mooreanus* (Vanatta, 1904) 143

79 *Solariorbis multistriatus* (A. E. Verrill, 1884) 145
80 *Solariorbis truncatus* (Gabb, 1881) 145
81 *Solariorbis schumoi* (Vanatta, 1913) 147
82 *Solariorbis semipunctus* Moore, 1965 149
83, 84 *Solariorbis terminalis* (Pilsbry & McGinty, 1946) 150
85 *Solariorbis ruris* spec. nov. 153
86 *Solariorbis lineopunctatus* spec. nov. 155
86 *Solariorbis* sp. 155
87 *Solariorbis punctostriatus* spec. nov. Rubio, Rolán & Lee 157
88, 89 *Solariorbis solidus* spec. nov. 159

GENUS *VITRINELLA*

90 *Vitrinella anneliesae* de Jong & Coomans, 1988 162
91 *Vitrinella contracta* (Vanatta, 1913) 164
92 *Vitrinella funiculus* (Dall, 1892) 165
93 *Vitrinella opsitelotus* (Dall, 1892) 167
94, 95 *Vitrinella helicoidea* C.B. Adams, 1850 167
96 *Vitrinella floridana* Pilsbry & McGinty, 1946 171
97 *Vitrinella canaliculata* spec. nov. 173
98 *Vitrinella aristata* spec. nov. 173
99 *Vitrinella pseudoaristata* spec. nov. 176
100 *Vitrinella pelorcei* spec. nov. 176
101 *Vitrinella aguayoi* (Corgan, 1968) 178
102 *Vitrinella calliglypta* Aguayo, 1949 181
103 *Vitrinella cupidinensis* Altena, 1966 181
104 *Vitrinella filifera* Pilsbry & McGinty, 1946 184
105 *Vitrinella solaris* nom. nov. 186

GENUS *VITRINORBIS*

106 *Vitrinorbis elegans* Olsson & McGinty, 1958 186

OTHER SPECIES

SPECIES NOT REPRESENTED IN OUR MATERIAL

Anticlimax schumoi (Vanatta, 1913) 189
Cochliolepis surinamensis Altena, 1966 189
Discopsis omalos (Folin, 1870) 189
Pleuromalaxis pauli Olsson & McGinty, 1958 190
Solariorbis hondurasensis (Vanatta, 1913) 190
107 *Solariorbis petitii* (P. Fischer, 1857) 190
Teinostoma avunculus Pilsbry,1953 191
Teinostoma morlierei Jousseaume, 1872 191
Teinostoma parvum (Stimpson, 1851) 192
108 *Vitrinella anomala* (d'Orbigny, 1842) 192
Vitrinella carinata (d'Orbigny, 1842) 192
Vitrinella hemphilli Vanatta, 1913 192
108G, 109 *Vitrinella pusilla* (L. Pfeiffer, 1840) 193
Vitrinella tryoni Bush, 1897 195

FOSSILS OR SUPPOSEDLY FOSSIL SPECIES, NOT RECENT

Anticlimax athleenae (Pilsbry & McGinty, 1946) 195

Aorotrema gardnerae Pilsbry, 1953 197
110 *Cyclostremiscus fargoi* Pilsbry, 1953 197
Cyclostremiscus gunteri (Mastfield, 1930) 197
Cyclostremiscus olssoni Pilsbry, 1953 197
Parviturboides avitus Pilsbry, 1953 197
111 *Solariorbis eugenes* Pilsbry, 1953 197
Teinostoma caloosaense Dall, 1892 199
Teinostoma tectispira Pilsbry, 1953 199

SPECIES FROM NEARBY OR RELATIVELY NEARBY AREAS

112 *Neusas marshalli* (Sykes, 1925) 199
113 *Ponderinella xacriaba* Absalão, 2009 200
Teinostoma abnorme E.A. Smith, 1890 200

SPECIES RECORDED ERRONEOUSLY FROM THE CARIBBEAN

Adeorbis elegans (A. Adams, 1850) 201
Vitrinella regularis (C.B. Adams, 1852) 201

SUPPLEMENT

DUBIOUS SPECIES, APPARENTLY NOT TORNIDAE

114 *Aorotrema erraticum* Pilsbry & McGinty, 1945 202
114 *Vitrinella tincta* C.B. Adams, 1850 202
115 *"Vitrinella" carinifex* Dall, 1927 202
Vitrinella cyclostomoides (Pfeiffer, 1840) 203
Vitrinella hyalina C.B. Adams, 1850 204

VITRINELLID SPECIES TRANSFERRED TO SUBFAMILY SKENEINAE IN THIS WORK

FAMILY TURBINIDAE

116 *Cirsonella floridensis* (Dall, 1927) 205
116 *Cirsonella georgiana* (Dall, 1927) 207
117 *Cirsonella margaritiformis* (Dall, 1927) 207
118 *Mikro cerion* (Dall, 1927) 208
119 *Xyloskenea rhyssa* (Dall, 1927) 210
120 *Xyloskenea translucens* (Dall, 1927) 211
"Vitrinella" massarita Dall, 1927 212

SPECIES THAT WERE INCLUDED IN TORNIDAE AND NOW BELONG TO OTHER FAMILIES

FAMILY TURBINIDAE

Ganesa proxima Tryon, 1888 215
Ganesa bushae Dall, 1927 215
Ganesa conica Dall, 1927 215
Ganesa depressa Dall, 1927 215
Ganesa valvata Dall, 1927 215
Ganesa diaphana A.E. Verrill, 1884 215
Ganesa striata Bush, 1897 215

Ganesa convexa Bush, 1897 215
Ganesa verrilli Tryon, 1888 215
Ganesa ornatam A.E. Verrill, 1884 215
Ganesa dalli A.E. Verrill, 1882 215
Ganesa abyssicola Bush, 1897 215
Granigyra limata Dall, 1889 216
Granigyra radiata Dall, 1927 216
Granigyra spinulosa Bush, 1897 216
121 *Dillwynella modesta* Dall, 1889 216
Molleriopsis abyssicola Bush, 1897 216
Molleriopsis sincera Dall, 1889 216
Leptogyra verrilli Bush, 1897 216
Leptogyra inconspicua Bush, 1897 216
Leptogyra eritmeta Bush, 1897 216

FAMILY LEPETELLIDAE

Choristella leptalea Bush, 1897 217
Choristella brychia Bush, 1897 217

FAMILY ODOSTOMIIDAE

Cyclostremella humilis Bush, 1897 217

© Sociedad Española de Malacología ——— Iberus, 29 (2):1-240 , 2011

The family Tornidae (Gastropoda, Rissooidea) in the Caribbean and neighboring areas

La familia Tornidae (Gastropoda, Rissooidea) en el Caribe y áreas vecinas

Federico RUBIO*, Raúl FERNÁNDEZ-GARCÉS** and Emilio ROLÁN***

Recibido el 28.04.2011. Aceptado el 26.09.2011

RESUMEN

Se estudian las especies del Caribe, incluidas en la familia Tornidae y que comprenden los géneros *Circulus, Teinostoma, Tornus, Anticlimax, Aorotrema, Cyclostremiscus, Cochliolepis, Episcynia, Parviturboides, Pleuromalaxis, Solariorbis, Vitrinella* y *Vitrinorbis,* sobre la base de unos 2700 ejemplares y conchas examinados. Los taxones estudiados de Tornidae son 101 en total, siendo 4 del género *Circulus*, 27 de *Teinostoma*, 2 de *Tornus*, 8 de *Anticlimax*, 2 de *Aorotrema*, 14 de *Cyclostremiscus*, 9 de *Cochliolepis*, 1 de *Episcynia*, 1 de *Parviturboides*, 1 de *Pleuromalaxis*, 16 de *Solariorbis*, 15 de *Vitrinella* y 1 de *Vitrinorbis*. De estas especies 23 son nuevas para la ciencia y se describen aquí: 8 en *Teinostoma*, 1 en *Anticlimax*, 3 en *Cyclostremiscus*, 3 en *Cochliolepis*, 4 en *Solariorbis* y 4 en *Vitrinella*. Se discuten las asignaciones a estos géneros y sus relaciones. Además, se aportan datos sobre 40 especies más, relacionadas en algún momento con la familia en estudio. Un nuevo nombre se propone para *"Cyclostrema" thomasi* Pilsbry, 1945, previamente ocupado.

Teinostoma nessaeum y *Teinostoma obtectum* son tratados como especies válidas, no sinónimos de *Teinostoma biscaynense*; *Cyclostremiscus trilix* no es sinónimo de *Cyclostremiscus pentagonus*; *Cyclostrema thomasi* no es sinónimo de *Vitrinella filifera*. Por el contrario, *Teinostoma clavium* es aquí considerada como sinónimo de *Teinostoma semistriatum*.

Se designan lectotipos para *Teinostoma reclusum, Teinostoma solidum, Parviturboides interruptus, Solariorbis petitii, Episcynia inornata* y *Cochliolepis parasitica*.

Se designan neotipos para *Teinostoma megastoma, Teinostoma semistriatum* y *Circulus* orbignyi.

Algunos tipos de las colecciones Dall y KJ Bush, todos en USNM, se fotografiaron por primera vez por SEM.

Del examen de los tipos de Dall (1927), llegamos a la conclusión de que un número de especies descritas en el mismo no son tornidos y sí skeneidos incluidos en los géneros *Cirsonella, Micro* y *Xyloskenea*.

ABSTRACT

The Caribbean species included within the family Tornidae in the genera *Circulus, Teinostoma, Tornus, Anticlimax, Aorotrema, Cyclostremiscus, Cochliolepis, Episcynia, Parvitur-*

---

* Pintor Ribera, 4-16ª, 46930 Quart de Poblet (Valencia), Spain e-mail: federubio@ono.com
** Centro de Estudios Ambientales de Cienfuegos (CEAC), División de Gestión Ambiental (DGA), calle 17, esquina Ave. 46, Cienfuegos, Cuba
*** Museo de Historia Natural, Campus Universitario Sur, 15782, Santiago de Compostela, Spain e-mail: erolan@emiliorolan.com

boides, Pleuromalaxis, Solariorbis, Vitrinella and *Vitrinorbis* are studied, based on about 2700 specimens and shells examined. There are a total of 101 species, including 4 in the genus *Circulus*, 27 in *Teinostoma*, 2 in *Tornus*, 8 in *Anticlimax*, 2 in *Aorotrema*, 14 in *Cyclostremiscus*, 9 in *Cochliolepis*, 1 in *Episcynia*, 1 in *Parviturboides*, 1 in *Pleuromalaxis*, 16 in *Solariorbis*, 15 in *Vitrinella*, and 1 in *Vitrinorbis*. Of all these species 23 are new and are described here: 8 in *Teinostoma*, 1 in *Anticlimax*, 3 in *Cyclostremiscus*, 3 in *Cochliolepis*, 4 in *Solariorbis*, and 4 in *Vitrinella*. The assignation of these species to these genera and their relationships are discussed. Furthermore, some information is given on 40 species more which have been related at times to the family studied. A new name is proposed for *"Cyclostrema" thomasi* Pilsbry, 1945, which is preoccupied.

Teinostoma nessaeum and *Teinostoma obtectum* are treated as valid species, not synonyms of *Teinostoma biscaynense*; *Cyclostremiscus trilix* is not a synonym of *Cyclostremiscus pentagonus*; *Cyclostrema thomasi* is not a synonym of *Vitrinella filifera*. Conversely, *Teinostoma clavium* is herein considered a synonym of *Teinostoma semistriatum*.

Lectotypes are here designated for *Teinostoma reclusum, Teinostoma solidum, Parviturboides interruptus, Solariorbis petitii, Episcynia inornata* and *Cochliolepis parasitica*.

Neotypes are designated for *Teinostoma megastoma, Teinostoma semistriatum,* and *Circulus* orbignyi.

Some types from the Dall and K.J. Bush collections, all in USNM, are photographed for the first time using SEM.

From the examination of Dall's (1927) types, we concluded that a number of species described therein are not tornids but skeneids included in the genera *Cirsonella, Micro* and *Xyloskenea*.

INTRODUCTION

The "vitrinellids" (Vitrinellidae Bush, 1897), here considered synonymous with Tornidae Sacco, 1896, are prosobranch molluscs generally living in shallow waters of tropical seas. In the Atlantic only *Tornus subcarinatus* (Montagu, 1803) and *Circulus striatus* (Philippi, 1836) live in the marine waters of Western Europe but there are many species known from the shores of West Africa (ADAM & KNUDSEN, 1969; ROLÁN & RUBIO, 2002; OLIVER & ROLÁN, 2011). There is no known case of anfiatlantism in species of the Tornidae family.

STIMPSON (1858) described the first vitrinellid for the malacological fauna of the SE United States: *Cochliolepis parasitica,* which was found alive under the scales of the giant scaly worm *Polydontes lupina*. GABB (1873, 1881) described several fossil species from the Miocene of Santo Domingo and the Pliocene of Costa Rica. Subsequently some of these species have been found living. *Circulus liratus* (A.E. Verrill, 1882) was described from north of Cape Hatteras, North Carolina

MOORE (1964) stated that no vitrinellids have been found south of Trinidad. Yet RIOS (1975, 1994) and DÍAZ MERLANO & PUYANA HEGEDUS (1994) mention several species from Brazil and Colombia respectively.

The supposed "vitrinellid" recorded alive in deeper water off the Azores by CLARKE (1962): *Teinostoma azorica* Dautzenberg & Fischer, 1896, was recently shown to be a turbinid. Its radula is rhipidoglossan, and its general characters are coincident with those of the Skeneinae species of the genera *Skenea* and *Dikoleps* (RUBIO & ROLÁN, 2009). Other vitrinellids collected in deep water such as *Circulus dalli* Bush (618 m), found very close to the north coast of Little Bahama Bank, have been considered to be transported downslope by the currents. *Teinostoma solidum* (Dall, 1889) was found below the continental shelf. MOORE (1964) mentions seeing specimens with animal and operculum in natural position, but in his opinion they could not be vitrinellids.

Most of the records of living vitrinellids are between one and several metres deep. Among the living species collected by PILSBRY & MCGINTY (1945a and 1946b) are: *Vitrinella helicoidea* C.B. Adams, *Teinostoma lerema* Pilsbry & McGinty, *Teinostoma parvicallum* Pilsbry & McGinty, *Teinostoma carinicallus* Pilsbry & McGinty and *Pleuromalaxis balesi* Pilsbry & McGinty. Other species collected alive: *Cyclostremiscus pentagonus* (Gabb) in sand-muddy bottom in Mississippi Sound; *Cyclostremiscus suppressus* (Dall) on *Thalassia* off Matheson Hammock, Biscayne Bay, less than 1 meter; *Solariorbis mooreana* (Vanatta), *Solariobis infracarinata* (Gabb), *Cyclostremiscus cubanus* (Pilsbry & Aguayo) and *Cyclostremiscus pentagonus* (Gabb) in sandy bottom and/or muddy-sandy bottom. *Circulus striatus* (Philippi), type species of the genus, lives on sandy bottoms off the Atlantic coasts of southern France and the Iberian Peninsula. The vitrinellids supposedly feed on detritus and diatoms.

We have scanty information on the soft parts of most of the species of the family Tornidae Sacco, 1896; it is a heterogeneous assortment of species fundamentally grouped together on the basis of some similarity of the shells. The ignorance of the soft anatomy and the radula of most of the species described up to now makes a correct generic and subgeneric placement difficult. The only anatomical studies published on these groups correspond to the type species of the genera *Circulus* Jeffreys, 1865 [*C. striatus* (Philippi, 1836) in FRETTER (1956)], *Cochliolepis* Stimpson, 1858 [*C. parasitica* Stimpson, in MOORE, 1972], *Tornus* Turton & Kingston, 1830 [*T. subcarinatus* (Montagu, 1803), in GRAHAM, 1982]. Also *Cyclostremiscus beaui* (P. Fischer, 1857) and *Circulus texanus* (Moore, 1965) in BIELER & MIKKELSEN (1988). We consider this an insufficient basis for understanding the family.

After a detailed anatomical examination of living samples of *Cochliolepis parasitica*, type species of the genus, MOORE (1972) placed *Cochliolepis* in Vitrinellidae, due their anatomical similarity. He went on to remark that, in spite of the fact that some of the species are more conchologically similar to those of *Tornus*, the relationship of *Cochliolepis* with *Tornus* and Tornidae is not close.

PONDER (1988) in his study on the phylogeny of Truncatelloidea (now known as Rissooidea), incorporated the available studies (FRETTER, 1956; MOORE, 1972; GRAHAM, 1982) into his own, apparently not published, and inferred that there was a complex of tornids-vitrinellids-adeorbids (= circulids), as a single family, which equates to Tornidae, but warned that two or more families could be separated from this group. This author affirmed that the Tornidae (included with vitrinellids for this analysis) have some characters in common, but in their overall anatomy approach the hydrobiids-truncatellids and more closely the Iravadiidae and Elachisinidae.

BIELER & MIKKELSEN (1988) studied several populations of two western Atlantic vitrinellids: *Cyclostremiscus beauii* (P. Fischer, 1897) and *Circulus texanus* (Moore, 1965) giving enough anatomical and radular data for generic differentiation.

PONDER (1994) described the external and internal morphology of three vitrinelliform species from Hong Kong. Two of these, *Sigaretornus plana* and *Circulus mortoni*, are placed in the Vitrinellidae, the other, a new genus and species, *Lantauia taylori*, is included in the Iravadiidae. The variation in organ systems in vitrinelliform species and the generic relationships are discussed, using the most comprehensive anatomical studies then available, provided by BIELER & MIKKELSEN (1988). They confirm that the anatomy of *Sigaretornus plana* and that of *Circulus mortoni* are very similar to that of *Cyclostremiscus beauii*, described in detail by BIELER & MIKKELSEN (1988). This shows the necessity of establishing a profile with the most important characters in vitrinellids and clarifying the relation between the type species of *Vitrinella* and *Tornus*, as both are the type genera of the families Vitrinellidae and Tornidae, due to the controversy on the relationships of both families.

Authors such as GRAHAM (1982) have suggested that few differences were found between both families and so, they could be grouped together, while other authors, like MOORE (1965) and BIELER & MIKKELSEN (1988) have suggested that both could be kept separate.

RUBIO & ROLÁN (1998) reported on the radulae of *Pachystremiscus ornatus* (Olsson & McGinty, 1958) and *P. pulchellus* (Olsson & McGinty, 1958) and placed both species in the genus *Lodderena* (Archaeogastropoda, Skeneidae), considering *Pachystremiscus* a synonym of *Lodderena*.

The species of tornids and vitrinellids are very similar in soft anatomy and radula as shown in ROLÁN & RUBIO (2002) in their report on the Tornidae of the east Atlantic.

BOUCHET & ROCROI (2005) summarized the state-of-the-art for taxonomy of the Gastropoda, casting new light on the historical evolution of the phylum Mollusca. Malacologists currently consider this classification a "hybrid" of the pre-existing traditional taxonomy based on morphological characters and the more recent far-reaching revisions, based on the molecular characteristics of DNA and RNA. Also there are opinions about the classification of families into subfamilies which are often not well resolved, and should be regarded as the best possible hypotheses. In our opinion, the new classification of gastropods drastically changes existing systematics and is an important step forward the gastropod nomenclature. In this work, the family Tornidae Sacco, 1896 is divided into four subfamilies: Torninae Sacco, 1896; Circulinae Fretter & Graham, 1962; Teinostomatinae Cossmann, 1917; and Vitrinellinae Bush, 1897. The subfamily Torninae includes the genera previously placed in *Tornus*; Circulinae only includes the genus *Circulus*; the subfamily Teinostomatinae only has the genus *Teinostoma* and Vitrinellinae groups together the other genera included in the old family Vitrinellidae Bush, 1897, herein considered a subfamily. This new classification will be employed in the present work.

As most of the species included in the group under consideration here have a typical shell form (orbicular to lenticular), we must point out that some species with similar shells actually belong to other families: for example, the genus *Cyclostrema* Marryat, 1818 is in Liotiidae Gray, 1850; the genera *Ganesa* Jeffreys, 1883, *Lydiphnis* Melvill, 1906, *Dillwynella* Dall, 1889, *Molleriopsis* Bush, 1897 and *Leptogyra* Bush, 1897 are in Turbinidae Rafinesque 1815, subfamily Skeneinae Clark, 1851; the genus *Choristella* Bush, 1897 is in Lepetellidae Dall, 1881 and the genus *Cyclostremella* Bush, 1897 is in Pyramidelloidea, Odostomiidae Pelseneer, 1928. Some of these generic names have erroneously been employed for species included in the group studied here.

MATERIALS AND METHODS

Most of the material studied in the present work was acquired from sediments obtained by diving or from dredgings and later separated with a binocular lens under magnification. Consequently most of the material is composed of empty shells in shell grit; occasionally a shell with soft parts could be obtained. An important part of the material studied is from Cuba, to which area we initially planned to limit our work; this material was mainly obtained from the collections of the second author in Cienfuegos Bay and later deposited mostly at the MHNS. For this reason, at the beginning of this study we only examined Cuban shells. Subsequently we included new material obtained by the third author on several trips to Yucatan (Mexico), Guatemala, Nicaragua, and south and west Cuba. Finally, we added other materials collected by Colin Redfern in the Bahamas, by Jacques Pelorce in several islands of the Caribbean, by some collectors from Itaparica, Brazil, and an important quantity from the collection of Harry G. Lee, which considerably amplified the study geographically and in terms of biodiversity. Some shells were lent by Marlo Krisberg, and we studied types and other material in other private collections and several Museums.

Abbreviations:

AMNH	American Museum of Natural History, New York
ANSP	Academy of Natural Sciences of Philadelphia
FLMNH	Florida Museum Natural History, Gainesville
IES	Instituto de Ecología y Sistemática, Havana
MCZ	Museum of Comparative Zoology, Philadelphia
MHNS	Museo de Historia Natural "Luis Iglesias", University of Santiago de Compostela (coll E. Rolán)
MNCN	Museo Nacional de Ciencias Naturales, Madrid
MNHN	Muséum National d'Histoire Naturelle, Paris
MPH	Museo Poey, Havana
NHMUK	National History Museum United Kingdom, London
PRI	Paleontological Research Institution, New York
RNHL	Rijksmuseum van Natuurlijke Historie, Leiden
USNM	National Museum of Natural History, Washington
YPM	Peabody Museum of Natural History, Yale University, New Haven, Connecticut
CCR	collection of Colin Redfern, Boca Raton
CEG	collection of E.F. Garcia, Louisiana
CFG	collection of R. Fernández-Garcés, Cienfuegos
CFR	collection of F. Rubio, Valencia
CHL	collection of Harry G. Lee, Florida
CJP	collection of J. Pelorce, Le Grau de Roi
CMK	collection of M. Krisberg, Florida
sp	specimen with soft parts
s	empty shell
j	juvenile
f	fragment

SYSTEMATIC PART

Superfamily RISSOOIDEA Gray, 1847
Family TORNIDAE Sacco, 1896
Subfamily CIRCULINAE Fretter & Graham, 1962

Genus *Circulus* Jeffreys, 1865

Lydiphnis Dall, 1927, pp. 123

Circulus Jeffreys, 1865: 315. *British Conchology. Vol. VIII.* Marine shells comprising the remaining Conchifera, the Solenoconchia and Gasteropoda as far as *Littorina*. J. Van Voorst. Plenum Press, New York and London, 393(+1) pp., 8 pls + frontispiece.

Type species (by monotypy): *Trochus duminyi* Requien, 1848 (= *Valvata striata* Philippi, 1836).

Diagnosis: *"Shell relatively strong, depressed; base smooth, rounded, umbilicus opened and deep spiral sculpture present on the dorsum and on the periphery"*.

Remarks: *Circulus* has been habitually treated as a section or subgenus of a better known genus. FISCHER (1887) places it as a subgenus of *Gibbula* Risso and BUSH (1897) as a section of *Vitrinella*. DALL (1927) reassigned to *Lydiphnis* Melville, 1906 some of the species placed in *Circulus* by Bush, but without giving an explanation.

THIELE (1929: 63) considered *Circulus* as a genus within *Cyclostrematidae* and mentions some details in the text about the radula.

FRETTER (1956) researched the anatomy of *Circulus striatus* (Philippi), type species of *Circulus,* and found several discrepancies in Thiele in reference to this genus. The radula is taenioglossate, not rhipidoglossate, and the animal is similar in appearance to that of the Rissoidae. The animal has a pair of pallial tentacles on the right margin of the mantle, and epipodial tentacles are wanting. The sexes are separate, and the male has a penis.

KEEN (1960) places the genus in Cyclostrematidae, Order Archaeogastropoda. But the detailed anatomical work of FRETTER (1956) has shown that the animal belongs in Mesogastropoda close to the family Rissoidae.

Species have been placed in the genus *Circulus* in the Caribbean, West Africa and Australia. *Circulus striatus* (Philippi) has been found on the southeast coast of Europe and in the Mediterranean. *Circulus liratus* (A.E. Verrill, 1882) was found from the east coast of Florida up to New England in the United States and *Circulus semisculptus* (Olsson & McGinty, 1958) from both coasts of Florida and Panama. Several species have been described from the latter region, but apparently they must be reassigned to other genera.

The shells are very similar in their general aspect to those of *Solariorbis*, but they lack the strong rib close to the umbilicus.

According to MOORE (1964) *Adeorbis orbignyi* P. Fischer, 1857, described from Cuba, may be included in this genus, but the type in the Laboratoire de Malacologie of MNHN is lost and so he considered the taxon a *nomen dubium*.

BIELER & MIKKELSEN (1988) give a complete account of the anatomy and reproductive biology of two species grouping them in Vitrinellidae: *Cyclostremiscus beaui* (P. Fischer, 1857) and *Circulus texanus* (Moore, 1965), from populations of both species found in Florida, in burrows in fine sand of the stomatopod crustacean *Lysiosquilla scabricauda* (Lamarck, 1818). The great size of *Cyclostremiscus beaui* (6-8 mm maximum diameter) simplified the detailed study of its anatomy and morphology and at the same time allowed the authors to confirm FRETTER'S (1956) hypothesis that some characters found in *Circulus striatus*, are in proportion to its overall size.

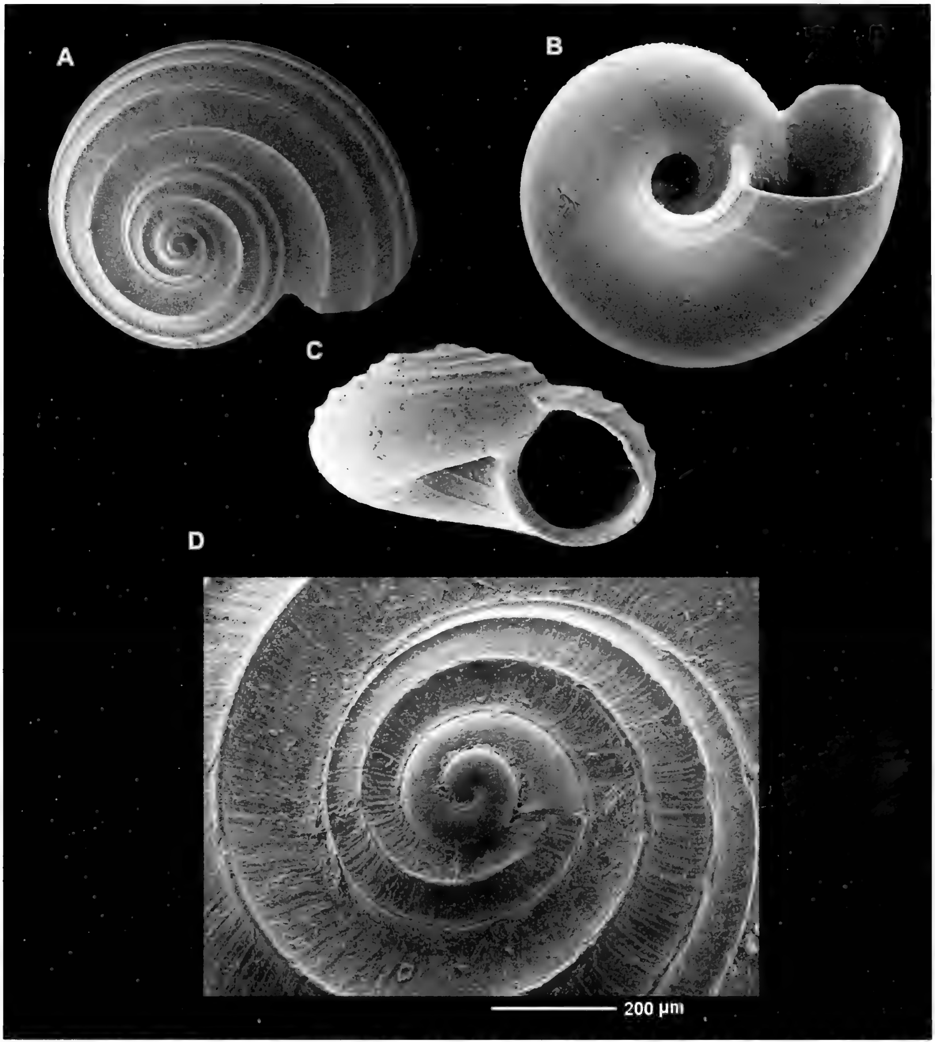
PONDER (1994: 258) says: "species of *Circulus* can be defined as vitrinellids having a spirally ridged shell with a simple non varicose aperture, a simple penis and a posteriorly notched foot lacking a metapodial tentacle. This latter character is absent in *Vitrinella texana* Moore, a species included in *Circulus* by BIELER & MIKKELSEN (1988)".

There are seven recent species of *Circulus* described from the east coast of USA and the Caribbean: *Circulus liratus* (A.E. Verrill, 1882), *Circulus texanus* (Moore, 1965), *Circulus semisculptus* (Olsson & McGinty, 1958), *Circulus orbignyi* (P. Fischer, 1957), *Circulus hendersoni* (Dall, 1927), *Circulus margaritiformis* (Dall, 1927) and *Circulus translucens* (Dall, 1927). In the present work all these taxa have been studied and figured. A neotype is designated for *C. orbignyi,* a taxon considered by some authors as a *nomen dubium*, the type material having been lost. DALL (1927) described *C. hendersoni, C. margaritiformis* and *C. translucens*, in the genus *Lydiphnis*, all of them from deep water dredgings in Georgia and Fernandina. These taxa will be discussed in the section following the main revision inasmuch as we have determined that they are not tornids but species in Skeneinae as will be demonstrated below.

Circulus semisculptus (Olsson & McGinty, 1958) (Figures 1A-D)

Vitrinella semisculpta Olsson & McGinty, 1958. *Bulletins of American Paleontology*, 39: 30-31, pl. 3, figs. 2-2b. [Type locality: Bocas Island, Panama].

Type material: Holotype represented in MOORE (1964: 220, fig. 7). Deposited in the ANSP (211888). Not examined.



Figures 1A-D. *Circulus semisculptus* (Olsson & McGinty, 1958). A-C: shells, 1.9, 1.6, 1.6 mm, Rancho Luna Beach, Cuba; D: protoconch.
Figuras 1A-D. Circulus semisculptus *(Olsson & McGinty, 1958). A-C: conchas 1,9 1,6, 1,6 mm, Playa Rancho Luna, Cuba; D: protoconcha.*

Other material examined: Cuba: 2 s, Rancho Luna Beach, Cienfuegos, 10-20 m (MHNS); 3 s, Rancho Luna Beach, 20-54 m (MHNS). Antigua and Barbuda: Antigua: 1 s, north St. John, 5-6 m (CJP). Martinique: 1 s, Pointe Borgnesse, 12 m, on sand-muddy on the base of the reef (CJP). Florida, USA: 1 s, SE Raccoon Key, Monroe Co., 0.5 m subtidal with *Halimeda* sps (CHL). Bahamas: 1 s, Olympus Reef, Grand Bahama Island, 36 m coralline algae bottom (CHL).

Description: Shell (Figs. 1A-C) rather strong, whorls rounded with spiral sculpture on the dorsum and base smooth. Protoconch (Fig. 1D) relatively large, about 310 μm maximum diameter, with 1 ½ spiral whorls where two stages of development are easily observable. Its surface is apparently smooth although some rough parts are present in the terminal portion. A strong varix marks the separation from the teleoconch. Last whorl with 5 spiral cords distributed on the dorsal half of the whorl between the suture and the periphery. A fine axial striation covers the interspaces between the spiral cords. Base rounded, totally smooth except growth lines slightly oblique, peristome not continuous.

Habitat: MOORE (1964: 73) suggests that the species seems to prefer shallow water, and all the shells in the type series were in beach sediments. However, several others came from between 10 and 54 m deep.

Distribution: It has been recorded from Colón island and Bocas island, Panama (OLSSON & MCGINTY, 1958); from South Florida and Panama (MOORE, 1964); from South of Florida and Central America (HOUBRICK, 1968); from Portete, Costa Rica (HOUBRICK, 1968; ROBINSON & MONTOYA, 1987); from south Florida and the western Caribbean (ABBOTT, 1974); from Aruba (DE JONG & COOMANS, 1988); from Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994); from Abaco, Bahamas (REDFERN, 2001). In the present work Cuba, Antigua and Martinique are added.

Remarks: Our material matches the figure in MOORE (1964: 220, fig. 7) and the shell photographed by REDFERN (2001, fig. 184) from Abaco, Bahamas.

Circulus orbignyi (P. Fischer, 1857) (Figures 2A-D)

Adeorbis orbignyi Fischer, P. 1857. *Journal de Conchyliologie*, 6: 173. [Type locality: Cuba].
Circulus sp.: In REDFERN, 2001: 43, pl. 21, figs. 185.

Type material: The holotype is lost. Neotype (Fig. 2A), here designated, in MNHN (24227).
Other material examined: Cuba: 1 s, Jibacoa, 3-6 m (MHNS); 1 s, Baracoa, on beach (MHNS); 5 s, Cienfuegos Bay, 20 m (MHNS); 1 s, Cienfuegos Bay, 30 m (MHNS); 1 s, Rancho Luna Beach, 12 m (MHNS); 23 s, Rancho Luna Beach, 10-20 m (MHNS); 11 s, Rancho Luna Beach, 45 m (MHNS); 1 s, Punta Tamarindo, 15 m (MHNS). Grenadines: 1 s, Mayreau, 8 m, coralline sand with coral, gorgonies and sponges (CJP). Trinidad and Tobago: Tobago, 1 s, Horse Shoe reef, Tobago Cays, 15 m, in sediments (CJP). Nicaragua: 1 s, Cayo Witties, 15 m (MHNS). Panama: 1 s, Portobello, drift (CHL). Florida, USA: 1 s, Hallandale Beach, Broward Co., Florida, drift (CHL). Bahamas: 1 s, Grand Bahama Island, 0.5 m on sand (CHL).
Type locality: Cuba; the neotype is from Rancho Luna Beach, Cienfuegos, Cuba.

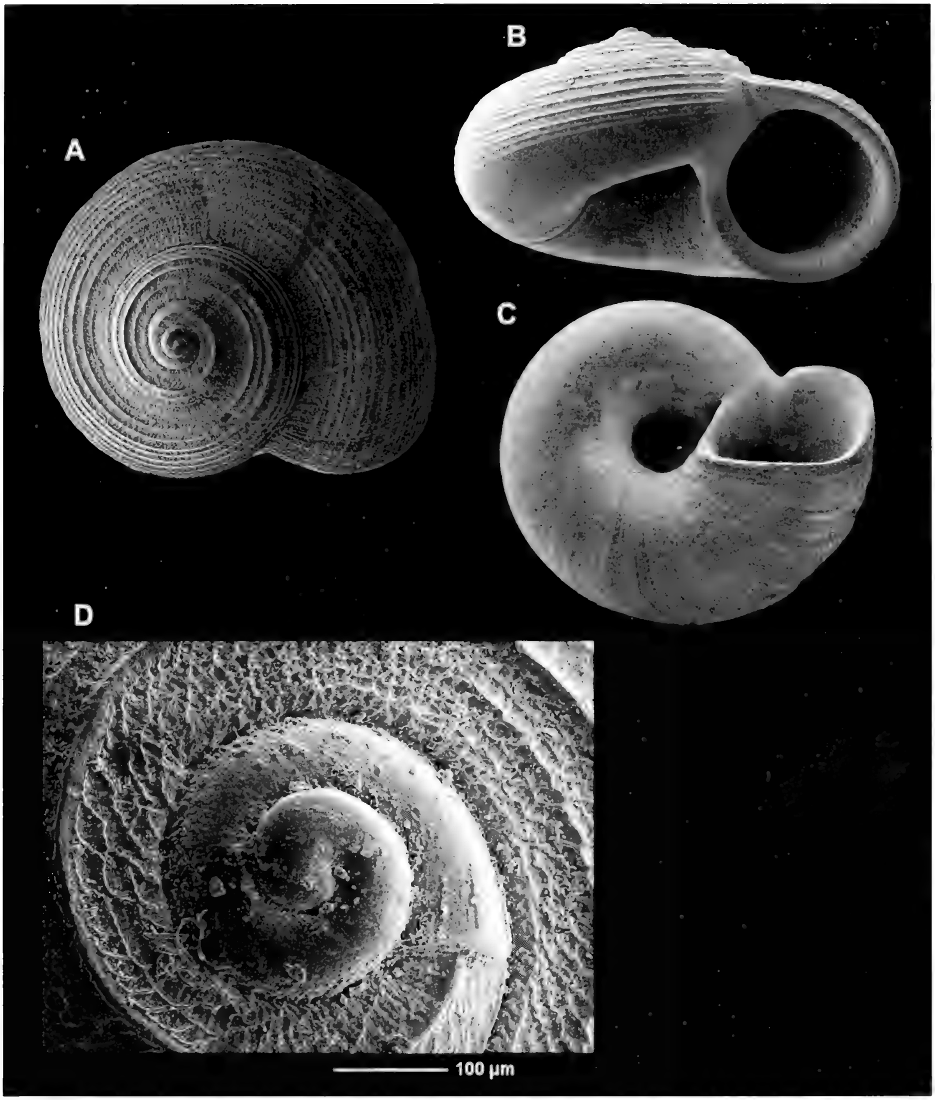
Description: Shell (Figs. 2A-C) strong, depressed, spire slightly elevated, composed of 4 ¼ whorls with spiral sculpture on its dorsal half and fine growth striae on the base. Umbilicus wide and deep. Protoconch (Fig. 2D) of almost 1 ¾ whorls, and about 302 μm in diameter, with two stages of development well separated; initially smooth, continuing with a slightly rough surface and 2-3 threads on its terminal portion. A strong varix marks the beginning of the teleoconch, which is composed of 2 ½ rounded whorls, smooth on the base except for growth lines, and 14 to 18 spiral cords on the dorsal middle on the last whorl. Spaces between cords covered by fine irregular reticulation. Aperture rounded, a little oblique. Columella slightly reflected. Under high magnification, faint spiral cordlets can be seen inside the umbilicus.

Dimensions: The neotype is 2.5 mm in diameter and 1.7 mm in height.

Animal and radula unknown.

Habitat: In Cuba it seems to be a widely distributed species, most shells were found between 10 and 20 m deep.

Distribution: The species is known from Cuba, Bahamas, the Grenadines and Tobago. It is mentioned from São Sebastião, São Paulo, Brazil (RIOS, 2008). It has been recorded from Abaco, Bahamas (REDFERN, 2001) as *Circulus sp*.



Figures 2A-D. *Circulus orbignyi* (P. Fischer, 1857). A: neotype, 2.5 mm (MNHN); B: shell, 2.7 mm, shell, Rancho Luna Beach, Cuba (CFG); C: 2.4 mm, Cayo Witties, Nicaragua (MHNS); D: protoconch.

Figuras 2A-D. Circulus orbignyi *(P. Fischer, 1857). A: neotipo, 2,5 mm (MNHN); B: concha, 2,7 mm, concha, Playa Rancho Luna, Cuba (CFG); C: 2,4 mm, Cayo Witties, Nicaragua (MHNS); D: protoconcha.*

Discussion: FISCHER (1857) in the original description of *Adeorbis orbignyi* said: "It is distinguished from congeneric species by the regularity of the ornamentation constituted by a dozen of transversal ribs placed at equal distance". MOORE (1964: 70-71) treated it as a *nomen dubium* only because the type was not found. This taxon cannot be considered as *nomen nudum* with a good description like the one available. The type, supposedly in the MNHN, is considered lost (Virginie

Héros pers. comm.). In our opinion there is no doubt that the description of this species corresponds to the shells we have from Cuba (type locality), where it is relatively common. For this reason and also because the taxon has been accepted by other taxonomists (e.g., www.malacolog.org) we have designated a neotype in order to maintain nomenclatural stability.

This species can be distinguished from *C. semisculptus* by the great number of spiral cords and the dense microsculpture between them.

Circulus liratus (A.E. Verrill, 1882) (Figures 3A-E)

Cyclostremiscus pentagonus auct. non Gabb, 1873.

Omalaxis lirata A.E. Verrill, 1882. *Transactions of the Connecticut Academy of Arts and Sciences* 5: 529. In Bush, 1893, pl. 1, fig. 11-12]. [Type locality: USFC sta. 770, off Newport, Rhode Island, 16 m].

Type material: Holotype in USNM (406741). Not examined.

Other material examined: Florida, USA: 1 s, Atlantic Beach, Duval Co. (CHL); 4 s, 30 m, 35 mi E St. Augustine, St. Johns Co. (CHL); 2 s, 53 m, 75 mi E St. Augustine, St. Johns Co. (CHL); 4 s, 16th Ave. S, Jacksonville Beach, Duval Co. (CHL).

Description: After Moore (1964: 74): *"Shell depressed, rather thick, whorls rounded, inner half of base smooth. Spiral sculpture of about eight to ten spiral ridges separated by grooves only slightly wider. Umbilicus wide and deep"*. Protoconch projecting with nearly 2 ¾ smooth whorls, about 530 µm in maximum diameter. Teleoconch with only 1 ½ whorls, ornamented with 10 spiral cords distributed between the dorsum and the outer base. The interspaces are wider, without axial sculpture except fine growth lines. Base flat, without sculpture. Umbilicus wide, the previous whorls being visible in its interior, and delimited by a strong cord and 2-3 more on its inner wall.

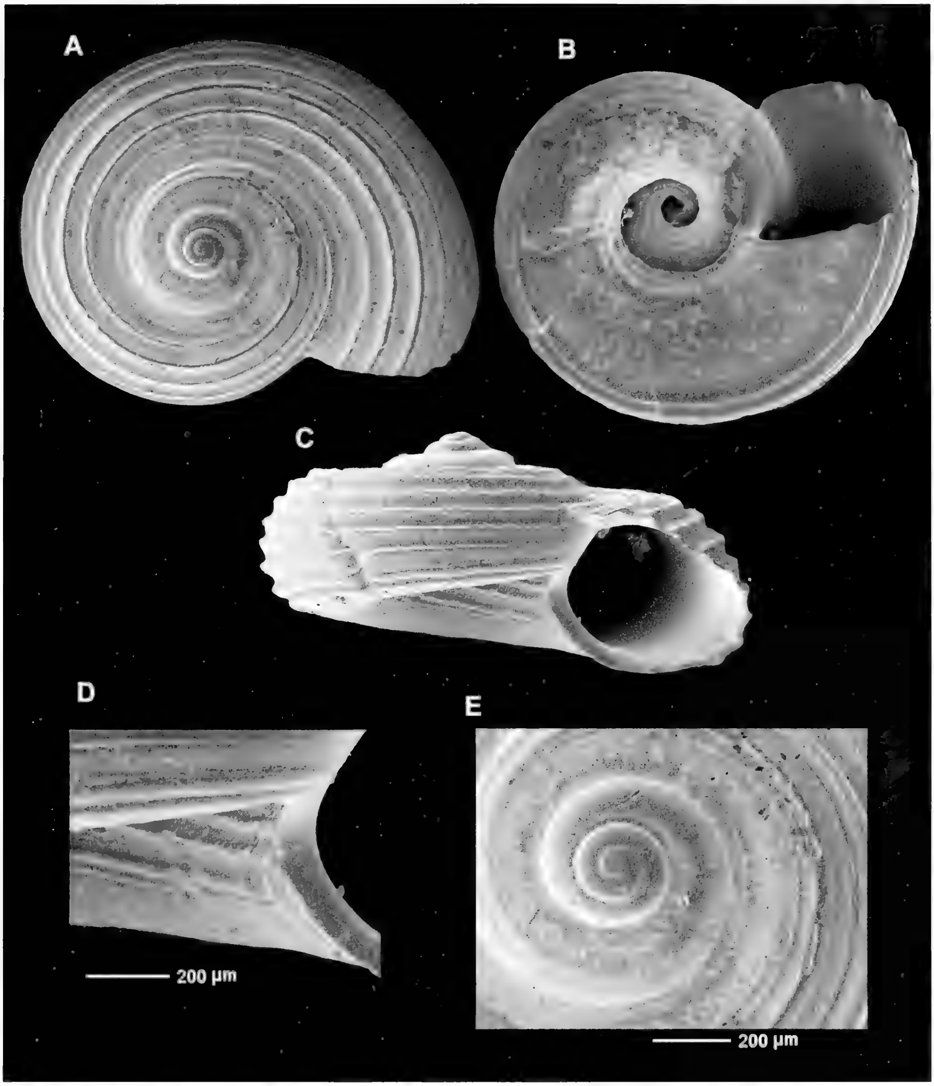
Holotype measures 2.1 mm. The figured shells are 2.3-2.7 mm in diameter and about 1.01 mm in height.

Habitat: This species seems to be found living in depths of a few meters (Moore, 1964). The bathimetry reported in the literature is between 7 and 165 m.

Distribution: East coast of Florida to Rhode Island. Recorded from Newport, Rhode Island (Verrill, 1882); from off Cape Hatteras, North Carolina (Bush, 1897); from Rockaway, New York and off Lantana, Florida (Moore, 1964); from St. Lucie Co., Florida (Lyons, 1989), from Atlantic Beach, Jacksonville Beach, Batten Island and St. Augustine, Florida (Lee, 2009).

Remarks: *C. liratus* is the only species of *Circulus* from the West Indies similar in morphological characters to *Circulus striatus* (Philippi, 1836) type species of the genus. *C. liratus* has been placed in the genera *Lydiphnis* and *Skenea*. *Circulus liratus* differs from *C. semisculptus* by its projecting protoconch while *C. semisculptus* is almost planispiral.

Solariorbis mooreana (Vanatta, 1904) is similar but it has a narrow umbilicus and lacks the thickening of the umbilical wall, which is typical of the *Solariorbis*; also this latter species lacks ornamentation in the interspaces between cords, and these cords do not extend to the base.



Figures 3A-E. *Circulus liratus* (A.E. Verrill, 1882). A-C: shells, 2.18, 2.14, 2.33 mm, Jacksonville Beach, Florida (CHL); D: detail of the umbilicus; E: protoconch.
Figuras 3A-E. Circulus liratus *(A.E. Verrill, 1882). A-C: conchas, 2,18, 2,14, 2,33 mm, Jacksonville Beach, Florida (CHL); D: detalle del ombligo; E: protoconcha.*

Circulus texanus (Moore, 1965) (Figures 4A-F)

Vitrinella texana Moore, 1965. *The Nautilus*, 78: 76-77, pl. 7 figs. 4-6. [Type locality: Mustang Island, near Port Aransas, Texas].
Vitridomus texanus (Moore, 1965), auct.

Type material: Holotype from Mustang Island, near Port Aransas, Texas, diameter, 1.72 mm, height, 0.78 mm. Deposited in the Division of Mollusks, USNM (636311). Not examined.

Other material examined: Brazil: 1 s, Itaparica (MHNS). Florida, USA: 1 s, Delray Beach, Palm Beach Co. (CHL); 1 s, Longboat Key, Sarasota Co. (CHL).

Description: Original description (Moore, 1965): *"The shell is depressed, and has a flattened apex. The umbilicus is narrow but deep, and is almost flat sided. Sides of the shell curve out and down gently so that the periphery forms an angle with the base of the shell. The aperture is oblique.*

"The protoconch consists of 1 ¾ glassy whorls. The teleoconch consists of about 1 ¼ whorls, and is sculptured on the upper side with fine spiral grooves and on the lower side with numerous short radiating riblets. These riblets are crossed by a few weak spiral grooves, and there are several stronger spiral grooves in the umbilicus. The ventral side is flattened, and, in the holotype, bears about 36 radiating riblets. The riblets become indistinct on the last half of the whorl, and become difficult to count".

"The aperture is oblique, and is broadly ovate. The peristome is deeply notched at the upper inner angle. The parietal wall is rather thick, and is extended a little forward of the aperture. The umbilicus is narrow and almost flat sided, but there is no angle with the base of the shell. The shell itself is quite thin and fragile, and only the holotype and one immature paratype are unbroken. One paratype is actually only half of the body whorl of a broken shell".

After Bieler & Mikkelsen (1988): *"Shell small (1.7-1.8 mm in diameter, 0.55-0.65 mm in height). With about 1 ½ teleoconch whorls; almost planispiral, sculptured dorsally and ventrally with about 18 fine spiral ribs; transparent when alive, opaque after death. Ribs slightly stronger, more widely spaced just below suture on dorsum and at periphery, where about 3 ribs form rounded keel below lateral midline. Suture impressed. Ventral surface below keel less convex. Often with 30-40 widely-spaced, low axial ribs which are primarily evident from inside of body whorl. Umbilicus wide. Outer lip very slightly reflected; some specimens with one former varix. Aperture at oblique angle to dorsoventral axis. Sutural sinus shallow. Periostracum thin, transparent, with spiral grooves more numerous than on shell surface. Protoconch smooth, 0.5 mm diameter, about 2 whorls. No sculptural demarcation separating protoconch I and protoconch II.*

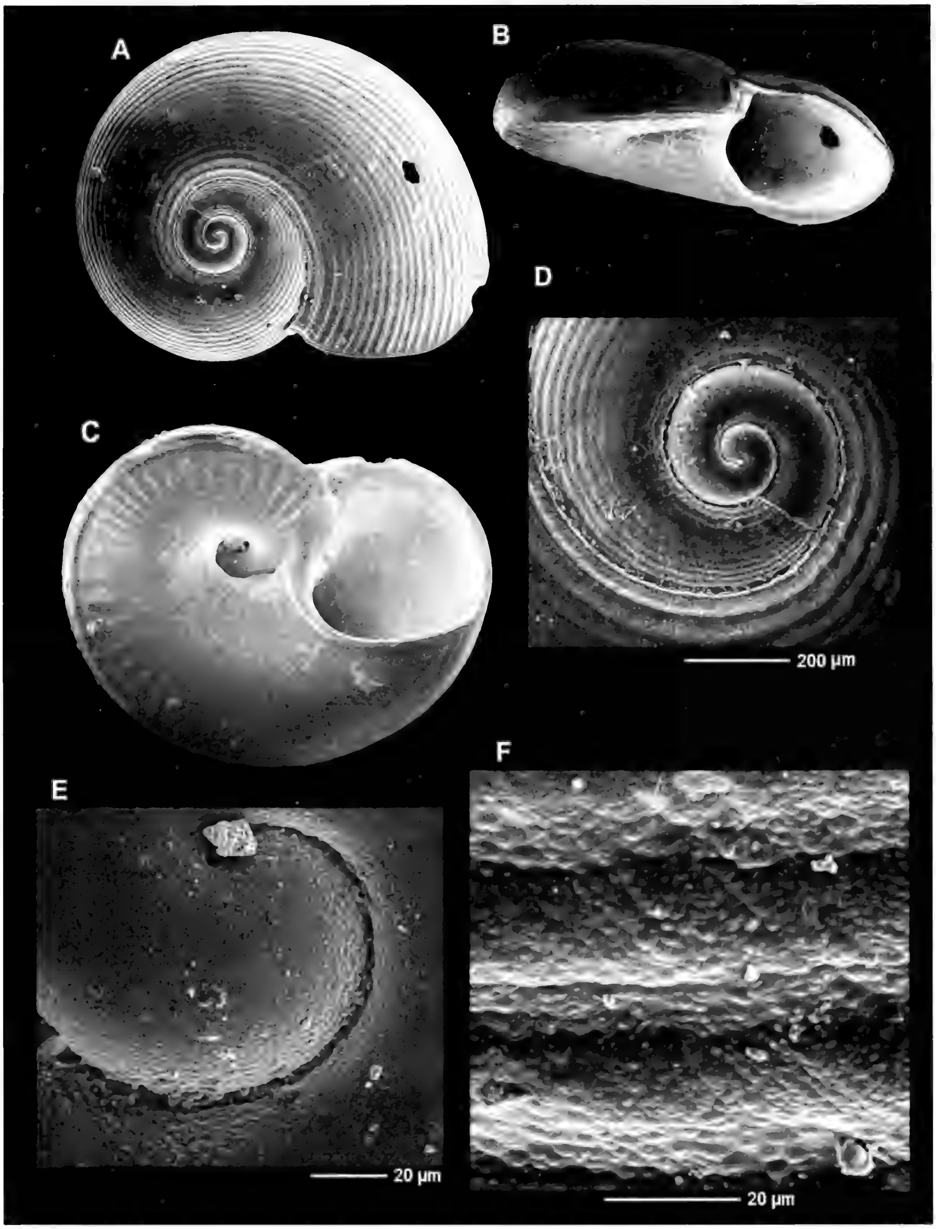
Maximum reported size: 2.1 mm".

We can add to this description the following: The protoconch (Figs. 4D-E) is about 340 µm in diameter, and it has a little more than 1 ½ whorls. Apparently it is smooth, but its nuclear portion is covered by very small tubercles of various sizes. This kind of microsculpture is also present on the dorsum of the teleoconch (Fig. 4F).

Habitat: Living specimens were taken from stomatopod burrows in shallow-water sand flats in the Indian River lagoon, St. Lucia County, eastern Florida (Bieler & Mikkelsen, 1988). It prefers a rather narrow range of temperature and salinity, and is probably most abundant in shallow coastal waters. Its bathymetric range is between 0 and 44 m in depth, and it was found alive between 0 and 0.5 m.

Distribution: USA: Florida: East Florida; Texas. Reported from Port Aransas, Texas (Moore, 1964); from Texas (Odé, 1987b); from the northwestern Gulf of Mexico (Bieler & Mikkelsen, 1988).

Remarks: This species was described in the genus *Vitrinella* (Moore, 1965). Bieler & Mikkelsen



Figures 4A-F. *Circulus texanus* (Moore, 1965). A-C: shell, 1.78 mm, Sarasota Co., Florida (CHL); D: protoconch; E: detail of the protoconch; F: detail of the microsculpture of the teleoconch.
Figuras 4A-F. Circulus texanus *(Moore, 1965). A-C: concha, 1,78 mm, Sarasota Co., Florida (CHL); D: protoconcha; E: detalle de la protoconcha; F: detalle de la microescultura de la concha.*

(1988) placed it in the genus *Circulus* sensu lato because it agrees in shell shape and sculpture with the type species, *Circulus striatus* from the eastern Atlantic. It differs from all other western Atlantic Circulinae principally in having radiating riblets on the ventral side.

Subfamily TEINOSTOMATINAE Cossmann, 1917

Genus *Teinostoma* H. & A. Adams, 1853

Teinostoma H. & A. Adams, 1853. *Genera of Recent Mollusca* 1: 122.
Type species: *Teinostoma politum* H. & A. Adams, 1853 (by monotypy). *Proc. Zool. Soc. Lond.* pl. 10, figs. 1-3.

Diagnosis: Shell minute, depresed-turbiniform, thin, glassy, smooth, umbilicate. Protoconch of about 1.3 convex whorls. Teleoconch whorls convex, base and umbilical rim angulate. Multispiral operculum. Rádula: Central tooth cutting area broadly "V" shaped, serrated, 2 basal denticles, ventral process "U" shaped. Lateral tooth cutting area at inner third, broadly angulated and serrated. Inner marginal cutting area very broad, comb-like. Outer marginal cutting area short.

MOORE (1964) defines the species as: *"Shell small to minutecompact, depressed, low spired, few flattened whorls which are rounded or carinate; smooth or sculptured by fine striations, suture not impressed, umbilicus covered partly or entirely by a heavy callus pad which is extended over the parietal wall, columella concave, thick. Animal very similar to* Vitrinella *but with a longer foot"*.

Remarks: According to PILSBRY (1953) the species included in the genus *Teinostoma* are known from the Upper Cretaceous to Recent, being very common in many Tertiary deposits. The genus *Teinostoma* has been subdividided by some authors into several subgenera (*Annulicallus, Pseudorotella, Idioraphe*); unfortunatly, the types of the type species of two of these subgenera are lost or in such poor condition that identification is uncertain. As the objective of this work is not supraspecific classification, we will group all the studied species in the genus *Teinostoma*.

Identification key

In order to make schematic the separation of the species in this group with so many species we present the following identification key for the genus pointing out the most important characters for each species:

1 - Shell with protoconch visible 2
- Shell with protoconch fully or partially covered by a thin coat 3

2 - Shell with rounded micropits spirally aligned 4
- Shell with spiral incised lines 5
- Shell completely smooth 6

3 - Shell with spiral cords 7
- Shell completely smooth 8

4 - Shell globose and fragile . . . . *T. ciskae*
- Shell globose with low spire . . . . *T. baldingeri*
- Shell with strong peripheral keel . . . . *T. goniogyrus*
- Shell angular at the periphery . . . . *T. lenticulare*
- Shell subangular . . . . *T. reclusum*

5 - Shell obtusely subangular . . . . *T. incertum*
- Shell with spiral irregular microcordlets fused between them in the first whorl . . . . *T. anastomosis*
- Shell with spire slightly elevated and striated callus . . . . *T. panamense*

6 - umbilicus completely covered by callus 9
- umbilicus partly covered by callus 10

7 - Shell totally covered by spiral cords . . . . *T. semistriatum*
- Shell dorsally covered by fine spiral cordlets . . . . *T. nesaeum*
- Shell with dorsum and umbilicus surrounded by a strong spiral carina *T. carinicallus*
- Shell with dorsum and umbilicus surrounded by a strong spiral carina and weak spiral striae . . . . *T. lituspalmarum*

8 - Shell strongly depressed, transversely dilated . . . . *T. obtectum*
- Shell with expanded aperture . . . . *T. expansum*
- Shell minute, flattened above and below . . . . *T. minusculum*
- Shell more elongated by extension (outwards from the outer lip . . . . . . *T. lerema*
- Shell transversely ovate . . . . *T. megastoma*
- Shell with periphery very rounded and strong umbilical callus . . *T. umbilicatum*

9 - broadly ovate aperture, rather strongly oblique . . . . *T. biscaynense*
- protoconch placed below the next whorl, rounded aperture, peristome almost continuous . . . . *T. cienfuegoensis*
- peristome externally reflected toward back . . . . *T. helicinum*
- Shell pyriform, umbilical callus very large . . . . *T. megacallum*
- a fine groove separates the umbilical callus from the columella . . . *T. parvicallum*

10 - a triangular callus at end of the columella . . . . *T. solidum*
- no groove of separation between columella and callus . . . . *T. cocolitoris*
- spire moderately elevated, callus with half moon shape . . . . *T. lunense*
- a groove separating the umbilical callus from the columella . . . . *T. altum*

Teinostoma ciskae Faber, 1995 (Figures 5A-C)

Teinostoma millepunctata Nowell-Usticke, 1969 non *T. millepunctatum* Pilsbry & Olsson, 1945. *A Supplementary Listing of New Shells, to be Added to the Check List of the Marine Shells of St. Croix*: 10, pl. 2, fig, 307.

Teinostoma millepunctata Nowell-Usticke, 1971. *A Supplementary Listing of New Shells, to be Added to the Check List of the Marine Shells of St. Croix, revised edition*: 6. [Type locality: Antigua, Secret Harbor, 40 ft].

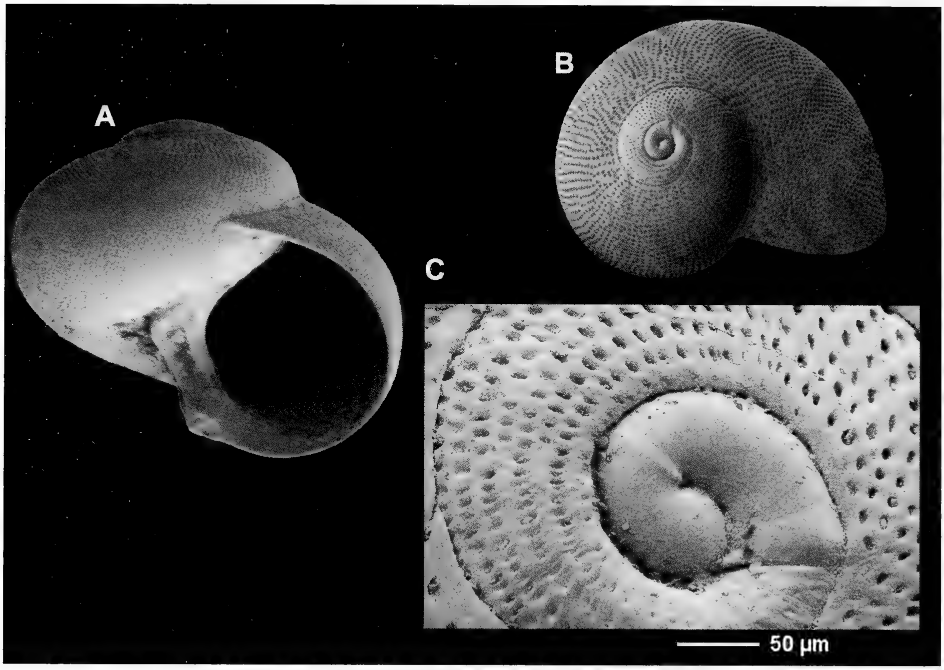
Teinostoma ciskae Faber, 1995. *De Kreukel*, 31: 62 [replacement name for *T. millepunctata* Nowell-Usticke, 1969].

Type material: Represented in NOWELL-USTICKE (1969, pl. 2, fig. 307). The lectotype of *T. millepunctata* was deposited in AMNH (nº 195413) (BOYKO & CORDEIRO, 2001). Not examined.

Other material examined: Cuba: 5 s, Bahía de Cienfuegos, 20-30 m (MHNS); 20 s, Rancho Luna Beach, 20-54 m (MHNS). Trinidad and Tobago: Tobago, 1 c, Horseshoe reef, 15 m, from shell grit (CJP). Virgin Islands: 1 s, Peter Island, 18 m, shell grit (CHL). Bahamas: 1 s, Olympus Reef, NNW West End, Grand Bahama Island, 36 m, from coralline algal fragments (CHL). Florida, USA: 2 s, APAC Pit, Sarasota Co. Plio-Pleistocene (CHL).

Description: Shell (Figs. 5A-B) globose, fragile, whitish and with its surface totally covered by punctiform incisions aligned spirally.

Protoconch (Fig. 5C) of about one whorl, with a finely granular surface at its beginning and smooth in the subsequent part, about 166 μm in diameter, and with two strong varices separating the two stages. Teleoconch of about 2 ¼ globose whorls, totally covered by the microsculpture mentioned above (Fig. 5C). Aperture rounded, external lip fine, inner lip and columella thickened.



Figures 5A-C. *Teinostoma ciskae* Faber, 1995. A-B: shells, 1.8, 1.2 mm, Rancho Luna Beach, Cienfuegos, Cuba; C: protoconch.
Figuras 5A-C. Teinostoma ciskae *Faber, 1995. A-B: conchas, 1,8, 1,2 mm, Playa Rancho Luna, Cienfuegos, Cuba; C: protoconcha.*

Umbilicus totally closed by an extension from the columella.

Dimensions: Holotype 1.59 mm in diameter. We have shells with about 2.5 mm in maximum dimension. Maximum reported size: 2.6 mm

Habitat: The species is distributed in the deep infralittoral, found between 15 and 54 m deep, on coralline bottoms.

Distribution: Known from Antigua, its type locality (NOWELL-USTICKE, 1969 and 1971; FABER, 1995); from Aruba (DE JONG & COOMANS, 1988); from Abaco, Bahamas (REDFERN, 2001) and from Virgin Islands, Bahamas, Tobago, and Cienfuegos, Cuba, in the present work.

Remarks: NOWELL-USTICKE (1969) described *Teinostoma millepunctata*. This name was preoccupied by *T. millepunctatum* Pilsbry & Olsson, 1945, from Ecuador, for this reason FABER (1995) proposed the replacement name *Teinostoma ciskae*, for Nowell-Usticke's species. *T. ciskae* may be distinguished from the other known species of *Teinostoma* by the more globose and fragile shell, by its peculiar protoconch, and mainly by its typical microsculpture of punctiform incisions. No similar species exists in the Caribbean region.

Teinostoma goniogyrus Pilsbry & McGinty, 1945 (Figures 6A-G)

Teinostoma goniogyrus Pilsbry & McGinty, 1945a. *The Nautilus*, 59: 3, pl. 1, figs. 8. [Type locality: Off Destin, west Florida].

Rotella carinata H. C. Lea, 1846. *Trans. Amer. Philos. Soc.*, 9: 263, pl. 36, fig. 78. (non d'Orbigny, 1842) [Type locality: Petersburg, Virginia, Neogene fossil].

Type material: Represented in PILSBRY & MCGINTY (1945a). Not examined.
Other material examined: Cuba: 1 s, Guajimico, 15 m (MHNS); 1 s, Cienfuegos Bay, stn. 12a, 22°07'N – 80°26'W, 4 m (MHNS); 12 s, Cienfuegos Bay, 10 m (CFG); 5 s, Rancho Luna Beach, 10-54 m (CFG). Florida, USA: 1 s, 65 mi. E St. Augustine, St. Johns Co., Fl., 53 m, dredged (CHL); 3 s, 32 mi. E St. Augustine, St. Johns Co., Fl., 30 m, dredged (CHL); 1 s, 23 mi. ENE Mayport, Duval Co., Fl., 26 m. (CHL); 1 s, Caloosahatchee Formation, La Belle, Hendry Co., Plio-Pleistocene (CHL).

Description: Shell (Figs. 6A-D) subconical, depressed, solid, whitish, and with a strong keel at the periphery. Protoconch (Figs. 6E-G) of about 2 whorls and about 360 µm in diameter, with a smooth surface at its beginning and fine lateral granulation and 5-6 spiral lines of small perforations on the subsequent part, varix scarcelly marked. Teleoconch of about 1 ¼ whorl, rapidly expanding, dorsally convex and ventrally concave in the umbilical area; surface totally covered by very fine clearly separated perforations, spirally aligned (Figs. 6G-H) and with a prominent cord-like keel at the periphery. A fine callus completely covers the umbilicus; a fine groove runs between the columella and the callus. Aperture ovoid, a little depressed, with the upper part of the external lip sharp and advanced.

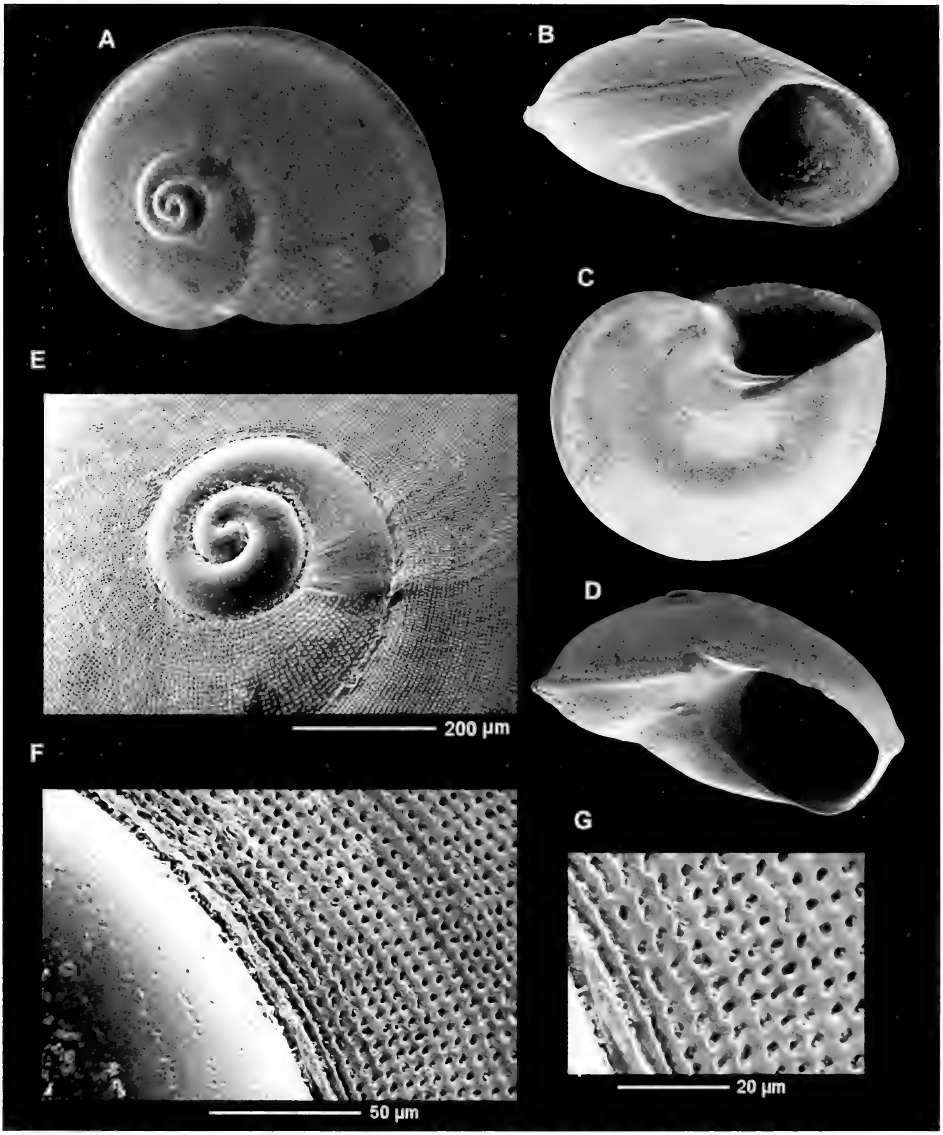
Dimensions: Holotype measures 1.95 mm in diameter. We have shells about 1.3 mm in maximum diameter.

Habitat: Marl Bottom, in 18-20 fms (32-56 m) (Pilsbry & McGinty, 1945a). It has been found alive between 42 and 59 m, but shells have been found in sediments collected between 10 and 100 m.

Distribution: It has been recorded from off Destin, west Florida (PILSBRY & MCGINTY, 1945a); from Bocas island, Panama (OLSSON & MCGINTY, 1958); from off northwest Florida, southern Haiti and Panama (MOORE, 1964); from northwest Gulf of Mexico (ODÉ, 1987); from Florida to Caribbean Panama (LYONS, 1989; LEE, 2009); from Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994); also from Cuba.

Remarks: PILSBRY & MCGINTY (1945a) mention that *Teinostoma goniogyrus* resembles *Rotella carinata* (d'Orbigny) from St. Thomas in shape, but instead of the small umbilical callus of that species, has a remarkable, extremely thick callus, exceeding that of any other *Teinostoma* except *T. pilsbryi*. Under high power some faint traces of close spiral striation can be seen in a few places on the unique type. MOORE (1964) commented that this species is also similar to *T. incertum* in the spiral punctiform lines and in the shape of the umbilical callus. *T. incertum* is more depressed and has a strong peripheral keel. The stratigraphic distribution of this species is from the Upper Miocene to Recent. There is a considerable variation of size between the fossil shells from the Miocene and Plio-Pleistocene and the recent ones.

PILSBRY & MCGINTY (1945a) described *T. goniogyrus* on the basis of a single shell, citing the wider umbilical callus as the specific difference from *R. carinata*. PILSBRY (1953) figured fossil shells of *T. goniogyrus* from Smithfield, Virginia and St. Petersburg, Plio-Pleistocene of southern Florida and kept the size of the umbilical callus as the only difference between species. We have examined shells from Florida and Cuba and found very little difference between them. We have also examined shells from the Pliocene, Caloosahatchee Formation, from La Belle, Florida, and we have not observed important differences in the size of the umbilical callus. K.J. BUSH (1897) identified two specimens from station 2278, off Cape Hatteras, in 16 fathoms (29 m), as the *R. carinata* of d'Orbigny.



Figures 6A-G. *Teinostoma goniogyrus* Pilsbry & McGinty, 1945. A-D: shells, 1.5, 1.5, 1.4, 1.5 mm, Cienfuegos Bay, Cuba; E: protoconch; F-G: microsculpture.
Figuras 6A-G. Teinostoma goniogyrus *Pilsbry & McGinty, 1945. A-D: conchas, 1,5, 1,5, 1,4, 1,5 mm, Bahía de Cienfuegos, Cuba; E: protoconcha; F-G: microescultura.*

In our opinion, *R. carinata* and *T. goniogyrus* may be the same species, and the different size of the umbilical callus is not enough for a specific separation. The problem is that the shells identified by K.J. Bush as *R. carinata* in USNM were not found. So, lacking comparative material, we keep both species-level taxa waiting until more material from the type locality is obtained in the future in order to decide if there is any specific difference.

Teinostoma lenticulare (H.C. Lea, 1846) (Figures 7A-K)

Rotella lenticularis H.C. Lea, 1846. *Trans. Amer. Philos. Soc.*, 9: 264, pl. 36, fig. 79. [Type locality: Petersburg, Virginia, Neogene fossil].

Type material: Type material in ANSP. Not examined.
Other material examined: Cuba: 12 s, Cienfuegos Bay, 22°07'N 80°27'W, 9 m (MHNS); 5 s, Cienfuegos Bay, sta. 12a, 22°07'N 80°26'W, 4 m; 19 s, Cienfuegos Bay, 10 m (MHNS); 1 s, Cienfuegos Bay, 20-30 m (MHNS); 15 c, Cienfuegos Bay, 10 m; 6 c, Cienfuegos Bay, 12 m (MHNS).

Description: This is the short original description: *"Shell lenticular, depressed, thin, smooth, polished, spire very short, sub-ovate; obtuse; sutures small, linear; whorls four, convex; last whorl angulate; base smooth; callus small; mouth subrotund; columella broad, curved"*. At same time H.C. Lea comments: *"The angle of the last whorl is very variable. It sometimes amounts almost to a carina. The mouth is nearly round. The callus is slightly depressed below the surrounding surface. This shell is, in part, allied to both the preceding species* [Rotella carinata], *but differs in the number of whorls, shape of the columella and spire, and the angle on the last whorl. They also differ much in thickness"*.

The shell (Figs. 7A-H) has the shape of a small trochoid, relatively solid, with a shagreen appearance due to minute punctae. Protoconch (Figs. 7I-J) of about 1 ¾ whorls and with about 310 µm in diameter, ornamented with very small and dispersed tubercles and 4-5 very fine spiral threads. Teleoconch of about 1 ½ whorls, rapidly expanding; the whorls are totally covered by very small punctiform pits, clearly separated from each other, spirally aligned and very dense. The middle of the last whorl is angular, and this angle is almost at the periphery, fading progressively and almost disappearing near the aperture. In adult specimens, from the last ½ whorl a thickening of the inner lip is present extending and projecting over the umbilicus nearly totally covering it and forming the characteristic callus of this species (Figs. 7 E-F). This callus can be observed in several degrees of development (Fig. 7K). The different forms of umbilical occlusion are related to the age and development of the individual.

Dimensions: Holotype 1.6 mm in diameter by 0.95 mm in height. Our largest shells measure 1.3 mm in diameter and 0.80 mm in height.

Habitat: The shells studied were collected in sediments between 4 and 30 m in depth, on a coralline sand bottom.

Distribution: Only known as recent species from Cienfuegos, Cuba.

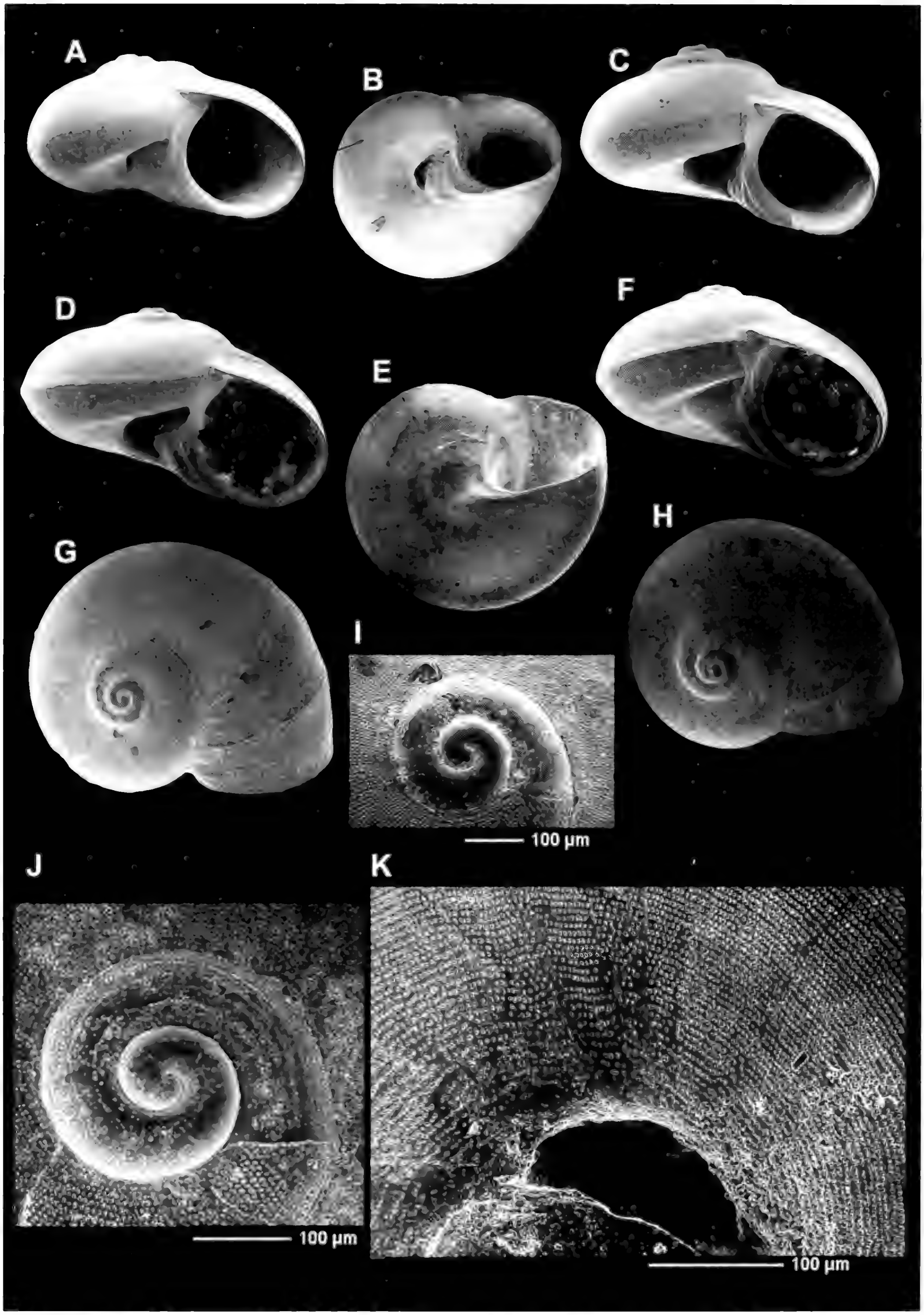
Remarks: *T. lenticulare* is a fossil species described from the Miocene of Smithfield, Virginia, Yorktown Formation.

PILSBRY (1953: pl. 50, figs. 3-3d), figured shells of *T. lenticulare* with sizes between 1.65 mm and 1.80 mm, and compared them to the type of Lea, with the intention of making a comparison with shells of *T. goniogyrus*. He did not mention any similarity to *T. incertum*, commenting that it is less depressed than *T. goniogyrus*, which in the first half of the last whorl is clearly angled, rather than keeled, and the angulation becomes obscure near the labrum. The columella is not clearly marked towards the external part from the umbilical callus.

MOORE (1964) also did not mention *T. lenticulare*. Further, he made no reference to *T. lenticulare* in his discussion of *T. incertum* only making a comparison to *T. parvicallum*.

In this species as well as others the callus form is very variable, and this is due to different developmental stages of the shell.

Teinostoma lenticulare as well as *T. goniogyrus*, *T. reclususm*, *T. ciskae* and *T. baldingeri* spec. nov. (see below), have a microsculpture formed by very small punctiform pits, clearly separated from each other, and spirally aligned. In contrast *T. incertum*, has punctiform pits at the beginning of the teleoconch, but they immediatly become incised spiral lines or sulci.



Figures 7A-K. *Teinostoma lenticulare* (H.C. Lea, 1846). A-H: shells in several positions, 1.1-1.3 mm, all from Cienfuegos Bay. I: protoconch; J: detail of the protoconch; K: detail of the umbilicus and microsculpture.

Figuras 7A-K. Teinostoma lenticulare *(H.C. Lea, 1846). A-H: conchas en diferentes posiciones, 1,1-1,3 mm, todas de la Bahía de Cienfuegos. I: protoconcha; J: detalle de la protoconcha; K: detalle del ombligo y microescultura.*

Teinostoma reclusum (Dall, 1889) (Figures 8A-G, 9A-F)

Ethalia reclusa Dall, 1889. *Bull. Mus. Comp. Zoology*, 18: 361, pl. 28, figs. 7. [Type locality: Yucatan Strait, 640 fms (1157 m); North Carolina, 12-63 fms (22-113 m)].

Type material: Syntype in MCZ (007552), from off Yucatan Strait, in 640 fms (1157 m) (Figs. 8A-G). This shell is here designated as the lectotype.
Other material examined: Florida, USA: 11 s, 32 mi. E St. Augustine, St. Johns Co., dredged 30 m (CHL); 1 s, 65 mi. E St. Augustine, St. Johns Co., dredged 53 m (CHL); 4 s, 29 mi. E Mayport, Duval Co., 23 m (CHL).

Description: This is the original description in DALL (1889a): "*Shell small, when fresh, vitreous transparent white, of three visible whorls, the last much the largest, smooth and polished above, or with only faint incremental lines below; periphery rounded, spire and base moderately rounded; margin of last whorl appressed at the suture so that the thin edge runs up over the preceding whorl and the real suture is almost invisible in fresh specimens; the outline of the preceding whorl being visible through the shell, the appearance of a suture is presented much nearer the periphery than the suture really is. Aperture nearly circular, oblique; the columella thick, appressed; umbilical callus sparse, not polished, in adolescent specimens not quite complete*".

We add: The shell (Figs. 8A-D, 9A-C) has 3 ¾ whorls, 2 corresponding to the protoconch and 1 ¾ to the teleoconch. The protoconch (Fig. 8F, 9D) is relatively large, about 260 μm in diameter, apparently smooth and two phases can be observed separated by a varix. The teleoconch is totally covered by rounded micropits clearly separated from each other, spirally aligned (Fig. 8G, 9E-F). The periphery of the last whorl is slightly angled near the base. Aperture quadrangular and peristome thick. Parietal callus wide. Columella and external lip wide and reflected outward. Base slightly convex, with a wide callus covering all the umbilicus.

Dimensions: The figured lectotype measures 1.7 mm in maximum diameter and 0.9 mm in height (ratio H/D= 0.52).

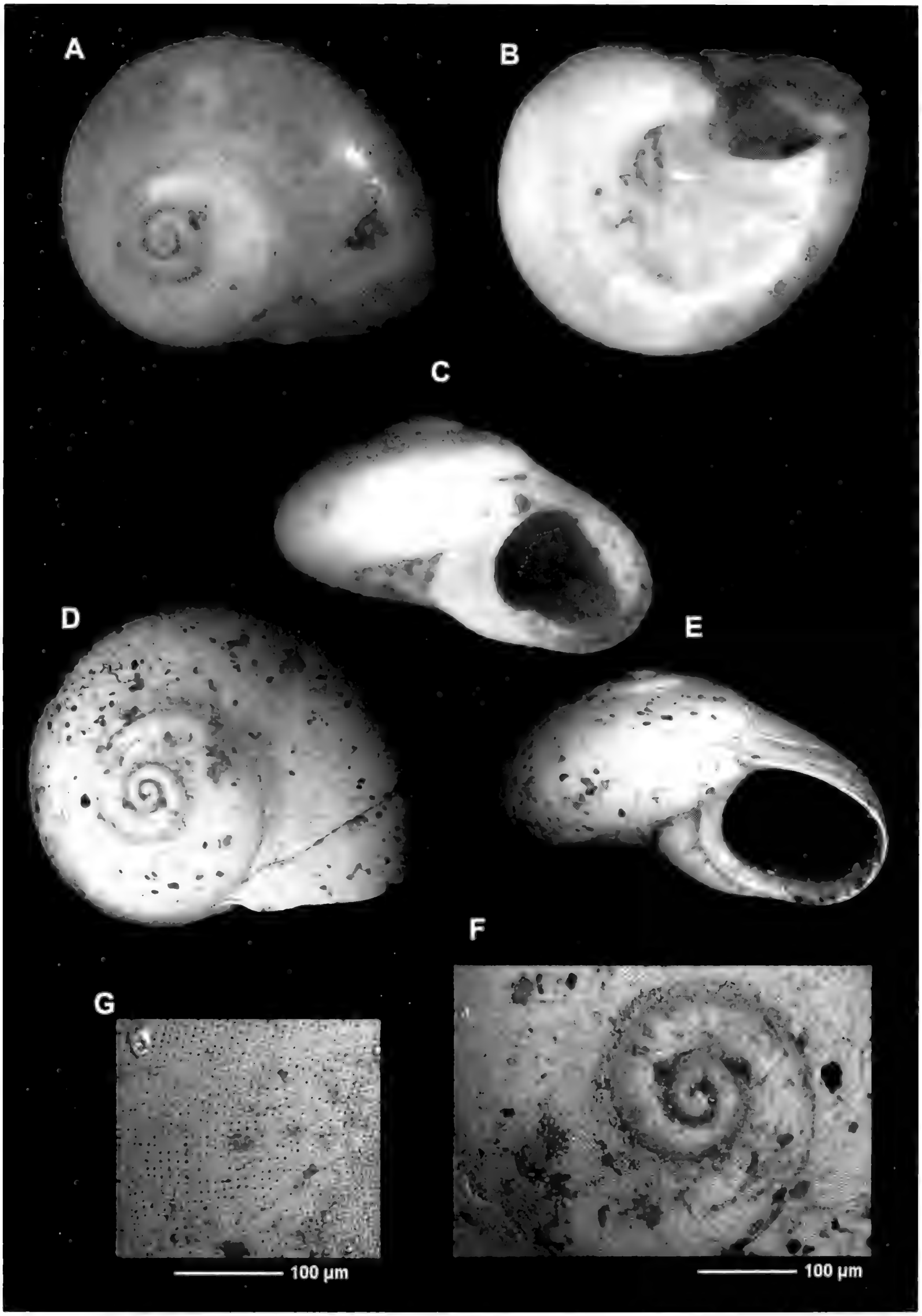
Habitat: This species is considered as being from deep water, having been described from shells collected in the Yucatan Strait in 1152 m depth (640 fathoms). In North Carolina (DALL, 1889) it was collected between 12 and 63 fms (22-113 m), on sandy and gravelly bottom in the warmer area. ODÉ (1987) recorded it at 22 m from North Carolina. LEE (2009) recorded it at 65 miles east of St. Augustine, St. Johns Co., Florida, dredged at 53 m.

Distribution: USA: North Carolina (JOHNSON, 1934; ODÉ, 1987a); Florida (LEE, 2009); Gulf of Mexico, 640 fms 1057 m; Yucatan Strait, Gulf of Mexico, 640 fms (1057 m) (DALL, 1889a).

Remarks: DALL (1889) reported the following: "This species is nearest to *Ethalia diaphana* d'Orbigny, so far as the base is concerned, but resembles *E. anomala* d'Orbigny in its upper surface, and was inadvertently referred to that species in my Preliminary Report (Bull., IX, p. 52). It has, however, a more elevated shell and a proportionately larger last whorl, while *E. anomala* has no basal callus over the umbilicus".

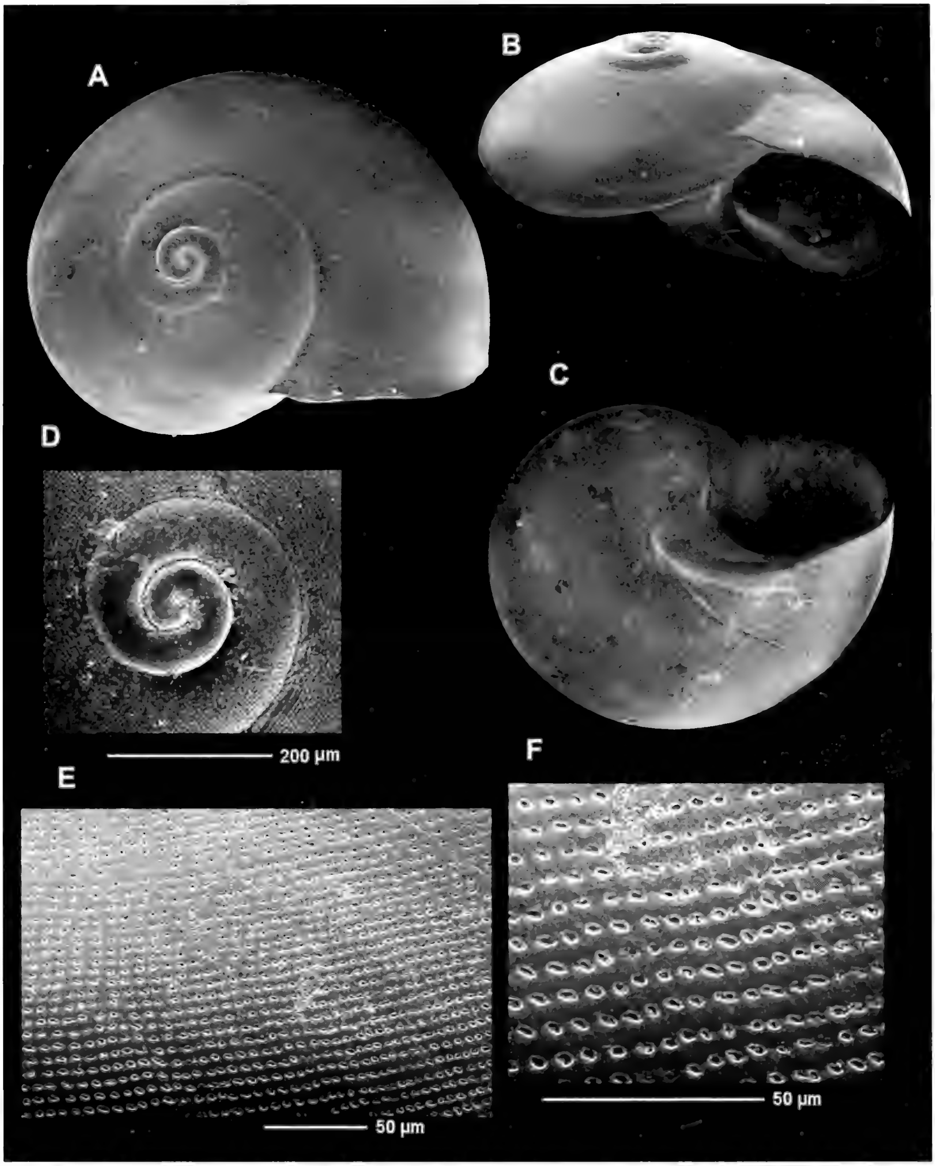
The figure in PILSBRY (1953, pl. 56, fig. 5) of the holotype of *T. subconicum* (H.C. Lea) is very similar to that of the holotype of *Ethalia reclusa* Dall, differing in the size of the callus, which does not totally cover the umbilicus and also because it lacks any microsculpture on the shell.

One of the distinguishing characters of *T. reclusum* are the micropits aligned spirally, which completely cover the shell. This character was not mentioned by DALL (1889) in the original description but was mentioned by LEE (2009, fig. 328) despite the companion shell figure appearing a little different from the lectotype.



Figures 8A-G. *Teinostoma reclusum* (Dall, 1889), lectotype from Yucatan Strait, 1.7 x 0.9 mm (MCZ 007552). A-C: optical photographs; D-E: SEM micrographs; F: protoconch; G: detail of the microsculpture.

Figuras 8A-G. Teinostoma reclusum *(Dall, 1889), lectotipo del Estrecho de Yucatán, 1,7 x 0,9 mm (MCZ 007552). A-C: fotografías ópticas; D-E: microfotografías MEB; F: protoconcha; G: detalle de la microescultura.*



Figures 9A-F. *Teinostoma reclusum* (Dall, 1889). A-C: shells, St. Augustine, St. Johns Co., Florida (CHL); D: protoconch; E-F: microsculpture.
Figuras 9A-F. Teinostoma reclusum *(Dall, 1889). A-C: conchas, St. Augustine, St. Johns Co., Florida (CHL); D: protoconcha; E-F: microescultura.*

T. reclusum could be grouped with *T. ciskae*-*T. goniogyrus*-*T. lenticulare*, all of which have their surface covered by pits.

T. ciskae is more globose and has fewer, larger micropits.

From *T. goniogyrus* and *T. lenticulare* it differs in having a smooth protoconch, the lack of spiral lines of micropits and the peripheral keel.

LEE (2009: 69; no. 328) figured this species (SEM).

Teinostoma baldingeri spec. nov. (Figures 10A-I)

Type material: Holotype (Figs. 10A-G) in MCZ (243769).
Type locality: At 3-4 miles S of Fort de France, St. Louis, Martinique, in 25-29 m.
Etymology: The specific name honors Adam J. Baldinger, Molluscs Collections Manager at the MCZ for his help in this paper.

Description: Shell (Figs. 10A-C) of very small size, whitish in color, almost transparent, shining, with a low spire, rounded periphery and globose appearance. The minute protoconch (Fig. 10I) has about 1 whorl, is apparently smooth, and measures 180 µm in diameter. The teleoconch has about 2 whorls, the suture is distinct, the periphery rounded, and is totally covered by micropits spirally aligned. The last whorl covers approximately 2/3 of the penultimate. Aperture oblique, subcircular; columella arched. Umbilical area concave, umbilicus completely covered by a thick callus that extends from the columella and which is characteristic of the species.

Dimensions: Holotype is 1.0 mm in maximum diameter.

Habitat: Dredged in 25-29 m.

Distribution: Only known from St. Louis, Martinique, the type locality.

Remarks: Despite its small size, we believe that the shell studied corresponds to an adult, if we consider the formation of the outer lip and columella, as well as the development of the umbilical callus.

Teinostoma baldingeri spec. nov. could be confused with other species of the genus *Teinostoma* such as *T. ciskae, T. goniogyrus, T. lenticulare , T. anastomosis* and *T. reclusum*, which have the same ornamentation, formed by micropits spirally aligned.

T. ciskae is more globose and its micropits are larger.

T. goniogyrus has a peripheral keel.

T. lenticulare has a peripheral keel and a protoconch with sculpture.

T. reclusum, is more depressed (ratio H/D= 0.52), has a different umbilical callus, and the spiral microsculpture is formed by aligned micropits.

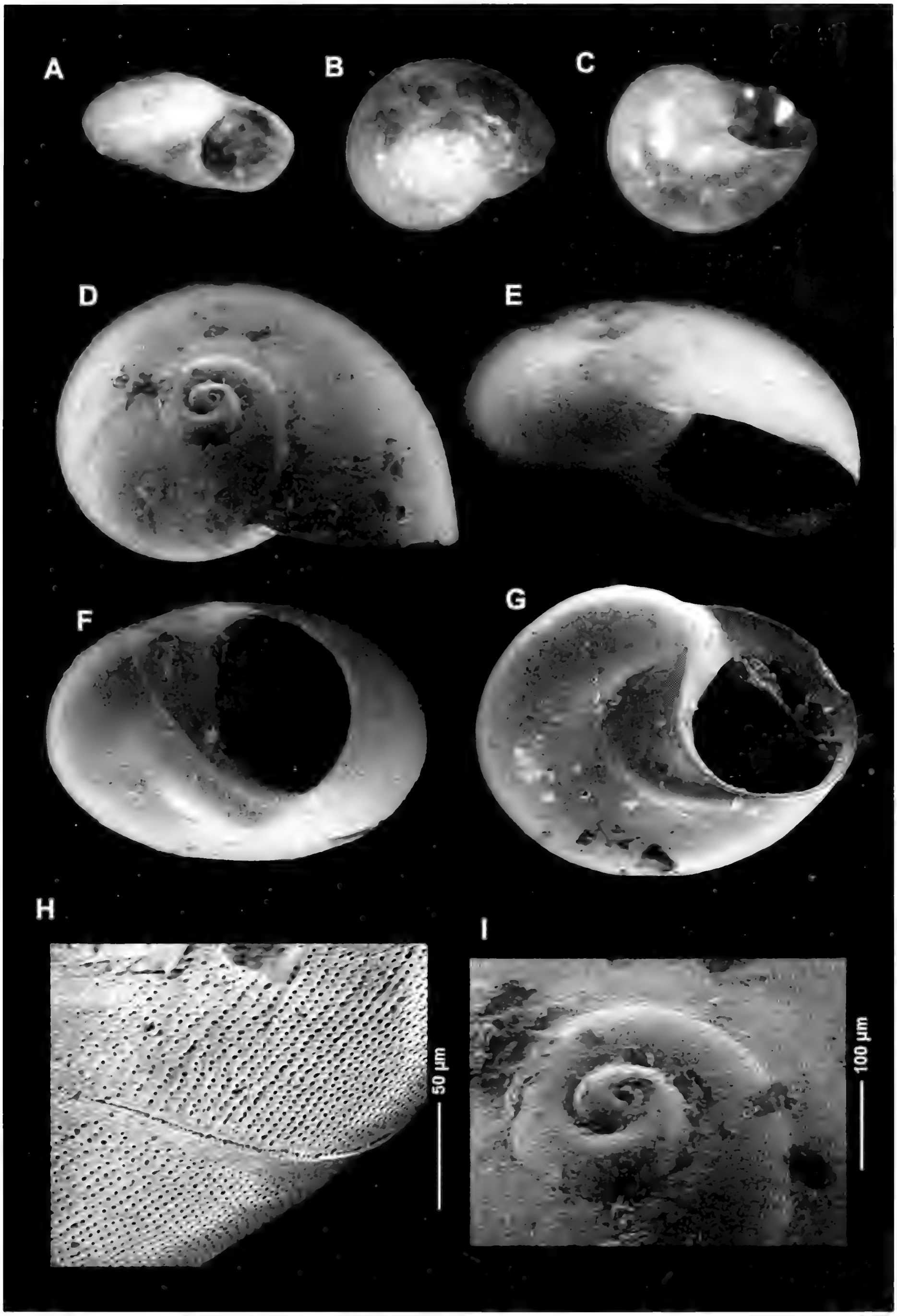
T. anastomosis spec. nov. (see below) has its first whorl totally covered by spiral irregular interdigitating microcordlets.

Teinostoma incertum Pilsbry & McGinty, 1945 (Figures 11A-E)

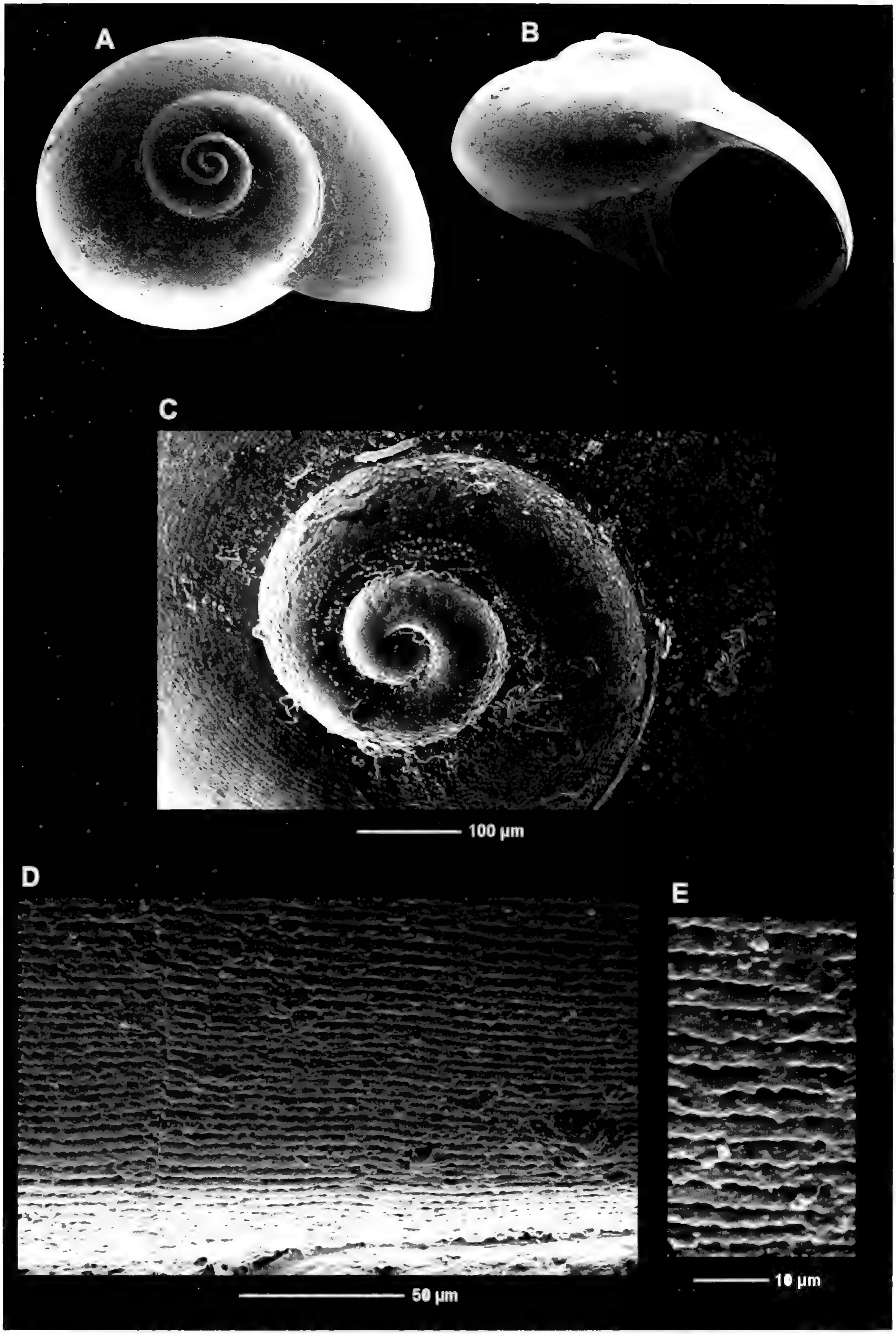
Teinostoma (Idioraphe) incertum Pilsbry & McGinty, 1945a. *The Nautilus*, 59: 7, pl. 1, fig. 7. [Type locality: Off Destin, northwest Florida].

Type material: Holotype of *T. incertum* in ANSP (181118). Not examined.
Other material examined: Florida, USA: 2 s, 1 m, Shoals reef, Shoals, Key West, Monroe Co. (CHL); 1 sp and 7 s, 32 mi E. St. Augustine, St. Johns Co., 30 m. dredged (CHL); 3 s, 23 mi ENE Mayport, Duval Co., 28 m (CHL); 2 s, 29 mi. ESE Mayport, Duval Co., 29 m, sand shell bottom (CHL).

Description: This is the original description: "*The shell is depressed but with a low-conic spire with distinct suture, a bluntly subangular periphery, microscopic spiral striation and very little umbilical callus. Whorls 3, convex, with impressed linear suture, the periphery of last whorl very obtusely subangular. The base is moderately convex, concave around the center. The oblique, circular aperture is somewhat angular above. Peristome blunt but rather thin outwardly; the columella very thick, passing into a moderate parietal callus. Behind the columellar thickening an umbilical callus closes the umbilicus, its edge ill-defined except towards the front of the shell, where it terminates in a rather deep*



Figures 10A-I. *Teinostoma baldingeri* spec. nov. A-C: holotype, 1 mm, optical photographs (MCZ 243769); D-G: holotype, SEM micrographs; H: microsculpture; I: protoconch.
Figuras 10A-I. Teinostoma baldingeri *spec. nov. A-C: holotipo, 1 mm, fotografías ópticas (MCZ 243769); D-G: holotipo, microfotografías MEB; H: microescultura; I: protoconcha.*



Figures 11A-E. *Teinostoma incertum* Pilsbry & McGinty, 1945. A-B: shell, 1.44 mm, Pelican Shoals, Florida (CHL); C: protoconch; D-E: microscupture.

Figuras 11A-E. Teinostoma incertum *Pilsbry & McGinty, 1945. A-B: concha, 1,44 mm, Pelican Shoals, Florida (CHL); C: protoconcha; D-E: microescultura.*

crease. Diameter 1.6 mm, height 0.95 mm".

There is a better and more complete description for *T. incertum* in MOORE (1964: 88-89).

The shell (Figs. 11A-B) is small, trochoid, relatively solid, with a shagreen appearance due to minute punctae. Protoconch (Fig. 11C) of about 2 whorls and about 380 µm in diameter, ornamented with randomly distributed tubercles and a line of tubercles close to the suture, the varix at the transition to the teleoconch is not thickened. Teleoconch of about 1 ½ whorls, increasing rapidly; whorls totally covered by pits in spiral lines connected by shallow grooves which transform them into incised lines. Periphery subangular, not angulated or keeled. Umbilicus totaly covered by numerous layers of callus originating behind the columella.

Dimensions: Holotype 1.6 mm in diameter by 0.95 mm in height. Our largest shells measure 1.44 mm in diameter.

Habitat: Marl bottom, in 32-36 m (PILSBRY & MCGINTY, 1945a).

Depth: 11 to 55 m. The shells studied were collected in sediments obtained at 1 m near the base of the reef. MOORE (1964) considered it as "a shallow shelf species along the Florida coasts".

Distribution: Known from the USA: East Florida, West Florida, Texas (PILSBRY & MCGINTY, 1945a; MOORE, 1964; LYONS, 1989; LEE, 2009); Florida and the east of Brazil (RIOS, 1994).

Remarks: PILSBRY & MCGINTY (1945a) mention, based on the incomplete callus and the final suture, that the name *"incertum"* does not refer to the validity of the species but to its systematic placement. They also comment that the minute spiral striation is too small to be shown in the figure of the holotype, suggesting that it is not present in beached shells.

It is curious to see that PILSBRY (1953, in OLSSON *ET AL.*, 1953) figured shells of *T. lenticulare* in comparison with *T. goniogyrus* but did not mention the existence of *T. incertum*, a species described by himself (PILSBRY & MCGINTY, 1945a: 7) which has a significant similarity in shell shape. MOORE (1964) also did not mention *T. lenticulare*. Further, he considers *T. incertum* close to *T. parvicallum*, from which it is differentiated by the spiral sculpture and the deeper suture. The umbilical callus, which is projected onto the lower part of the peristome, can also help in the identification.

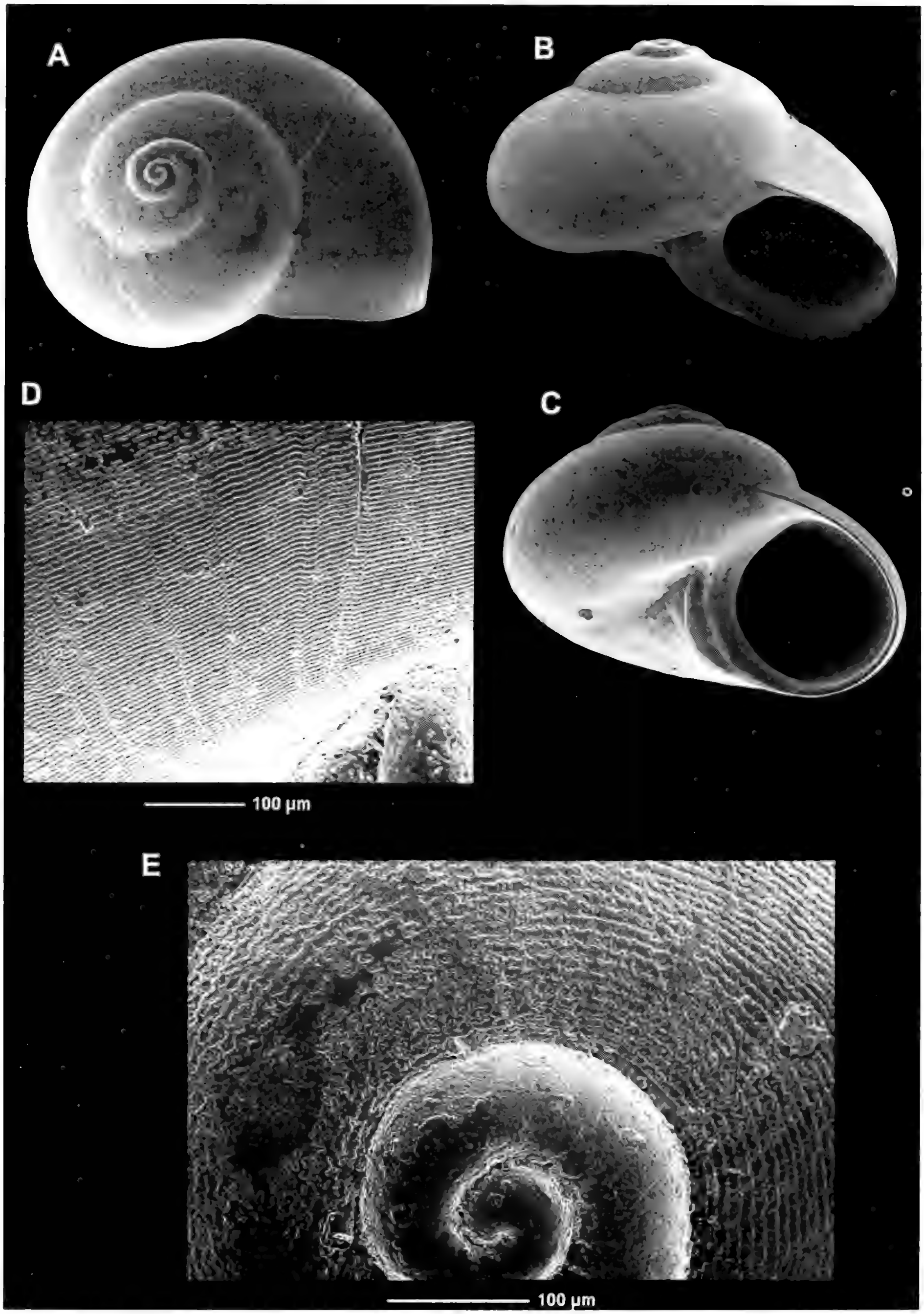
We think that the characteristic callus of *T. incertum* is simply due to the consideration of less than fully-developed specimens.

T. incertum is a species characterized by the microsculpture of the teleoconch, beginning with connected, vs. isolated, pits which promptly transform themselves into spiral lines completely covering the shell. *T. ciskae*, *T. goniogyrus*, *T. lenticulare*, *T. reclususm*, and *T. baldingeri* are different because the microculpture is formed by discrete punctiform pits spirally aligned but distinctly isolated from their neighbors.

LEE (2009: 68; no. 324) provided a SEM of a specimen missing some of its outer lip.

Teinostoma anastomosis spec. nov. Rubio, Rolán & Lee (Figures 12A-E)

Type material: Holotype (Figs. 12A-C) deposited in FLMNH (448607).
Type locality: Channel east of Seahorse Key, Cedar Keys, Levy Co., Florida, dredged 4.5-7 m.
Etymology: The specific name is in reference to the interdigitating sculpture on the early postnuclear whorls.



Figures 12A-E. *Teinostoma anastomosis* spec. nov. Rubio, Rolán & Lee. A-C. holotype, 1.79 mm, Channel east of Seahorse Island, Cedar Keys, Levy Co., Florida (FLMNH); D: microsculpture; E: microsculpture and protoconch.

Figures 12A-E. Teinostoma anastomosis *spec. nov. Rubio, Rolán & Lee. A-C. holotipo, 1,79 mm, Canal este de Seahorse Island, Cedar Keys, Levy Co., Florida (FLMNH); D: microescultura; E: microescultura y protoconcha.*

Description: Shell (Figs. 12A-C) solid, with trochoid aspect, a little wider than high (H/D= 0.75), and spire formed by 4 whorls. Protoconch (Fig. 12E) apparently smooth, measuring about 370 μm in diameter, with 1 ¾ whorls and with two stages, each delimited by a thick varix. The teleoconch has 2 ¼ whorls, the suture is distinct, the periphery rounded and totally covered by spiral irregular microcordlets (Figs. 12D-E) tend to fuse on the first whorl, producing micropits in their interspaces. Aperture rounded, slightly prosocline; columella thickened behind, without any canal, and with a callus which extends parallel to and behind it, partially closing the umbilicus.

Dimensions: Holotype is 1.79 mm in maximum diameter and 1.34 mm in height (ratio H/D= 0.75).

Habitat: Dredged between 4.5 to 7 m.

Distribution: Only known from the type locality.

Remarks: *Teinostoma anastomosis* spec. nov. may be distinguished from *T. ciskae*, *T. goniogyrus*, *T. lenticulare*, *T. baldingeri* and *T. reclusum*, because all these have a microsculpture formed by rounded micropits spirally aligned.

T. incertum and *T. panamense* have the same ornamentation formed by incised spiral lines, but *T. incertum* has a subangular periphery, and *T. panamense* is ornamented by widely-spaced punctiform incisions and has a striated umbilical callus.

Teinostoma panamense spec. nov. Rubio, Rolán & Lee (Figures 13A-D)

Type material: Holotype (Figs. 13A-B) deposited in FLMNH (448606).
Type locality: Portobello, Panama.
Etymology: The specific name alludes to the country where the species was collected.

Description: Shell (Figs. 13A-B) solid, with trochoid aspect and spire slightly elevated; formed by 4 whorls. Protoconch (Fig. 13C) a little uncleaned in the sutural area, without tubercles or spiral sculpture, measuring about 350 μm in diameter, with 2 whorls, delimited by a weak varix. The teleoconch has 2 whorls, is covered entirely by micropits aligned spirally, which initially are rounded and are closer, becoming somewhat more punctiform incisions (Fig. 13D). Suture covered by a thin horny layer uncemented. Periphery rounded, not keeled, angular, or subangular. Aperture rounded, slightly prosocline. Columella not thickened, separated from the callus by a shallow groove at its outer edge. Base slightly concave. A thick striated callus completely occludes the umbilicus.

Dimensions: Holotype is 1.40 mm in maximum diameter.

Habitat: Unknown. Material studied from drift sample.

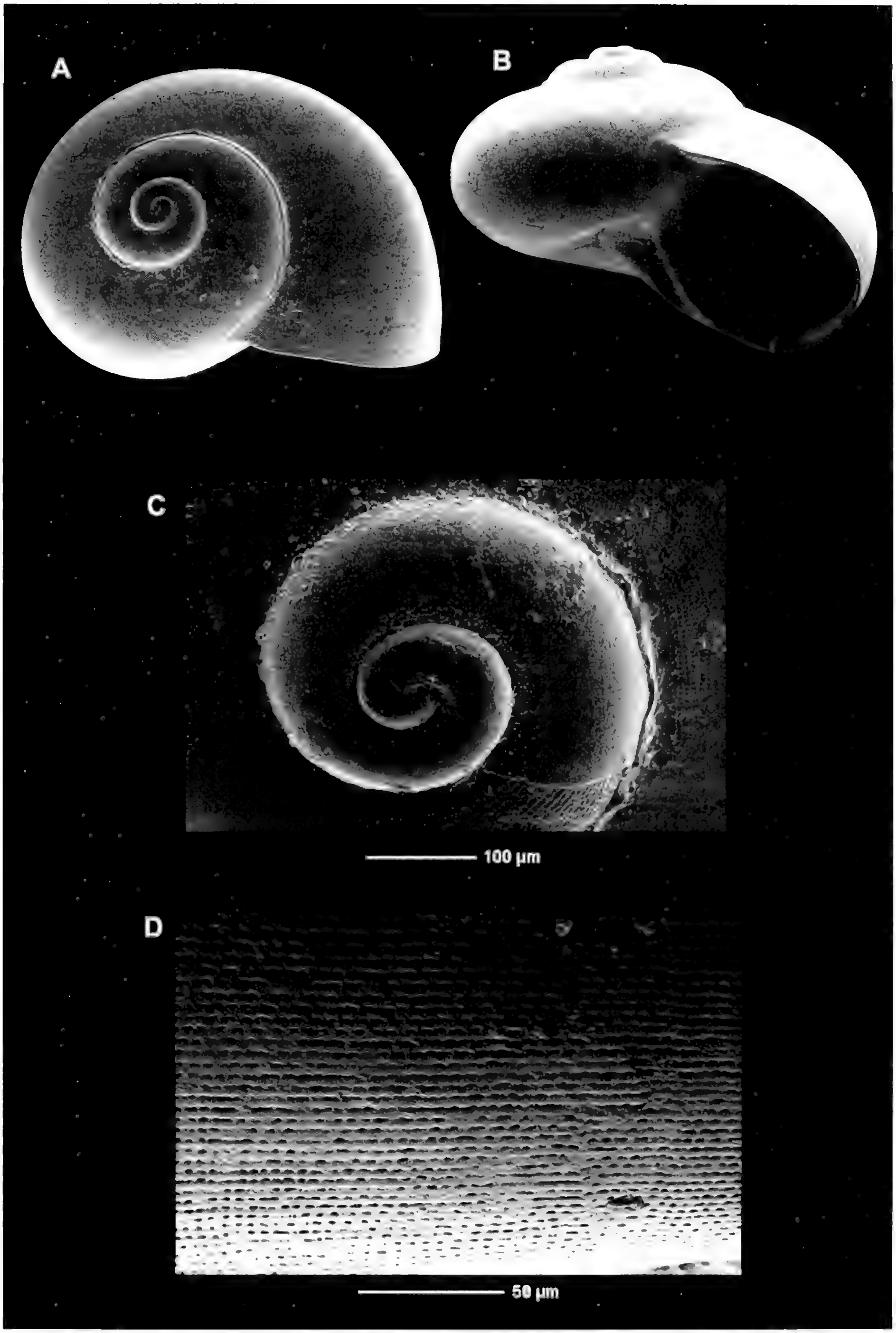
Distribution: Only known from the type locality.

Remarks: *Teinostoma panamense* spec. nov. can be distinguished from *T. ciskae*, *T. goniogyrus*, *T. lenticulare*, *T. baldingeri* and *T. reclusum* because all of these have a microscupture formed by rounded micropits spirally aligned.

T. incertum and *T. anastomosis* have the same ornamentation formed by incised spiral lines. But *T. incertum* has a subangular periphery and *T. anastomosis* is ornamented by spiral irregular microcordlets which are fused occasionally between them on the first whorl, presenting micropits in their interspaces.

Teinostoma biscaynense Pilsbry & McGinty, 1945 (Fig. 14A-D)

Teinostoma (Idioraphe) biscaynense Pilsbry & McGinty, 1945a. *The Nautilus*, 60: 5, pl. 1, fig. 4. [Type locality: Biscayne Bay at Coconut Grove, Florida].



Figures 13A-D. *Teinostoma panamense* spec. nov. Rubio, Rolán & Lee. A-B: holotype, 1.4 mm, Portobello, Panama (FLMNH); C: protoconch; D: microsculpture.

Figuras 13A-D. Teinostoma panamense *spec. nov. Rubio, Rolán & Lee. A-B: holotipo, 1,4 mm, Portobello, Panamá (FLMNH); C: protoconcha; D: microescultura.*

Type material: Holotype in ANSP (181104). Not examined.
Other material examined: Florida, USA: 1 s, 50-60 mi. E Ponte Vedra, St. Johns Co., 45 m (CHL); 1 s, Pelican Shoals, Key West, Monroe Co., 1 m, edge of reef (CHL); 1 s, 32 mi. E St. Augustine, St. Johns Co., 30 m (CHL); 1 f, Anclote Key, Pasco Co., sand bar (CHL). ABC: 3 s, off Palm Beach, Aruba, 5 m (CHL). Cayman Islands: 1 s, 100 m off Seven Mile Beach, 30 m, base of coral, Grand Cayman (CHL). Virgin Islands: 2 s, Dead Man Reef, 18 m (CHL). Panama: 1 s, Colín Is., Bocas Islands (CEG). Bahamas: 3 s, South Riding Rocks, Cay Sal Bank, 28 m, base of live coral reef (CHL). Cuba: 7 s, Guajimico (MHNS).

Description: Original description in PILSBRY & MCGINTY (1945a): *"The strongly depressed shell is glossy and smooth except for fine weak growth-lines; about equally convex above and below, with rounded periphery and small umbilical callus. There are about 3 ½ whorls, the first projecting, the next rather narrow and flat, the last whorl increasing very rapidly. The suture is distinct, visibly impressed, not obscured by overlaid callus. The broadly ovate aperture is rather strongly oblique, angular above. The upper margin is thin, arching rather strongly forward. The columella is rather thick, rounded, reflected in a broad callus covering the umbilicus and passing into a rather thin parietal callus, which is thickened in the posterior angle of the aperture. Diameter 1.8 mm, height 0.9 mm"*.

In our material it is possible to see that the largest shell has most of the columellar callus while there is a fine coating covering the suture.

Habitat: It lives in shell sand in Biscayne Bay at Coconut Grove and near Baker's Haulover, also on rocky sand bars (PILSBRY & MCGINTY, 1945a). It is a common inshore and shallow coastal water species in the southeastern United States (MOORE, 1964).

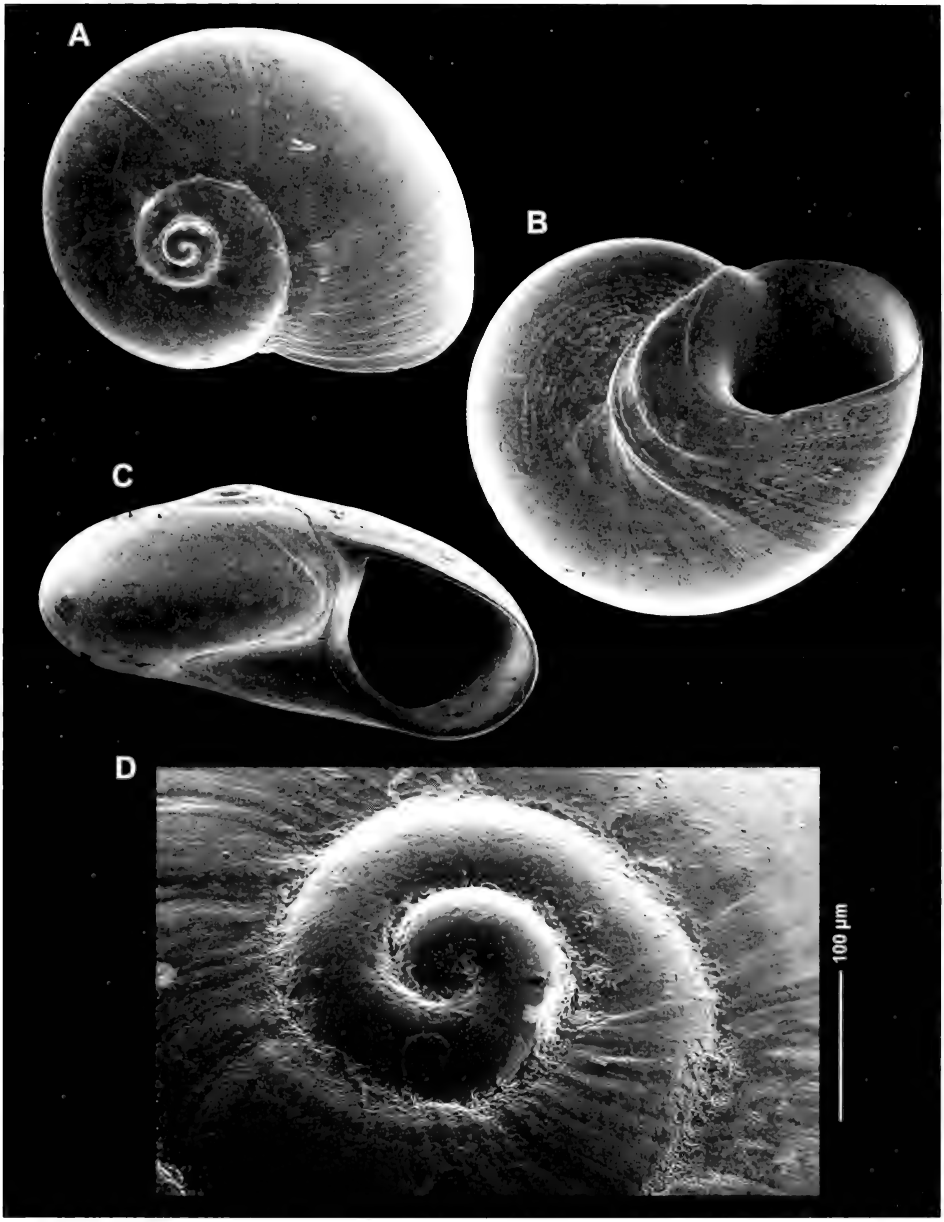
Distribution: *Teinostoma (Idioraphe) biscaynense* has been recorded from Biscayne Bay at Coconut Grove, Florida (PILSBRY & MCGINTY, 1945a); from East Florida, West Florida and Texas (MOORE, 1964); from Florida Peninsula (COOLEY, 1978); from Florida to Texas (EMERSON & JACOBSON, 1976; LYONS, 1989; LEE, 2009); from Mexico: Tabasco (GARCÍA-CUBAS & REGUERO, 1990) and Veracruz (REGUERO *ET AL.*, 1991); from Abaco, Bahamas (REDFERN, 2001). Now recorded from Panama and Cuba.

Remarks: In the original description, PILSBRY & MCGINTY (1945a) make reference to its similarity to *T. reclusum* in size and in the small columellar callus, being different because the spire of the latter species is more elevated, and the upper margin of the lip is also different.

MOORE (1964: 95) remarked that he had examined the types of *T. biscaynense*, *T. nesaeum* and *T. obtectum*, deposited in the ANSP, commenting that the type of de *T. biscaynensis* is a juvenile beached shell which had lost a great part of the dorsal callus; that of *T. obtectum* is also a beached shell but in better condition; finally, that of *T. nesaeum* is a specimen collected alive with soft parts remaining in the shell. After the comparison of the three types with hundreds of shells from Biscayne Bay, he commented that no differences between them were found except those related to variation in size. As for the spiral cordlets on the dorsum present in the shells of *T. nesaeum*, he did not consider them an important taxonomic character, making reference to them as "extremely evanescent". Thus, he concluded that *T. biscaynense*, *T. obtectum* and *T. nesaeum* were the same species giving *T. biscaynense,* the first species published in the same work, priority.

We do not agree with this conclusion, and, as we will show in the description and figures, each one has constant taxonomic characters sufficient to consider them as valid species just as they were described by PILSBRY & MCGINTY (1945a). The shells photographed agree perfectly with the material described and figured by PILSBRY & MCGINTY (1945a: fig. 4).

MOORE (1964) also stated that *T. biscaynense* is different from the other



Figures 14A-D. *Teinostoma biscaynense* Pilsbry & McGinty, 1945. A: shell, 1.3 mm, Florida (CHL); B-C: shells, 1.2, 1.36 mm, Guajimico, Cuba (MHNS); D: protoconch, from Cuba.
Figuras 14A-D. Teinostoma biscaynense *Pilsbry & McGinty, 1945. A: concha, 1,3 mm, Florida (CHL); B-C: conchas, 1,2, 1,36 mm, Guajimico, Cuba (MHNS); D: protoconcha, de Cuba.*

species of the genus *Teinostoma* from shallow water in the West Indies because it has the spire totally covered by a fine callous coat. Also, this character made it similar to *T. cryptospira* (= *T. umbilicatum*), a species from deep water off Cape Hatteras, North Carolina.

We do not agree with this because PILSBRY & MCGINTY (1945a) stated in their original description: *"The suture is distinct, visibly impressed, not obscured by overlaid callus"*. In relation with the protoconch: *"There are about 3 ½ whorls, the first projecting, the next ..."* Based on this passage, the spire of *T. biscaynense* cannot be totally covered by a callous coating, as is emphasized by MOORE (1964: 96, 98). This discrepancy may reflect an error in the identification of the examined types.

T. biscaynense differs from a group of species formed by *T. umbilicatum* (=*T. cryptospira*), *T. nesaeum*, *T. obtectum*, *T. lerema* and *T. clavium*, because in these a fine callous coat covers the spire, partially or totally, the protoconch being hidden in some of them.

Teinostoma obtectum Pilsbry & McGinty, 1945 (Figures 15A-B)

Teinostoma (Idioraphe) obtectum Pilsbry & McGinty, 1945a. *The Nautilus*, 59: 6, pl. 1, fig. 6. [Type locality: "Treasure Island", the first islet south of Singer Bridge, northern end of Lake Worth, Palm Beach, Florida].

Type material: Holotype in ANSP (181121). Not examined.
Material examined: Florida, USA: 1 s, 29 mi. ESE Mayport, Duval Co., Fl., 23 m(CHL); 1 s, just S jetty, Anastasia Island, St. Augustine Beach, St. Johns Co. (CHL); 1 s, beach, Indian Pass, Port St. Joe, Gulf Co. (CHL).

Description: This is the original description of PILSBRY & MCGINTY (1945a): *"The moderately solid smooth shell is strongly depressed, transversely dilated, the spire covered with a translucent glaze through which the suture shows. About three rather rapidly increasing but regularly spiral whorls are visible through the subtransparent callous coat over the spire, which superficially shows no trace of the suture. The periphery is rounded, the base not very convex. Aperture is rounded, but angularly produced and slightly channelled above and with a flattened parietal outline. Outer margin of peristome thin, the concave columella rather thick, passing into the rather large and slightly convex umbilical callus. Parietal callus is rather thick. Diameter 2.2 and 1.65 mm, height 0.95 mm"*.

Maximum reported size: 2.2 mm

Habitat: Shell sand bottom (PILSBRY & MCGINTY, 1945a). Bathymetric range 0 to 500 m.

Distribution: USA: Florida: East Florida (PILSBRY & MCGINTY, 1945a; MOORE, 1964: 4; LEE, 2009: 68); Mexico: Campeche State, Yucatan State, Quintana Roo (VOKES & VOKES, 1984); Venezuela: unlocalized (PRINCZ, 1982a); Puerto Rico (WARMKE & ABBOTT, 1961).

Remarks: After the description of the species PILSBRY & MCGINTY (1945a) mention: *"The elliptical outline, the strong depression, and the callus smoothly covering the spire, distinguish this species, which is known by a single shell. A small nick in the outer lip was restored in the figure"*.

MOORE (1964: 97) stated: *"The types of* Teinostoma biscaynensis, T. nasaeum *and* T. obtectum *have been examined by the writer. That of* T. biscaynensis *is a worn dead shell which has lost most of the dorsal shelly callus. The type of* T. obtectum *is also a dead shell, but is in much better condition. It is near the maximum size of the species. The type of* T. nasaeum *was taken alive, and the soft parts still remain in the shell. The writer has compared all three types with each other and with several hundred specimens from Biscayne Bay, and can find no differences other than those resulting from wear and tear or variation in size. As* T. biscaynensis *is the first species listed in PILSBRY & MCGINTY (1945a), it is given page precedence, and the other two species are placed in synonomy"*.

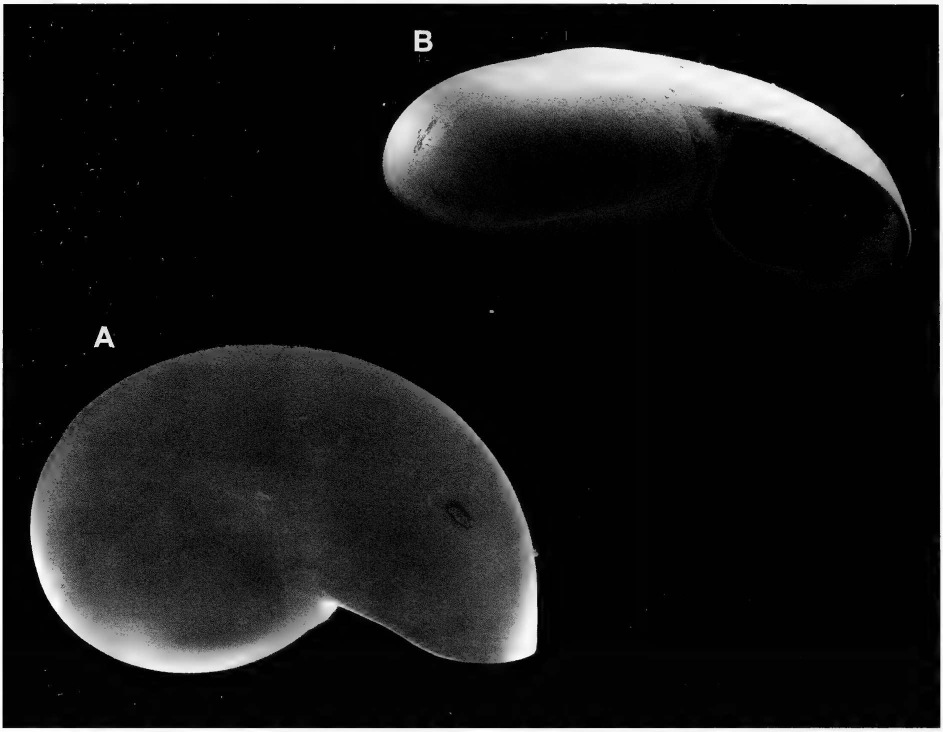


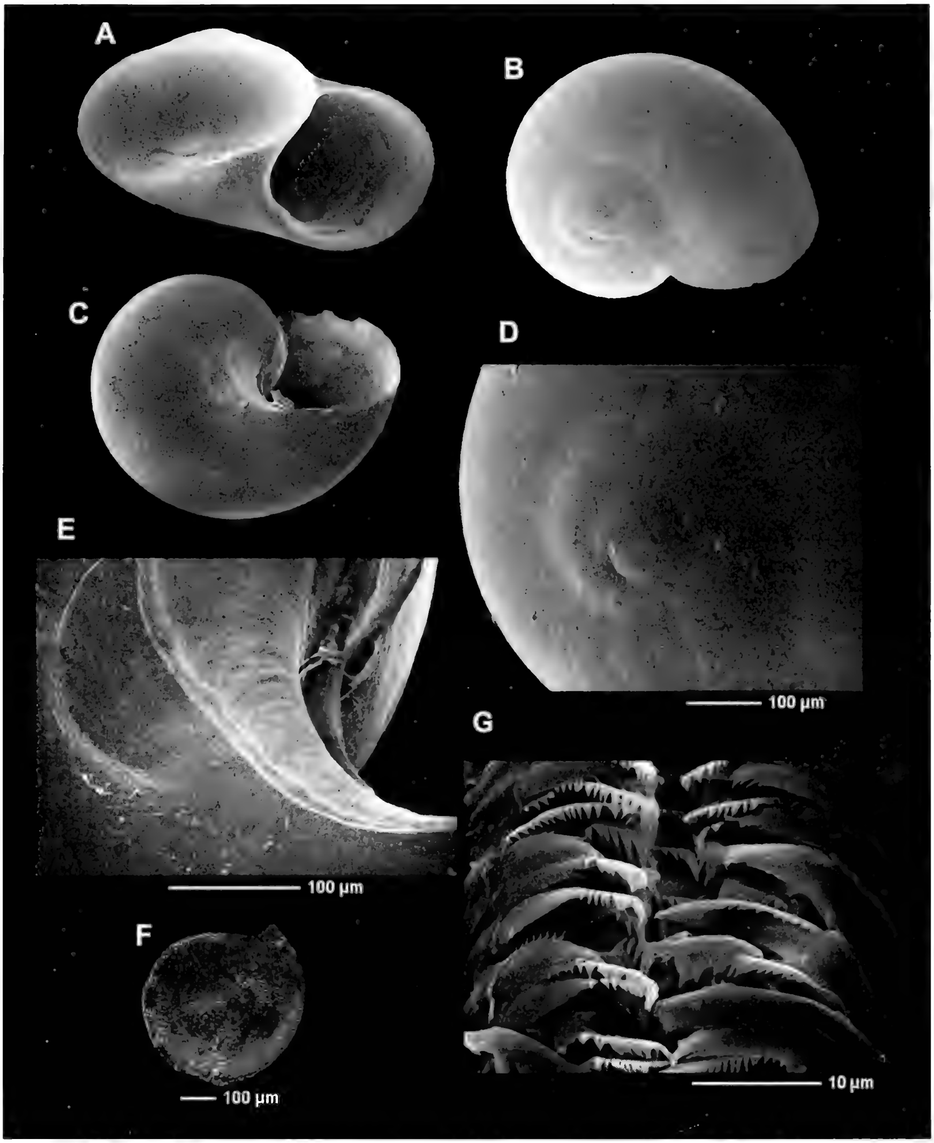
Figure 15A-B. *Teinostoma obtectum* Pilsbry & McGinty, 1945. A-B: shell, 1.9 mm, Port St. Joe, Gulf Co, Florida (CHL).
Figura 15A-B. Teinostoma obtectum *Pilsbry & McGinty, 1945. A-B: concha, 1,9 mm, Port St. Joe, Gulf Co, Florida (CHL).*

We can not agree with this opinion, because the descriptions and the figures of the original papers given by PILSBRY & MCGINTY (1945a) of these three species synonymized by MOORE (1964) have been enough to identify the material studied in them. Our only explanation is that there was mixing of the type material deposited in the museum. The shells photographed agree perfectly with the material described and figured by PILSBRY & MCGINTY (1945a: fig. 6).

There is a real confusion between *T. biscaynense* and *T. obtectum* because the latter species was described from a single shell and also because neither was figured with its original description. They were then placed in synonymy by MOORE (1964), whose judgement was accepted. *T. obtectum* differs from *T. biscaynense* in having the spire totally covered by a fine callous coating and also in the shape of the umbilical callus.

Teinostoma expansum spec. nov. (Figures 16A-G)

Type material: Holotype (Fig. 16A) deposited in MNCN (15.05/55063). Paratypes in USNM (1155031, 1 s, Fig. 16B) and MNHN (24402, 1 s, Fig. 16C).
Other material examined: Cuba: 2 sp and 4 s, Cienfuegos Bay, 22°07'N 80°27'W, 9 m (MHNS).
Type locality: Cienfuegos Bay, Cuba.
Etymology: The specific name refers to the expansion of the aperture.



Figures 16A-G. *Teinostoma expansum* spec. nov. A: holotype, 1.1 mm (MNCN). B-C: paratypes, 1.2, 1.3 mm, Cienfuegos, Cuba; D: protoconch; E: detail of the umbilical callus; F: operculum; G: radula. *Figuras 16A-G.* Teinostoma expansum *spec. nov. A: holotipo, 1,1 mm (MNCN). B-C: paratipos, 1,2, 1,3 mm, Cienfuegos, Cuba; D: protoconcha; E: detalle del callo umbilical; F: opérculo; G: rádula.*

Description: Shell (Figs. 16A-C) depressed, the spire totally covered by a fine callous surface which even hides the protoconch (Fig. 16D). By transillumination 3 ½ spiral whorls can be seen, the last one rapidly expanding and smooth except for fine growth lines. Aperture ovoid, oblique and wide; external lip sharp, projected outward. Columella (Fig. 16E) wide, rounded, reflected in a large callus which cover the umbilicus.

Dimensions: The largest shells studied were 1.3 mm in diameter.

Operculum (Fig. 16F) multispiral with a central nucleus.

Radula (Fig. 16G) taenioglossate, with formula 2+1+R+1+2. Central tooth wide basally, the ventral margin without denticles. Cutting area formed by a main large and sharp cusp and 4 denticles of lesser size on each side. Lateral teeth similar to the central one, the bases are quadrangular and also without denticles; border area with a central cusp and 5 smaller denticles at each side, more elongated wich central tooth. Marginal teeth wide and elongate; the inner with 28-30 slight denticles on the cutting edge is hook shaped; the outer marginal teeth are inclined outward in their upper third and have 14-18 denticles on the upper end of their internal margins.

Habitat: Our material was collected in about 9 m depth.

Distribution: Only known from Cienfuegos Bay, its type locality.

Remarks: *Teinostoma expansum* is close in shell characters to *T. biscaynense*, *T. obtectum* and *T. lerema*, all them characterized by having the spire covered totally or partially by a fine callous coat.

Teinostoma biscayense lacks this fine coat and the spire is free, thus allowing the protoconch to be photographed easily.

Teinostoma obtectum has a much more depressed shell, and the aperture is more deflected and oblique.

Teinostoma lerema has the aperture slightly oblique, grooved in the upper internal angle.

Teinostoma nesaeum Pilsbry & McGinty, 1945 (Figures 17A-F)

Teinostoma (Idioraphe) nesaeum Pilsbry & McGinty, 1945a. *The Nautilus*, 60: 5-6, pl. 1, fig. 2. [Type locality: Missouri Key, Florida].

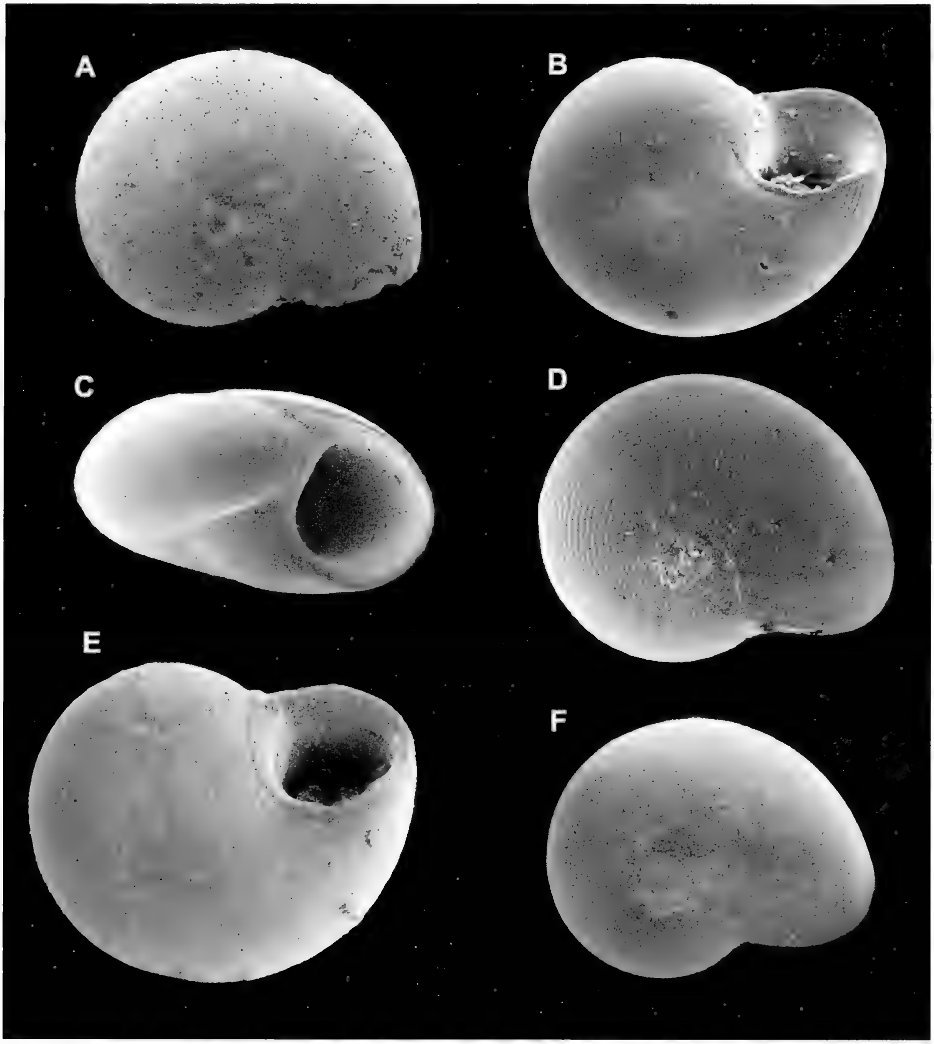
Type material: Holotype in ANSP (181117). Not examined.
Material examined: Cuba: 14 s, Guajimico, 15 m (MHNS); 1 s, Bahía de Cienfuegos, 20-30 m (MHNS); 15 s, Rancho Luna Beach, 30 m (MHNS).

Description: The original description in PILSBRY & MCGINTY (1945a: 5-6) is as follows: "*The shell is rather strongly depressed, about equally convex above and below, with rounded periphery; glossy, with some spiral striae on the upper surface, none on the lower. There are apparently about 2 ½ whorls, but the sutures are obliterated by a coat of translucent callus which covers the spire, with a shallow impression over the apex. The upper surface shows shallow spiral striae which weaken towards the periphery and disappear on the base. The aperture is oblique, rounded, but acute at the upper angle, which however is filled, making the cavity round. Outer lip blunt. Columella thickened, passing into the rather thick parietal callus. Umbilical callus thick, slightly convex, a trifle rugose*". The shells are represented in Figs. 17A-F)

Dimensions: Holotype 1.45 mm on maximum dimensions (diameter). The largest shell in our material is 1.4 mm.

Habitat: Living under stones and in rocky sandbars (PILSBRY & MCGINTY, 1945a: 6). Mangrove swamps, sandy and rocky areas (VOKES & VOKES, 1984). Shallow, soft bottoms (DÍAZ MERLANO & PUYANA HEGEDUS, 1994).

Distribution: The species has been collected from Missouri Key, Florida and Biscayne Bay near Baker's Haulover, Miami (PILSBRY & MCGINTY, 1945a:6). From Colón and Bocas island, Panama (OLSSON & MCGINTY, 1958). From South and North Carolina to the Caribbean Sea (HOUBRICK, 1968). From Campeche to Carmen and Zacatal cities, from Ninum Point to Campeche, from El Cuyo to Ninum Point, from Point Yalcupul to Cerritos island and from isla Mujeres to Isla Holbox, Mexico (VOKES & VOKES, 1984). From Curaçao, Aruba and Bonaire (DE JONG



Figures 17A-F. *Teinostoma nesaeum* Pilsbry & McGinty, 1945, shells, 1.2, 1.2, 1.2, 1.1, 1.0, 1.4 mm, Rancho Luna Beach, Cuba (MHNS).
Figuras 17A-F. Teinostoma nesaeum *Pilsbry & McGinty, 1945, conchas, 1,2, 1,2, 1,2, 1,1, 1,0, 1,4 mm, Playa Rancho Luna, Cuba (MHNS).*

& COOMANS, 1988). From North Carolina to Panama and Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). Also found in Cuba: Cienfuegos.

Remarks: MOORE (1964: 95-99) placed the taxa *T. nesaeum* and *T. obtectum* in synonymy with *T. biscaynense* (see above). We consider *T. nesaeum* a valid species, easily differentiable from its congeners by the following characters: dorsal ornamentation of fine spiral cordlets; base smooth; umbilical callus strong; suture covered by a translucent callus coat. These characters were also considered by PILSBRY & MCGINTY (1945a) as important for species separation.

All the shells studied have the cordlets on the dorsum but not on the base. We have not found intergradations.

Teinostoma semistriatum (d'Orbigny, 1842) (Figures 18A-I, 19A-F)

Trochus (Rotella) semistriata d'Orbigny, 1842. *Mollusques. Histoire Physique, Politique et Naturelle de l'île de Cuba* 2: 61, pl. 18, figs. 20-22. [Type locality: Cuba]

Pseudorotella semistriata (d'Orbigny): In P. Fischer, 1957. *Journal de Conchyliology* 6: 52.

Teinostoma (Idioraphe) clavium Pilsbry & McGinty, 1945a. *The Nautilus*, 60: 4, pl. 1, fig. 1. [Type locality: Tavernier, Key Largo].

Type material: Two syntypes in NHMUK (in very bad condition). Neotype here designated of *Trochus (Rotella) semistriata* in MCZ (208142), from La Chorrera, Habana, Cuba. Type species of *Teinostoma (Idioraphe) clavium* in ANSP (181106). Not examined.

Other material examined: Guadeloupe: 1 s, coralline sandy and rocky bottom, 2 m (CJP). Cuba: 5 s, Matanzas, Varadero (N Cardenas) (MCZ 109344); 7 s, Archipielago de los Canarreos, 15 m (MHNS); 8 s, Cayo Diego Perez, 12 m (MHNS); 19 s, Jibacoa, 3-6 m (MHNS); 1 s, Cienfuegos Bay, 20-30 m (MHNS); 48 s, Rancho Luna Beach, 20 m (MHNS); 2 s, Comodoro, 0 m (MHNS); 4 s, playa Girón, 5 m (MHNS). Florida USA: 1 s, Peanut Island, Lake Worth, Palm Beach Co. (CHL); 3 s, Virginia Key, Dade Co. (CHL); Spoil bank, APAC Pit, Sarasota Plio-Pleistocene (CHL). Bahamas: 2 s, Matt Lowes Cay, Abaco, grit (CHL); 1 s, Paradise Island, New Providence, 2 m (CHL); 6 s, West End, Grand Bahama Island, grit (CHL). Puerto Rico: 1 s, San Juan, grit (CHL). St. Martin: 15 s, Leeward Island, grit (CHL). Virgin Islands: 1 s, Frederiksted, St. Croix, grit (CHL).

Description: This is the original description in D'ORBIGNY (1842): *"Shell orbicular, depressed, thin, transparent, white, above transversely (i.e. concentrically) striae, beneath polished; umbilical callus shining; spire very short, obtuse, whorls four, slightly convex; aperture oval. Diameter 1.5 mm; height 0.7 mm"*.

Shell (Figs. 18A-F, 19A-E) strong, solid, somewhat depressed, totally covered by spiral cords. Umbilical callus wide (Fig. 18C). Protoconch (Figs. 18G-H, 19F) with about 1 ½ whorls, smooth, about 180 μm, partially covered by the first whorl of the teleoconch so only the apex of the protoconch is visible. Teleoconch with about 2 ¼ whorls, covered with spiral cords lacking sculpture in their interspaces (Fig. 18I); periphery rounded. Umbilical callus strong and wide, completely covering the umbilicus. Aperture oblique, with a small groove on the upper internal angle which is somewhat extended giving the shell an elongate aspect.

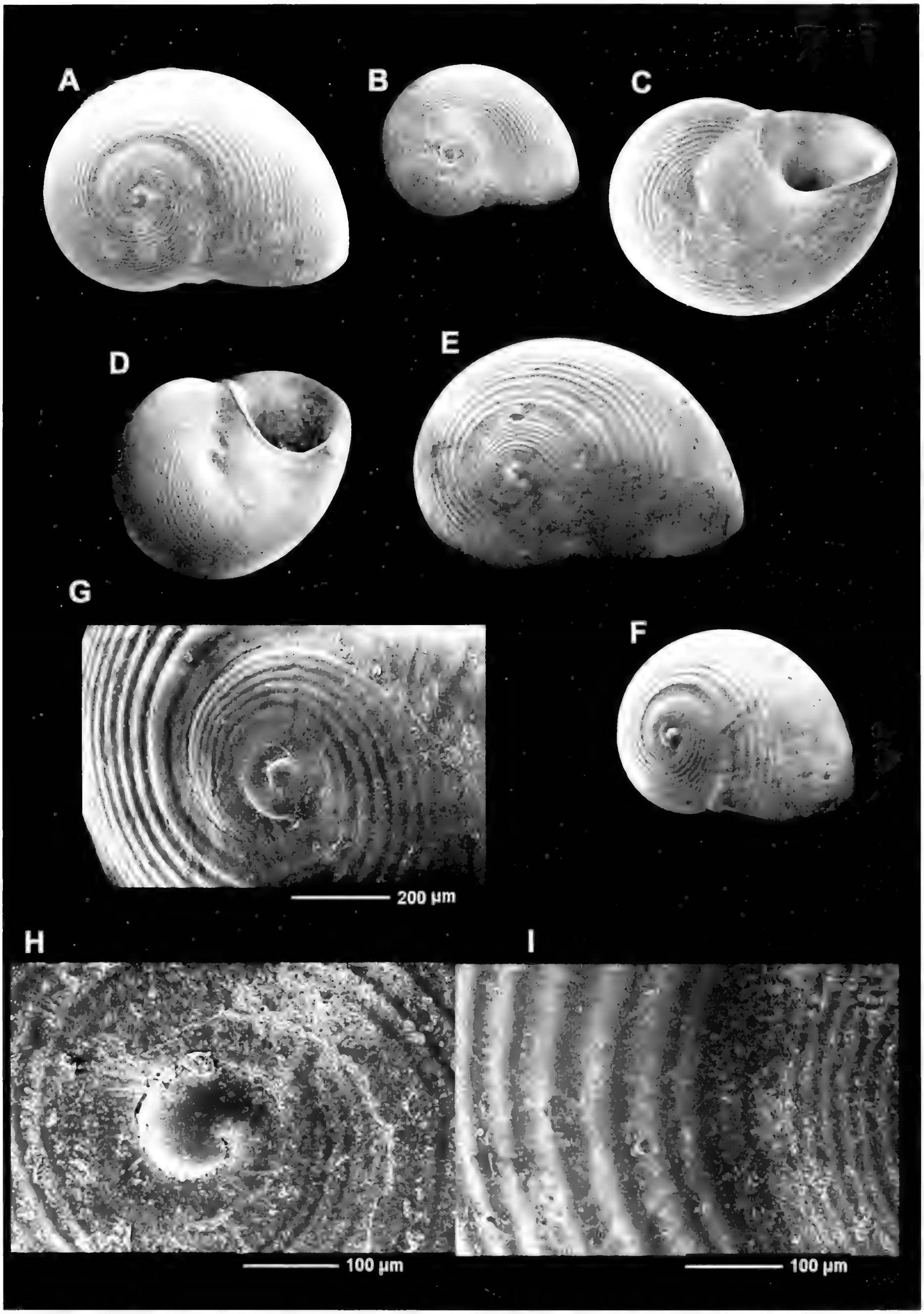
Dimensions: Holotype of *T. clavium* 2.3 mm in maximum diameter.

Habitat: This species lives in shallow water between 0 and 18 m depth. In Cuba it is relatively common, it was collected in sediments from between 5 and 30 m.

Distribution: Known from USA: Florida: East Florida, Florida Keys (JOHNSON, 1934; PILSBRY & MCGINTY, 1945a; MOORE, 1964; LEE, 2009); Mexico: Campeche State, Quintana Roo (ODÉ, 1987); Colombia, Venezuela: Sucre (DÍAZ MERLANO & PUYANA HEGEDUS, 1994; PRINCZ, 1986); Bahamas: New Providence (MOORE, 1964), Abaco (REDFERN, 2001); Puerto Rico (WARMKE & ABBOTT, 1961); Cuba (ORBIGNY, 1842; P. FISCHER, 1857; ESPINOSA *ET AL.*, 1985). Now recorded from Guadeloupe.

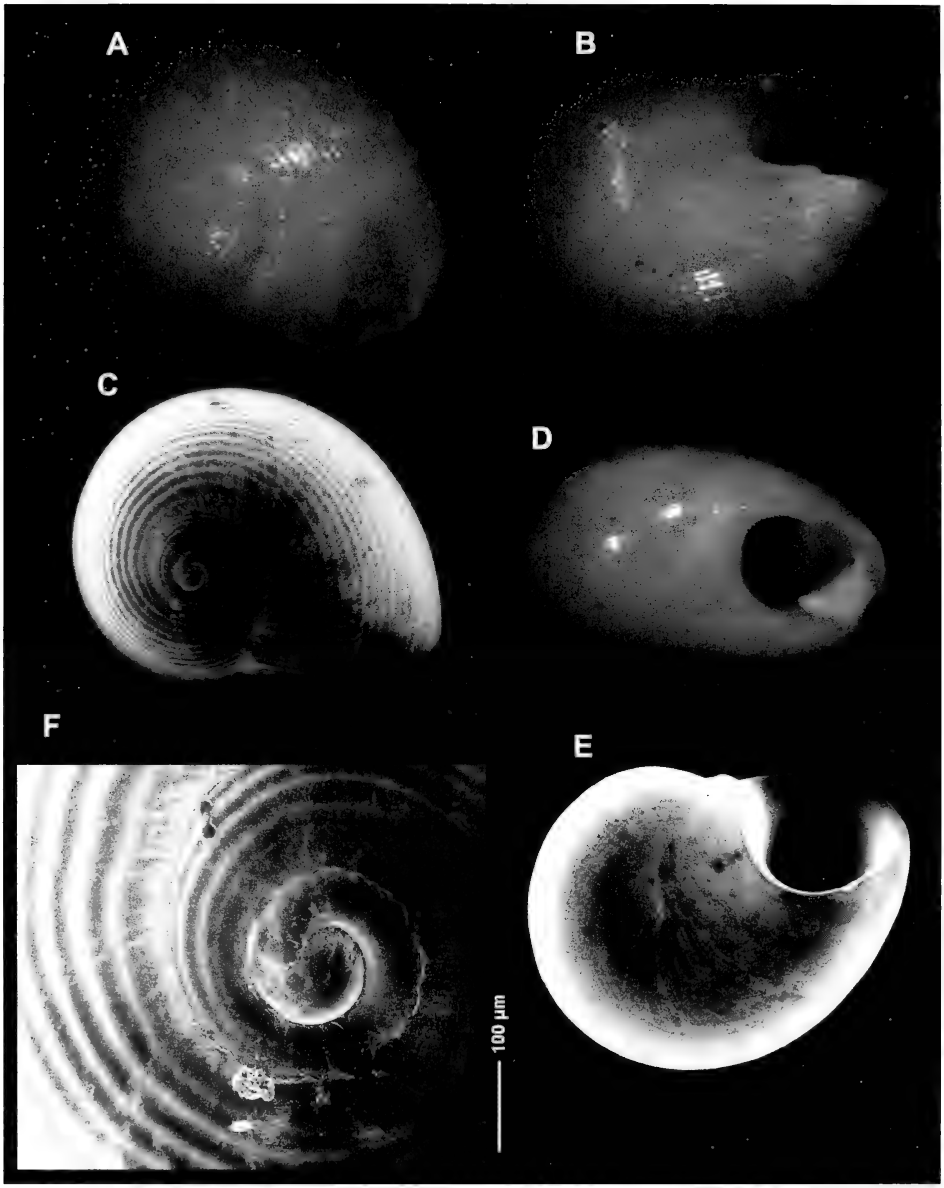
Remarks: *Nomen dubium* according to MOORE (1964: 81-82) who commented: *"The types of* Pseudorotella, T. semistriata *d'Orbigny, are in the British Museum (Natural History), but both types have deteriorated badly and the principle characters can not be made out. There has been a great deal of confusion with d'Orbigny's species for over a century, and, without an authentic specimen of* T. semistriata *to compare with other species, the true characters of the subgenus must remain in doubt. It is impossible to say which of d'Orbigny's (1842) species belong to the genus, and, since the types are no longer identifiable, they are here considered species indeterminate"*.

We have seen this type material in the NHMUK, and it is in very poor con-



Figures 18A-I. *Teinostoma semistriatum* (d'Orbigny, 1842). A-F: shells, 1.6, 0.9, 1.6, 1.1, 2.1, 1.1 mm, Cienfuegos, Cuba (MHNS); G: protoconch; H: detail of the protoconch; I: detail of microsculpture.

Figuras 18A-I. Teinostoma semistriatum *(d'Orbigny, 1842). A-F: conchas, 1,6, 0,9, 1,6, 1,1, 2,1, 1,1 mm, Cienfuegos, Cuba (MHNS); G: protoconcha; H: detalle de la protoconcha; I: detalle de la microescultura.*



Figures 19A-F. *Teinostoma semistriatum* (d'Orbigny, 1842). A-C: neotype, 2.1 mm, La Chorrera, La Habana (MCZ 208142); D-E: shells, 1.8, 2.2 mm, Matanzas, Cuba (MCZ); F: protoconch.
Figuras 19A-F. Teinostoma semistriatum *(d'Orbigny, 1842). A-C: neotipo, 2,1 mm, La Chorrera, La Habana (MCZ 208142); D-E: conchas, 1,8, 2,2 mm, Matanzas, Cuba (MCZ); F: protoconcha.*

dition, but in our opinion the taxon is not a *nomen dubium*.

In the type material of the Museum of Comparative Zoology (MCZ) there were two lots labeled: "*Pseudorotella semistriata* (Orb.), 5 specimens from Matanzas, Varadero, Cuba" deposited with nº 109344, which were sent by M. L. Jaume, a well-known Cuban malacologist, and another "*Teinostoma semistriata* d'Orb., 1 specimen from La Chorrera, Habana, Cuba," with nº 208142. We studied them closely, and they conform to the description of *Trochus semistriata*. This species seems to be relatively common along the Cuban coast, having being found in the beached shell grit.

In SAGRA (1842: 177) Orbigny mentions in relation to *Rotella semistriata*: *"It lives in Cuba, together with the former (*R. diaphana*). It can be found in large numbers in the sands of Playa del Chivo y of La Chorrera; found also in St. Thomas".*

For these reasons and in order to keep nomenclatural stability, we have designated as neotype the specimen from La Chorrera, Habana, deposited in MCZ with n° 208142 considering *T. clavium* Pilsbry & McGinty, 1945 a junior synonym.

In the original description d'Orbigny also mentions: *"beneath polished"*. This means the origin of the material employed for this description was beached and eroded; those shells have the base totally smooth and polished due to abrasion. However, as we can observe in fresh shells, the base is totally covered by spiral cordlets as is the dorsum.

Teinostoma semistriatum is a species easily distinguished from its congeners by its robustness and the size of the shell, the form of the umbilical callus, and the ornamentation of the teleoconch with spiral cords which completely cover the dorsum. The protoconch is partially concealed by the first whorl of the teleoconch. As in previous species, it can form a group with *T. umbilicatum*, *T. biscaynense*, *T. nessaeum* and *T. lerema*, because in all of them the last whorl is extended covering some or all of the previous whorls. MOORE (1964) mentions its similarity to *T. biscaynense* and *T. lerema*.

Teinostoma minusculum (Bush, 1897) (Figures 20A-D)

Pseudorotella minuscula Bush, 1897. *Transactions of the Connecticut Academy of Arts and Sciences* 10: 118-119, text-figs. 3a-c. [Type locality: USFC sta. 2283, off Cape Hatteras, North Carolina].

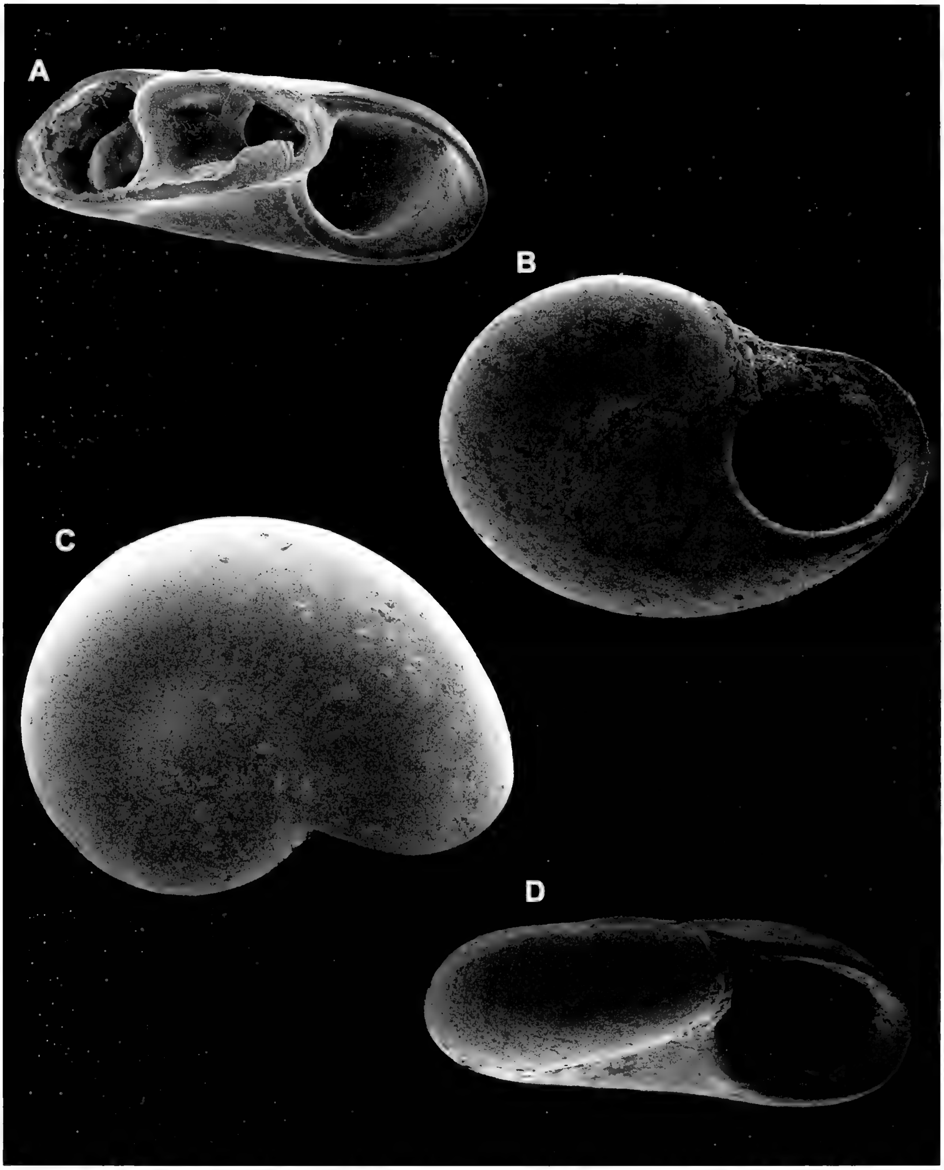
Type material: Holotype in USNM (41623) is a broken shell. Examined in micrograph (Fig. 20A).
Other material examined: USA: 1 s, off Dry Tortugas, Monroe Co., Florida, 20-50 fms (USNM); 1 s (more deteriorated), ENE Mayport, Duval Co., Florida, 26 m (CHL).

Description: Original description in BUSH (1897): *"Shell thick, solid, porcellanous, slightly tinted with yellow along the suture and on the base; flattened above and below, with the indented umbilical region covered with a thin lustrous glaze or layer of enamel. Surface smooth and very lustrous, marked only by irregular, microscopic, growth lines. Suture inconspicuous. Whorls about 2 ½, coiled in the same plane, lapping well on to each other, rapidly enlarging, with a very small nuclear whorl and large body-whorl. Aperture very oblique, somewhat ovate; peritreme not continuous, modified into a thin, inconspicuous glaze on the body-whorl, elsewhere with rounded edge, with a slight callous deposit beneath the suture where the outer-lip extends obliquely well forward from the body-whorl, with little, if any, curvature and forms a slight sutural notch. Greatest diameter, about 1.5 mm; height, about 0.5 mm". T. minusculum* has the umbilical region entirely covered by a thin, very lustrous glaze or layer of enamel, not in any sense a thickened pad as in *Teinostoma umbilicatum*.

Habitat: Depth: 14 to 50 fms.

Distribution: USA: North Carolina (BUSH, 1897); Florida: East Florida (LEE, 2009)

Remarks: This species was described in the subgenus *Pseudorotella* P. Fischer, 1857. BUSH



Figures 20A-D. *Teinostoma minusculum* (Bush, 1897). A: holotype, 1.5 mm, (USNM, 41623); B-D: shell, 1.6 mm, Dry Tortugas, Monroe Co., Florida (CHL).
Figuras 20A-D. Teinostoma minusculum *(Bush, 1897). A: holotipo, 1,5 mm, (USNM, 41623); B-D: concha, 1,6 mm, Dry Tortugas, Monroe Co., Florida (CHL).*

(1897) says: "*This species approaches* Teinostoma cryptospira *(A.E. Verrill) Dall, but it is a much smaller shell, with the whorls quite differently coiled and with the umbilical callus represented by a thin glaze*". Really, the only similarity with *Teinostoma cryptospira* is that both have the spire covered by a fine callous covering. LEE (2009: 68; no. 326) figured this species.

Teinostoma lerema Pilsbry & McGinty, 1945 (Figures 21A-H)

Teinostoma (Idioraphe) lerema Pilsbry & McGinty, 1945a. *The Nautilus*, 60: 6-7, pl. 2, figs. 1-1a. [Type locality: Missouri Key, Florida Keys].

Type material: Holotype in ANSP (181120). Not examined.
Other material examined: Cuba: 3 s, Cienfuegos Bay, 22°07'N, 80°27'W, 9 m (MHNS); 7 s, Cienfuegos Bay, 22°07'N80°26'W, 4 m (MHNS). Martinique: 1 s, Pointe Borgnesse, 12 m, sand-muddy bottom, close to the reef (CJP). St. Kitts & Nevis: 4 s, Monkey Shoals, Nevis Island, 18 m (CHL). Haiti: 1 s, Labaree, sand beach (CHL). Puerto Rico: 1 s, San Juan, grit (CHL). Panama: 3 s, Isla Carenero s, 8-9 m (CHL); 1 s, 1 mi. Punta San Blas, San Blas Island, sand bar just inside reef (CHL).

Description: Shell (Figs. 21A-G) very small, solid, smooth and shiny. Protoconch (Fig. 21H) smooth, with about 2 whorls, and a diameter of about 200 µm, but usually partially covered by the first teleoconch whorl. The teleoconch has a little more than one whorl and is smooth except for fine growth lines. Suture covered by a fine callous coat. Umbilicus totally covered by a thin callus. Aperture oblique, rounded, without any sulcus on the upper internal angle; the outer lip is extended outward, giving the shell a more elongated aspect.

Dimensions: Holotype 1 mm in maximum diameter and 0.45 mm in height. The largest of our shells is 1.0 mm in diameter.

Animal figured by PILSBRY & MCGINTY (1945a, pl 2, fig. 1a).

Habitat: Living under rocks (PILSBRY & MCGINTY, 1945a). Collected alive under stones between 0.6 and 16 m in depth. The Cuban shells were found in sediments from between 4 and 9 meters. Records between 0 and 48 m.

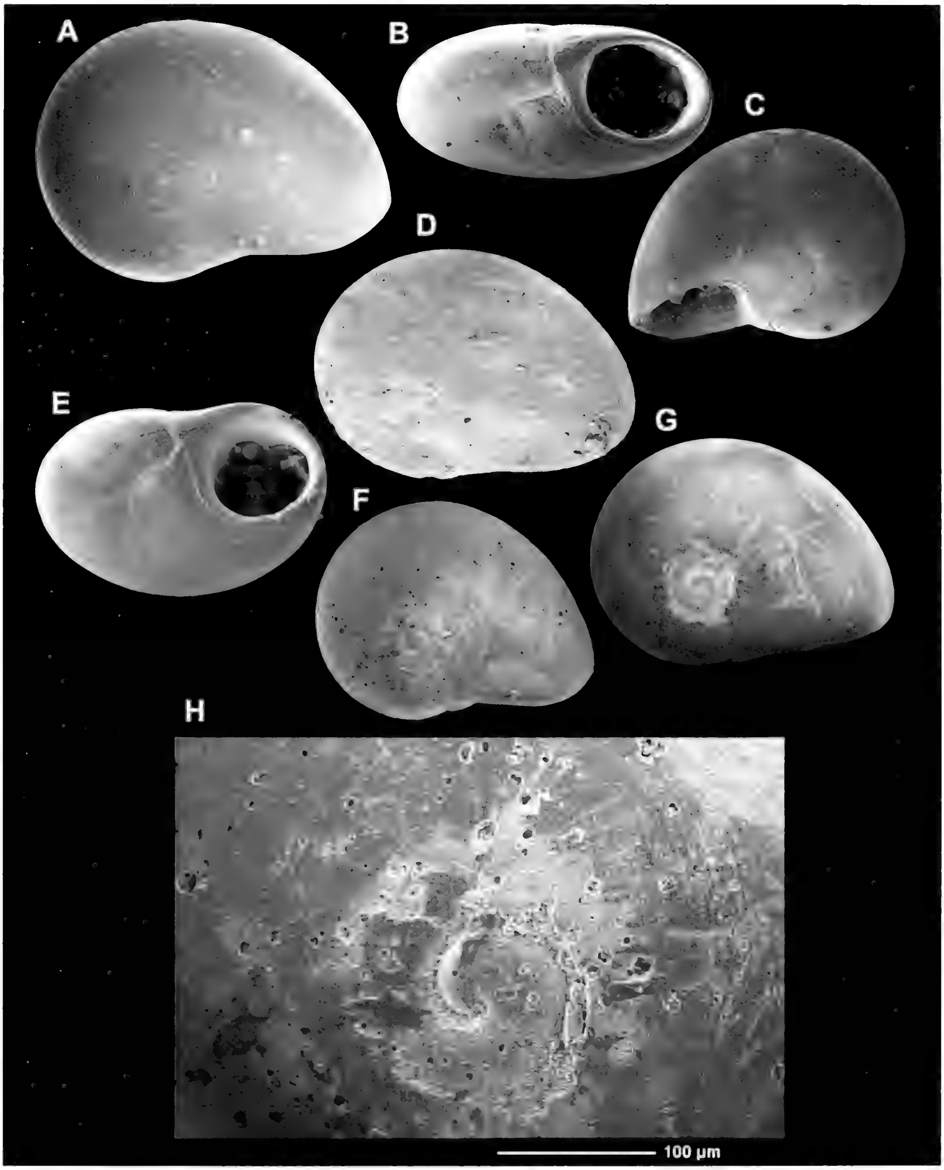
Distribution: Know from the USA: West Florida, Missouri Key (PILSBRY & MCGINTY, 1945a); Texas (ODÉ, 1987); Mexico: Tabasco, Veracruz, Campeche State (GARCÍA-CUBAS, 1971); Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994); Virgin Islands: St. John (MOORE, 1964), Curaçao (DE JONG & COOMANS, 1988); Cuba (SARASÚA, 1970; ESPINOSA *ET AL.*, 1985).

Remarks: It is the smallest *Teinostoma* described up to now. Its small size, the suture covered by a fine callous layer and the elongated form of the aperture differentiate it from congeneric species. *Teinostoma lerema* has a certain similarity to *T. biscaynense* in general form, but the latter has the spire totally covered by a fine callus.

Teinostoma umbilicatum (H.C. Lea, 1843) (Figures 22A-G)

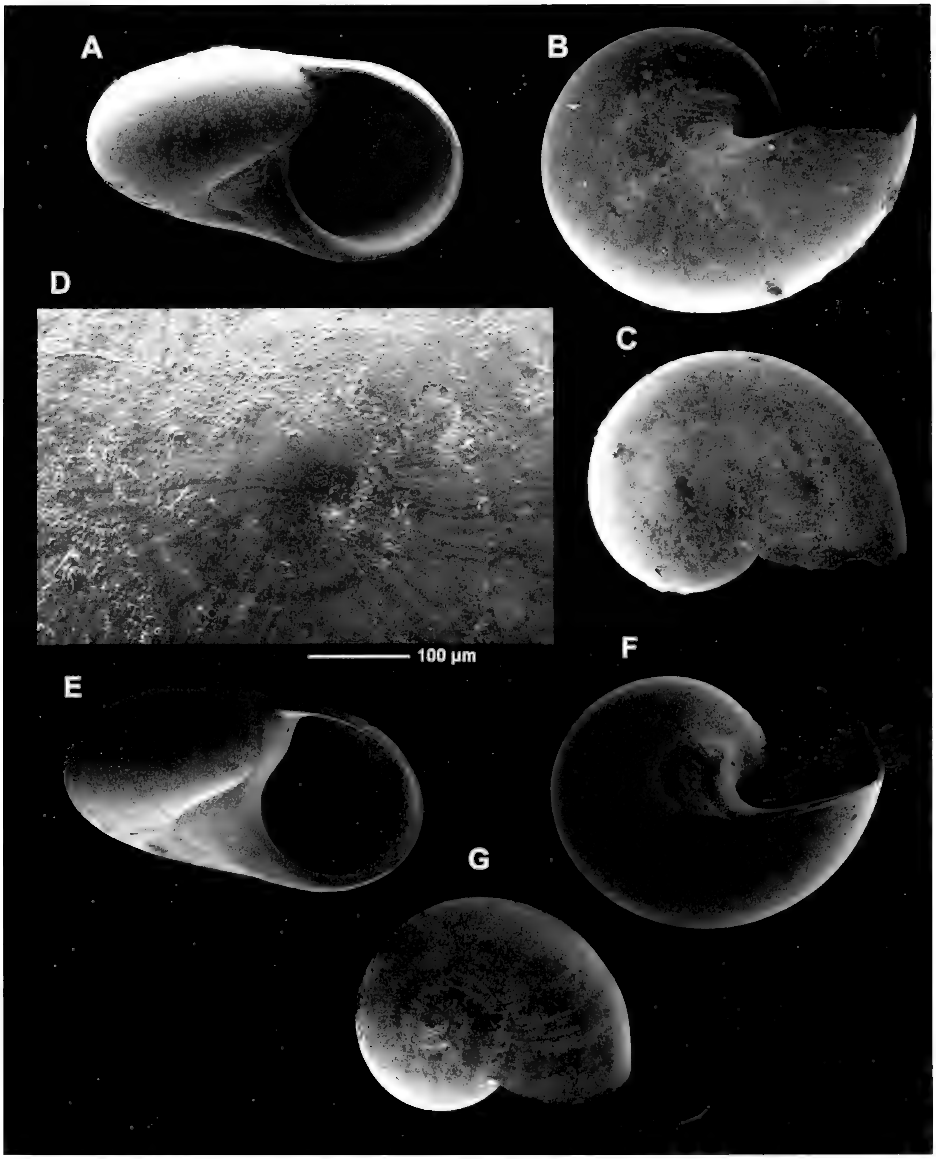
Rotella umbellicata H.C. Lea, 1843. *Proc. Amer. Philos. Soc.*, 3: 164. (Nude name).
Rotella umbilicata H.C. Lea, 1846. *Trans. Amer. Philos. Soc.* (new series) 9: 264, pl. 36, fig. 80. [Type locality: Miocene of Petesburg].
Rotella cryptospira A.E. Verrill, 1884. *Transactions of the Connecticut Academy of Arts and Sciences*, 6: 241-242 (not figured). [Type locality: USFC sta. 2109, off Cape Hatteras, North Carolina].

Type material: Lectotype of *Rotella cryptospira* USNM 35731; it was selected and figured by JOHNSON (1989). *MCZ Publications on Mollusks Occasional Papers on Mollusks*, 5(67): 32, pl. 10, fig. 8. Not examined.
Material examined: Cuba: 5 s, Rancho Luna Beach, 20-54 m (MHNS); 6 s, Cienfuegos Bay, 10 m (MHNS). Florida, USA: 1 s, 23 mi. ENE Mayport, Duval Co., 26 m (CHL); 1 s, Jacksonville Beach, Duval Co. grit (CHL); 2 s, Anclote Key, Pasco Co. sand bar (CHL); 7 s, channel E Seashore Key, Cedar Key, Levy Co. 4-6 m (CHL); 2 s, Louisiana: off western part, 22 m (CHL). Jamaica: 3 s, Priory, St. Ann's Parish, dredged shallow water (CHL). Trinidad and Tobago: Tobago: 7 s, Horse Shoe reef, 15 m, shell sand (CJP).



Figures 21A-H. *Teinostoma lerema* Pilsbry & McGinty, 1945; shells 1.0, 0.8, 0.7, 1.0, 0.8, 0.7, 0.9 mm, Rancho Luna Beach, Cienfuegos, Cuba (CFG).
Figuras 21A-H. Teinostoma lerema *Pilsbry & McGinty, 1945; conchas, 1,0, 0,8, 0,7, 1,0, 0,8, 0,7, 0,9 mm, Playa Rancho Luna, Cienfuegos, Cuba (CFG).*

Description: Shell (Figs. 22A-C, 22E-G) strongly depressed, smooth, rapidly expanding. A fine callous layer covers a great part of the previous whorl, keeping visible the protoconch and a small part of each whorl (Fig. 22D). Periphery very rounded. Aperture slightly oblique, rounded, grooved in the upper internal angle. Columella strong, reflected towards the external



Figures 22A-D. *Teinostoma umbilicatum* (H.C. Lea, 1843). A-C: shells, 1.9, 1.9, 1.6 mm respectively, Cienfuegos Bay, Cuba; D: protoconch; E-G: 1.8, 1.6, 1.3 mm, Tobago (CHL).
Figuras 22A-D. Teinostoma umbilicatum *(H.C. Lea, 1843). A-C: conchas, 1,9, 1,9, 1,6 mm respectivamente, Bahía de Cienfuegos, Cuba; D: protoconcha; E-G: 1,8, 1,6, 1,3 mm, Tobago (CHL).*

part forming a strong and characteristic callus which completely covers the umbilicus.

Dimensions: The lectotype is 2.5 mm in maximum diameter. The largest shell examined was 1.93 mm in diameter and 1.07 mm in height.

Habitat: A species of wide bathymetric distribution, recorded between 18 and 305 m depth. DALL (1892) collected it alive off the coasts of North Carolina and Florida in 30 to 50 fathoms, U.S. Commission. Our material was collected on coralline sandy bottoms between 10 and 54 m.

Distribution: Recorded from the USA: New Jersey, Campeche, North Carolina and Florida (A.E. VERRILL, 1884; DALL, 1892; LEE, 2009); from Mexico: Campeche State (ODÉ, 1987a); Venezuela (PRINCZ, 1982) and Cuba (ESPINOSA *ET AL*., 1985).

Remarks: VERRILL (1884) says: *"This species bears some resemblance to* Rotella anomala *D'Orbigny, but is peculiar in having the whorls of the spire concealed, or nearly so, by the last whorl"*. DALL (1892) mentions: *"This little shell resembles* T. umbilicatum *Lea in having the whorls nearly concealed by the thinned-out edge of the preceeding whorl, which is appressed nearly to the apex. The surface is smooth and polished. The fossils have been identified by comparison with a specimen named by the author, who has not yet figured his species"*. PILSBRY (1953: 416, in OLSSON *ET AL*., 1953) placed *T. cryptospira* in the subgenus *Idioraphe* Pilsbry, 1922, saying: *"The suture is characterized because the last whorl envelopes all of those preceeding, or leaves only the apical whorl exposed. The suture is developed only as an arcuate or angular line radiating from summit to periphery"*. In this subgenus are included *T. umbilicatum*, *T. verrilli* O. Meyer, 1885 and *T. nanum* H.C. Lea, 1833. PILSBRY (1953) mentions that in many shells observed the callous coat in the sutural border of the last whorl almost reaches the apex or only the apex is free. The type of *T. umbilicatum* is broken, but the apical area is preserved in good condition. The *T. umbilicatum* group of teinostomes has continued to the present day in species only very slightly different from the ancestral form, the living representative being named *T. cryptospira*.

Teinostoma altum Pilsbry, 1953 (Figures 23A-D)

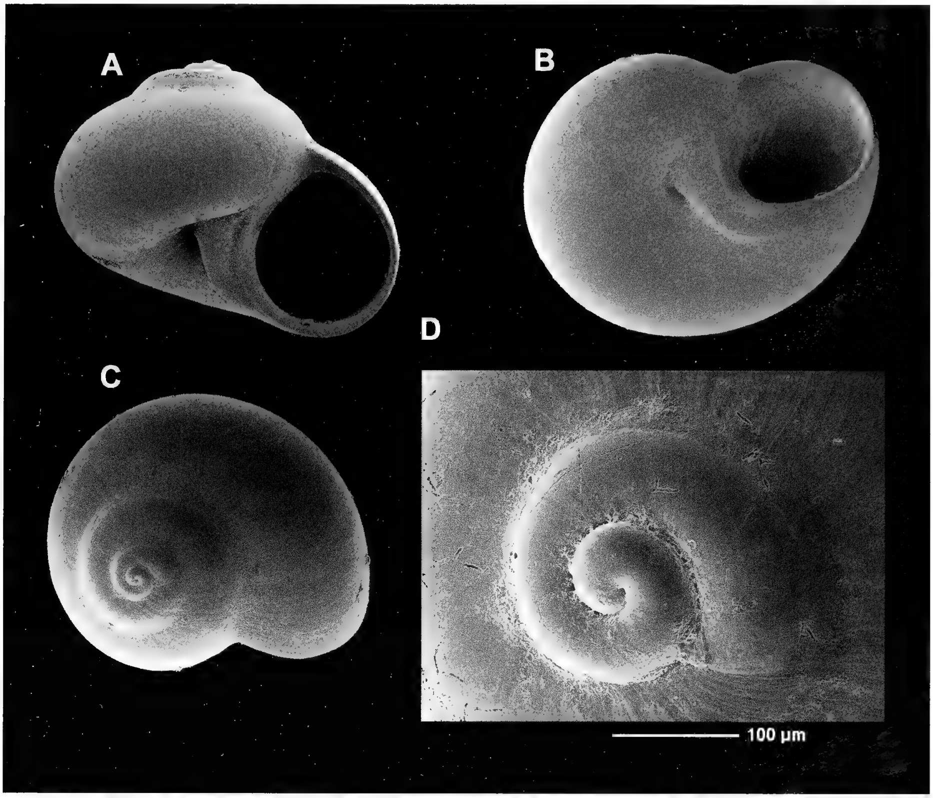
Teinostoma (Pseudorotella) altum Pilsbry, 1953 (in OLSSON *ET AL*., 1953). *Acad. Nat. Sci. Philadelphia*, Monographs 8: 413, pl. 49, fig. 2-2f. [Type locality: Plio-Pleistocene of North St. Petersburg, Florida].

Type material: Holotype in ANSP (18398). Not examined.
Other material examined: Cuba: 2 s, Bahía de Cienfuegos, 20-30 m (MHNS).

Description: The original description in OLSSON *ET AL*. (1953) is as follows: *"The shell is solid, depressed globose with conic spire, smooth surface, very incomplete umbilical callus divided from the columella by a groove. It is often perforate, or the umbilicus may be closed. There are fully four moderately convex whorls united by a distinctly impressed suture. The last whorl is broadly rounded at periphery, the base strongly convex, excavated around the narrow umbilical crevice (which is often closed). The aperture is nearly circular, but angular above. Peristome is rather long and evenly concave, somewhat thickened, separated from the callus by a shallow groove at its outer edge. The umbilical callus is a rather small, convex, lunate lobe, which typically does not wholly close the umbilicus"*.

We show some images of shells (Figs. 23A-C) and protoconch (Fig. 23D). We must point out these distinguishing characters of the species: the elevated spire, the rounded periphery, the groove which separates the columella from the umbilical callus and that this callus does not always cover the umbilicus.

Dimensions: Holotype 2.2 mm in maximum diameter and 1.6 in height. Our largest shell is 1.50 mm in diameter



Figures 23A-D. *Teinostoma altum* Pilsbry, 1953. A-C: shells, 1.3, 1.4, 1.3 mm, Cienfuegos Bay, Cuba. D: protoconch.
Figuras 23A-D. Teinostoma altum *Pilsbry, 1953. A-C: conchas, 1,3, 1,4, 1,3 mm, Bahía de Cienfuegos, Cuba. D: protoconcha.*

and 1.15 mm in height (ratio H/D: 0.76).

Habitat: The only two shells found were from shell grit between 20 and 30 m in depth. Elsewhere in the literature it is reported from 0 to 139 m.

Distribution: Florida, USA: Fossil, from the Plio-Pleistocene of St. Petersburg (Pilsbry, 1953; Odé, 1987) Recent of: Cuba: Cienfuegos. USA: Georgia: 57 mi E Sapelo Is. 18-20 m (Lee, 2009). Florida: 28 mi E ESE Mayport, Duval Co. 22.5 m (LEE, 2009).

Remarks: Fossil species described from the Plio-Pleistocene of South Florida. The shells from Cuba seem to be recent.

Teinostoma altum is similar to *T. cocolitoris*, but the latter is larger, the spire lower, has fewer whorls and lacks the groove separating the columella and the umbilical callus.

From *T. parvicallum* it may be differentiated by the characters of the umbilical callus. Also it is a little similar to *T. reclusum* in its general form and in the groove in the umbilical callus, but the latter has a lower spire and a different peripheral profile.

Another close species is *Teinostoma subconicum* (H.C. Lea), described from the Miocene of Smithfield, Virginia from only one shell.

PILSBRY (1953; pl. 56, fig. 5), gives a drawing of this species showing the differences with *T. altum*: the shell is more depressed, the periphery of the last whorl more arched, and the umbilicus is totally closed.

In the web page www.jaxshell.org, as well as in "Marine Shells of Northeast Florida" and "Select Images of Western Atlantic Gastropods" there is a SEM micrograph of a specimen of *Teinostoma altum* called *Teinostoma sp. aff. altum*, dredged in 30 m, 32 mi E St. Augustine, Florida, which is identical to our material from Cuba and that figured by PILSBRY (1953). This figure also appears in (LEE, 2009: 67; species no. 320)

"Teinostoma" solidum (Dall, 1889) (Figures 24A-G)

Ethalia solida Dall, 1889. *Bull. Mus. Comp. Zoology*, 18: 362, pl. 28, figs. 3, 5. [Type locality: Station 19, Lat. 23°3'N, Lon. 83°10'W, off Bahia Honda, Cuba].

Type material: Syntype in MCZ (007553), from off Bahia Honda, Cuba. Range: 23.3°N-83.10°W, in 567 m. This shell is here designated the lectotype (Fig. 24).

Description: The original description in DALL (1889) is as follows: *"Shell small, solid, stout, ivory white, of three rounded whorls, the last much the largest. Sculpture of fine incremental lines, sometimes faintly wrinkled near the suture; upper surface rounded, subconic, the whorls not impressed at the suture, which is fairly distinct. Periphery rounded, base subconic, umbilicus reduced to a minute chink with a twisted callus above it; aperture circular, oblique, with a triangular callus at each end of the columella; the upper margin declining".*

We add: The shell (Figs. 24A-E) is solid and compact, trochoid, spire formed by 3 ¼ rounded whorls separated by a distinct suture. The protoconch has scarcely one whorl (which is not certain due to the difficulty in discerning the separation from the teleoconch). It measures about 450 μm in diameter and the nucleus 160 μm. The protoconch is short, bulbous, and is covered by small, sharp, branching tubercles arranged in a spiral pattern. Teleoconch formed by 2 ½ whorls, totally smooth except for numerous growth lines. Umbilicus almost totally closed by a fine callous layer, which is the extension of the columella; within, it is possible to see two small folds which delimit several axial striae and spiral cordlets which cross and produce a reticular pattern. Aperture rounded, slightly angulate in its parietal part portion. Parietal callus, columella and internal lip strong and wide. There is no sulcus between the columella and the callus.

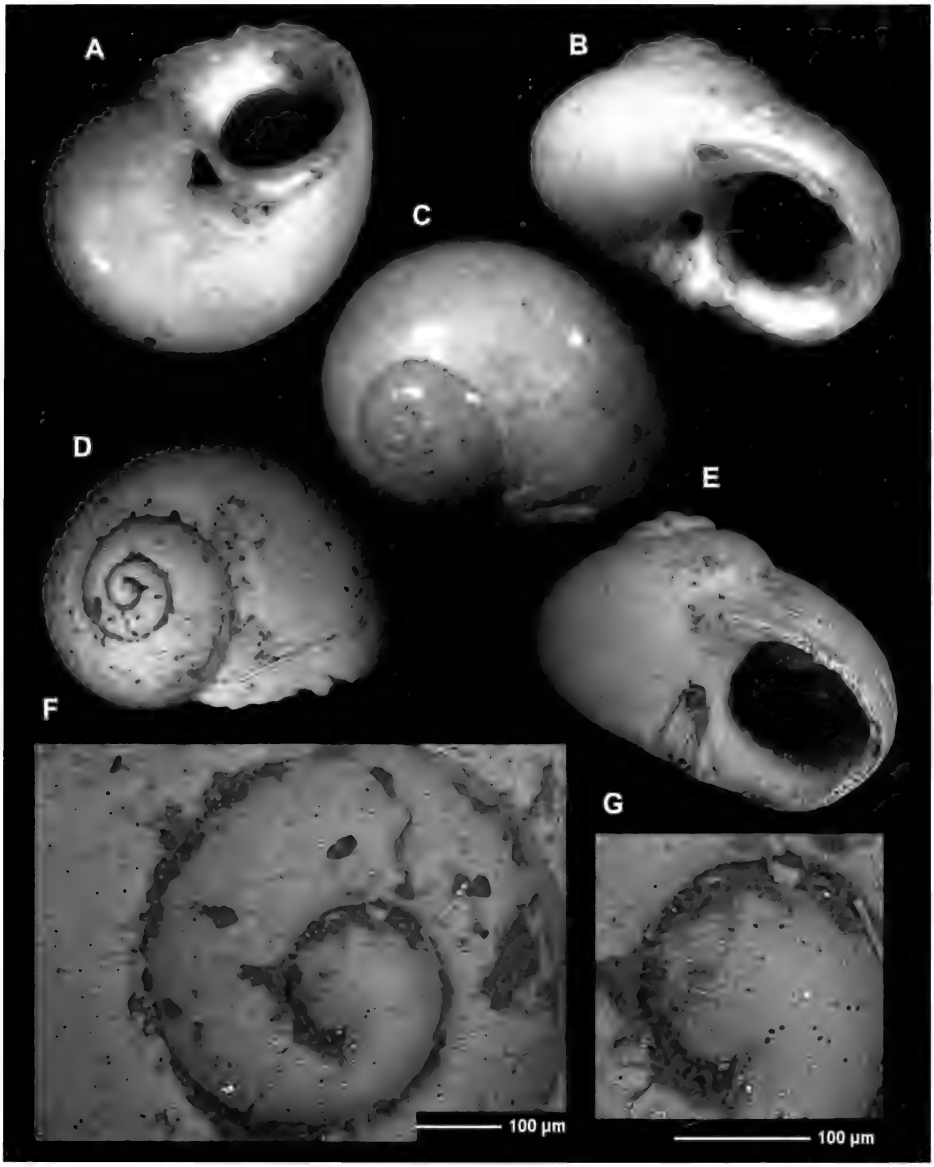
Dimensions: Lectotype 2.1 mm in maximum diameter and 1.6 mm in height.

Habitat: This is a fairly deep-water species that apparently lives only on the continental slope (MOORE, 1964). From 529-792 m.

Distribution: From Georgia to West Florida, off Fernandina (JOHNSON, 1934). Recorded in Bahia Honda, Cuba (DALL, 1889); Florida Keys (MOORE, 1964).

Remarks: Provisionally, we keep this species in the genus *"Teinostoma"* in quotes, uncertainty about its correct placement for the reasons cited above. The name *Teinostoma solidum* is preoccupied by a West African species of E.A. SMITH (1871: 737, pl. 75, fig. 25), which has all the typical characters of the genus. But the Caribbean species could be a Skeneid, in which case the name would be available because it was described in the genus *Ethalia*. At present, we prefer to keep it in this dubious status instead of creating a replacement name.

It is necessary to point out the great similarity of *"Teinostoma" solidum* to some species of the skeneid genera *Lisomphalia, Skenea* and *Trochaclis*. Some deep water species of the genus *Skenea* living along the coast of Iceland and Scandinavia are characterized by the trochoid aspect of the shell, the short and bulbous protoconch, usually sculp-



Figures 24A-G. "*Teinostoma*" *solidum* (Dall, 189), lectotype, 2.1 x 1.6 mm Bahía Honda, Cuba (MCZ 007553). A-C: optical photographs; D-E: SEM micrographs; F: protoconch; G: detail of the protoconch.

Figuras 24A-G. "Teinostoma" solidum *(Dall, 189), lectotipo, 2,1 x 1,6 mm Bahía Honda, Cuba (MCZ 007553). A-C: fotografías ópticas; D-E: microfotografías MEB; F: protoconcha; G: detalle de la protoconcha.*

tured, and having an umbilicus which, as in many species such as *Skenea trochoides* (Friele, 1876), is very narrow and deep and has riblets within. The species of the genus *Trochaclis* are characterized by a short and bulbous protoconch with fine spiral cordlets. WARÉN (1991: 179) reported that the genus

Trochaclis was originally classified in the Mesogastropoda and later transferred to the Vetigastropoda by HICKMAN & MCLEAN (1990) because of the morphology of the operculum, epipodium and ctenidium.

Due to these similarities we consider the placement of this species in Tornidae, subfamily Teinostomatinae as dubious, but we mantain this clasification until anatomical, opercular and radular morphology allow correct systematic placement. MOORE (1964) treated *T. solidum* and *T. floridensis* (Dall, 1889) in a similar fashion.

"Teinostoma" solidum is more solid and elevated than any other species described from this region (DALL, 1889). According to MOORE (1964: 100), the small, bulbous and ornamented protoconch, subglobose shape and narrow chink-like umbilicus and shelf within the aperture distinguish this species from other West Indian species.

Teinostoma lunense spec. nov. (Figures 25A-D)

Type material: Holotype (Figs. 25A-B) in MNCN (15.05/55066); a paratype in MHNS.
Type locality: Rancho Luna Beach, Cienfuegos, Cuba, 20 m.
Etymology: The specific name refers to the type locality.

Description: Shell (Figs. 25A-C) rounded, a little higher than wide, spire moderately elevated, with four whorls, solid, smooth and somewhat shiny. Protoconch (Fig. 25D) of about 1 ¼ smooth whorls. Teleoconch with surface smooth except for fine growth lines, periphery rounded. Suture faintly indicated, visible by transparency, covered by a fine callous layer. Aperture rounded, peristome almost continuous, internal upper angle grooved. Columella and inner lip rounded, reflected towards the umbilicus, forming a characteristic callus, wide and fine, with a half moon crescent shaped, which partially covers the umbilicus. There is no groove of separation between columella and callus.

Dimensions: Holotype is 1.3 mm in maximum diameter and 0.9 mm of in height.

Habitat: This species was collected in shell grit at 20 m depth.

Distribution: Only know from Cienfuegos, Cuba, the type locality.

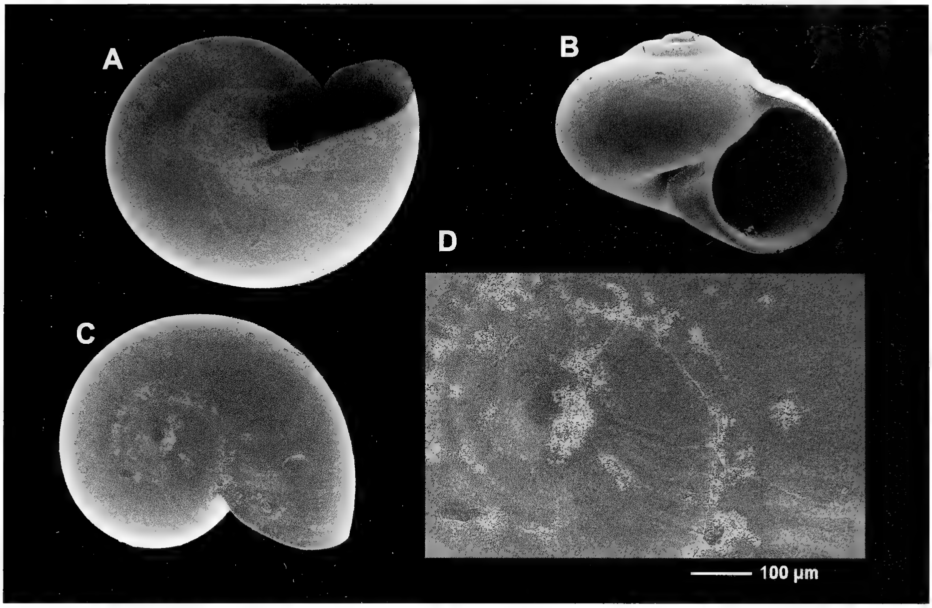
Remarks: The figure in PILSBRY (1953, pl. 56, fig. 5) of the holotype of *T. subconicum* (H.C. Lea) is very similar to this species differing in the size of the callus, which, like a crescent moon does not completely cover the umbilicus.

From *T. altum* it may be separated by the absence of the groove between the columella and the callus.

Teinostoma cocolitoris Pilsbry & McGinty, 1945 (Figures 26A-G)

Teinostoma (Ellipetylus) cocolitoris Pilsbry & McGinty, 1945a. *The Nautilus*, 59: 8-9, pl. 1, fig. 3. [Type locality: Off Lake Worth, Palm Beach County, Florida].

Type material: Holotype in ANSP (181122). Not examined.
Material examined: Cuba: 1 s, Canarreos Archipelago, 5 m; 1 s, Cayo Diego Perez, 5 m (MHNS); 13 s and 2 sp, Cienfuegos Bay, 20-30 m (MHNS); 3 s, Rancho Luna Beach, 10-20 m (MHNS); 16 s, Rancho Luna Beach, 10-30 m (MHNS); 10 s, Rancho Luna Beach, 45 m (MHNS); 16 s, Rancho Luna Beach, 20-54 m (MHNS); 3 c, Los Laberintos, Rancho Luna Beach, 35 m (MHNS); 19 s and 2 sp, Faro los Colorados, 56 m (MHNS); 2 s, Punta Tamarindo, 15 m (MHNS); 3 s, Havana, 30 m. USA: 31 s, off Louisiana, 56-65 m (CHL). Antigua and Barbuda: Antigua, 1 s, 67 m, SE Falmouth Harbour, dredged (CHL). Bahamas: 1 s, French Bay, San Salvador, 15 m, sand ledge (CHL); 4 s, Samphire Cay, NW Nassau, 15 m, base of reef (CHL). Jamaica: 3 s, Priory, St. Ann's, Parish, shallow water (CHL). ABC Islands: 1 s, off Klein Bonaire, Bonaire, 38 m, base of reef (CHL).



Figures 25A-D. *Teinostoma lunense* spec. nov. A-B: holotype, 1.3 mm, (MNCN); C: 1.5 mmm, paratype; both from Rancho Luna Beach, Cienfuegos, Cuba; D: protoconch.
Figuras 25A-D. Teinostoma lunense *spec. nov. A-B: holotipo, 1,3 mm, (MNCN); C: 1,5 mmm, paratipo; ambas de Playa Rancho Luna, Cienfuegos, Cuba; D: protoconcha.*

Description: Shell (Figs. 26A-F) with 3 ¾ rounded whorls, solid, smooth, rounded aperture, umbilicus partially occluded. Protoconch (Fig. 26G) of barely one whorl and about 230 μm in diameter, with a smooth surface and a strong varix at its end. Teleoconch of about 2 ¾ whorls. Dorsally convex with very numerous, curved, prosocline growth lines; ventrally, very slightly convex, with the same growth lines. Umbilicus narrow and deep, partially occluded by the callus that originates between the columella and the internal lip, callus small and semicircular. Aperture rounded, peristome continuous.

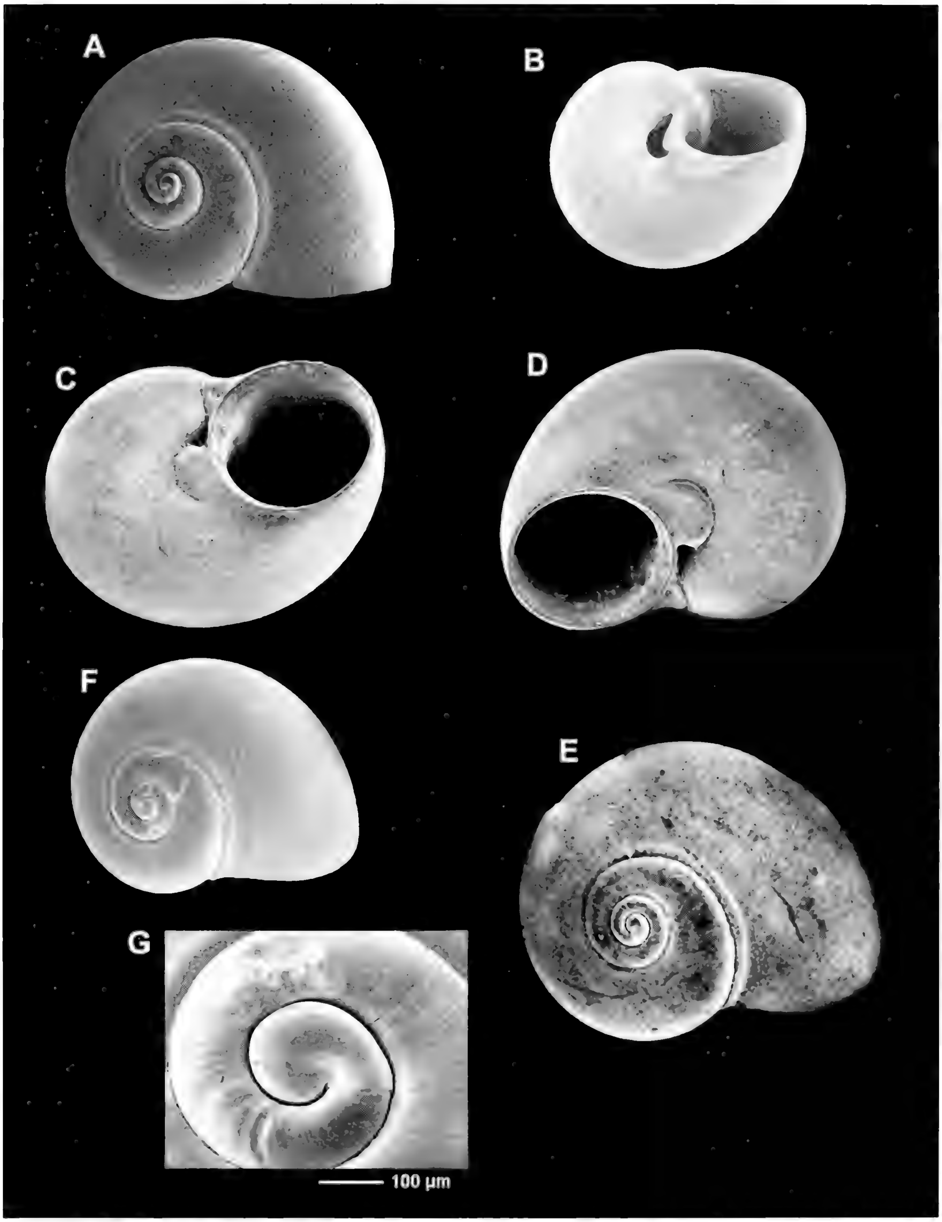
Dimensions: Holotype 3.0 mm in diameter and 2.0 mm in height. Our shells reach 2.85 mm in maximum diameter.

Operculum multispiral with a central nucleus.

Habitat: Species with wide bathymetric distribution, recorded between 18 and 122 m depth. In Cuba, it was found in sediments collected between 5 and 56 m; the living material examined was collected on coralline sandy bottom between 20 and 56 m. In Cuba, off Rancho Luna Beach and Yaguanabo, living specimens were collected at 30-36 m on *Halimeda* sp.

Distribution: Previously known from USA: North Carolina (PORTER, 1974), Florida (PILSBRY & MCGINTY, 1945a), Louisiana (ODÉ, 1987); Colombia (GARCIA, 2002); Brazil: Rio de Janeiro (RIOS, 1994); Abaco, Bahamian islands (REDFERN, 2001). Cuba: Cienfuegos Bay.

Remarks: This is a characteristic species, with its surface totally smooth, the aperture rounded, and the umbilicus partially closed by the callus; these characters differentiate it from other congeneric species. Its callus is similar to that of *T. incertum*, but the lack of ornamentation in the protoconch and teleoconch differentiate them.



Figures 26A-G. *Teinostoma cocolitoris* Pilsbry & McGinty, 1945. A-F: shells, between 2.0 and 2.6 mm, Cienfuegos Bay, Cuba; G: protoconch.
Figuras 26A-G. Teinostoma cocolitoris *Pilsbry & McGinty, 1945. A-F: conchas, entre 2,0 y 2,6 mm, Bahía de Cienfuegos, Cuba; G: protoconcha.*

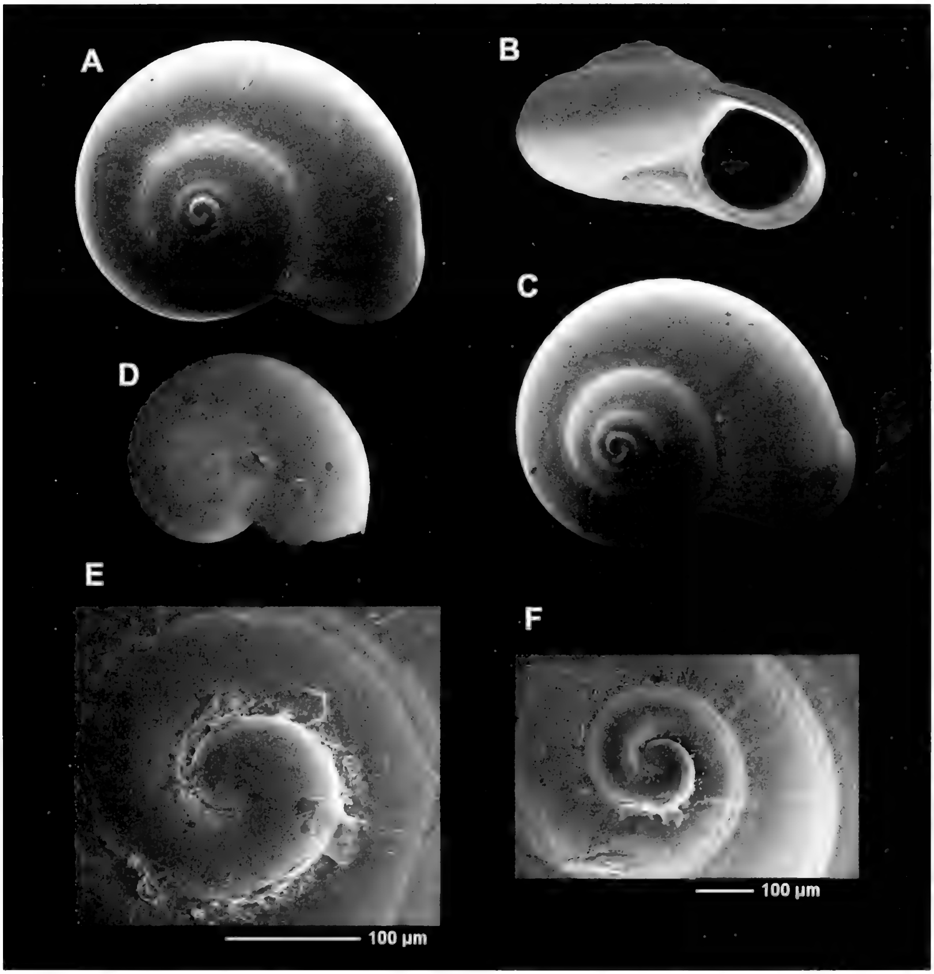
Teinostoma helicinum spec. nov. (Figures 27A-F)

Type material: Holotype (Fig. 27A) in MNCN (15.05/55064) and 2 paratypes (Fig. 27B y 27D) (15.05/55065), from type locality. Other paratypes: AMNH (1 s), FLMNH (448613, 1 s), MNHN (24403, 1 s), IES (2 s), MHNS (100540, 1 s), USNM (1155032, 1 s), CFR (3 s), GHL (1 s) and CFG (6 s).

Other material examined: Cuba: 3 s and 1 sp, Faro de los Colorados, 56 m (MHNS).
Type locality: Rancho Luna Beach, Cienfuegos, Cuba, 40-45 m.
Etymology: The specific name refers to the shape of the peristome, which resembles that of the land snail, subfamily Helicinae.

Description: Shell (Figs. 27A-D) strong, solid, somewhat depressed, with about 4 whorls, whitish, smooth and shiny. Protoconch (Figs. 27E-F) of about 1 ¼ smooth whorls and about 280 μm in diameter. It is separated from the teleoconch by a strong varix. Teleoconch of about 2 ½ whorls, totally smooth.

Convex dorsally with very numerous, curved, prosocline growth lines; ventrally, very slightly convex, also with the same growth lines. Periphery



Figures 27A-F. *Teinostoma helicinum* spec. nov.; A: holotype, 2.0 mm (MNCN); B: paratype, 1.8 mm, (MNCN); C: paratype, 1.9 mm (MNHN); D: paratype, 1.5 mm (MNCN), Rancho Luna Beach, Cienfuegos, Cuba; E-F: protoconch.
Figuras 27A-F. Teinostoma helicinum *spec. nov.; A: holotipo, 2,0 mm (MNCN); B: paratipo, 1,8 mm, (MNCN); C: paratipo, 1,9 mm (MNHN); D: paratipo, 1,5 mm (MNCN), Playa Rancho Luna, Cienfuegos, Cuba; E-F: protoconcha.*

rounded. A well formed suture can be seen by transillumination, being covered by a fine callous coat. Umbilicus entirely covered by a small callus formed by a thickening of the columella. Aperture nearly ovoid without any groove in the upper inner angle. Peristome sharp, externally reflected.

Dimensions: Holotype 2.0 mm in maximum diameter and 0.95 mm of in height.

Habitat: Collected on sandy bottoms between 20 and 56 m depth.

Distribution: Only known from Cienfuegos, Cuba.

Remarks: *Teinostoma helicinum* spec. nov. may be distinguished from its congeners by the fine and narrow callous layer which covers the suture, by the small umbilical callus, and particularly by the outwardly deflected peristome as seen in some species of terrestrial shells of the subfamily Helicinae.

It may be distinguished from *T. ciskae*, *T. goniogyrus* and *T. lenticulare* because these have the teleoconch surface totally covered by punctiform incisions; from *T. clavium* and T. *nesaeum* because these have the teleoconch covered totally or partially by spiral cords, and from *T. lerema*, *T. umbilicatum* and *T. biscaynense* because these have the protoconch totally covered by a fine callous layer. From *T. megacallus* it can be distinguished by its externally reflected peristome and the smaller umbilical callus, and from *T. megastoma* by the sunken protoconch of the latter.

Teinostoma megastoma (C.B. Adams, 1850) (Figures 28A-C)

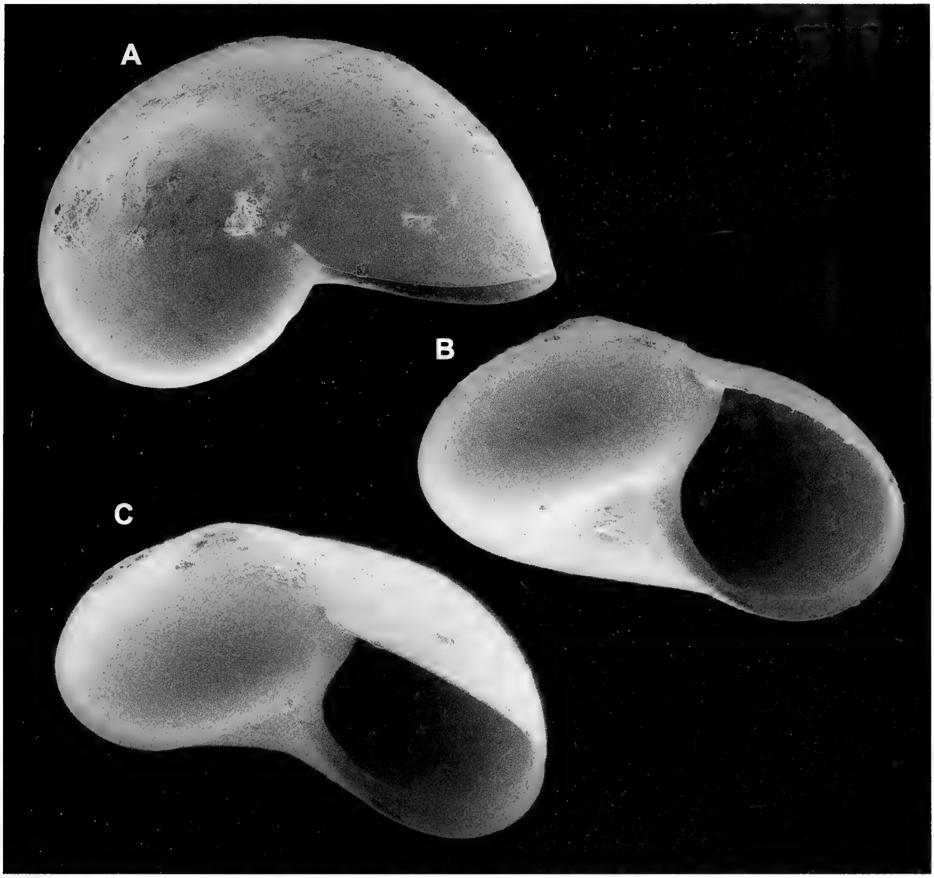
Vitrinella megastoma C.B. Adams, 1850. *Monog. Vitrin.*: 7. [Type locality: Port Royal, Jamaica].
Teinostoma biscaynense auct. non Pilsbry & McGinty, 1945a.

Type material: Lectotype (Figs. 28A-C) in MCZ (156269) after Clench & Turner (1950: 306, plate 35, fig. 2). At present it is destroyed. There are 11 paralectotypes (labeled as paratypes), from Jamaica in MCZ (186187). A neotype is here designated from one of these shells (Figs. 28A-C) of this lot.
Material examined: Bahamas: 1 s, Olympus Reef, 12 mi. NNW West End, Grand Bahama, 36 m, coralline algae fragments (CHL). USA: Florida: 1 s, Spoil, Apac Pit, Sarasota Co., fossil (CHL); 1 s, 32 mi. E St. Augustine, St. Johns Co. 27 m ft (CHL). Louisiana: 1 s, 71-74 m (CHL).

Description: We repeat the original description in C.B. Adams (1850): "*Much depressed, transversely ovate: white, translucent: smooth and shining: apex very obtuse: spire convex, but little elevated: whorls a little more than three, moderately convex, with a distinct suture; last whorl very large, rapidly increasing in the last part, well rounded: aperture scarcely modified by the last whorl: umbilical region very widely and deeply indented. Mean divergence about 130°; length of spire 0.01 inch; total length .033 inch; greatest breadth 0.06 inch, least breadth 0.045 inch*".

Pilsbry (1946) mentioned the original description and figured the species for the first time. He complemented the description: "*The shell is transparent, glassy, quite thin and globose for* Teinostoma, *with very large aperture, and very small, sloping umbilical callus, which is flat or slightly concave, the base rising around it. The wholly superficial suture is bordered by a false sutural line by transparence; sometimes this gives the illusion of a deeply impressed suture. Diameter: 2 mm, height 1.2 mm*". And he follows: "*This was rather abundant. By the very small umbilical callus it agrees with* Pseudorotella, *as Miss Bush has noted on the label. The "paratype" figured is the largest in the lot. Adams's measurements were apparently from a smaller one. Except in size, the dozen specimens are all very much alike*".

Shell (Figs. 28A-C) solid, smooth, whitish and shiny; spire of a little more than 3 rapidly-expanding whorls. Teleoconch with about 2 whorls, smooth except for fine growth lines. Periphery



Figures 28A-C. *Teinostoma megastoma* (C.B. Adams, 1850). A-C: neotype, 1.5 mm, Jamaica (MCZ 156269).
Figuras 28A-C. Teinostoma megastoma *(C.B. Adams, 1850). A-C: neotipo, 1,5 mm, Jamaica (MCZ 156269).*

rounded. Suture seen by transillumination to be covered by a fine coat of shell material which also covers the protoconch and the first teleoconch whorl. Each whorl covers much of the previous one. Callus completely covers the umbilicus. Aperture oval, not modified. Base concave, umbilicus totally covered by a fine callus.

Maximum reported size: 2.5 mm

Habitat: Species with wide bathymetric distribution, recorded between 0 and 123 m depth. Collected alive between 0 and 42 m. It lives in mangroves, sand, muddy, and rocky bottom. Shallow soft bottom (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). In Cuba, most of the samples were collected between 4 and 10 m.

Distribution: Recorded from Port Royal, Jamaica (C.B. ADAMS, 1850; CLENCH & TURNER, 1950); from Colón and Bocas Island, Panama (OLSSON & MCGINTY, 1958); from St. Croix, Virgin Islands (NOWELL-USTICKE, 1959); from USA: Louisiana, Texas; Mexico: Campeche State, Yucatan State, Quintana Roo (MOORE, 1964; ODÉ, 1987); from NE Florida (LEE, 2009); from North Carolina and south of the Caribbean Sea, and Portete, Costa Rica (HOUBRICK, 1968); from Campeche to Ciudad del

Carmen and Zacatal, from Ninum Point to Campeche, from El Cuyo to Ninum Point, from Yalkupul Point to Cerritos Islands and from Isla Mujeres to Holbox Island, Mexico (Vokes & Vokes, 1984); from North Carolina to the western Caribbean (Abbot, 1974); from Cuba (Espinosa *et al.*, 1985); from Portete and Moín, Costa Rica (Robinson & Montoya 1987); from Curaçao, Aruba and Bonaire (de Jong & Coomans, 1988); from North Carolina to Panama and Colombia (Díaz Merlano & Puyana Hegedus, 1994); from Brazil: Rio de Janeiro (Rios, 1994). Martinique, in our material.

Remarks: The tube with the label of the lectotype in MCZ (156269) had only a few fragments; so, from the lot of the paralectotypes (MCZ 186187) we have selected one shell which is here designated the neotype.

Pilsbry (1946) accepted the descriptions and figured the species of *Vitrinella* described from Jamaica by C.B. Adams, but he placed this species in the genus *Teinostoma*, subgenus *Pseudorotella*, agreeing with the opinion of Katherine J. Bush noted in the label of lectotype, MCZ 156269. The globose aspect, the rounded aperture, the umbilical callus reduced to a fine slightly convex callous coat, and the protoconch placed below the following whorl separate it from its congeners. Lee (2009, fig. 325) figured a shell dredged at 27 m, 32 miles East of St. Augustine, Florida, but in our opinion this is not *T. megastoma* but a member of the Cornirostridae, genus *Tomura*. In the web page www.jaxshells.org, as well as in "Marine Shells of Northeast Florida" as in "Selected Images of Western Atlantic Gastropods" there is a SEM micrograph under the name of *Teinostoma megastoma* which, in our opinion, is *T. umbilicatum* (=*T. cryptospira*). The two species are similar because they have the spire partially covered by a fine callous coating. The differences between them are that in *T. umbilicatum* the callous cap completely covers the shell, including the protoconch; the spire is flat, the umbilical callus is stronger and the aperture is almost circular. In *T. megastoma* the spire is more elevated, the umbilical callus is finer, and the aperture ovoid.

Teinostoma cienfuegosense spec. nov. (Figures 29A-D)

Type material: Holotype (Fig. 29A) in MNCN (15.05/55061) and 2 paratypes (Figs. 29B-C) in MNCN (15.05/55062). Other paratypes: MHNS (100547, 10 s), AMNH (2 s), NHMUK (2 s), MNHN (24393, 2 s), (IES, 2 s), (CFR, 3 s) and (CFG, 6 s).

Other material examined: Cuba: 11 s, Cienfuegos Bay, 10 m (MHNS); 4 j, Cienfuegos Bay, 20-30 m (MHNS). Martinique: 1 c, Pointe Borgnesse, 12 m, sandy-muddy bottom, close the reef (CJP).

Type locality: Cienfuegos Bay, sta. 12a, 22°07'N 80°26'W, 4 m.

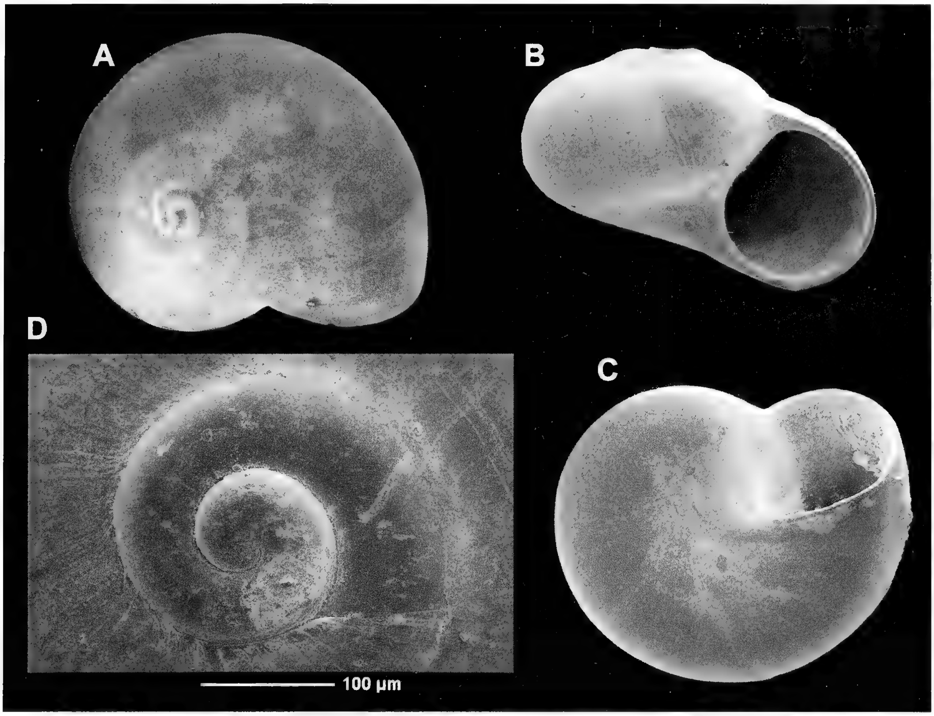
Etymology: The specific name refers to the type locality, an area extensively sampled by the second author.

Description: Shell (Figs. 29A-C) a little depressed, rounded, trochiform, solid, smooth, whitish and shiny; spire formed by 4 rapidly-increasing whorls. Protoconch (Fig. 29D) bulbous, of about 1 ¾ whorls, and of two clearly differentiated stages, the first one smooth and the second with small dispersed granules; it measures about 280 µm and it is placed below the next whorl. Teleoconch with about 2 ¼ whorls, totally smooth except for fine growth lines. Periphery rounded. Suture barely distinguishable, seen by transillumination to be covered by a fine coat of shell material. Each whorl covers much of the previous one. Callus covers the umbilicus completely.

Dimensions: Holotype is 1.43 mm of maximum diameter.

Maximum reported size: 2.5 mm

Habitat: In Cuba, most of the samples were collected between 4 and 10 m in coralline sand bottom.



Figures 29A-D. *Teinostoma cienfuegosense* spec. nov. A: holotype, 1.43 mm (MNCN); B-C: paratypes, 1.2, 1.3 mm, Cienfuegos Bay, Cuba (MNCN); D: protoconch.
Figuras 29A-D. Teinostoma cienfuegosense *spec. nov. A: holotipo, 1,43 mm (MNCN); B-C: paratipos, 1,2, 1,3 mm, Bahía de Cienfuegos, Cuba (MNCN); D: protoconcha.*

Distribution: Only known from Cienfuegos Bay, Cuba.

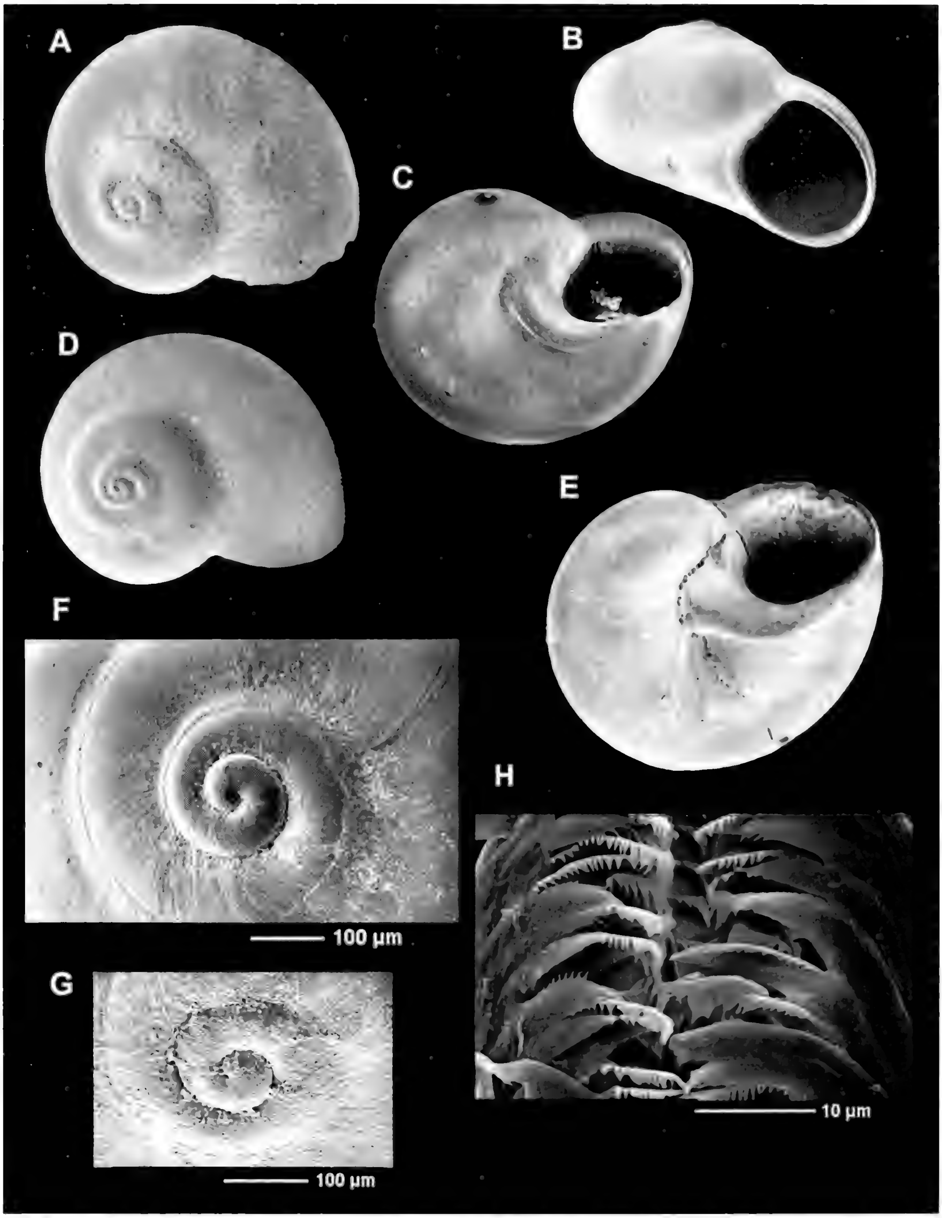
Remarks: Early in the course of this work this species was confused with *T. megastoma* on the basis of the figure of the holotype provided by PILSBRY (1946). *Teinostoma cienfuegosense* spec. nov. bears little similarity to *T. megastoma*, from which it can be distinguished by its uncalloused protoconch and the rounded, almost circular aperture.

The globose aspect, the rounded aperture, the umbilical callus reduced to a fine callous slightly convex coat, and the protoconch placed below the following whorl separate it from its congeners.

Teinostoma parvicallum Pilsbry & McGinty, 1945 (Figures 30A-H)

Teinostoma (Idioraphe) parvicallum Pilsbry & McGinty, 1945a. *The Nautilus*, 59: 4-5, pl. 2, fig. 2. [Type locality: Missouri Key, Florida].

Type material: Holotype in ANSP (181105). Not examined.
Material examined: Cuba: 34 s, Cienfuegos Bay, 22°07'N 80°27'W, 9 m (MHNS); 42 s, Cienfuegos Bay, 10 m (MHNS); 9 s, Rancho Luna Beach, 20 m (MHNS); 5 s, Rancho Luna Beach, 15-54 m (MHNS). Trinidad and Tobago: Tobago: 1 s, Horse Shoe Reef, 15 m, coralline sandy grit near the reef (CJP).



Figures 30A-H. *Teinostoma parvicallum* Pilsbry & McGinty, 1945. A-E; shells, between 1.0 and 1.5 mm, Cienfuegos Bay Cuba; F-G: protoconch; H: radula.
Figuras 30A-H. Teinostoma parvicallum *Pilsbry & McGinty, 1945. A-E; conchas, entre 1,0 y 1,5 mm, Bahía de Cienfuegos, Cuba; F-G: protoconcha; H: rádula.*

Description: In PILSBRY & MCGINTY (1945a: 4-5) and MOORE (1964: 85-87).

Shell (Figs. 30A-E) trochiform, with spire relatively high, umbilical callus medium in size, totally covering the umbilicus in adult individuals. Protoconch (Figs. 30F-G) of about 1 ¾ smooth whorls, and about 270 µm in diameter. Teleoconch of about 2 ¼ whorls, totally smooth except for small growth lines.

Periphery and base rounded. Between the columella and the umbilical callus there is a fine groove. Umbilicus generally closed totally by the callus, except in young individuals, in which a small fissure may persist. Aperture slightly oblique, with a sharp border on the external lip and a continuous peristome.

Dimensions: Holotype 2.0 mm in diameter by 1.5 mm in height. Our shells reach 1.5 mm in diameter and 1.09 mm in height, and being smaller keep the same ratio (D/H: 0.75).

Animal of holotype figured by PILSBRY & MCGINTY (1945a).

Radula (Fig. 30H) taenioglossate, with formula 2+1+R+1+2. Central tooth wide basally, the ventral margin well developed, without denticles. Cutting surface formed by a central large, sharp cusp and 5 denticles of medium size on each side. Lateral teeth similar to the central, their bases are quadrangular and also without denticles; free margin with a central cusp and 4-5 smaller denticles on each side, more elongated than central tooth. Marginal teeth long, narrow, and hook-shaped; the medial aspect with 24-26 weak denticles on the upper outer margin; the outer marginal teeth are inclined outwards in their distal third and possess 15-16 denticles on the upper end of their medial aspects.

Habitat: This species lives under stones between 10 and 50 m in depth. Some authors recorded it in deeper water (up to 90 m) based only on empty shells. Considered a continental species by MOORE (1964) it is widely distributed among the islands of the Caribbean.

Distribution: It has been recorded from the USA: Missouri Key, Florida (PILSBRY & MCGINTY, 1945a); from Puerto Rico (WARMKE & ABBOTT, 1961); from Florida Keys, Texas to Mexico (MOORE, 1964); from Texas (ANDREWS, 1977); from Cuba (ESPINOSA *ET AL.*, 1985); from Venezuela, Sucre and Isla Margarita (PRINCZ, 1986); from Florida to Texas (LYONS, 1989); from Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994); from Abaco, Bahamas (REDFERN, 2001). From Tobago, in the present work.

Remarks: *T. parvicallum* is very similar in general aspect with the shell of *T. incertum*, from which it can be distinguished by the obliteration of the umbilicus by callus even in juvenile shells and in lack of ornamentation on the teleoconch.

Teinostoma megacallum spec. nov. (Figures 31A-E)

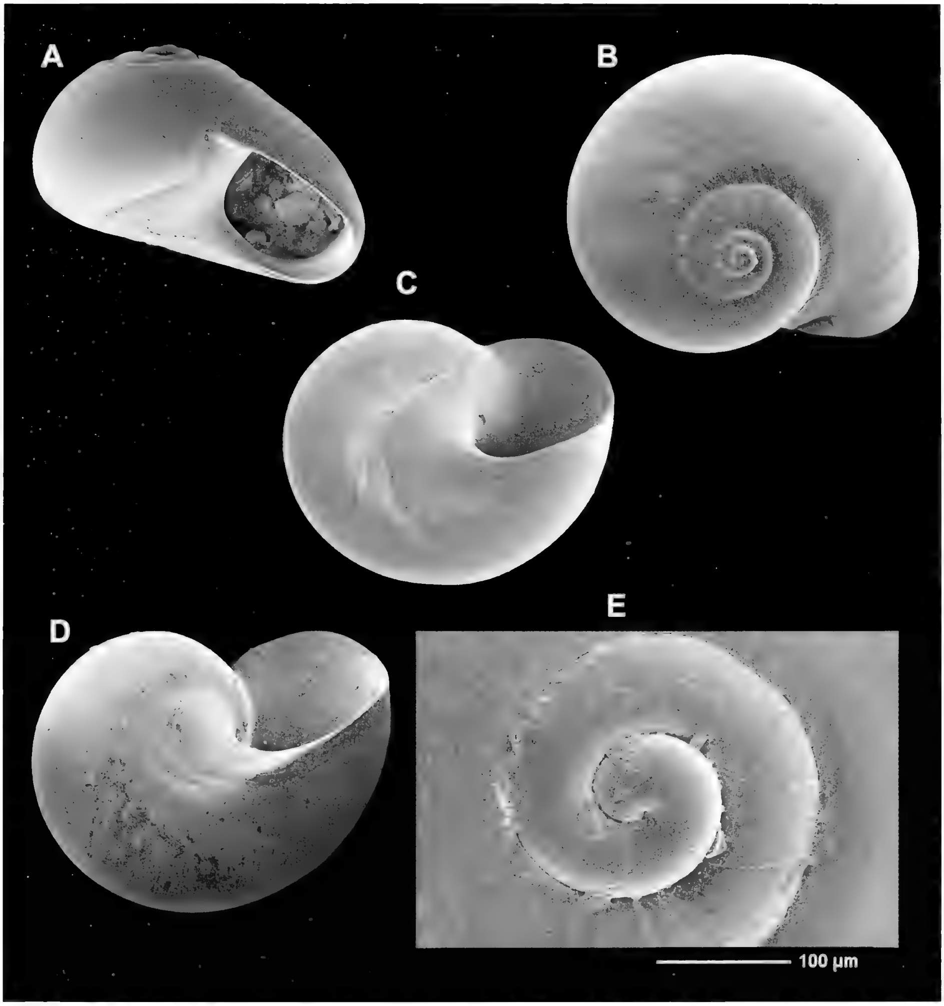
Type material: Holotype (Fig. 31A) in MNCN (15.05/55067), and 2 paratypes (Figs. 31B-C) in MNCN (15.05/55068), from type locality. Other paratypes from Cienfuegos Bay, sta. 12a, 22°07'N 80°26'W, 4 m: MHNS (100548, 1 s, Fig. 31D), MNHN (24394, 1 s), FLMNH (448614, 1 s), AMNH (1 s), CFG (2 s), CFR (2 s).

Other material examined: Cuba: 2 s, Cienfuegos Bay, sta. 12, 22°07'N 80°27'W, 9 m; 10 s, Cienfuegos Bay, sta. 12a, 22°07'N 80°26'W, 4 m; 1 s, Cienfuegos Bay, 20-30 m; 2 s, Rancho Luna Beach, 15-30 m.

Type locality: Cuba, Bahía de Sagua, northeast Cuba, 3-6 m.

Etymology: The specific name refers to the large callus, which characterizes the species.

Description: Shell (Figs. 31A-D) trochoid, pyriform, very solid, almost as wide as high, smooth, umbilical callus very large. Protoconch (Fig. 31E) of about 1 ½ smooth whorls, and about 230 μm in diameter. Teleoconch of about 2 whorls, no ornamentation, with visible suture and rapid expansion. Dorsally convex with very numerous, curved, prosocline growth lines; ventrally, very slightly convex, also with the same growth lines, which are more evident on the dorsum and periphery. Umbilicus totally hidden by a strong



Figures 31A-E. *Teinostoma megacallum* spec. nov. A: holotype, 1.65 mm, Sagua, Cuba (MNCN); B: paratype, 1.5 mm, Sagua, Cuba, (MNCN); C: paratype, 1.6 mm, Cienfuegos, Cuba (MNCN); D: paratype 1.8 mm (MHNS); E: protoconch.

Figuras 31A-E. Teinostoma megacallum *spec. nov. A: holotipo, 1,65 mm, Sagua, Cuba (MNCN); B: paratipo, 1,5 mm, Sagua, Cuba (MNCN); C: paratipo, 1,6 mm; Bahía de Cienfuegos, Cuba (MNCN); D: paratipo 1,8 mm (MHNS); E: protoconcha.*

callus formed by the thickening of the columella and the internal lip. Aperture nearly quadrangular with an expansion of the peripheral labrum, columella wide and almost straight, outer lip sharp, the upper part advanced.

Dimensions: Holotype 1.65 mm in maximum diameter and 1.12 mm of height.

Habitat: In Cuba this species has been collected in sandy grit between 3 and 30 m deep.

Distribution: Only know from Cienfuegos, Cuba.

Remarks: *Teinostoma megacallum* may be distinguished from its congeners by the robust shell and principally by the thick columella and the great size of the umbilical callus.

Teinostoma carinicallus (Pilsbry & McGinty, 1946) (Figures 32A-D)

Teinostoma lituspalmarum auct. non Pilsbry & McGinty, 1945.
Teinostoma (Annulicallus) carinicallus Pilsbry & McGinty, 1946a. *The Nautilus*, 60: 17-18, pl. 2, figs. 6-6b. [Type locality: Missouri Key, Florida].
Pseudorotella carinicallus Pilsbry & McGinty, 1946.
Pseudorotella carinicallum (sic).

Type material: Holotype in ANSP (181979). Not examined.
Other material examined: Florida, USA: 1 s east side, Peanut Island, under rocks (CMK); 1 s, Anclote Key, Pasco Co. (CHL); 1 s, Pelican Shoals, Key West, Monroe Co., 5-7 m, (CHL).

Description: The best description is in MOORE (1964: 101-102) *"Shell depressed, shoulder concave, bearing a low spiral rib at its outer edge; umbilicus surrounded by a strong spiral carina. Spire flattened, formed by four whorls, two in the protoconch and two in the teleoconch. Periphery rounded; umbilical area is bordered with a strong spiral carina. Aperture oblique, parietal callus rather thin. There is a small groove at the upper inner angle"*.

We add: A short channel is formed at the junction of the umbilical keel with the columella. The protoconch (Fig. 32D) is barely detectable due to a fine callous layer which covers the shell dorsally. In the studied material the dorsal cord is prominent and produces a distinct angulation on the shell.

Maximum reported size: 2.7 mm. Our shell (Figs. 32A-C) measures 2.15 mm in diameter and 1.25 mm in height.

Habitat: Depth between 0 to 46 m. The type specimen was taken alive in shallow water. However the species appears to be rare in shallow inshore waters (MOORE, 1964).

Distribution: USA: Florida: East Florida, West Florida, Florida Keys (PILSBRY & MCGINTY, 1946b); Texas (ODÉ, 1987b); Panama (OLSSON & MCGINTY, 1958).

Remarks: This species was collected from the Plio-Pleistocene of St. Petersburg. PILSBRY (1953) stated: *"among the Pliocene specimens there are many in which the spiral angle of the upper surface is wholly absent"*. Our shell presents the typical characters of the species.

T. carinicallus is very similar to *T. lituspalmarum* Pilsbry & McGinty. The main difference between the two species is that *T. carinicallus* is smooth and *T. lituspalmarum* has weak spiral striae.

Teinostoma lituspalmarum Pilsbry & McGinty, 1945

Teinostoma (Annulicallus) lituspalmarum Pilsbry & McGinty, 1945a. *The Nautilus* 59: 7-8, pl. 2, fig. 3. [Type locality: Off Palm Beach, Florida].

Type material: Holotype deposited in ANSP (181103). Not examined.

Description: See PILSBRY & MCGINTY (1945a).

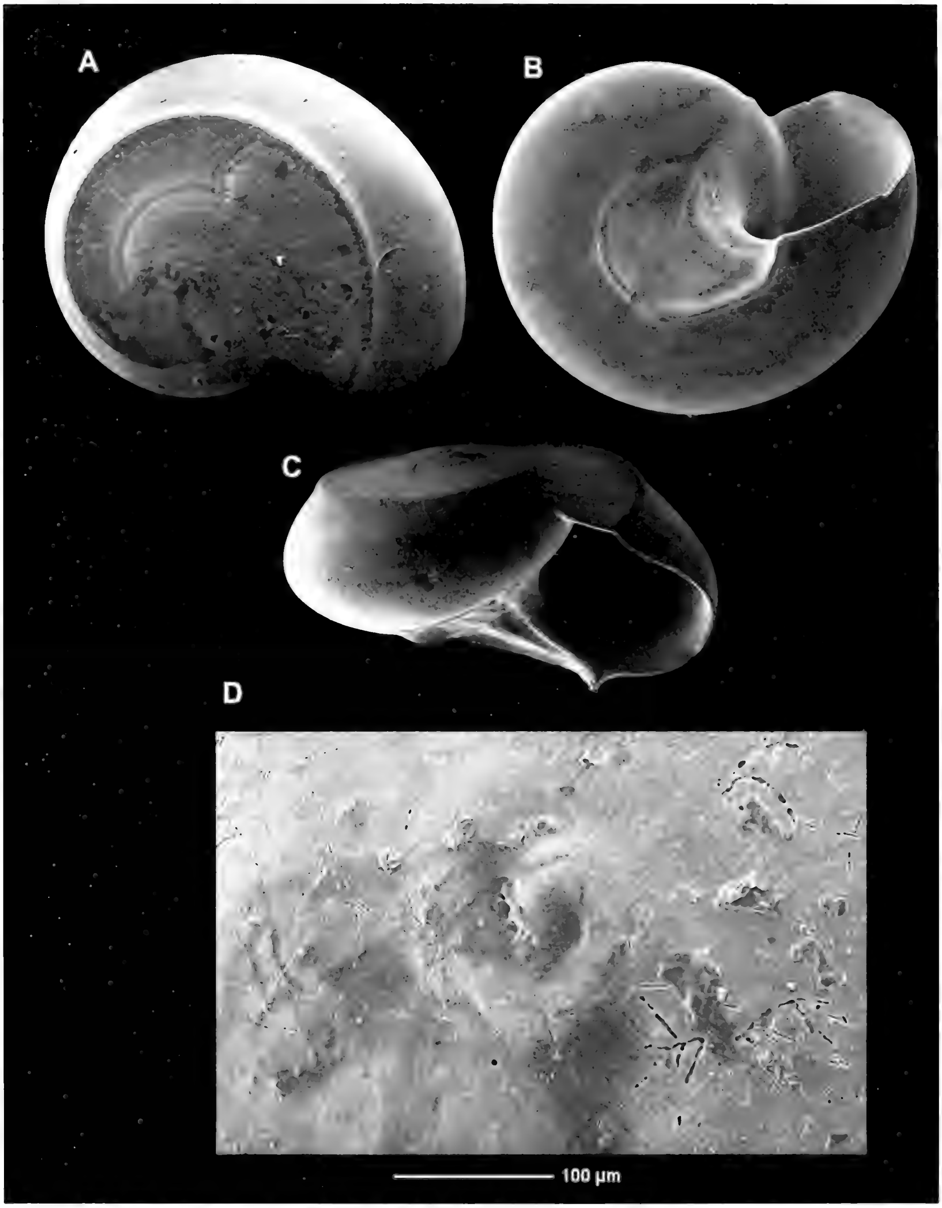
Maximum reported size: 1.7 mm.

Habitat: Rocky reef, in 90 m deep (50 fms).

Distribution: USA: Florida: East Florida (PILSBRY & MCGINTY, 1945a).

Remarks: See also *T. lituspalmarum* auct. = *T. carinicallus*.

Since its original description this species has not been recorded. MOORE (1964: 102-103) mentions: "Teinostoma carinicallus *is very similar to* T. lituspalmarum *Pilsbry and McGinty. The main difference*



Figures 32A-D. *Teinostoma carinicallus* Pilsbry & McGinty, 1946. A-C: shell, 2,15 mm, Peanut Island, Florida (CMK); D: protoconch.

Figuras 32A-D. Teinostoma carinicallus *Pilsbry & McGinty, 1946. A-C: concha, 2,15 mm, Isla Peanut, Florida (CMK); D: protoconcha.*

between the two species is that T. carinicallus *is smooth and* T. litus-palmarum *has weak spiral striae. More material may show that the two are merely forms of the same species, but it is best to keep them separate until the problem can be solved".*

Subfamily TORNINAE Sacco, 1896

Genus *Tornus* Turton & Kingston, 1830

Tornus Turton & Kingston, 1830. *Testacea Britanica*, pp. 438, pl. 7, fig. 9. [Type species: *Helix subcarinata* Montagu, 1803, by monotypy. Recent. Europe].

Adeorbis S. Wood, 1842. *Ann. Mag. Nat. History*, 9:530. [Type species: *Adeorbis subcarinatus* (Montagu, 1803)].

Diagnosis: Shell of small size (2-3 mm), solid, usually depressed, spire with 3-4 whorls. Protoconch smooth, between 1 and 2 whorls (most frequently 1 ¾), not elevated. Teleoconch with strong spiral cords crossed by strong axial ribs. External lip crenulated. Aperture subtrigonal. Operculum ovoid, paucispiral and chitinous.

Habitat: Acording to FRETTER & GRAHAM (1978) and GOFAS, PINTO AFONSO & BRANDAÕ (1985), the true *Tornus* live deeply buried in sand under stones, but they need clean sand through which the water circulates and allows good oxygenation. In The Straits of Gibraltar, Spain it lives with other species in areas with strong current and heavy waves partially buried in a sandy bottom among boulders and stones.

Remarks: Numerous species of *Tornus* have been described from European coasts as well as West Africa. ROLÁN & RUBIO (2002) revised the family Tornidae in the East Atlantic, studying 39 species of which 13 are in the genus *Tornus*. But on the other side of the Atlantic, no species had been described in the genus *Tornus* from either coast of the New World. However, two species previously placed in the genus *Cyclostremiscus* are, in our opinion, members of this genus. The morphology of their shells, very similar to some of the West African coast, is of interest.

Tornus caraboboensis (Weisbord, 1962) (Figures 33A-C)

Cyclostremiscus caraboboensis Weisbord, 1962. *Bulletins of American Paleontology*, 42(193): 140-141, pl. 13, figs. 7-9. [Type locality: La Salina, west of Puerto Cabello, state of Carabobo, Venezuela]. Fossil record.

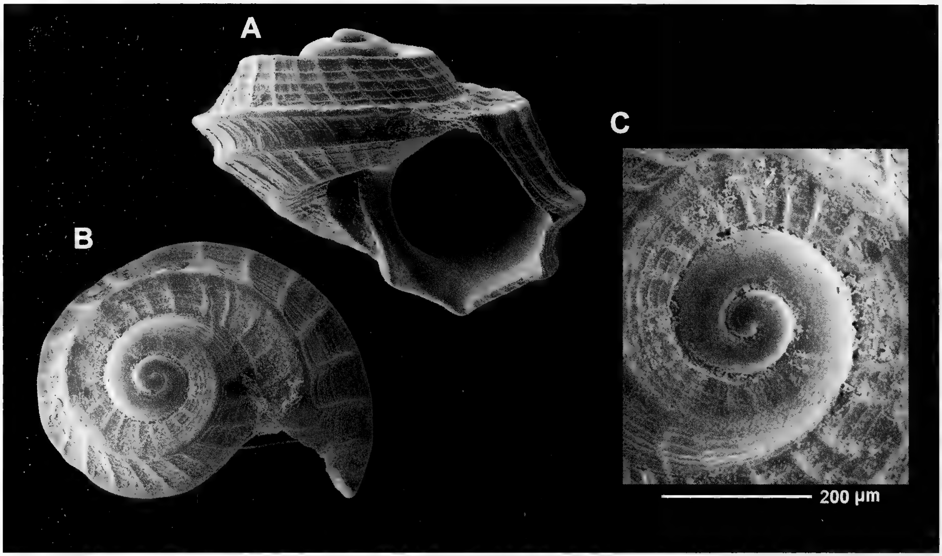
Type material: Type material deposited in PRI (26094). Not examined.
Other material examined: Guatemala: 2 s, Livingston, 2 m (MHNS).

Description: (See WEISBORD, 1962 and ALTENA, 1975). Shell (Figs. 33A-B) with a reticulated surface, produced by the spiral cords crossing the axial ribs. Protoconch (Fig. 33C) of about 1 ¾ smooth whorls, about 260 μm in diameter. Teleoconch sculpture formed by strong keel-like spiral cords placed one on the dorsum, two at the periphery, another one on the base, and finally the last one delimiting the umbilicus. Fine spiral threads are distributed between the keels. Spiral cords and threads are crossed by narrow strongly prosocline axial ribs. Aperture rounded, outer lip with five prominences caused by the ends of the spiral keels. Columella strong, slightly curved.

Dimensions: Holotype 2.3 mm in maximum diameter, but largest shells can reach 3.0 mm. Our material measures 1.23 mm in diameter and 0.82 mm in height.

Habitat: In shallow water. The samples studied were collected in muddy sand bottom at 2 m in depth.

Distribution: Species considered of continental distribution. Recorded from Venezuela (WEISBORD, 1962); Colombia (COSEL, 1986; DÍAZ



Figures 33A-B. *Tornus caraboboensis* (Weisbord, 1962). A-B: shells, 1.1, 1.0 mm, Livingston, Guatemala (MHNS); C: protoconch.
Figuras 33A-B. Tornus caraboboensis *(Weisbord, 1962). A-B: conchas, 1,1, 1,0 mm, Livingston, Guatemala (MHNS); C: protoconcha.*

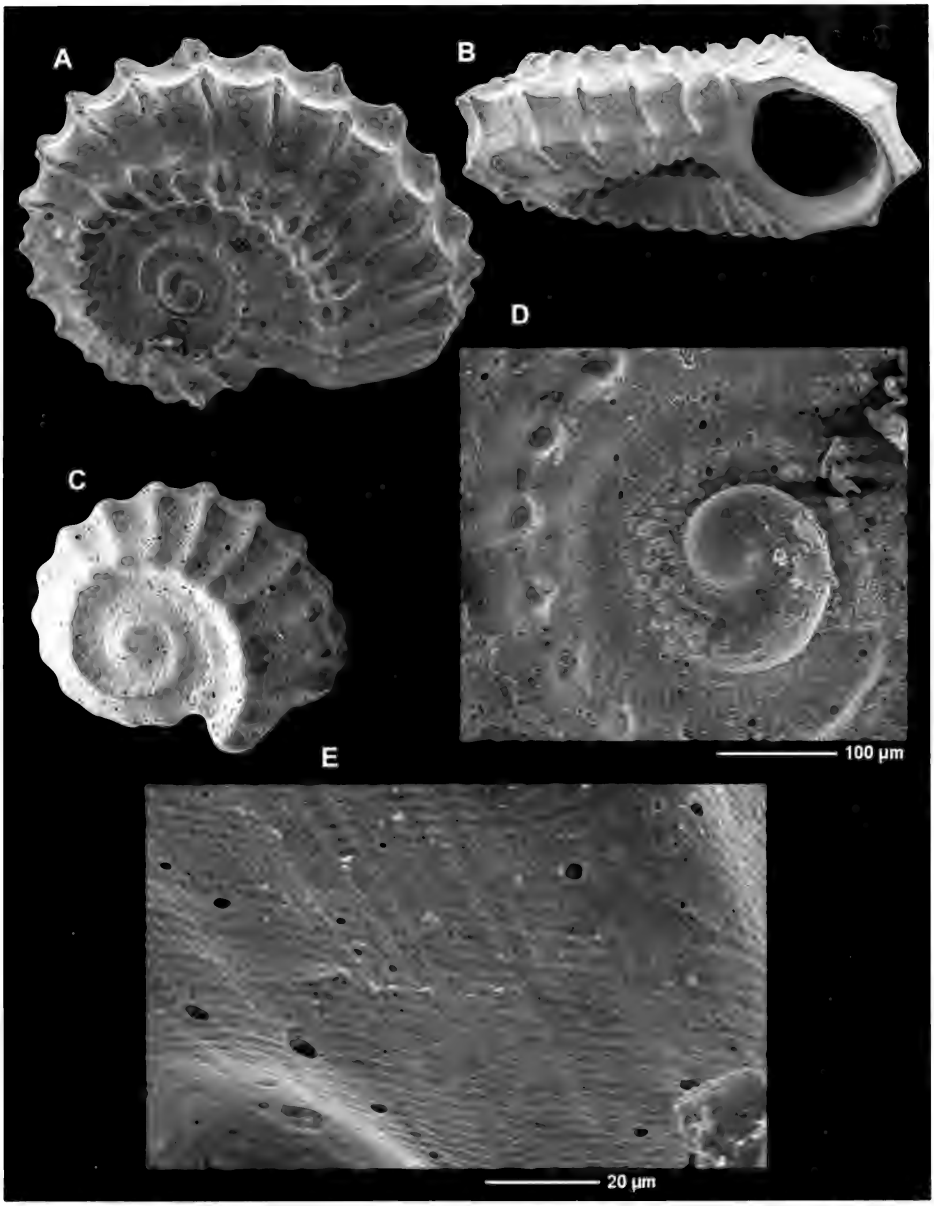
MERLANO & PUYANA HEGEDUS, 1994); Surinam (ALTENA, 1975); Curaçao: Schottegat and Spaanse Waters (DE JONG & COOMANS, 1988); Brazil: Espirito Santo (RIOS, 1994); Guatemala (the present work). The only insular record is that of DE JONG & COOMANS (1988) for Curaçao, very close to the continent, not entirely inconsistent with the "continental" distribution paradigm.

Remarks: This species was described as fossil in the Pliocene of Carabobo, Venezuela. The samples recorded from Surinam are also fossil but derived from the Holocene deposites. The material here studied is recent from Livingstone, Guatemala. By their development stage they seem to be juvenile shells. The morphology of the sculpture (strong cords and fine spiral cordlets crossing with axial ribs forming a characteristic reticule) recall some West African species of Tornidae, *T. subcarinatus* (Montagu, 1803); *T. africanus* Adam & Knudsen, 1969; *T. aemilii* Rolán & Rubio, 2002; *T. erici* Rolán & Rubio, 2002; and particularly *T. umbilicorda* Rolán & Rubio, 2002, a species with which it has considerable similarity. For this reason we have placed *Cyclostremiscus caraboboensis* in the genus *Tornus*.

Tornus schrammii (P. Fischer, 1857) (Figures 34A-E)

Cyclostrema schrammii P. Fischer, 1857. *Journal de Conchyliologie*, 6: 287-288, pl. 10, fig. 11 [Type locality: Guadeloupe].
Cyclostremiscus schrammii (P. Fischer, 1857)

Type material: Type material deposited in MNHN. Lost according to HOUBRICK (1967).
Other material examined: Guatemala: 1 s, Livingstone, 2 m (MHNS). Trinidad and Tobago: Tobago, 4 s, Buccoo (CHL).



Figures 34A-E. *Tornus schrammii* (P. Fischer, 1857). A-B: shell, 1.5, 1.55 mm, Tobago (CHL); C: shell, 1.15 mm, Livingstone, Guatemala (MHNS); D: protoconch, Tobago; E: microsculpture.
Figuras 34A-E. Tornus schrammii *(P. Fischer, 1857). A-B: concha, 1.5, 1,55 mm, Tobago (CHL); C: concha, 1,15 mm, Livingstone, Guatemala (MHNS); D: protoconcha, Tobago; E: microescultura.*

Description: Shell: see P. FISCHER (1857). Shell (Fig. 34A-C) very solid, depressed and whitish in color. Protoconch (Fig. 34D) with 1 ½ whorls, about 230 µm in diameter, with strong tubercles irregularly placed, which are smaller and more numerous near the varix which appears at the transition to the teleoconch. Teleoconch sculptured by 4 strong nodular spiral cords (one on the dorsum, two on the periphery, and one more on the base. There are 20-22 strong axial ribs. At the crossing points there are nodules. Subsutural area ornamented by fine spiral striae. The nodules of the subsutural cord are more elevated than that of the upper peripheral cord. Aperture rounded, prosocline. Umbilicus wide and deep which allows the previous whorls to be seen.

Dimensions: The holotype is 2.0 mm in diameter. Largest shell, a paratype in MNHN, is 3.2 mm in diameter. Our shells did not exceed 1.55 mm.

Habitat: Recorded from the external reefs (VOKES & VOKES, 1984) and shallow water (ROBINSON, 1991).

Distribution: : It has been recorded from Guadeloupe (P. FISCHER, 1857); from Colón and Bocas Island, Panama (OLSSON & MCGINTY, 1958); from Costa Rica (HOUBRICK, 1967); from Guadeloupe and Central America (HOUBRICK, 1968); from Cancún to the Belize border, Arcas Keys, Alacran reef and Cayos del Norte and Lobos from the Banco Chinchorro, Mexico (VOKES & VOKES, 1984; ROBINSON, 1991); from the Caribbean Sea (ABBOTT, 1974); and from Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994).

Remarks: It is not a very common species, few shells are known even from the type locality. Since the description by P. FISCHER (1857), no new records had been published until HOUBRICK (1967), who figured one of seven shells found in Portete, Provincia Limón, Costa Rica. Houbrick considered this specimen of particular impostance since he reported that the holotype in the MNHN was lost.

Tornus schrammii is very similar in shell morphology to some species from the west coast of Africa such as *T. leloupi*, *T.* aff. *attenuatus*, *T. ryalli*, and *T. rachelae*. These all share a depressed shell sculptured with strong nodulous cords or tubular extensions.

Subfamily VITRINELLINAE Bush, 1897

Marine prosobranchs that have small or minute depressed shells, which are transparent while the animal is alive. The aperture is usually oblique, rounded, and without a terminal varix. There are usually one to three postlarval whorls which may be smooth or sculptured. The operculum is circular and multispiral, and the radula taenioglossate.

The animal has small black eyes, a pair of cephalic tentacles, and a pair of pallial tentacles. Both pairs are provided with mobile cilia for producing respiratory currents and are tipped with long stiff inmobile cilia. The male is equipped with a penis located behind the head and which extends back into the mantle cavity (MOORE, 1964).

In the Recent fauna, there are ten genera grouped within the subfamily Vitrinellinae: *Anticlimax* Pilsbry & McGinty, 1946; *Aorotrema* Schwengel & McGinty, 1942; *Cyclostremiscus* Pilsbry & Olsson, 1945; *Cochliolepis* Stimpson, 1858; *Episcynia* Mörch, 1875; *Parviturboides* Pilsbry & McGinty, 1950; *Pleuromalaxis* Pilsbry & McGinty, 1945; *Solariorbis* Conrad, 1865; *Vitrinella* C.B. Adams, 1850 and *Vitrinorbis* Pilsbry & Olsson, 1952, and all them are present in the geographic area studied. A new genus, *Neusas* Warén & Bouchet, 2001, has been placed provisionally in Vitrinellinae, although the authors considered it in an uncertain systematic position, probably not in the Tornidae

Genus *Anticlimax* Pilsbry & McGinty, 1946

Climacia Dall, 1903: 1633 (Preoccupied, M'Lachlan, 1869 (Neuroptera)).
Climacina Aguayo & Borro, 1946: 11. (Preoccupied by Gemellaro, 1878 (Mollusca)).
Anticlimax Pilsbry & McGinty, 1946. *The Nautilus*, 60: 12.
Type species: *Teinostoma (Climacia) calliglyptum* Dall, 1903 (by monotypy).

Remarks: PILSBRY & OLSSON (1950) revised the genus and gave the following description: "*The shell is wider than high, with a dome-shaped or low-conic spire of few (3 or 4) whorls, carinate periphery and more or less convex base. The protoconch is smooth, of scarcely more than one convex whorl to 1 ¼. Sculpture of close, usually punctate, spiral striation and radial wavelike ribs on the base, sometimes on the upper surface also. The aperture is oblique, quadrangular or triangular, with a thickened peristome, the outer lip is angular or often extended at the termination of the keel. Umbilicus bordered by a spirally emerging callous rib, terminating at the columella or in the genus* Subclimax *it fills the umbilicus*".

PILSBRY & OLSSON (1950) divided *Anticlimax* into two subgenera:

Subgenus *Anticlimax s. str.*: characterized by having the umbilicus open, bordered by a spiral cord which terminates in the columella in a small triangular callus. Type species: *Anticlimax calliglypta* (Dall).

Subgenus *Subclimax*: characterized by having an umbilicus, totally or partially closed by a solid column which terminates in a callus fused to the columella. Type species: *A. hispanioliensis* Pilsbry & Olsson, 1950.

Nothing is known about the animal of *Anticlimax*. Its generic assignment has been based only on the distinguishing characters of the shell, as the form, the radial folds on the base, the angular form of the external lip, and the spiral grooves in zigzag, among others.

Most of the known species are fossil from the Miocene and Plio-Pleistocene. There are few recent species described, and they occur in North Carolina, Florida and Belize.

AGUAYO & BORRO (1946) described *Canimarina* and placed it provisionally as a subgenus of *Cyclostremiscus*, to accommodate the new species *Cyclostremiscus (Canimarina) crassilabris*.

This species, in their opinion, had characters which could ally it to the genera *Cyclostremiscus*, *Miralabrum*, *Teinostoma* and *Climacia*, but also it could be considered as a new genus due to its own different unique characters.

Almost at the same time, PILSBRY & MCGINTY (1946a) introduced the replacement name *Anticlimax*, for the monotypic genus containing *Teinostoma (Climacia) calliglyptum* Dall, 1903, since the genera *Climacia* Dall, 1903 and *Climacina* Aguayo & Borro, 1946, based on the same type species, were unavailable homonyms (see above).

FABER (2007) considers *Canimarina* a valid genus, comparing it only with *Cyclostremiscus*, and places it in Vitrinellidae solely on the basis of its lacking "a clear apertural varix". Also he considers *Solariorbis decipiens* Olsson & McGinty, 1958 a junior synonym of *Cyclostremiscus (Canimarina) crassilabris*. Since then databases treat *Canimarina* as a valid genus and place it in Vitrinellinae. In our opinion, *Canimarina* must be considered a synonym of *Anticlimax* for the following reasons:

-FABER (2007) considered it a valid genus without comparison to the genus *Anticlimax*.

-the description of the subgenus is not sufficiently detailed to allow distinction from other species placed in *Anticlimax*.

-*Cyclostremiscus (Canimarina) crassilabris* shares all the generic characters of *Anticlimax*.

-The stated date of publication for *Anticlimax* is July and that of *Canimarina* is August of the same year, giving the former priority.

Anticlimax crassilabris (Aguayo & Borro, 1946) (Figures 35A-G)

Cyclostremiscus (Canimarina) crassilabris Aguayo & Borro, 1946. *Revista de la Sociedad Malacológica "Carlos de la Torre,"* 4(2): 46-47, lám. 3, figs. 1-3. [Type locality: Barranco E. del rio Canímar. Formación "Yumurí," Upper Miocene. Matanzas, Cuba].

Solariorbis decipiens Olsson & McGinty, 1958. *Bulletins of American Paleontology*, 39: 28-29, pl. 3, figs. 5, 5a, 5b. [Type locality: Bocas Island, Panama].

Type material: Type of *Cyclostremiscus (Canimarina) crassilabris* deposited in Museo Poey, University of Havana. Type of *Solariorbis decipiens* in ANSP (211914). Not examined.

Other material examined: Cuba: 1 s, Carenas Key, Cienfuegos Bay, 3 m, under stones (MHNS); 1 s, in the channel to Cienfuegos Bay, 30 m (MHNS); 3 c, Rancho Luna Beach, 20 m (MHNS); 7 s Cienfuegos (MHNS). Martinique: 1 c, Pointe Borgnesse, 12 m, from coralline sandy grit near the reef (CJP).

Description: The description of the species in Aguayo & Borro (1946) is as follows: *"Concha diminuta, deprimida; espira cónica, algo elevada sobre el plano de la ultima vuelta. Provista de 2 ½ vueltas, la primera lisa, las siguientes esculpidas radial y espiralmente. Escultura axil o radial formada por costillitas salientes (unas 30 en la última vuelta) que desaparecen al 1/8 final de la última vuelta. Estas costilla persisten, aunque menos marcadas en el cuerpo de la última vuelta; pero desaparecen en la base al llegar a la quilla espiral inferior. Base lisa. Escultura espiral formada por dos quillas salientes que delimitan el contorno de la última vuelta, quedando articuladas por las costillas axiles. Además hay líneas finas espirales entre ambas quillas, y algunas evanescentes en la base. Cuerpo de la última vuelta de contorno cuadrangular visto de perfil. Ombligo estrecho, parcialmente cubierto por un callo. Al final de la última vuelta la quilla superior se proyecta tangencialmente hacia la abertura, formando un engrosamiento muy marcado en ángulo recto. Abertura subtriangular, engrosada por una callosidad formada por la citada prolongación de la quilla superior. Borde parietal de la abertura con un callo peculiar en su ángulo superior".*

The protoconch (Figs. 35F-G) is about 230 µm in diameter, and it is totally smooth. The teleoconch is totally covered by fine spiral cordlets. On the dorsum, strong radial ribs may be observed. They are slightly prosocline and, on the last 1/3 of the body whorl, become more fine and numerous and are crossed by the spiral cordlets to form a reticule. Basally the shell is very convex and expresses strong radial undulating ribs. The external lip is angled in the peripheral area and is projected forward forming a characteristic extension. Umbilicus small, partially occluded by the thickening and extension of the columella.

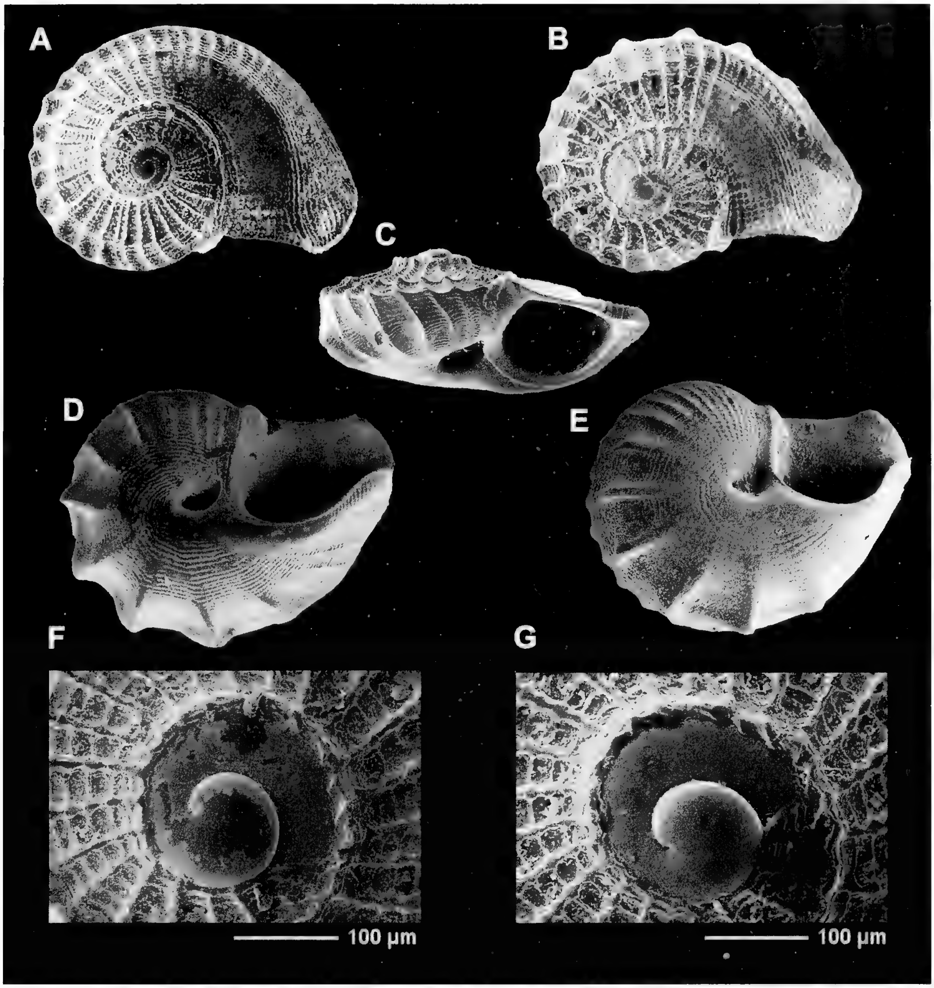
Dimensions: The holotype of *Cyclostremiscus (Canimarina) crassilabris* is 1.20 mm in maximum diameter and 0.78 mm in height. The holotype of *Solariorbis decipiens* measures 1.25 mm in maximum diameter and 0.50 mm in height.

Animal and radula unknown.

Distribution: Panama: Bocas Island (Olsson & McGinty, 1958; Faber, 2007); and Portobello (Faber, 2007); Dominica (Faber, 2007); Cuba: Matanzas, fossil (Aguayo & Borro, 1946); Rancho Luna Beach, Cienfuegos Bay and Martinique, in the present work.

Habitat: In Cuba this is a uncommon species, having been found in sediments collected between 20 and 50 m in depth.

Remarks: *Anticlimax crassilabris* was described as fossil from the Upper Miocene, "Yumurí" Formation. Aguayo & Borro (1946) mention that the base is lacking sculpture. There are axial undulating folds, which do not appear in the original figuration. These axial folds on the base are observed in the individual examined from Cuba.



Figures 35A-G. *Anticlimax crassilabris* (Aguayo & Borro, 1946). A-E; shells, between 1.2 and 2.0 mm, Rancho Luna Beach, Cuba (MHNS); F-G: protoconch.

Figuras 35A-G. Anticlimax crassilabris *(Aguayo & Borro, 1946). A-E; conchas, entre 1,2 y 2,0 mm, Playa Rancho Luna, Cuba (MHNS); F-G: protoconcha.*

OLSSON & MCGINTY (1958) described *Solariorbis decipiens* on the basis of only one specimen. Which such limited material it has not been possible to know the morphological variability of the shell. Our shells conform to the description of *Solariorbis decipiens* as well as that of C. crassilabris and have a consistency in the distinguising characters. Principal among these features are the sculpture of the dorsum formed by axial ribs with spiral threads in the intervals and the strongly convex base with strong undulating radial folds. External lip angular and apparently not channeled by the keel. All specimens are characteristic of the genus *Anticlimax,* and for this reason we have placed the species in this genus and not in *Solariorbis*. At the same time the similarity of *Anticlimax crassilabris* to *Solariorbis decipiens* Olsson & McGinty impels us to consider the two synonymous.

Anticlimax glabra spec. nov. Rubio, Rolán & Pelorce (Figures 36A-D)

Type material: Holotype (Fig. 36A) and a paratype (Figs. 36B-C) in MNHN (24200).
Type locality: Grenadines, Martinique, Pointe Borgnese, 12 m.
Etymology: The specific name refers to the smooth surface of the shell in opposition to other congeneric species.

Description: Shell (Figs. 36A-C) very small, lenticular, spire consists of 3 rounds of rapid growth. Protoconch (Figs. 36D) slightly projecting, about 180 μm in diameter, and totally smooth. Teleoconch totally smooth except for the first quarter whorl in which there is ornamentation formed by spiral cords and axial ribs that intersect to form a characteristic reticulate sculpture. There is a thick subsutural cord that begins at the protoconch and ends in the parietal area of the aperture, forming a thick callus. Basally the shell is more convex than dorsally and withouth strong radial undulating ribs. Aperture oval and with a small groove at the upper inner angle; the external lip is angled at the periphery; columella straight, inner lip reflected toward the umbilicus. A thin horny layer covers the entire umbilical area.

Dimensions: The holotype measures 1.00 mm and the paratype 1.06 mm.

Animal and radula unknown

Distribution: Known only from the type locality.

Habitat: Collected in muddy sand at the base of the reef, at a depth of 12 m.

Remarks: *Anticlimax glabra* spec. nov. is very similar to *Anticlimax crassilabris* to the point that we thought that it represented eroded specimens of that species. But the characters are constant in both known specimens, and they are very characteristic of this new species. The protoconch shape, the angular, unchanneled external lip, the subsutural cord, and its similarity to *A. crassilabris* militated for its placement in *Anticlimax* although it also shares characteristics with *Teinostoma*.

Anticlimax glabra spec. nov. differs from *A. crassilabris* by its lack of dorsal and basal ornamentation, by its rounded periphery and by having its umbilicus completely covered by a thin horny layer.

Anticlimax decorata Rolán, Fernández-Garcés & Rubio, 1997 (Figures 37A-D)

Anticlimax decorata Rolán, Fernándes-Garcés & Rubio, 1997. *Iberus*, 15(1): 31-34. figs. 1-2 [Type locality: Rancho Luna Beach, Cienfuegos, Cuba].

Type material: Holotype in MNCN (15.05/27420) (Figs. 37A-B). Paratypes in the following collections: AMNH, NHMUK, CFG, IES, MHNS.
Other material examined: Cuba: 1 c, Rancho Luna Beach, 10-20 m.

Description: See ROLÁN, FERNANDEZ-GARCÉS & RUBIO (1997). Shell (Figs. 37A-B). Protoconch (Fig. 37D); microsculpture (Fig. 37C).

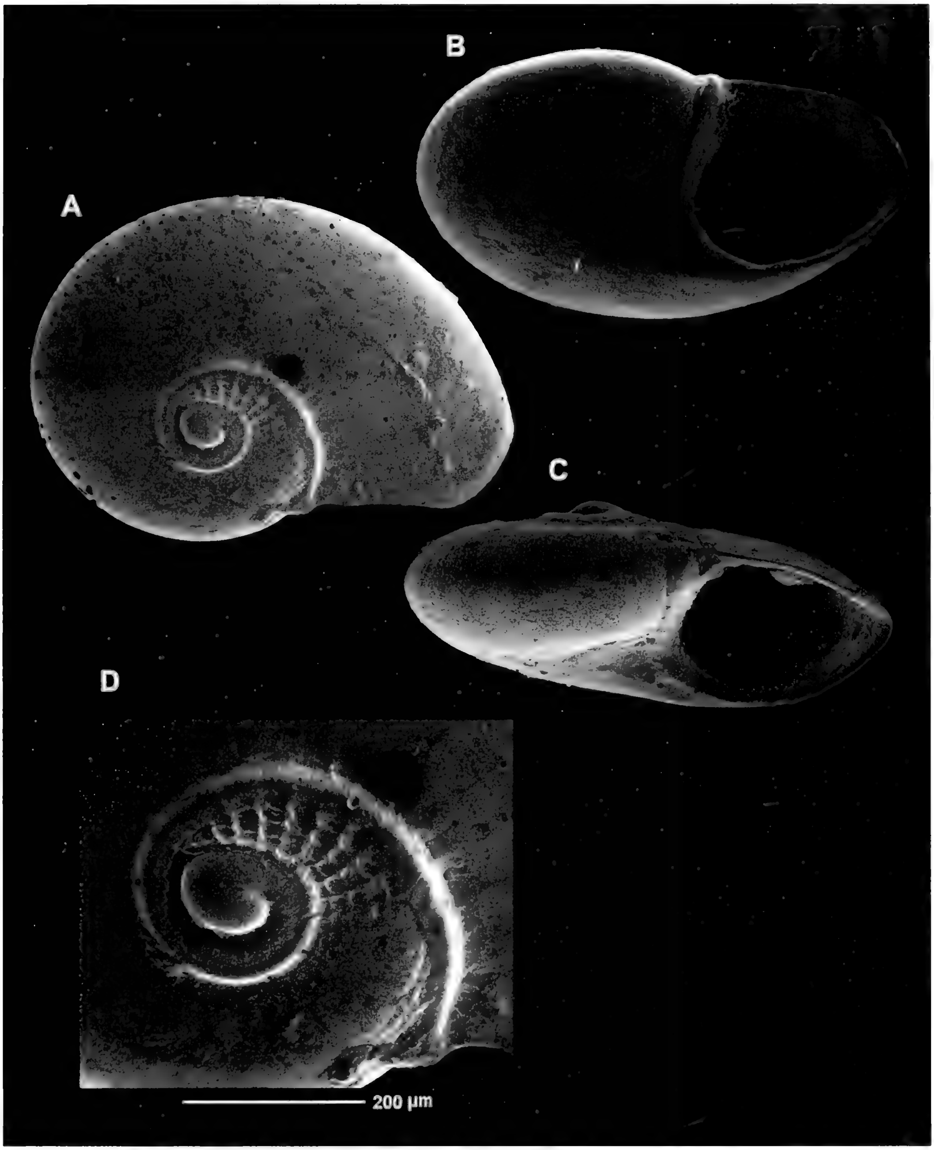
Dimensions: Holotype 1.4 mm in maximum diameter.

Animal and radula unknown.

Distribution: Only known from Cuba.

Habitat: Unknown.

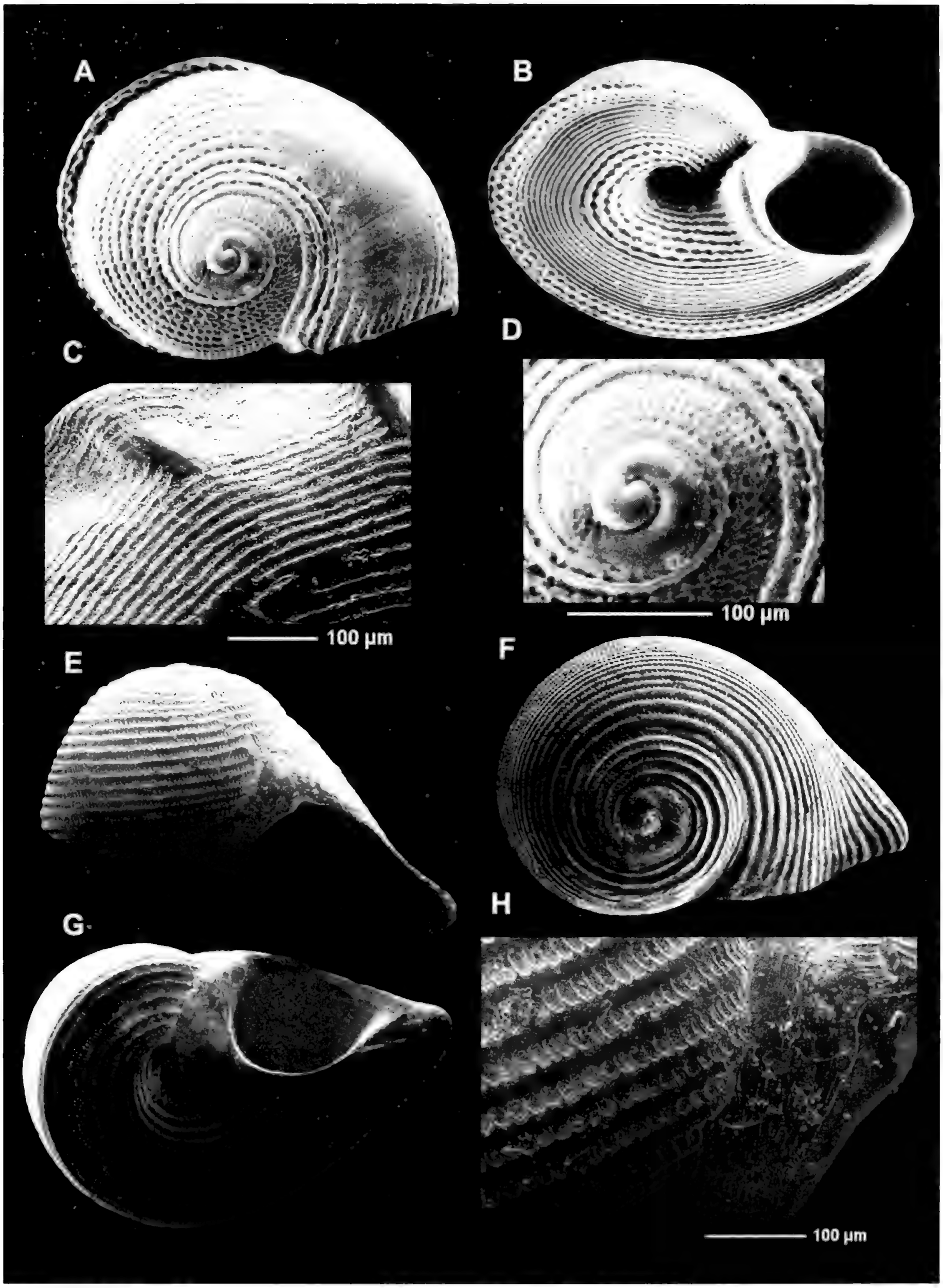
Remarks: The genus *Anticlimax*, as has been noted above, is divided in two subgenera: *Anticlimax* and *Subclimax*. PILSBRY & OLSSON (1950) mentioned that there is no species demonstrating intergradation between these subgenera. Nevertheless, *A. decorata* presents morpho-



Figures 36A-D. *Anticlimax glabra* spec. nov. Rubio, Rolán & Pelorce. A: holotype, 1.0 mm, Martinique (MNHN); B-C: paratype, 1.06 mm, Pointe Borgnese, Martinique (MNCN); D: protoconch.

Figuras 36A-D. Anticlimax glabra *spec. nov. Rubio, Rolán & Pelorce. A: holotipo, 1,0 mm, Martinique (MNHN); B-C: paratipo, 1,06 mm, Pointe Borgnese, Martinique (MNCN); D: protoconcha.*

logical characters which are intermediate. The open umbilicus and lack of columellar callus would place it in *Anticlimax s. st.*, but the absence of axial sculpture on the base and of any kind of prolongation of the labrum, suggest *Subclimax*. We prefer to employ only the full generic assignment in this report.



Figures 37A-D. *Anticlimax decorata* Rolán, Fernandez-Garcés & Rubio, 1997. A-B: holotype, 1.4 mm, Rancho Luna Beach, Cuba (MNCN); C: details of sculpture; D: protoconch.
Figures 37E-H. *Anticlimax proboscidea* (Aguayo, 1949). E-G: shells, 1.4, 1.4, 1.6 mm, Rancho Luna Beach, Cuba; H: detail of the microsculpture.
Figuras 37A-D. Anticlimax decorata *Rolán, Fernandez-Garcés & Rubio, 1997. A-B: holotipo, 1,4 mm, Playa Rancho Luna, Cuba (MNCN); C: detalle de la escultura; D: protoconcha.*
Figuras 37E-H. Anticlimax proboscidea *(Aguayo, 1949). E-G: conchas, 1,4, 1,4, 1,6 mm, Playa Rancho Luna, Cuba; H: detalle de la microescultura.*

Anticlimax proboscidea (Aguayo, 1949) (Figures 37E-H)

Teinostoma (Anticlimax?) proboscidea Aguayo, 1949. *Revista de la Sociedad Malacológica "Carlos de la Torre,"* 6: 93-94, pl. 4, fig. 5. [Type locality: Camarioca, Matanzas, Cuba].

Type material: Holotype in the Museo Poey (n° 12902), Havana, Cuba.
Other material examined: Antigua and Barbuda: Redonda island, 1 c, among rocks, 5-15 m. Cuba: 1 s, Rancho Luna Beach, 10-20 m; 1 s, Baracoa, 15 m; 2 s, Cienfuegos Bay, 15 m. ABC Islands: 1 s, 50 mi. off Palm Beach, Aruba, 5 m (CHL).

Description: This is the text in the original description (AGUAYO, 1949): *"Concha diminuta, sólida, blanca, en forma de domo, base casi plana, periferia obtusamente angular; ombligo marcado por una línea microscópica. Provista de 3 ½ vueltas de espira, de las cuales las nucleares (1 ½ vueltas) son lisas, y las restantes, con numerosas líneas espirales microscópicamente punticuladas (unas 15 en la última vuelta, desde la sutura hasta la periferia). Base con una escultura similar de 12 líneas espirales punticuladas. Región umbilical con un callo que no obtura por completo el umbilicus, dejando una pequeña cisura muy estrecha. Última vuelta prolongada tangencialmente de una manera semejante a la del género* Miralabrum *Pilsbry y Olsson, 1945. Abertura transversalmente ovoidal, pero casi subcircular, prolongada en un estrecho canal en el ángulo basal externo. Un grueso callo une a la abertura con la región parietal y columelar de la concha".*

The protoconch has a little more than one whorl, with a diameter of about 310 μm and under high magnification it can be seen that the surface is slightly roughened.

The teleoconch (Figs. 37E-G) is totally covered by evenly-spaced spiral cords, which present small ovoid small ovoid cells in their interspaces. Aperture triangular, the external lip is elongated basolaterally to produce an acute angulation at its lateral margin. Aside from this feature, the lip lacks an internal channel. Peristome thickened. The columellar callus is extended towards the base partially closing the umbilicus.

Dimensions: Holotype is 1.7 mm in maximum diameter. Our shells measure 1.55 mm in maximum diameter and 0.74 mm in height.

Animal and radula unknown.

Distribution: MOORE (1965) considered it endemic to Cuba. DE JONG & COOMAN (1988) recorded it in Bonaire and Aruba (5 sps). REDFERN (2001) mentions numerosous shells from Abaco, Bahamas, collected in sediment from 23 m in depth. One shell from Redonda (Antigua and Barbuda) confirms its presence for the Lesser Antilles.

Habitat: It is an uncommon species. We have it from sediments collected between 10 and 20 m in depth, but the holotype came from 40 m.

Remarks: AGUAYO (1949: 94) stated that the general aspect of *T. proboscidea* is similar to that of *Teinostoma pilsbryi* McGinty, 1945, from which it is distinguished by its small size, lack of the globose callus in the umbilicus, and the prolongation at the end of the last whorl. The domed shape and the aforementioned projection have similarity to some species of the genus *Anticlimax* Pilsbry & McGinty, 1946.

Teinostoma pilsbryi McGinty, 1945 is smaller and has a different umbilical callus.

Climacia tholus Pilsbry and McGinty, 1946 is smaller and has a different umbilical callus.

Anticlimax pilsbryi (McGinty, 1945) (Figures 38A-C)

Teinostoma pilsbryi McGinty in Pilsbry and McGinty, 1945. *The Nautilus*, 58: 142-143, pl. 1, fig. 5. [Type locality: One and one half miles off Cape Florida, 70 feet].

Climacia tholus Pilsbry & McGinty, 1946a. *The Nautilus*, 59: 79-80, pl. 1-1b, 2-2a. [Type locality: About four miles off Carysfort Light, Florida].

Type material: Holotype of *Teinostoma pilsbryi* in ANSP (181080). Holotype of *Climacia tholus* in ANSP (181290). Not examined.
Other material examined: Florida, USA: 1 s, Tarpon Springs, Hillsborough County, dredged in 12 m at SW of Anclote Key (CMK).

Description: The shell (Figs. 38A-B) has a dome shaped spire, peripheral keel at the base, a heavy callus which partly or completely fills the umbilicus, sculpture of many low close-set zigzag grooves, and low radiating waves on the base. Protoconch (Fig. 38C) of 1 ½ smooth whorls, size about 240 μm, without any varix at the transition to the teleoconch. Sculpture formed by fine spiral zigzag grooves. There are about 20 on the base and 22-23 on the dorsal aspect of the body whorl. A thick ridge borders the umbilicus, and a heavy callus fills it partly or completely. Aperture of triangular shape, a little oblique. Parietal callus well developed, columella very strong and extended towards the umbilicus. There is no sulcus at the convergence with the peripheral keel.

Holotype of *Teinostoma pilsbryi* 3.4 mm in diameter and 2.0 mm in height. The photographed shell measures 1.9 mm in diameter.

Habitat: This is a species of wide bathymetric distribution having been collected between 0 and 152 m in depth. MOORE (1986) considered it a continental species living in shallow water on mud bottom.

Distribution: USA: Florida: East Florida (MCGINTY, 1945; PILSBRY & MCGINTY, 1946a), Texas (ANDREWS, 1977); Mexico: Campeche State, Yucatan State, Quintana Roo (ODÉ, 1987b); Venezuela: unlocalized (PRINCZ, 1982). South Florida, Texas and Mexico (MOORE, 1964; EMERSON & JACOBSON, 1976).

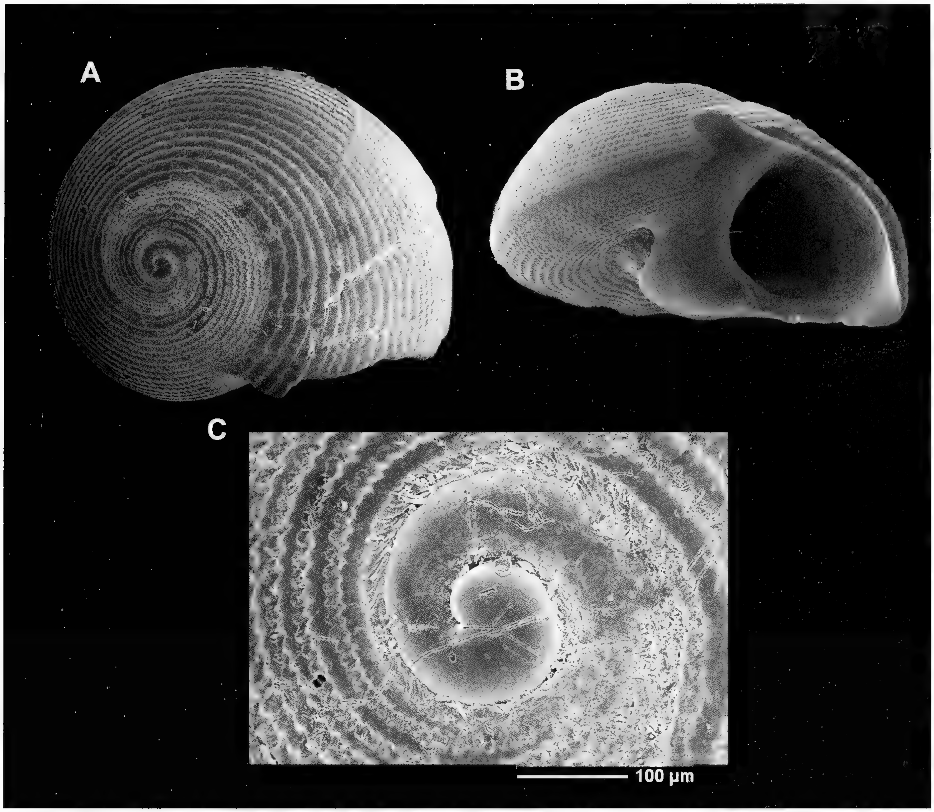
Remarks: MOORE (1964: 167) synonymyzed *Teinostoma pilsbryi* McGinty, 1945 and *Climacia tholus* Pilsbry & McGinty, 1946a, saying that the species has a considerable variation in size and extension of the umbilical callus and that these characters overlapped between the two taxa to the extent that one could not distinguish the two. We agree with this conclusion. The only difference between *A. pilsbry* and *A. tholus* is the size of the umbilical callus, which in *A. pilsbry* is large, reflected outward and occluding the umbilicus, which is narrow and deep. *A. pilsbryi* shows considerable variation in the size and extent of the umbilical callus. The lack of radial costulation on the base, observed in the holotype of *T. pilsbry*, was considered a consequence of the immaturity of the specimen. Moore placed both species in *Anticlimax*.

Anticlimax locklini Pilsbry & Olsson, 1950 (Figures 39A-D)

Anticlimax locklini Pilsbry & Olsson, 1950. *Bull. Amer. Paleont.*, 33: 114, nº 135, pl. 2, figs. 8, 8a, 9. [Plio-Pleistocene of Shell Creek, Florida].

Type material: Holotype in ANSP (nº 18393). Not examined.
Other material examined: Nicaragua: 1 s, Witties Reef, 20-30 m. (MHNS).

Description: This is the original description in PILSBRY & OLSSON (1950): *"The shell has a low-conic truncate upper surface, a carinate periphery and rather flatly convex base. The spire is small, occupying about one-third of the diameter of the shell. There are 3 ¼ whorls, the first 1 ¼ glossy, convex and projecting very slightly, the next whorl narrower, the penultimate whorl having several low radiating waves*



Figures 38A-C. *Anticlimax pilsbryi* (McGinty, 1945). A-B: shell, 1.9 mm, Tarpon Spring, Hillsborough Co., Florida (CMK); C: protoconch.
Figuras 38A-C. Anticlimax pilsbryi *(McGinty, 1945). A-B: concha, 1,9 mm, Tarpon Spring, Hillsborough Co., Florida (CMK); C: protoconcha.*

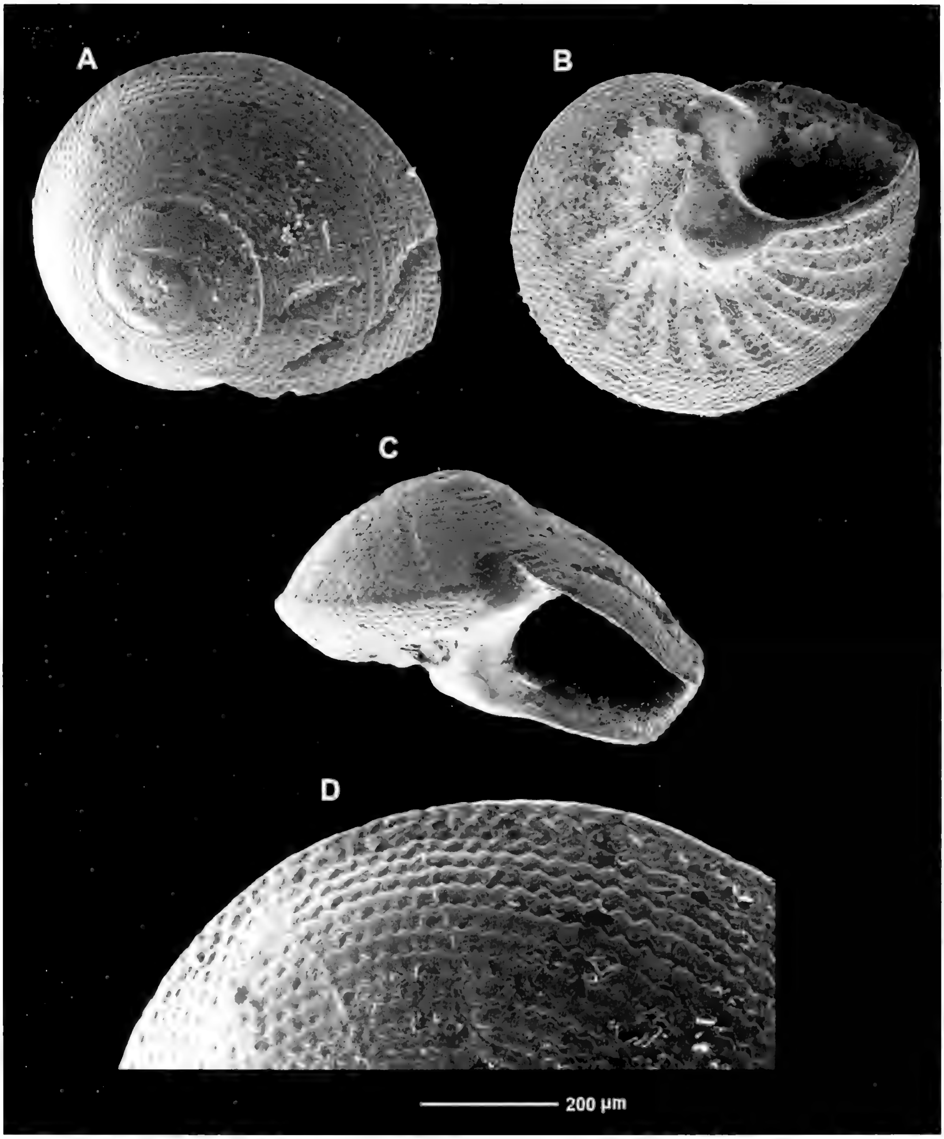
which do not extend upon the last part of the whorl. The last whorl has nearly straight lateral slopes, concave above the peripheral keel and closely marked with punctuate spiral striae. The base has about 12 somewhat protractively radiating wave-like ribs and weak, partly effaced striae. The aperture is triangular. The umbilicus is filled by a callus, forming a raised, convex pad in connection with the columellar callus, a small umbilical notch left next to the parietal callus".

Habitat: Our shell (Figs. 39A-C) was collected on a coralline bottom between 20 and 30 m in depth.

Distribution: Only know as a fossil species from Plio-Pleistocene of Shell Creek and St. Petersburg, Florida (PILSBRY & OLSSON, 1950); off Yucatan, Mexico (TREECE, 1980) and Witties Reef, Nicaragua.

Remarks: PILSBRY & OLSSON (1950) reported: *"This species differs from related Miocene forms by reduction of the radial waves of the upper surface to a few grouped near the middle of the penultimate whorl. The umbilical callus pad is quite unlike the complete one of* A. annae, *and* A. locklini *has a more pronounced peripheral keel than that species, the whorl being concave above it. As in other species, the number of radiating ribs varies individually".*

TREECE (1980) considered *A. locklini* a recent species recorded off Yucatan. Our shell confirms that *A. locklini* is a recent species.

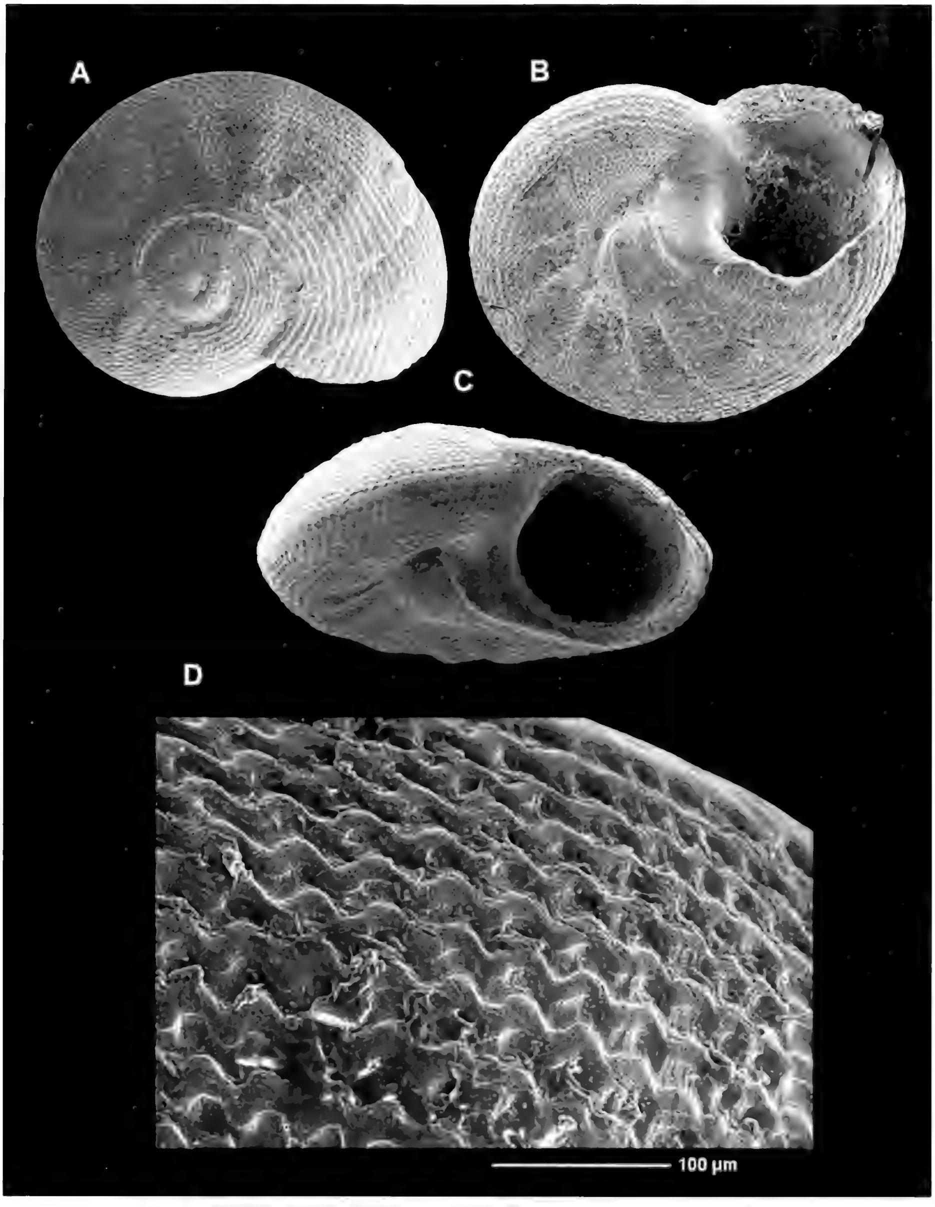


Figures 39A-D. *Anticlimax locklini* Pilsbry & Olsson, 1950. A-C: shell, 1.3 mm, Witties Reef, Nicaragua (MHNS); D: microsculpture.
Figuras 39A-D. Anticlimax locklini *Pilsbry & Olsson, 1950. A-C: concha, 1,3 mm, Witties Reef, Nicaragua (MHNS); D: microescultura.*

Anticlimax annae Pilsbry & Olsson, 1950 (Figures 40A-D)

Anticlimax annae Pilsbry & Olsson, 1950. *Bull. Amer. Paleont.*, 33: 113. nº 135: 11, pl. 3, figs. 12 a-b. [Type locality: Plio-Pleistocene of St. Petersburg, Florida –fossil species-].

Type material: Holotype and paratype in ANSP (nº 18397). Not examined.
Other material examined: Mexico: 1 s, Puerto Morelos, 24 m, Yucatan (MHNS).



Figures 40A-D. *Anticlimax annae* Pilsbry & Olsson, 1950. A-C: shell, 1.6 mm, Puerto Morelos, Yucatan (MHNS); D: microsculpture.
Figuras 40A-D. Anticlimax annae *Pilsbry & Olsson, 1950. A-C: concha, 1,6 mm, Puerto Morelos, Yucatán (MHNS); D: microescultura.*

Description: This is the original description (PILSBRY & OLSSON, 1950): "*The rather strong, solid shell is convex below, and in the form of a low truncate cone above the angular periphery. The spire is very narrow, level or slightly sunken. There are about three and one-third whorls the first 1 ¼ glossy, convex, the next narrow and depressed at first, but increasing rapidly near its end. The* *last whorl is very wide, sloping to the periphery. Sculpture of punctuate spiral grooves, about twenty on the upper surface, the base with similar but weaker grooves. Radiating sculpture of rather strong waves on the penult whorl and about half of the last whorl, the base having about 8 to 15 stronger radiating waves which fade out near the periphery. The aperture is subtriangular, a little effuse at the peripheral angle. The thick parietal callus extends well forward, and with the rather flattened, semicircular, columellar lobe, completely closes the umbilicus".*

Holotype is 2.5 mm in diameter and 1.35 mm in height. Our shell (Figs. 40A-C) is 1.6 mm in diameter.

Habitat: Abundant in the Pliocene deposits of St. Petersburg. Our material was collected in sediments from coralline bottom.

Distribution: Only known as a fossil from St. Petersburg and Orlando, Florida. Our specimen is clearly of recent origin.

Remarks: Pilsbry & Olsson (1950) stated: *"This species differs from* A. hispaniolensis *and* A. hispaniolensis cratera *by the very strong parietal callus and the more flattened callus pad which wholly closes the umbilicus. It is rather variable in size and especially in the development of radial waves on the upper surface. In most specimens examined, waves are present on the first half of the last whorl, but occasionally they do not extend beyond the penultimate whorl, the whole last whorl lacking of them".*

A. locklini is distinguished by the more pronounced peripheral keel and by a small thickened parietal callus and columella.

Anticlimax hispaniolensis cratera Pilsbry & Olsson, 1950 (Figures 41A-E)

Anticlimax hispaniolensis cratera Pilsbry & Olsson, 1950. *Bull. Amer. Paleont.*, 33: 116, nº 135, pl. 2, fig. 6, pl. 3, figs. 11-11b. [Miocene of Banana River, Costa Rica].

Type material: Holotype in ANSP (nº 18403). Not examined.
Other material examined: Nicaragua: 1 s, Witties, 20-30 m (MHNS).

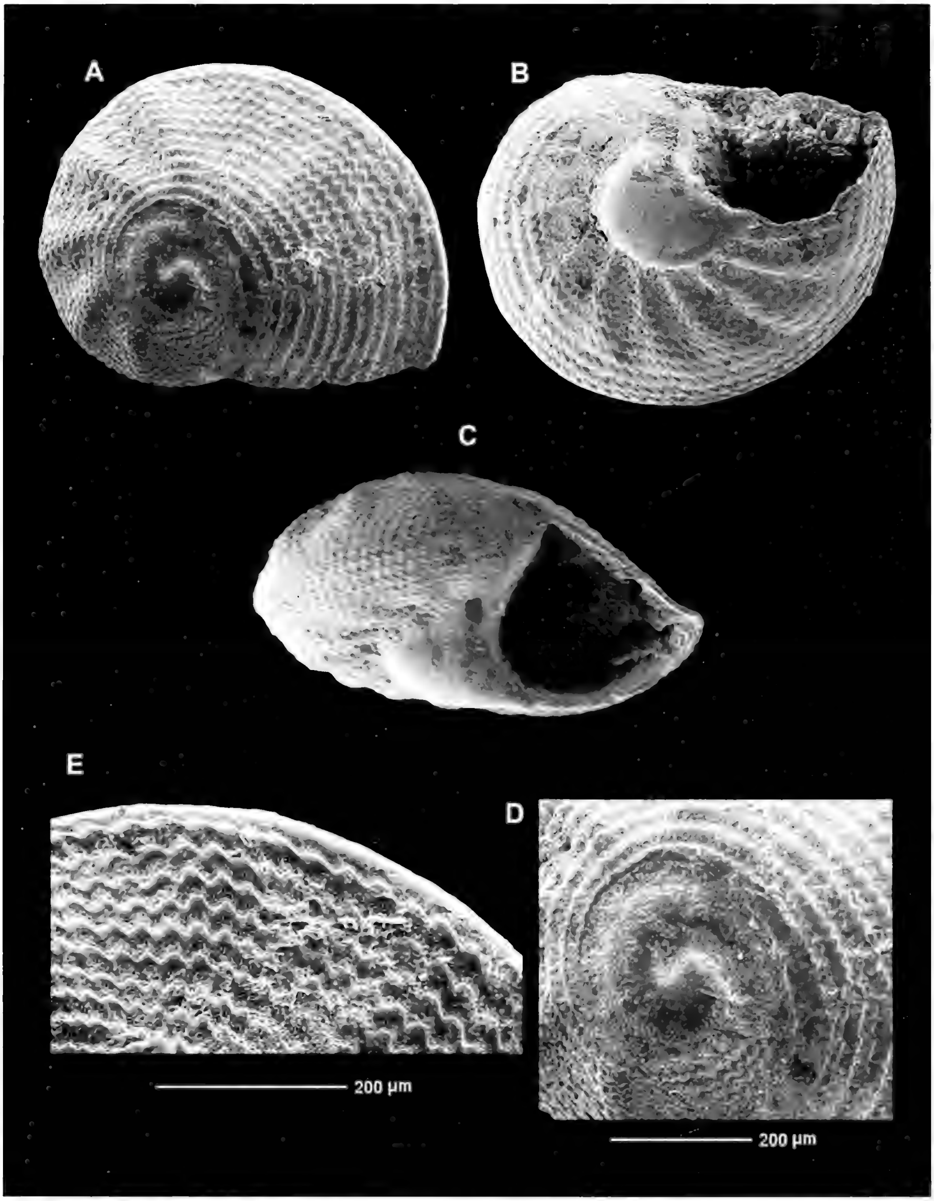
Description: This is the original description (Pilsbry & Olsson, 1950): *"The shell is similar to* A. hispaniolensis *in form, but the spire is somewhat more sunken. There are 3 1/ 3 whorls, the first two planorboid, narrow. The last whorl rises in the narrowly rounded ridge, crater-like, around the spire, then slopes straightly to the blunty carinate periphery, below which it is rather weakly convex. Sculpture of strongly impressed punctuate (or minutely zigzag) spiral lines and radiating waves on the base. The aperture is triangular, the upper margin of the peristome nearly straight, extending above the peripheral keel. The umbilicus is filled by a callus which expands into a strongly convex semicircular pad, united with the columellar callus".*

Dimensiones: Our shell (Figs. 41A-C) has 1.0 mm in diameter.

Habitat: Our shell was collected in coralline bottom at a depth of 20-30 m.

Distribution: Only known as a fossil species from Miocene of Banana River, Costa Rica (Pilsbry & Olsson, 1950) and Nicaragua.

Remarks: Pilsbry & Olsson (1950) stated: *"The close relationship between* A. hispaniolensis cratera *and* A. hispaniolensis *has been noted under the latter species. Both are based upon specimens not fully mature. We believe that the posterior grooved commissure of the aperture, conspicuous in these specimens, would be nearly or wholly obliterated and the peris-*



Figures 41A-E. *Anticlimax hispaniolensis cratera* Pilsbry & Olsson, 1950. A-C: shell, 1.0 mm, Witties, Nicaragua (MHNS); D: protoconch; E: details of the microscupture.
Figuras 41A-E. Anticlimax hispaniolensis cratera *Pilsbry & Olsson, 1950. A-C: concha, 1,0 mm, Witties, Nicaragua (MHNS); D: protoconcha; E: detalle de la microescultura.*

tome thickened in the adult stage, as in A. annae".

This species has some similarity to *A. locklini*, from which it can be distinguished by the shape and larger extension of the columellar callus as well as the suppression of the radiating waves on the base.

Genus *Aorotrema* Schwengel & McGinty, 1942

Aorotrema Schwengel & McGinty, 1942. *The Nautilus*, 56: 17 (as a subgenus of *Cyclostrema*).
Type species: *Cyclostrema (Aorotrema) pontogenes* Schwengel & McGinty, 1942 (by original designation).

Diagnosis: *"Shell with a few whorls which are strongly angular above, at the periphery and around the broadly funnel shaped umbilicus; the aperture subtriangular, peristome only shortly in contact with preceding whorl or free".*

Remarks: Four species from the western Atlantic have been included in the genus *Aorotrema*: *A. cistronium* (Dall, 1889a), *A. pontogenes* Schwengel & McGinty, 1942; *A. erraticum* Pilsbry & McGinty, 1945 and *A. gardnerae* Pilsbry, 1953. The first three were considered as recent species while *A. gardnerae* was considered a fossil species from the Miocene. Of the recent species, *A. cistronium* and *A. pontogenes* have been considered valid species. MOORE (1964: 189), after the examination of the holotype of *A. erraticum*, decides that it is a juvenile of *Turbo castanea* Gmelin, as a result of the similarity of the details of the protoconch, shape, and teleoconch sculpture. Also, after the examination of a paratype of *A. pontogenes* he considered that it is a juvenile shell probably of an *Astraea*. With respect to *A. gardnerae*, the fossil species from the Miocene, he stated that by its shape it could be also a juvenile *Turbo*. Therefore the similarity between the species of *Aorotrema* with young *Turbo* or *Astraea* is evident, the latter differing by their possession of a calcareous operculum.

Aorotrema cistronium (Dall, 1889) (Figures 42A-G)

Cyclostrema cistronium Dall, 1889a. *Bulletin of the Museum of Comparative Zoology*, 18: 394, (DALL, 1889b, pl. 42, fig. 11) [Type locality: off the coast of North Carolina [USFC stas. 2595, 2598, 2608, 2610, 2612 (DALL, 1889b)]].

Type material: Type in ANSP (178697). Not examined.
Material examined: Florida, USA: 1 s, E Gulf Blvd, NE end Sand Key (CHL); 42 s, trawled 27 m, 20 mi E St. Augustine, (CHL); 71 s, dived, sponge grunge 36 m, 45 mi E Mayport, Duval Co. (CHL); 1 s, dredged 54 m, 20 mi SE Pensacola Co, (CHL); 4 s, *Ex* batfish trawled, 39-45 m, 60 mi E Ponte Vedra, St. Johns Co. (CHL); 1 s, dredged, 53 m, 65 mi E St. Augustine, St. Johns Co. (CHL). Fossil: 1 s, Pliocene of La Belle, FL (CHL).

Description: The original description by DALL (1889) is as follows:

"Shell small, white, with a polished nucleus, one and half rounded and as many more carinated whorls; spire depressed; radiating sculpture of fine close flexuous threads, which appear chiefly in the interspaces of the spirals, giving the surface a minutely punctate appearance; these extend over the whole surface except of the nuclear whorls; spiral sculpture of on the summit seven or eight, between the carinae six or eight, and on the base ten or fifteen extremely fine threads, even and uniform, with about equal interspaces, some a little granular from the radiating sculpture; beside these there are three very strong carinae; one forms the margin of the nearly flat spire, the second extends horizontally just below the periphery, the space between them deeply excavated; the third forms the edge of the funicular narrow deep umbilicus. The base is conical, excavated just within the peripheral carina;

it rises to the edge of the umbilicus, which is marked by a strong thread, and within is vertically striated. The last whorl descends from the general plane and finally becomes separated from the body whorl; the margin is simple, sharply angulated by the carinations, otherwise the aperture would be ovate, with the columellar side somewhat excavated".

Alt. 1.6; max. diam. 2.0 mm.

Maximum reported size: 2.5 mm.

Habitat: Off the coast of North Carolina, in 22-63 fms (40-130 m), on a sand and gravel bottom, in the warmer area (DALL, 1989a). From sponge-associated debris, in 39 m, East of Mayport, Florida (LEE, 2009).

Depth: 14 to 115 m (live 22 to 46 m).

Distribution: USA: North Carolina (DALL, 1989a), Texas (ODÉ, 1987b) and Florida (LEE, 2009). CAMPBELL (1993) recorded it as a fossil from the Pliocene of Yorktown and Chowan river formations in Virginia.

Remarks: The material examined agrees with that figured by PILSBRY (1953, pl. 54, figs. 5-5c) from St. Petersburg Plio-Pleistocene.

Some shells (Fig. 43E) have a separation of the aperture from the terminal body whorl.

Aorotrema pontogenes (Schwengel & McGinty, 1942)

Cyclostrema (Aorotrema) pontogenes Schwengel & McGinty, 1942. *The Nautilus*, 56: 17-18, pl. 3, fig. 3 [Type locality: South by West of Destin, Florida, 18 miles off shore].

Type material: A paratype in ANSP (178697). Not examined.

Description: This is the original description in SCHWENGEL & MCGINTY, (1942): *"The openly umbilicate, white shell is strongly bicarinate with flattened spire, of 3 whorls, the first two planorboid. The first 1 whorls are smooth, convex, the convexity increasing on the next whorl, and overhanging outwardly on the last whorl, forming a strong but blunt upper carina. There is a more extended and somewhat up-curved carina at the periphery, a deep concavity between the two carinae. Below the peripheral keel the surface slopes straight to the prominent ridge around the umbilicus.*

On the last whorls there is a secondary sculpture of fine low spiral threads, their intervals crossed by finer growth lines, giving a minutely punctate appearance in some places; these spirals not extending into the funnel-shaped umbilicus. Aperture with the columellar margin deeply concave in the middle. Outer lip inserted just below the keel of next-to-last whorl, gently sloping to the first carina, then concave to the stronger and more extended peripheral carina, below which it slants straight to the base".

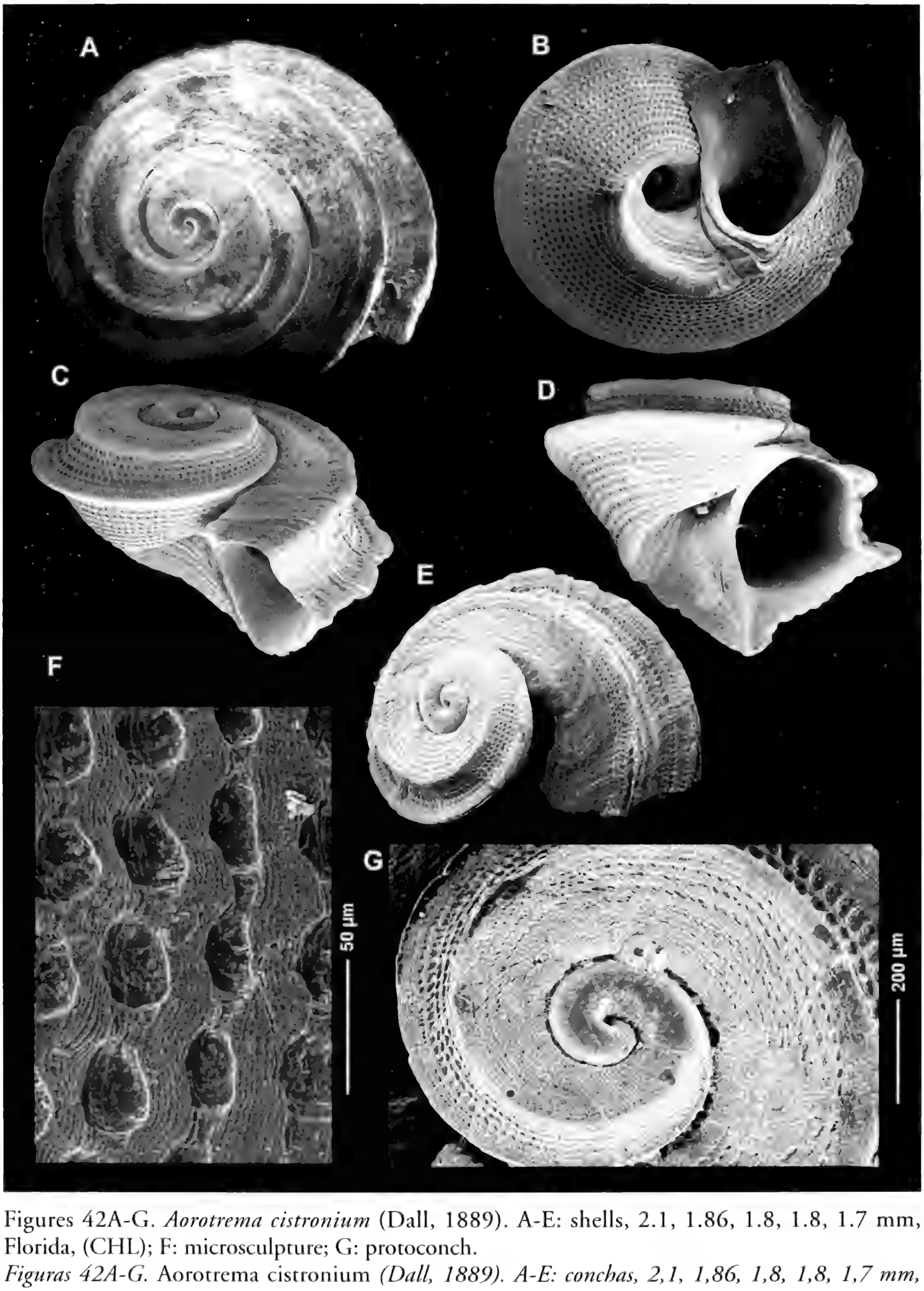
Height 1.3 mm, diameter 1.9 mm.

The umbilicate shell is strongly bicarinate. Protoconch of one whorl, smooth and glassy. Teleoconch consists of 1 ½ whorls; the spire is almost flat out to the shoulder. Carina strongly angular and outer slope is concave. Peripheral carina strong and flat on top. Ornamentation formed by fine punctate spirals, present over all the shell, even in the inner umbilicus. Aperture modified by the carina, columella large and concave. Umbilicus narrow and deep, well delimited by the umbilical carina.

Habitat: Dredged in 18 to 20 fathoms (32-36 m), off Destin, Northwest Florida. Collected on sandy marl bottom.

Distribution: USA: Florida: West Florida (SCHWENGEL & MCGINTY, 1942).

Remarks: SCHWENGEL & MCGINTY (1942) mention: *"This species is similar in size, sculpture and form to* C. cistronium *Dall, but the spire is flatter, second carina much more extended in a "pie-*



Figures 42A-G. *Aorotrema cistronium* (Dall, 1889). A-E: shells, 2.1, 1.86, 1.8, 1.8, 1.7 mm, Florida, (CHL); F: microsculpture; G: protoconch.
Figuras 42A-G. Aorotrema cistronium *(Dall, 1889). A-E: conchas, 2,1, 1,86, 1,8, 1,8, 1,7 mm, Florida, (CHL); F: microescultura; G: protoconcha.*

crust" manner, the last whorl not descending and the aperture more angled and not separated from the body whorl as in C. cistronium*".*

MOORE (1964) thought this might be juvenile *Astralium phoebium*.

We lack material on which to base an opinion.

Genus *Cyclostremiscus* Pilsbry & Olsson, 1945

Cyclostremiscus Pilsbry & Olsson, 1945: 266.

Type species: (by original designation) *Vitrinella panamensis* C.B. Adams, 1852. *Proc. Acad. Nat. Sci. Phila.*, 97: 266. Recent, Caribbean.

Diagnosis: The description of the genus (PILSBRY & OLSSON, 1945) is as follows: *"Shell small, solid, moderately strong, depressed or discoidal, much wider than high, umbilicate, of few whorls, from which the first 1 ½ to 2 form a smooth glassy protoconch. Last whorl typically with several spiral angles or carinae. Their intervals usually with lower axial riblets or striae. Aperture subcircular or modified by the angles of the shell, the peristome continuous, not thickened externally".*

Remarks: PILSBRY & OLSSON (1945) introduced *Cyclostremiscus* for a series of small or minute species, abundantly represented in the West American tropics. Some of them had been described in the genera *Vitrinella* and *Cyclostrema*. They designate *Vitrinella panamensis* C. B. Adams, 1852 as the type species of the genus; this species is characterized by *"the last whorl typically having several spiral angles or carinae, their intervals typically with lower axial riblets or striae".*

PILSBRY (1953) described the subgenus *Ponocyclus* with *Adeorbis beauii* as the type species, and distinguished it from *Cyclostremiscus* by its lack of axial sculpture.

MOORE (1964) divides *Cyclostremiscus* species into three small groups: *Cyclostremiscus beauii, C. dalli* and *C. pentagonus* are practically identical in their general appearance; all have 2 or 3 keels on the periphery and several grades of finer spiral sculpture. *C. suppressus* and *C. jeannae* resemble each other with their smaller umbilicus and three-keeled periphery. *C. cubanus* does not seem to have any relation to any of the previously mentioned species.

BIELER & MIKKELSEN (1988) after the study of the anatomy of *Circulus texanus* and *Cyclostremiscus beauii* making a comparison with *Circulus striatus,* conclude saying that the differences between both genera are mainly anatomical.

PONDER (1994) mentions that the assignation of *Cyclostremiscus beauii* to the genus *Cyclostremiscus* needs a revision.

The genus *Cyclostremiscus* Pilsbry & Olsson, 1945 is based on *Vitrinella panamensis* C.B. Adams, 1852. The type species is small, has strong axial sculpture (distinct axials lacking in *Cy. beauii*), a few strong spiral ribs which are rendered nodulose by the axials, and has an apertural varix. These shell characters are markedly discordant with those of *"Cy". beauii*. The genus *Ponocyclus* (Pilsbry, 1953) was erected for *Adeorbis beauii* and it can be used for this species.

If we accept this establishment, we could differentiate this group of species placing them outside *Cyclostremiscus* and including them in *Ponocyclus*, but this could only be tentative, because it is necessary to have an anatomical study of each species in order to decide their correct final position.

RUBIO & ROLÁN (1998) presented radular information on *Pachystremiscus ornatus* Olsson & McGinty, 1958 and *Pachystremiscus pulchellus* Olsson & McGinty, 1958 and placed both species in the genus *Lodderena* (Archaeogastropoda, Skeneidae), considering the genus *Pachystremiscus* as a synonym.

We have considered the comments of BIELER & MIKKELSEN (1988) and PONDER (1994) about the differences between *Circulus* and *Cyclostremiscus,* which are mainly anatomical. Also there is not a basic model of morphological characters which allows us to place the species in one or the other genus. So, it is very difficult to make a generic differentiation in the known species placed in group 1, which could be placed also in

Circulus. Only an anatomical study of each of them would allow us to know the correct genus. For all of these reasons, we prefer to keep these species in their present status, as considered by other authors.

The genus *Cyclostremiscus* is in our opinion one of the most conchologically heterogeneous of those within the subfamily Vitrinellinae. All the previously described recent taxa have been studied and figured in the present work, and two taxa new to science are also treated.

In an attempt to better differentiate *Cyclostremiscus* species we have distinguished two groups which clearly differ from the other congeners:

Group 1. *Cyclostremiscus beauii* – *C. multiliratus* - *C. dalli* – *C. pentagonus* – *C. trilix* – *C. hendersoni*.

Group 2. *C. bartschi* (only fossil) - *C. jeannae* - *C. suppresus* - *C. vanbruggeni* - *C.* sp.

The species not included in these groups have such distinctive morphological characters that their identification is relatively simple.

Group 1

These species are quite similar in general appearance; all have 2 or 3 peripheral keels and several degrees of smaller spiral sculpture.

Cyclostremiscus beauii (P. Fischer, 1857) (Figures 43A-E)

Cyclostrema angulatum auct. non A. Adams, 1850.

Adeorbis beauii P. Fischer, 1857. *Journal de Conchyliologie*, 6: 286, pl. 10, fig. 12. [Type locality: Guadeloupe].

Cyclostrema bicarinatum Guppy, 1866. *Quarterly Journal of the Geological Society of London*, 22(1): 281-295, pls. 16-18. [Type locality: "Miocene" (Lower Pliocene), Jamaica].

Skenea sulcata Simpson, 1887: 61 [*nomen nudum*, see MOORE, 1964: 131].

Adeorbis beauii bicarinatus (Guppy, 1866): Dall, 1903: 1595. [Type locality: Oligocene of Jamaica].

Circulus bicarinatus (Guppy, 1866): in WOODRING, 1828: 439, pl. 37, figs. 10-12.

Circulus stirophorus M. Smith, 1937. *The Nautilus*, 51: 67, pl. 6, figs. 2a, b [Type locality: Plio-Pleistocene, Florida].

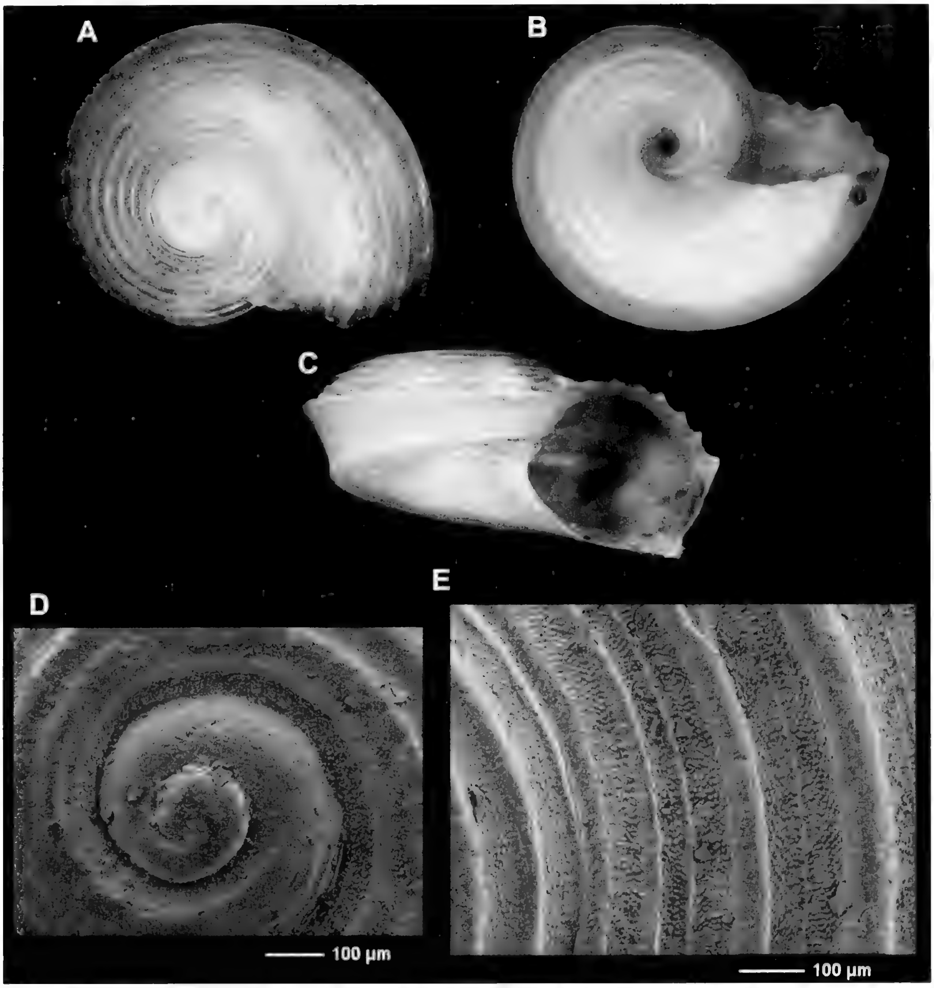
Type material: BIELER & MIKKELSEN (1988) designated the only specimen extant in the MNHN, corresponding to the lot deposited by Fischer, as lectotype.

Other material examined: Florida, USA: 2 s, 39-45 m, 50-60 mi., E Ponte Vedra, St. Johns Co., Fla. (CHL); 3 s, Delray Beach, Palm Beach Co. Fla (CHL); 2 s, 2 j, near Mantis Shrimp Holes, St. Lucia Inlet, Stuart Martin Co., Fla. (CHL); 1 s, 84 m, WNW Tortugas (CHL); 2 s, 54-60 m, Cedar Keys, Fla (CHL). Cuba: 3 s, Cienfuegos Bay, 10 m (MHNS). Colombia: 1 s, Cayos de San Andrés, in coral bottom 20-25 m (CHL).

Description: It is one of the better studied species of the Vitrinellinae, including morphology, radula, ecology, and anatomy, see BIELER & MIKKELSEN (1988).

Maximum reported size: 12.5 mm. The studied and photographed material (Figs. 43A-C) from Cuba measures 8.1 mm in maximum diameter and 3.0 mm in height. The shell from Colombia in the CHL is 10.1 mm.

Distribution: The species is known in the Western Atlantic, from North Carolina to Brazil. Recorded from Puerto Rico (WARMKE & ABBOTT, 1975). From Campeche to Ciudad del Carmen and Zacatal, from El Cuyo to Ninum Point, from Yalkupul Point to Cerritos Island and from Cancún to the Belize border, Mexico (VOKES & VOKES, 1983). From North Car-



Figures 43A-E. *Cyclostremiscus beauii* (P. Fischer, 1857). A-C: shell, 8.1 mm, Cienfuegos Bay, Cuba; D: protoconch; E: detail of the microsculpture.
Figuras 43A-E. Cyclostremiscus beauii *(P. Fischer, 1857). A-C: concha, 8.1 mm, Bahía de Cienfuegos, Cuba; D: protoconcha; E: detalle de la microescultura.*

olina to Florida; the Antilles; Ceará, Pernambuco and Alagoas, Brazil (RIOS, 1985). Guadaloupe; Jamaica; Florida; the Antilles; North Carolina; Dry Tortugas; Sint Maarten; Colombia; from North Carolina to Brazil (BIELER & MIKKELSEN, 1988). Aruba (DE JONG & COOMANS, 1988). From North Carolina to Brazil (ROBINSON, 1991). From North Carolina to the central coasts of Brazil (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). Carolinas to West Indies (MORRIS, 1973). Laguna Indian River, Florida (MIKKELSEN *ET AL*, 1995). Cuba (ESPINOSA *ET AL.*, 1985).

Habitat: BIELER & MIKKELSEN (1988) reported this species inhabiting burrows of the stomatopod *Lysiosquilla scabricauda* (Mantis Shrimp), between 0.5

and 1 m in depth. Other authors mention its shells in the digestive tracts of the seastar *Astropecten articulatus* (Say, 1825), probably as prey, but parasitism is possible. Other recorded habitats are between 0 and 46 m in depth, sand, muddy, and rocky bottom (Vokes & Vokes, 1984); sand in shallow water (Díaz Merlano & Puyana Hegedus, 1994), but these are based on empty shells.

Discussion: *C. beauii* is the largest vitrinelid in the West Atlantic. It may be distinguished from other known species by its larger size, by its bicarinate periphery, and by the numerous and strong spiral cords which form its dorsal sculpture. Two recent species (*Cyclostremiscus major* Olsson & Smith, 1951 and *Cyclostrema gordana* Hertlein & Strong, 1951) from the Panamic region are very similar in size, sculpture and form. Bieler & Mikkelsen (1988) consider *Cyclostrema bicarinata* Guppy and *Circulus stirophorus* Smith synonyms of *C. beauii*, indicating that the variation in the basal sculpture, probably due to ontogenetic change, was not enough reason for their differentiation.

Cyclostremiscus multiliratus spec. nov. Rubio, Rolán & Garcia (Figures 44A-F)

Type material: Holotype (Figs. 44A-C) in USNM (1155028) (ex CEG).
Type locality: SW Florida, 27°51.79'N – 84°59.82'W, dredged in 308-323 m.
Etymology: The name refers to the numerous cords on the dorsum.

Description: Shell (Figs. 44A-C) planispiral with spire slightly elevated, periphery bicarinate, and a wide umbilicus. Protoconch (Fig. 44F) slightly projected, with 1 ¼ whorls, and a maximum diameter of about 530 µm, apparently smooth with two stages dist inguis-hable: the first one, embryonic] with ¾ whorls; the second part is almost ½ whorls. Indistinct separation from the rest of the shell. Teleoconch with 2 ¼ whorls; sculpture formed by 2 keels which define the periphery of the shell, one placed on the middle part and the other in the basal area. First whorl with 10-12 spiral cordlets, with axial growth lines in the interspaces. The dorsum on the last whorl has 18-20 spiral cords, of which 6 are very closely-placed and near the suture and 3-4 near the peripheral keel; the interspaces between the cords are covered by microtubercles. Between the peripheral keels there are 10-12 fine spiral cordlets with regular interspaces. On the base there is a spiral cord limiting the umbilical infundibulum. Base and inside the umbilicus with numerous fine spiral cordlets. Aperture almost quadrangular, prosocline. Peristome modified by the peripheral keels; columellar area arched, parietal zone not thickened.

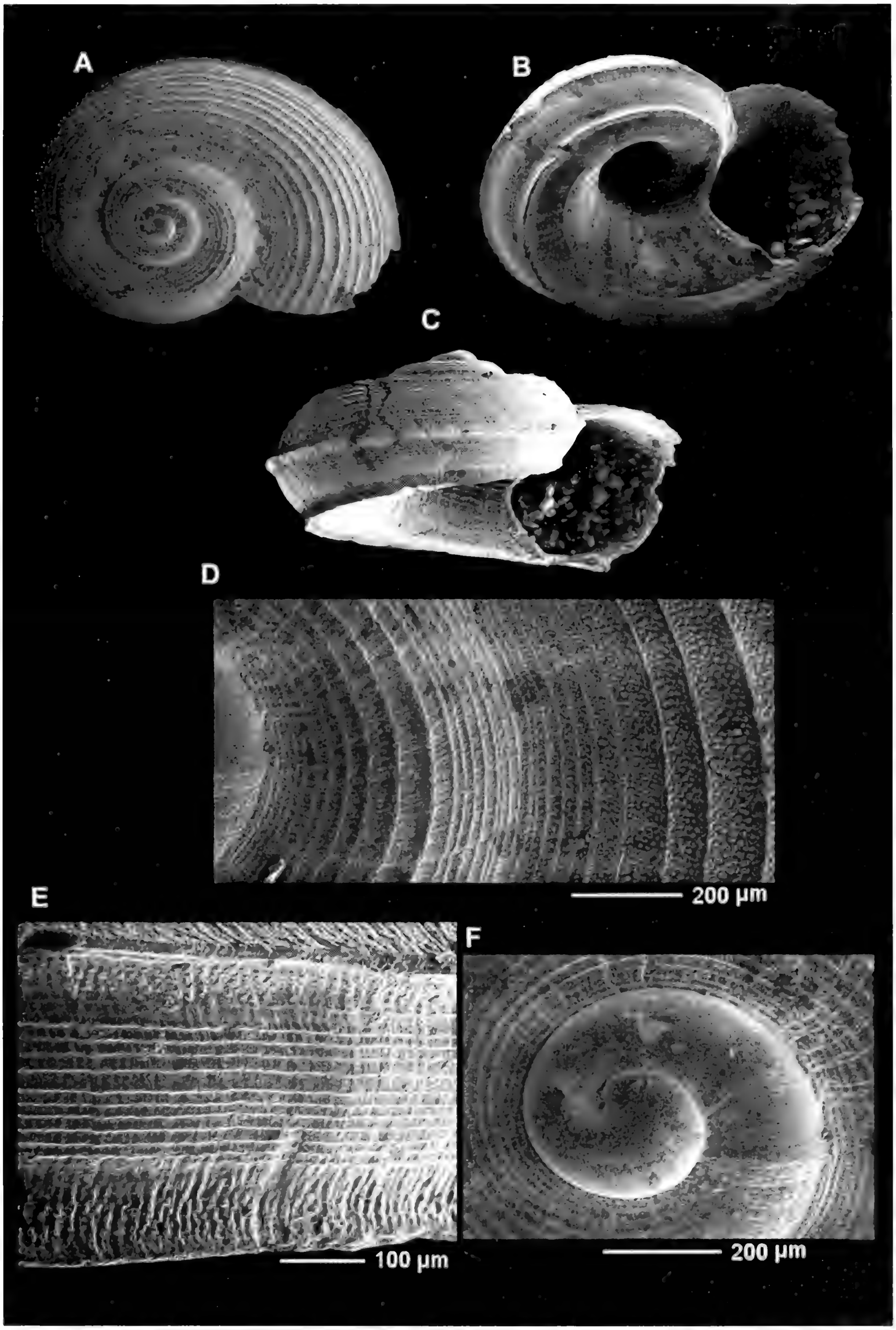
The holotype measures 3.18 mm in maximum diameter.

Distribution: Only known from SW Florida, its type locality.

Habitat: Deep water, dredged at 308-323 m deep.

Remarks: *C. multiliratus* spec. nov. is very similar in its general appearance to *C. beauii*, but the latter is larger, its protoconch has a smaller diameter, and the number of dorsal cords is smaller (5-7). Further, it lacks microtubercles between the dorsal cords and cordlets between the two peripheral keels.

Another similar species is *C. dalli*, but it lacks ornamentation between the cords, has fewer dorsal cords, which are stronger and more elevated, and lacks spiral cordlets between the peripheral keels. Both species have a wide bathymetric range.



Figures 44A-F. *Cyclostremiscus multiliratus* spec. nov. Rubio, Rolán & García. A-C: holotype, 3.18 mm (USNM); D: dorsal microsculpture; E: peripheral microsculpture; F: protoconch.
Figuras 44A-F. Cyclostremiscus multiliratus *spec. nov. Rubio, Rolán & García. A-C: holotipo, 3,18 mm (USNM); D: microescultura dorsal; E: microescultura periférica; F: protoconcha.*

Cyclostremiscus dalli (Bush, 1897) (Figure 45A-D)

Circulus dalli Bush, 1897. *Transactions of the Connecticut Academy of Arts and Sciences*, 10: 126, pl. 23, figs. 3-3a, 6. [Type locality: USFC sta. 2655, 27°22'N, 78°07'30"W].
Lydiphnis dalli (Bush, 1897).

Type material: Holotype in YPM (15802); paratype in USNM (44983). Not examined.
Other material examined: Florida, USA: 1 s, 36-90 m, off Dry Tortuga, Gulf of Mexico (CHL).

Description: The original description (BUSH, 1897) is as follows: "*This deep-water species is of more delicate texture and more transparent than the more northern shallow-water species of similar form. It is ornamented on the body-whorl with two rather inconspicuous carinae, one defining the base and the other on the periphery; above this the surface is cut by about seven delicate, unequal, microscopic shallow grooves or striae, the two uppermost being the most distinct; above these the surface is smooth and appears somewhat flattened; there are also a few less distinct striae below the periphery and in the umbilical region. Greatest width: 3.0 mm; height: 1.4 mm*".

We add: This larger species (Figs. 45A-C) is characterized by having 2 strong keels, one basal and the other at the middle of the periphery. On the dorsum, between the peripheral keel and the suture, 4-6 strong spiral cords can be observed without any sculpture between the cords except for very fine growth lines. Near the base there are about 8 spiral cords, a little smaller that the dorsal ones and 3-4 more very fine threads inside the umbilicus. The protoconch (Fig. 45D) is wide, and has a little more than one whorl, about 540 μm in diameter, apparently smooth but perhaps with some small axial cordlets mainly at its terminus.

Maximum reported size: 4 mm. The shell figured here is 4,3 mm in diameter and 1.87 mm in height.

Habitat: Among Foraminifera, in 338 fms (608 m) (BUSH, 1897). Bathymetric range: 79 to 618 m.

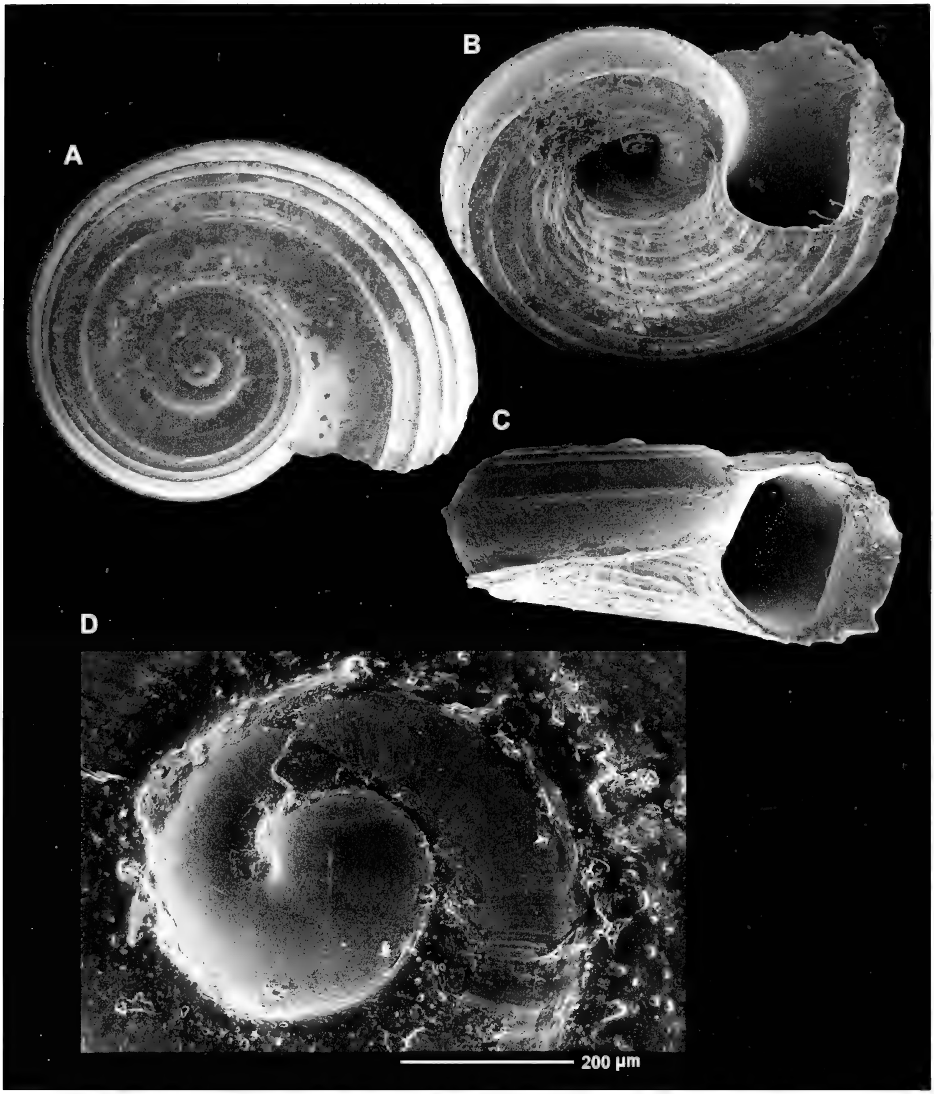
Distribution: USA: North Carolina, Florida: Florida Keys; Bahamas: Great Bahama Bank (BUSH, 1897 and MOORE, 1964).

Remarks: This larger species, with its inconspicuous sculpture, seems to be a connecting link between the distinctly grooved ones and the carinated ones, so we can make a series of gradation in sculpture from the smooth variety of *Cyclostremiscus supranitidus*, followed by *C. supranitidus* (typical), *C. trilix*, *C. dalli*, *C. smithi*, *C. striatus*, up to the strongly grooved *C. liratus* (Bush, 1897). The latter species may be distinguished from *C. pentagonus* and *C. trilix* by having two peripheral keels instead of three.

Cyclostremiscus pentagonus (Gabb, 1873) (Figures 46A-F)

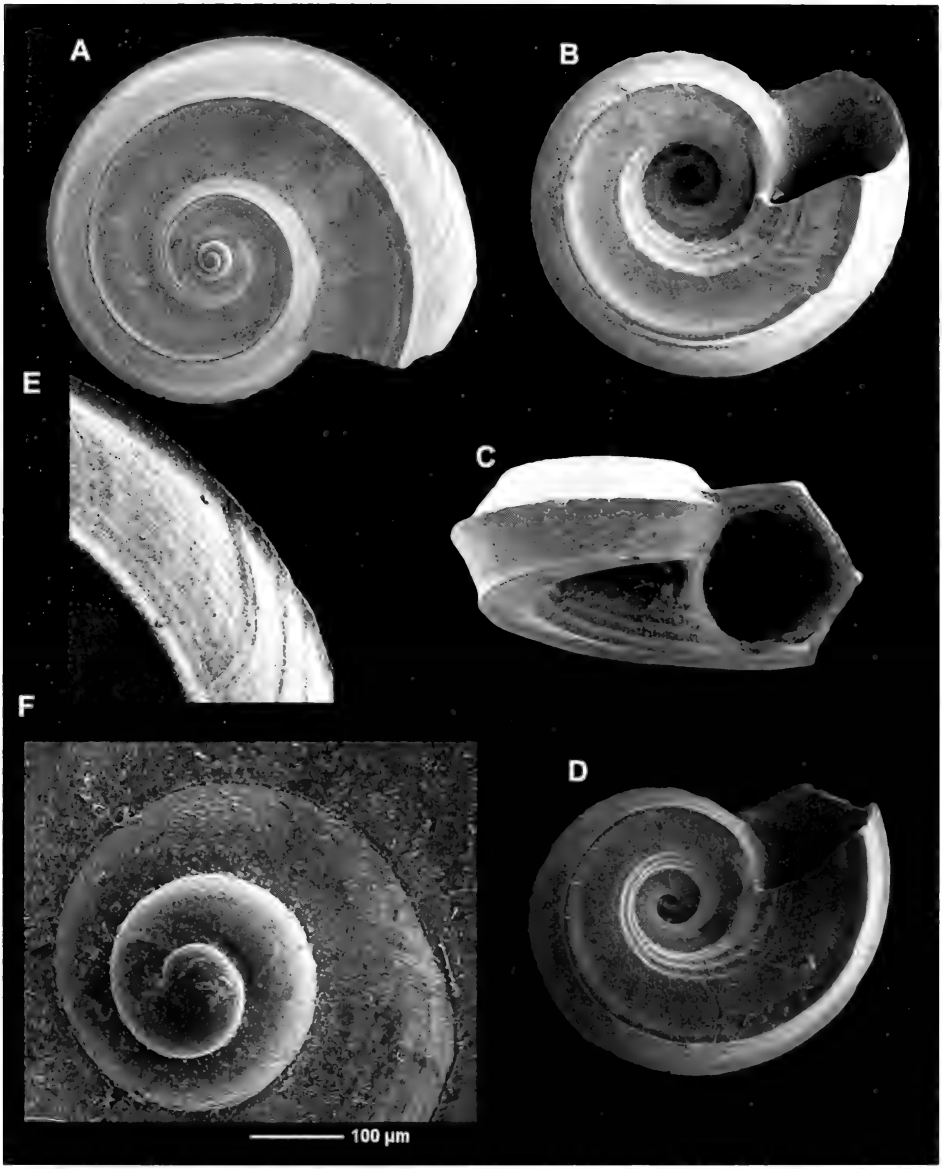
Adeorbis supranitidus auct. non Wood, 1842.
Cyclostrema pentagonum Gabb, 1873. *Amer. Philos. Soc. Trans. New series*, 15: 243. [Type locality: Miocene of the Dominican Republic].
Vitrinella pentagonus (Gabb, 1873): GABB, 1881: 368, pl. 47, fig. 68.
Cyclostremiscus pentagonus (Gabb, 1873): WOODRING (1928: 73).

Type material: Holotype in ANSP (2831) represented in MOORE (1964, fig. 23). Not examined.
Material examined: Cuba: 5 s, Rancho Luna Beach, 40 m (MHNS); 2 s, Cienfuegos Bay, 10 m (MHNS).



Figures 45A-D. *Cyclostremiscus dalli* (Bush, 1897). A-C: shell, 4.3 mm, off Dry Tortuga, Florida (CHL); D: protoconch.
Figuras 45A-D. Cyclostremiscus dalli *(Bush, 1897). A-C: concha, 4,3 mm, frente a Dry Tortuga, Florida (CHL); D: protoconcha.*

Description: Shell (Figs. 46A-C) rounded, depressed, whitish to yellowish brown in color, solid. Protoconch (Fig. 46D), erect projecting, with a little more than 2 whorls, smooth or slightly rough, and with a diameter of about 420 µm. Two well differentiated parts can be seen on it: the first one, embryonic, is shorter, with a little more that ½ whorl; the second is almost 1 ½ whorls. The separation from the rest of the shell is distinct. Teleoconch with 2 rapidly-increasing whorls; sculpture formed by 3 keels which define the periphery. There is a spiral cord which delimits



Figures 46A-F. *Cyclostremiscus pentagonus* (Gabb, 1873). A-C: shells, 2.9, 2.7, 2.3 mm, Rancho Luna Beach, Cienfuegos, Cuba (MHNS); D: shell, 2.1 mm, Brazil (CHL); E: microsculpture; F: protoconch.

Figuras 46A-F. Cyclostremiscus pentagonus *(Gabb, 1873). A-C: conchas, 2,9, 2,7, 2,3 mm, Playa Rancho Luna, Cienfuegos, Cuba (MHNS); D: concha, 2,1 mm, Brasil (CHL); E: microescultura; F: protoconcha.*

the umbilicus and fine spiral cords more evident in the spaces between the keels. Also there are fine sinuous axial growth lines. Umbilicus wide and deep exposing the previous whorls, even the protoconch; on its interior up to 5 spiral cords can be seen. Aperture hexagonal, more distinctly at the periphery because of the keels.

Dimensions: The holotype measures 3.5 mm. The studied shells were up to 2.96 mm in maximum diameter.

Habitat: The bathymetric range of this species is very wide, having been recorded between 0 and 538 m in depth for the three synonymized species; the records for living specimens are between 0 and 45 m: between 13 and 31 m (ABBOTT, 1974); in muddy sand in the surf zone (ANDREWS, 1977); in shallow water beetween 13 and 30 m in depth (DÍAZ MERLANO & PUYANA HEGEDUS, 1994).

Distribution: USA, Mexico, Costa Rica, Colombia; Venezuela, Puerto Rico and Cuba. Recorded from Cape Hatteras, North Carolina (BUSH, 1885). From Puerto Rico (WARMKE & ABBOTT, 1961). From North Carolina, northwestern Florida and Alabama, Texas and Campeche Bank, Miocene and Pliocene of Panama, Jamaica, Dominican Republic and Florida (MOORE, 1964). From North Carolina (PORTER, 1974). Off North Carolina to Florida, Texas and the West Indies (ABBOTT, 1974; EMERSON & JACOBSON, 1976). From the southeast of USA to the Antilles and Texas (ANDREWS, 1977). From Laguna de Termino, Campeche (GARCÍA-CUBAS, 1981). From Venezuela (PRINCZ, 1982). From Campeche to Ciudad del Carmen and Zacatal, and from Cancún to the Belize border, Mexico (VOKES & VOKES, 1984). From Puerto Rico (ORTIZ-CORPS, 1985). From Moín, Costa Rica (ROBINSON & MONTOYA, 1987). From North Carolina to Florida, Texas and the Caribbean Sea (LYONS, 1989). From off North Carolina to the Caribbean (ROBINSON, 1991). North Carolina Florida, West Indies, South Brazil (RIOS, 1994). From North Carolina to the South American coast (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). From Cuba (ESPINOSA, FERNÁNDEZ-GARCÉS & ROLÁN, 1995). From Abaco, Bahamas Islands (REDFERN, 2001). From Cahuita to Gandoca, Costa Rica (ESPINOSA & ORTEA, 2001).

Remarks: Until its definitive placement in *Cyclostremiscus*, this species was placed in the genera *Adeorbis, Circulus, Lydiphnis, Skenea* and *Vitrinella*. The prominent protoconch and its tricarinate periphery in the recent samples, give the shells of this species a characteristic appearance and easily distinguish it from congeneric species. MOORE (1964) mentioned having seen living specimens of this species, and the animals showed the typical characters of the vitrinellids, with ciliated tentacles and without epipodia.

Cyclostremiscus trilix (Bush, 1885) (Figures 47A-D)

Skenea trilix Bush, 1885. *Expl. Albatross. Report U.S. Com. Fish and Fisheries for 1883*: 464. [Type locality: Off Cape Hatteras, North Carolina, 7-17 fathoms (13-31 m) [USFC sta. 2113 (JOHNSON, 1989)]].

Circulus trilix (Bush, 1885): BUSH, 1897: 127, pl. 22, figs. 6, 10, 12; pl. 41, fig. 7.

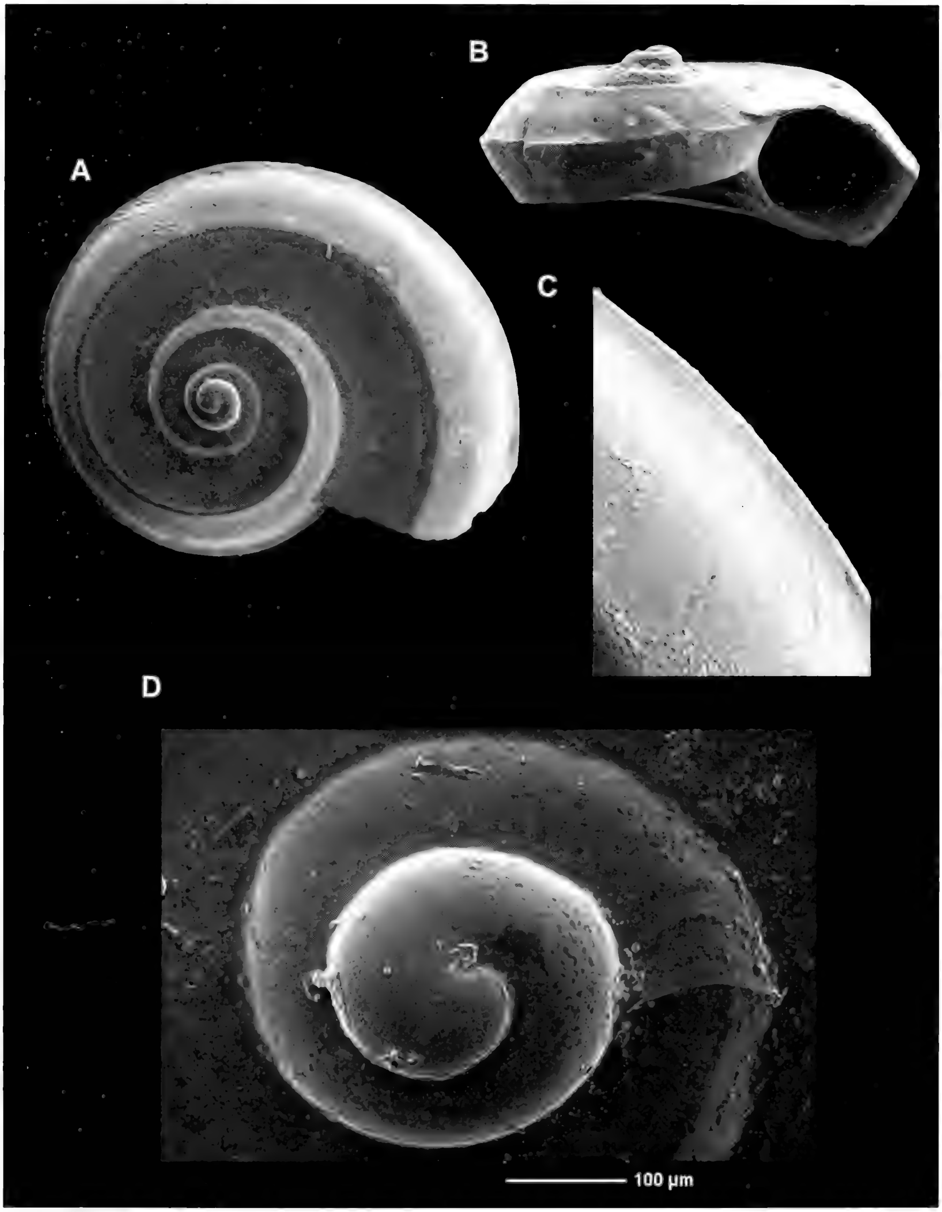
Cyclostremiscus trilix (Bush, 1885) *in* MOORE (1961: 18).

Type material: Holotype in USNM (35365). Not examined.

Material examined: Panama: 1 s, 600-700 m, off Atlantic coast (CHL).

Description: The original description in BUSH (1885: 584) is as follows: *"This species closely resembles* Adeorbis supranitida *Wood, in form and sculpture, but it has a thin, horny operculum and an animal like* Skenea*".* Depth range, 14 to 15 fathoms (25-27 m).

BIELER & MIKKELSEN (1988) mention: *"Based on the misconception that these species are archaeogastropods, BUSH (1897: 127, 142, pl. 22, figs. 47A-G) erroneously constructed a rhipidoglossate radula for* Circulus trilix *(Bush, 1885) [=* Cyclostremiscus pentagonus *(Gabb, 1837), fide MOORE,*



Figures 47A-D. *Cyclostremiscus trilix* (Bush, 1885). A-B: shells, 2.3, 1.7 mm, 600-700 m, off Atlantic coast, Panama (CHL); C: microsculpture; D: protoconch.

Figuras 47A-D. Cyclostremiscus trilix *(Bush, 1885). A-B: conchas, 2,3, 1,7 mm, 600-700 m, frente a la costa Atlántica, Panamá (CHL); C: microescultura; D: protoconcha.*

1964: 138]". Its radula is taenioglossate like any species of the Tornidae.

We add: Protoconch (Fig. 47D) projecting with almost 1 ¾ smooth whorls, about 440 µm in maximum diameter; under high magnification irregular microtubercles can be seen on its surface. A strong varix marks the transition to the teleoconch. On its first quarter whorl the teleoconch exhibits a strong spiral cord which will later become a keel placed on the dorsal aspect of the periphery. There is no other dorsal spiral sculpture. On the ventral aspect, three spiral cords delimit the umbilicus. Aperture rounded; peristome continuous.

Maximum reported size: 3 mm

Habitat: The bathymetric range of this species is quite ample, having been collected between 2 and 538 m in depth. The species is relatively common in Cape Hatteras between 7 and 17 fms (19-31 m) of depth. The living material was collected between 26 and 27 m (BUSH, 1897).

Distribution: USA: Massachusetts, North Carolina (BUSH, 1885b; DALL, 1927), Florida: West Florida (MOORE, 1964); Texas (PARKER, 1959; MOORE, 1964); Puerto Rico (WARMKE & ABBOTT, 1961).

Remarks: *Cyclostremiscus trilix* was described initially in the genus *Skenea* and later transferred to the genus *Circulus, Lydipnis* and *Vitrinella*. WOODRING (1957) gives a lengthy discussion on *C. trilix* and *C. pentagonus*, concluding that the only difference was that *C. trilix* was larger. MOORE (1964) considers the two synonymous.

We believe that there are enough characters to distinguish these two taxa at the species level. The presence of microtubercles on the protoconch and the lack of spiral microsculpture between the perypheral keels allow us to differentiate *Cyclostremiscus trilix* from *Cyclostremiscus pentagonus*. The shell figured here is very similar to that described and figured by BUSH (1897).

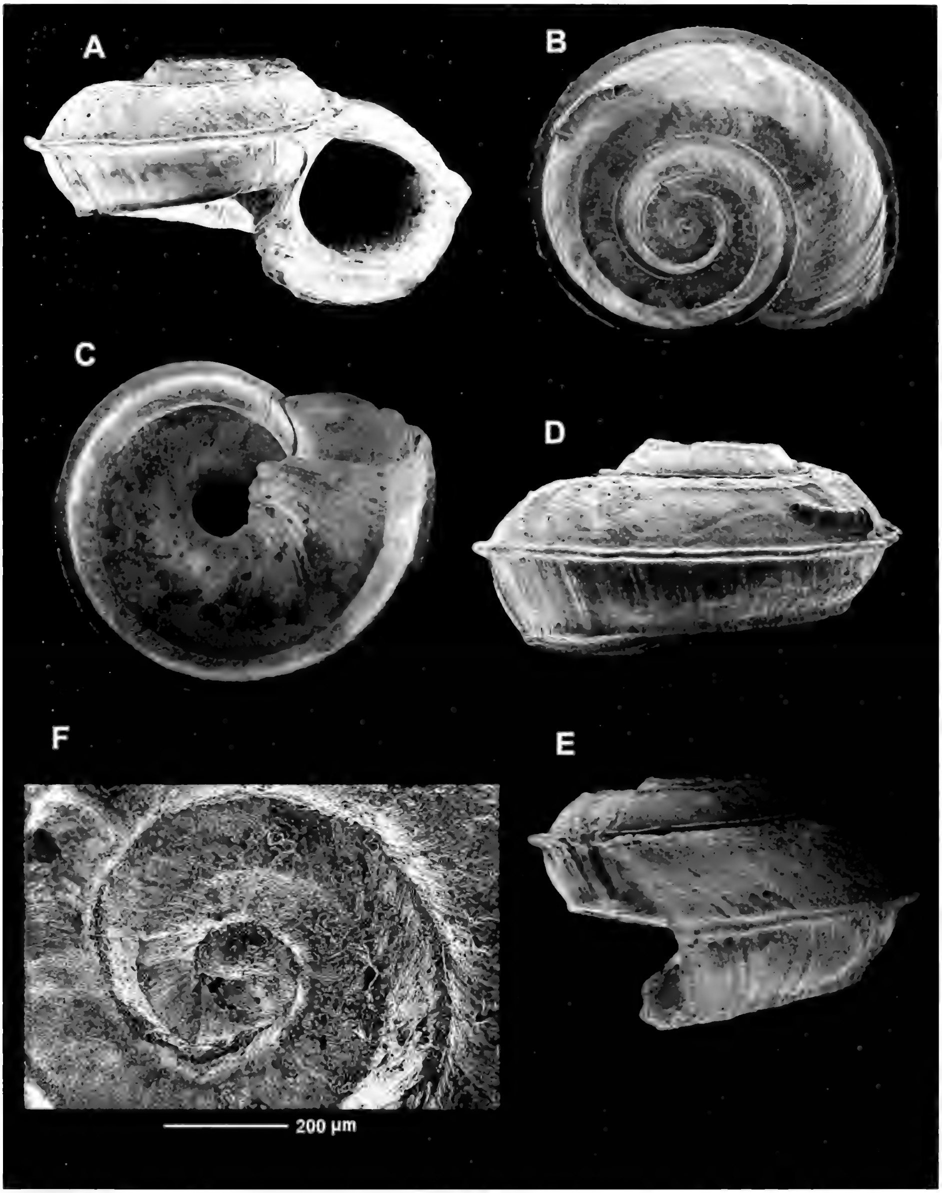
Cyclostremiscus hendersoni (Dall, 1927) (Figures 48A-F)

Lydiphnis hendersoni Dall, 1927. *Proceedings of the United States National Museum*, 70(2667): 124-125. [Type locality: Off Georgia].
Circulus hendersoni Dall.

Type material: Lectotype (Figures 48A-F) in USNM (108396). Examined by SEM.
Other material examined: None.

Description: This is the original description by DALL (1927): *"Shell small, white, depressed, glassy, with about three tricarinate whorls, the nucleus deeply sunken; axial sculpture of faint incremental lines, on the spire retractively oblique and on the base protractively arcuate; spiral sculpture of a prominent carina at the periphery, a less prominent one on the spire about one-third of the way from the suture to the periphery, and on the base another slightly nearer the umbilicus than to the periphery; these two secondary keels are variable, sometimes strong, sometimes almost obsolete, sometime partly one or the other on the same specimen; the edges of the carina are sometimes finely spirally striated, suggesting that they may when fresh and intact carry a series of epidermal fringes like* Episcynia*; the space within the basal carina is funicular, extending to a moderately narrow perforate umbilicus; the aperture would be rounded, but in those specimens in which the carinae are all developed the thin margin is modified and the aperture is angulated by them; in some specimens faint spiral striation is indicated on the surface between the carinae; the margin of the aperture in the adult is continuous over the body of the shell. Maximum diameter, 3.5 mm; minimum diameter, 2.9 mm; height, 1.3 mm".*

We add: The protoconch (Fig. 48F) is of small size, has a rough aspect and terminates with a thickened varix. Size about 170 μm in maximum diameter.



Figures 48A-F. *Cyclostremiscus hendersoni* (Dall, 1927). A-E: Lectotype in different positions, 3.5 mm (USNM, 108396); F: protoconch.

Figuras 48A-F. Cyclostremiscus hendersoni *(Dall, 1927). A-E: Lectotipo en distintas posiciones, 3,5 mm (USNM, 108396); F: protoconcha.*

The teleoconch has a very prominent peripheral keel placed in the middle of the shell; also two less prominent cords, one of them on the dorsum at the mid-point between the suture and the outer keel; and the other ventral, closer to the periphery. The dorsal cord slowly fades out disappearing near the middle of the body whorl. Under high magnification very fine spiral striae can be seen in the spaces between the cords and the keel. Another character typical of this shell is that the last whorl envelops the previous one below the peripheral keel, which, being prominent, hides this suture. A thickening of the umbilical wall progressively covers the umbilicus, which is narrow and deep. Internal lip a little thickened and reflected outward, further impinging on the umbilicus.

Habitat: Dredged from 805 meters depth, in broken coral, on a coarse sand and broken shell bottom, where numerous samples were collected.

Distribution: Only known from the type locality.

Remarks: DALL (1927) mentions the following: "*The periostracum on* Episcynia *is extremely fugacious, and it is not prudent to assume that these and other small shells dredged and showing none are normally without one. A few have a persistent periostracum, and there is no good reason to suppose that others never posses one*".

The depressed spire, the tricarinate shell, with spiral striae between the keels, and the form of the umbilicus allow us to place this species in the genus *Cyclostremiscus*. Only the protoconch gives us some doubts, which can not be resolved due to the lack of live-collected material to permit study of the radula. *Cyclostremiscus pentagonus*, *C. trilix* and *C. dalli* are the species with greatest affinity, principally because of their shells bearing three spiral keels. The present species can be distinguished from them by the form of the inner lip and the ornamentation of the umbilicus.

Group 2

This group of species clearly shows the evolution from the fossil forms with elaborate ornamentation (*Cyclostremiscus bartschi*) towards the recent species with more subdued sculpture (*Cyclostremiscus* spec. nov.).

Cyclostremiscus bartschi (Mansfield, 1936) (Figures 49A-D)

Cyclostrema bartschi Mansfield, 1936. *Florida State Geol. Surv. Bull.* Nº 3: 132, pl. 20, figs. 13-15. [Type locality: Upper Miocene of Harveys Creek, Leon Co., Florida] Fossil.

Material examined: Florida, USA: 1 s, Plio-Pleistocene Belle (CHL).

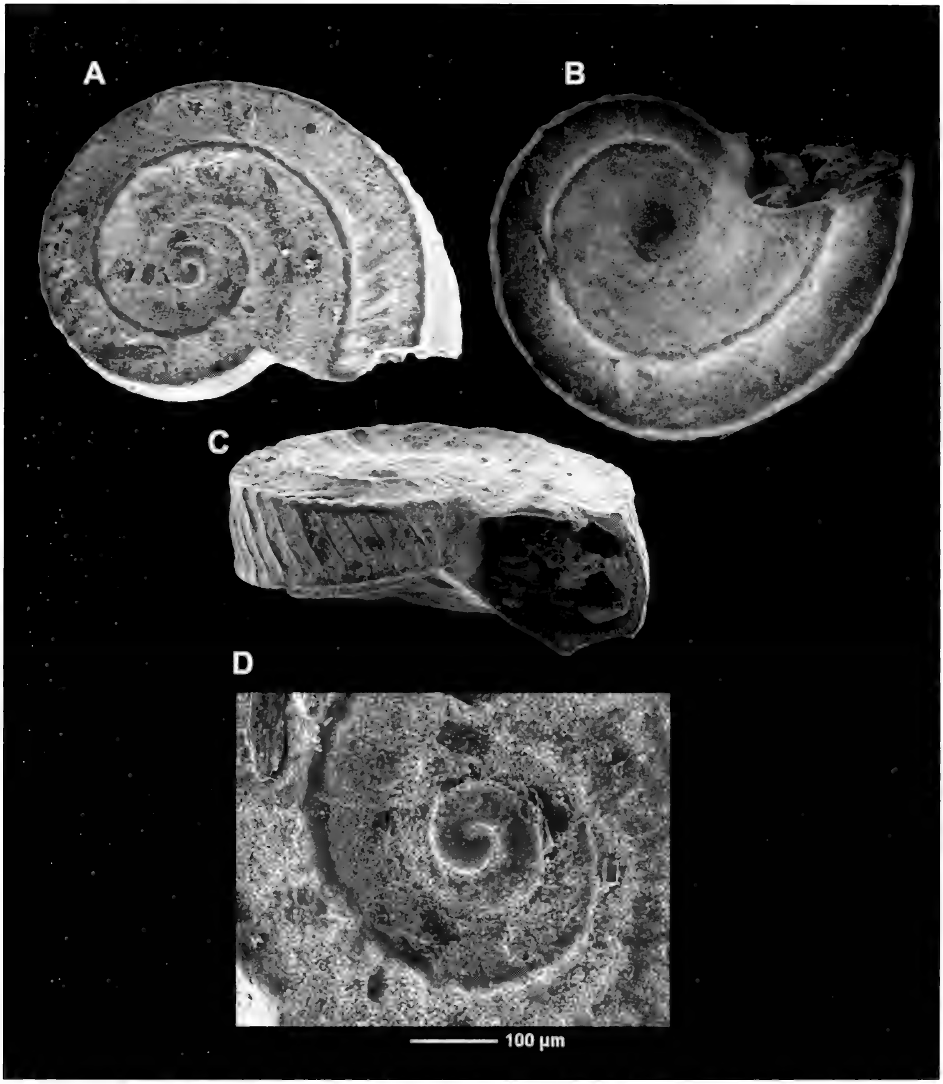
Description: In PILSBRY (1953): "*Shell is rather solid, discoidal, the upper surface flattened, with a spiral ridge midway on the last whorl, the vertical peripheral zone bounded by keels above and below; the base with a prominent keel bounding a broad, conic umbilicus. There are 3 ½ whorls, the first weakly convex; following half turn is narrower. After the second turn the whorls in apical view are somewhat concave and weakly folded radially on both sides of a median spiral ridge. The peripheral zone has oblique folds, and base is folded radially. Umbilicus is conic and has smooth, straight sides. The aperture is moderately oblique, more or less distinctly hexagonal, the peristome blunt, thickened at the basal angle and columellar slope, continued in a rather thick parietal callus, which is slightly advanced beyond the upper angle of the mouth*".

Height 0.9 mm, diameter 1.55 mm.

Habitat: Dredged from 28 and 30 fms (50-54 m), Sta. 2112 and 2110.

Distribution: TREECE (1980) mentions this species from the northeastern shelf and upper slope of Yucatan. RIOS (2009) also records it from Guatemala and East Brazil.

Remarks: This species was initially considered exclusively fossil following its original description. TREECE (1980)



Figures 49A-D. *Cyclostremiscus bartschi* (Mansfield, 1936). A-D: shell, 1.4 mm, Plio-Pleistocene of La Belle, Florida (CHL); D: protoconch.
Figuras 49A-D. Cyclostremiscus bartschi *(Mansfield, 1936). A-D: concha, 1,4 mm, Plio-Pleistoceno de La Belle, Florida (CHL); D: protoconcha.*

mentioned it as a recent species from Yucatan, Gulf of Mexico, but this record was considered dubious by Malacolog, version 4.1.1. <www.malacolog.org>. A Database of Western Atlantic Marine Mollusca. RIOS (2008) recorded it again from Guatemala and East Brazil, and based on these records we have considered *Cyclostremiscus bartschi* as a recent species. Morphologically, the vertical periphery, limited by two keels, and the wide spiral cord placed on the dorsum and on the base of the shell are the main differential characters to distinguish it from closely related species. The nodules on the cords and keels are formed by the intersecting axial ribs.

Cyclostremiscus jeannae Pilsbry & McGinty, 1946 (Figures 50A-D)

Vitrinella panamensis auct. non C.B. Adams, 1852.
Cyclostremiscus jeannae Pilsbry & McGinty, 1946. *The Nautilus,* 59: 82, pl. 8, figs. 4-4a. [Type locality: Off Palm Beach, Florida].

Type material: Holotype in ANSP (181371). Figured by MOORE (1964, fig. 25). Not examined.
Material examined: Florida, USA: 1 s, 60 m, off Sombrero Light, Key Vaca, Monroe Co. (CHL); 1 s, dredged, 30 m, 32 mi E St. Augustine, Dt. Johns Co. (CHL); 1 s, 26 m, Tanzler's Waters, 23 mi ENE Mayport, Duval Co. (CHL); 1 s, 27.75 mi ESE Mayport, Duval Co. (CHL). St. Kitts & Nevis: 1 s, 18 m, base of the reef, Monkey Shoals (CHL). Guadeloupe: 1 s, Île d'Aves, Saint Martin Island, 8 m (CJP).

Description: Shell (Figs. 50A-B) depressed, spire flat, periphery flat, tricarinate, but central carina weak, umbilicus funnel shaped with strong delimiting carina. Protoconch (Fig. 50C) of about 1 ½ -2 whorls; smooth and glassy, about 250 µm in diameter. The end of the protoconch not clearly marked lacking a varix. Sculpture formed by a tricarinate periphery. There is a weak spiral rib on the middle of the dorsal side and a low cord at the suture. The base is smooth except for weak axial costulation. Umbilicus funnel shaped with flat walls, bordered by a strong descending carina. Aperture strongly modified by the carina and peripheral keels. The parietal callus is rather heavy and extends a little in front of the aperture.

Dimensions: The holotype size is 2.3 mm. The studied shells average 1.52 mm in maximum dimension (diameter).

Habitat: The bathymetric range of this species is ample, having been recorded between 0 and 128 m in depth; but the records for living material are between 42 and 91 m.

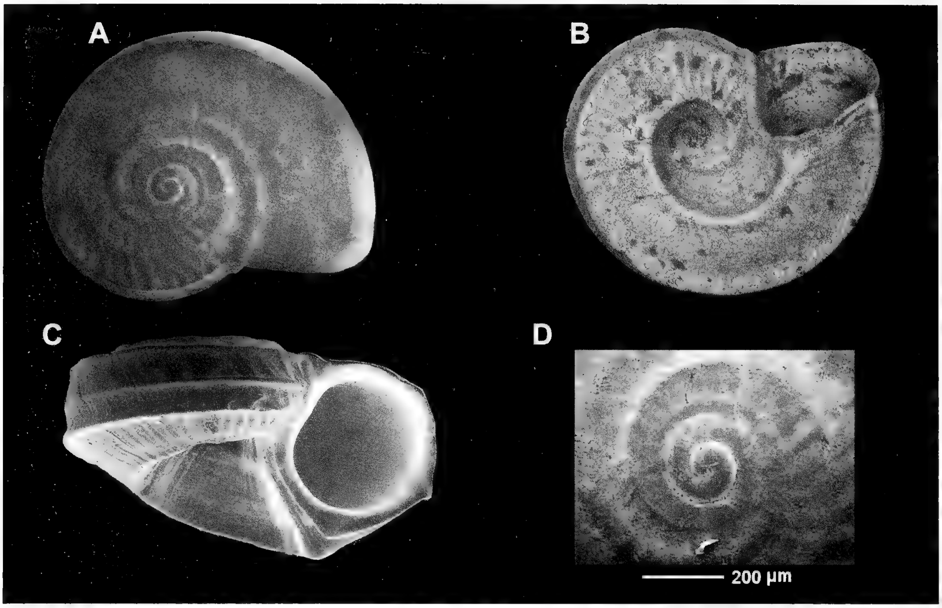
Distribution: It has been recorded from USA, off Palm Beach, Florida (PILSBRY & MCGINTY, 1946); Colón and Bocas Island, Panama (OLSSON & MCGINTY, 1958); Florida Peninsula, from Palm Beach to St. Petersburg (MOORE, 1964); North Carolina (PORTER, 1974); South half of Florida to Texas, Costa Rica and Panama (ABBOTT, 1974); Portete, Costa Rica (HOUBRICK, 1968; ROBINSON & MONTOYA, 1987); Louisiana and Texas (ODÉ, 1988); South Florida to Texas, Costa Rica and Caribbean Panama (LYONS, 1989); Mexico: Veracruz and Campeche State (REGUERO & GARCÍA-CUBAS, 1991); South Florida and from Texas to Panama and Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994); northeast Florida (LEE, 2009).

Remarks: The flat spire, the flattened periphery and the strong, descending umbilical carina are the important characters of the species. *C. jeannae* has a much larger umbilicus with a stronger bordering carina than *C. suppressus* (Dall, 1889). A similar species is *C. bartschi* (Mansfield, 1930), but it lacks the weak central keel on the periphery.

Cyclostremiscus suppressus (Dall, 1889) (Figures 51A-H)

Teinostoma (Ethalia) suppressa Dall, 1889a. *Bulletin of the Museum of Comparative Zoology* 18: 1-492, pls. 10-40. [Type locality: Goodland Point, West Florida].
Circulus suppressus (Dall, 1889).

Material examined: USA, Florida: 3 s, Anclote Key, Tarpon Springs (CHL); 1 sp, Sunset Park, Tarpon Springs, Pinellas Co. (CMK); 2 s, NE end Sand Key, Little Pass, Pinellas Co. (CHL); 1 s, Seaquarium Flats, Virginia Key, Dade Co. (CHL); 1 s, dredged 1.5-3 m, 5 mi SW Cedar Key, Levy Co. (CHL). Louisiana: 2 s, Last Island, Terra bone (CEG).



Figures 50A-D. *Cyclostremiscus jeannae* Pilsbry & McGinty, 1946. A-B; shells, 1.5 mm, San Martin Island (CJP); C: shell, 1.7 mm, Sombrero Light, Key Vaca, Florida (CHL); D: protoconch.
Figuras 50A-D. Cyclostremiscus jeannae *Pilsbry & McGinty, 1946. A-B; conchas, 1,5 mm, San Martin Island (CJP); C: concha, 1.7 mm, Sombrero Light, Key Vaca, Florida (CHL); D: protoconcha.*

Description: Shell (Figs. 51A-D) depressed, spire flat, periphery strongly tricarinate, additional spiral carina close to suture, umbilicus minute, constricted, carinate. Protoconch (Fig. 51E) with 2 whorls, smooth and flat, and a diameter of about 390 μm. Teleoconch formed by about 2 whorls. Spiral sculpture consists of 3 narrow sharp keels on the periphery, the middle one a little more prominent than the others. Near the suture there is another less prominent keel. Base flattened, bordered by the lower peripheral carina on the outher edge, and by another carina around the umbilicus. Aperture oblique, parietal callus wide and with a sulcus on the upper inner angle. Umbilicus narrowed by the thickened inner wall.

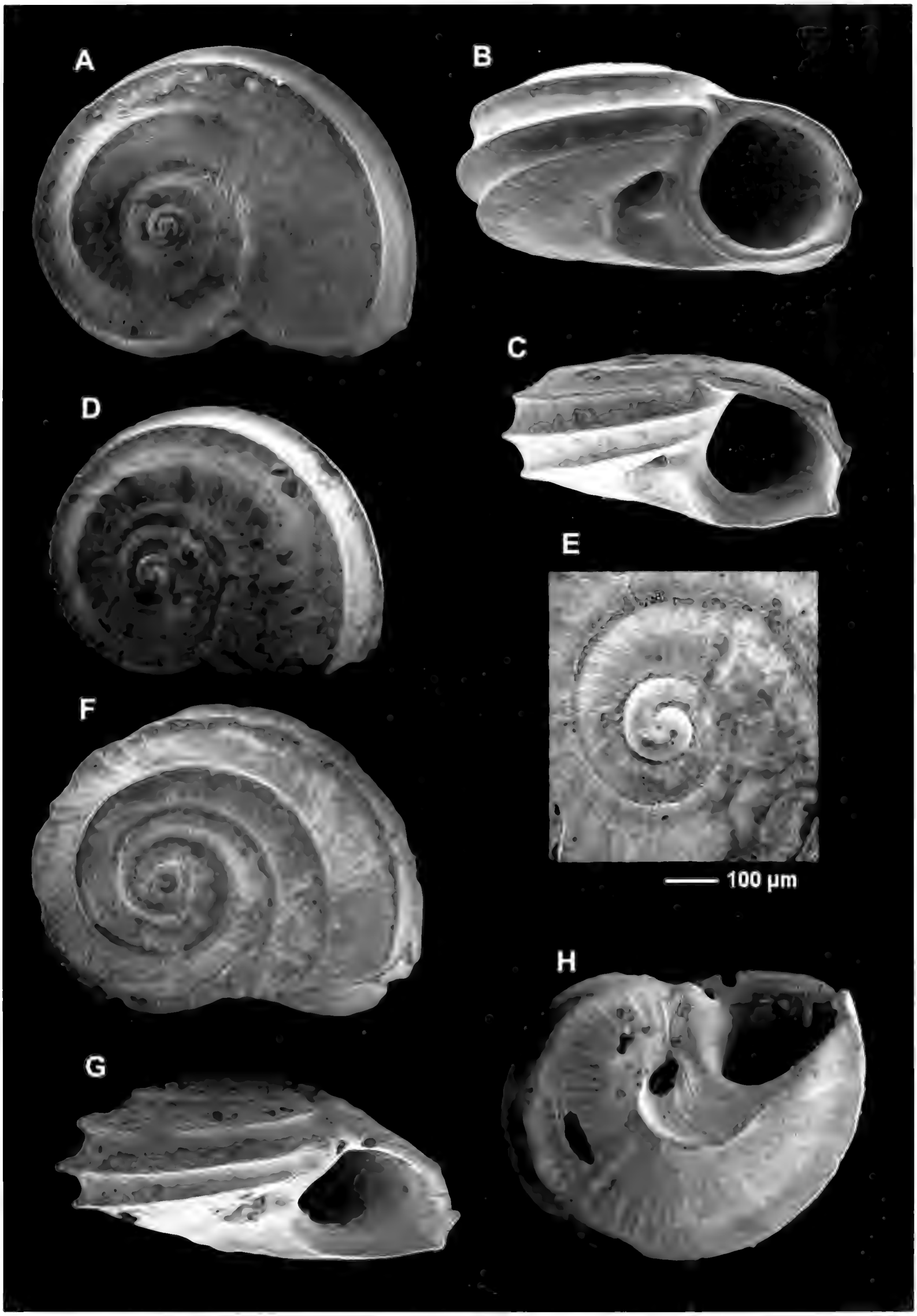
Dimensions: Maximum reported size: 2.4 mm. The figured specimens measure 1.5 and 1.8 mm in maximum diameter.

Habitat: Depth: 0 to 58 m (live 0.6 m). Moore (1964) reported that this species lives in shallow water strictly and is restricted to continental shores.

Distribution: USA: North Carolina, Florida: East Florida, West Florida (Dall, 1889a; Johnson, 1934), Louisiana, Texas; Mexico: Campeche State, Yucatan State. Recorded from Goodland Point; Hemphill and Baker's Haulover, Biscayne Bay, Florida (Pilsbry & McGinty, 1946) and from the lower east coast and entire west coast of Florida and the coast of Texas (Moore, 1964; Emerson & Jacobson (1976); from North Carolina (Porter, 1974); from Louisiana and Texas (USA) and Campeche State and Yucatan State, Mexico (Odé, 1988).

Remarks: The flat spire, the three strong and sharp carinae, and the reduced umbilicus are the identifying characters of this species.

The shells from Last Island, Terrabone, Louisiana, are apparently more depressed, present two strong cords on the dorsum, one of them near the suture, and the umbilicus is a little



Figures 51A-H. *Cyclostremiscus suppressus* (Dall, 1889). A-D: shells, 1.5, 1.8 mm, Pinellas Co., Florida (CMK); E: protoconch. F-H: shells, 2.2, 2.1 mm, Last Island, Terrabone, Louisiana (CEG).

Figuras 51A-H. Cyclostremiscus suppressus *(Dall, 1889). A-D: conchas, 1,5, 1,8 mm, Pinellas Co., Florida (CMK); E: protoconcha. F-H: conchas, 2,2, 2,1 mm, Last Island, Terrabone, Louisiana (CEG)* more closed than in shells from Florida. This could represent the morphological variability of the species.

The closest species is *Cyclostremiscus jeannae*, which is distinguished by the lack of pronounced peripheral keels and the presence of a wide umbilicus.

Cyclostremiscus colombianus Pilsbry & Olsson, 1845 is morphogically similar.

Cyclostremiscus vanbruggeni de Jong & Coomans, 1988 (Figures 52A-E)

Cyclostremiscus vanbruggeni de Jong & Coomans, 1988. *Studies on the Fauna of Curaçao and other Caribbean Islands*, 69: 32, pl. 2, fig. 136. [Type locality: Curaçao / Aruba].

Type material: Holotype in ZMA (3.87.063). Not examined.
Material examined: Brazil: 2 s, Praia da Itararé, São Vicente, São Paulo (CHL). Trinidad and Tobago: Tobago, 1 s, Scarborough (CHL).

Description: The original description is as follows: "*Shell wider than high. The sculpture consists of fine spiral striae and low radial ribs which on the upper side of the last whorl are weak or nearly absent. On the periphery at the beginning of the last whorl there are 3 smooth keels of which the middle one soon disappears and gradually also the upper one, so that near the aperture practically only the lower keel remains. On the upper side there is a ridge which gradually fades away. The very wide umbilicus is bordered by a ridge*".

Maximum reported size: 1.6 mm

Habitat: Nothing is mentioned by DE JONG & COOMANS (1988) about the habitat of this species. The shell photographed was collected in sandy sediments.

Distribution: ABC Islands: Aruba, Curaçao (DE JONG & COOMANS, 1988).

Remarks: The closest species conchologically is *Cyclostremiscus jeannae*, from which it can be distinguished by the weaker dorsal ornamentation and the smaller umbilicus. *Cyclostremiscus suppressus* may be distinguished by its lack of axial sculpture except very fine growth lines.

Cyclostremiscus diminutus spec. nov. Rubio, Rolán & Pelorce (Figures 53A-G)

Type material: Holotype (Figs. 53A-D) in MNHN (24201) (*ex* CJP); one paratype from Pointe-á-Pitre, Guadeloupe (FLMNH, 448611). Other paratypes: USNM (1155030, 1 s, Fig. 53D), AMNH (1 s, Fig. 53E), from Bocas Island, Panama (*ex* CHL); CHL (1 s, Puerto Rico).
Type locality: Guadeloupe.

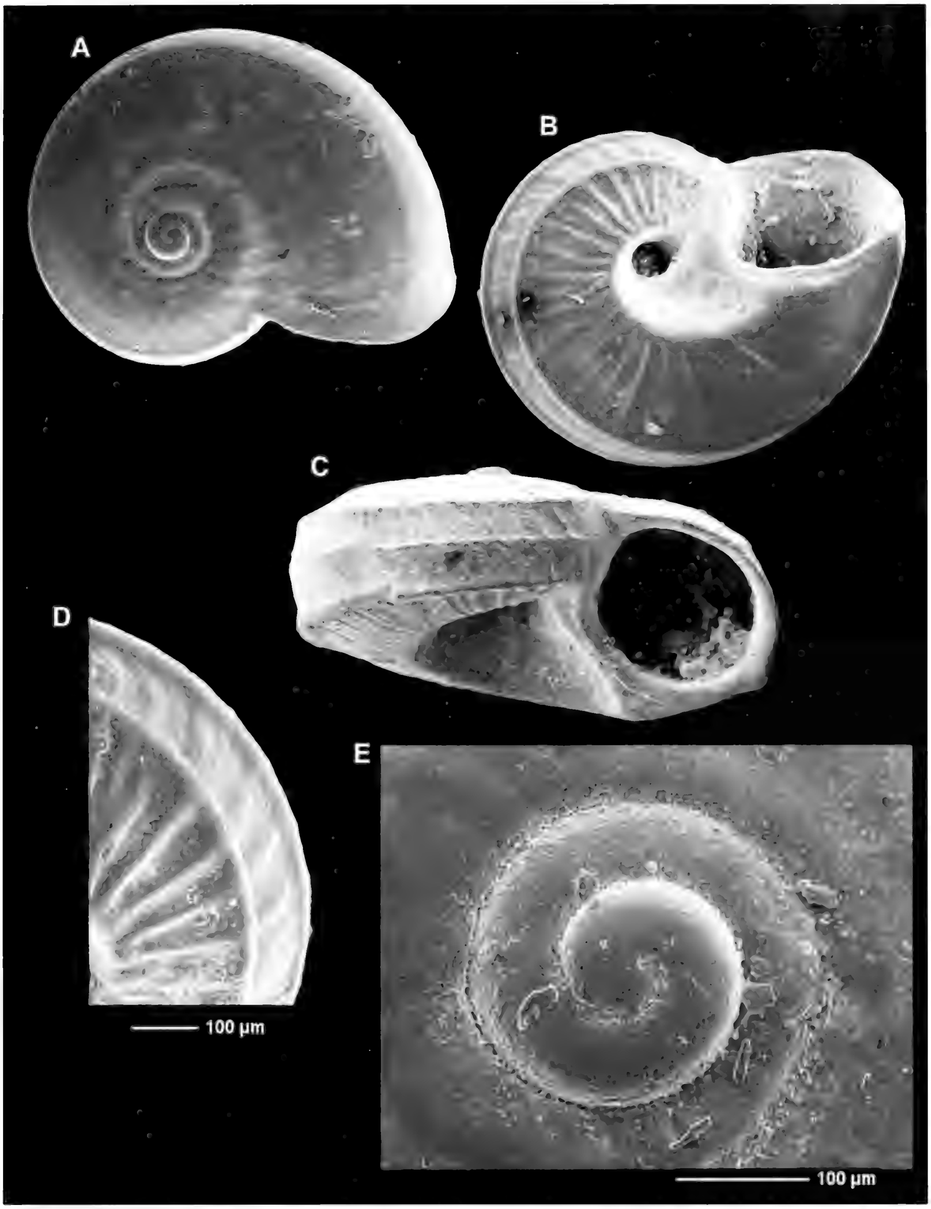
Description: Shell (Figs. 53A-C) solid, depressed, lenticular, with a short spire. Protoconch (Fig. 53D) smooth, bulbous, about 290 μm in diameter, with 1 ¼ whorls. Teleoconch with a little more than one whorl. Ornamentation produced by 5 spiral cords which are distributed regularly on the periphery and which are marked by axial growth striae, also evident near the umbilicus. At the beginning of the teleoconch a spiral cord may be seen on the dorsum but it promptly fades. Aperture rounded, columella and inner lip reflected outward. Umbilicus wide and deep, spiral cords absent from its border and inner aspect.

Holotype is 0.75 mm in maximum diameter and 0.32 mm in height.

Habitat: No information. All the material was collected in drift sediments.

Distribution: Only known from the type material: Guadeloupe, Puerto Rico and Panama.

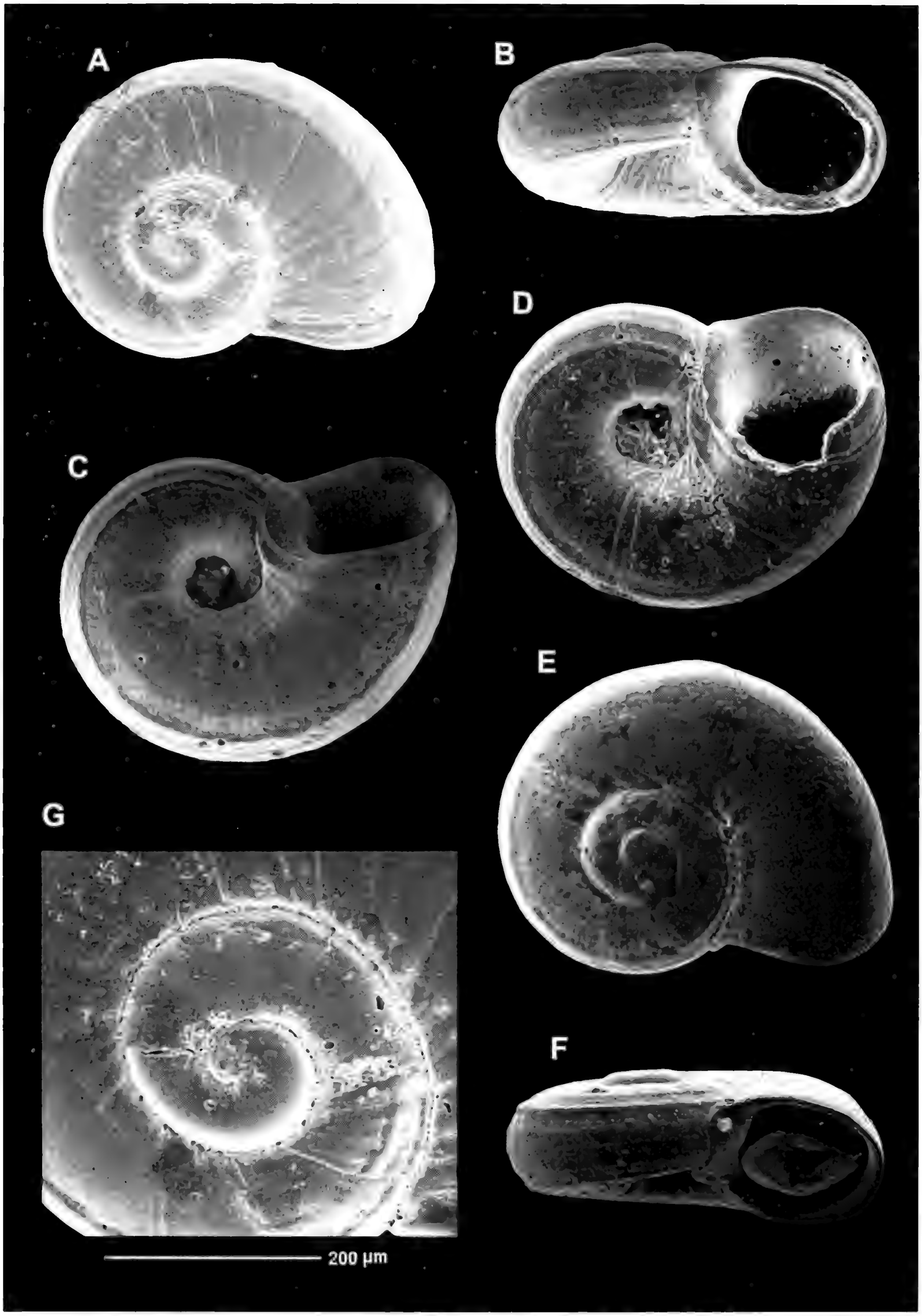
Remarks: *Cyclostremiscus* spec. nov. may be distingished from the other



Figures 52A-E. *Cyclostremiscus vanbruggeni* de Jong & Coomans, 1988. A-B: shells, 1.43, 1.28, Praia da Itararé, São Vicente, São Paulo (CHL); C: shell, 1.7 mm, Searborough, Tobago (CHL); D: detail of the sculpture; E: protoconch.

Figuras 52A-E. Cyclostremiscus vanbruggeni *de Jong & Coomans, 1988. A-B: conchas, 1,43, 1,28, Praia da Itararé, São Vicente, São Paulo (CHL); C: concha, 1,7 mm, Searborough, Tobago (CHL); D: detalle de la escultura; E: protoconcha.*

species of the complex *bartschi-jeannae-vanbruggeni-suppresus*, by the lack of any axial sculpture, having at the periphery 5 spiral cords not particularly prominent, delimiting a convex periphery.



Figures 53A-G. *Cyclostremiscus diminutus* spec. nov. Rubio, Rolán & Pelorce. A-C: holotype, 0.75 mm, Guadeloupe (MNHN); D-E: paratypes, 0.95, 0.87 mm, Bocas Island, Panama (USNM and AMNH, *ex* CHL)); F: paratype, 0,92 mm, Puerto Rico (CHL); G: protoconch.
Figuras 53A-G. Cyclostremiscus diminutus *spec. nov. Rubio, Rolán & Pelorce. A-C: holotipo, 0,75 mm, Guadeloupe (MNHN); D-E: paratipos, 0,95, 0,87 mm, Isla Bocas, Panamá (USNM and AMNH, ex CHL)); F: paratipo, 0,92 mm, Puerto Rico (CHL); G: protoconcha.*

Cyclostremiscus cubanus (Pilsbry & Aguayo, 1933) (Figures 54A-G)

Circulus cubanus Pilsbry & Aguayo, 1933. *The Nautilus,* 46: 120. pl. 6 figs. 6-6b. [Type locality: Varadero, Matanzas, Cuba].

Cyclostrema cubanus (Pilsbry & Aguayo, 1933).

Cyclostremiscus puntagordensis Weisbord, 1962: 141-142, pl. 13, figs. 10-12. [Type locality: Playa Grande Formation (Maiquetía member) at W-23, north flank of Punta Gorda anticline, Venezuela]. Fossil record.

Type material: Holotype in ANSP (160198). Represented in MOORE (1964: 230, fig. 26).

Other material examined: Belize: 2 s, 18 m, Deadman's Reef, Turneffe Island (CHL). Panama: 1 s, 1 mi N Punta San Blas, San Blas Islands (CHL). Honduras: 3 s, Calabash, Roatan Island (CHL). Puerto Rico: 2 s, Holiday Inn, San Juan (CHL). Cuba: 4 s, Varadero Beach, Matanzas (MCZ 109345, 179783); 1 s, Archipelago de los Canarreos, 5 m (CFR); 1 s, Cayo Avalos, 8 m (MHNS); 1 s, Cayo Diego Perez, beached (MHNS); 1 s, Faro Perez Diego, 10 m (MHNS); 2 s, Jibacoa, 3-6 m (MHNS); 5 s, Rancho Luna Beach, 10 m (MHNS); 15 s, Rancho Luna Beach, 20 m (MHNS); 4 s, Rancho Luna Beach, 45 m. Florida, USA: 1 s, 30 m, 32 mi E St. Augustine, St. Johns (CHL). Bahamas: 1 s, 15 m, French Bay, San Salvador (CHL); 4 s, 36 m, Mt Olympus Reef, 12 mi NNW Great Bahama Is (CHL); 4 s, 15 m, Samphire Cay, near Nassau (CHL); 21 s, 18 m, South Ridring Rocks, Cay Sal Bank (CHL); 1 s, 25 m, Marina Long Cay (CHL). Saint Kitts & Nevis: 6 s, 18 m, Monkey Shoals (CHL). Martinique: 1 s, coralline reefs of Point Borgnesse, 12 m, sand-muddy bottom (CJP). Trinidad and Tobago: Tobago, 16 s, Horse Shoe Reef, 15 m, shells grit bottom (CJP). Aruba: 1 s, 15 m, off Palm Beach (CHL). Bonaire: 1 s, 39 m, off Klein Bonaire (CHL). Virgin Islands: 5 s, 18 m, Deadman Chest (CHL); 5 s, Magens Bay, N coast of St. Thomas (CHL); 1 s, Virgin Gorda (CHL).

Description: Shell (Figs. 54A-C) depressed, whitish, robust, with spiral sculpture. Protoconch (Fig. 54D) of almost 1 ½ whorls, about 270 μm in diameter, and with two clearly differentiated stages; numerous strong irregular tubercles are seen on its surface. There is no varix evident at the transition between protoconch and teleoconch. The latter has about 1 ¼ rapidly-expanding whorls. Ornamentation formed by 6 strong spiral cords: 3 on the periphery, keel-like, having a slightly oblique profile; dorsally one spiral cord extends between the suture and the upper peripheral cord. On the base there are two spiral cords: one around the umbilicus and the other between this and the basal peripheral cord. On the spiral cords some thickening can be seen at the points where the axial growth striae cross. The entire surface of the shell is covered by a microsculpture (Figs. 54E-G) of fine spiral anastomosing threads. Aperture quadrangular, thickened; outer lip with very fine dentition on its inner margin. Columella and internal lip reflected towards the umbilicus. Parietal callus complete. Umbilicus wide and deep. Dimensions: The holotype is 1 mm in maximum diameter.

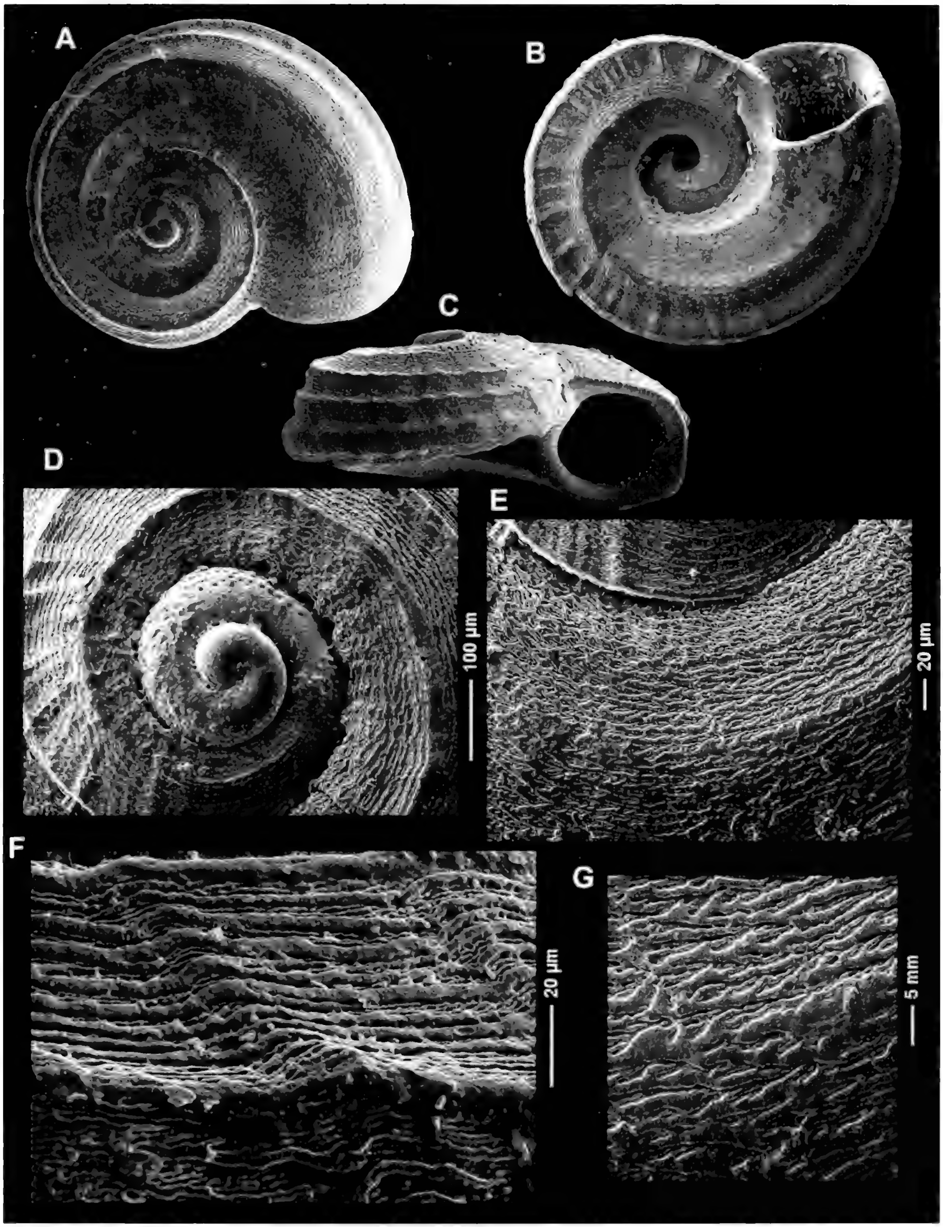
In our material there are some larger shells (1.20 mm in maximum diameter).

Animal and radula unknown.

Habitat: The bathymetric range of this species is large, having been recorded between 0 and 140 m in depth. There is no record of live-collected material, so its true habitat is unknown.

Distribution: This species has a wide Caribbean distribution. It has been recorded from Varadero, Cuba (PILSBRY & AGUAYO, 1933); from Florida, Cuba and the Virgin Islands (MOORE, 1964); from Florida, Garden Banks, Texas (ODÉ, 1988); from Florida, St. Augustine (LEE, 2009); from Abaco, Bahamas (REDFERN, 2001); and from Panama (OLSSON & MCGINTY, 1958). More localities are added in the present work.

Remarks: We have pointed out some shell features which were not mentioned in the original description or considered erroneous in the original or subsequent descriptions. With respect to the protoconch, PILSBRY & AGUAYO (1933) mentioned only that it is smooth and small; the dimensions of the holotype are erroneus because it was reported to be 1 mm in height and 0.45 mm in diameter. MOORE (1964) says that the protoconch has 2 ¼ whorls when really it has only 1 ½; he also comments that the



Figures 54A-G. *Cyclostremiscus cubanus* (Pilsbry & Aguayo, 1933). A-C: shells, 1.1, 1.2, 1.1 mm, Rancho Luna Beach, Cienfuegos, Cuba (MHNS); J-K: protoconch; E-G: details of the microsculpture.

Figuras 54A-G. Cyclostremiscus cubanus *(Pilsbry & Aguayo, 1933). A-C: conchas, 1,1, 1,2, 1,1 mm, Playa Rancho Luna, Cienfuegos, Cuba (MHNS); J-K: protoconcha; E-G: detalles de la microescultura.*

microsculpture covers all the shell, but it is absent from the umbilicus.

C. puntagordensis, a species placed in synonymy by MOORE (1964) was described as a fossil from the Plio-Pleistocene of Venezuela by WEISBORD (1962), but the only shell known, the hololotype, has slighty larger dimensions (1.4 mm).

Cyclostremiscus euglyptus Aguayo & Borro, 1946 (Figures 55A-D)

Cyclostremiscus euglyptus Aguayo & Borro, 1946. *Rev. Sdad. Malac. "Carlos de la Torre,"* 4(1): 9-10, figs. 4-6. [Type locality: Matanzas, Cuba].

Type material: Holotype represented in AGUAYO & BORRO (1946, figs. 4-6), in MPH (11877). Described as a fossil of the Upper Tertiary found in the formation "Yumurí," Upper Miocene of Cuba.
Other material examined: Cuba: 1 s, Cayo Avalos, 8 m (MHNS); 1 s, Cayo Perez Diego, 5 m (MHNS); 1 s, Jibacoa, 3-6 m (MHNS); 16 s, Cienfuegos Bay, 20-30 m (CFG); 2 s, Rancho Luna Beach, 12 m (CFG); 47 s, Rancho Luna Beach, 20 m (MHNS); 1 s, Rancho Luna Beach, 35 m (CFG); 14 s, Rancho Luna Beach, 45 m (CFG); 5 s, Faro los Colorados, 56 m (CFG); 2 s, Punta Tamarindo, 25 m (CFG).

Description: Shell (Figs. 55A-C). The original description of AGUAYO & BORRO (1946: 9-10) is as follows: *"Concha pequeña, discoidal, de espira muy poco elevada, ampliamente umbilicada. Con 1 ¼ vueltas embrionarias lisas y 2 ¼ postnucleares fuertemente esculpidas. Escultura espiral formada por dos quillas periféricas que limitan el contorno de la última vuelta y otra basal que bordea el ombligo. Finas líneas espirales se observan entre las expresadas quillas. Escultura axial formada por unas 40 costillas radiales en la última vuelta, que forman nódulos o incisiones al cruzar los cordones espirales. Periferia de la última vuelta con los lados casi paralelos y formando ángulos marcados con el eje de la concha. Ombligo amplio, dejando ver las vueltas nucleares. Pared del ombligo con escultura radial, pero sin líneas espirales. Abertura cuadrangular, con el lado columelar muy arqueado; el resto poligonal por la articulación de las quillas espirales".*

Protoconch (Fig. 55D) with a diameter of about 190 μm, smooth except at the earliest, embryonic, part where irregular short lines can be seen. The separation from the teleoconch is very evident.

Dimensions: the holotype is 1.05 mm in diameter and 0.56 mm in height. The single paratype, from the same lot, measured 1 mm in diameter and 0.60 mm in height. The dimensions of our material are similar to those of the holotype.

Habitat: This species is relatively common in Cuba. Its bathymetric distribution is between 5 and 60 m; most of the shells of our material were collected between 20 and 56 m.

Distribution: Only known from Cuba.

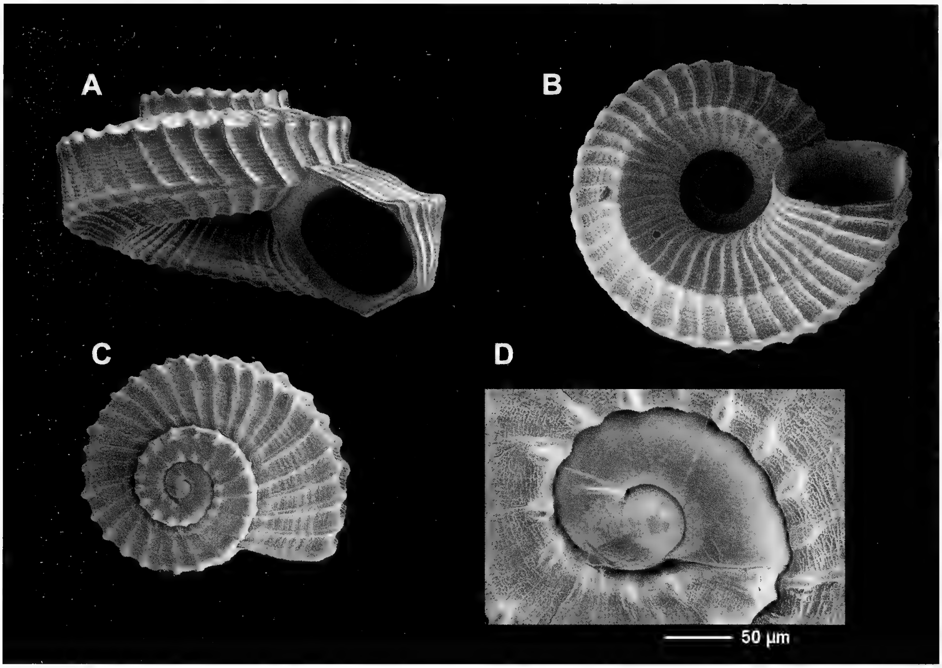
Remarks: There is no other species in the genus with this shell morphology, thus its identification is easy. Being a species probably "endemic" to the island of Cuba, it has been overlooked in published works and electronic databases.

Cyclostremiscus microstriatus spec. nov. Rubio, Rolán & Lee (Figures 56A-H)

Vitrinorbis sp. Lee, 2009: 69, nº 333.

Type material: Holotype (Fig. 56A) in MNCN (15.05/55055). Paratypes in the following collections: MNHN (24395, 1 s, Fig. 56B), MHNS (100549, 1 s, Fig. 56C) from the type locality (all *ex* CFG). Other paratypes: FLMNH (448609, 1 s, Fig. 48D, trawled 30 m, 35 mi E Mayport, Duval Co., Fla.; 3 s, trawled 30 m, 35 mi E St. Augustine, St. Johns Co., Fla. (Fig. 56E) (one in USNM 1155029, other in ANSP and a third in CHL).
Type locality: Rancho Luna Beach, Cienfuegos, Cuba.
Etymology: The specific name refers to the minute striation in the interspaces between cords.

Description: Shell (Figs. 56A-E) of very small size, planispiral, robust, whitish, solid, not shiny. Protoconch (Fig. 56F) with a fine granulation barely observable; 1 ¼ whorls and about 240 μm in diameter; there is no thick rib at



Figures 55A-D. *Cyclostremiscus euglyptus* Aguayo & Borro, 1946. A-C: shells, 1.0, 0.95, 0.8 mm, Cienfuegos, Cuba; D: protoconch.
Figures 55A-D. Cyclostremiscus euglyptus *Aguayo & Borro, 1946. A-C: conchas, 1,0, 0,95, 0,8 mm, Cienfuegos, Cuba; D: protoconcha.*

the junction with the teleoconch. Teleoconch with about 1 ¾ whorls. The entire shell is covered by wide spiral cords of almost equal size. The interspaces between cords are covered by fine axial incisions (Figs. 56G-H). On the last whorl there are between 20 and 23 cords; 7-8 on the dorsum, 8 on the periphery and 6-8 on the base. On the base, there is a space without cords from the middle of the last whorl to the umbilical border. Umbilicus smaller than those in congeneric species, the previous whorls can be seen on its interior. Aperture prosocline, rounded, thickened, its external margin forms a characterístic point in the area where the 7th-9th cords, the three most prominent ones, are placed. The columella as well as the internal lip and the upper part of the external lip are reflected outward. The first peripheral cord, as well as the dorsum and the last peripheral cord near the base are visible from above, the base being sligtly concave.

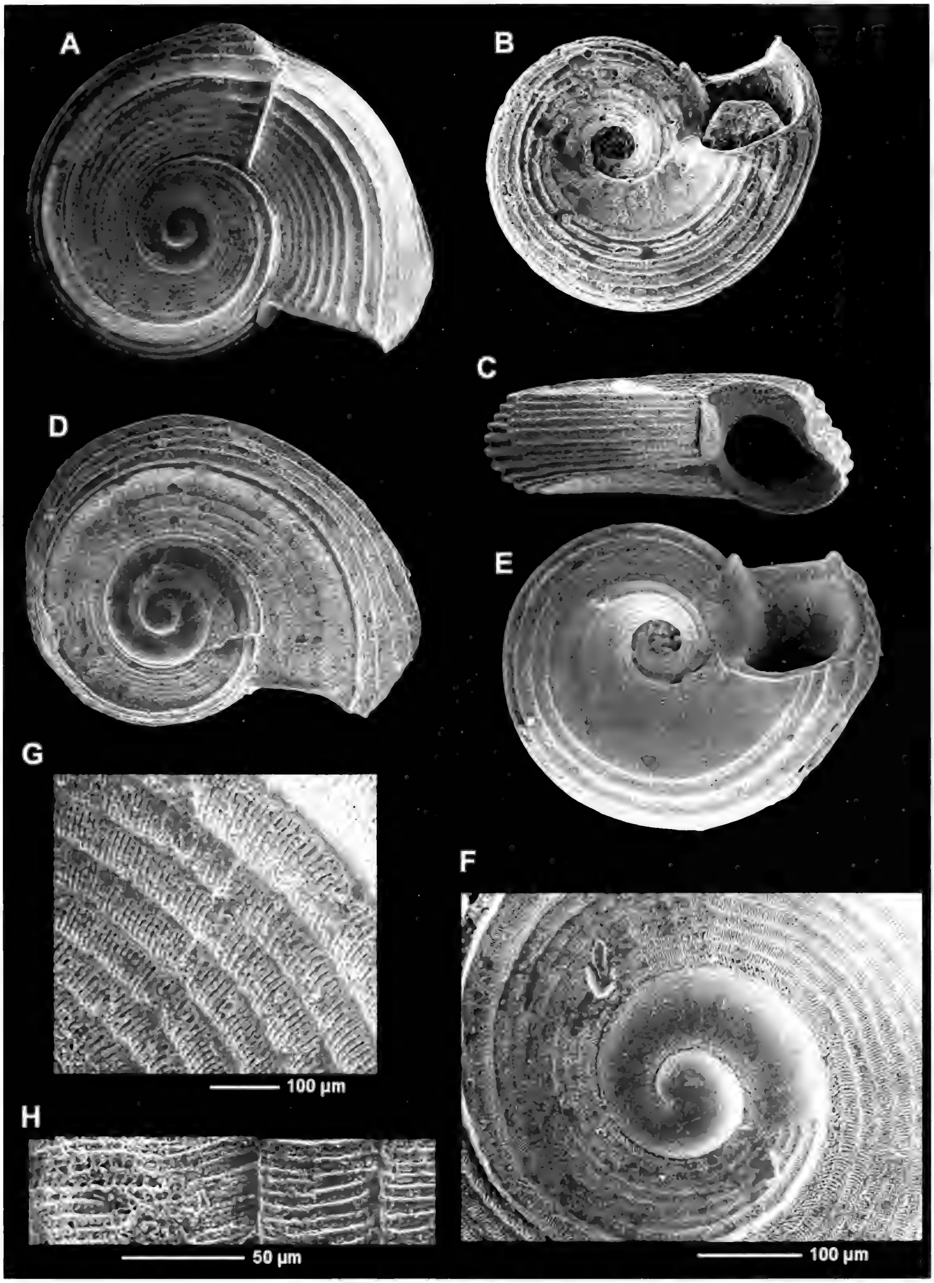
Dimensions: The holotype is 1.3 mm in maximum diameter and 0.40 mm in height.

Animal and radula unknown.

Distribution: Known only from Cienfuegos, Cuba and Florida, USA.

Discussion: *Cyclostremiscus microstriatus* spec. nov., is a very characteristic species; its form is almost planispiral, its ornamentation is formed by subequal spiral cords and very fine axial incisions in the interspaces, as well as the prolongation which forms the border of the external lip.

A similar species was recorded by LYONS (1989) as *Vitrinorbis* sp. It is much more flattened in profile and is markedly angulate at the level of the lowest peripheral keel. LEE (2009) suggested that *Circulus gunteri* (Mansfield, 1930), described from the Miocene of Florida, was ancestral to *Cyclostremis-*



Figures 56A-H. *Cyclostremiscus microstriatus* spec. nov. Rubio, Rolán & Lee. A: holotype, 1.3 mm (MNCN); B: paratype, 1.1 mm (MNHN); C: paratype, 1.0 mm (MHNS), Rancho Luna Beach, Cienfuegos, Cuba; D: paratype, 1.3, Duval Co., Florida (FLMNH); E: paratype, 1.2 mm, E St. Angustin, St. Johns Co., Florida (USNM); F: protoconch; G-H: microsculpture.

Figures 56A-H. Cyclostremiscus microstriatus *spec. nov. Rubio, Rolán & Lee. A: holotipo, 1,3 mm (MNCN); B: paratipo, 1,1 mm (MNHN); C: paratipo, 1,0 mm (MHNS), Playa Rancho Luna, Cienfuegos, Cuba; D: paratipo, 1,3, Duval Co., Florida (FLMNH); E: paratipo, 1,2 mm, E St. Angustin, St. Johns Co., Florida (USNM); F: protoconcha; G-H: microescultura.*

cus microstriatus spec. nov. (his *Vitrinorbis* species [no. 333]); the fossil, while having the same flat spire, differs in having the body whorl totally covered by cords and lacking the labral projection.

Circulus quadricristatus (Aguayo, 1949) is also similar to *C. microstriatus* spec. nov., but it only presents 4 wide cords on the periphery and lacks the labral projection.

LEE (2009) also suggested that the Panamic *Cyclostremiscus salvatierrensis* Hertz, Myers & Gemmill, 1992 was cognate with *C. microstriatus* spec. nov. (his *Vitrinorbis* species [no. 333]).

Genus *Cochliolepis* Stimpson, 1858

Cochliolepis Stimpson, 1858. *Proc. Boston Soc. Nat. Hist.*, VI: 308.
Type species: *Cochliolepis parasiticus* [sic] Stimpson, 1858, by monotypy. Recent, Caribbean.

Diagnosis: MOORE (1964: 168) *"Thin-shelled, strongly depressed and openly umbilicate. Apex flat or sunken, surface smooth except for growth lines or occasionally spiral striations. Aperture oblique, peristome very briefly in contact with preceding whorl. Adult whorls rapidly increase in size. Soft parts described as bright red, with two long pallial tentacles, and with a supplementary gill projecting from the right side of the aperture. Operculum thin and flexible"*.

C. parasitica was collected alive below the "elytra" of the giant worm *Polidontes lupinus*. *C. parasitica* is a commensal and not a parasite. It apparently feeds on the fine particulate organic material drawn into the tube by the worm`s respiratory and feeding current. It possibly performs a cleaning function.

Remarks: MOORE (1964) commented on the distribution of the genus: "*the genus appears to be confined to the West Indian region.* C. parasitica *is found on the Carolina coast,* C. nautiliformis *and* C. striata *live on the Gulf of Mexico and* C. adamsii *is known from Guadeloupe*".

However, we have found a very different situation: First at all, we have tried to make the specific differentiation basing not only on the characters of the teleoconch but also the protoconch. Fortunately we were able to compare shells from very different Caribbean localities confirming the morphology of the protoconch of *Cochliolepis parasitica* shown for the first time *by* REDFERN (2001). The sculpture is very characteristic, and it allows the distinction from congeneric species even as juveniles.

As for *Cochliolepis nautiliformis* (Holmes, 1859), in spite of the opinion of some authors who consider it as a synonym of *C. parasitica*, we could not confirm this due to the difficulty of observing the protoconch of that species; thus we prefer to present it provisionally as a separate taxon.

Cochliolepis adamsii (P. Fischer, 1857) (Figures 57A-D)

Adeorbis adamsii P. Fischer, 1857. *Journal de Conchyliologie*, 6: 287, pl. 10, fig. 11. [Type locality: Guadeloupe].

Type material: In MNHN. Not examined.
Other material examined: Bahamas: 1 s, beach near Current Cut, Current Eleuthera (CHL); 1 s, 36 m, Olympus Reef, 12 mi NNW West End, Grand Bahama Island (CHL). Florida, USA: 1 s, 1 m, Peanut Island, Palm Beach Co. (CHL).

Description: This is the original description of P. FISCHER (1857: 287): "*Testa translucida, corneo-alba, nitida, complanata, suborbiculari, umbilicata; suprà minutissimé et concentricè striata; subtus laevicula; anfractibus 3 ½ rapidè accrescentes, ultimo compressiusculo, non carinato; aperture subovata, parum transversa; margine dextro tenui, fragil*". This description must be suplemented with some information obtained from the materal presently studied:

Shell (Figs. 57A-D) depressed, fragile, of whitish-tan color, comprised of 3 ½ rapidly-expanding whorls. Protoconch (Fig. 57C) about 390 μm in diameter with a nucleus of about 160 μm. Following the nucleus a prominent spiral sculpture appears, being formed by four discrete cordlets which terminate at the beginning of the teleoconch. The teleoconch has a fine spiral striation which is crossed by numerous distinct growth lines, even into the widely-open umbilicus. Aperture suboval, with a fine and fragile border. No columellar or parietal callus.

Dimensions: Holotype 6.5 mm in maximum diameter and 2.0 mm in height.

Our shells are 7.1 and 6.2 mm in diameter.

Animal and radula unknown.

Habitat: This species, as well as its congeners, prefers shallow water in coastal bays. No bathymetric information was provided in the original description. Our shell came from a sandy and rocky bottom at 2 m deep.

Distribution: Recorded from USA: Florida: Florida Keys (MAURY, 1922; MOORE, 1964) and Guadeloupe (FISCHER, 1857).

Remarks: The species was previously included in the genus *Macromphalina*.

MOORE (1964) mentioned that during his stay in Paris in 1963, he examined the type of *Adeorbis adamsii* P. Fischer, 1857, concluding that "it is a *Cochliolepis* very similar to *C. striata* Dall, 1889, but more inflated".

The four species in the West Indian region may be separated into two groups: *C. parasitica* and *C. nautiliformis* are relatively small, smooth and shiny; *C. striata* and *C. adamsii* are relatively larger, spirally striated and have a light tan coloration. Contrary to the observations of MOORE (1964: 174), the base presents the same ornamentation as the rest of the shell.

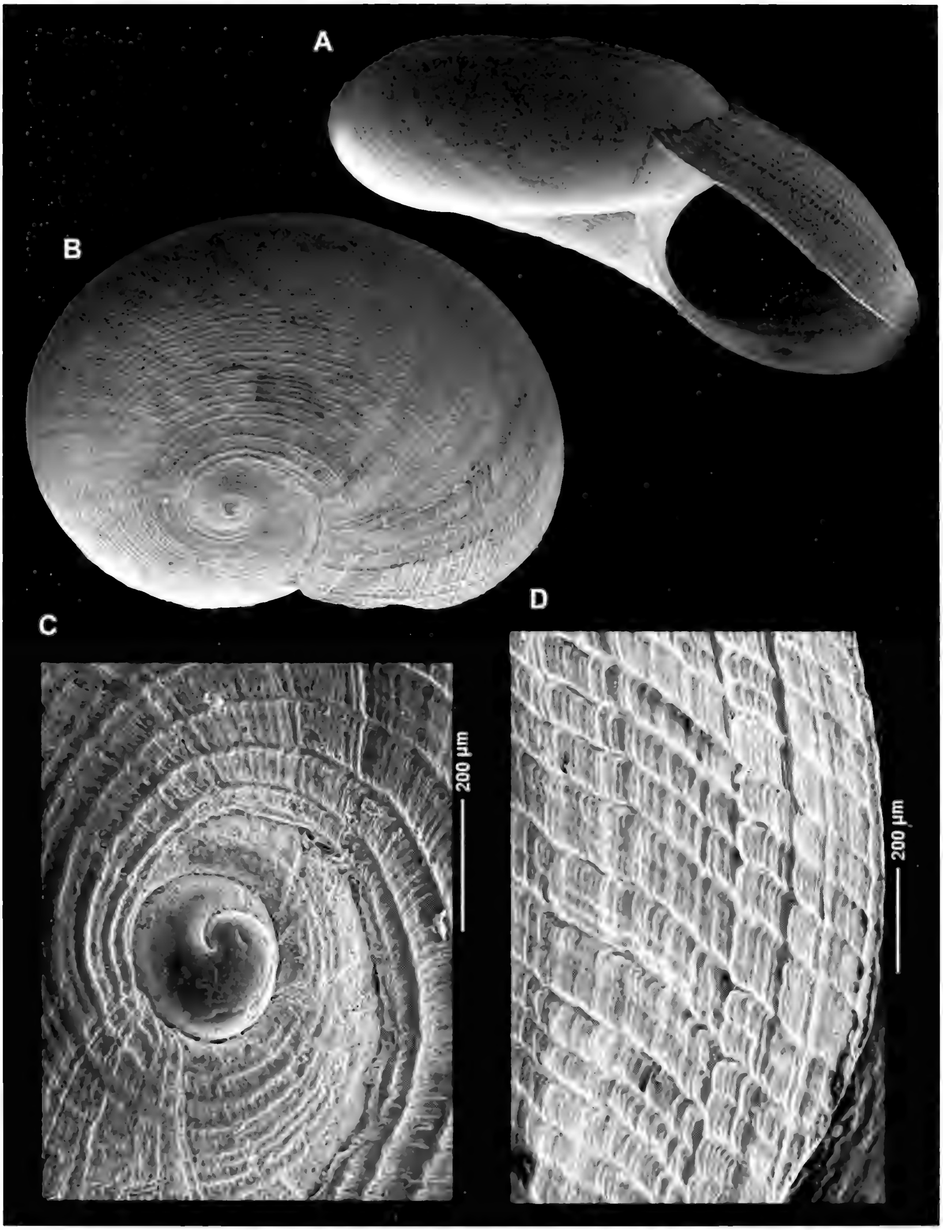
Cochliolepis holmesii (Dall, 1889) (Figures 58A-F)

Cochliolepis parasiticus [sic] Holmes, 1859. *Post-Pleiocene Fossils of South Carolina:* 93-94, pl. 14, figs. 9, 9a, 9b. [Type locality: South Carolina, Post Pliocene] non *Cochliolepis parasiticus* [sic] Stimpson, 1858.

Vitrinella holmesii Dall, 1889a. *Bulletin of the Museum of Comparative Zoology* 18: 360, 392.

Type material: Deposited in MCZ. Not examined.
Material examined: Florida, USA: 5 s, APAC Pit, Sarasota, Plio-Pleistocene (CHL). Mexico: 2 s, Puerto Morelos, Yucatan, 10-16 m (MHNS).

Description: From PILSBRY (1953: 433-434): "*The thin shell is biconvex; the periphery, below the middle of the whorl, is quite narrowly rounded, the whorl being more convex above than below it. The spire is nearly level but the apex is visible in a face view. The suture is deeply impressed, the whorls convex. The umbilicus is very broad and open, with a deep suture, the umbilical side of the whorls being strongly convex. The weak wrinkles of growth become stronger as they approach the lip, and are often rather fine and close on the base of the last third of the body-whorl. A microscopic, close, spiral striation covers the last whorl in good specimens, being weaker*

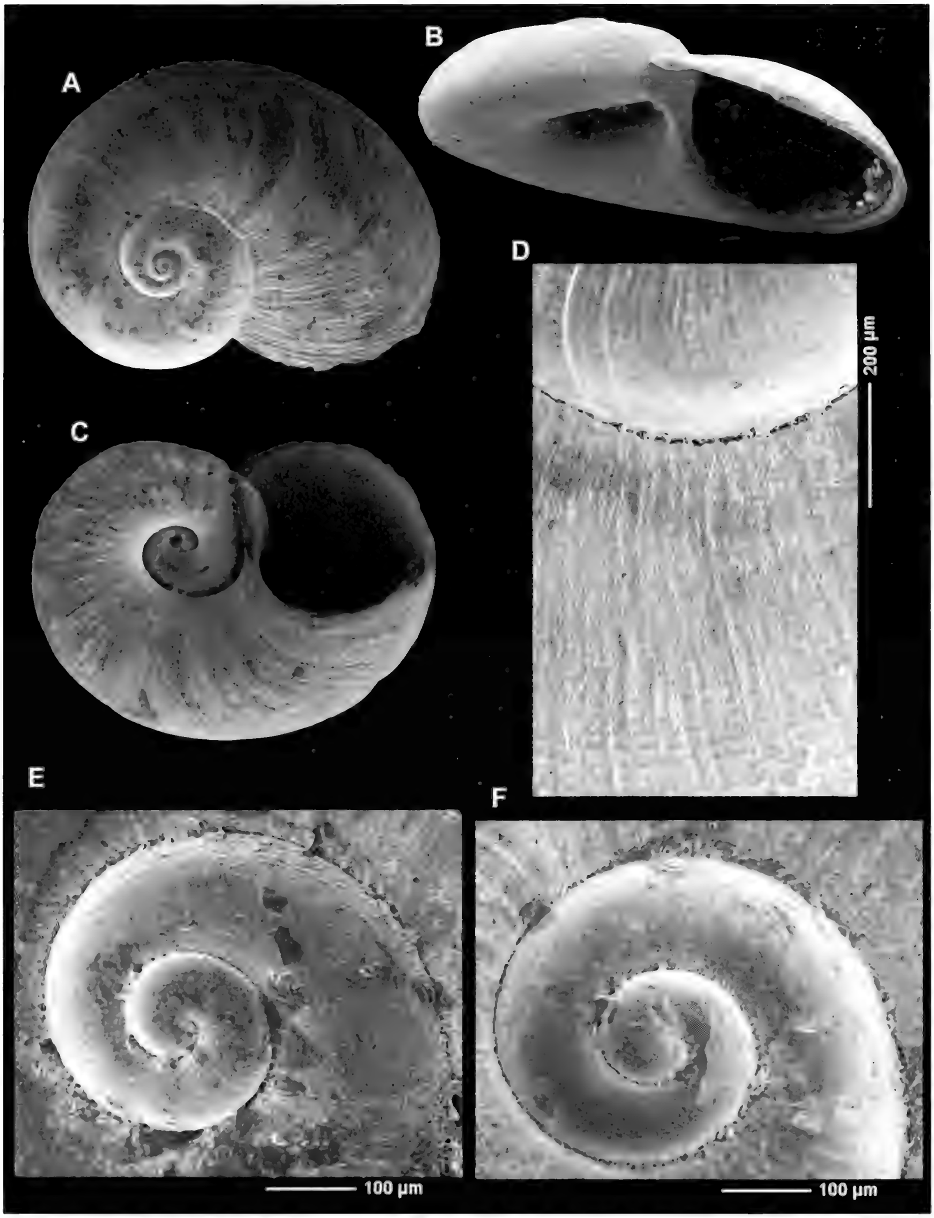


Figures 57A-D. *Cochliolepis adamsii* (P. Fischer, 1857). A-B; shells, 7.1, 6.2 mm, Bahamas (CHL); C: protoconch; D: microsculpture.

Figuras 57A-D. Cochliolepis adamsii *(P. Fischer, 1857). A-B; conchas, 7,1, 6,2 mm, Bahamas (CHL); C: protoconcha; D: microescultura.*

at the base. The aperture is oblique. Peristome is thin, the columellar margin concave below, then in a straight line to the insertion just below the periphery. It is thin throughout. The parietal callus is very short and thin".

We add: The shells (Figs. 58A-C) examined have the protoconch (Figs.



Figures 58A-F. *Cochliolepis holmesii* (Dall, 1889). A-C: shells, 3.66, 3.0, 2.96 mm, Plio-Pleistocene of Sarasota, Florida (CHL); D: microsculpture; E-F: protoconchs.
Figuras 58A-F. Cochliolepis holmesii *(Dall, 1889). A-C: conchas, 3,66, 3,0, 2,96 mm, Plio-Pleistoceno de Sarasota, Florida (CHL); D: microescultura; E-F: protoconchas.*

58E-F) bulbous, about 470 µm, 1 ¾ whorls, and with a very marked suture. Two stages may be easily distinguished: the embryonic shell is ¾ of whorl, measuring about 170 µm in diameter and is covered by a fine granulation, more evident in the areas close to the suture. The second stage has 5-6 fine spiral lines and minute growth marks.

The teleoconch is completely covered by growth marks and spiral striae; on the dorsum of the shell the collabral growth marks are more robust, especially at the later stages of growth, while on the base they are finer and denser on the last third of the whorl. Periphery subangular.

Maximum reported size: 2.4 mm

Habitat: Depth: 2 to 11 m.

Distribution: USA: Florida: East Florida (Lyons, 1989); Mexico: Cozumel (Moore, 1973).

Remarks: The name *Vitrinella holmesii* was introduced by Dall because *Cochliolepis parasiticus* [sic] Stimpson was misidentified by Holmes (1859: 93-94, pl. 14, figs. 9, 9a, 9b); it was, in fact, a new species.

The type of this species appears to be lost; it was described and figured by Holmes (1859) but no topotypic specimens have been collected. Dall's notes (1892) mention a specimen in the USNM (114368), which he identified with the Post-Pliocene species of Holmes (1859). Dall (1889a) used the spelling *'holmesi'* on p. 360 and *'holmesii'* on p. 392. Dall (1892), acting as First Reviser, employed the latter spelling, thus establishing the correct original spelling.

C. holmesii was described as a fossil of the Post-Pleiocene of South Carolina (Holmes, 1859; Dall, 1889a); from the Miocene of Duplin County, North Carolina (Dall, 1892); from the St. Petersburg Pliocene, the Pliocene in the Waccamaw formation of North Carolina, and the Miocene of the Natural Well, Duplin Co., North Carolina (Pilsbry, 1953).

Cochliolepis nautiliformis (Holmes, 1859) (Figures 59A-C)

Adeorbis nautiliformis Holmes, 1859: 93, pl. 14, figs. 8-8b. [Type locality: Cainhoy, Wando River, South Carolina].

Type material: Unknown.

Other material examined: Florida, USA: 1 sp, Tarpon Springs, Pinellas Co., S end of the parking lot Howard Park, (CHL); 1 s, Gulfport, Pinellas Co. (CHL).

Remarks: In discussing figured specimens of *Cochliolepis nautiliformis* (Holmes) from the St. Petersburg Plio-Pleistocene, Pilsbry (1953) in Olsson & Harbison (1953) commented: "*Dall (1889: 360) stated that* A. nautiliformis *Holmes is identical with* C. parasitica *Stimpson, and this synonymy has been accepted by some later authors without verification. There are several specific differences, the most conspicuous being the much more extensive envelopment of the spire in* C. nautiliformis, *reducing the visible spiral, the summit being left as a slight depression. The apical whorl is wider and fully exposed in* C. parasitica".

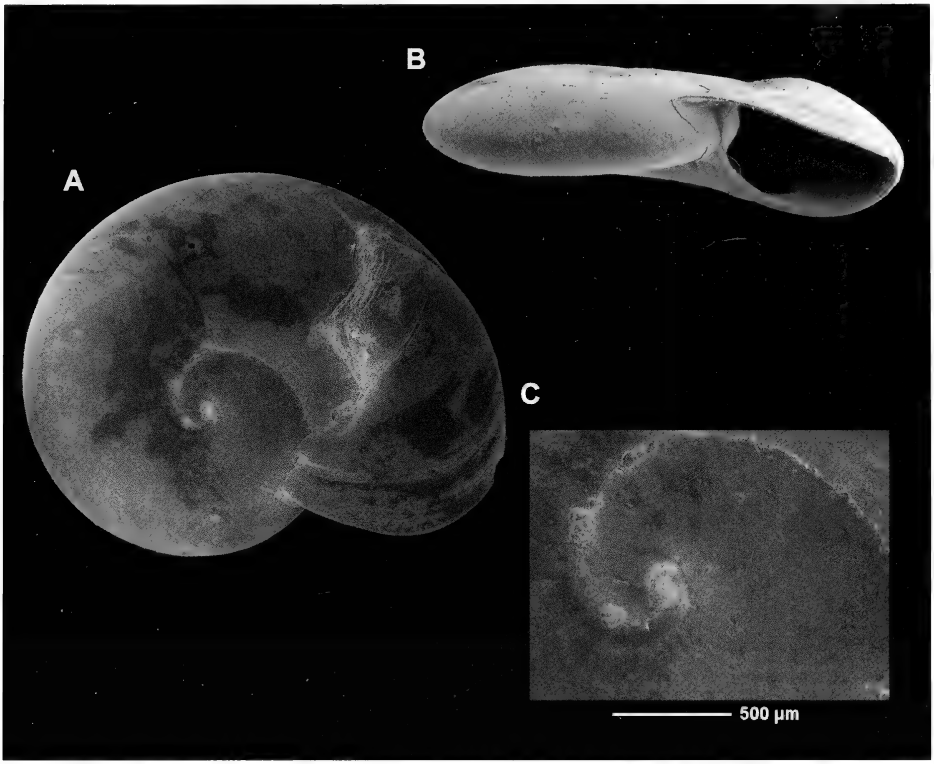
We have insufficient material to formulate an opinion about this taxon, therefore we present figures of what we perceive as this species. The problem can only be resolved with more material, including live-collected specimens.

Cochliolepis parasitica Stimpson, 1858 (Figures 60A-G, 61A-H, 62A-F)

Cochliolepis parasiticus [sic] Stimpson, 1858: 307-309, text-fig. [Type locality: Charleston Harbor, South Carolina].

Nemafera compressa Kurtz, 1960: 8. Not figured. [Type locality: Fort Johnson, South Carolina].

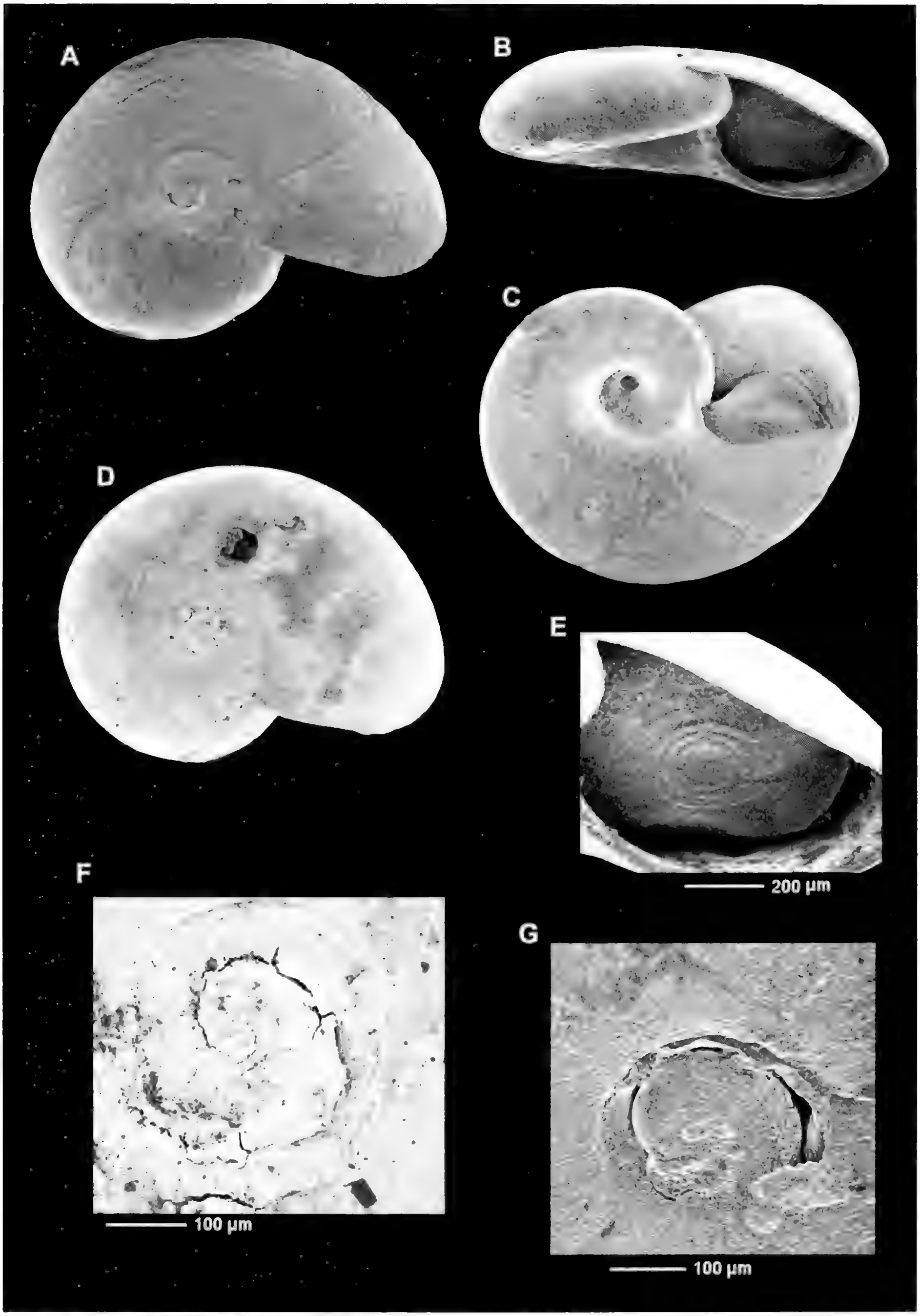
Type material: Two syntypes in USNM (95079) (corresponding to two specimens deposited with nº 87142, given by Stimpson to Isaac Lea). Examined in photographs (Figures 60A-G). The larger one is here designated the lectotype.



Figures 59A-C. *Cochliolepis nautiliformis* (Holmes, 1859). A-B: shell, 5.0 mm, Gulfport, Pinellas Co., Florida (CHL); C: protoconch.
Figuras 59A-C. Cochliolepis nautiliformis *(Holmes, 1859). A-B: concha, 5,0 mm, Gulfport, Pinellas Co., Florida (CHL); C: protoconcha.*

Other material examined: Bermuda: about 300 s, Gibbons Bay (CHL). Bahamas: 1 s, Channel, Chub Cay (CHL); 1 s, W end Grand Bahama (CHL); 3 s, beach, 300 m N Current Cut, Eleuthera (CHL); 2 s, 15 m, NW Nassau (CHL); 85 s and some j, from Abaco, 10-23 m (CCR). Florida, USA: 1 s, 36-90 m, off Dry Tortugas (CHL); 2 s, beach, 500 m W Flamingo Visitors Center, Monroe Co (CHL). Mexico: 3 s, Puerto Morelos, Yucatan, 8-18 m (MHNS). Guadeloupe: 1 s, north Olive Bay, 2 m, among rocks (CJP). Cuba: 5 s, Maria la Gorda, 20 m (MHNS); 3 s, Playa Girón, 2 m (MHNS); 4 s, Cayo Carenas, Cienfuegos Bay, 5 m. Turks & Caicos: 13 s, 18 m, French Cay (CHL). Puerto Rico: 1 s, beach, Holiday Inn, San Juan (CHL). St. Kitts and Nevis: 1 s, 14 m, The Garden, Nevis (CHL). Aruba: 1 s, 15 m, off Palm Beach (CHL). Grand Cayman Island: 1 s, beach grit, 100 m S. Rum Pt., Cayman Kai (CHL).

Description: Shell (Figs. 60A-D, 61A, 62A-C): See STIMPSON (1858). The best description is in MOORE (1972: 103): *"The smooth glassy shell is strongly depressed, flattened on top, and broadly umbilicate. The protoconch is slightly immersed in the teleoconch and consists of about 1 ¾ whorls. The teleoconch consists of slightly more than two whorls in a large specimen 4.02 mm in diameter. The first adult whorl has a thin callus of shell up to, or sometimes covering part of, the protoconch; the suture is carried out toward the periphery on the last half whorl. The suture thus follows a nearly crescent-shaped curve from the protoconch to the inner corner of the aperture. There is a thin*



Figures 60A-G. *Cochliolepis parasitica* Stimpson, 1858. A-B: lectotype, 3.4 mm (USNM 87142); C-D: shell of the same lot, 3.4 mm (USNM); E: detail of the operculum; F-G: protoconch of the both specimens. (SEMs by Yolanda Villacampa, USNM).

Figuras 60A-G. Cochliolepis parasitica *Stimpson, 1858. A-B: lectotipo, 3,4 mm (USNM 87142); C-D: concha del mismo lote, 3,4 mm (USNM); E: detalle del opérculo; F-G: protoconcha de ambos ejemplares. (fotografías al MEB de Yolanda Villacampa, USNM).*

callus on the parietal wall, and the columella is thickened where it joins the preceding whorl. The aperture is oblique, for the upper part the peristome is extended well beyond the remainder of the outer lip. The aperture is wider than high, with a ratio of about 4 to 3. The outer lip is thin, smooth, and with no thickening to indicate maturity. Most adult specimens have one or more strong growth lines, which give a nautiloid appearance to the shell. The umbilicus is widely open and penetrates to the protoconch. Height-to-breadth ratio for the teleoconch is about 1.0 to 3.5. A specimen 4.02 mm in diameter was 1.23 mm high. Maximun diameter is about 4.5 mm".

Curiously, until the work of REDFERN (2001) the protoconch of *Cochliolepis parasitica* had never been described, probably due to the destruction of the holotype and because putative type material now in USNM (labelled "syntype", possible paratypes), though juveniles, have the protoconch eroded or concealed in callus. In our opinion the description of the protoconch of *Cochliolepis parasitica* is very important, because it is necessary for the correct differentiation from otherwise quite similar species in the genus.

According REDFERN'S (2001) description: *"The protoconch of adult shells is usually abraded, showing only traces of the distinctive sculpture seen on a larval shell. The embryonic whorl is smooth and translucent, but the subsequent whorl is more opaque, with an irregular pattern of raised zigzag spiral threads. Each of these produces random off-shoots that project obliquely towards the adjacent thread, and this sculpture tends to become more regular towards the periphery".*

We were able to compare the protoconchs from the Bahamas with those from Bermuda and Turks & Caicos, and we conclude that, despite small differences among them, all fall within Redfern's description (Figures 60F-G, 61B-H, 62D-F).

Maximum reported size: 4.2 mm. Lectotype in USNM 3.4 mm. The other specimen in the lot is of a similar size.

Size of a specimen from Playa Giron, Cuba: shell 3.05 mm diameter; protoconch 570 μm in diameter.

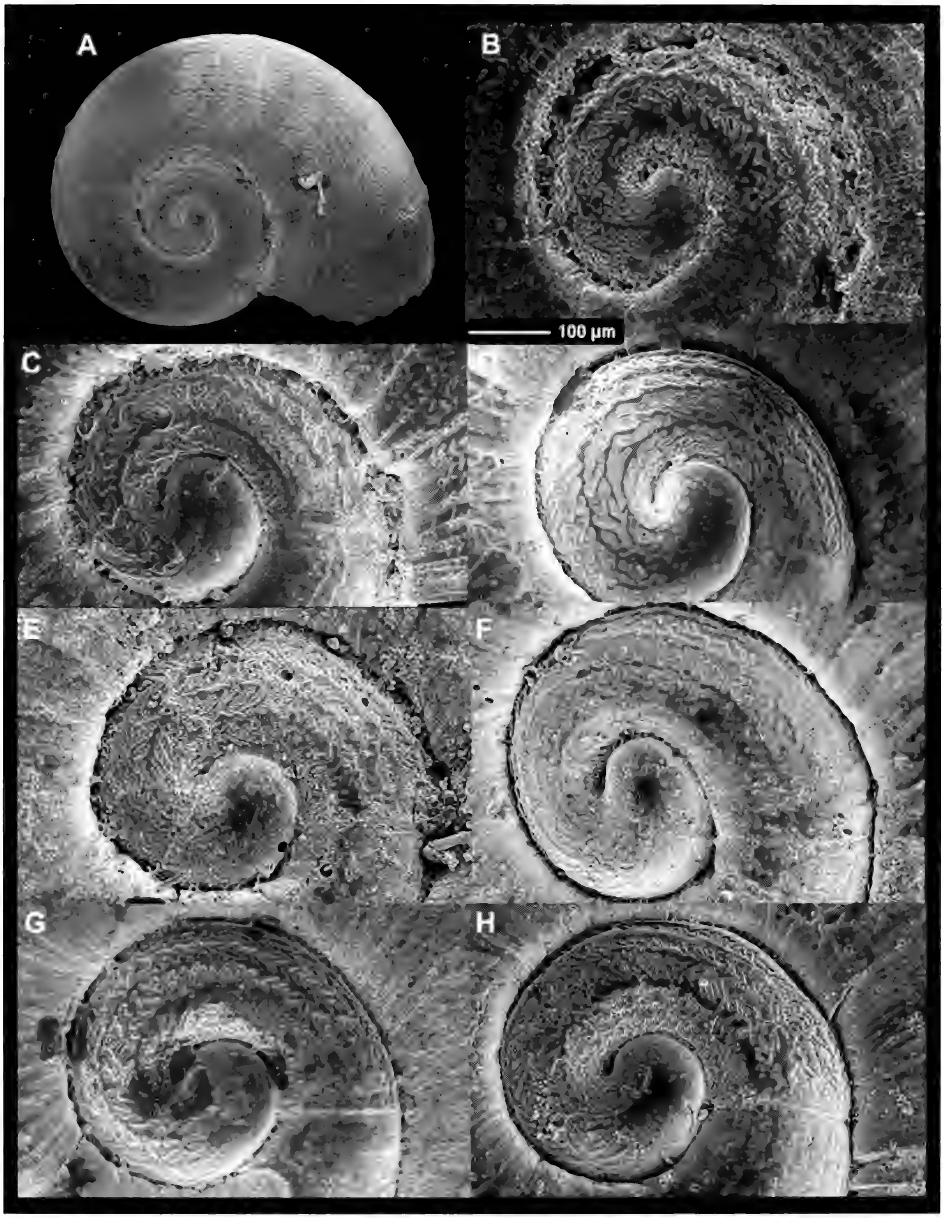
Size specimen from Puerto Morelos, Yucatan: shell 2.63 mm diameter; protoconch 463 μm in diameter.

The animal has a pair of cephalic tentacles, two more pallial tentacles, which project from the upper angle of the aperture, a medium-sized slipper-like foot, a multispiral operculum, a large and well developed ctenidium and an elongate, narrow and curved penis in the male (MOORE, 1972).

Habitat: Depth: 0 to 48 m (living at 0.3 to 0.6 m). MOORE (1972) concludes that *C. parasitica* is not a parasite of the annelid *Acoetes lupina* Stimpson, but a herbivore which lives as a dependent symbiont. Since the snails are often found on the worm itself, they possibly perform a cleaning function.

Distribution: *Cochliolepis parasitica* Stimpson was originally found in the harbor of Charleston, South Carolina, living under scales of the annelid *Acoetes lupina*. It was reported by HOLMES (1860) from the Post-Pliocene at Simmons Place, Wando River, South Carolina, but this was an erroneous identification; the species figured by him is not that of Stimpson, and it was renamed *Vitrinella holmesii* Dall.

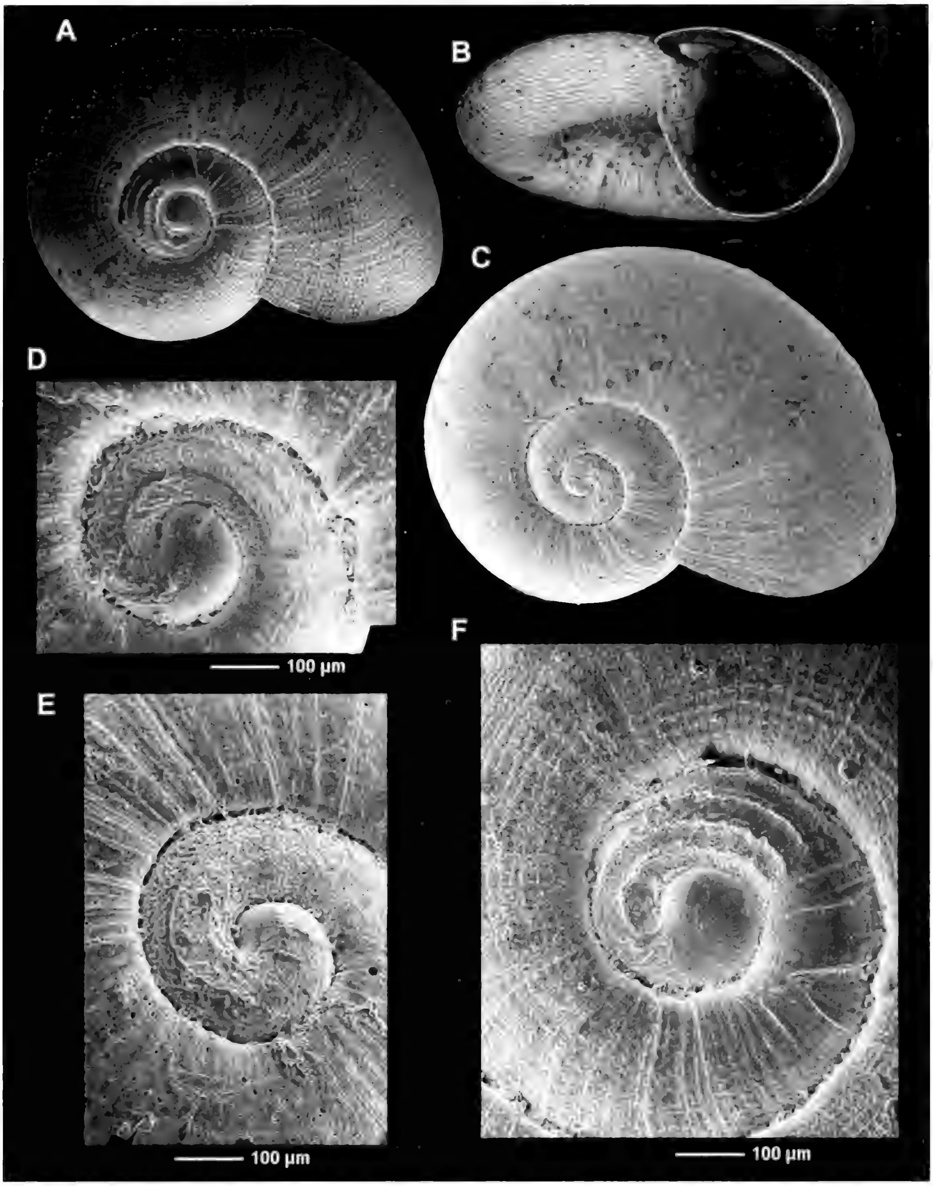
Its actual known range is: USA: North Carolina, South Carolina, Florida: West Florida, Florida Keys, Texas; Mexico: Campeche State, Yucatan State, Quintana Roo; Colombia; Bermuda; Puerto Rico. Recorded from Charleston Harbor, South Carolina (STIMPSON, 1858); from (DALL, 1892); from Cainhoy, Wando River, South Carolina (HOLMES, 1859); from Fort Johson, South Carolina (KURTZ, 1860); from Beaufort, North Carolina (HARTMAN, 1945); from Grand Cayman (ABBOTT, 1958) but MOORE (1972) considers that Abbott's record corresponds to another different species); from the west coasts of Florida and Aransas Bay, Texas (MOORE, 1964); from Aransas Bay, Texas to Beaufort,



Figures 61A-H. *Cochliolepis parasitica* Stimpson, 1858. A: juvenile shell, 1.36 mm, Bahamas; B: protoconch, Bahamas; C-H: protoconchs, Bermuda (CHL).

Figuras 61A-H. Cochliolepis parasitica *Stimpson, 1858. A: concha juvenil, 1,36 mm, Bahamas; B: protoconcha, Bahamas; C-H: protoconchas, Bermuda (CHL).*

North Carolina (MOORE, 1972); from North Carolina (PORTER, 1974); from Campeche State, Yucatan State and Quintana Roo, Mexico (ODÉ, 1988); from Colombia (DÍAZ MERLANO & PUYANA HEGEDUS (1990); from Florida (LYONS, 1998); from Abaco, Bahamas (REDFERN, 2002) and from St. Augustine (LEE, 2009); from Cuba in the present work.



Figures 62A-F. *Cochliolepis parasitica* Stimpson, 1858. A-B: juvenile shell, 1.6 mm, Guadeloupe (CJP); C: shell, 2.1 mm, Maria la Gorda, Cuba; D-F: protoconchs; D: from Turks & Caicos; E: Maria la Gorda; F: from Guadeloupe.

Figuras 62A-F. Cochliolepis parasitica *Stimpson, 1858. A-B: concha juvenil, 1,6 mm, Guadeloupe (CJP); C: concha, 2,1 mm, Maria la Gorda, Cuba; D-F: protoconchas; D: de Turks & Caicos; E: Maria la Gorda; F: de Guadeloupe.*

C. parasitica has been recorded as fossil (as *Adeorbis nautiliformis*; a disputed synonym) from the post-Pliocene of South Carolina at the Wando River (HOLMES, 1860); from the Plio-Pleistocene of the Caloosahatchie beds, Florida (DALL, 1892) and from the Plio-Pleistocene of St. Petersburg, Florida (PILSBRY, 1953).

Remarks: The type specimen of *C. parasitica* was lost in the Chicago fire of 1871, but two specimens given by Stimpson to Isaac Lea are now in the National Museum, nº 95079. The larger one, diameter 3.4 mm, is designated the lectotype.

Cochliolepis striata Dall, 1889 (Figures 63A-E)

Cochliolepis parasitica auct. non Stimpson, 1858.
Cochliolepis striata Dall, 1889. *Bull. Mus. Comp. Zool. Harvard*, 18: 360. [Type locality: Egmont Key, Tampa Bay, Florida].

Type material: In USNM. Not examined.
Other material examined: Mexico: 1 s, Puerto Morelos, Yucatan, 6-18 m (MHNS). Florida, USA: 4 s, Sanibel, Lighthouse Beach (CHL); 1 s, dredged 4.5-7 m, Seahorse Key, Cedar Keys, (CHL); 1 s, APAC Pit, Sarasota Pit, Plio-Pleistocene (CHL).

Description: Protoconch (Fig. 63D-E) white in color, smooth, composed of 2 whorls (frequently not fully exposed, partially or totally covered by the subsequent whorls), and for this reason its diameter cannot be accurately measured. The shell (Figs. 63A-C) is light honey in color, shows a uniform sculpture on its entire surface, including the base and the inner umbilical area; this is formed by numerous spiral cordlets with axial microstriae in the interspaces. There are also sinous growth lines. The spiral cords with microstriae are predominant on the dorsum of the shell, while on the base and in the umbilicus the growth lines are predominant.

Dimensions: Holotype 6.5 mm in maximum diameter and 2.0 mm in height.

Our largest shells measure 7.8 mm in diameter.

Animal and radula are unknown.

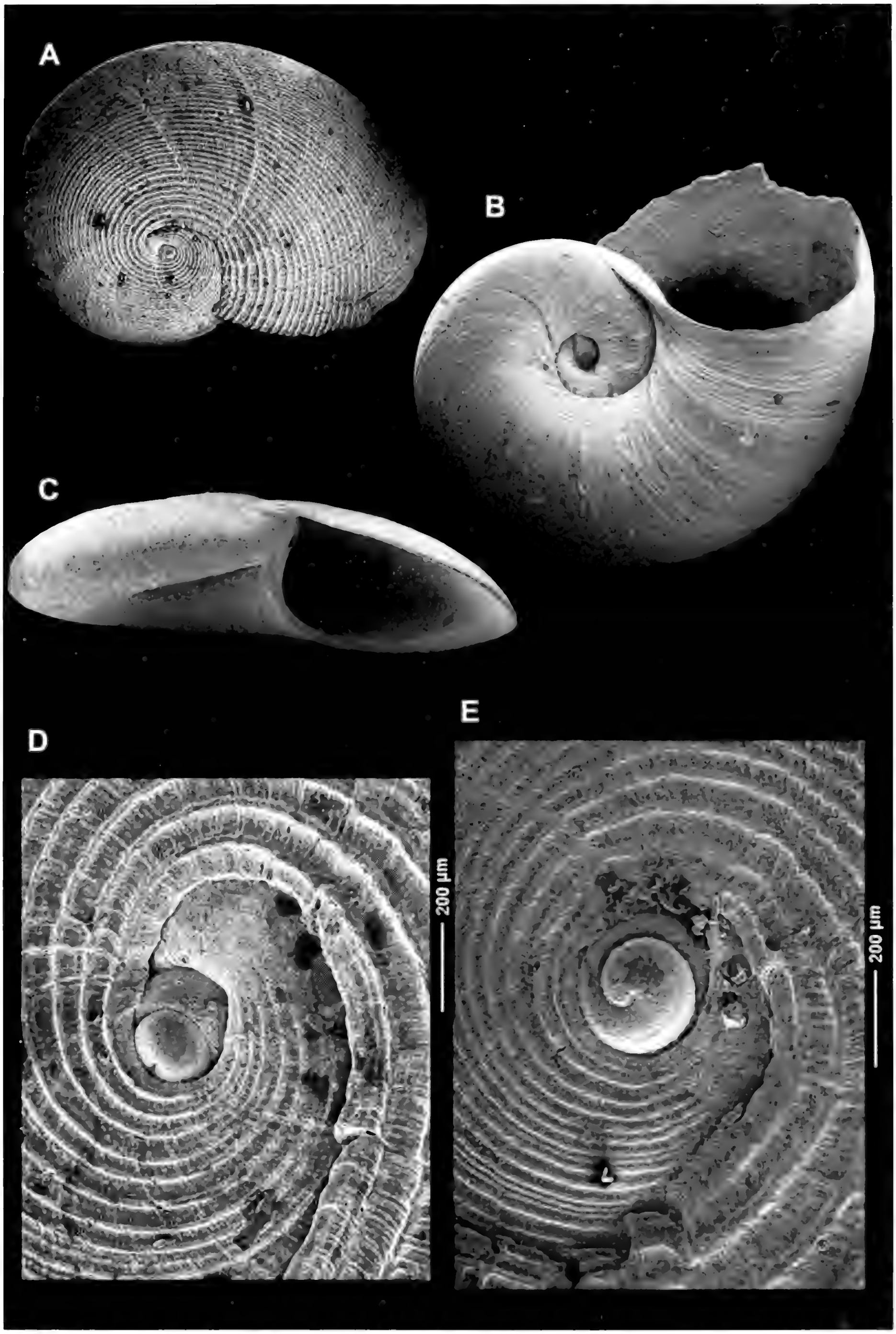
Distribution: This species has been recorded from Beaufort, North Carolina (Jacot, 1921); from Florida (Johnson, 1934); Virgin Islands (Nowell-Usticke, 1959); from North Carolina, Florida: East Florida, West Florida and Texas (Moore, 1964, Emerson & Jacobson (1976); from southeastern Panama (Radwin, 1969); from Texas (Andrews, 1977); from northwest Gulf of Mexico (Odé, 1969, 1988); from Abaco, Bahamas (Redfern, 2001); also, in the present work, from Mexico: Yucatan and Cuba: Cienfuegos.

Habitat: Moore (1964) indicated that the species seems to prefer coastal bays with shallow waters. It is distributed in the intertidal area between 0 and 27 m. Various authors who have found it reported a depth between 0 and 50 m, but these records were based only on empty shells. Nothing is known of the soft parts. Moore (1964: 41) considers *C. striata* an endemic species from the Gulf of Mexico, with strictly limited distribution. Our record indicates that the distribution is wider than expected.

Remarks: The spiral cords and the axial microstriae in the interspaces distinguish this species from all congeners. Contrary to Moore (1964: 174) the shell has the same sculpture on the base as on the rest of the shell.

Cochliolepis planispiralis spec. nov. (Figures 64A-E)

Type material: Holotype (Fig. 64A) in MNCN (15.05/55054); paratypes: MHNS (100550, 1 s, Fig. 64B), MNHN (24396, 1 s, Fig. 64C), IES (1 s), CFG (1 s), MCZ (1 s), USNM (1155034, 1 s), all from the type locality.
Type locality: 15-20 m, Puerto Morelos, Yucatan, Mexico.
Etymology: The specific name refers the planispiral development of the shell spire.



Figures 63A-E. *Cochliolepis striata* Dall, 1889. A-C: shells, 6.2, 7.8, 7.8 mm, Sanibel Light House Beach, Florida; D-E: protoconchs.
Figures 63A-E. *Cochliolepis striata* Dall, 1889. A-C: conchas, 6,2, 7,8, 7,8 mm, Sanibel Light House Beach, Florida; D-E: protoconchas.

Description: Shell (Figs. 64A-C) depressed, planispiral, the spire formed by about 2 ½ whorls. The protoconch (Fig. 64D-E) has one whorl or a little more, measuring about 480 µm in diameter. The embryonic whorl is smooth, but the subsequent whorl has an irregular pattern of raised zigzag spiral threads. Each of these produces random off-shoots that project obliquely towards the adjacent thread, and this sculpture tends to become more regular towards the periphery. Varix at the transition to the teleoconch not very thickened. Teleoconch with two whorls and rounded periphery. Ornamentation consists of fine spiral grooves, which are best seen in the first whorl of the spire and at the periphery, and marked growth lines, some of them very sharp, spread over the dorsum and base of the shell. The umbilicus is widely open, and on its apex the protoconch can be seen. Aperture ovoid, parietal area not callous, columella straight, reflected outward, with slight thickening of the umbilical wall; no progresive occlusion of the umbilicus is observed.

Dimensions: The holotype is 2.63 mm in maximum diameter; one paratype (MCZ) reachs 2.8 mm.

Habitat: The shells were collected in sandy bottom.

Distribution: Only known from the type locality.

Remarks: The dorsal and basal ornamentation are very constant. *Cochliolepis planispiralis* spec. nov. shows great similarities to *C. parasitica* in protoconch ornamentation and teleoconch spiral grooves, but it is different because the periphery is regularly rounded and not in a low position; also in the development of the spire, and shape of the periphery, dorsal border of the aperture and columella (see Fig. 64).

C. holmesii, *C. patricioi* and *C. differens* are different by the different sculpture of the protoconch.

C. striata and *C. adamsi* lack the spiral cordlets in the protoconch, having a stronger striation on the teleoconch.

Cochliolepis patricioi spec. nov. Rubio, Rolán & Lee (Figures 65A-G)

Type material: Holotype (1 s, Figs. 65A-B) in FLMNH (448608); paratypes: USNM (1155035, 1 s), ANSP (1 s), CHL (1 s) from St. Augustine, St. Johns (Figs. 65C-E) (all *ex* CHL).
Type locality: 60 m, off Sombrero Light, Key Vaca, Monroe Co. Florida, USA.
Etymology: The species is named for Patricio Calviño, good friend of the first author.

Description: Shell (Figs. 65A-E) depressed, almost planispiral, composed of 3 ½ whorls. The protoconch (Fig. 65F-G) has 1 whorl measuring about 340 µm in diameter, apparently smooth although very small granules can be seen all over, mainly on the areas close to the suture. Varix at the transition with the teleoconch not thickened. Teleoconch with two whorls; the first possessing 35-40 somewhat robust axial ribs. At the beginning of the second whorl the ribs begin to rapidly fade and soon change into simple, but marked, growth lines. This ornamentation, although most easily seen dorsally, can be observed on the periphery as well as on the base. Umbilicus wide and deep. Aperture ovoid, parietal area not callous, columella reflected outward, without thickening of the umbilical wall or progressive occlusion of the umbilicus.

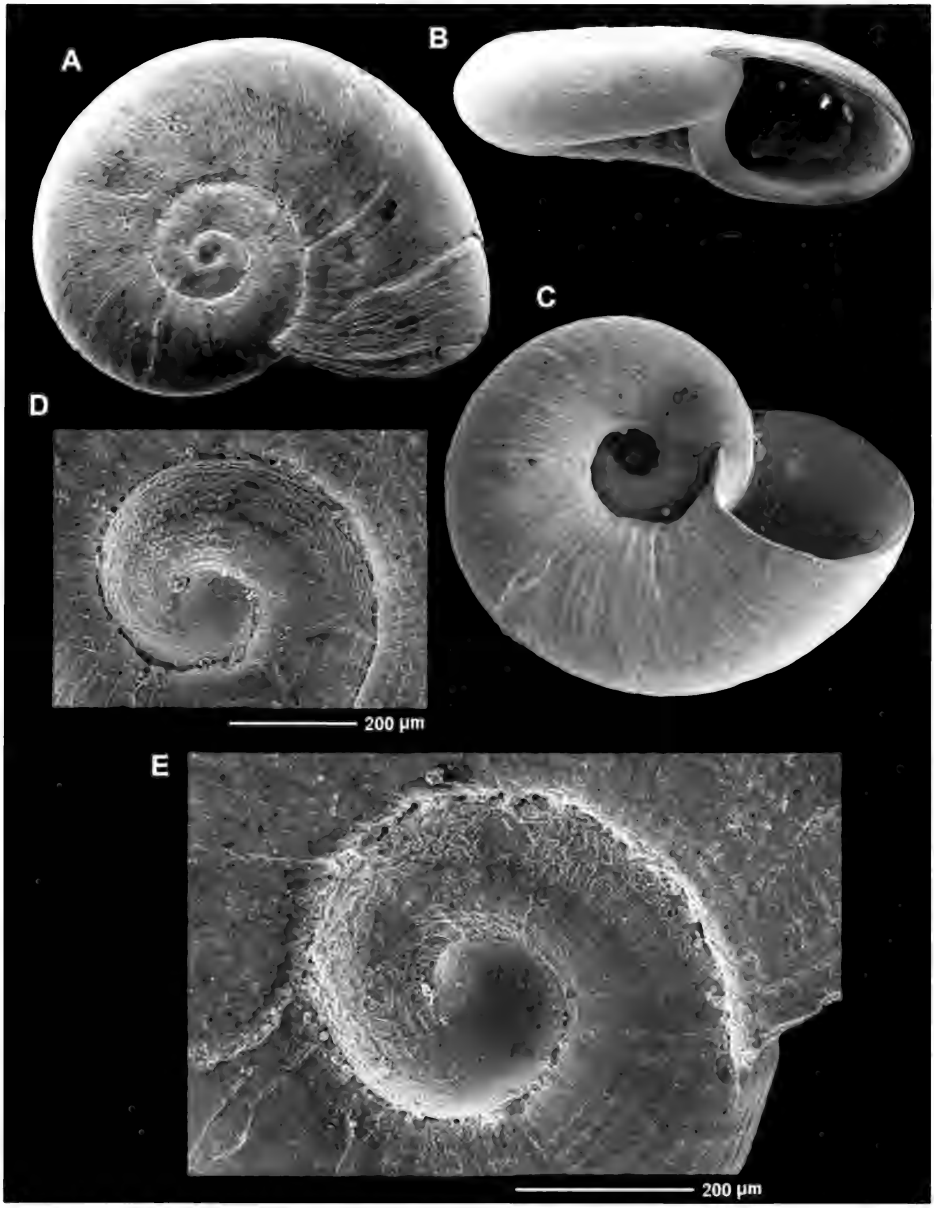
Dimensions: 2.0 mm in maximum diameter.

Habitat: Collected in sandy sediment at 60 m.

Distribution: Only known from the type locality and off St. Augustine, Florida.

Remarks: The dorsal ornamentation is very variable. Some shells lack the axial ribbing so evident on the first whorl of the teleoconch, showing only strong growth lines.

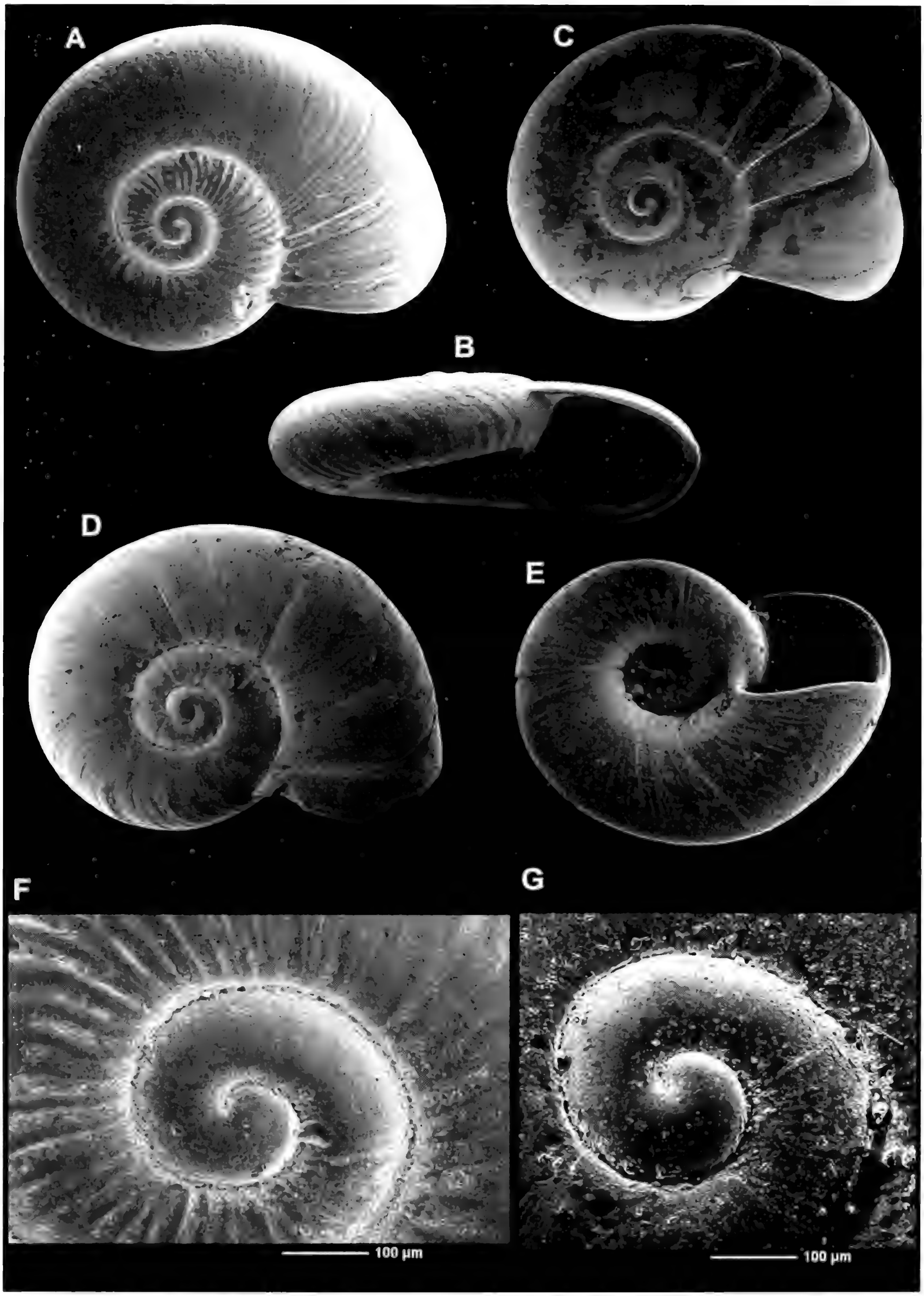
Cochliolepis patricioi spec. nov. can be distinguished from:



Figures 64A-E. *Cochliolepis planispiralis* spec. nov. A: holotype, 2.63 mm, Puerto Morelos, Yucatan (MNCN); B-C: paratypes, 2.4 mm (MNHN), 2.2 mm (MHNS); D-E: protoconchs.
Figuras 64A-E. Cochliolepis planispiralis *spec. nov. A: holotipo, 2,63 mm, Puerto Morelos, Yucatan (MNCN); B-C: paratipos, 2,4 mm (MNHN), 2,2 mm (MHNS); D-E: protoconchas.*

C. parasitica, which has consistent sculpture in the protoconch and lacks ribs on the first whorl of the teleoconch.

C. holmesii, which also lacks this ribbing and has the periphery lower and subangulate, rather than rounded and at mid-whorl.



Figures 65A-G. *Cochliolepis patricioi* spec. nov. Rubio, Rolán & Lee. A-B: holotype, 2.0 mm, Monroe Co. Florida (FLMNH); C-E: paratypes: 1.8, 1.9, 1.7 mm, St. Augustine, Florida (USNM, ANSP and CHL, respectively); F-G: protoconchs: F: from the holotype; G: from the paratype of fig. C.

Figuras 65A-G. Cochliolepis patricioi *spec. nov. Rubio, Rolán & Lee. A-B: holotipo, 2,0 mm, Monroe Co. Florida (FLMNH); C-E: paratipos: 1,8, 1,9, 1,7 mm, St. Augustine, Florida (USNM, ANSP y CHL, respectivamente); F-G: protoconchas: F: del holotipo; G: del paratipo de la fig. C.*

C. striata and *C. adamsi*, which also lack the ribs on the teleoconch and have conspicuous spiral striation.

C. differens spec. nov., which lacks the axial ribs on the first whorl of the teleoconch, has a more inflexed columella, and has a smaller umbilicus.

Cochliolepis differens spec. nov. Rubio, Rolán & Lee (Figures 66A-D)

Type material: Holotype (Figs. 66A-D) in FLMNH (448615) *ex* CHL.
Type locality: APAC Pit, Sarasota, Florida, USA Plio-Pleistocene.
Etymology: The specific name refers to the shell characters, which differ rather strikingly from those of its congeners.

Description: Shell (Figs. 66A-C) depressed, fine, smooth, composed of 3 ¾ whorls. The protoconch (Fig. 66D) has 1 ½ bulbous whorls, about 430 μm in diameter, slightly raised above the other whorls. Two stages can be discerned: on the first the surface is covered by microgranules; the second exhibits fine growth striae. Teleoconch formed by 2 ¼ convex and rapidly-expanding whorls and is totally smooth except for fine growth lines. Suture wide and strongly marked on all the shell except on the last quarter of the body whorl. Periphery nearly symmetrically rounded. Aperture strongly prosocline, angled at the suture. Columella arched, a little reflected towards the umbilicus; external lip sharp, angled at the periphery and a little sinuous basally. Parietal callus barely appreciable. Umbilicus wide and deep, with a straight and striated wall.

Dimensions: Holotype is 4.3 mm in maximum diameter and 1.76 mm in height.

Habitat: Unknown.

Distribution: Only known from the type material.

Remarks: *Cochiolepis differens* can be distinguised from *C. parasitica,* because the latter has sculpture on the protoconch and its apex is flat.

C. holmesii has a different protoconch sculpture and a sculptured teleoconch.

Cochiolepis striata and *C. adamsi* have conspicuous spiral sculpture on the teleoconch.

C. patricioi has axial ribs on the first whorl of the teleoconch, possesses a less inflexed columella, and has a larger, more open umbilicus.

Cochliolepis sp. (Figures 67A-C)

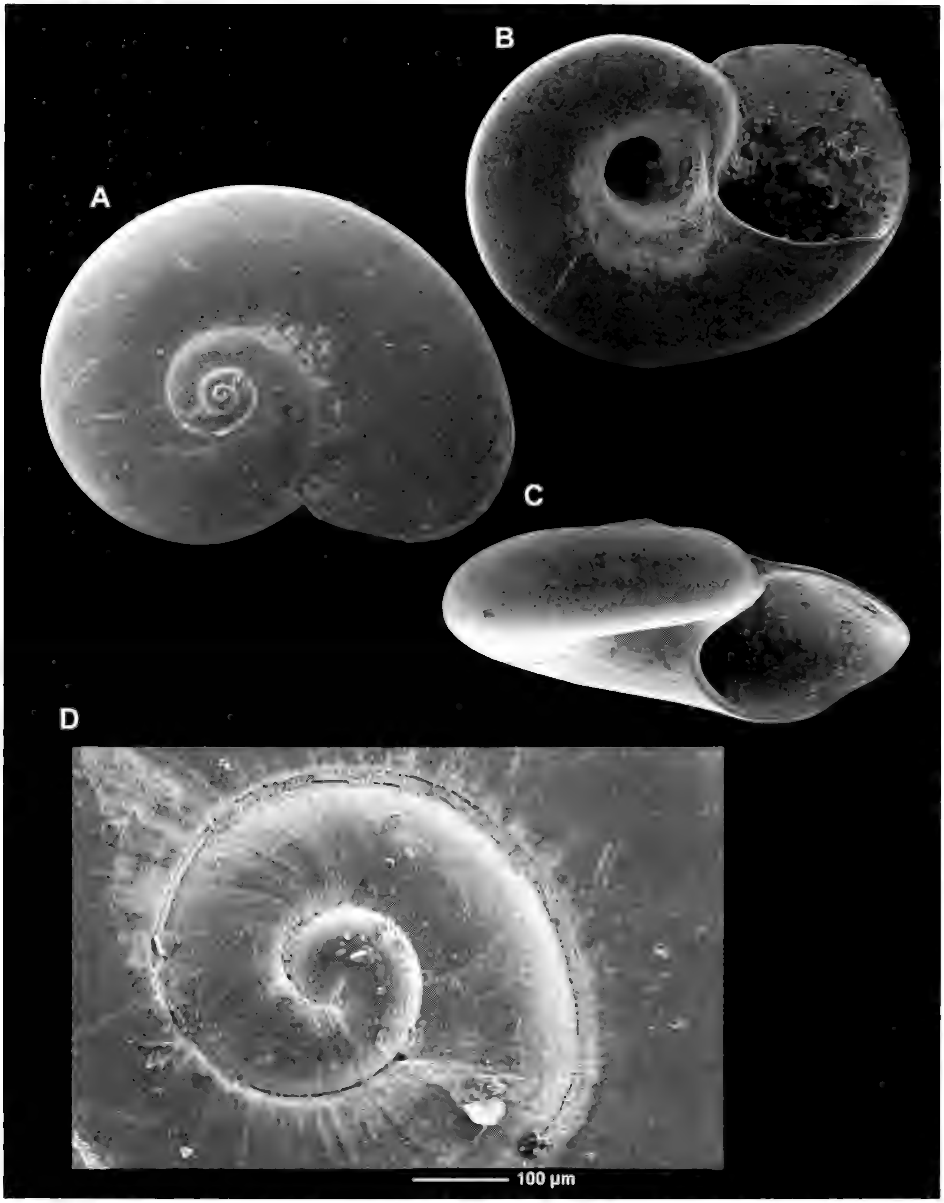
Material examined: Cuba: 2 s, Rancho Luna Beach, Cienfuegos, 20 m (MHNS).

Description: Protoconch (Fig. 67C) white in color, smooth, formed by 1 ¼ whorls of spire and about 360 μm of diameter; apparently it has two well-differentiated stages, the first is bulbous, projected from the rest of the shell and terminates in a varix; the second stage, of one whorl only has fine growth lines. A varix marks the beginning of the teleoconch and the onset of the spiral sculpture. The shell (Figs. 67A-B) is light honey in color, and shows a uniform sculpture on the entire surface, including the base and the inner umbilical area; this is formed by numerous spiral cordlets with axial microstriae in the spaces between cords. Sinuous growth lines are also present.

Dimensions: Our shells measure 2.9 and 3.0 mm in diameter and 1.63 mm in height.

Animal and radula are unknown.

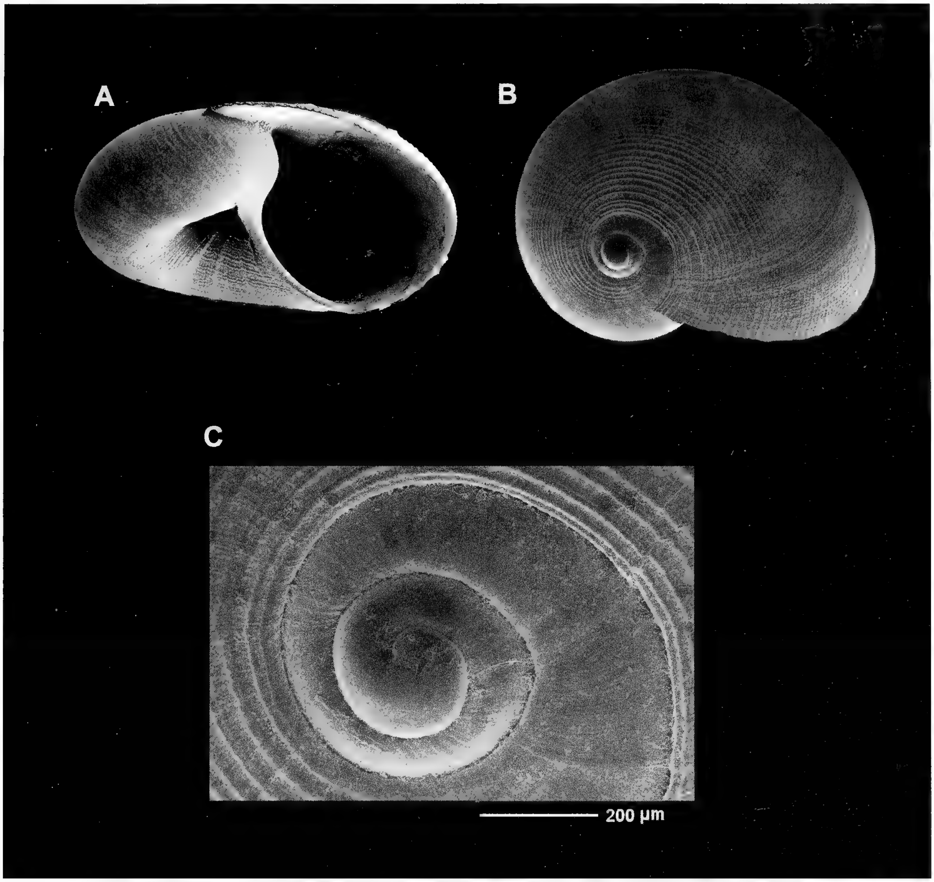
Remarks: *Cochliolepis sp.* is rather similar in its general appearance to *C. adamsii*, but the protoconch is pro-



Figures 66A-D. *Cochliolepis differens* spec. nov. Rubio, Rolán & Lee. A-C: holotype, 4.3 mm, Plio-Pleistocene of Sarasota, Florida (FLMNH); D: protoconch.

Figuras 66A-D. Cochliolepis differens *spec. nov. Rubio, Rolán & Lee. A-C: holotipo, 4,3 mm, Plio-Pleistoceno de Sarasota, Florida (FLMNH); D: protoconcha.*

jected upward, shows two different stages of development, and is not partially covered by the first whorl of the teleoconch. Since this is the main distinguishing character and we have such scanty material we defer naming this taxon until we have more material for study.



Figures 67A-C. *Cochliolepis* sp. A-B: shells, 2.9, 3.0 mm, Rancho Luna Beach, Cuba; C: protoconch.
Figuras 67A-C. Cochliolepis *sp. A-B: conchas, 2,9, 3,0 mm, Playa Rancho Luna, Cuba; C: protoconcha.*

Genus *Episcynia* Mörch, 1875

Episcynia Mörch, 1875 (described as subgenus of *Architectonica*). *Malak, Blätter*, 22: 155.
Type species: (by monotypy) *Solarium inornatum* d'Orbigny, 1842.

Diagnosis: Shell trochiform, whorls rather convex, and with a minutely serrate peripheral keel, base flattened, umbilicus narrow and deep, flat sided and strongly angled with the base of the shell. Periostracum thin, produced into spiral fringes of filaments above and below the periphery.

Remarks: MOORE (1964) placed *Episcynia multicarinata* in synonymy with *Episcynia inornata* comparing the types of Dall and d'Orbigny and reporting that there were no morphological differences between them. Species of *Episcynia* are known from the Miocene to Recent. Two valid species have been described from the West Atlantic: *Episcynia inornata* (a recent species) and *Episcynia naso* (a fossil species from the Miocene of the Dominican Republic).

Episcynia inornata (d'Orbigny, 1842) (Figures 68A-F, 69A-C)

Trochus (Solarium) inornatum d'Orbigny, 1842. *Moll. Hist. Phys. Pol. et Nat. L'île de Cuba*, 2: 67-68, pl. 19, figs. 25-27. [Type locality: Saint Thomas, Virgin Islands].

Vitrinella multicarinata Dall, 1889. *Bull. Mus. Comp. Zoology*, 18: 392-393. [Type locality: Off Cape Hatteras, North Carolina, 15 fms].

Type material: Lectotype (here designated) in NHMUK (Fig. 69C) and paralectotypes (Figs. 69A-B).

Other material examined: Florida, USA: 1 s, beach, 16 Ave. S, Jacksonville Beach, Duval Co. (CHL); 1 s, 39-45 m, 40-60 mi E Ponte Vedra, St Johns Co. (CHL); 1 s, 30 m, 20 mi E St. Augustine, St Johns Co. (CHL); 1 s, 53 m, 65 mi E St. Augustine, St Johns Co. (CHL); 1 s, 4.5-6 m, E Seahorse Key, Cedar Keys, Levy Co. (CHL). Cuba: 6 s, Cienfuegos Bay, 20 m (MHNS); 32 s, Rancho Luna Beach, 10-54 m (CFG). Martinique: 1 s, Fort de France, NW of Grande Seche, 18 m (MCZ 361885); 1 s, Fort de France, St. Louis, 3-4 miles S. of Fort, 14-16 fms (MCZ 243767). Surinam: 1 s, 70 miles NNE Paramaribo, 6°52'N, 54°46'W, 51 m (MCZ 274032). Brazil: 1 s, Praia Itararé, São Vicente, São Paulo (CHL); 1 s, Itaparica, 4-5 m (MHNS); 2 s, Salvador (MHNS).

Description: The most complete description is in MOORE (1964: 105-109).

Shell (Figs. 68A-D) with 5 whorls. The protoconch (Figs. 68E-F) has barely one whorl with a slightly rough surface, about 190 μm in maximum diameter.

Dimensions: the figured shell is 3.3 mm in diameter and 1.73 mm in height.

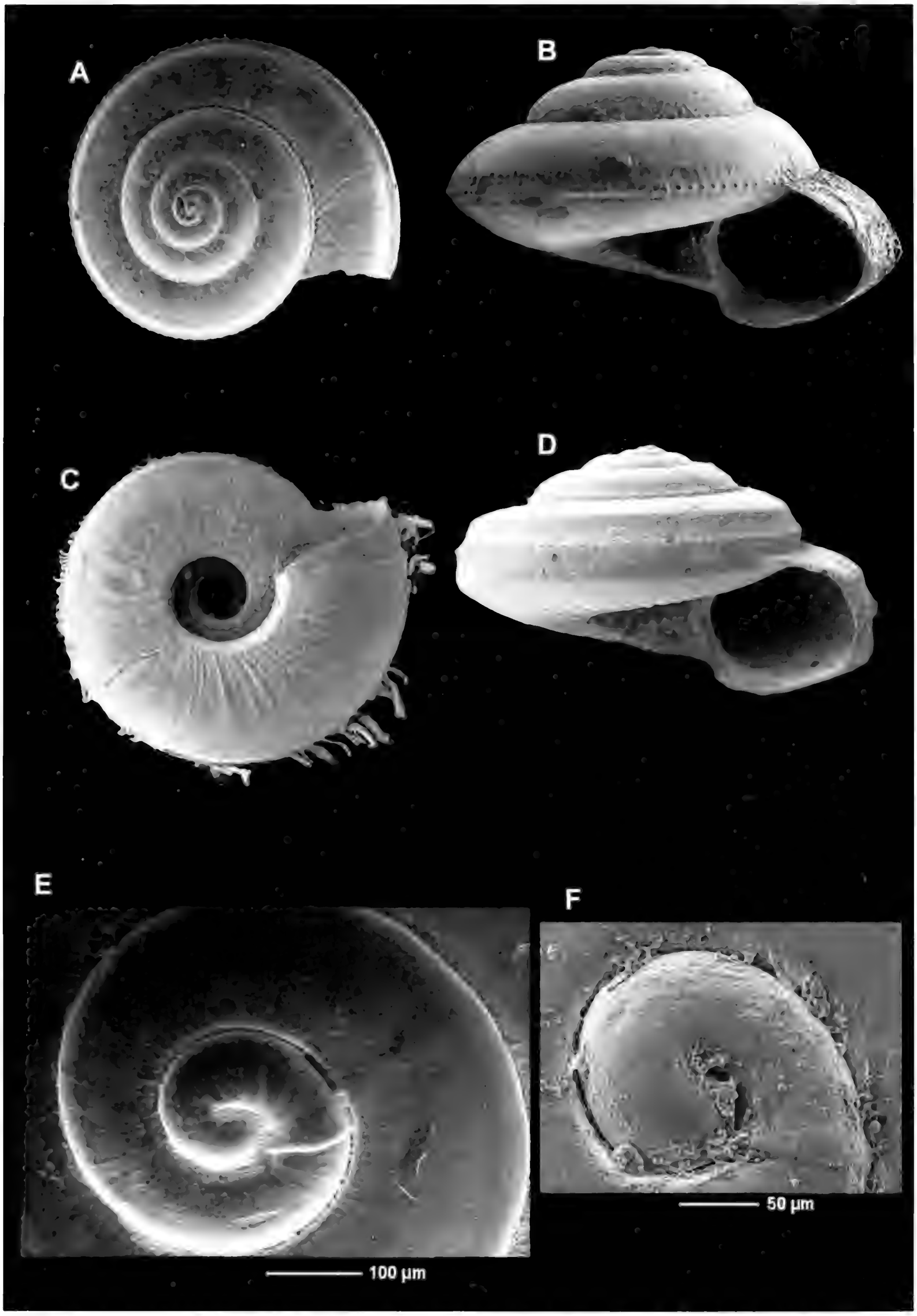
Animal and radula unknown.

Habitat: Species with a large bathymetric distribution, recorded between 15 and 110 m in depth. According to MOORE (1964) the species has a wide range of distribution, but it is uncommon; it seems that the species prefers shallow water and the deepest record for living material is 15 fathoms, cited by DALL (1889a).

Distribution: It has been recorded from St. Thomas, Virgin Islands (D'ORBIGNY, 1842); from off Cape Hatteras, North Carolina (DALL, 1889); from Lake Worth, Palm Beach, Cape Florida, Miami and Destin, Florida (PILSBRY & MCGINTY, 1946); from Pernanbuco and Alagoas, Brazil (LANGE DE MORRETES, 1949); from Bocas Island, Panama (OLSSON & MCGINTY, 1958); from North Carolina, South Florida, west coast of Florida, Texas, Panama, Puerto Rico and the Virgin Islands (MOORE, 1964); Puerto Rico (WARMKE & ABBOTT, 1961); from northwestern Campeche Bank, Mexico (RICE & KORNICKER, 1965); from North Carolina to Florida, Texas and the Greater Antilles (ABBOTT, 1974); from Texas shores (ANDREWS, 1977); from Venezuela (PRINCZ, 1982); Cuba (ESPINOSA *ET AL*., 1985); from Pernambuco, Brazil (MELLO & PERRIER, 1986); from northwest Gulf of Mexico (ODÉ, 1988); from Aruba island (DE JONG & COOMANS, 1988); from shallow waters off Hutchinson Island, Florida to Texas and the Caribbean Sea (LYONS, 1989); from northeast Florida (LEE, 2009).

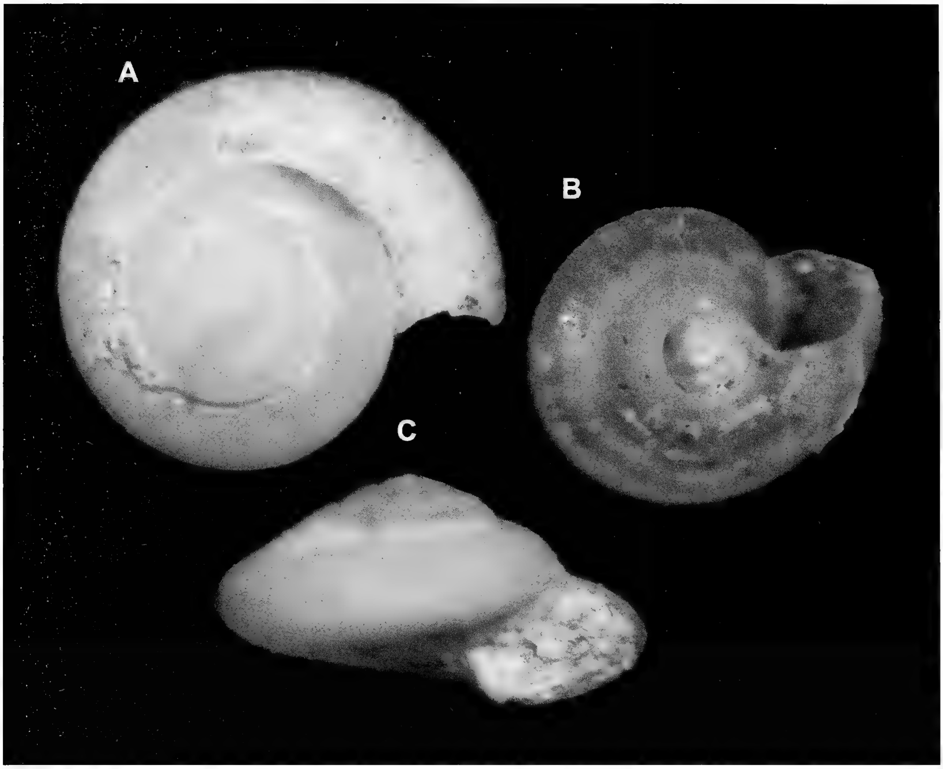
Remarks: Over the years, this species has been included in the genera *Adeorbis, Architectónica, Torinia, Trochus* and *Vitrinella* before its definitive placement in *Episcynia*. The fine periostracum, the finely serrated peripheral keel and the straight-sided umbilicus are the main distinguishing characters of this species.

DALL (1889a) described *Vitrinella (Episcynia?) multicarinata* from Cape Hatteras, North Carolina, but he did not make a comparison of his species with that of d'Orbigny, and most malacologists assumed that the two were different. MOORE (1964) considered them synonymous, indicating that he had the opportunity to review d'Orbigny's four syntypes in the British Museum. The types were in a vial labelled by d'Orbigny as *Rotella carinata*, but they fit the description of *Solarium inornatum*. The specimens were compared to the American specimens, and no distinguishing characters could be found. Of the four syntypes, the smallest one (Fig. 69C) is in good condition and is hereby designated the lectotype. So, *Episcynia multicarinata* may be considered simply as a form with extra angulations on the periphery of the whorls (Fig. 68D).



Figures 68A-F. *Episcynia inornata* (d'Orbigny, 1842). A-C: shells, 3.2, 2.7, 3.3 mm, Rancho Luna Beach, Cienfuegos, Cuba (MHNS); D: shell, form "multicarinata," 3.6 mm, Praia Itararé, São Vicente, São Paulo (CHL); E-F: protoconchs, from Cuba and Florida.

Figuras 68A-F. Episcynia inornata *(d'Orbigny, 1842). A-C: conchas, 3,2, 2,7, 3,3 mm, Playa Rancho Luna, Cienfuegos, Cuba (MHNS); D: concha, forma "multicarinata," 3,6 mm, Praia Itararé, São Vicente, São Paulo (CHL); E-F: protoconchas, de Cuba y Florida.*



Figures 69A-C. *Episcynia inornata* (d'Orbigny, 1842). A-C: shells labeled as *Rotella carinata* in NHMUK: A-B: paralectotypes; C: lectotype.
Figuras 69A-C. Episcynia inornata *(d'Orbigny, 1842). A-C: conchas etiquetadas como* Rotella carinata *en NHMUK: A-B: paralectotipos; C: lectotipo.*

Genus *Parviturboides* Pilsbry & McGinty, 1950

Parviturboides Pilsbry & McGinty, 1950. *The Nautilus*, 63(3): 86.
Type species: (by original designation) *Vitrinella interrupta* C.B. Adams, 1850 = *Cyclostrema sanibelense* Pilsbry, 1939. Caribe, Recent.

Diagnosis: In MOORE (1964: 155) *"The shell is small, trochiform, sculpture of spiral cords and axial threads, umbilicus narrow and bordered by a spiral cord. Aperture subcircular but angular above, columellar margin thickened. The animal has two ciliated tentacles, black eyes, two pallial tentacles, a pair of opercular lobes amd the posterior end of the foot may be bilobed. The penis is long, straight, and glandular. The operculum is thin, multispiral and circular"*.

Remarks: The shell is very similar to some of the genus *Parviturbo* Pilsbry & McGinty, 1945, from which it can be distinguished by its protoconch, which is less than 2 whorls, and by the abrupt beginning of the sculpture on the teleoconch. PILSBRY (1950: 87), in describing the genus *Parviturboides*, stated that it should be compared with the genus *Pseudorbis* Monterosato, 1884 for the similarity in shell characters. MOORE (1964: 156) stated *"but this has not yet been done"*. This comparison is no longer necessary because the genus *Pseudorbis* was placed in Skeneidae by RUBIO & RODRÍGUEZ BABÍO (1991), who noted that its radula is rhipidoglossate, and its anatomical characters are similar to those of the genera *Skenea* and *Dikoleps*.

Parviturboides interruptus (C.B. Adams, 1850) (Figures 70A-I, 71A-E)

Vitrinella interrupta C.B. ADAMS, 1850. *Monograph of Vitrinella, a new genus of new species of Turbinidae*: 6. [Type locality: Port Royal, Jamaica].

Cyclostrema zacalles Mazÿck, 1913: 18.

Cyclostrema sanibelense Pilsbry, 1939. *The Nautilus*, 53: 53, pl. 8, fig. 3. [Type locality: Sanibel Island, Florida].

Parviturbo zacalles (Mazÿck, 1913): In PILSBRY & MCGINTY, 1945b. *The Nautilus*, 59: 57, pl. 6, figs. 2, 2a, 5.

"Cyclostrema" interruptum sanibelensis Pilsbry & McGinty, 1945b. *The Nautilus*, 59: 58, pl. 6, fig. 9.

Cyclostrema interruptum C.B. Adams *in* Pilsbry, 1946. *Notulae Naturae*, 162: 5, pl. 1, fig. 4-5.

Type material: CLENCH & TURNER (1950: 294, plate 35) mention two specimens in the lot of C.B. Adams Collection (MCZ 156270), and they represent two different shells in their plate, but they caption the two figures "holotype" despite the fact that there are two different shells depicted. In the actual lot examined by us only one shell is present and we consider it the lectotype.

Other material examined: Cuba: 159 sp, Cañón de la Bahía de Cienfuegos, between 0-10 m (CFG); 14 sp, Rancho Luna Beach, 10-20 m (MHNS); 28 sp, Rancho Luna Beach, 45 m (MHNS). Guadeloupe: 2 s, north coast, 2 m, between rocks (CJP); 3 s, Point-a-Pitre, 5 m (CHL). Florida, USA: 2 s, 21 m, 14 mi ENE Mayport, Duval Co. (CHL); 2 s, 3-4 ft, Pelican Shoals, Key West, Monroe Co. (CHL); 5 sp, Sebastian Inlet, Brevard County, North Jetty, under bridge (CHL); 3 s, SE Clearwater Island bridge Little Pass, Pinellas Co. (CHL); 1 s, 10th Avenue, Atlantic Beach, Duval Co. (CHL); 1 f, 2-3 m, Seahorse Key, Cedar Keys, Levy Co. (CHL). Puerto Rico: 7 s, beach, Holiday Inn, San Juan, (CHL). Virgin Islands: 7 s, beach, Magens Bay, N coast St. Thomas (CHL). Nicaragua: 3 s, The Witties, 20 m (MHNS). Panama: 1 s, beach, Portobello (CHL); 5 s, Careneros Island 9°20.394'N, 32°13.932'W, 8-9 m (CHL); 1 s, 1 mi Punta San Blas, San Blas Island, intertidal (CHL); 1 j, 09°22.027'N, 82°14.336'W (CEG). Venezuela: 12 s, near Jose Griego, N Margarita Island (CHL). Haiti: 6 s, Labaree, sand beach (CHL). Brazil: 1 s, Praia de Itararé, São Vicente, São Paulo (CHL).

Description: The best conchological and anatomical description is in MOORE (1964: 156-161).

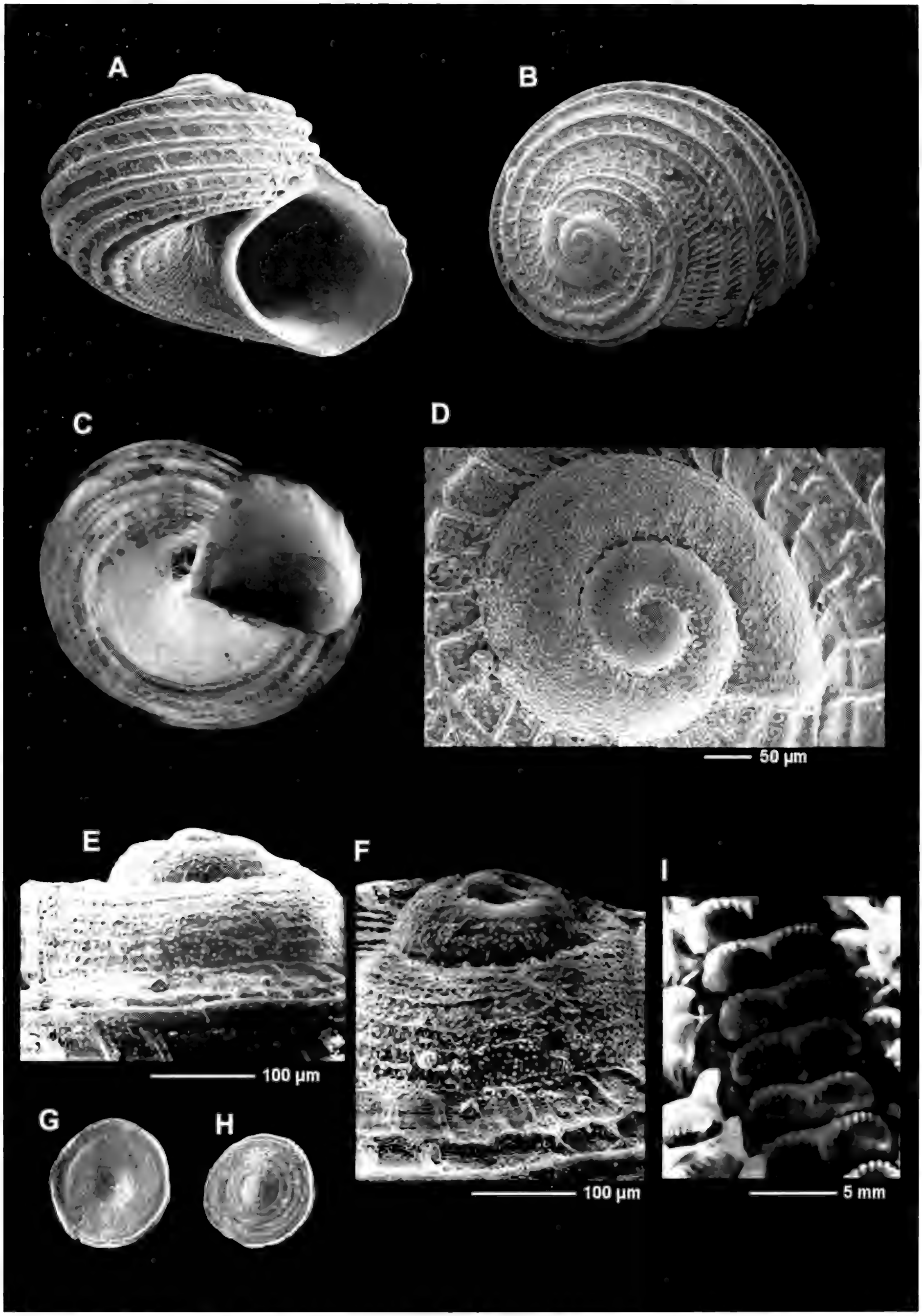
Shell (Figs. 70A-C, 71A-C) a little depressed, globose, trochiform, spiral sculpture formed by strong cords and fine axial striae; umbilicus very narrow. Protoconch (Figs. 70D-F) large, with a diameter of about 400 μm, its surface roughened by numerous tubercles and some spiral lines. Two different stages can be distinguished. Teleoconch with spiral strong cords and fine axial ribs in the interspaces; on the last whorl 8-9 spiral cords can be seen. Base rounded, aperture oblique, almost circular, but a little angled at the fusion point of the external lip with the columella.

Dimensions: Holotype 1.59 mm in diameter. Our largest shells measure about 2.5 mm in maximum dimension.

Operculum (Figs. 70G-H) chitinous, multispiral with a central nucleus.

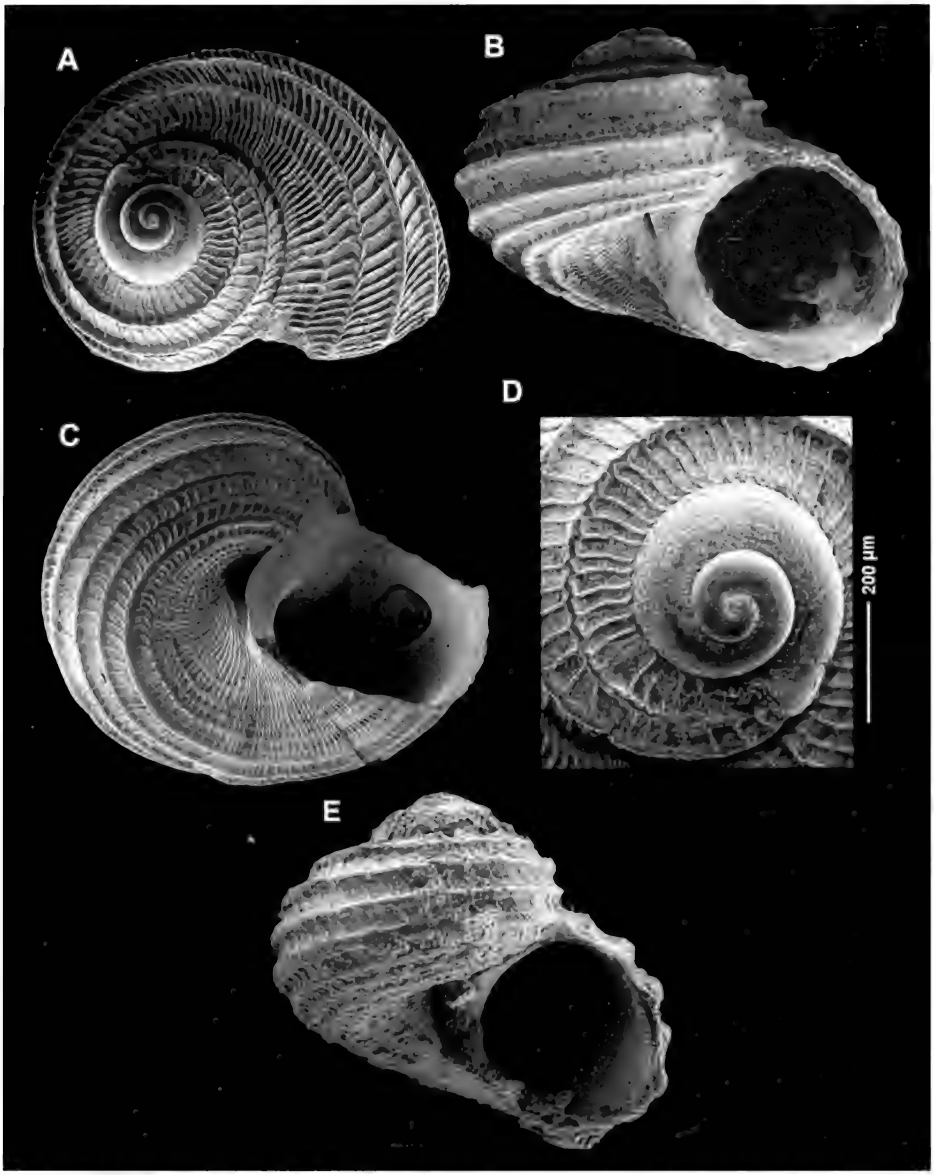
Radula (Fig. 70I) taenioglossate, the formula 2+1+R+1+2. Central tooth wide basally, with three denticles on the ventral margin. Cutting area formed by a large and sharp cusp and 6-7 small denticles of small size at each side. Lateral teeth similar to the central one, cutting area with a central cusp and 4-5 smaller denticles at each side. Marginal teeth elongated, with 22-25 denticles on the free margin.

Habitat: This species lives between 0 and 48 m deep; deeper records are based on empty shells. In Cienfuegos



Figures 70A-I. *Parviturboides interruptus* (C.B. Adams, 1850). A-C: shells, 1.4, 1.4, 1.3 mm, Rancho Luna Beach, Cienfuegos, Cuba (CFG); D-F: protoconchs; G-H: operculum, 0.65 and 0.5 mm, from shells of 1.5 and 1.4 mm; I: radula.

Figuras 70A-I. Parviturboides interruptus *(C.B. Adams, 1850). A-C: conchas, 1,4, 1,4, 1,3 mm, Playa Rancho Luna, Cienfuegos, Cuba (CFG); D-F: protoconchas; G-H: opérculos, 0,65 y 0,5 mm, procedentes de conchas de 1,5 y 1,4 mm; I: rádula.*



Figures 71A-E. *Parviturboides interruptus* (C.B. Adams, 1850). A-C: shells, 1.25, 1.1, 1.3 mm, The Witties, Nicaragua (MHNS); D: protoconch; E: shell, Guadeloupe (CJP).
Figuras 71A-E. Parviturboides interruptus *(C.B. Adams, 1850). A-C: conchas, 1,25, 1,1, 1,3 mm, The Witties, Nicaragua (MHNS); D: protoconcha; E: concha, Guadeloupe (CJP).*

Bay, Cuba it is relatively common between 0 and 10 m deep. It has been recorded on sponges from 7 to 90 m deep (ABBOTT, 1974). Under rocks and in crevices in shallow water (ANDREWS, 1977). On rocky coasts it has been found among sabellariid polychetes (WILEY *ET AL.* 1982). Also found on sandy and muddy bottoms (VOKES & VOKES, 1984). On reefs far from the coast this species has been seen associated with colonies of *Oculina varicosa*, algae, sponges, octocorals and dead coral, between 6 and 80 m deep (REED & MIKKELSEN, 1987). Also on algae and sand bottom (MIKKELSEN *ET AL.* 1995). It has been collected directly on sponge and algae in 1-2 feet and from colonies of *Vermicularia knorri* taken at 30 m (LEE, 2009). In Cuba it has been collected in the bases of *Gorgonia flabellum* and *G. ventalina*.

Distribution: It is a common and widely distributed species in the West Indies. It has been recorded from Port Royal, Jamaica (C.B. ADAMS, 1850). From Sanibel Island, Florida (PILSBRY, 1939). From Colón and Bocas Island, Panama (OLSSON & MCGINTY, 1958). From South Carolina, Florida, Texas, Mexico, Panama, Jamaica, Haiti and Puerto Rico (MOORE, 1964; ANDREWS, 1977). From South Carolina to Gulf of Mexico and Caribbean Sea (HOUBRICK, 1968). From Portete, Costa Rica (HOUBRICK, 1968; ROBINSON & MONTOYA, 1987). From North Carolina (PORTER, 1974). From punta del Morro to Punta Delgada, Veracruz, Mexico (WILEY *ET AL.* 1982). From Campeche to Ciudad del Carmen and Zacatal; from El Cuyo to punta Ninum; from Punta Yalkupul to isla Cerritos; from Isla Mujeres to Isla Holbox; from Cancún to the Belize border (VOKES & VOKES, 1984). From North Carolina to Florida; Texas, the Antilles, Brazil, Uruguay (RIOS, 1985). From Cuba (ESPINOSA *ET AL.*, 1985). From Florida (REED & MIKKELSEN, 1987). Aruba; Puerto Rico (DE JONG & COOMANS, 1988). From Florida to Texas and north coast of South America, Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). From Indian River Lagoon, Florida (MIKKELSEN *ET AL.* 1995); from Abaco, Bahamas (REDFERN, 2001). From Cahuita to Gandoca, Cuba (ESPINOSA & ORTEA, 2001). From St. Augustine Inlet, northeast Florida (LEE, 2009). Venezuela, Haití, Panama, Nicaragua, and Brazil from our material.

Remarks: *Parviturboides interruptus* is like no other vitrinellid from the West Atlantic. On the other hand, it can be confused with some species of the genus *Parviturbo* Pilsbry & McGinty, 1945, distinguished from them by its protoconch of no more than 2 whorls, its sculpture commencing abruptly at the end of the protoconch. Another genus with conchologically similar species, *Pseudorbis* Monterosato, 1884, has been placed in Skeneidae, based on the rhipidoglossate radula of *Pseudorbis granulum* (Brugnone, 1873), that has been recently observed (RUBIO & RODRÍGUEZ BABÍO, 1991).

Some populations (shown in Figures 71A-C) present more numerous riblets in the axial sculpture (about 45 on the first whorl versus 23) than the shells of other populations (Fig. 70A-E).

Genus *Pleuromalaxis* Pilsbry & McGinty, 1945

Pleuromalaxis Pislbry y McGinty, 1945a. *The Nautilus*, 59: 1-13.

Type species: (by monotypy) *Pseudomalaxis (Pleuromalaxis) balesi* Pilsbry & McGinty, 1945. Caribe, Recent.

Diagnosis: Shell strongly depressed, with two spiral keels on the periphery. Space between the keels concave, axial riblets present on both top and bottom of the whorl. Umbilicus wide, shallow to moderately deep.

Remarks: The taxon *Pleuromalaxis* was created as a section of *Pseudomalaxis*, as Pilsbry & McGinty believed that their species was congeneric with *Pseudomalaxis nobilis* A.E. Verrill. Later OLSSON & MCGINTY (1958) considered it a full genus and placed it in the Vitrinellidae, removing it from the Architectonicidae.

Pleuromalaxis balesi (Pilsbry & McGinty, 1945) (Figures 72A-D)

Pseudomalaxis (Pseudomalaxis) balesi Pilsbry & McGinty, 1945a. *The Nautilus*, 59: 10, pl. 2, fig. 8. [Type locality: Missouri Key, Florida Keys].

Type material: Holotype in ANSP (181124). Represented in MOORE (1964). Not examined.
Other material examined: Cuba: 2 s, Cayo Avalos, 8 m (MHNS); 1 s, Cayo Perez Diego, 5 m (MHNS); 1 s, Jibacoa, 3-6 m (MHNS); 1 s, Baracoa, 0 m (MHNS); 4 s, Guajimico, 0 m (MHNS); 3 s, Cienfuegos Bay, sta. 12, 22°07'N 80°27'W, 9 m (MHNS); 32 s, Cienfuegos Bay, 8 m (MHNS); 1 s, Cienfuegos Bay, 20-30 m (MHNS); 1 s, Rancho Luna Beach, 12 m (MHNS); 1 s, Rancho Luna Beach, 35 m (MHNS); 13 s, Rancho Luna Beach, 45 m (MHNS); 2 s, Los Laberintos, Rancho Luna Beach, 35 m (MHNS). Granadines: 1 s, Mayreau, 8 m, coralline sand with coral blocks, gorgonians and sponges (CJP). Trinidad and Tobago: Tobago, 1 s, Horse shoe reef, 15 m, sandy grit (CHL). Mexico: 1 s, Puerto Morelos, Yucatan, 6-18 m (MHNS).

Description: Shell (Figs. 72A-B) strongly depressed but not planispiral. Umbilicus wide. Protoconch (Fig. 72D) apparently smooth, measuring 260 μm, it has two distinct parts, and terminates in a varix. Teleoconch completely covered by fine spiral cordlets. Peripherally bicarinate and concave between the two keels. On the dorsum there are two series of axial ribs: the finer ones begin on the suture and fade towards the middle of the dorsum; the stronger ones run from the middle of the dorsum out to the upper peripheral keel, forming strong nodules at their terminations. The base is divided in two by a strong spiral cord. Aperture oblique, peristome not continuous, parietal callus strong. Umbilicus wide and shallow which exposes the protoconch within.

Dimensions: Holotype 1.59 mm in diameter. Our material is between 1 and 1.5 mm, but a 1.8 mm shell is mentioned in the literature.

Operculum (Fig. 72C) fine, multispiral and with a central nucleus.

Habitat: This species has a wide bathymetric range, being recorded between 0 and 100 m in depth. It has been collected alive under rocks in shallow water (MOORE, 1964). In Cuba it is a relatively frequent species but not common, only 1-2 specimens appear in each station studied. In Cuba it was collected between 0 and 40 m. Reported further down in other areas.

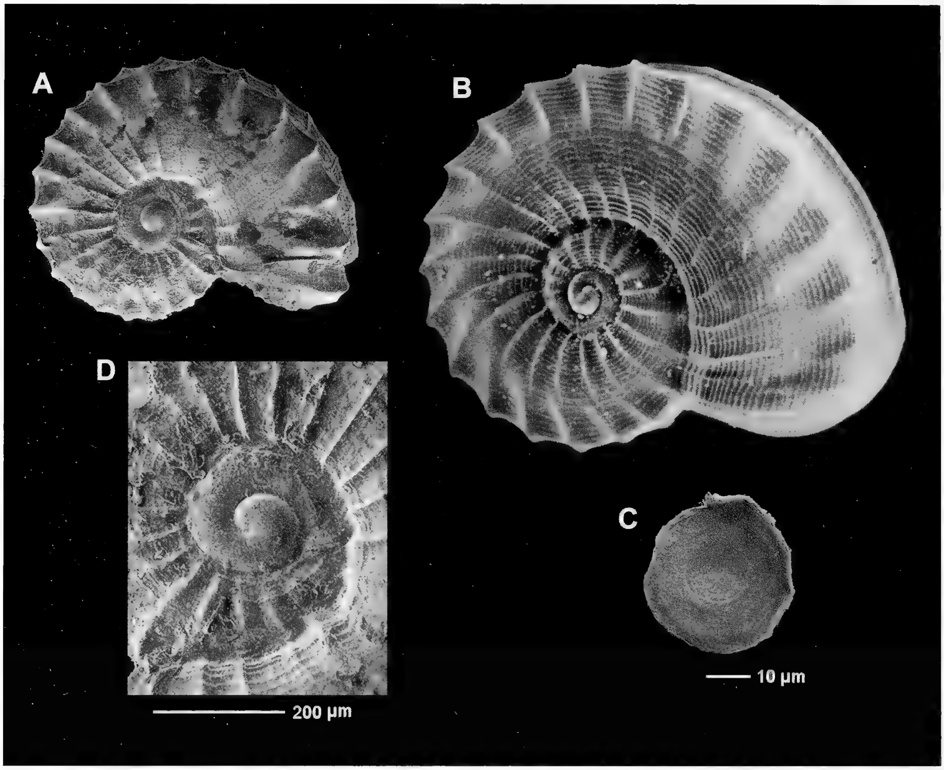
Distribution: It is recorded from the USA: Missouri Key, Florida Keys (PILSBRY & MCGINTY, 1945a); from Havana Province, Cuba (JAUME & BORRO, 1946); from Bocas Island, Panama (OLSSON & MCGINTY, 1958); from Grand Cayman Island (ABBOTT, 1958); from Puerto Rico (WARMKE & ABBOTT, 1961); from Florida, Texas and Panama (MOORE, 1964); from Southeast Florida, Texas and the Caribbean (ABBOTT, 1974); from Quintana Roo, Mexico (VOKES & VOKES, 1984). From Grenadines and Tobago in the present work.

Remarks: The only other species known in this genus, *Pleuromalaxis pauli* Olsson & McGinty, 1958,is smaller and has a more elevated spire.

Genus *Solariorbis* Conrad, 1865

Solariorbis Conrad, 1865. *Amer. Journ. Conch*. 1: 30.
Type species: (by monotypy) *Delpinula depressa* Lea. Eocene of Clairbonian, Alabama.

Diagnosis: After PILSBRY (1953): "*Shell 2 to 4 mm, white, strong, depressed, with 3 or 4 whorls, either rounded or angular, and usually with some spiral striation, the grooves typically punctate; apical whorls level and smooth. The umbilicus has a spiral ridge on a thickening of the wall,*



Figures 72A-C. *Pleuromalaxis balesi* (Pilsbry & McGinty, 1945). A-B: shells, 1.0, 1.5 mm, Rancho Luna Beach, Cienfuegos, Cuba; C: operculum; D : protoconch.

Figuras 72A-C. Pleuromalaxis balesi *(Pilsbry & McGinty, 1945). A-B: conchas, 1,0, 1,5 mm, Playa Rancho Luna, Cienfuegos, Cuba; C: opérculo; D : protoconcha.*

ending in a callus lobe or ledge at the columellar margin. Aperture rounded, with a small groove at the top. Outer lip rather thin and evenly curved".

Remarks: *Solariorbis* was described as a section or subgenus of *Teinostoma*. The peculiar thickening around the umbilicus is one of the more important characteristics of the genus. Another character common to many species is the reticular punctate sculpture due to the interaction of spiral grooves and axial ribs; this character was mentioned by Dall (1892) in reference to *T. depressum* as the type species of *Solariorbis*. The genus is distributed from the Eocene to the Recent with numerous fossil species described. Moore (1964) considered the following species as Recent: *S. multistriata* (A.E. Verrill, 1884), *S. mooreana* (Vanatta, 1904), *S. blakei* (Rehder, 1944), *S. infracarinata* (Gabb, 1881), *Solariorbis schumoi* (Vanatta, 1913), *S. hondurasensis* (Vanatta, 1913), *S. terminalis* (Pilsbry & McGinty, 1946), *S. corylus* Olsson & McGinty, 1958, *S. decipiens* Olsson & McGinty, 1958, and *S. semipunctus* Moore, 1964. To these it is necessary to add *S. guianensis* Altena, 1966 and *S. antillensis* de Jong & Coomans, 1988, which were described subsequently; also included in the present account as recent are *S. funiculus* (Dall, 1892) and *S. contractus* (Vanatta, 1913). *Solariorbis decipiens* is transferred to the genus *Anticlimax* due to the conchological similarity with the species of this genus.

Some species previously placed in the genus *Solariorbis*, such as *S. con-*

tractus, S. funiculus and *S. opsitelotus* present a small triangular thickening at the junction of the columella and the umbilical margin, which does not impinge on the umbilicus; further more they lack the characteristic ornamentation of the genus *Solariorbis* (the reticular punctate sculpture due to the interaction of the spiral grooves and axial ribs). For these reasons and because their spiral cord ornamentation, umbilical margin and protoconch are more similar to *Vitrinella anneliesae*, we have determined that they are better placed in *Vitrinella*.

Solariorbis antillensis de Jong & Coomans, 1988 (Figures 73A-C)

Solariorbis antillensis de Jong & Coomans, 1988. *Studies of the Fauna of Curaçao and other Caribbean Islands*, 69: 33, pl. 13, fig. 143. [Type locality: Curaçao/Aruba]

Type material: Holotype in ZMA (3.87.064). Represented in DE JONG & COOMANS (1988). Not examined.
Other material examined: Cuba: 1 s, Rancho Luna Beach, 35 m (MHNS). Puerto Rico: 1 s, E Boca de Cangrejos (MCZ 361886). Bahamas: 1 s, South Riding Rocks, Cay Sal Bank, base of coral reef in fine sediment (CHL). Antiqua and Barbuda: 1 s, Île Sister, N St. Johns, 5-6 m (CJP). Guadeloupe: 2 s, 1 f, Port Louis, 0-2 m, brushing stones (CJP).

Description: The original description given by DE JONG & COOMANS (1988) is as follows: *"Shell disc-shaped, wider than high, 1 ½ nuclear and two postnuclear whorls. The whorls are rounded, without carinae and covered by spiral striae with punctuated grooves.* S. antillensis *differs from* S. guianensis *by a quite different protoconch, the under side being less flattened, the umbilicus less closed, the axial wrinkles less manifest, the spirals more prominent and their punctuation more clear"*. The ambiguity of the distinguishing characters has given us reason to amplify the description.

We add: Shell (Figs. 73A-B) planispiral, depressed, shell of 2 ¾ rapidly-expanding whorls. Protoconch (Fig. 73C) with 1 ¼ whorls, totally smooth, about 240 μm in maximum diameter. Teleoconch with 1 ½ whorls ornamented by regularly spaced axial ribs and spiral cords of equal size. This sculpture covers all the shell except a small area on the base close to the periphery. The intersection of ribs and cords forms a regular reticulation characteristic of the genus. Aperture rounded, base of the columella and internal lip thickened and reflected outward forming a typical callus. Umbilicus narrow and deep, nearly closed by the thickening of the columella until the last ¼ of the body whorl, which then deviates laterally.

Dimensions: Holotype 1.6 mm in diameter. The figured specimen measures 1.29 mm in maximum dimension.

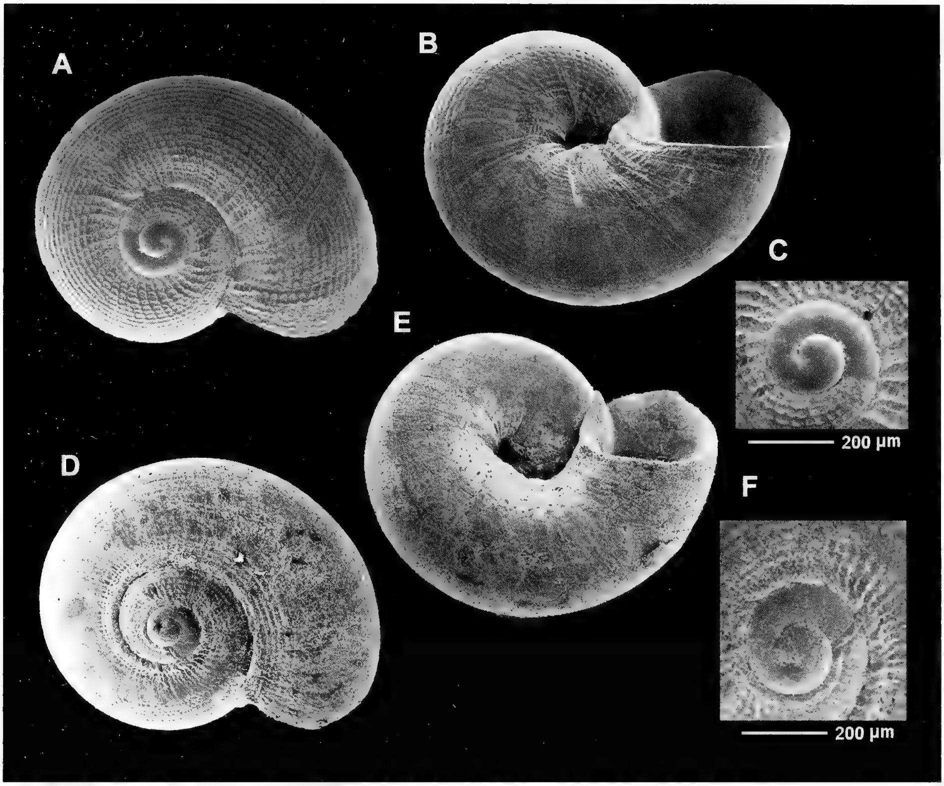
Habitat: Nothing is mentioned by DE JONG & COOMANS (1988) in the description work of the species. Our material comes from a coralline sandy bottom 35 m deep.

Distribution: Only know from Curaçao/Aruba, Puerto Rico, Bahamas, and Cuba.

Remarks: *S. antillensis* is very close to *S. guianensis*, with which it can be confused. It is best differentiated by the regularity of the ornamentation, which forms a characteristic reticulation not present in *S. guianensis*.

Solariorbis guianensis Altena, 1966 (Figures 73D-F)

Solariorbis guianensis Altena, 1966. *Zoologische Mededelingen*, 41: 238-239, figs. 4a-c. [Type locality: Cupido, Maratakka River, Surinam].



Figures 73A-C. *Solariorbis antillensis* de Jong & Coomans, 1988. A-B: shell, 1.3 mm, Rancho Luna Beach (MHNS); C: protoconch. Figures 73D-F. *Solariorbis guianensis* Altena, 1966. D-E: shell, 1.5 mm, Cienfuegos Bay (MHNS); F: protoconch.

Figuras 73A-C. Solariorbis antillensis *de Jong & Coomans, 1988. A-B: concha, 1,3 mm, Playa Rancho Luna (MHNS); C: protoconcha. Figuras 73D-F.* Solariorbis guianensis *Altena, 1966. D-E: concha, 1,5 mm, Bahía de Cienfuegos (MHNS); F: protoconcha.*

Type material: Represented in ALTENA (1966, 1975). Not examined.
Other material examined: Cuba: 2 s, Cienfuegos Bay, 20-30 m (MHNS).

Description: ALTENA (1966: 238, figs. 4a-c) figuring the holotype, presents a drawing without many details attempting to depict the essential aspects of ornamentation: spiral pitted lines and axial ribs. DE JONG & COOMANS (1988: 33) remarked: *"sculpture of the last whorl consisting of little pronounced and irregular fine radiating striae starting from the suture and the umbilicus, but not reaching the periphery and a few indistinct spirals, near the suture on the upper side and near the periphery on the under side;"* pointing out the distinguished characters of this species.

We add: Shell (Figs. 73D-E) lenticular, depressed, of 3 ½ rapidly increasing whorls. Protoconch (Fig. 73F) smooth, 1 ¼ whorl, measuring about 240 µm; a strong varix is present at the transition to the teleoconch, on the first whorl of which there is a pitted reticular sculpture formed by the crossing of spiral cords and axial ribs.

The principal distinguishing character is the ornamentation on the last whorl, formed by fine and irregular radial ribs which begin at the suture and disappear before reaching the periphery, and spiral cordlets which are more evident near the suture and close to the umbilicus, keeping a central zone of the last whorl without sculpture. Base convex, without ornamentation, except for the growth lines. The umbilicus is narrow and deep, nearly obliterated by the thickened columella until the last ½ of the body whorl, where it abruptly deviates laterally. Aperture rounded, external lip fine, internal lip thickened and reflected towards umbilicus.

Dimensions: Holotype 0.90 mm in diameter. The figured shell measures 1.47 mm in maximum diameter.

Habitat: DE JONG & COOMANS (1988: 33) mention that a significant number of specimens was found near Cabrietenberg in Spaanse Water, always together with *Teinostoma lerema*. In the area studied by us it is quite scarce and only 2 specimens were found.

Distribution: Known from Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994), Aruba (DE JONG & COOMANS, 1988), and Cuba: Cienfuegos.

Remarks: Originally described as a fossil of the Holocene of Surinam. DÍAZ MERLANO & PUYANA HEGEDUS (1994) recorded it as live-collected in Colombia and DE JONG & COOMANS (1988) in Aruba. The shell presents the basic characters which distinguish this species from others included in the genus *Solariorbis*: the thickening of the umbilical wall and the finely pitted reticular sculpture.

Solariorbis blakei (Rehder, 1944) (Figures 74A-D)

Vitrinella blakei Rehder, 1944a. *The Nautilus*, 57: 97, pl. 9, figs. 1-2. [Type locality: Bed 1 (lowest bed) of the Talbot Formation, Wailes Bluff, near Cornfield Harbour, St. Mary's County, Virginia].

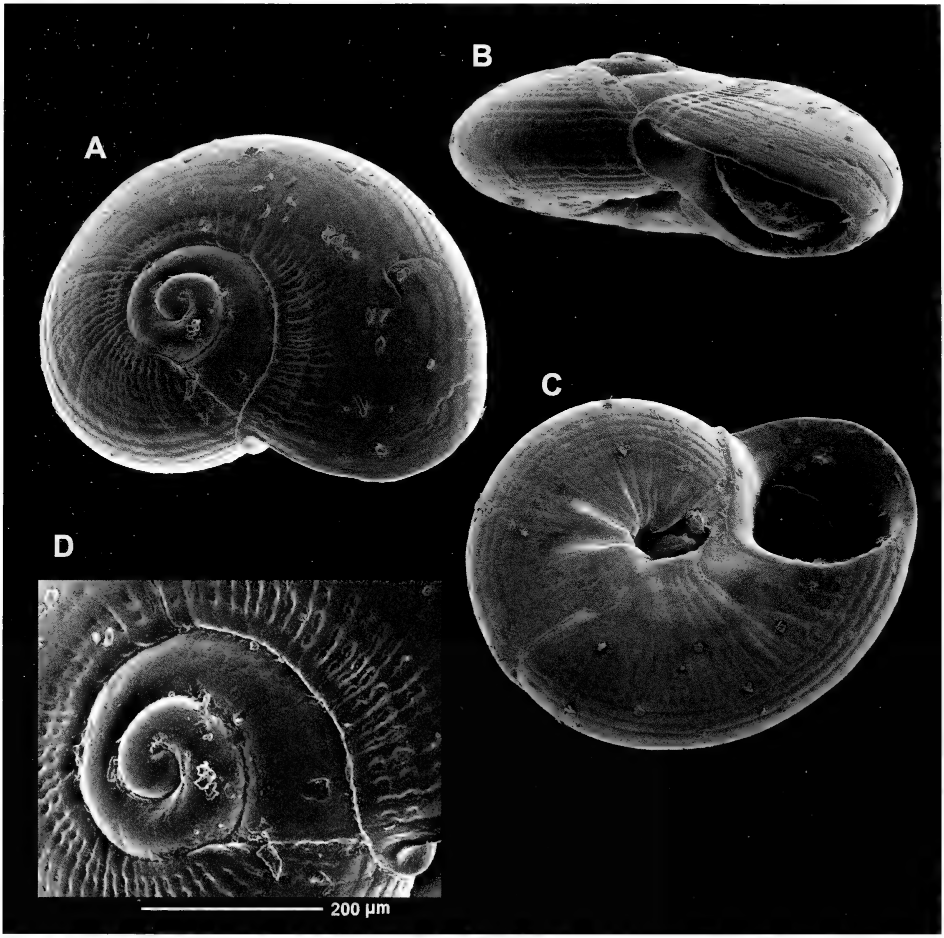
Type material: Holotype in USNM (537834). Not examined.
Material examined: <u>Florida, USA</u>: 4 s, E. St. Augustine, St. Johns Co., (CHL); 2 s, Cedar Key, Levy Co., 4.5-6 m shell/rubble bottom (CHL); 2 s, Stuart, Martin Co. (CHL); 2 s, Pinellas Co., (CHL); 1 s, SE Mayport (CHL). <u>Puerto Rico</u>: 2 s, beach at Holiday Inn, San Juan (CHL). <u>Turks & Caicos</u>: 1 s, Grand Turk (CHL).

Description: Shell (Figs. 74A-C) strongly depressed, small size, spire almost flat, very weakly sculptured, umbilicus nearly or entirely covered by the thickening of the umbilical wall. Protoconch (Fig. 74D) smooth with 2 whorls, size about 330 μm in diameter and projecting slightly apically. Teleoconch with 1 ¼ whorls, sculptured with faint spiral cords/grooves and short axial wrinkles that radiate out from the suture. On the last half whorl the cords are weakened and the axial ribs almost disappear, persisting only in the subsutural area. The base is broad, smooth, and evenly rounded. Aperture oblique with a heavy parietal callus. Columella thickened, reflected towards the umbilicus, forming a small callus. Umbilicus reduced to a very narrow fisure, limited, and partially occluded by the thickening of the umbilical margin although the columella deviates laterally in the last ¼ whorl. On the umbilical wall strong growth folds can be seen.

Dimensions: About 1.5 mm in maximum diameter.

Habitat: It lives in creeks and bays (ANDREWS, 1977). Bathymetric range: 0 to 26 m.

Distribution: This species was considered a continental species with an extensive distribution along the east coast of North America. It had never been reported from any of the West Indian islands (MOORE, 1964), but actually there are records from a few islands. USA: South Carolina, Florida:



Figures 74A-D. *Solariorbis blakei* (Rehder, 1944). A-C: shell, 0.8 mm, Holiday Inn, Puerto Rico (CHL); D: protoconch.
Figuras 74A-D. Solariorbis blakei *(Rehder, 1944). A-C: concha, 0,8 mm, Holiday Inn, Puerto Rico (CHL); D: protoconcha.*

East Florida, West Florida; Mississippi; Texas; Mexico: unlocalized; Costa Rica, Panama. Reported from Colón and Bocas Island, Panama (OLSSON & MCGINTY, 1958). From Florida, Mississippi, Texas, Oregon, and Campeche Bank, Mexico (MOORE, 1964). From South Carolina to the Gulf Mexico and the Caribbean Sea (HOUBRICK, 1968). From South Carolina to Texas and the Caribbean Sea (ABBOTT, 1974); from the states of the Gulf to Mexico (EMERSON & JACOBSON, 1976). East coast of the USA; Florida; states of the Gulf of Mexico; Mexico (ANDREWS, 1977). Portete, Costa Rica (HOUBRICK, 1968; ROBINSON & MONTOYA, 1987). From Martin, Palm Beach, Pinellas, and Levy Cos., Florida; Texas and Puerto Rico (ODÉ, 1988). From Lee Co. (GUNDERSEN, 1998). From SE Mayport and St. Augustine, Florida (LEE, 2009).

Remarks: Described as a Pleistocene fossil. *S. blakei* like *S. semipunctus* is smaller than other West Indian *Solariorbis*. *S. blakei* can be distinguished from *S. semipunctus* by the rounded and smoother dorsal surface.

Solariorbis elegans (Olsson & McGinty, 1958) (Figures 75A-G)

Vitrinella (Striovitrinella) elegans Olsson & McGinty, 1958. *Bulletins of American Paleontology* 39: 31, pl. 3, figs. 1-1d. [Type locality: Bocas Island, Panama].

Type material: Holotype in ANSP (211877). Not examined.
Material examined: Panama: 3 s, Bocas Island, drift (CHL); 2 s, Portobello, drift (CHL).

Description: Shell (Figs. 75A-E) white or glassy, depressed, about 3 ½ whorls. The protoconch (Figs. 75F-G) is projected over the teleoconch, has a little more than one whorl, smooth, and about 400 μm in maximum diameter. In some shells two strong varices can be seen, which mark the two stages of development. Teleoconch totally covered by spiral cords of similar size, which at the crossing points with the axial lines form small rectangles, more evident and rounded on the dorsum and on the base of the teleoconch, and a little more elongate on the periphery. There are more than 35 spiral cordlets on the last whorl. Aperture rounded, oblique, external lip fine, columella strong and reflected towards the umbilicus, forming a small callus. Umbilicus deep; the peristome sharp, a little thickened near the base. Inner wall of the umbilicus with growth folds.

The largest shell examined measures 2.0 mm in maximum diameter and 1.1 mm in height.

Habitat: Sand in shallow water (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). Depth: 0 m (live 0 m).

Distribution: Costa Rica, Panama, Colombia, Venezuela: unlocalized.

Reported from Colón and Bocas Island, Panama (OLSSON & MCGINTY 1958). Central América (HOUBRICK, 1968). Western Caribbean (ABBOTT, 1974). Portete and Moin, Costa Rica (HOUBRICK, 1968; ROBINSON & MONTOYA 1987). From Venezuela (PRINCZ, 1982). From Costa Rica to Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994).

Remarks: Described in the subgenus *Striovitrinella* Olsson & McGinty, 1950; this is characterized by having the entire surface of the shell sculptured with fine, threadlike spirals, operculum circular, thin, chitinous, with numerous, slowly enlarging spiral whorls; radula taenioglossate. Based on the thickening of the umbilical wall due to the enlargement and reflecting towards the umbilicus of the columella, the columellar callus, and the pits formed by the crossing of spiral cords and growth folds, we have decided to place this species in *Solariorbis*.

Solariorbis elegans is very similar to *Solariorbis multistriatus*, from which it can be distinguished by the shape of the umbilical callus, being less globose, and because the protoconch is more erect.

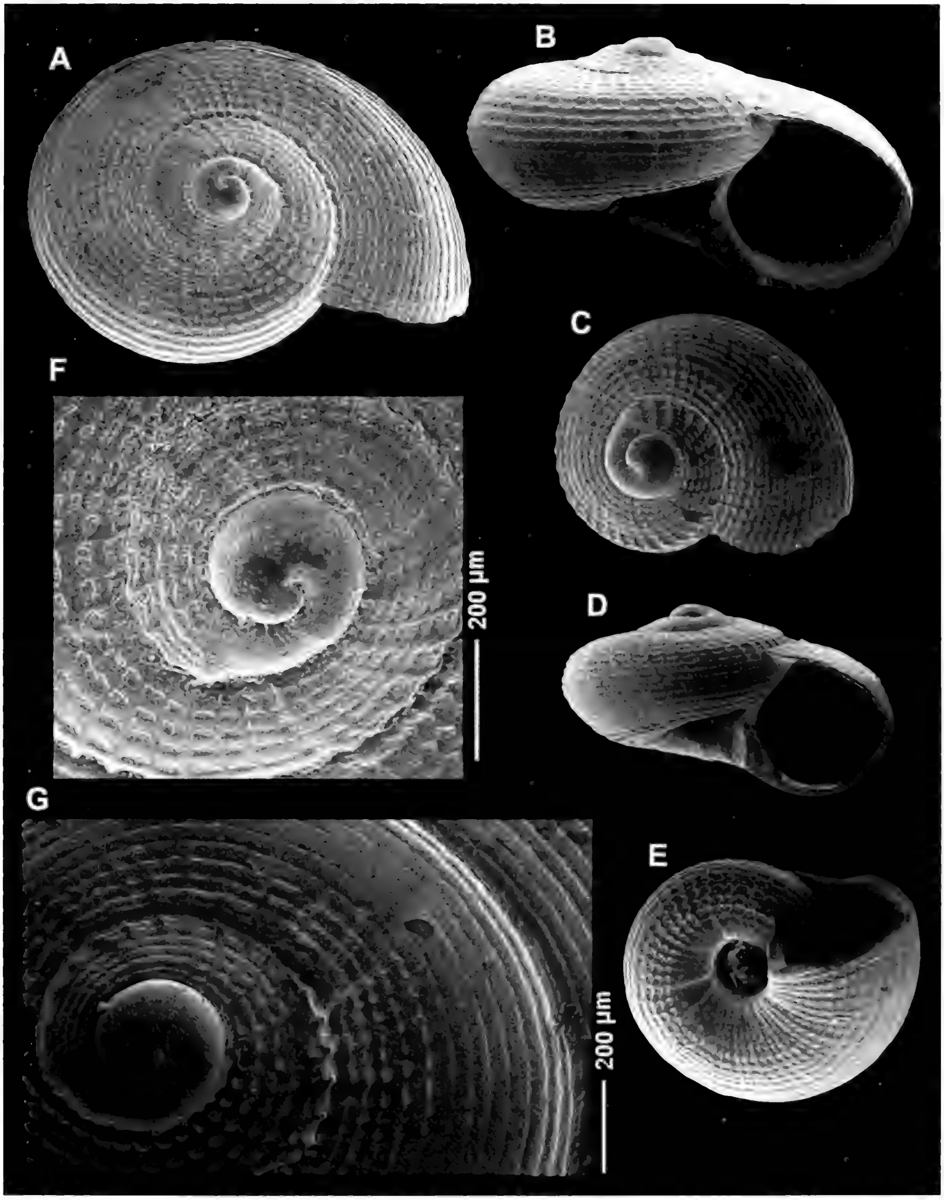
Solariorbis infracarinatus (Gabb, 1881) (Figures 76A-H, 77A-C)

Adeorbis infracarinata Gabb, 1881. *Journ. Acad. Nat. Sci. Philadelphia*, 2 serie, 8: 365, pl. 46, fig. 62 [Type locality: Pliocene beds of Limon, Costa Rica].

Teinostoma bartschi Vanatta, 1913. *Proc. Acad. Nat. Sci. Phil.*, 65: 26-27, pl. 2, figs. 9-11. [Type locality: Porto Barrios and Livingston, Guatemala].

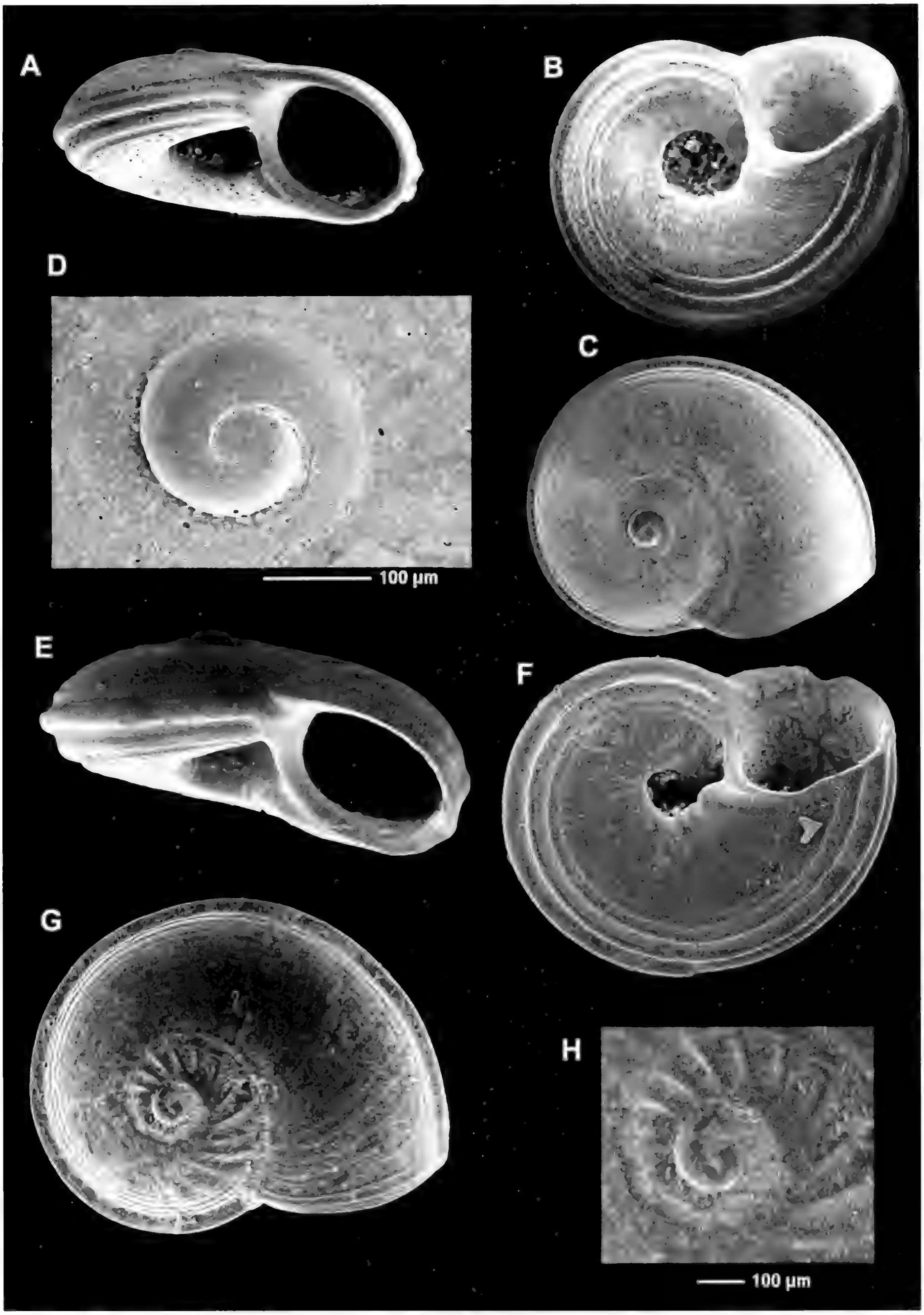
Solariorbis euzonus Pilsbry & McGinty, 1950. *The Nautilus*, 63: 85, pl. 5, figs. 7-7a. [Type locality: Sebastian, Indian River County, Florida].

Type material: Holotype of *Adeorbis infracarinata* in ANSP (3380) and figured by MOORE (1965). Holotype of *Teinostoma bartschi* in ANSP (76501) figured by VANATTA (1913). Not examined.



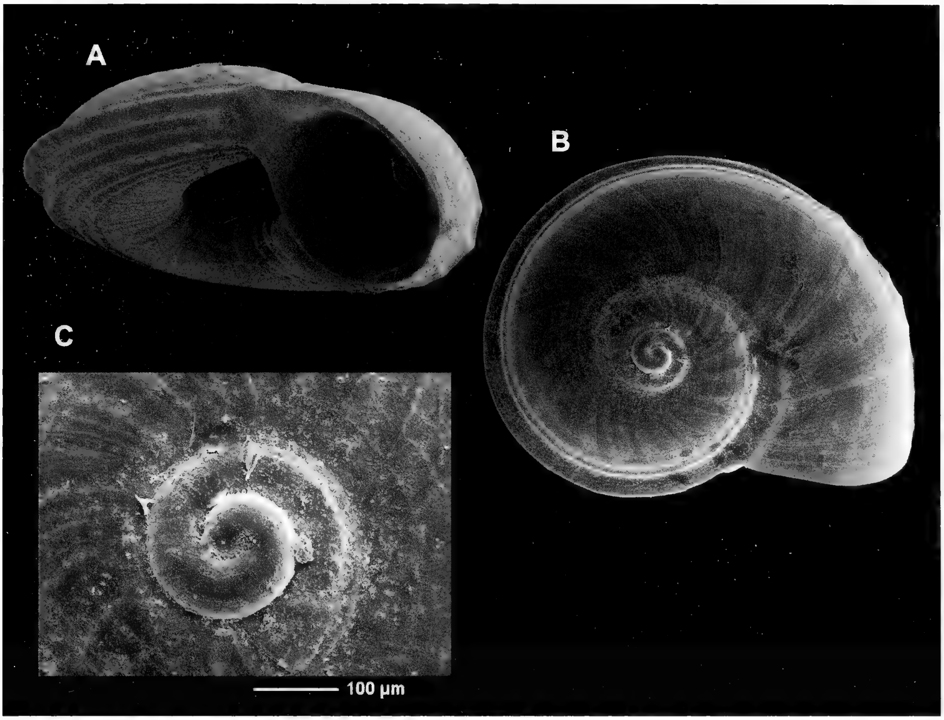
Figures 75A-G. *Solariorbis elegans* (Olsson & McGinty, 1958). A-B: shell, 2.0 mm, Portobello, Panama (CHL); C-E: shells, 1.5, 1.4, 1.5 mm, Bocas Island, Panama (CHL); F-G: protoconchs.
Figuras 75A-G. Solariorbis elegans *(Olsson & McGinty, 1958). A-B: concha, 2,0 mm, Portobello, Panama (CHL); C-E: conchas, 1,5, 1,4, 1,5 mm, Isla Bocas, Panama (CHL); F-G: protoconchas.*

Other material examined: Guatemala: 2 s, Livingston, 3 m (MHNS). Brazil: 1 s, Itaparica (MHNS); 1 s, Praia de Itararé, São Vicente, São Paulo (CHL). Florida, USA: 7 s, Cedar Key (CHL); 1 s, Bahia Honda Key, Monroe Co. (CHL); 1 s, Marco Island, Collier Co. (CHL); 1 s, SE Mayport (CHL); 2 s, APAC Pit, Sarasota, Plio-Pleistocene (CHL).



Figures 76A-H. *Solariorbis infracarinatus* (Gabb, 1881). A-C: shell, 1.4 mm, Livingstone, Guatemala (MHNS); D: protoconch; E-H: form with axial ribs, 1.7, 1.8, 2.0 mm, Florida, USA (CHL); H: protoconch.

Figuras 76A-H. Solariorbis infracarinatus *(Gabb, 1881). A-C: concha, 1,4 mm, Livingstone, Guatemala (MHNS); D: protoconcha; E-H: forma con costillas axiales, 1,7, 1,8, 2,0 mm, Florida, USA (CHL); H: protoconcha.*



Figures 77A-C. *Solariorbis infracarinatus* (Gabb, 1881). A-B: shell, 1.7 mm, Itaparica, Brazil (MHNS); C: protoconch.

Figuras 77A-C. Solariorbis infracarinatus *(Gabb, 1881). A-B: concha, 1,7 mm, Itaparica, Brazil (MHNS); C: protoconcha.*

Description: Shell (Figs. 76A-C, 77A-B) depressed, rounded spire, carinate at the periphery, and narrowly umbilicate. Protoconch (Fig. 76D) of nearly 1 ½ whorls and about 340 µm in diameter. Teleoconch of about 2 whorls with a strong carina near the periphery. Between this and the umbilicus there are 3 spiral cords. On the dorsum, between the suture and the periphery there are numerous axial ribs. A strong cord borders the umbilicus internally, thickening slowly towards the aperture and forming a callous lobe on the columellar margin typical of the genus.

Habitat: Species common in shallow water in coastal bays. Amply distributed in continental waters. Not recorded in any island of the West Indies (Moore, 1964).

Distribution: It has been recorded from Florida to Texas (USA), Campeche Bank (Mexico), Guatemala and Panama (Moore, 1964). From the USA, North Carolina to Gulf of Mexico and Caribbean Sea (Houbrick, 1968). On both sides of Florida; from Texas to Campeche Bank; Central America (Andrews, 1977). From Campeche to Ciudad del Carmen and Zacatal, Mexico (Vokes & Vokes, 1984). From Florida (Lyons, 1989). South of Florida; Texas; Caribbean Sea (Robinson, 1991). Florida and Texas to Colombia (Díaz Merlano & Puyana Hegedus, 1994). Rio Grande do Norte, Brazil (Rios, 1994). Our material is from Livingston, Guatemala. Also Florida Plio-Pleistocene: record from Chesapeake Bay, Virginia by Wass (1972: 125) needs confirmation.

Remarks: Moore (1964) considered *Teinostoma bartschi* Vanatta, 1913 and *Solariorbis euzonus* Pilsbry & McGinty, 1950 synonyms of *Solariorbis infracarinatus* not finding important differences. In spite of this, some databases treat *T. bartschi* as a valid species. The figured shell (Figs. 77A-C) was collected in Livingston, Guatemala, its type locality.

PILSBRY (1953) figured a shell of *Solariorbis euzonus* from the Plio-Pleistocene of St. Petersburg, in which he distinguished 2-3 fine but easily-seen spiral cordlets on the dorsum, above the keel, as well as fine axial ribs on the first whorl of the teleoconch, which fade on the last whorl. Both these features can be found in well-preserved specimens of *T. bartschi* and *S. infracarinata*.

VANATTA (1913) and PILSBRY & MCGINTY (1950), in describing *T. bartschi* and *S. euzonus* respectively, did not compare these species to *S. infracarinatus* described by GABB (1881). Based on the preceding analysis, and consistent with MOORE (1964), we consider *T. bartschi* and *S. euzonus* junior synonyms of *S. infracarinatus*.

In reference to *S. infracarinatus*, MOORE (1964) stated: *"No other* Solariobis *in the western Atlantic has the combination of low round spire, radial waves on the first whorl and spiral sculpture which is not visible from above"*. We agree with this diagnosis.

Solariorbis mooreanus (Vanatta, 1904) (Figures 78A-F)

Vitrinella mooreana Vanatta, 1904. *Proc. Acad. Nat. Sic. Philadelphia*, 55: 757, figs. 1-3. [Type locality: Gulf side of Crooked Island near Panama City, Florida].

Solariorbis bassilisus Pilsbry, 1953. *Monographs of Acad. Nat. Sci. Philadelphia*, 18: 420, pl. 56, figs. 4-4c. [Type locality: Pliocene of St. Petersburg, Florida].

Type material: Five syntypes of *Vitrinella mooreana* in ANSP (84611). Holotype of *Solariorbis bassilisus* deposited in ANSP (18408). Not examined.

Other material examined: Cuba: 3 s, Cienfuegos Bay, 20-30 m (MHNS). Florida, USA: 1 sp, St. Joe Bay, grass flats (CHL). Brazil: 1 s, Praia de Itararé, São Vicente, São Paulo (CHL); 1 s, off Santos, São Paulo State, trawled by nets at 100 m (CHL).

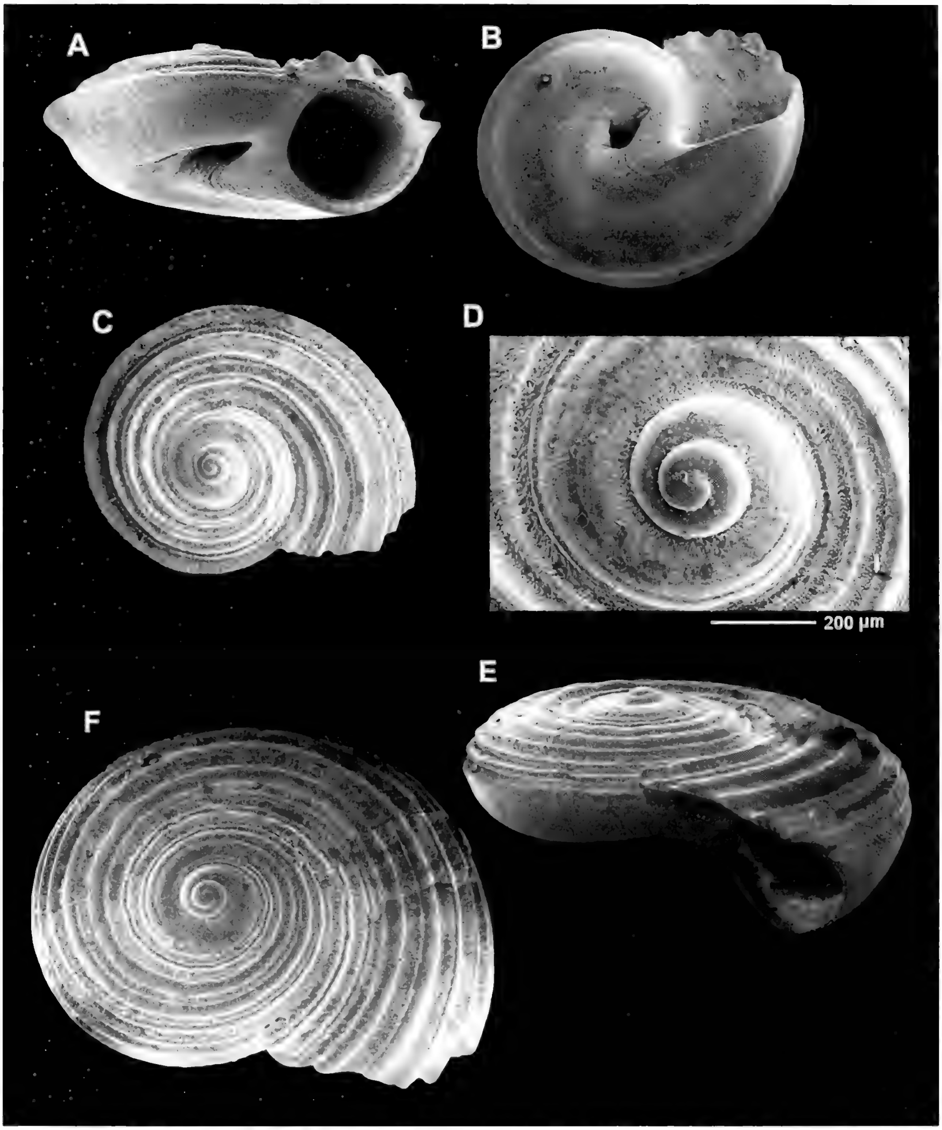
Description: Shell (Figs. 78A-C, 78E-F) depressed, with six spiral ridges on dorsal of the shell. The peripheral cord is very prominent, like a keel. Base smooth, umbilicus narrow and deep. The protoconch (Fig. 78D) is projected over the teleoconch, with 2 spiral whorls, smooth and with about 350 μm in maximum diameter. The teleoconch has two spiral whorls; the periphery is keeled by a peripheral cord, sharp and prominent, and strong cords on the dorsum. Ornamentation formed by punctiform sulcus, dorsally as well as ventrally. Base slightly concave. Aperture rounded, without canal on the upper internal angle. Columella thickened, with an expansion which from the internal lip is reflected outward forming a small triangular callus which closes the umbilicus gradually.

Dimensions: Holotype of *Vitrinella mooreana* is 1.08 mm in diameter and 1.2 mm of height. There are records up to 2.75 mm. Holotype of *Solariorbis basilissus* is 2.4 mm in diameter and 1.25 mm in height.

Animal and radula unknown.

Habitat: The species has been found in a shell grit bottom at 9 m. According to MOORE (1964) it occurs on sandy bottoms in turbid waters.

Distribution: Recorded from Gulf side of Crooked Island near Panama City, Florida (VANATTA, 1904); from Missisippi (ANDREWS, 1977); from East and West Florida (LYONS, 1998); from Texas (ODÉ, 1988a); from Florida, Texas, north-



Figures 78A-F. *Solariorbis mooreanus* (Vanatta, 1904). A-C: shell, 1.9 mm, Cienfuegos Bay (MHNS); D: protoconch; E-F: shell, 2.6 mm, Itararé, São Vicente, Brazil (CHL).
Figuras 78A-F. Solariorbis mooreanus *(Vanatta, 1904). A-C: concha, 1,9 mm, Bahía de Cienfuegos (MHNS); D: protoconcha; E-F: concha, 2,6 mm, Itararé, São Vicente, Brasil (CHL).*

east Brazil, and Abrolhos Islands (RIOS, 1994). Also from Cienfuegos, Cuba.

Remarks: This species is also known as a fossil. *Solariorbis mooreanus* is different from the congeneric species by the spiral cords which cover the dorsum of the shell, the sharp and prominent peripheral cord which forms a keel around the shell, the spiral sulcus with punctiform incisions which cover the interspaces between the cords, and the triangular callus originating at the internal lip, which impinges on the umbilicus as it grows.

Solariorbis multistriatus (A.E. Verrill, 1884) (Figs. 79A-I)

Ethalia multistriata A.E. Verrill, 1884. *Trans. Connect. Acad. Arts and Sci,* 6: 242-243. [Type locality: *Albatross* sta. 2109, off Cape Hatteras, North Carolina].

Type material: Lectotype in USNM (35733). Not examined.
Other material examined: Cuba: 5 s, Cienfuegos Bay, 20 m (MHNS); 2 s, Rancho Luna Beach, 20 m (MHNS).

Description: Shell (Figs. 79A-E) strong, spire a little elevated, formed by 3 ½ whorls. Protoconch (Figs. 79G-I) relatively large, bulbous, measuring about 480 μm and with a little more than one whorl; two stages are distinguised, the first one with a rough surface and the second with an evident reticulation and between one and seven strong varices on its dorsal aspect. Teleoconch with 2 ½ whorls, totally covered by spiral cords of similar size, more than 50 on the body whorl. Between the cords there are spiral punctiform sulci (Fig. 79F) formed by the intersections with axial ribs. The pitting is more evident on the first whorl of the teleoconch, being barely detectable on the body whorl. Due to the thickening of the umbilical margin a characteristic triangular callus is formed and a gradual closing of the umbilicus is produced.

Dimensions: Lectotype 1.59 mm in diameter. The larger shell figured is 3.1 mm of maximum diameter.

Animal and radula are unknown.

Habitat: Species with a large bathymetric distribution, recorded between 5 and 312 m deep. Our shells were collected on coralline sandy bottom at 20 m. The type material was obtained at 142 fms (312 m).

Distribution: Recorded off Cape Hatteras (A.E. VERRILL, 1884); from Cuba: North Havana Province (AGUAYO & JAUME, 1936); North Carolina to West Indies (ABBOTT, 1974); from Bocas Island, Panama (OLSSON & MCGINTY, 1958); from the Yucatan Peninsula, Mexico (VOKES & VOKES, 1984); from the northeast Gulf of Mexico (PARKER & CURRAY, 1956); from Cape Lookout, North Carolina (MOORE, 1964); from Laguna de Termino, Campeche, Mexico (GARCÍA-CUBAS, 1982); from Puerto Rico and the Lesser Antilles (WARMKE & ABBOTT, 1961); from Guyana (PRINCZ, 1977); from Venezuela (PRINCZ, 1982). Also Cienfuegos, Cuba.

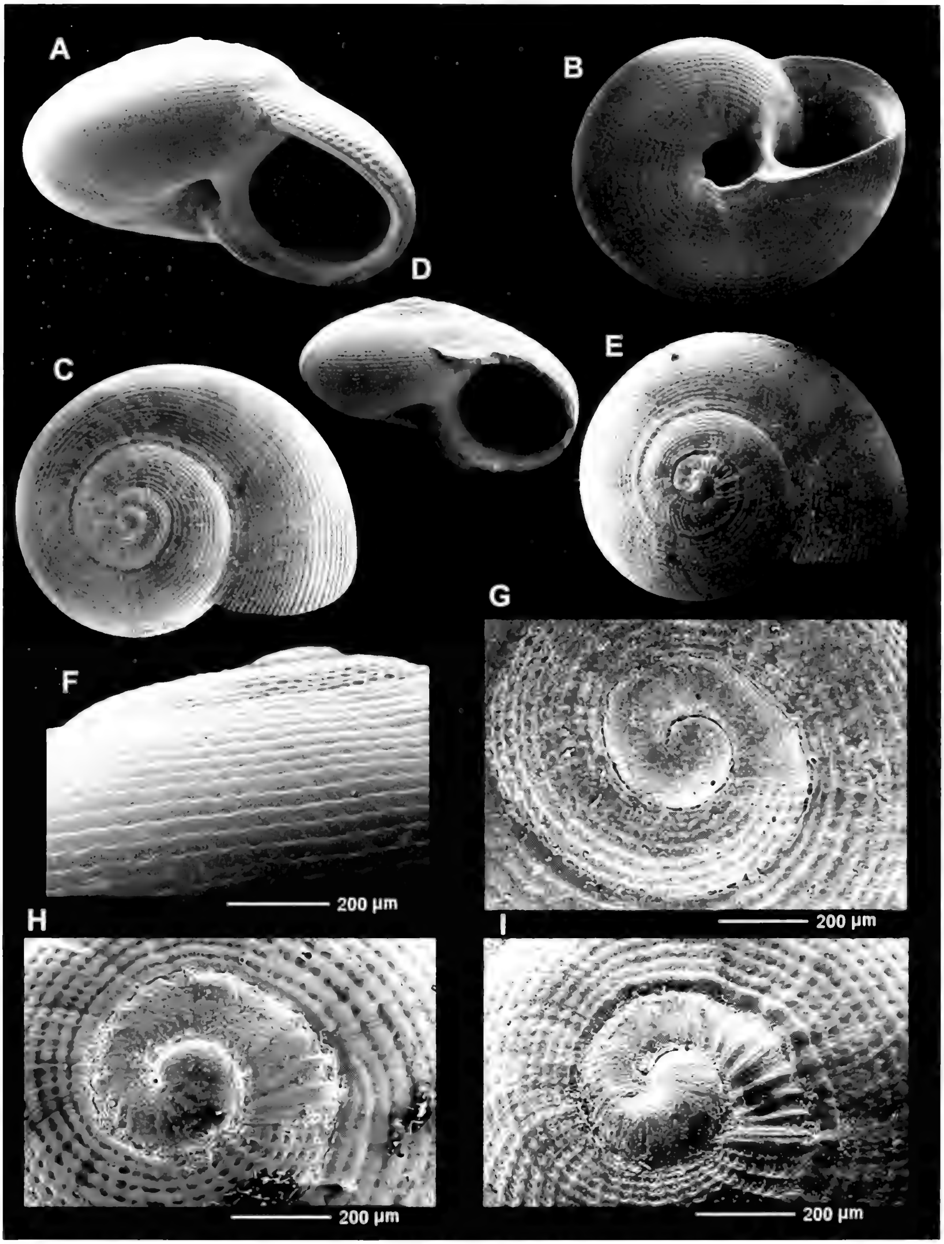
Remarks: *S. multistriatus* was described by A.E. VERRILL (1884) from a juvenile specimen, which had not yet developed all the adult conchological characters, and perhaps for this reason he placed the species in the genus *Ethalia*. BUSH (1897) placed the species in *Vitrinella* due to the apparent similarity of its shell to *V. helicoidea,* type species of that genus. MOORE (1964) moved it to *Solariorbis* after studying an adult specimen showing the thickening of the umbilical wall and pitted sulcus. He also mentioned that *S. multistriatus* is similar to *S. terminalis,* from which it can be differentiated by its smaller size, its higher spire and smaller umbilical callus.

In our opinion the number and regularity of the spiral cords and the triangular callus are the main distinguishing characters of this species.

Solariorbis truncatus (Gabb, 1881) (Figures 80A-C)

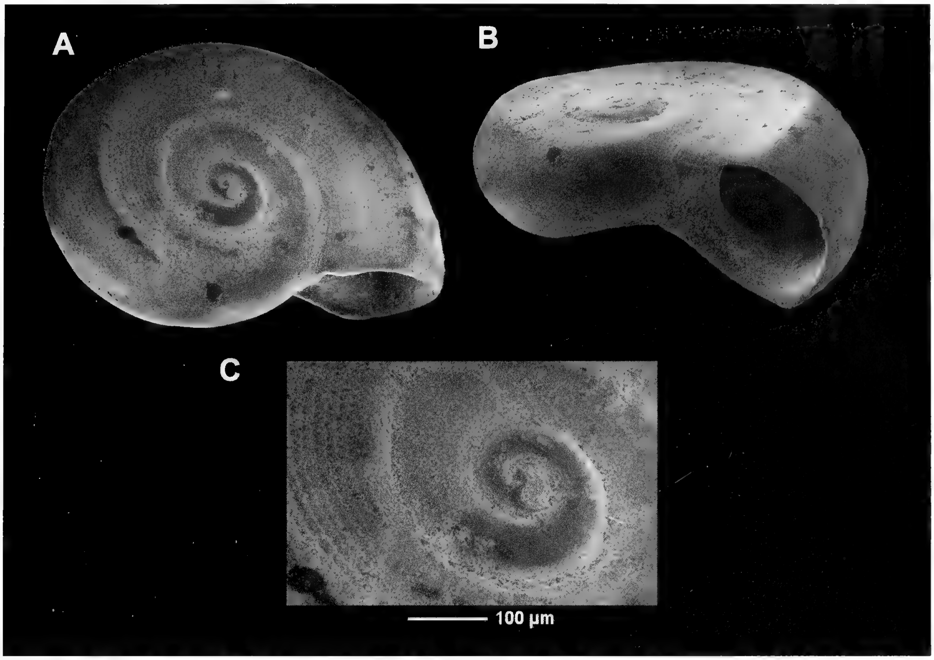
Vitrinella truncata Gabb, 1881. *Journ. Ac. Nat. Sci.*: 367, pl. 47, fig. 65. [Type locality: Limon, Costa Rica, Miocene].

Solariorbis corylus Olsson & McGinty, 1958. *Bulletins of American Paleontology, 39:* 28, pl. 3, figs. 4-4b. [Type locality: Bocas Island, Panama].



Figures 79A-I. *Solariorbis multistriatus* (A.E. Verrill, 1884). A-E: shells, 2.5, 2.6, 3.1, 2.56, 2.85 mm, Cienfuegos Bay; F: microsculpture; G-I: protoconchs.
Figuras 79A-I. Solariorbis multistriatus *(A.E. Verrill, 1884). A-E: conchas, 2,5, 2,6, 3,1, 2,56, 2,85 mm, Bahía de Cienfuegos; F: microescultura; G-I: protoconchas.*

Type material: *V. truncata*: Type in ANSP (3107). Holotype of *S. corylus* (ANSP 211909) and a paratype in ANSP (211910). Not examined.
Other material examined: 1 s, Portobello, Panama (CHL).



Figures 80A-C. *Solariorbis truncatus* (Gabb, 1881). A-B: shell, 1.66 mm, Portobello, Panama (CHL); C: protoconch.
Figuras 80A-C. Solariorbis truncatus *(Gabb, 1881). A-B: concha, 1,66 mm, Portobello, Panamá (CHL); C: protoconcha.*

Description: Shell (Figs. 80A-B) small, white or glassy, with a strongly flattened, depressed spire bounded by a ridged shoulder, the profile of the body whorl below the shoulder being wider and evenly convex. Protoconch (Fig. 80C) with 1 ½ whorls.

Maximum reported size: 2.4 mm

Habitat: Sandy bottom (DÍAZ MERLANO & PUYANA HEGEDUS, 1994).

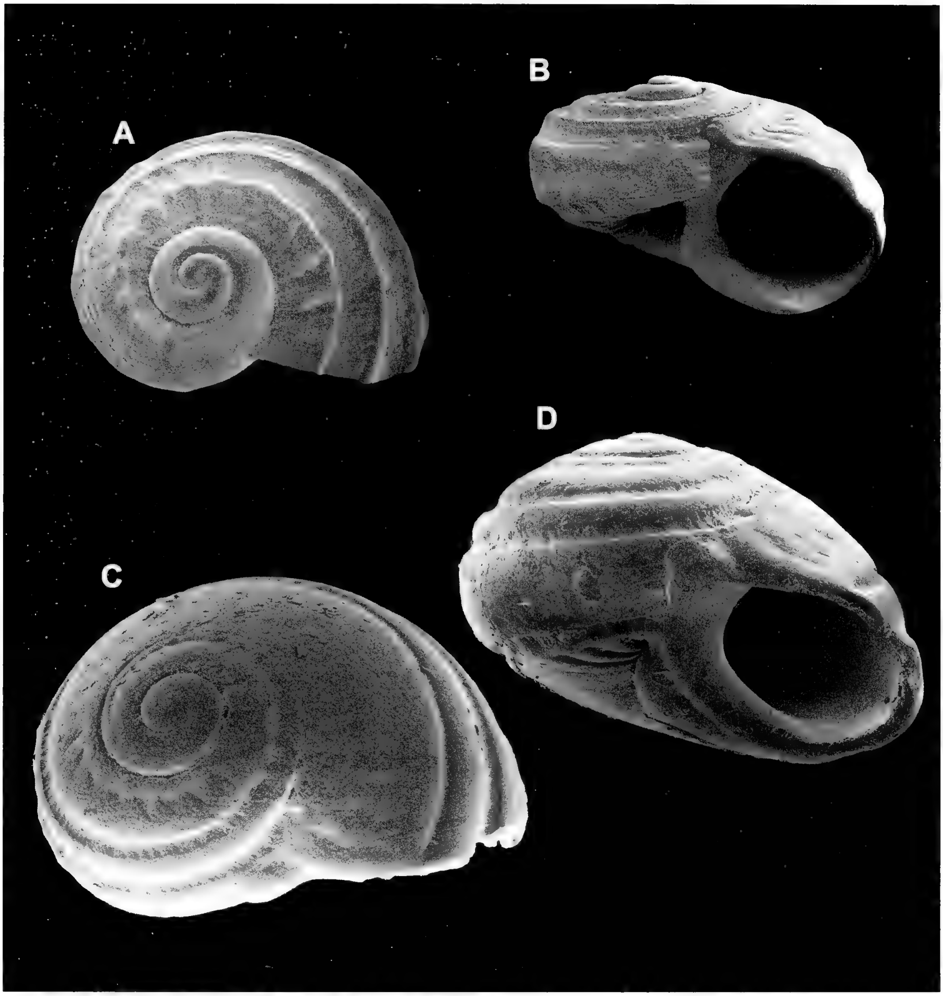
Distribution: Recorded from the Pleistocene, Moín, Costa Rica (ROBINSON & MONTOYA, 1987; ROBINSON, 1991). From Colón and Colón and Bocas Island, Panama (OLSSON & MCGINTY, 1958). From southeastern Panama (RADWIN, 1969). From Panama and Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994).

Remarks: OLSSON & MCGINTY (1958) stated: "*Similar to* S. contracta *(Vanatta) from Monkey River, Honduras but lacks the central or peripheral keel and has a higher shell*".

Solariorbis schumoi (Vanatta, 1913) (Figs. 81A-D)

Teinostoma schumoi Vanatta, 1913. *Proc. Acad. Nat. Sci. Philadelphia*, 65: 25-26, pl. 2, figs. 5, 10. [Type locality: Porto Barrios and Livingston, Guatemala].

Type material: Holotype in ANSP (73483) figured by VANATTA (1913). Not examined. Best representations in ALTENA (1966: 240-241, figs. 6a-e) and ALTENA (1975: figs. 11a-c).
Other material examined: Guatemala: 2 s, Livingston, 3-4 m (MHNS). Brazil: 1 s, Praia Itararé, São Vicente, São Paulo, drift (CHL).



Figures 81A-D. *Solariorbis schumoi* (Vanatta, 1913). A-B: shells, 0.8, 1.1 mm, Livingston, Guatemala (MHNS). C-D: shell, 1.8 mm, Praia Itararé, São Vicente, Brazil (CHL).
Figuras 81A-D. Solariorbis schumoi *(Vanatta, 1913). A-B: conchas, 0,8, 1,1 mm, Livingston, Guatemala (MHNS). C-D: concha, 1,8 mm, Praia Itararé, São Vicente, Brasil (CHL).*

Description: Shell (Figs. 81A-D) small, imperforate in adult individuals, white, very compact, suture marked, rounded periphery, with undulant profile due to the spiral cords; the penultimate whorl exhibits a spiral sulcus near the suture. Protoconch of nearly 1 ¾ whorls and about 340 μm in diameter. Teleoconch with 2 ½ whorls, with an ornamentation formed by strong spiral cords and fine spiral threads, strong axial ribs, and fine axial striae; the spaces between the cords are convex and are crossed by a fine axial striation. On the dorsum there is a strong nodulous cord produced by the intersection with axial ribs, the latter progressively more evident as the shell grows. There are 5-7 spiral cords on the periphery. Near the periphery of the base there are two spiral cords. Strong growth folds extend from the basal cords towards the inner part of the umbilicus. Aperture suborbicular; external lip sharp, parietal area wide. Columella and inner lip are reflected outward, forming a wide callus which increases the umbilical wall and may close totally the umbilicus in adult shells. This character is fundamental in the placement of the related species, *T. hondurasensis*, in *Solariorbis*.

The holotype measures 2.23 mm in diameter and 1.51 mm in height. The largest shell figured measures 1.2 mm in diameter and 0.71 mm in height, and it is a non-adult individual.

Habitat: It lives in shallow water at about 2 meters depth.

Distribution: Known from Guatemala (VANATTA, 1913); Costa Rica, Panama and Colombia (COSEL, 1986); ABC Islands: Aruba (DE JONG & COOMANS, 1988); Brazil: Pernambuco, São Paulo (MELLO & PERRIER, 1986); Moin, Costa Rica (ROBINSON & MONTOYA, 1987); Surinam (ALTENA, 1966)

Remarks: This species was originally included in the genus *Teinostoma*. MOORE (1964) placed them in *Solariorbis* on the basis of the enlargement of the umbilical wall and the pitted spiral sulcus in the original figures of *T. schumoi* and *T. hondurasensis*. *T. schumoi* may be differentiated from *T. solidum* Smith by the sculpture on the dorsum; from *S. hondurasensis* Vanatta, 1913 it may be differentiated by having more spiral cords and being umbilicated as juvenile and imperforate, or nearly so, as an adult.

Solariorbis semipunctus Moore, 1965 (Figures 82A-D)

Solariorbis semipunctus Moore, 1965. *The Nautilus*, 78: 77-78, pl. 8, figs. 1-3. [Type locality: Northwest Campeche Bank, Mexico].

Type material: Holotype in USNM (636309) figured by MOORE (1965). Not examined. Best representation in FABER (2007).
Other material examined: Cuba: 3 s, Rancho Luna Beach, 20 m (MHNS); 2 s, Cienfuegos Bay, 20-30 m (MHNS).

Description: Shell (Figs. 82A-C) strongly depressed, 3 ¼ whorls, spiral sculpture punctiform with a rounded periphery and umbilicus sealed by callus. Protoconch (Fig. 82D) smooth with nearly 1 ½ whorls and about 200 μm in diameter. Teleoconch of about 1 ¾ whorls; fine spiral punctiform cordlets cover the whole surface. In the middle of the dorsum and after the first ½ whorl, the shell is keeled. The umbilicus of the adult shells is totally occluded by the columellar callus, which, in the form of a fine callous surface, also covers the cordlets close to the umbilicus. Base somewhat convex.

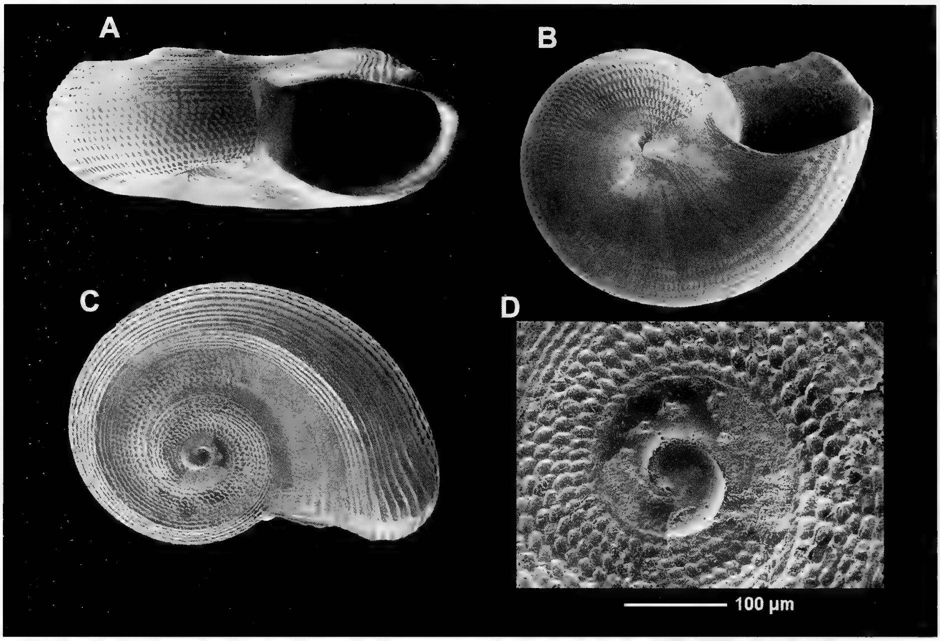
Dimensions: Holotype 0.93 mm in diameter and 0.4 mm of height. The material studied and figured is 1.4 and 1.6 mm in diameter and 0.6 mm in height.

Animal and radula unknown.

Habitat: The species lives on a muddy bottom at 18 m deep (MOORE, 1965). Our samples are from sediments collected on a coralline bottom between 25 and 50 m.

Distribution: Recorded from Yucatan State, Mexico and Haiti (MOORE, 1965); from Campeche Bank, Mexico (18 m) and Haiti (ABBOTT, 1974); from East and West Florida (LYONS, 1998); from Florida: Virginia Key and Schottegat, Curaçao (FABER, 2007) and from Cuba: Cienfuegos.

Remarks: *S. semipunctus* may be distinguished from its congeners by the strongly depressed spire, dorsal keel, and the umbilicus being totally occluded by the callus formed from the inner lip.



Figures 82A-D. *Solariorbis semipunctus* Moore, 1965. A-C: shells, 1.4, 1.6, 1.3 mm, Rancho Luna Beach (MHNS); D: protoconch.
Figuras 82A-D. Solariorbis semipunctus *Moore, 1965. A-C: conchas, 1,4, 1,6, 1,3 mm, Playa Rancho Luna (MHNS); D: protoconcha.*

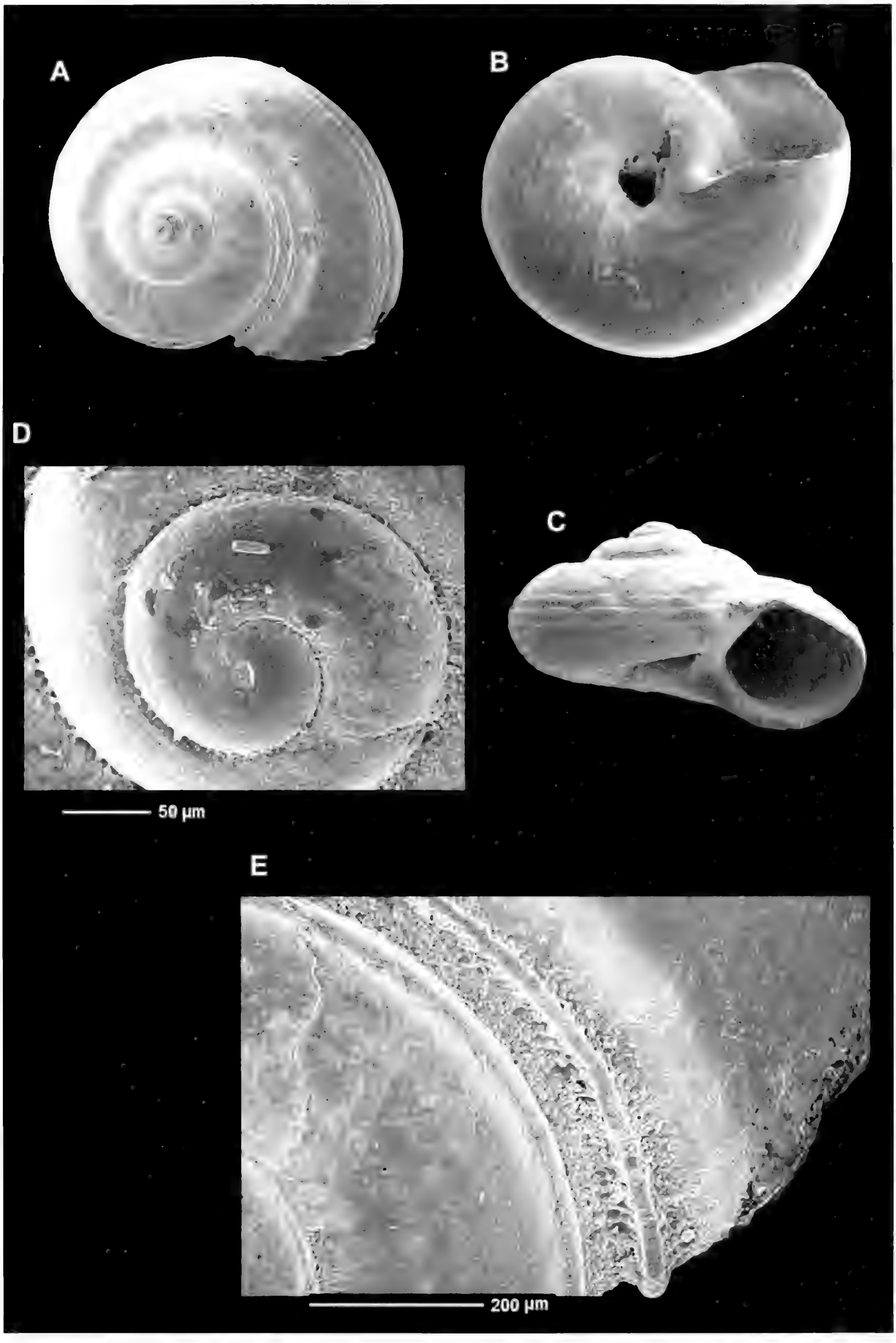
Solariorbis terminalis (Pilsbry & McGinty, 1946) (Figures 83A-E, 84A-F)

Vitrinella terminalis Pilsbry & McGinty, 1946. *The Nautilus*, 60: 17, pl. 2, fig. 5-5a. [Type locality: Destin, northwestern Florida].

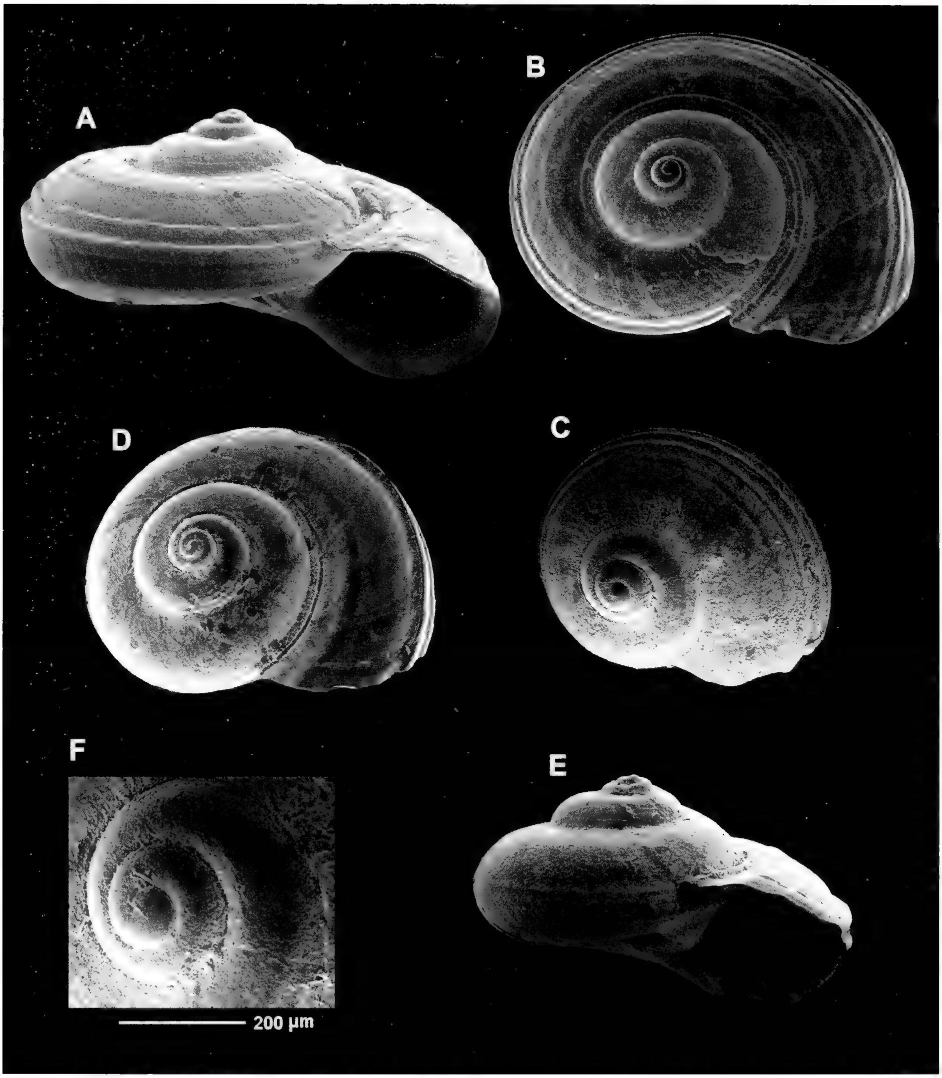
Type material: Type species in ANSP (181883). Not examined.
Material examined: Florida, USA: 1 s, Tarpon Springs, Pinellas Co., dredged S of Anclote Key, in 3.5-6 m (CMK); 2 s, 30°18.13'N 81°06.91'W, 24 m, off Mayport, Duval Co. (CHL); 1 s, off Fort Myers Beach, Lee Co., trawled 20 m (CHL); 2 s, 50-60 mi E Ponte Vedra, St. Johns Co., trawled at 39-45 m (CHL); 1 s, 10 mi SW Seahorse Key, Cedar Keys, Levy Co., trawled at 18 m (CHL); 1 s, St. Augustine, St. Johns Co., tailings scallop processing plant (CHL); 2 s, drift, Jacksonville Beach, Duval Co. (CHL).

Description: From the original description (Pilsbry & McGinty, 1946) we have copied some paragraphs which express important characters of the species: *"There are 4 ½ convex whorls joined by a rather strongly impressed suture. Last whorl is rounded at periphery and base. Sculpture of a few very weak but coarse spirals in the peripheral region. The columellar margin is extremely thick, reflected over part of the umbilicus"*.

The low conic shell (Fig. 83A-C, 84A-C) is relatively thick and heavy, and has a very small constricted umbilicus. Protoconch of 2 smooth glassy whorls. Teleoconch has two whorls. The spire is elevated and allows all the whorls to be seen in apertural view. Suture impressed. The sculpture consists of several low spiral threads on the peripheral area. The base is broad and smooth except for spiral sculpture on the outer part. Aperture circular; columella thick and heavy (Moore, 1965: 117-118).



Figures 83A-E. *Solariorbis terminalis* (Pilsbry & McGinty, 1946). A-D: shell, 1.7 mm, Tarpon Spring, Pinellas Co. (CMK); D: protoconch eroded; E: detail of the spire.
Figuras 83A-E. Solariorbis terminalis (Pilsbry & McGinty, 1946). A-D: concha, 1,7 mm, Tarpon Spring, Pinellas Co. (CMK); D: protoconcha erosionada; E: detalle de la espira.



Figures 84A-F. *Solariorbis terminalis* (Pilsbry & McGinty, 1946). A: shell, 2.5 mm, off Fort Myers Beach, Lea Co. (CHL); B-C: shells, 2.3, 1.1 mm, off Mayport, Duval Co. Florida, 20 m (CHL); D-E: shells, 1.9, 1.8 mm, 50-60 mi E Ponte Vedra, St. Johns Co. (CHL); F: protoconch.
Figuras 84A-F. Solariorbis terminalis *(Pilsbry & McGinty, 1946). A: concha, 2,5 mm, frente a Fort Myers Beach, Lea Co. (CHL); B-C: conchas, 2,3, 1,1 mm, off Mayport, Duval Co. Florida, 20 m (CHL); D-E: conchas, 1,9, 1,8 mm, 50-60 millas al E de Ponte Vedra, St. Johns Co. (CHL); F: protocon-*

We add the following: The protoconch (Figs. 83D, 84F) has about 2 whorls, is smooth, and measures about 350 µm in diameter, lacking any thickening in the transition to the teleoconch. The teleoconch is dorsally smooth, having a marked suture developing into a sulcus which progressively enlarges until the middle part of the body whorl, thence forming a subsutural cord on the final quarter whorl. On the periphery of the last whorl 3-4 spiral cords can be seen. Columella wide, reflected towards the umbilicus, thickening the umbilical wall and subtotally closing the umbilicus. Internal lip reflected outward.

Within the umbilicus there are 2-3 fine spiral cordlets.

Dimensions: Maximum reported size: 2.4 mm

Habitat: This species lives on sandy bottom in depths between 18 and 35 m.

Distribution: USA: North Carolina (PORTER, 1974), West Florida (PILSBRY & MCGINTY, 1946b; MOORE, 1964); Panama (OLSSON & MCGINTY, 1958). MOORE (1964) considered the distribution of the species to be very limited, being restricted to northwestern Florida, but he did not consider the record of OLSSON & MCGINTY (1958) from Panama. ODÉ'S (1973b) record from the northwest Gulf of Mexico, must be confirmed, because he himself (ODÉ, 1988) did not again record this species.

Remarks: PILSBRY & MCGINTY (1946: 17) stated: *"The conic spire has more whorls and a deeper suture than in typical Vitrinellidae, and the columella is very heavily callused. The umbilicus is quite small up to the last half whorl of the umbilical suture, when it becomes rapidly much wider"*. In our opinion, the subsutural sulcus on the last whorl, the peripheral cords, and the lack of dorsal and basal ornamentation, with the exception of the thickened umbilical margin, are the distinguishing characters of the species.

Vitrinella diaphana (d'Orbigny, 1842) could be this species, but the type material is in such poor condition that this cannot be ascertained (see Fig. 108G). It should be considered, therefore, a nomen *dubium*.

Solariorbis ruris spec. nov. (Figures 85A-J)

Type material: Holotype (Fig. 85A) in MNCN (15.05/55058) and 1 paratype (Fig. 85B), from type locality, at -20 m (15.05/55059). Other paratypes: MHNS (100551, 1 s, Fig. 85C), at -20 m; MNHN (24397, 1 s, Figs. 85D-E), at -45 m.

Other material examined: Martinique: 1 s, (CJP) (Figs. 85F-G).

Type locality: Rancho Luna Beach, 20 m, Cienfuegos, Cuba.

Etymology: The specific name is derived from the Latin third declension noun *rus, ruris,* meaning "of the farm; rural" in reference to its surface, in some areas with parallel lines, as in the surface of a plowed field.

Description: Shell (Figs. 85E-G) of small size, depressed, solid, 4 whorls, with characteristic spiral threads and punctiform grooves. Protoconch (Figs. 85H) of about 2 whorls, measuring about 290 μm in diameter; its surface is covered by fine tubercles; a delicate varix is observed. Teleoconch of about 2 rapidly-increasing whorls; dorsally and ventrally convex; totally covered by spiral cordlets and punctiform incisions in the interspaces, forming the characteristic reticular punctiform sculpture. In the dorsal area of the last whorl, between the suture and the periphery, a central zone without spiral microsculpture can be observed; a similar area can be seen close to the umbilicus on the base of the last ½ whorl. Axial ornamentation consists of growth striae. Base slightly convex, umbilicus small, progresively occluded by the columellar callus. Aperture rounded, prosocline, external lip sharp, columellar margin and internal lip thickened, reflected towards the umbilicus forming a characteristic triangular callus.

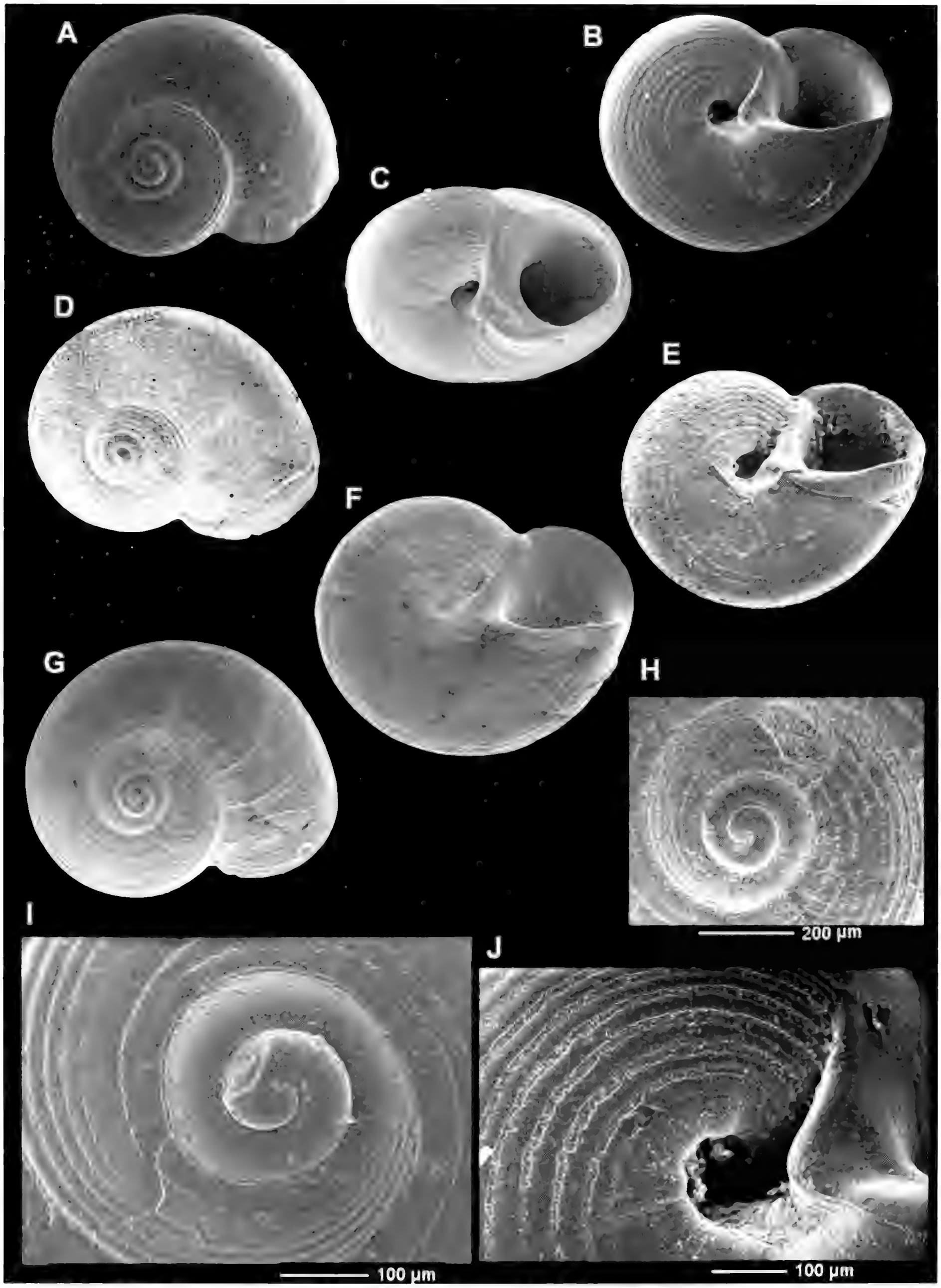
Dimensions: Holotype 1.50 mm in diameter and 0.57 mm in height.

Animal unknown.

Habitat: The species has been found on a coralline sandy bottom, sometimes with a little mud, at 45 m.

Distribution: Only known from Cuba and Martinique.

Remarks: *Solariorbis ruris* spec. nov. has a sculpture formed by spiral cordlets with punctiform incisions in the interspaces which covers all the shell except for a short band without



Figures 85A-J. *Solariorbis ruris* spec. nov. A: holotype, 1.3 mm, Rancho Luna Beach (MNCN); B: paratype, 1.4 mm (MNCN); C: paratype, 1.3 mm (MHNS); D-E: paratype, 1.3 mm (MNHN); F-G: shell, 1.5 mm, Martinique (CJP); H-I: protoconchs; H: from the shell of Fig. G; I: from the holotype Fig. A; J: detail of the base (paratype Fig. B).

Figuras 85A-J. Solariorbis ruris *spec. nov. A: holotipo, 1,3 mm, Playa Rancho Luna (MNCN); B: paratipo, 1,4 mm (MNCN); C: paratipo, 1,3 mm (MHNS); D-E: paratipo 1,3 mm, (MNHN); F-G: concha, 1,5 mm, Martinica (CJP); H-I: protoconchas; H: de la concha de la Fig. G; I: del holotipo Fig. A; J: detalle de la base (paratipo Fig. B).*

spiral microsculpture on the dorsum and base of the last whorl. It also possesses a triangular columellar callus.

Solariorbis terminalis is the only species with somewhat similar ornamentation, but the cords cover only the dorsum of the shell and are wider and less numerous.

From *Solariorbis lineopunctatus* (see below) it may be distinguished by the fewer, thicker and spiral cordlets.

From *Solariorbis* sp. (see below) it may be differentiated by its rounded convex periphery and the sulcus with punctiform incisions instead of quadrangular hollows.

Solariorbis lineopunctatus spec. nov. (Figures 86A-D)

Type material: Holotype (Figs. 86A-B) in MNCN (15.05/55056) and one paratype in MNCN (15.05/55057).
Type locality: Cienfuegos Bay, sta. 12, 22°07'N 80°27'W, 9 m, Cuba.
Etymology: The specific name refers to the punctiform sculpture aligned spirally which totally covers the shell.

Description: Shell (Figs. 86A-B) of very small size, not very depressed, apparently not very solid; spire formed by three rapidly-increasing whorls, sligtly angled at the periphery, not keeled. Protoconch (Figs. 86C) of about 2 whorls, measuring about 400 μm in diameter, being placed on a plane slightly above the subsequent whorls and with its surface covered by small tubercles and very fine spiral threads. [In some places these form a fine reticule. Teleoconch with a little more than 1 rapidly-increasing whorl; convex dorsally as well as on the base, periphery angled; surface totally covered by punctiform incisions spirally aligned except inside the umbilicus, where only numerous growth marks are appreciated. Aperture rounded, without a sulcus in the inner upper angle. Outer lip sharp. Columella and inner lip thickened and reflected outward. Umbilicus relatively wide and deep, without evident ornamentation except for the axial growth marks.

Dimensions: Holotype 1.05 mm in diameter, and 0.36 mm in height.

Animal unknown.

Habitat: The species was found in depths between 10 and 60 m, on coralline and slightly muddy bottoms.

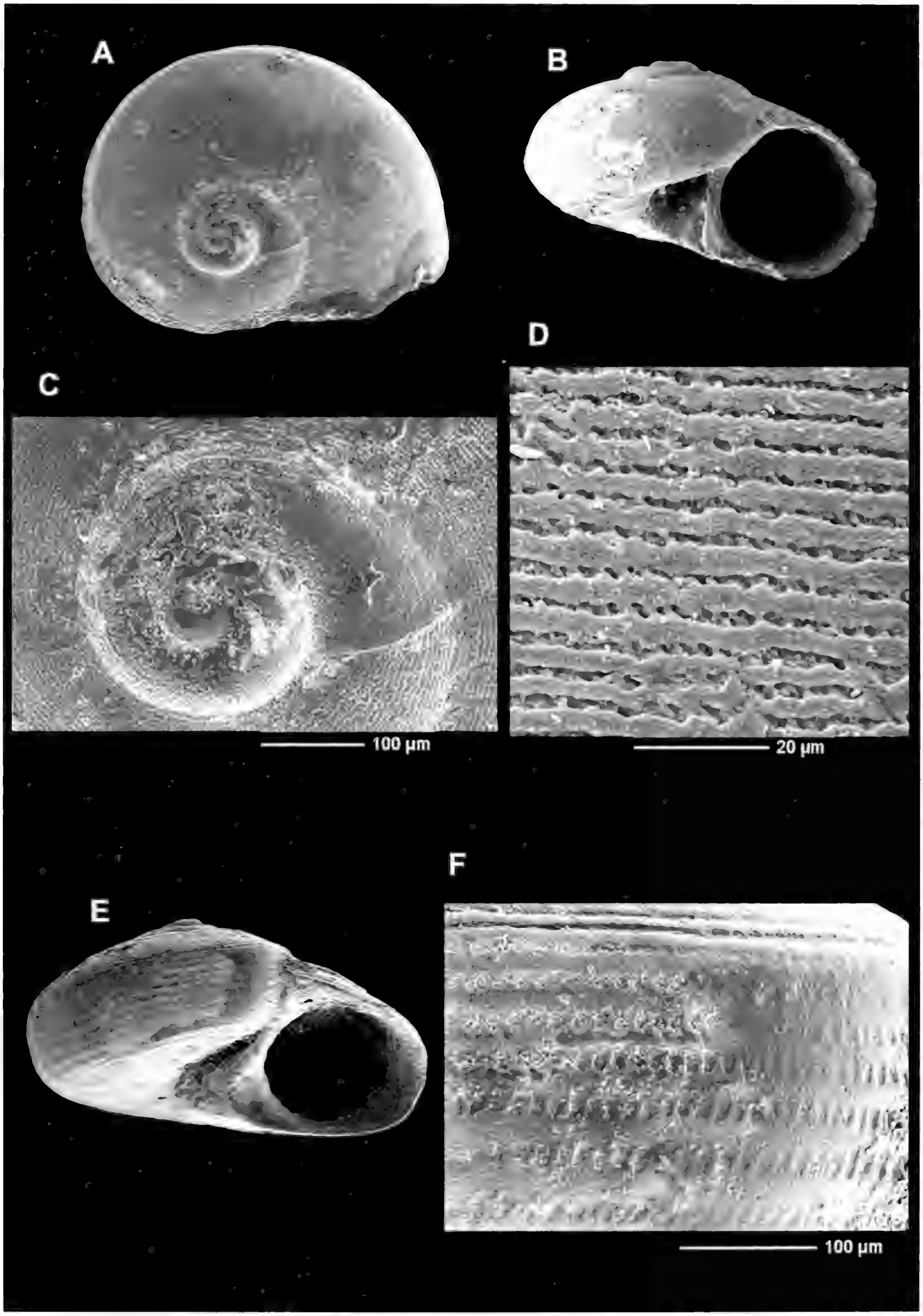
Distribution: Only know from Cuba.

Remarks: The shell of *Solariorbis lineopunctatus* spec. nov. is not very strong, with a fragile aspect, reddish color, and dull in luster. Its teleoconch, totally covered with spirally-aligned punctiform incisions makes it easily recognizable and distinguishes it from its congeners. Its ornamentation is rather similar to that present in some species of the genus *Teinostoma* (*T. goniogyrus, T. lenticulare*), but the wide umbilicus and the thickening of the umbilical border are distinctive.

Solariorbis sp. (Figures 86E-F)

Material studied: One shell (Figs. 86E) off Dominica, 200 m, in detritus obtained from inside submerged bottles (lost during the study).

Description: Shell (Fig. 86E) trochoid, solid, not very depressed, of dirty white color. Protoconch with about 2 spiral whorls on a little higher plane than the later whorls. Teleoconch formed by about 2 whorls totally



Figures 86A-D. *Solariorbis lineopunctatus* spec. nov. A-B: holotype, 1.05 mm, Cienfuegos Bay (MNCN); C: protoconch; D: microsculpture. Figures 86E-F. *Solariorbis* sp. E: shell, 1.47 mm, off Dominica; F: microsculpture.

Figuras 86A-D. Solariorbis lineopunctatus *spec. nov. A-B: holotipo, 1,05 mm, Bahía de Cienfuegos (MNCN); C: protoconcha; D: microescultura. Figuras 86E-F.* Solariorbis *sp. E: concha, 1,47 mm, frente a Dominica; F: microescultura.*

covered by spiral cords of equal size and axial sulci forming quadrangular spaces. Periphery only slighty convex, almost straight; a spiral cord in the dorsal extreme and another in the basal part form the limits and create slight angulations. Base slightly concave in its central part. Umbilicus small, almost occluded by a callus formed from a thickening of the columella. Aperture rounded, the superior angle with a sulcus; parietal area straight and thickened, external lip sharp. Columella widened and reflected towards the external part forming a characteristic callus.

Dimensions: The shell is 1.47 mm in diameter and 0.76 mm in height.

Animal unknown

Habitat: The only specimen known was collected in the shell grit found inside one of a few bottles found at 200 m.

Distribution: Only known from the island of Dominica.

Remarks: The present shell may be distinguished from its congeners by its sculpture of spiral cordlets and cuadrangular hollows covering the shell, by the wide callus formed by the thickening of the columella, and principally by the dorsal and basal cords which angulate the periphery, giving it an almost straight profile. *S. lineopunctatus* n. sp. has narrower, more numerous spiral cords and the sulcus has punctiform incisions. From *S. ruris* n. sp. it can be separated by the latter having the smooth zones on the body whorl and its smaller, triangular columellar.

Unfortunately this shell was lost during the study, and we decided not to name this species until new material can be collected.

Solariorbis punctostriatus spec. nov. Rubio, Rolán & Lee (Figures 87A-E)

Type material: Holotype (Figs. 87A-B) deposited in FLMNH (448610)(*ex* CHL). One paratype from the type locality (CHL). Another paratype in USNM (1155036, 1 s, *ex* CHL, from Courland Bay, Tobago).

Type locality: Isla Margarita, Venezuela.

Etymology: The specific name refers to its microsculpture formed by spiral striae with punctiform depressions.

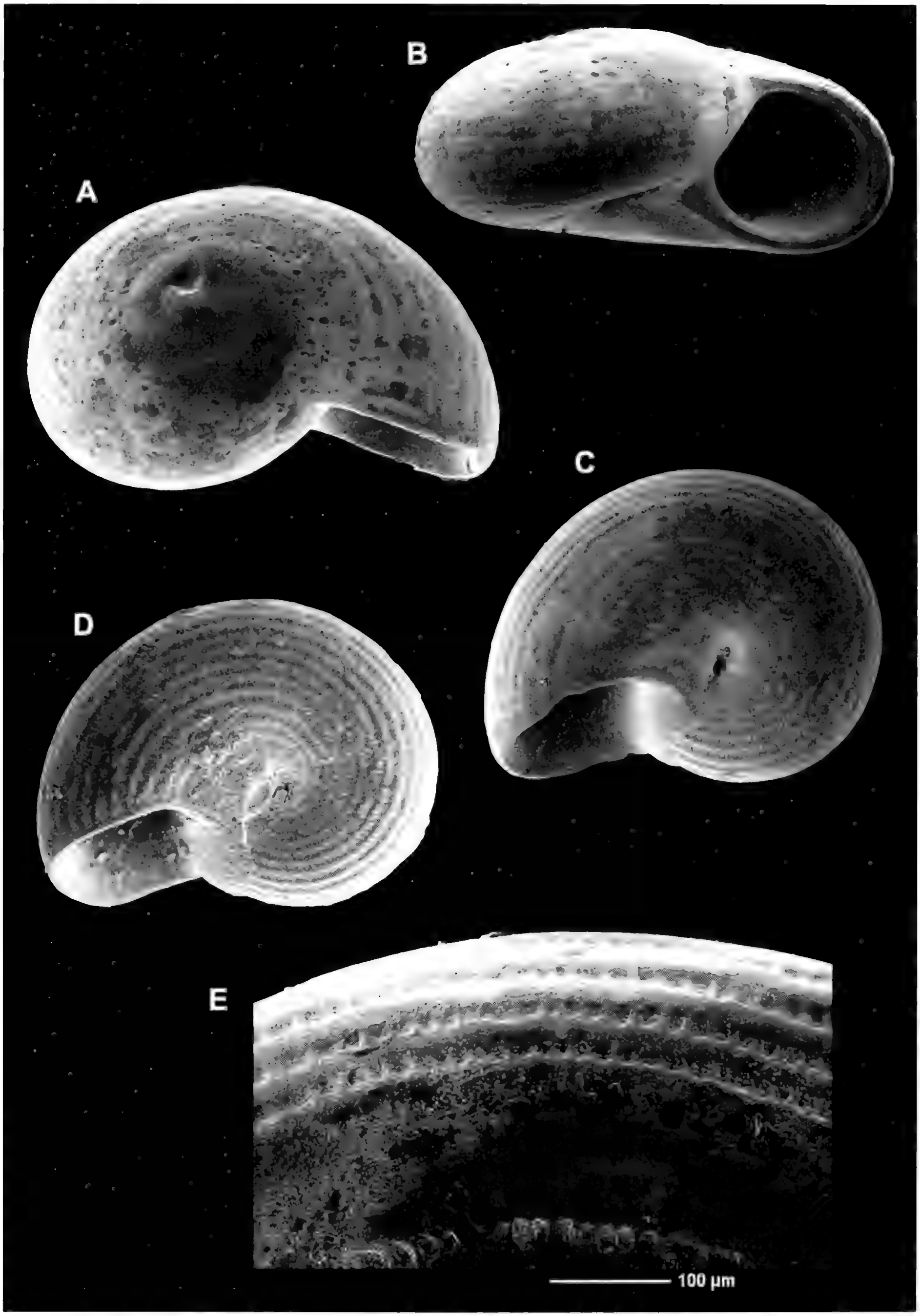
Description: Shell (Figs. 87A-D) solid, depressed, about equally convex above and below, with rounded periphery and spiral striae throughout. Protoconch of about 1 ½ whorls, not projecting upward. Teleoconch of about 2 whorls, totally covered by spiral cords, in interspaces of which axial striae can be seen, forming characterístic small hollows. Rounded periphery. Aperture rounded, slightly prosocline, external lip a little thickened, columella thickened and reflected outward forming a small callus. Umbilical area concave. Umbilicus almost closed by the thickening of the umbilical margin.

Dimensions: Holotype 1.39 mm in diameter and 0.63 mm height. One paratype with about 1.4 mm in maximum dimension.

Habitat: Unknown, the material was collected in sediments.

Distribution: Only known from Isla Margarita, Venezuela, its type locality, and Courland Bay, Tobago.

Remarks: *Solariorbis punctostriatus* spec. nov. has a shell very similar in general appearance to that of *V. cupidinensis*, from which it can be distinguished by having the umbilicus practically closed, almost reduced to a fissure, and by the columellar callus which thickens the umbilical wall and closes the umbilicus. Also it is similar to some *Teinostoma* species, from which it can be distinguished by the typical occlusion of the umbilicus by the thickening of the columella and by its typical *Solariorbis* sculpture.



Figures 87A-E. *Solariorbis punctostriatus* spec. nov. Rubio, Rolán & Lee. A-B: holotype, 1.4 mm, Isla Margarita, Venezuela (FLMNH); C: paratype, 1.4 mm, from type locality (CHL); D: paratype, 1.2 mm, Tobago (USNM); E: detail of the ornamentation.

Figuras 87A-E. Solariorbis punctostriatus *spec. nov. Rubio, Rolán & Lee. A-B: holotipo, 1,4 mm, Isla Margarita, Venezuela (FLMNH); C: paratipo, 1,4 mm, de la localidad tipo (CHL); D: paratipo, 1,2 mm, Tobago (USNM); E: detalle de la ornamentación.*

"Solariorbis" solidus spec. nov. (Figures 88A-F, 89A-F)

Type material: Holotype (Fig. 88A) in MNCN (15.05/55060). Paratypes: MNHN (24398, 1 s, Fig. 88B), NHMUK (1 s, Figs. 88E, 89A), MCZ (1 s, Figs. 89B-C), USNM (1155037, 1 s, Fig. 89F), all from type locality; AMNH (1 s, Fig. 88C) Cayo Diego Perez, Canarreos Archipelago, 20 m, Cuba; MHNS (100552, 1 s, Fig. 88D) Cienfuegos, 20-30 m.

Other material examined: Cuba: 3 s, Canarreos (MHNS). Florida, USA: 1 s, Little Madeira Bay. Everglades N.P. Florida, Monroe Co., low tide (CHL).

Type locality: Rancho Luna Beach, Cienfuegos, 20-45 m, Cuba.

Etymology: The specific name refers to the solidity of the shell, more observable in the contour of the aperture.

Description: Shell (Figs. 88A-E, 89A-F) trochoid, solid, yellowish white, polished and shiny. Protoconch (Fig. 88F) broad and flat, slightly projecting, with about 1 ¼ whorls, 410 µm in diameter, and without sculpture. Teleoconch of about 1 ¼ rapidly-increasing whorls; dorsally and ventrally convex. The shell is generally smooth and without sculpture except for weak axial growth lines, which in some specimens are much more rough and sharp, and faint spiral cords on the basal periphery. Aperture oval, outer lip thick, columellar margin thickened and reflected outward. Umbilicus wide and deep, inside there is a thick cord formed by a thickening of the columella, which surrounds and limits the umbilical infundibulum.

Dimensions: Holotype 1.3 mm in diameter, but there is a paratype 1.8 mm in diameter.

Animal unknown.

Habitat: This species has been collected between 5 and 45 m, on a coralline sand bottom.

Distribution: Only known from Cuba and Florida, USA.

Remarks: We are not totally sure that this species is a tornid, not even having complete security about it being a marine species. Therefore its generic placement in *Solariorbis*, and even in Tornidae, is provisional. We made a comparison with a paratype of *Paludinella helicoides* "Gundlach" 1865 (MCZ), and our impresion is that the latter is not as solid. The dearth of conchological characters makes a proper comparison difficult. *Paludinella helicoides* is a species of fresh water hydrobiid considered endemic to Cuba, but due to its seldom being collected it has been recorded only a few times. Anyway, in our material there are other shells, collected in areas as distant as Cuba and Florida. We keep its provisional description while awaiting more material.

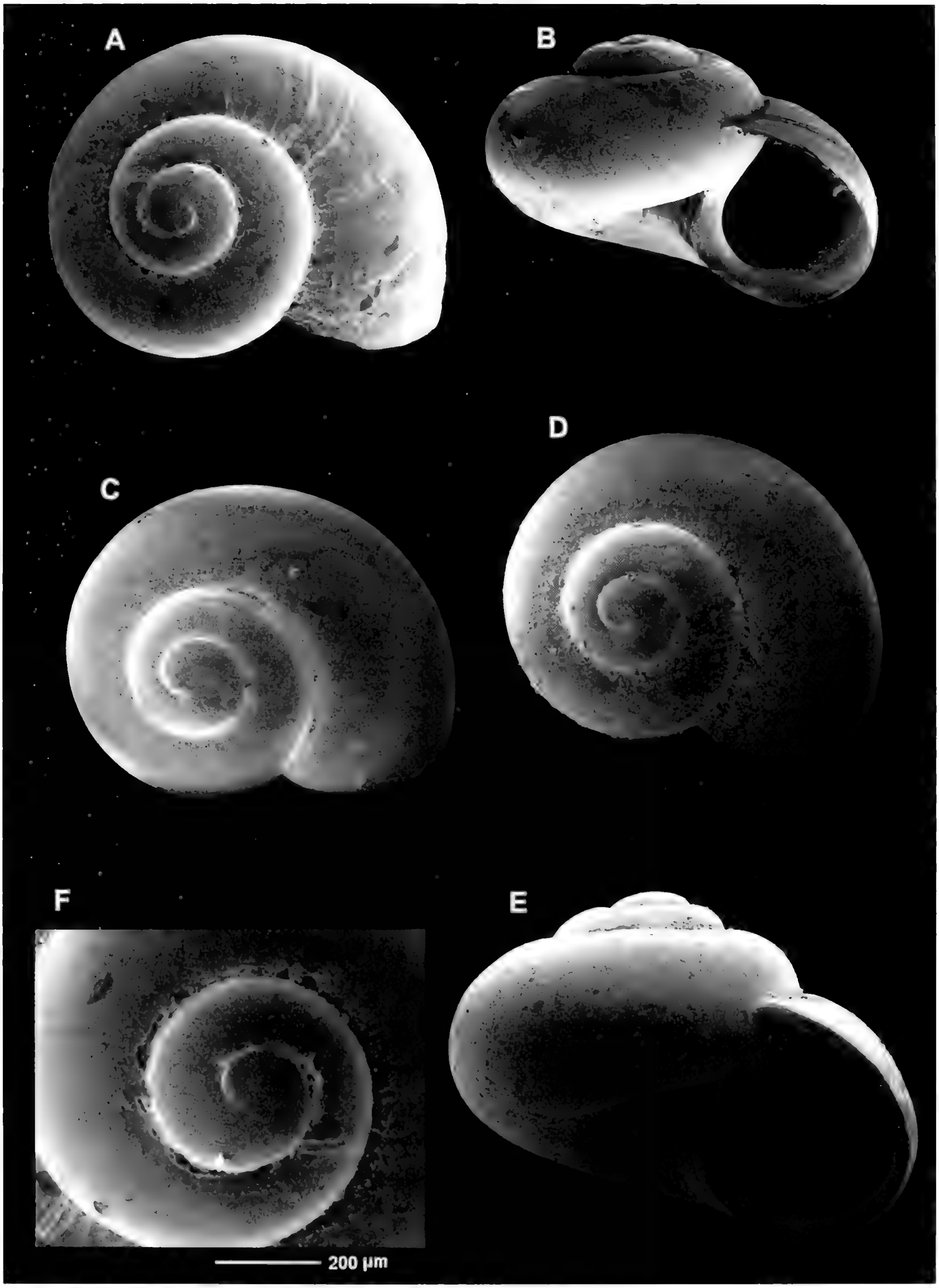
Although the overall appearance of the shell, wide umbilicus and aperture, predisposes us to place it in *Vitrinella*, the columellar thickening and the thickening of the umbilical wall are typical characters of the genus *Solariorbis*.

Solariorbis solidus spec. nov. differs from provisional congeneric species by a trochoid form, its wide umbilicus, the lack of ornamentation on the teleoconch, and its solidity in spite of its fragile appearance.

Genus *Vitrinella* C.B. Adams, 1850

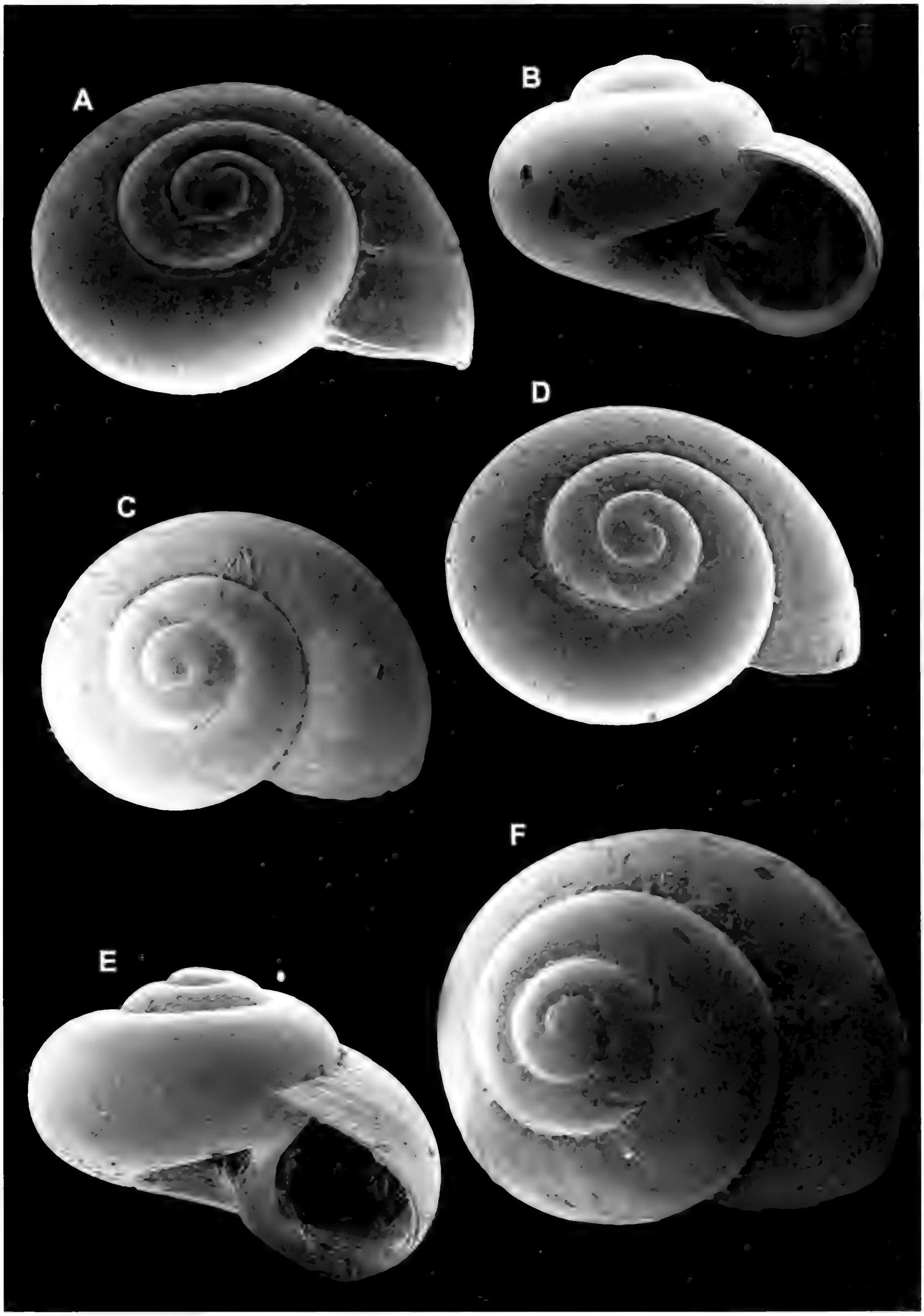
Vitrinella C.B. Adams, 1850. *Monograph of Vitrinella, a new genus of species of Turbinidae*. 10 p. Amherst Massachusetts.

Type species: (by original designation) *Vitrinella helicoidea* C.B. Adams, 1850 (by subsequent designation: BUSH, 1897: 105. Caribbean, Recent.



Figures 88A-F. "*Solariorbis*" *solidus* spec. nov. A: holotype, 1.3 mm, Rancho Luna Beach, Cuba (MNCN); B: paratype, 1.08 mm, Rancho Luna Beach (MNHN); C: paratype, 1.14 mm, Canarreos, Cuba (AMNH); D: paratype, 1.08 mm, Cienfuegos Bay (MHNS); E: paratype, 1.6 mm, Rancho Luna Beach (NHMUK); F: protoconch of the holotype.

Figuras 88A-F. "Solariorbis" solidus *spec. nov. A: holotipo, 1,3 mm, Playa Rancho Luna, Cuba (MNCN); B: paratipo, 1,08 mm, Playa Rancho Luna (MNHN); C: paratipo, 1,14 mm, Canarreos, Cuba (AMNH); D: paratipo, 1,08 mm, Bahía de Cienfuegos (MHNS); E: paratipo, 1,6 mm, Playa Rancho Luna (NHMUK); F: protoconcha del holotipo.*



Figures 89A-F. "*Solariorbis" solidus* spec. nov. A: paratype, 1.6 mm, Rancho Luna Beach (NHMUK); B-C: paratype, 1.17 mm, Rancho Luna Beach (MCZ); D-E: shells, 1.2 mm, Cienfuegos Bay; F: paratype, 1.8 mm, Rancho Luna Beach (USNM).

Figuras 89A-F. "Solariorbis" solidus *spec. nov. A: paratipo, 1,6 mm, Playa Rancho Luna (NHMUK). B-C: paratipo, 1,17 mm, Playa Rancho Luna (MCZ); D-E: conchas, 1,2 mm, Bahía de Cienfuegos; F: paratipo, 1,8 mm, Playa Rancho Luna (USNM)..*

Diagnosis: Shell small, fine, smooth or weakly sculptured, low spire and open, deep umbilicus. Aperture rounded and only slightly modified by the previous whorl. Parietal callus usually thin. Animal provided with a pair of ciliated cephalic tentacles, a pair of epipodial tentacles, and a circular multispiral operculum. Radula taenioglossate.

Remarks: C.B. ADAMS (1850) instituted a new genus *Vitrinella* for five new species of micromolluscs found in beach sand from Jamaica. No type species was selected and none of the species was figured. BUSH (1897) designed *Vitrinella helicoidea* as the type species of the genus, describing this species again and figuring it for first time.

Vitrinella anneliesae de Jong & Coomans, 1988 (Figures 90A-I)

Vitrinella anneliesae de Jong & Coomans, 1988. *Marine gastropods from Curaçao, Aruba and Bonaire*: 31, pl. 2, fig. 131. [Type locality: Curaçao].

Type material: Holotype in ZMA (3.87.062). Represented in de JONG & COOMANS (1988). Not examined.
Other material examined: Cuba: 10 s, Canarreos Archipelago, 5 m (MHNS); 4 c, Cayo Avalos, 8 m (MHNS); 4 c, Cayo Diego Perez, 15 m (MHNS); 2 c, Faro Diego Perez, 10 m (MHNS); 3 s, Jibacoa, 3-6 m (MHNS); 3 c, Guajimico, 5 m (MHNS); 5 c, Cienfuegos Bay, 20-30 m (MHNS); 2 c, Cienfuegos Bay, 30 m (MHNS); 14 s, Rancho Luna Beach, 12 m (MHNS); 37 s, 10-30 m (MHNS); 2 s, Rancho Luna Beach, 35 m (MHNS); 20 s, Rancho Luna Beach, 45 m (MHNS); 106 s, Rancho Luna Beach, 5-54 m (MHNS); 7 s, Los Laberintos, Rancho Luna Beach, 35 m (MHNS); 21 c, Faro los Colorados, 56 m (MHNS); 11 s, Tamarindo Point, 56 m (MHNS). Martinique: 8 c, Pointe Borgnesse, 12 m, muddy sandy bottom near the reef (CJP). Grenadines: Mayreau, 1 c, west coast, 8 m, coralline sandy bottom with coral blocks, gorgonians, and sponges (CJP). Bahamas: 2 s, 6 m, off N Andros, dredgeg (CHL); 2 s, Riding Rocks, Cay Sal Bank, 18 m, base coral reef (CHL); 2 s, NW Nassau, 50 ft. Saint Vincent: 1 s (CHL). Honduras: 1 s, Roatan Island, 12 m, coralline sand. Puerto Rico: 1 s, NW Puerto Rico (CHL).

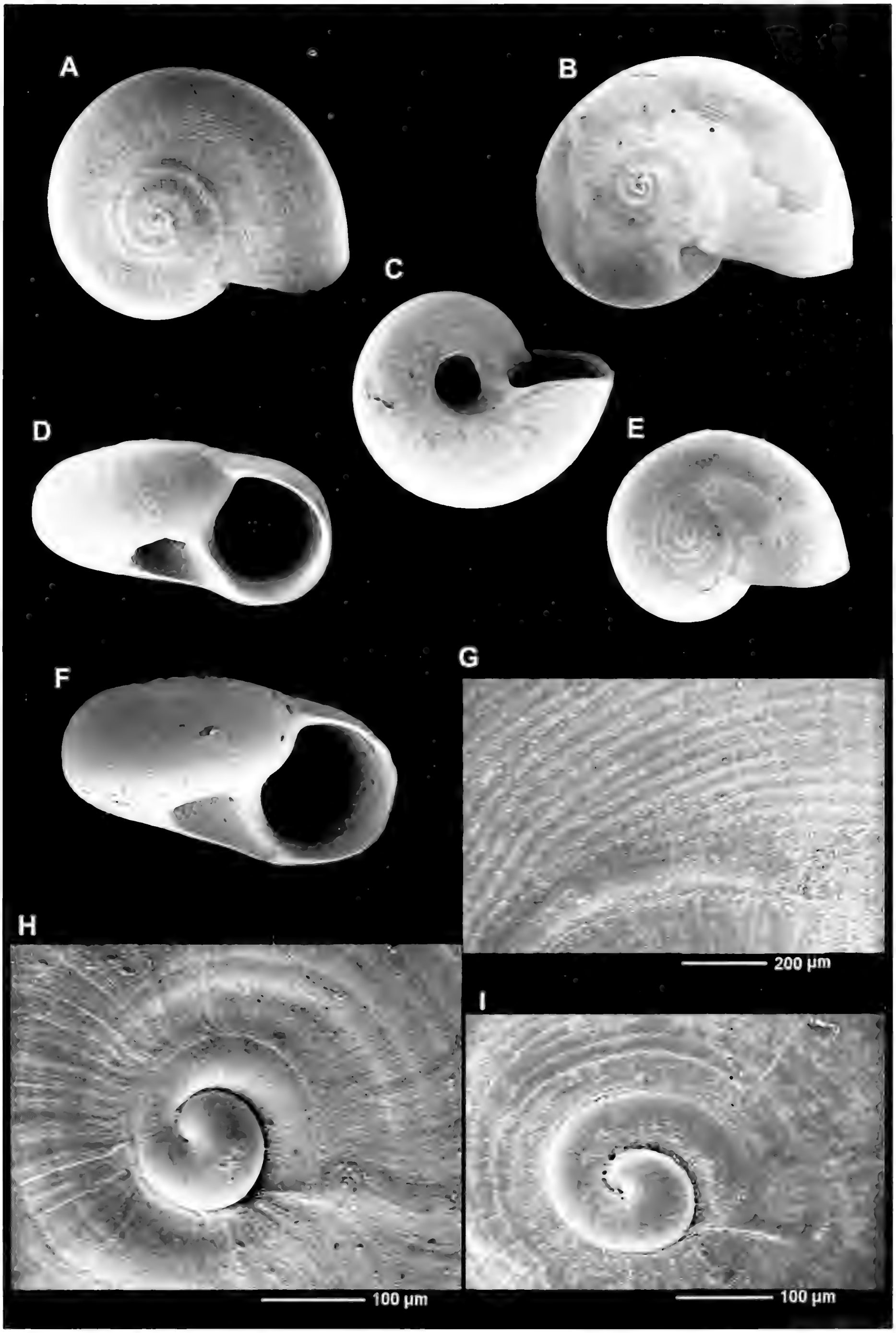
Description: The original description is as follow: *"Shell wider than high. Whorls without a keel. Except for the nucleus sculptured with fine spiral threads, which in larger specimens become hardly visible, or absent at the periphery of the last whorl. Umbilicus present"*. This is a very short description for a correct specific determination.

Therefore we are providing a new description pointing out the most important distinguishing characters: Shell (Figs. 90A-F) subconical depressed, solid, whitish and without any keel, spire formed by 3 ½ convex whorls, each overlapping most of the previous whorl. Protoconch (Figs. 90H-I) about 300 µm in diameter and about 1 ¼ whorls, with a slightly rough surface and a strong varix which marks the beginning of the teleoconch. Teleoconch of a little more than 2 whorls, totally covered by fine spiral cordlets which reach from the suture to the umbilical border. On the dorsum of the body whorl, the cords diverge somewhat laterally to the growth axis so that new ones continue to appear at the suture. One prominent spiral cord limits and precipitously angulates the umbilical infundibulum, which is deep and not very wide. Aperture rounded; columella robust; inner lip thickened by the crossing of the umbilical cord but without any callus.

Dimensions: Holotype 1.59 mm in diameter. We have shells reaching about 2.5 mm in maximum dimension. Maximum reported size: 1.7 mm

Habitat: This is one of the most common species in Cuba. Usually it was collected between 10 and 56 m, but sometimes shells have been found in shallower water.

Distribution: ABC Islands: Curaçao (DE JONG & COOMANS, 1988); Mar-



Figures 90A-I. *Vitrinella anneliesae* de Jong & Coomans, 1988. A-F: shells, 2.7, 2.8, 2.1, 2.7, 2.2, 3.1 mm, Cienfuegos, Cuba (MHNS); G: microsculpture of the shell Fig. A; H-I: protoconchs.
Figuras 90A-I. Vitrinella anneliesae *de Jong & Coomans, 1988. A-F: conchas, 2,7, 2,8, 2,1, 2,7, 2,2, 3,1 mm, Cienfuegos, Cuba (MHNS); G: microescultura de la concha de la Fig. A; H-I: protoconchas.*

tinique; Mayreau and Cuba: mainly collected in Cienfuegos Bay, but also in Canarreos and other areas.

Remarks: Since its original description this species has not been recorded from any Caribbean locality. It is a very characteristic species which has only a little similarity to *V. funiculus* and *V. contracta*. From *V. funiculus* it may be distinguished by the smaller umbilicus and by the smaller and more numerous spiral cordlets. From *V. contracta* it differs in the shape of its spiral cordlets and because they run parallel to, rather than obliquely from, the suture.

Vitrinella contracta (Vanatta, 1913) (Figures 91A-E)

Omalaxis funiculus contractus Vanatta, 1913. *Proc. Acad. Nat. Sci. Philadelphia*, 65: 25, pl. 2, figs. 4, 6. [Type locality: Monkey River, British Honduras].

Type material: Represented in VANATTA (1913) and deposited in ANSP (106.125). Not examined.
Other material examined: Cuba: 14 s, Rancho Luna Beach, 45 m (MHNS). Trinidad and Tobago: Tobago, 2 c, Horse Shoe Reef, 15 m, shell grit (CJP). Bahamas: 5 s, Olympus Reef, NNW West End, Grand Bahama Island, 36 m, coralline algal fragments bottom (CHL); 4 s, French Bay, San Salvador, 18 m (CHL); 6 s, Grand Bahamas, 7.5 m (CHL). St. Kitts & Nevis: 4 s, Monkey Shoals, Nevis, 18 m (CHL). ABC Islands: 1 s, NW Klein Bonaire, Bonaire, 15 m (CHL). St. Vincent: 1 s (CHL). Belize: 4 s, Dead Mans Reef, Turneffe Is., 18 m, sand (CHL). Turks & Caicos: 3 s, French Bay, 18 m (CHL). Florida, USA: 3 s, APAC Pit, Sarasota, Plio-Pleistocene (CHL).

Description: Shell (Figs. 91A-C). Protoconch (Fig. 91D) of about 1 ¼ smooth whorls, about 200 µm in diameter, set in a lower plane than the teleoconch. Two different stages can be distiguished: the embryonic, with barely ½ whorl and the larval with ¾ whorl and partially covered by the first whorl of the teleoconch. The entire surface of the teleoconch is sculptured by spiral cords which are placed parallel to the suture (Fig. 91E); there is no punctiform sculpture; a more prominent spiral cord is placed in the middle of the periphery and gives a keeled profile to the shell. Base convex, umbilicus deep and narrow, delimited by a spiral cord and not closed by the columellar thickening. Aperture orbicular; columella and inner lip thickened and reflected outward.

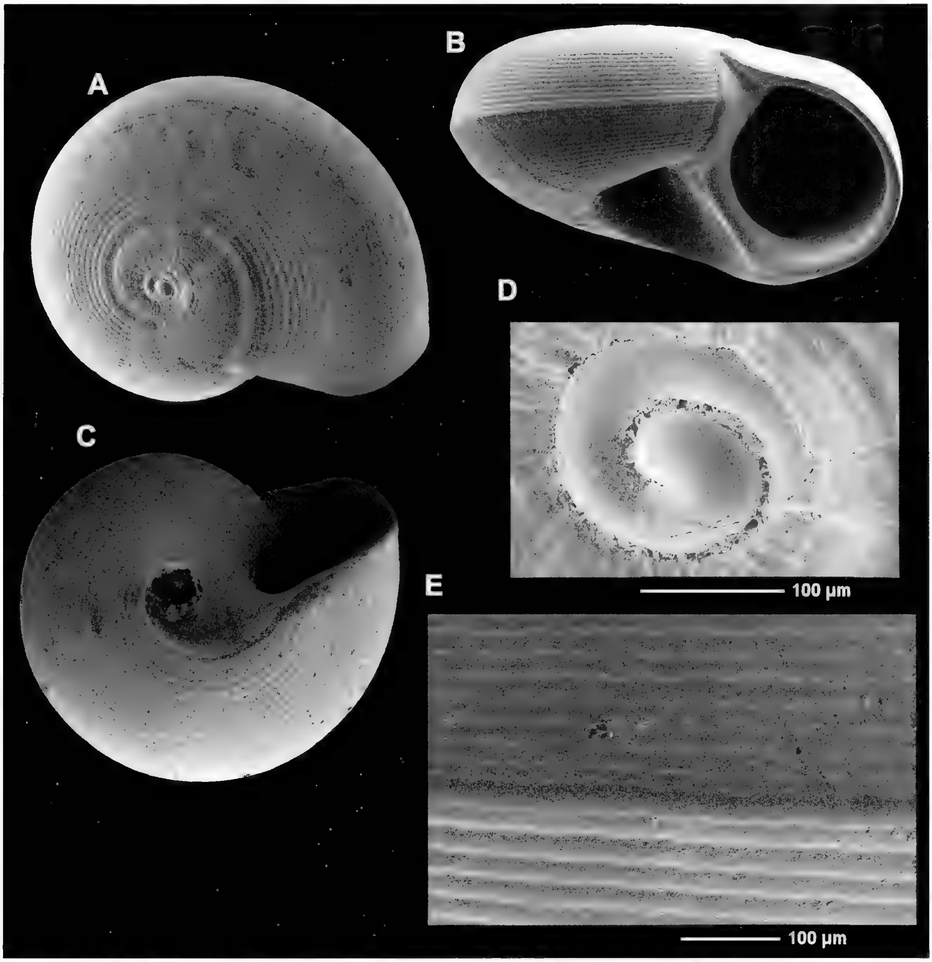
Dimensions: Holotype 1.85 mm in diameter. We have shells up to about 2.2 mm in maximum dimension.

Animal and radula unknown.

Habitat: Not described due to the fact that the holotype was found on an anchor. Our material was collected on coralline bottom between 25 and 50 m in depth.

Distribution: Known from Monkey River, British Honduras (VANATTA, 1913); Tobago; and Cienfuegos, Cuba.

Remarks: VANATTA (1913) described this taxon as a variety of *Omalaxis funiculus* Dall, from which it is distinguished by having a narrower umbilicus and because the spiral cords run parallel to the suture. *S. contracta* was placed in the genus *Solariorbis* due to the presence of a small triangular callus formed in the inner lip in the periumbilical region. We think that the existence of this small callus is insufficient indication to consider it a *Solariorbis*; instead, due to its similarity to several species of the genus *Vitrinella*, we consider its placement in this genus more accurate. *Vitrinella contracta*, as well *V. funiculus* and *V. anneliesae*, have a similar ornamentation, which is at the same time different from the other species included in this genus: smooth spiral cords, non-punctiform sulci, strong growth lines, and a strong periumbilical carina.



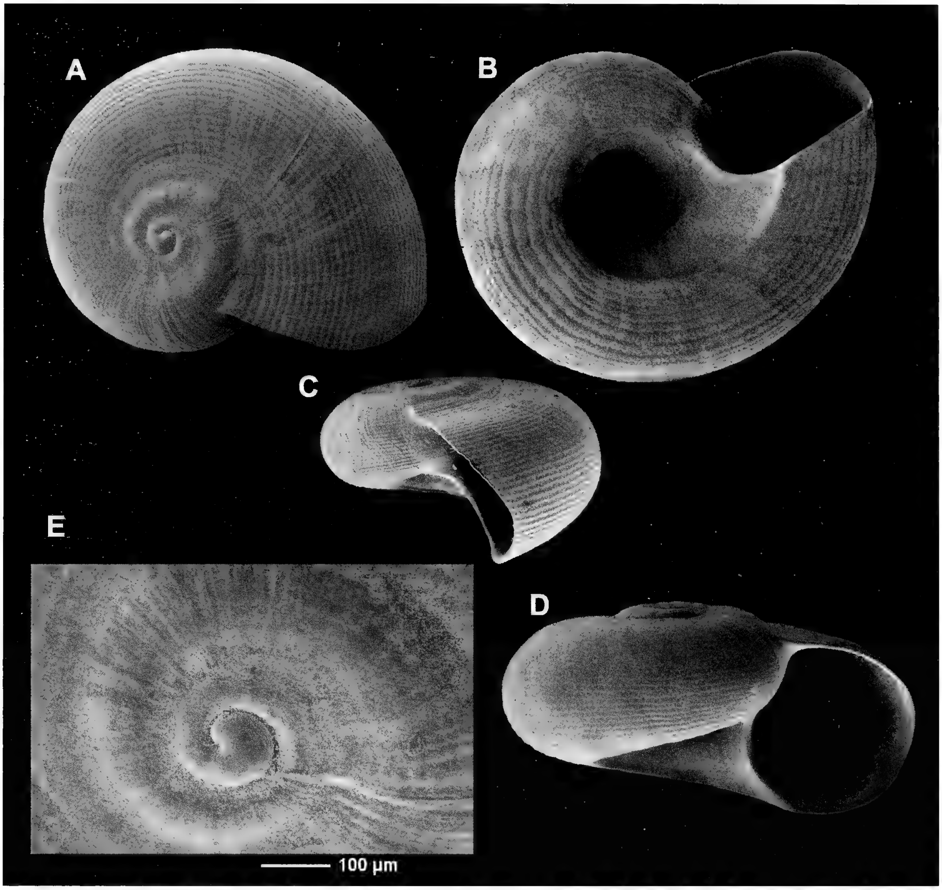
Figures 91A-E. *Vitrinella contracta* (Vanatta, 1913). A-C: shells, 2.0, 2.2, 2.0 mm, Rancho Luna Beach, Cuba. D: protoconch, from shell of Fig. A; E: sculpture.
Figuras 91A-E. Vitrinella contracta *(Vanatta, 1913). A-C: conchas, 2,0, 2,2, 2,0 mm, Playa Rancho Luna, Cuba. D: protoconcha, de la concha de la Fig. A; E: escultura.*

Vitrinella funiculus (Dall, 1892) (Figures 92A-E)

Teinostoma (Solariorbis) funiculus Dall, 1892. *Trans. Wagner Free Inst. Sci. Philadelphia*, 3: 417, pl. 23, fig. 15. [Type locality: Caloosahatchee River, Florida. Described as fossil of the Plio-Pleistocene].

Type material: Holotype in USNM (112652). Represented in DALL (1892). Not examined.
Other material examined: Cuba: 4 s, Rancho Luna Beach, 45 m.

Description: Shell (Figs. 92A-D). Protoconch (Fig. 92E) heterostrophic, of about 1 ¼ smooth whorls, about 230 µm in diameter, placed on a plane slightly below that of the teleoconch. Two distinct stages can be observed: the embryonic protoconch with barely ½ whorl and the larval one, which has ¾ of



Figures 92A-E. *Vitrinella funiculus* (Dall, 1892). A-D: shells, 1.6, 1.9, 1.5, 1.8 mm, Rancho Luna Beach (MHNS); E: protoconch.

Figuras 92A-E. Vitrinella funiculus *(Dall, 1892). A-D: conchas, 1,6, 1,9, 1,5, 1,8 mm, Playa Rancho Luna (MHNS); E: protoconcha.*

whorl and is partially covered by the first teleoconch whorl. In adult specimens there is no peripheral angulation. The teleoconch has its surface totally covered by spiral cordlets, which run obliquely from the suture and are a little wider on the base near the periumbilical cord. There is no punctiform ornamentation. Umbilicus very wide, infundibuliform, exposing the previous whorls. The umbilical wall, corresponding to the columellar margin, lacks spiral cords. No columellar callus.

Dimensions: Holotype 1.75 mm in diameter. We have shells of about 1.9 mm in maximum dimension.

Distribution: This species has been recorded live-collected in Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). From Cuba, Cienfuegos in present work.

Remarks: DALL (1892) mentions that *V. funiculus* is very similar to the juveniles of *Teinostoma opsitelotus*, being distinguished from this species by the umbilical characters. *V. funiculus* is very similar to *V. anneliesae*, from which it can be distinguished by its fewer spiral cords and wider umbilicus which exposes the previous whorls. From *V. contracta* it may be differentiated by its spiral cordlets running obliquely, not parallel, to the suture and by the larger umbilicus.

Vitrinella opsitelotus (Dall, 1892) (Figures 93A-E)

Teinostoma opsitelotus Dall, 1892. *Trans. Wagner Free Inst. Sci.*, 3: 414, pl. 19, figs. 5, 5b. [Type locality: Plio-Pleistocene of the Caloosahatchee River and Shell Creek, Florida].

Solariorbis opsitelotus (Dall): In PILSBRY (1953). *Monogr. Acad. Nat. Sci. Philad.* 8: 419, pl. 53, figs. 4-4e.

Type material: Holotype in USNM (113104). Not examined. Specimens figured by PILSBRY (1953) deposited in ANSP (18411).

Other material examined: Florida, USA: 7 s, APAC Pit, Sarasota Plio-Pleistocene (CHL).

Description: Original description in DALL (1892: 414). Description expanded in PILSBRY (1953: 419).

Distribution: Fossil species recorded from the Pliocene of the Caloosahatchee River and Shell Creek, Florida (DALL, 1892); from St. Petersburg Pliocene and Alligator Creek at Acline, Florida (PILSBRY, 1953).

Remarks: DALL (1892) placed this species in the genus *Teinostoma* mentioning in his description that the umbilicus was "*completely filled by a flattish, somewhat irregular callus,*" in shells which Dall believed to be adult of *T. opsitelotus*. PILSBRY (1953) placed it in *Solariorbis* mentioning: "*That [imperforate] form is not represented in the St. Petersburg series of over forty specimens. Many of them are about equal in size, and appear to be adult. This condition may perhaps permit the suggestion that Dall's form with the umbilicus filled by a callus is an abnormal or gerontic individual or possibly another species*".

If the columellar thickening proves sufficient a a reason to keep it in the genus *Solariorbis*, the form and ornamentation of the protoconch, together with the sculpture of the teleoconch and the umbilicus (which in basal view, is not closed by the thickening of the umbilical wall) seem to place this species close to the *Vitrinella anneliesae*, *V. contracta* and *V. funiculus* group. So, in our opinion it must be placed in the genus *Vitrinella*.

Vitrinella helicoidea C.B. Adams, 1850 (Figures 94A-G, 95A-D)

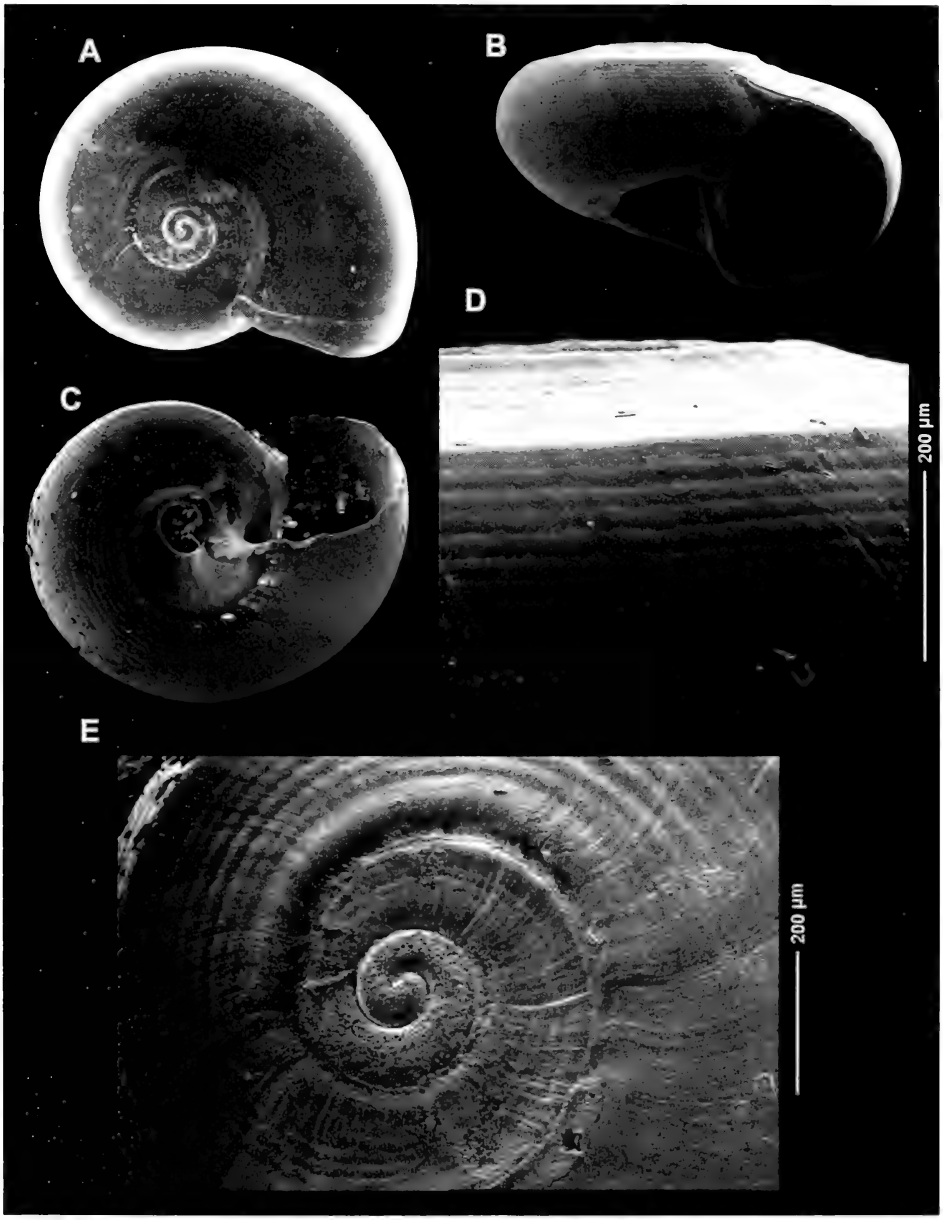
Vitrinella helicoidea C.B. Adams, 1850. *Monograph of Vitrinella, a New Genus of New Species of Turbinidae*: 9. [Type locality: Port Royal, Jamaica].

Vitrinella praecox Pilsbry & McGinty, 1946b. *The Nautilus*, 60: 14-15, pl. 2, figs. 1-1b. [Type locality: North end of Lake Worth].

Type material: Lectotype in MCZ (156271), represented in CLENCH & TURNER, 1950: plate 35, fig. 1); 1 paralectotype (labeled as paratype), also from the type locality (MCZ 186188). *Vitrinella praecox* represented in PILSBRY & MCGINTY (1946b). Not examined.

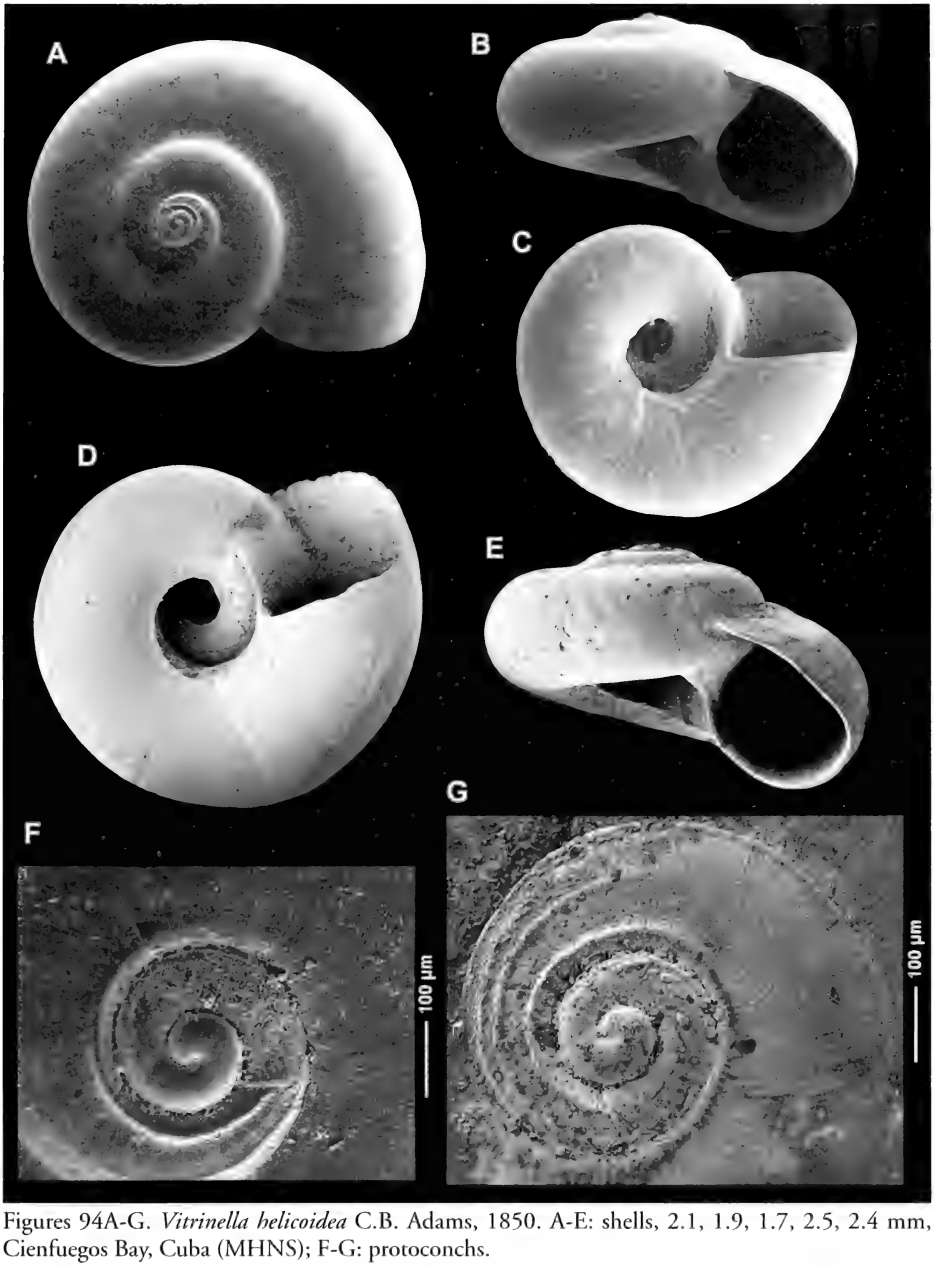
Other material examined: Cuba: 5 s, Sancho Pardo Shoal, 15 m (MHNS); 5 s, Guajimico, 5 m (MHNS); 30 s, Cienfuegos Bay, 8 m (MHNS); 1 s, Cienfuegos Bay, sta. 12, 22°07'N 80°27'W, 9 m (MHNS); 4 s, Cienfuegos Bay, sta. 12a, 22°07'N 80°26'W, 4 m (MHNS); 3 s, Cienfuegos Bay, 20-30 m (MHNS); 18 s, Rancho Luna Beach, 20 m (MHNS); 1 j, Rancho Luna Beach, 10-20 m (MHNS); 4 s, Cienfuegos Bay, 8 m (MHNS); 4 s, Guajimico, figured (MHNS). Virgin Islands: 2 s, St. Thomas (MCZ 156276). Venezuela: 3 s, José Griego, north coast Isla Margarita, 0 m, drift (CHL). ABC Islands: 1 s, Newport Reef, Curaçao, 20 m (CHL). Antigua: 1 s, Falmouth Harbour, 1-2 m, sand grass, (CHL). Turks & Caicos: 1 s, The G Spot, French Cay, 18 m (CHL). Florida, USA: 1 s, off Boynton inlet, Palm Beach Co., 76-90 m (CHL).

Description: Shell (Figs. 94A-E) trochoid in shape, glossy, with a low profile, 4 ½ whorls; each whorl overlaps the periphery of the previous one. Protoconch (Figs. 94F-G) with a finely wrinkled surface at its beginning and spiral irregu-



Figures 93A-E. *Vitrinella opsitelotus* (Dall, 1892). A-C: shells, 2.1, 2.1, 2.2 mm, Sarasota Co. Florida (CHL); D: detail of the sculpture; E: protoconch.
Figuras 93A-E. Vitrinella opsitelotus *(Dall, 1892). A-C: conchas, 2,1, 2,1, 2,2 mm, Sarasota Co. Florida (CHL); D: detalle de la escultura; E: protoconcha.*

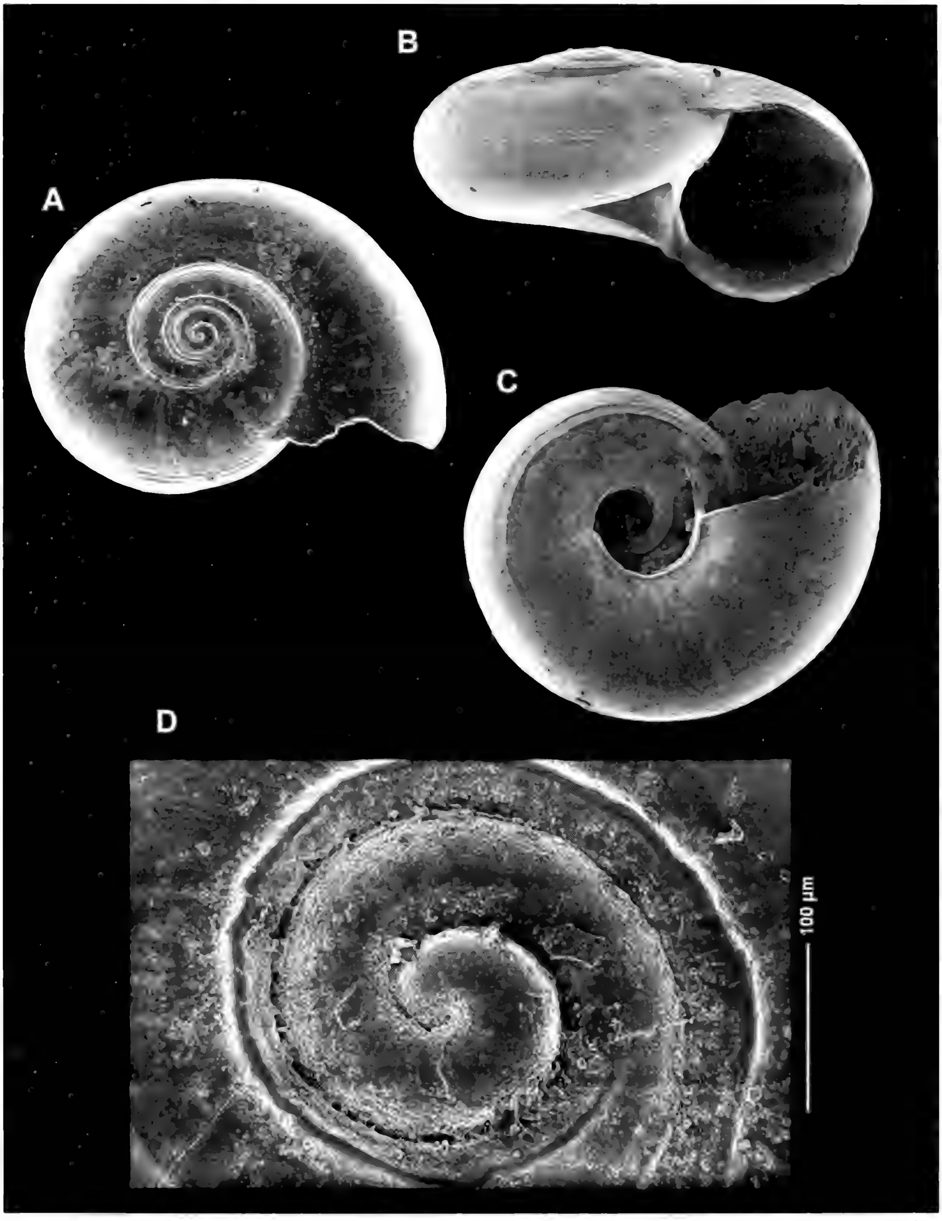
lar cordlets in the subsequent part; about 280 µm in diameter and a little more than 1 ½ whorls. Teleoconch formed by 2 ½ whorls. From the varix which marks the end of the protoconch there are two strong spiral cords which extend up to the end of the first whorl of the teleoconch where they fade out. The subsequent part of the



Figures 94A-G. *Vitrinella helicoidea* C.B. Adams, 1850. A-E: shells, 2.1, 1.9, 1.7, 2.5, 2.4 mm, Cienfuegos Bay, Cuba (MHNS); F-G: protoconchs.
Figuras 94A-G. Vitrinella helicoidea *C.B. Adams, 1850. A-E: conchas, 2,1, 1,9, 1,7, 2,5, 2,4 mm, Bahía de Cienfuegos, Cuba (MHNS); F-G: protoconchas.*

shells is nearly smooth, with only very fine growth lines. A spiral cord angulates the border of the umbilical infundibulum. Umbilicus deep with smooth walls.

Dimensions: Lectotype 2.7 mm in diameter and 1.6 mm in height. The largest shell in our material measures 2.95 mm in diameter and 1.7 mm in height.



Figures 95A-D. *Vitrinella helicoidea* C.B. Adams, 1850. A-C: shells, 1.8, 1.7, 1.4 mm, Sandro Pardo Shoal, Cuba (MHNS); D: protoconch.

Figuras 95A-D. Vitrinella helicoidea *C.B. Adams, 1850. A-C: conchas, 1,8, 1,7, 1,4 mm, Bajo de Sandro Pardo, Cuba (MHNS); D: protoconcha.*

Habitat: This species was found between 0 and 42 m in depth. It has been found under rocks close to shore (ANDREWS, 1977). Under rocks in shallow waters (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). Our material was collected on a coralline bottom between 5 and 20 m.

Distribution: Recorded from Port Royal, Jamaica (ADAMS, 1850); from the north inlet of Lake Worth, Palm Beach Co., Florida (PILSBRY & MCGINTY, 1946); from Colón and Bocas Island, Panama (OLSSON & MCGINTY, 1958); Bermuda, off Cape Hatteras (JOHNSON, 1934), North Carolina, South Florida, Texas, Jamaica, Haiti, Puerto Rico and Panama (MOORE, 1964); Virgin Islands (NOWELL-USTICKE, 1959); SE United States; the Antilles; E coast of Central America (HOUBRICK, 1968). Puerto Rico (WARMKE & ABBOTT, 1975). Bermuda; from southeast USA to the Antilles; Texas; Quintana Roo; Costa Rica; Panama (ANDREWS, 1977). From Campeche to Ciudad del Carmen and Zacatal, Mexico (VOKES & VOKES, 1984). Curaçao (DE JONG & COOMANS, 1988). Bermuda; from North Carolina to Florida and the Caribbean Sea (ROBINSON, 1991). From Bermuda and North Carolina to the Dutch Antilles and Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). Abaco, Bahamas (REDFERN, 2001). Our material extends the range to Cuba, the ABC Islands, Turks & Caicos, and Venezuela.

Remarks: MOORE (1964: 58) considers *V. praecox* a synonym of *V. helicoidea* applying the observation that it was described by PILSBRY & MCGINTY (1946) on the basis of juvenile specimens which show the spiral cords. We have found shells (Figs. 94C-E) with the teleoconch whorls more depressed, dorsally and ventrally, and which exhibit three spiral cords instead of two on the first ½ whorl of the teleoconch. The rest of the sculptural characters and dimensions of the shell and protoconch are similar (3 x 1.8 mm; proto 270 μm). Lacking radular and anatomical information on these slightly different shells, we provisionally consider them only morphological variations of a single species.

Vitrinella floridana Pilsbry & McGinty, 1946 (Figures 96A-D)

Vitrinella floridana Pilsbry y McGinty, 1946. *The Nautilus,* 60: 16-17, pl. 2, figs. 4-4a. [Type locality: Northern Biscayne Bay near Baker's Haulover, Miami].

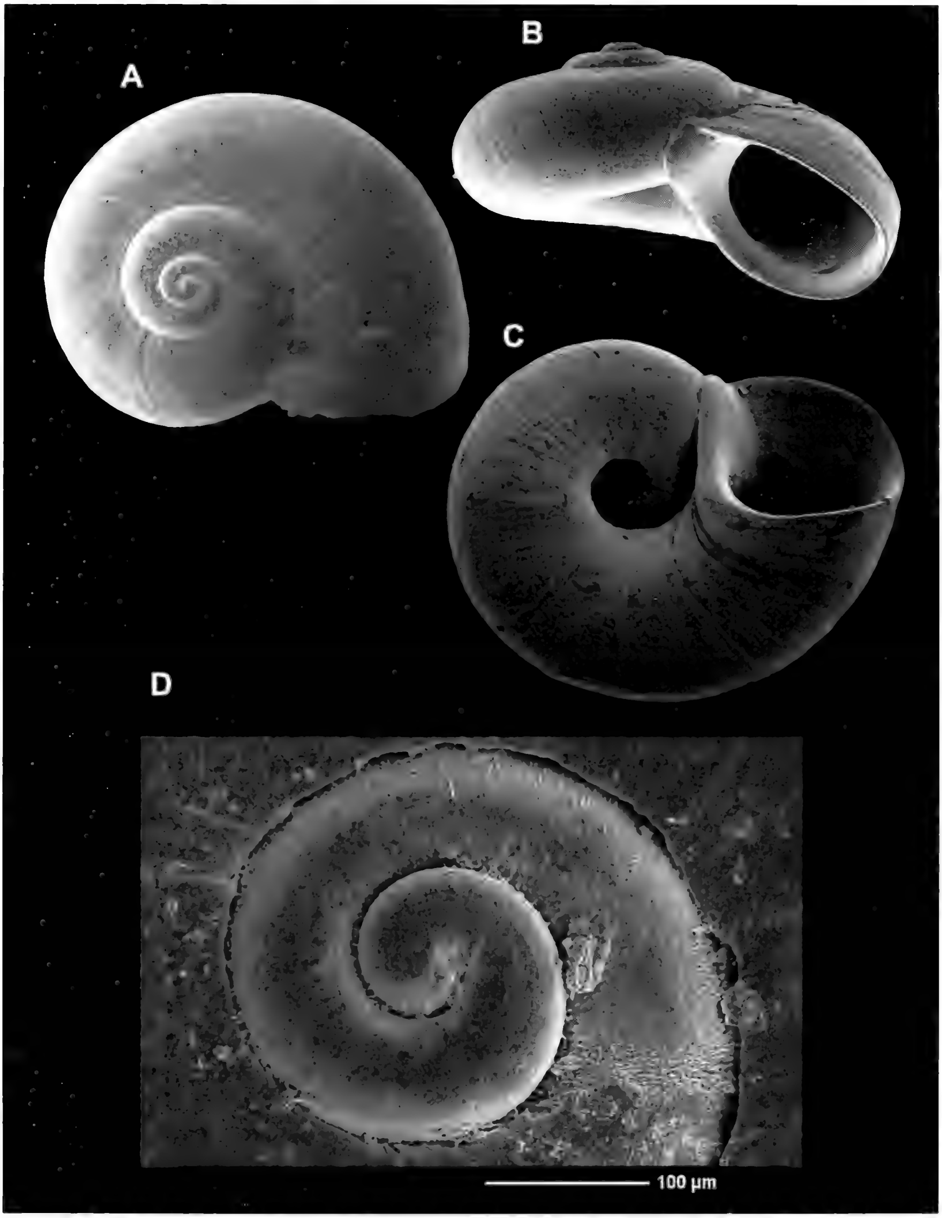
Type material: Holotype figured by MOORE (1964, Fig. 4) deposited in ANSP (181880). Not examined.
Other material examined: Florida, USA: 32 s, Hypoluxo Island, Lantana, Palm Beach Co., drift (CHL); 1 s, N Peanut Island, Lake Worth, Palm Beach Co., dredged at 2-4.5 m (CHL).

Description: This is the original description in PILSBRY & MCGINTY (1946): *"The minute shell is depressed, whitish, smooth, openly umbilicate, the umbilicus contained 3.25 times in the diameter. There are barely 3 ½ convex whorls, the last whorl somewhat flattened below the periphery, rounded at periphery, base, and umbilical border, the umbilicus rather broadly open, perspective, the whorls visible within it convex. The aperture is rather strongly oblique, rounded angular above (or in a basal view it appears bluntly triangular). Peristome thin, the upper margin only moderately arched forward. The columellar margin is thickened and runs forward above. Parietal callus rather thick and short. Diameter 1.95 mm, height 0.95 mm; umbilicus 0.6 mm wide".*

We can add: Shell (Figs. 96A-C). Protoconch (Fig. 96D) of about 1 ¾ whorls and about 330 μm in maximum diameter, with a slightly rough surface, more evident on the subsutural area, which gives it a frosted appearance. Teleoconch of about 2 whorls, smooth except for clear growth lines also visible within the umbilicus. Umbilicus wide and deep with rounded walls, lacking a periumbilical cord. Aperture ovoid strongly prosocline.

Dimensions: We have shells with about 1.30 mm in maximum dimension and 0.75 mm in height.

Habitat: This species has a mainly continental distribution, living between 0 and 46 m in depth. MOORE (1964) mentions that it is very common in some localities, having examined a lot of



Figures 96A-C: *Vitrinella floridana* Pilsbry & McGinty, 1946. A-C: shells, 1.3, 1.3, 1.4 mm, Hypoluxo Island, Lantana, Palm Beach Co., Florida (CHL); D: protoconch.
Figuras 96A-C: Vitrinella floridana *Pilsbry & McGinty, 1946. A-C: conchas, 1,3, 1,3, 1,4 mm, Hypoluxo Island, Lantana, Palm Beach Co., Florida (CHL); D: protoconcha.*

924 specimens from Mud Island, Aransas Bay, Texas.

Distribution: The species is known from the USA: Recorded from Northern Biscayne Bay near Baker's Haulover, Miami; Indian River south of Sebastian, Indian River Co.; North Inlet of Lake Worth, Palm Beach; and Barnes Sound, Key Largo, Florida (PILSBRY & MCGINTY, 1946); East and West Florida, Texas (LYONS, 1971; ANDREWS, 1977); Texas (ODÉ, 1987). Mexico: Quintana Roo (VOKES & VOKES, 1984); Tamaulipas, Tabasco, Veracruz, Campeche Bank, Quintana Roo (GARCÍA-CUBAS, 1970, 1990). Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). Cuba: Cienfuegos Bay.

Remarks: The small size, rather large umbilicus without a bordering cord, and the feeble convexity of the upper margin of peristome in apical or basal view are its more conspicuous features (PILSBRY & MCGINTY, 1946). *Vitrinella floridana* has a shell very similar in general appearance to that of *Vitrinella helicoidea* from which it can be distinguished by the ornamentation of the protoconch, by the lack of spiral cords on the first ½ whorl of the teleoconch and the lack of a bordering umbilical cord. From *Vitrinella canaliculata* it can be differentiated by the absence of the sutural canal and the ornamentation of the protoconch.

Vitrinella canaliculata spec. nov. (Figures 97A-C)

Type material: Holotype (Fig. 97A) in MNCN (15.05/55070). Paratypes: MHNS (100553, 1 s); MNHN (24399, 1 s); CFG (1 s).
Type locality: Rancho Luna Beach, Cienfuegos, Cuba.
Etymology: The specific name refers to the sutural canal which is visible along the full extent of the teleoconch.

Description: Shell (Figs. 97A-B) depressed, without sculpture and with a broad umbilicus. Protoconch (Fig. 97C) of about one whorl, with a slightly rough surface, and about 320 μm in maximum diameter; immediately after the protoconch there commences a wide suture which forms a small groove. Teleoconch of about 2 whorls, smooth except for fine growth and the sutural canal, which is visible all the way to the aperture. Umbilicus wide and deep with rounded walls, without a periumbilical cord.

Dimensions: Holotype 1.8 mm in diameter.

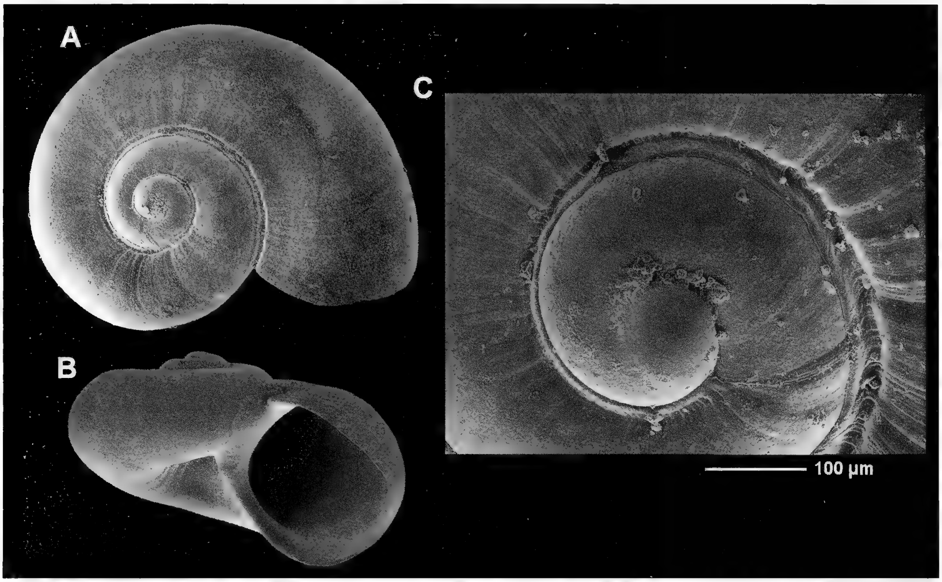
Habitat: The studied material came from coralline sand bottoms 20 m in depth.

Distribution: Only known from Rancho Luna Beach, Cienfuegos, Cuba, its type locality.

Remarks: *V. canaliculata* spec. nov. has a shell very similar in general appearance to that of *V. helicoidea* and *V. floridana*, from which it can be distinguished by the ornamentation of the protoconch, the lack of spiral cords on the first ½ whorl of the teleoconch, having a sutural canal and the lack of periumbilical cord.

Vitrinella aristata spec. nov. (Figures 98A-I)

Type material: Holotype (Fig. 98A) in MNCN (15.05/55069). Paratypes: ANSP (1 s); AMNH (4 s); FLMNH (448612, 1 s); MCZ (1 s); MHNS (100554, 24 s); MNHN (24400, 1 s); NHMUK (1 s); USNM (1155033, 1 s); IES (1 s); CFG (10 s), CHL (3 s) and CFR (10 s).
Other material examined: Cuba: 3 s, Cienfuegos Bay, 20-30 m (MHNS); 2 s, Rancho Luna Beach, 12 m (MHNS); 1 sp, 14 s, Rancho Luna Beach, 10-20 m (MHNS); 2 s, Rancho Luna Beach, 35 m (MHNS); 8 s, Rancho Luna Beach, 40 m (MHNS); 27 c, Rancho Luna Beach, 45 m (MHNS); 4 c, Los Laberintos, Rancho Luna Beach, 35 m (MHNS); 1 sp, 17 s Faro de los Colorados, 56 m (MHNS); 1 s, Punta de Tamarindo.
Type locality: Rancho Luna Beach, Cienfuegos, Cuba.



Figures 97A-C. *Vitrinella canaliculata* spec. nov. A-B: holotype, 1.8 mm (MNCN); B: paratype, 1.3 mm, Rancho Luna Beach (MHNS); C: protoconch.
Figuras 97A-C. Vitrinella canaliculata *spec. nov. A-B: holotipo, 1,8 mm (MNCN); B: paratipo, 1,3 mm, Playa Rancho Luna (MHNS); C: protoconcha.*

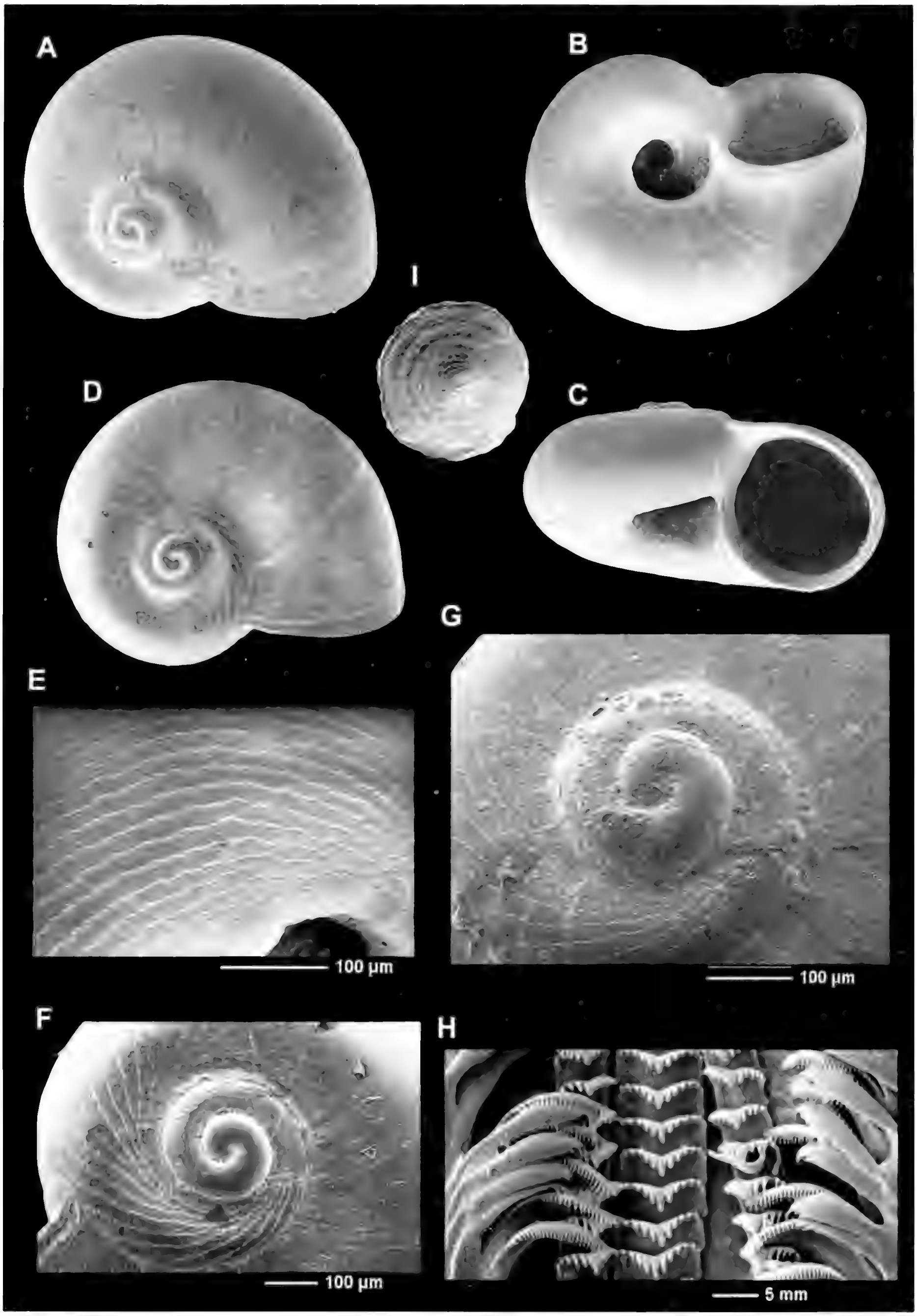
Etymology: The specific name refers to the unique pattern of dorsal opisthocline and ventral prosocline grooves, which meet at an acute angle at the mid-periphery creating a pattern reminscent of an ear, or husk, of grain, in Latin "arista".

Description: Shell (Figs. 98A-D) depressed, solid, brown, polished, and with characteristic oblique grooves. Protoconch (Figs. 98F-G) heterostrophic, about 1 ¾ whorls, and about 280 μm in diameter, placed on a plane slightly above that of the other whorls, with a smooth surface at its beginning followed by a segment with coarse prosocline growth lines terminating with a faint axial varix. Teleoconch of about 1 ¼ rapidly-increasing whorls; dorsally and ventrally convex; from the suture and from the umbilical border, oblique sulci (opisthocline and prosocline respectively) converge at the middle of the periphery. These sulci are less evident on the last ½ whorl. Aperture rounded, oblique, columellar margin not thickened, outer and inner lips sharp. Umbilicus wide and deep, exposing the previous whorls, without ornamentation except for the growth lines and several faint spiral cords.

Dimensions: Holotype 1.23 mm in diameter and 0.57 mm in height.

Operculum corneous and multispiral with a central nucleus.

Radula (Fig. 98H) taenioglossate, with formula 2+1+R+1+2. Central tooth wide basally, the ventral margin well developed, without denticles. Cutting area formed by a large and sharp cusp and 5 denticles of medium size at each side. Lateral teeth similar to the central one, but the base is narrower; free margin with a central cusp and 4-5 smaller denticles at each side. Marginal teeth narrow and elongate; the inner with 24-26 fine denticles on the upper outer margin; the outer marginal teeth are strongly inclined outward in their upper third and



Figures 98A-I. *Vitrinella aristata* spec. nov. A-B: holotype, 1.23 mm, Rancho Luna Beach, Cuba (MNCN); C-D: paratypes, 1.0, 0.9 mm, Rancho Luna Beach (MHNS); E: microsculpture; F-G: protoconch; H: radula: I: operculum, 0.5 mm in diameter.

Figuras 98A-I. Vitrinella aristata *spec. nov. A-B: holotipo, 1,23 mm, Playa Rancho Luna, Cuba (MNCN); C-D: paratipos, 1,0, 0,9 mm, Playa Rancho Luna (MHNS); E: microescultura; F-G: protoconcha; H: rádula: I: opérculo, 0.5 mm de diámetro.*

possess 16-18 denticles on the upper end of their inner margin.

Animal unknown. Operculum (Fig. 98I) rounded and multispiral.

Habitat: This species has been collected between 10 and 60 m, on a coralline, slightly muddy bottom.

Distribution: Only known from Cuba.

Remarks: *Vitrinella aristata* spec. nov. has a glistening shell with a very attractive and characteristic sculpture which makes it unmistakable. *V. anneliesae* is the only species with a similar ornamentation, with slightly oblique cords emerging from the suture. The radula is similar to that of other tornid species.

Vitrinella pseudoaristata spec. nov. (Figs. 99A-E)

Type material: Holotype (Fig. 99A) in MNCN (15.05/55071). Paratypes: MNHN (24401, 1 s, Fig. 99B) and IES (1 s, Fig. 99C), both from type locality.
Type locality: Rancho Luna Beach, Cienfuegos, Cuba.
Etymology: The specific name refers to the similarity with the species *Vitrinella aristata*.

Description: Shell (Figs. 99A-C) depressed, solid, polished, and with characteristic oblique grooves. Protoconch (Fig. 99D) heterostrophic, 1 ½ whorls, about 290 μm in diameter, and slightly projected. Teleoconch of about 2 rapidly-increasing whorls; dorsally and ventrally convex; completely smooth except for 5-6 somewhat oblique incised lines seen on the dorsum of the first teleoconch whorl; these fade on the periphery, which is rounded. A thick cordon marks the boundary of the umbilicus, which is not occluded by a callus. Aperture rounded, robust; thick and somewhat reflected columella, but without callus formation. Umbilicus not too wide or deep, flanked by the spiral cord. Aperture rounded, oblique, columellar margin not thickened, outer and inner lips sharp.

Dimensions: Holotype 1.26 mm in diameter, similar to the paratypes.

Animal and radula unknown.

Habitat: This species has been collected between 15 and 35 m in coralline sand.

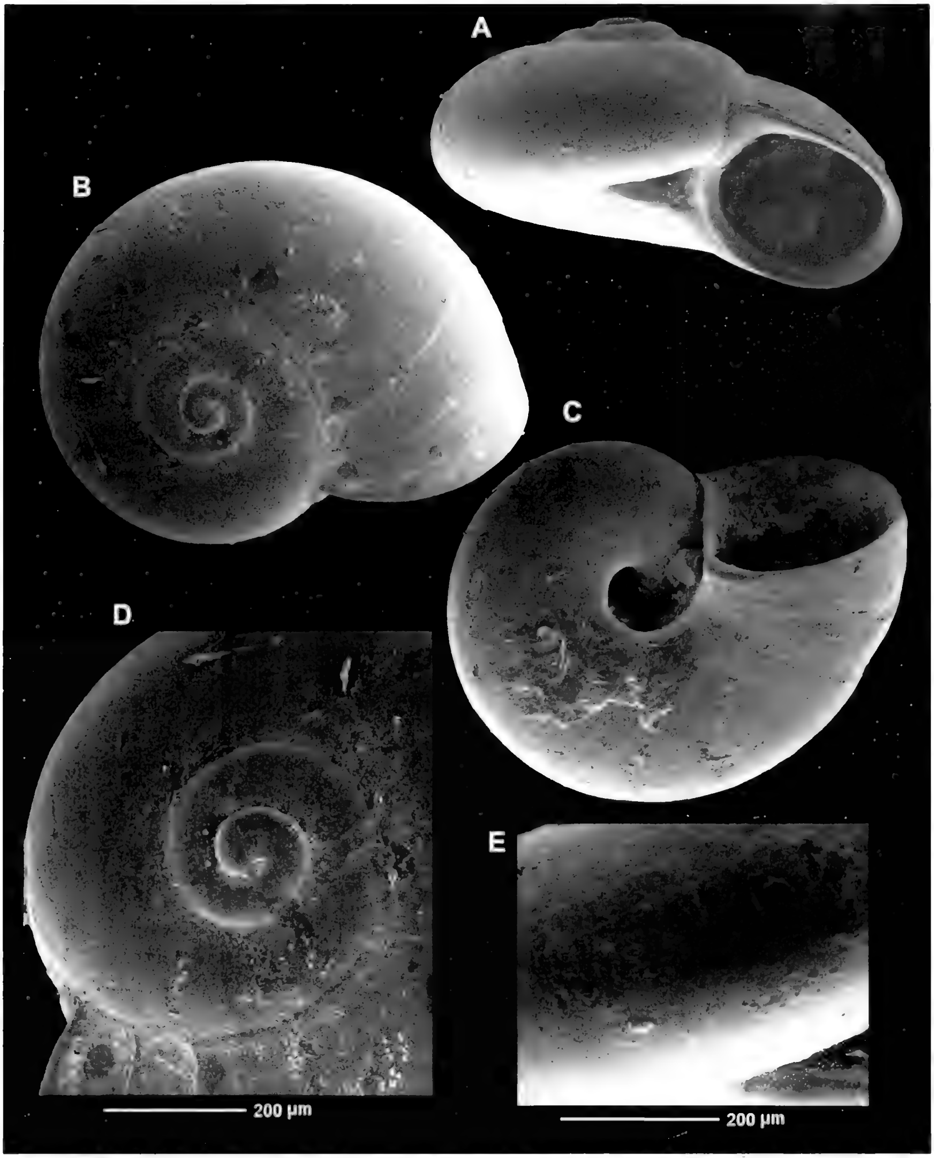
Distribution: Only known from Cuba.

Remarks: *Vitrinella pseudoaristata* spec. nov. has a glistening shell with a very attractive and characteristic sculpture which makes it unmistakable. *V. anneliesae* and *V. aristata* are the only species with a similar ornamentation, possessing slightly oblique cords near the suture. *V. pseudoaristata* spec. nov. differs from *V. aristata* spec. nov. by having fewer oblique lines and having them limited to the dorsum of the first teleoconch whorl; furthermore it has a spiral cord that delimits the umbilicus.

Vitrinella pelorcei spec. nov. (Figures 100A-C)

Type material: Holotype (Figs. 100A-B) in MNHN (24202).
Type locality: Reef Bay Bronage, Antigua.
Etymology: After Jacques Pelorce, the French malacologist who collected the holotype.

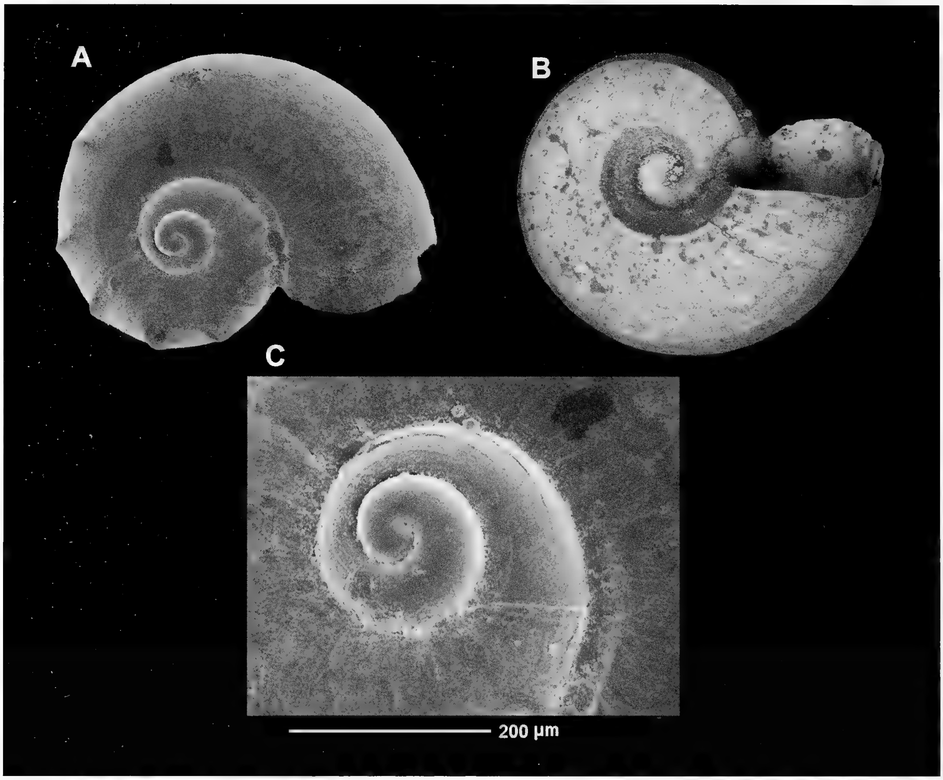
Description: Shell (Figs. 100A-B) of small size, depressed, appearing fragile, with a sutural groove and characteristic large axials ribs. Protoconch (Fig. 100C) of about 1 ¾ whorls, placed on a higher plane than the teleoconch, with a smooth surface at its beginning and 3-4 fine spiral cordlets of microtubercles in the subsequent part, about 290 μm in diameter. Teleoconch with almost 1 ¼ rapidly-increasing whorls; dorsally and ventrally convex. Ornamentation formed by axial growth lines and strong axial



Figures 99A-G. *Vitrinella pseudoaristata* spec. nov. A: holotype, 1.26 mm, Rancho Luna Beach, Cuba (MNCN); B: paratype, 1.2 mm, Rancho Luna Beach (MNHN); C: paratype, 1.2 mm, Rancho Luna Beach (IES); D: protoconch; E: microsculpture.

Figuras 99A-G. Vitrinella pseudoaristata *spec. nov. A: holotipo, 1,26 mm, Playa Rancho Luna, Cuba (MNCN); B: paratipo, 1,2 mm, Playa Rancho Luna (MNHN); C: paratipo, 1,2 mm, Playa Rancho Luna (IES); D: protoconcha; E: microescultura.*

ribs, nine on first teleoconch whorl; the last ¼ whorl loses its axial sculpture leaving only very faint spiral cordlets. The suture is very evident in the protoconch, and it becomes a wide groove along the teleoconch. Aperture rounded, oblique, columellar margin not thickened, outer and inner lips



Figures 100A-C. *Vitrinella pelorcei* spec. nov. A-B: holotype, 1.02 mm, Reef Bay Bronage, Antigua (MNHN); C: protoconch.

Figuras 100A-C. Vitrinella pelorcei *spec. nov. A-B: holotipo, 1,02 mm, Reef Bay Bronage, Antigua (MNHN); C: protoconcha.*

sharp. Umbilicus wide and deep exposing the previous whorls. No sculpture except for axial growth lines.

Dimensions: Holotype 1.02 mm in maximum diameter.

Animal and radula unknown.

Habitat: The only shell known was collected on a coralline bottom at 1 m.

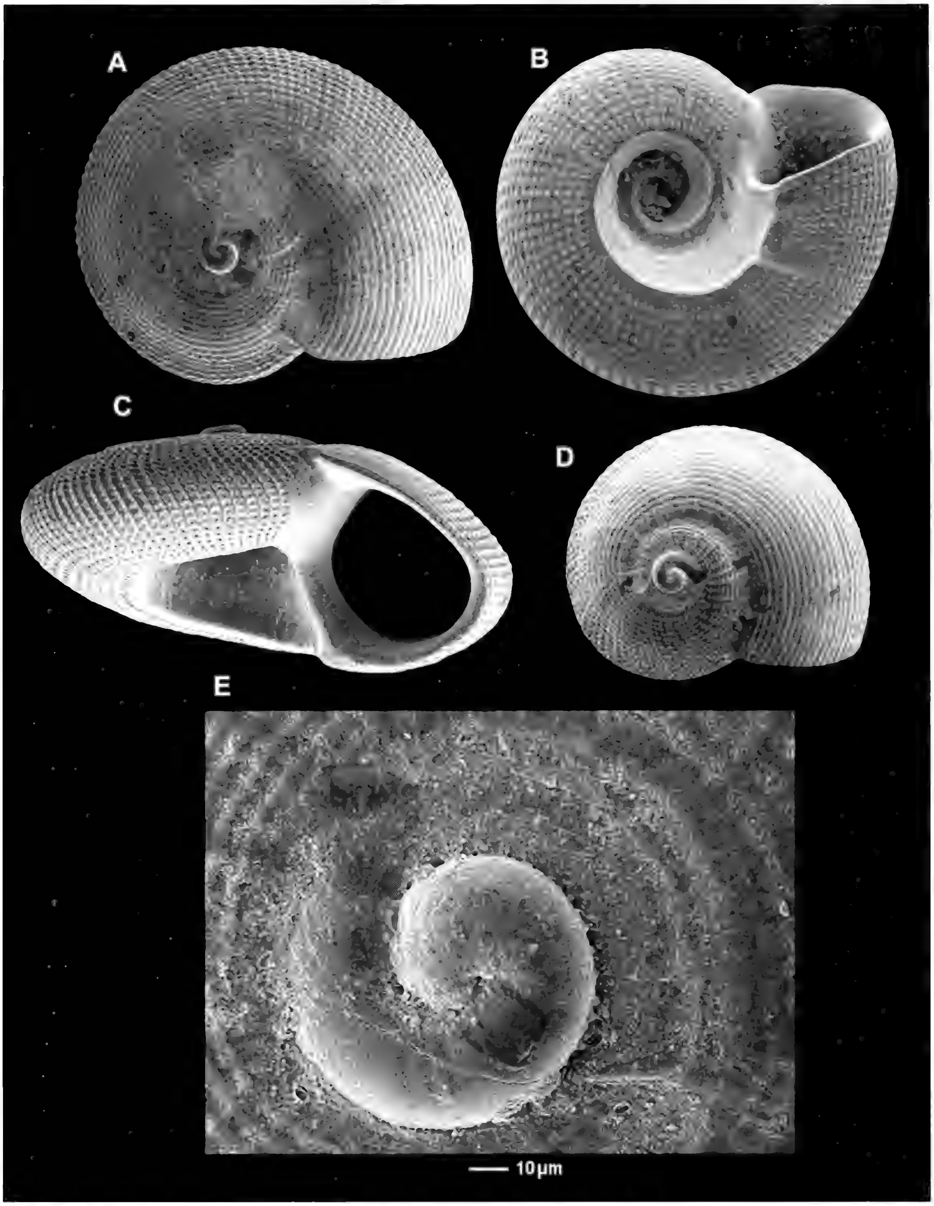
Distribution: Only known from Antigua, the type locality.

Remarks: *Vitrinella pelorcei* spec. nov. has a characteristic ornamentation formed by strong and widely-spaced axial ribs and an evident suture in the protoconch which in the teleoconch evolves into a sutural sulcus continuing to the aperture. These characters make this species unmistakable. *Vitrinella floridana* is the only species with a similar sutural sulcus, but it is narrower and deeper; Furthermore the latter has no other sculpture, axial or spiral.

Vitrinella aguayoi (Corgan, 1968) (Figures 101A-E)

Vitrinella tenuisculpta Aguayo & Borro, 1946b. *Rev. Sociedad. Malac. "Carlos de la Torre,"* 4(2): 43-44, pl. 3, figs. 4-6. [Type locality: Matanzas, Cuba], preoccupied by *Vitrinella tenuisculpta* Carpenter, 1865.

Solariorbis aguayoi Corgan, 1968.



Figures 101A-H. *Vitrinella aguayoi* Corgan, 1968. A-D: shells, 1.45, 1.4, 1.4, 1.2 mm, Cienfuegos, Cuba (MHNS); E: protoconch.
Figuras 101A-H. Vitrinella aguayoi *Corgan, 1968. A-D: conchas, 1,45, 1,4, 1,4, 1,2 mm, Cienfuegos, Cuba (MHNS); E: protoconcha.*

Type material: Holotype represented in AGUAYO & BORRO (1946, figs. 4-6). Deposited in Museo Poey, Havana, Cuba (12005). Described as fossil of the Upper Tertiary found in the formation "Yumurí," Upper Miocene of Cuba. Not examined.

Other material examined: Cuba: 6 s, Rancho Luna Beach, 12 m (MHNS); 51 s, Rancho Luna Beach, 10-20 m (MHNS); 1 s, Rancho Luna Beach, 35 m (MHNS); 1 sp, 5 s Faro de los Colorados, 56 m (MHNS).

Description: The original description (AGUAYO & BORRO, 1946b) is as follows: *"Concha diminuta, deprimida, plano convexa por encima, ampliamente umbilicada por debajo. Provista de 3 vueltas redondeadas, la ultima ligeramente aquillada. Las primeras 1 ½ (nucleares), lisas, las restantes de escultura reticulada. Escultura espiral formada por numerosas líneas salientes (unas 15 en la última vuelta); escultura axial formada por líneas mas elevadas que las espirales, formando con estas cuadrículas que comunican a la concha un aspecto granuloso. Periferia subangulosa. Ombligo amplio, formando con la base de la concha un ángulo muy marcado que lo bordea por completo. Abertura semilunar, con el borde unido por un leve callo parietal".*

Shell (Figs. 101A-C) subconical, depressed, solid, whitish and formed by 3 ¾ rapidly-increasing whorls. Protoconch (Fig. 101H) of about 1 ¾ whorls, about 290 µm in diameter, has a rough surface at its beginning and fine oblique threads in the subsequent part, slightly overlapped by the subsequent whorl. Teleoconch of about 2 ¼ whorls, sculpture of 38-39 spiral cordlets, 24 on the dorsum and 14-15 ventrally, spiral cordlets crossed by 75-80 fine axial ribs, forming small quadrangular hollows. Dorsally convex with a subangulated periphery. Ventrally slightly concave with one prominent spiral cord which limits a wide infundibulum of the deep umbilicus with smooth walls. Aperture oval almost circular, columella and inner lip very thick and reflected outward and the upper part of the external lip sharp and advanced. There is no columellar thickening or encroachment on the umbilicus. At junction of the columella and umbilical cord the aperture is slightly angulated.

Dimensions: Holotype 1.19 mm in diameter and 0.5 mm in height. We have shells reaching 1.45 mm in maximum dimension

Habitat: The type is a fossil specimen collected in the Upper Miocene of Cuba, from the "Yumuri" Formation. Our recent material was collected between 10 and 56 m.

Distribution: Cuba: Cienfuegos. Since its description this species has not been recorded from any other Caribbean locality. Thus it could be endemic to Cuba.

Remarks: *Solariorbis aguayoi* was proposed by CORGAN (1968) as a replacement name for *Vitrinella tenuisculpta* Aguayo & Borro, 1946, which is preoccupied by *V. tenuisculpta* Carpenter, 1865. The renamed species, known only from the Miocene of Cuba, was placed in the vitrinellid genus *Solariorbis* Conrad, 1865 by Corgan on the basis of reticulate microsculpture.

AGUAYO & Borro (1946b) mentioned that *V. tenuisculpta (=V. aguayoi)* is more similar to *Vitrinella multistriata* (A.E. Verrill), and it can be distinguished by being smaller, having weaker sculpture, the axial lines being proportionately more prominent than the spiral ones, the umbilicus wider, and the periphery angled angulate.

Vitrinella aguayoi and *V. calliglypta* are very similar, and they were considered as morphotypes of the one species in the past. They live in the same type of marine bottom, and maintain their distinguishing characters without intergradation. The protoconchs are identical in size and ornamentation and, as with other species included in the genus *Vitrinella* (*V. annelisae, V. contracta, V. funiculus*), the protoconch is slightly overlapped by the first whorl of the teleoconch.

Vitrinella aguayoi may be distinguished from *V. calliglypta* by its angled periphery and by the greater number of spiral cordlets and axial ribs.

Vitrinella calliglypta Aguayo, 1949 (Figures 102A-E)

Vitrinella (Delphinoidea) calliglypta Aguayo, 1949. *Rev. Sdad. Malac. "Carlos de la Torre,"* 6: 94, pl. 4, fig. 4, 6. [Type locality: Gibara, Eastern, Cuba].

Type material: Holotype deposited in the Museo Poey, Havana, Cuba (12901). Collected by P.J. Bermudez and C.G. Aguayo. Not examined.
Other material examined: Cuba: 2 s, Cienfuegos Bay, 20-30 m (MHNS); 1 s, Cienfuegos Bay, 30 m (MHNS); 48 s, Rancho Luna Beach, 10-20 m (MHNS); 3 s, Rancho Luna Beach, 40 m (MHNS); 8 s, Rancho Luna Beach, 45 m (MHNS); 3 s, Los Laberintos, Rancho Luna Beach, 35 m (MHNS); 3 s, Faro los Colorados, 56 m (MHNS).

Description: The original description (AGUAYO, 1949) is as follows: *"Concha diminuta, deprimida, planorboide, blanca, lustrosa, translúcida, ampliamente umbilicada. Espira deprimida, sutura profunda pero estrecha. Provista de 3 ½ vueltas, de las cuales 1 ½ son lisas, y las restantes con una escultura entrecruzada, formada por numerosas costillitas planas axiales, algo más estrechas que sus intervalos y muchas costillas espirales (unas 15 en la última vuelta) más bajas que las axiales, cuyo entrecruzamiento le da un aspecto de numerosas depresiones cuadrangulares. Periferia redondeada. Base aplanada, con un ámplio ombligo de un 40% del diámetro de la concha. Abertura subcircular, peristoma cortante".*

Shell (Figs. 102A-D) subconical depressed, solid, whitish, and comprised of 3 ¾ rapidly-increasing whorls. Protoconch (Fig. 102E) projecting slightly upward, about 1 ½ whorls and about 290 μm in diameter. It has a rough surface at its beginning and fine oblique threads in the subsequent part, slightly overlapped by the subsequent whorl. Teleoconch of about 2 whorls, with sculpture formed by 32-34 spiral cordlets: 20 on the dorsum and 12-14 ventrally, each crossed by 55-60 fine axial ribs, forming small quadrangular hollows. Dorsally slightly convex with a biangulated periphery. Ventrally the shell is slightly concave with one spiral cord which limits a wide infundibulum of the deep umbilicus. Aperture oval, almost circular, columella and inner lip very thick and reflected outward, and the upper part of the external lip sharp and advanced. At the junction between columella and the periumbilical cord, the aperture is slightly angulated.

Dimensions: Holotype 1.0 mm in diameter and 0.6 mm of height. We have shells reaching about 1.23 mm in maximum dimension.

Habitat: The type was dredged off Gibara, East of Cuba, at 30 fathoms in depth. Our material was collected between 10 and 56 m.

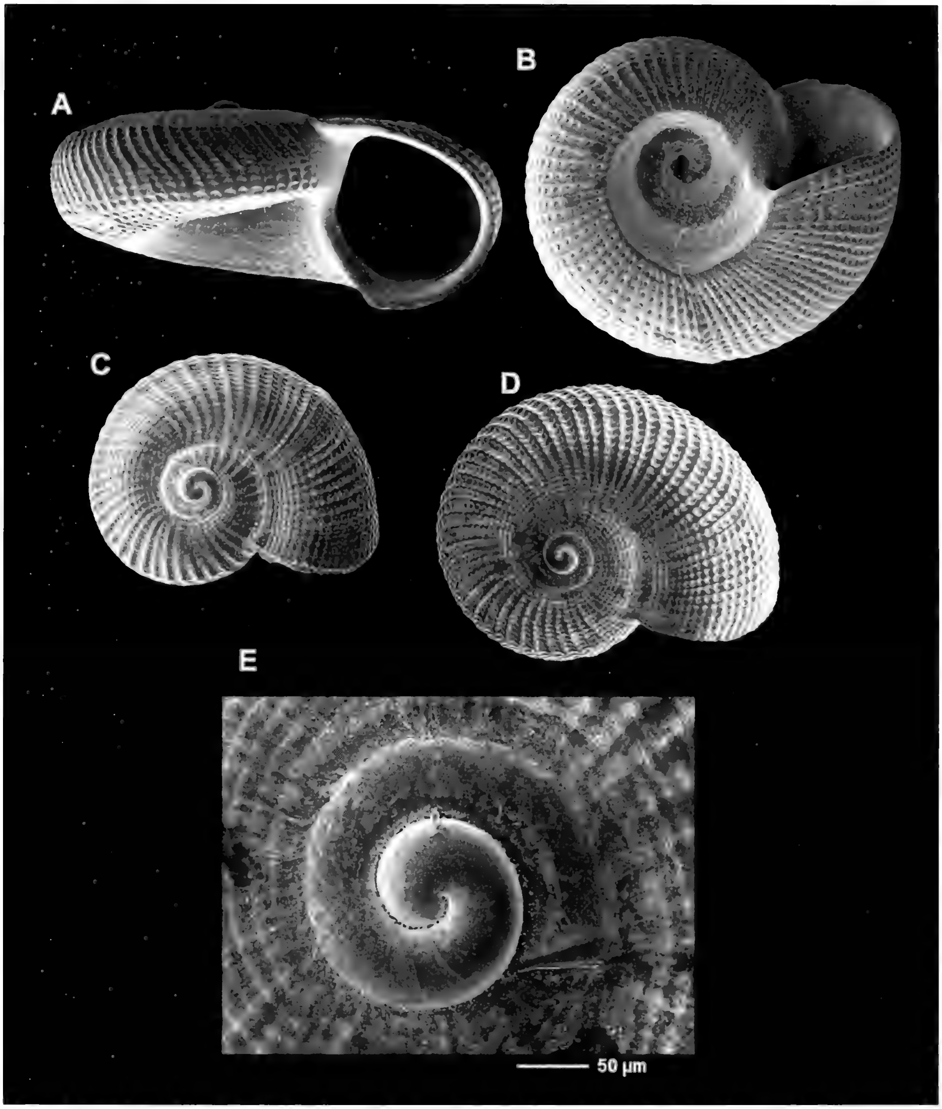
Distribution: Cuba: Holguin, Gibara, Cienfuegos. Since its description this species has not been recorded from any other Caribbean locality, so it could be endemic to Cuba.

Remarks: AGUAYO (1949) mentioned that *V. calliglypta* shows a little similarity to *V. tenuisculpta* Aguayo & Borro, and it can be distinguished by the biangulate periphery and the fewer axial ribs and spiral cords. *V. multistriata* Bush is smaller and has stronger sculpture.

Vitrinella cupidinensis Altena, 1966 (Figures 103A-F)

Vitrinella (Striovitrinella) cupidinensis Altena, 1966. *Zoologische Mededelingen,* 41: 235-236, figs. 2a-d. [Type locality: Cupido, river Maratakka, Surinam].

Type material: Represented in ALTENA (1966b, 1975). Not examined.

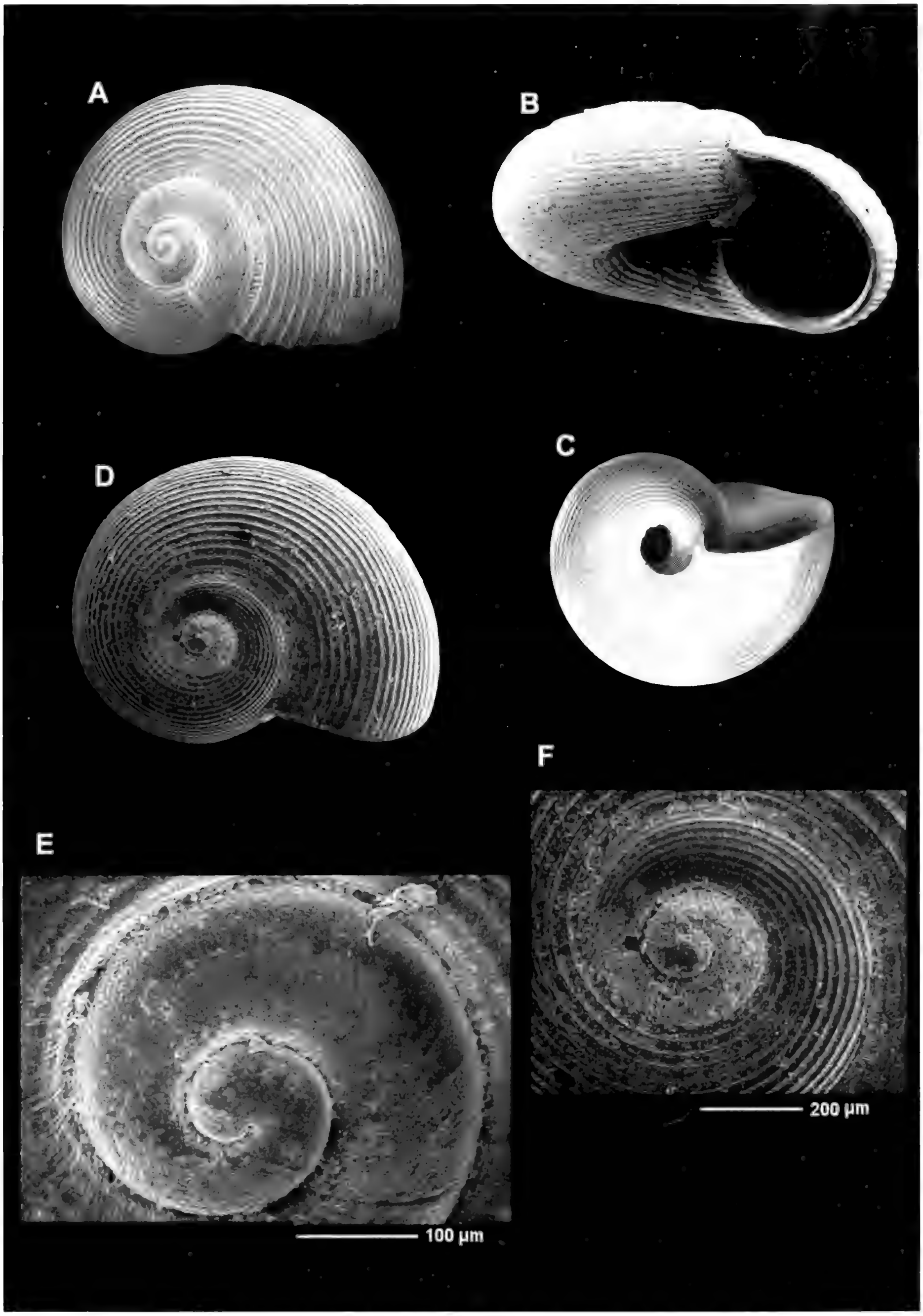


Figures 102A-E. *Vitrinella calliglypta* Aguayo, 1949. A-D: 1.4, 1.3, 1.1, 1.2 mm, Rancho Luna Beach, Cuba (MHNS); E: protoconch.

Figuras 102A-E. Vitrinella calliglypta *Aguayo, 1949. A-D: 1,4, 1,3, 1,1, 1,2 mm, Playa Rancho Luna, Cuba (MHNS); E: protoconcha.*

Other material examined: Guatemala: 2 s, Livingston, 3 m (MHNS). Trinidad and Tobago: Tobago, 1 s, Courland Bay, drift (CHL); 1 s, Scarborough (CHL). Venezuela: 1 f, Juan Griego, Isla Margarita (CHL); 2 s, Isla Margarita (CHL).

Description: Shell (Figs. 103A-C) lenticular, depressed, whitish, with 3 ¼ spiral whorls. Protoconch (Fig. 103D) 1 ½ whorls, diameter of about 350 µm; the first ½ whorl is smooth, and the next whorl has small granules on the peripheral area. Two varices mark the end of each stage. Teleoconch of about 1 ¾



Figures 103A-F. *Vitrinella cupidinensis* Altena, 1966. A-C: shells, 1.7, 1.7, 1.35 mm, Livingston, Guatemala (MHNS); D: shell, 1.7 mm, Tobago (CHL); E: protoconch, Guatemala; F: Protoconch, Tobago.

Figuras 103A-F. Vitrinella cupidinensis *Altena, 1966. A-C: conchas, 1,7, 1,7, 1,35 mm, Livingston, Guatemala (MHNS); D: concha, 1,7 mm, Tobago (CHL); E: protoconcha, Guatemala; F: protoconcha, Tobago.*

whorls, its surface totally covered by spiral cords of similar size and very fine axial striae which cross the sulci forming a characteristic sculpture.

Dimensions: Holotype 1.8 mm in diameter and 0.9 mm in height. We have shells reaching 1.7 mm in maximum diameter and 1.06 mm in height.

Habitat: We found no mention of the habitat of this species in the literature. Our material was collected in muddy bottom with turbid waters at 3 m.

Distribution: Colombia (DÍAZ & PUYANA, 1994). Brazil: Recife (Altena, 1966), Pernambuco (RIOS, 1994) and Livingston, Guatemala.

Remarks: *Vitrinella cupidinensis* was described from fossil shells in the Holocene of Surinam. The distinguishing characteristic of this species is the teleoconch sculpture of fine spiral cords crossed by very fine axial striae. ALTENA (1966) indicated that this species is very similar to *Vitrinella (Striovitrinella) elegans* Olsson & McGinty, 1958, but the latter is slightly larger and, at the same number of whorls, the spiral sculpture is smaller and the radial more prominent.

Vitrinella filifera Pilsbry & McGinty, 1946 (Figures 104A-D)

Vitrinella filifera Pilsbry & McGinty, 1946. *The Nautilus*, 60: 15, pl. 2, figs. 2-2b. [Type locality: Biscayne Bay at Baker's Haulover, Miami, Florida].

Type material: Holotype in ANSP (nº 181879) not figured by MOORE (1964). Not examined.
Material examined: Virgin Islands: 1 s, Magens Bay, N St. Thomas, (CHL).

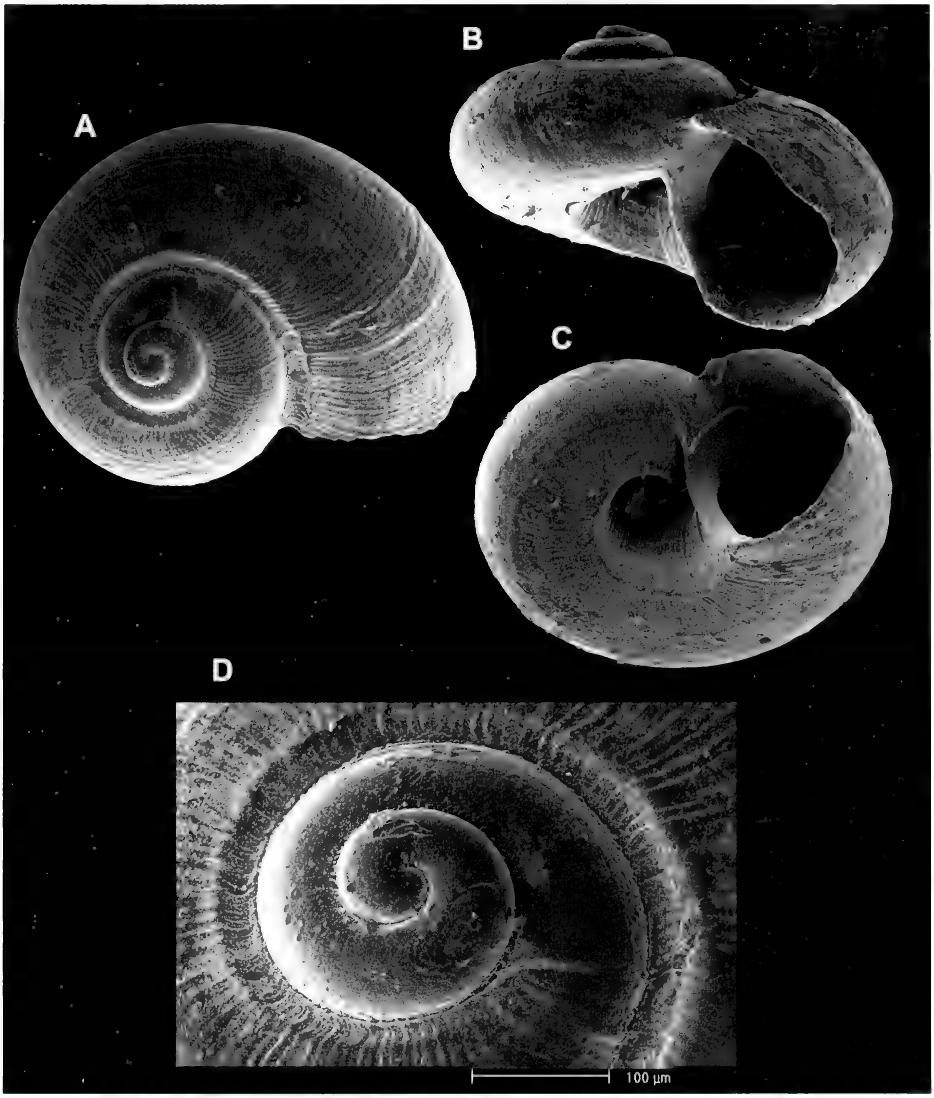
Description: This is the original description in PILSBRY & MCGINTY (1946): "*The shell is depressed, umbilicate, the width of umbilicus contained a little more than 4 times in the diameter; thin, white (dead), smooth. The upper surface is convex with slightly prominent apex, the whorls convex, the last whorl having a cord a short distance below the suture and parallel to it, becoming weaker near the aperture; the periphery is broadly rounded; base convex, a little impressed along the cord around the umbilicus; which in its last turn enlarges to about double its former width and is bounded by a cord which becomes weaker near the aperture. The aperture is rounded, somewhat oblique, the peristome thin, upper margin is strongly arched forward, retracted to the upper insertion, the basal margin straightened or a little curved forward in a basal view, and there is a slight angle at the termination of the umbilical cord. The columella is slanting, near straight, rather thick. Parietal callus thin. Diameter 1.25 mm; height 0.7 mm; 3 ¼ whorls*".

We add the following: The protoconch (Fig. 104D) projects slightly, has 1 ¾ spiral whorls, is bulbous, measures about 280 μm in diameter, and is sculptured with microtubercles of varying size distributed irregularly, the larger ones near the subsutural area. On the last segment there are some spiral threads near the suture. The teleoconch has 1 ¼ whorls completely covered by dense, fine axial ribs, which cross the spiral cordlets, more evident on the periphery. The axial sculpture is predominant on the dorsum.

On the base two more prominent spiral cords can be observed; one of them borders the periphery, and the other delimits the umbilical zone. The umbilicus is wide, with convex walls on which axial and spiral cordlets can be seen. Aperture rounded, columella thickened and reflected outward.

Habitat: This species has not yet been found alive (PILSBRY & MCGINTY, 1946). MOORE (1964) did not comment on its ecology.

Distribution: The species is known from the USA: recorded from Biscayne Bay at Baker's Haulover, Miami, Florida (PILSBRY & MCGINTY, 1946b); from both sides of the Florida penin-



Figures 104A-D. *Vitrinella filifera* Pilsbry & McGinty, 1946. A-C: shell, 0.92 mm, St. Thomas, Virgin Islands (CHL); D: protoconch.
Figuras 104A-D. Vitrinella filifera *Pilsbry & McGinty, 1946. A-C: concha, 0,92 mm, St. Thomas, Virgin Islands (CHL); D: protoconcha.*

sula from Palm Beach to St. Petesburg (MOORE, 1964); from Florida to Texas and Colombia (ODÉ, 1987). Colombia, (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). Brazil: Cabo Frio, Rio de Janeiro (RIOS, 1994).

Remarks: PILSBRY & MCGINTY (1946) described *Vitrinella filifera*, but in spite of some similarities with *V. thomasi* (Pilsbry, 1945), they didn't compare the two species. MOORE (1964) considered the two synonymous, indicating that *V. filifera* was described from a somewhat eroded adult shell which may have lost some sculptural characters Furthermore, he considered *Vit-*

rinella filifera as the valid nominal taxon since *"Cyclostrema" thomasi* was a secondary junior homonym of *Vitrinella thomasi* Bartsch, 1918 (see below). The strong thread which follows the suture and the strongly convex outline of the upper margin of the aperture, seen in apical or basal view, are distinctive features of this species, which has not yet been found alive (PILSBRY & MCGINTY, 1946). The projected protoconch, the fine and dense axial ribs, which cross the spiral cordlets, distinguish it from *V. solaris*.

Vitrinella solaris nom. nov. (Figures 105A-C)

"Cyclostrema" thomasi Pilsbry, 1945b. *The Nautilus*, 59: 60, pl. 6, figs. 7-7b. [Type locality: North Inlet of Lake Worth, Palm Beach, Florida].
[non *Vitrinella thomasi* Bartsch, 1918].

Type material: The holotype of *"Cyclostrema" thomasi* in ANSP (181309). The drawings in the original description are quite distinctive.

Other material examined: Cuba: 1 s, Cienfuegos Bay, 8 m (MHNS); 1 s, Cienfuegos Bay, 10-20 m (MHNS); 4 s, Cañon of Cienfuegos Bay, 8 m (MHNS); 1 s, Rancho Luna Beach, 10-20 m (MHNS); 2 s, Cayo Carenas, Cienfuegos Bay, 10 m (CFG).

Etymology: The specific name is based on the image of a child's drawings of the sun, rounded with radial lines.

Description: See PILSBRY (1945b). The holotype is 1 mm.

Habitat: Species living in shallow waters. Bathymetric range: 1-20 m.

Distribution: USA: Florida (PILSBRY, 1945b); Texas (MOORE, 1964); ODÉ, 1987b). Cuba in our material.

Remarks: *Vitrinella solaris* nom. nov. and *Vitrinella filifera* are two very close species. For this reason, they were placed in synonymy by MOORE (1964). While it is true that the shells on which *V. filifera* was based were very eroded, and some characters were lost by abrasion, it is nonetheless a distinct species. The shells figured here show that there are two species involved, a little similar in profile but perfectly distinct in SEM microphotographs. *Vitrinella filifera* has narrow and curved axial ribs on the dorsum, and the protoconch has a spiral row of tubercles which are not seen in *V. solaris* nom. nov.

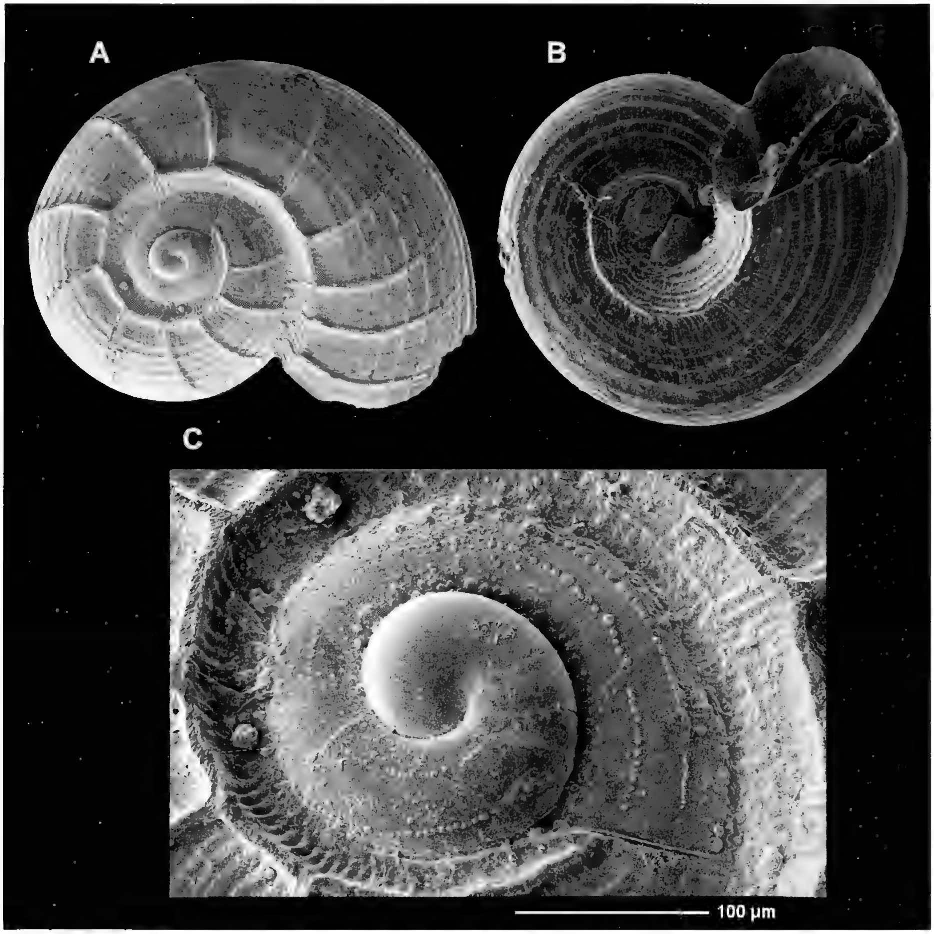
Genus *Vitrinorbis* Pilsbry & Olsson, 1952

Vitrinorbis callistus Pilsbry & Olsson, 1952. Type species by original designation.

Remarks: This genus was proposed for a group of minute, few-whorled discoidal species with a low, flat or concave spire, the base with a wide, open umbilicus and strongly carinated periphery. The surface is delicately sculptured with microscopic spiral threads which give it a soft, satiny luster. The two previously known species are from the eastern Pacific (Panamic Province), but the following one from the Caribbean appears to belong to this genus (PILSBRY & OLSSON, 1952).

Vitrinorbis elegans Olsson & McGinty, 1958 (Figures 106A-E)

Vitrinorbis elegans Olsson & McGinty, 1958. *Bulletin of American Paleontology* 39: 31-32, pl. 4, figs. 3-3a. [Type locality: Bocas Island, Panama].

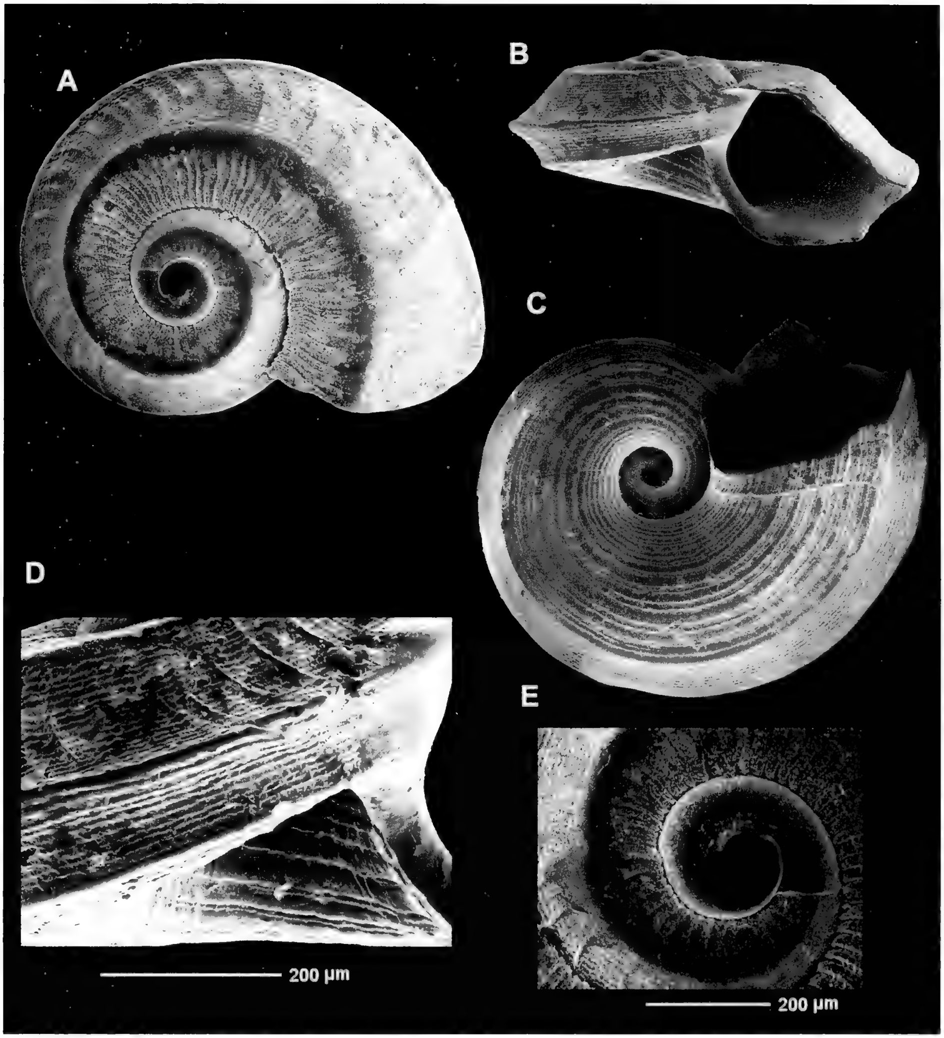


Figures 105A-C. *Vitrinella solaris* nom. nov. A-B: shells, 0.95, 0.95 mm, Cienfuegos Bay (MHNS). C: protoconch.

Figuras 105A-C. Vitrinella solaris *nom. nov. A-B: conchas, 0,95, 0,95 mm, Bahía de Cienfuegos (MHNS). C: protoconcha.*

Type material: Holotype (211881) and one paratype (211882) in ANSP. Not examined.
Other material examined: Panama: 2 s, Portobello (CHL); 3 s, Bocas Island, topotypes (CHL).

Description: The original description (OLSSON & MCGINTY, 1958) is rather complete: *"The shell is small (greater diameter, 1.4 to 1.7 mm.), thin, white or subtranslucent, depressed, with a large peripheral keel. The spire is slightly elevated, composed of 2 ½ to 3 whorls of which the nuclear portion of 1 ½ whorls is relatively large, smooth, helicoid in shape. The postnuclear whorls are a little convex or vaulted by a large, angular, submedial ridge; on the inner side of this ridge the surface is flattened to depressed, the outer side a little wider and slopes convexly towards the outer suture or towards the peripheral keel. The basal section of the shell is more depressed than the upper and likewise carries a submedial ridge or angle; within this ridge the surface has the shape of a vortex which dips into a deep umbilicus showing the inner volutions of*



Figures 106A-E. *Vitrinorbis elegans* Olsson & McGinty, 1958. A-C: shells, 1.6, 1.3, 1.6 mm, Bocas Island, Panama (CHL); D: detail of the sculpture; E: protoconch.

Figuras 106A-E. Vitrinorbis elegans *Olsson & McGinty, 1958. A-C: conchas, 1,6, 1,3, 1,6 mm, Isla Bocas, Panamá (CHL); D: detalle de la escultura; E: protoconcha.*

the spire whorls. Surface on both the dorsal and ventral sides has a delicate satiny texture produced by a sculpture of fine, microscopic spiral threads minutely cancellated by still finer lines of growth; in the sutural areas, the growth lines are heavier and may develop into axials nearly as large and strong as the spiral threads; aperture subovate, strongly oblique, attached weakly to the body whorl between the basal ridge and the peripheral keel; no parietal callus. Holotype greater diameter 1.4 mm".

Maximum reported size: 1.7 mm. Of the figured specimens, the larger is about 1.60 mm in diameter and the other about 1.27 mm in diameter and 0.59 in height.

Habitat: Nothing is known about the habitat of this species. The type material was obtained by sorting beach drift.

Depth: 0 m.

Distribution: Costa Rica (HOUBRICK, 1968); Panama (OLSSON & MCGINTY, 1958).

Remarks: This is the only species considered to be in the genus described in the Caribbean, the two previously known species are from the Panamic Province. This is a very characteristic species easily recognized by its delicate ornamentation and characteristic profile.

SPECIES NOT REPRESENTED IN OUR MATERIAL

Anticlimax schumoi (Vanatta, 1913)

Discopsis schumoi Vanatta, 1913. *Proc. of the Acad. of Nat. Sci. of Philadelphia,* 65: 24-25, pl. 2, figs. 2, 7. [Type locality: Monkey River, British Honduras].

Type material: In ANSP (76581).

Description: In VANATTA (1913).

Maximum reported size: 2.5 mm.

Distribution: British Honduras: Belize (VANATTA, 1913), Panama (RADWIN, 1969), Venezuela: unlocalized (PRINCZ, 1982).

Remarks: This species is not *Teinostoma schumoi* Vanatta, 1913.

Cochliolepis surinamensis Altena, 1966

Cochliolepis surinamensis Altena, 1966. *Zoologische Mededelingen,* 41: 236-237, figs. 3a-d. [Type locality: shell ridge at the "Kerkplein" (Church square) in Paramaribo, Surinam, at 1 m depth].

Type material: In RNHL.

Description: In ALTENA (1966).

Maximum reported size: 2.7 mm.

Distribution: Venezuela: unlocalized (PRINCZ, 1982).

Remarks: Described as Holocene fossil (ALTENA, 1966, 1975); recorded as living by PRINCZ (1982).

Discopsis omalos (de Folin, 1870)

Adeorbis omalos Folin, 1870. *Les Fonds de la Mer* 1: 190-191, pl. 23, figs. 6-7. [Type locality: Pointe-à-Pitre, Guadeloupe].

Discopsis omalus (sic): Error for *D. omalos* by JOHNSON (1934).

Description: In De FOLIN (1870).

Maximum reported size: 1.7 mm.

Distribution: Guadeloupe.

Remarks: PILSBRY & OLSSON (1945b) wrote that "D. omalos *has not been found, to our knowledge, since the original collection*". However the name *Discopsis omalos* has been used for Europe by NORDSIECK (1968), and West Africa, albeit with reservations, because the species was supposed to be Caribbean. The claim of PILSBRY & OLSSON (1945b) and the absence of specimens of this species in the material studied for this work, leads us to consider the possibility that the species is not really from the Caribbean and may have a limited distribution in the eastern Mediterranean and West Africa. De Folin was the captain of Bayonne harbour and received anchor mud from ships worldwide, which makes the possibility of mixing localities quite likely.

Pleuromalaxis pauli Olsson & McGinty, 1958

Pleuromalaxis pauli Olsson & McGinty, 1958. *Bulletins of American Paleontology*, 39: 30, pl. 3, figs. 3-3a. [Type locality: Bocas Island, Panama].

Type material: In ANSP (211902).

Description: In OLSSON & MCGINTY (1958).

Maximum reported size: 1 mm.

Distribution: Panama; Trinidad & Tobago: Tobago (OLSSON & MCGINTY, 1958).

Depth: 0 m.

Solariorbis hondurasensis (Vanatta, 1913)

Teinostoma hondurasensis Vanatta, 1913. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 65: 26, pl. 2, figs. 8, 12. [Type locality: Belize and Monkey River, British Honduras].

Type material: In ANSP (76535).

Description: In VANATTA (1913).

Maximum reported size: 1.8 mm.

Distribution: British Honduras: Belize (VANATTA, 1913); Panama (RADWIN, 1969).

Remarks: MOORE (1964) placed this species in *Solariorbis*.

Solariorbis petitii (P. Fischer, 1857) (Figures 107A-B)

Skenea petitii P. Fischer, 1857c. *Journal de Conchyliologie*, 6: 288. [Type locality: Guadeloupe].

Type material: Syntypes in MNHN (23240), the better preserved one (Fig. 107) is hereby designated the lectotype.

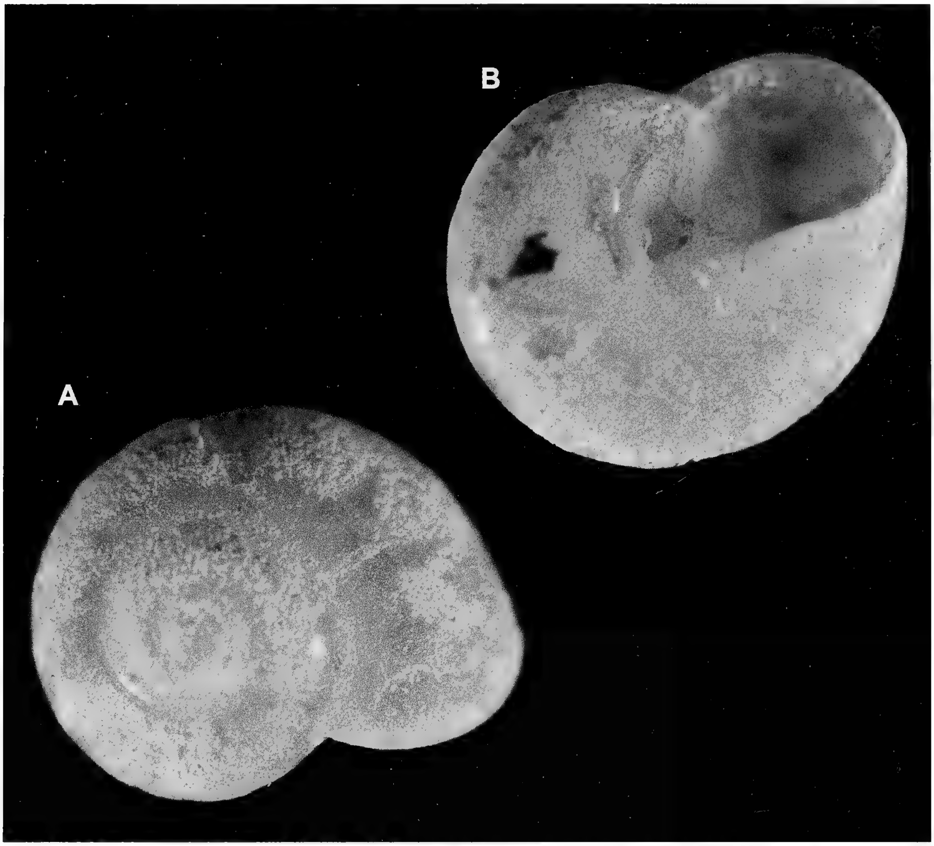
Description: In P. FISCHER (1857).

Maximum reported size: 2.5 mm.

Distribution: Guadeloupe (P. FISCHER, 1857).

Remarks: MOORE (1964: 110-111): *"The type of this species could not be found in the Paul Fischer type collection in the Laboratoire de Malacologie in Paris. However, in the general collection of the Laboratoire there is a card bearing a glass tube containing four specimens. The card bears the following information:* "Adeorbis petitii *P. Fisch. (86)"*. In his discussion of his new species, Fischer states that soft parts and operculum resemble *Skenea planorbis*, while the shell has more the aspect of an *Adeorbis*. The shells fit the description of *Skenea petiti* with only one discrepancy, the diameter is 3 ½ mm instead of Fischer's figure of 2 ½ mm. Fischer apparently wrote *Adeorbis* on the card while working on the collection from the Antilles and did not bother to change it later. Thus the writer considers the four specimens to be the syntypes of Fischer's lost species. It has never been figured.

We have examined the photograph of one of the best preserved syntypes in MNHN and saw that the poor state of conservation precludes morphological comparison. Some small spiral cordlets on the external margin of the lip and the shape of the umbilicus suggest some similarity with *Solariorbis multistriatus*.



Figures 107A-B. *Solariorbis petitii* (P. Fischer, 1857). A-B: Lectotype (MNHN).
Figuras 107A-B. Solariorbis petitii *(P. Fischer, 1857). A-B: Lectotipo (MNHN).*

Teinostoma avunculus Pilsbry, 1953

Teinostoma (Pseudorotella) avunculus Pilsbry, 1953. *Monographs of the Academy of Natural Sciences of Philadelphia*, 18: 413-414, pl. 49, fig. 3-3d. [Type locality: Plio-Pleistocene of North St. Petersburg, Florida].

Type material: In ANSP (18917).

Description: In PILSBRY (1953).

Maximum reported size: 2.3 mm.

Distribution: USA: Florida, Texas (ODÉ, 1987b).

Depth: 11 to 18 m.

Remarks: Fossil species described by PILSBRY (1953); Recent species by ODÉ (1987b, 1988).

Teinostoma morlierei Jousseaume, 1872

Range: 14.5°N, 61°W.

Maximum reported size: 3.5 mm.

Distribution: Martinique.

Teinostoma parvum (Stimpson, 1851)

Rotella parva Stimpson, 1851 (dubious name).

Range: 34°N to 33.5°N; 79°W to 78°W.

Distribution: USA: North Carolina.

References: KURTZ (1860); PORTER (1974).

Vitrinella anomala (d'Orbigny, 1842) (Figures 108A-C)

Trochus (Rotella) anomala d'Orbigny, 1842. *Mollusques. Histoire Physique, Politique et Naturelle de l'île de Cuba* 2: 64, pl. 18, figs. 32-34. [Type locality: Saint-Thomas].

Type material: In NHMUK.

Description: D'ORBIGNY (1842) in Sagra: "*Concha orbicular, muy deprimida, translúcida, muy lisa, brillante, ligeramente aquillada en su contorno; ombligo abierto sin encostramiento calcareo, verificandose el engrosamiento calcareo por dentro del borde columelar. Espira casi horizontal, compuesta de cinco vueltas deprimidas. Boca oblonga, oval, el borde columelar muy grueso. Color blanco vítreo*".

Maximum reported size: 1.9 mm.

Distribution: Colombia (DÍAZ MERLANO & PUYANA HEGEDOS, 1994); Virgin Islands: St. Thomas (D'ORBIGNY, 1842).

Vitrinella carinata (d'Orbigny, 1842)

Trochus (Rotella) carinata d'Orbigny, 1842. *Mollusques. Histoire Physique, Politique et Naturelle de l'île de Cuba* 2: 62-63, pl. 18, figs. 26-28. [Type locality: Saint-Thomas].

Type material: The material in USNM was not found (Yolanda Villacampa, pers. comm.). The material in NHMUK apparently had the labels changed and was a different species.

Description: In D'ORBIGNY (1842).

Maximum Reported Size: 1.5 mm

Distribution: USA: North Carolina (PORTER, 1974); Virgin Islands: St. Thomas (D'ORBIGNY, 1842b). Depth: 29 m.

Remarks: *Nomen dubium* according to MOORE (1964).

Vitrinella hemphilli Vanatta, 1913

Vitrinella hemphilli Vanatta, 1913. *Proceedings of the Academy of Natural Sciences of Philadelphia* 65: 24, pl. 2, figs. 1, 3. [Type locality: Cedar Keys, Florida].

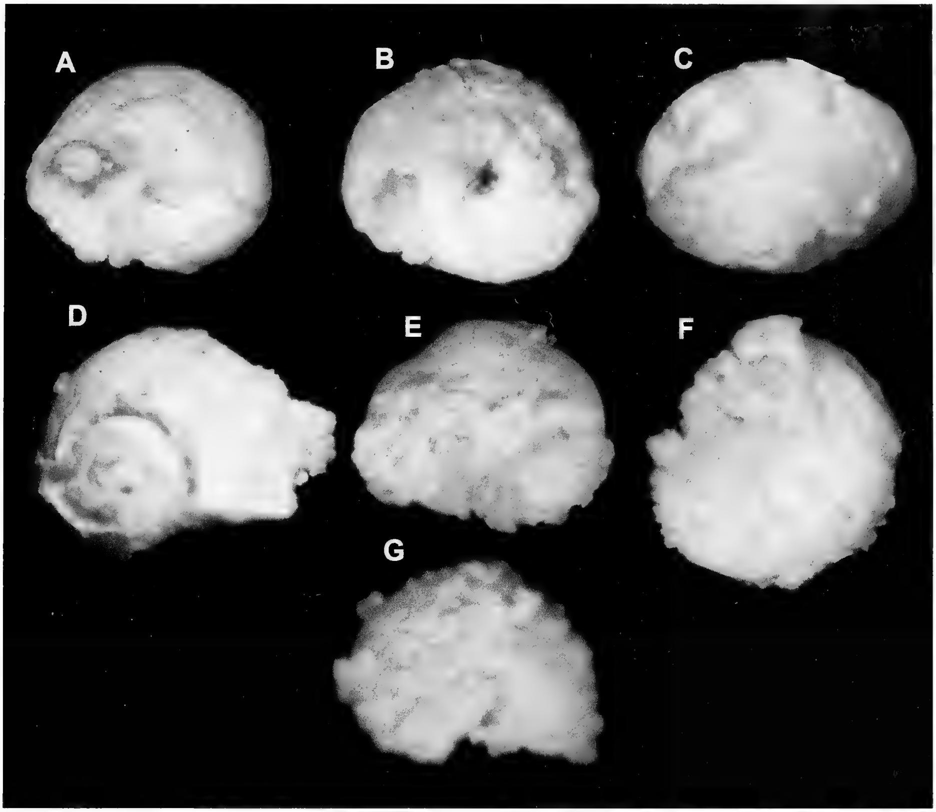
Type material: In ANSP (10236).

Description: In VANATTA (1913).

Maximum reported size: 2.5 mm.

Distribution: USA: Florida: West Florida (VANATTA, 1913); Texas (ODÉ, 1987c); Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994). Depth: 0.6 to 73 m (alive at 51 m).

Remarks: MOORE (1964): "V. hemphilli *has a dorsal spiral cord which disappears after one turn. In this, it is*



Figures 108A-G. Syntypes of *Rotella*. A-C: *Rotella anomala* (d'Orbigny, 1842), syntypes in NHMUK; D-F: *Rotella striata* (d'Orbigny, 1842), syntypes in NHMUK; G: *Rotella diaphana* (d'Orbigny, 1842), syntype in NHMUK.

Figuras 108A-G. Sintipos de Rotella. *A-C:* Rotella anomala *(d'Orbigny, 1842), sintipos en NHMUK; D-F:* Rotella striata *(d'Orbigny, 1842), sintipos en NHMUK; G:* Rotella diaphana *(d'Orbigny, 1842), sintipo en NHMUK.*

like V. helicoidea, *but the pointed spire and absence of a strong carina around the umbilicus separates it from that species".*

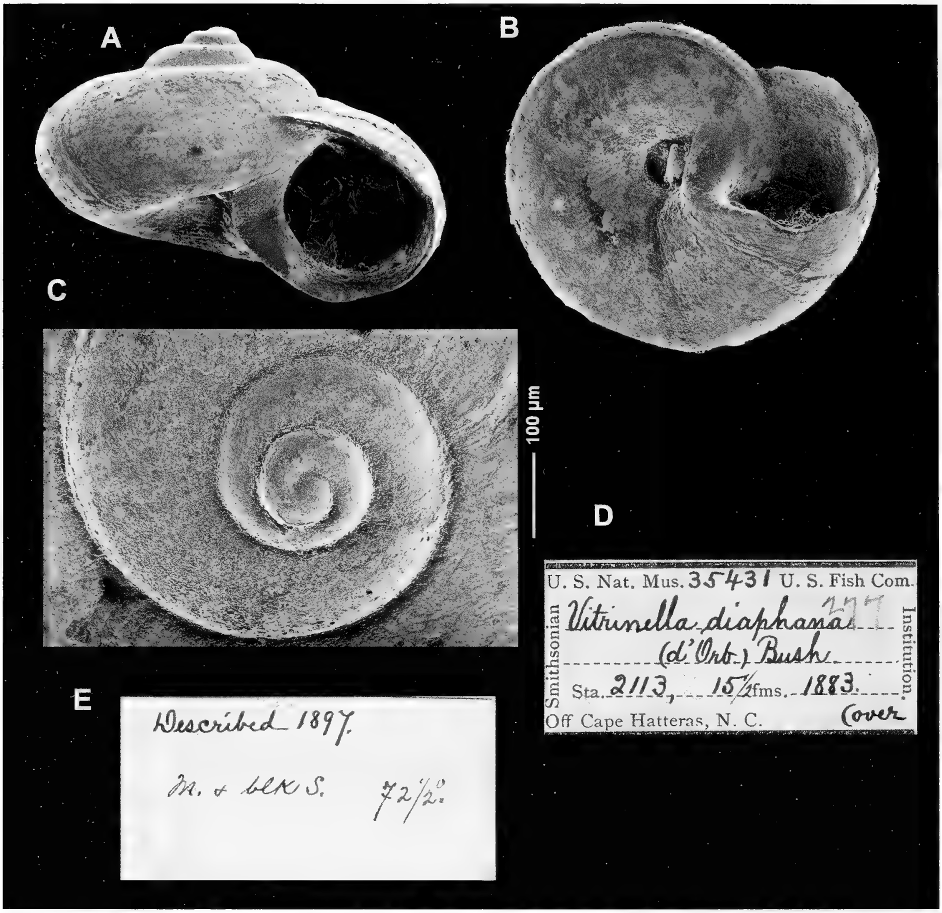
Vitrinella pusilla (L. Pfeiffer, 1840) (Figs. 108G, 109A-E)

Rotella pusilla Pfeiffer, 1840. *Archiv für Naturgeschichte,* 6(1): 255. Not figured [Type locality: Cuba (Nordküste, L. PFEIFFER 1839: 349; Matanzas Bay or Cardenas, based on localities cited by L. PFEIFFER, 1854].

Trochus (Rotella) diaphana d'Orbigny, 1842. *Mollusques. Histoire Physique, Politique et Naturelle de l'île de Cuba* 2: 62, pl. 18, figs. 23-25. [Type locality: Saint-Thomas].

Pseudorotella pusilla (L. Pfeiffer, 1840).

Type material: One syntype in NHMUK (Fig. 108G]. In USNM (35431) (secondary type collection: as *Rotella diaphana*).



U. S. Nat. Mus. 35431 U. S. Fish Com.
Smithsonian Institution.
Vitrinella diaphana
(d'Orb.) Bush
Sta. 2113, 15½fms. 1883.
Off Cape Hatteras, N. C. Cover

Described 1897.
M. + blk S. 72/2°

Figures 109A-E. *Vitrinella diaphana* (d'Orbigny, 1842b). A-B: specimens identified by Bush, from off Cape Hatteras; 1.27 mm, USNM (35431); C: protoconch; D-E: labels.

Figuras 109A-E. Vitrinella diaphana *(d'Orbigny, 1842b). A-B: ejemplares identificados por Bush, procedentes de frente a Cape Hatteras; 1,27 mm, USNM (35431); C: protoconcha; D-E: etiquetas.*

Description: Original description of *Rotella pusilla* in Pfeiffer (1840): *"Testa discoidea nitide alba; anfract. 3; basi concaviuscula, medio callosa: apertura orbiculari. Diam. ¾, alt. 1/ 3 lin"*.

Original description of *Trochus (Rotella) diaphana* in d'Orbigny, 1842: *"Coquille orbiculaire, deprimee, diaphane, trés lisse, très polie, convexe du côte de la espire, legérement concave du côte de la bouche, la callosite étant peu etendue. Spire peu elevée, tres obtuse, composée de quatre tours convexes, á pourtour arrondie. Bouche ovale, oblique. Couleur: blanc transparent comme du verre.*

Maximum reported size: 1.5 mm.

Distribution: Cuba: North Havana Province (Arango, 1880); USA: North Carolina (Bush, 1897); Panama: Bocas Island (Olsson & McGinty, 1958).

Remarks: The types of *Rotella pusilla* Pfeiffer, 1840 are untraceable. L. Pfeiffer (1840) offered a short and ambiguous text and no figure. Consequently it may be confused with several taxa. The type material is from

Cuba, but we have not found any museum or shell collection with material labeled *R. pusilla,* which could serve as a reference. Therefore we consider *Rotella pusilla* L. Pfeiffer, 1840 as a *nomen dubium* until the type material is located. Under these conditions the synonymy established for *Vitrinella diaphana* can not be accepted.

The types of *Vitrinella diaphana* Orbigny, 1842 in NHMUK are in very poor condition (Fig. 108G). In the secondary type collection of the USNM (35431) are deposited 2 shells labeled by BUSH (1897) as *V. diaphana* (d'Orb.), from Cape Hatteras, North Carolina.

This taxon has been included in the following genera: *Parkeria, Adeorbis* and *Teinostoma*.

We have some doubts about the accuracy of the identification made by BUSH (1897) due to its great similarity to *Solariorbis terminalis*. The differences between them are quite minor: The shell labeled as *V. diaphana* lacks the subsutural sulcus, its periphery is more rounded, and some wide depressed spiral cords are visible on the whole surface of the shell. At present we shall keep the taxa separate until topotypes of *V. diaphana* become available. Such material should help in the correct assignament of both nominal taxa.

Vitrinella tryoni Bush, 1897

Vitrinella helicoidea auct. non C.B. Adams, 1850.

Vitrinella tryoni Bush, 1897. *Transactions of the Connecticut Academy of Arts and Sciences,* 10: 123, pl. 22, figs. 11-11a. [Type locality: USFC sta. 2278, off Cape Hatteras, North Carolina, 16 fms (29 m)].

Type material: Holotype in USNM (41561).

Description: BUSH (1897).

Maximum reported size: 2 mm.

Distribution: USA: North Carolina (BUSH, 1897); Cuba: North Havana Province, North Matanzas (AGUAYO & JAUME, 1936).

Depth: 29 m.

Remarks: The species was misidentified by TRYON (1888: 102, pl.34, figs. 40, 41) as *V. helicoidea* C.B. Adams. The type of this species (USNM 41561) is only a fragment and canot be identified at the species level (Yolanda Villacampa and Jerry Harasewych, pers. comm.).

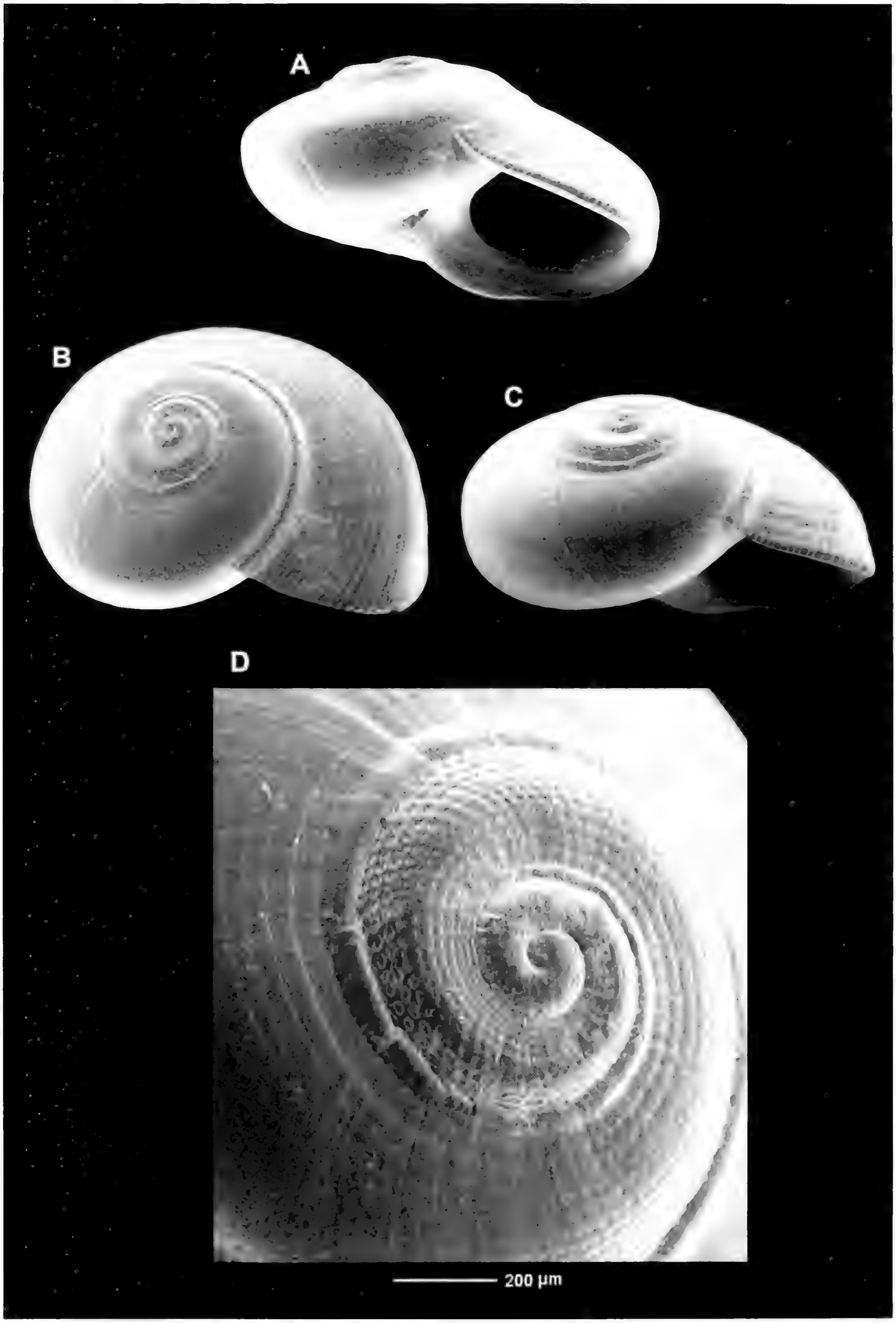
FOSSIL OR SUPPOSEDLY FOSSIL SPECIES, NOT RECENT

Many of the fossil species described in some papers (for example, PILSBRY, 1953) have been recorded in other works as also occurring in the recent. Other species, already known as fossil, are added in this paper to the recent fauna for the first time. Others yet, only known as fossil species, are not the main topic of this work. Of the last group, we can mention the following:

Anticlimax athleenae (Pilsbry & McGinty, 1946)

Climacia athleenae Pilsbry & McGinty, 1946. *The Nautilus,* 59: 78-79, pl. 8, figs. 3-3a. [Type locality: Boca Ciega Bay].

Type material: In ANSP (181291).



Figures 110A-F. *Cyclostremiscus fargoi* Pilsbry, 1953. A-C: shell, 1.6 mm, Pliocene of La Belle, Florida (CHL); D-F: shell, 1.4 mm, Pliocene of La Belle, Florida (CHL).

Figuras 110A-F. Cyclostremiscus fargoi *Pilsbry, 1953. A-C: concha, 1,6 mm, Plioceno de La Belle, Florida (CHL); D-F: concha, 1,4 mm, Plioceno de La Belle, Florida (CHL).*

Description: In PILSBRY & MCGINTY (1946).

Maximum reported size: 2.6 mm.

Distribution: USA: Florida: West Florida (Pilsbry & McGinty, 1946a); Colombia (DÍAZ MERLANO & PUYANA HEGEDUS, 1994).

Remarks: MOORE (1964) mentions: *"This species is known from a single specimen taken from fill dredged from Boca Ciega Bay. It is here considered to be a fossil of unknown age"*.

Aorotrema gardnerae Pilsbry, 1953.

Aorotrema gardnerae Pilsbry, 1953. *Monographs of the Academy of Natural Sciences of Philadelphia*, 18: 424, pl. 39, fig. 13. [Type locality: Upper Miocene, Natural Well, Duplin Co., North Carolina].

Type material: In ANSP (19550).

Cyclostremiscus fargoi Pilsbry, 1953 (Figures 110A-F)

Cyclostremiscus fargoi Pilsbry, 1953. *Monographs of the Academy of Natural Sciences of Philadelphia*, 18: 424-425, pl. 56, figs. 1-1c. [Type locality: Plio-Pleistocene, St. Petersburg, Florida].

Type material: ANSP (18399).
Other material examined: USA: 2 s, Pliocene of La Belle, Florida (CHL).

Cyclostremiscus gunteri (Mansfield, 1930)

Circulus gunteri Mansfield, 1930. *Florida State Geol. Survey Bull.* 3: 132, pl. 20, figs. 16-18. [Type locality: Upper Miocene, Leon County, Florida].

Type material: In USNM (370493).

Cyclostremiscus olssoni Pilsbry, 1953.

Cyclostremiscus olssoni Pilsbry, 1953. *Monographs of the Academy of Natural Sciences of Philadelphia*, 18: 426, pls. 54, figs. 6-6c. [Type locality: Plio-Pleistocene, Shell Creek, Florida].

Type material: In ANSP (18453).

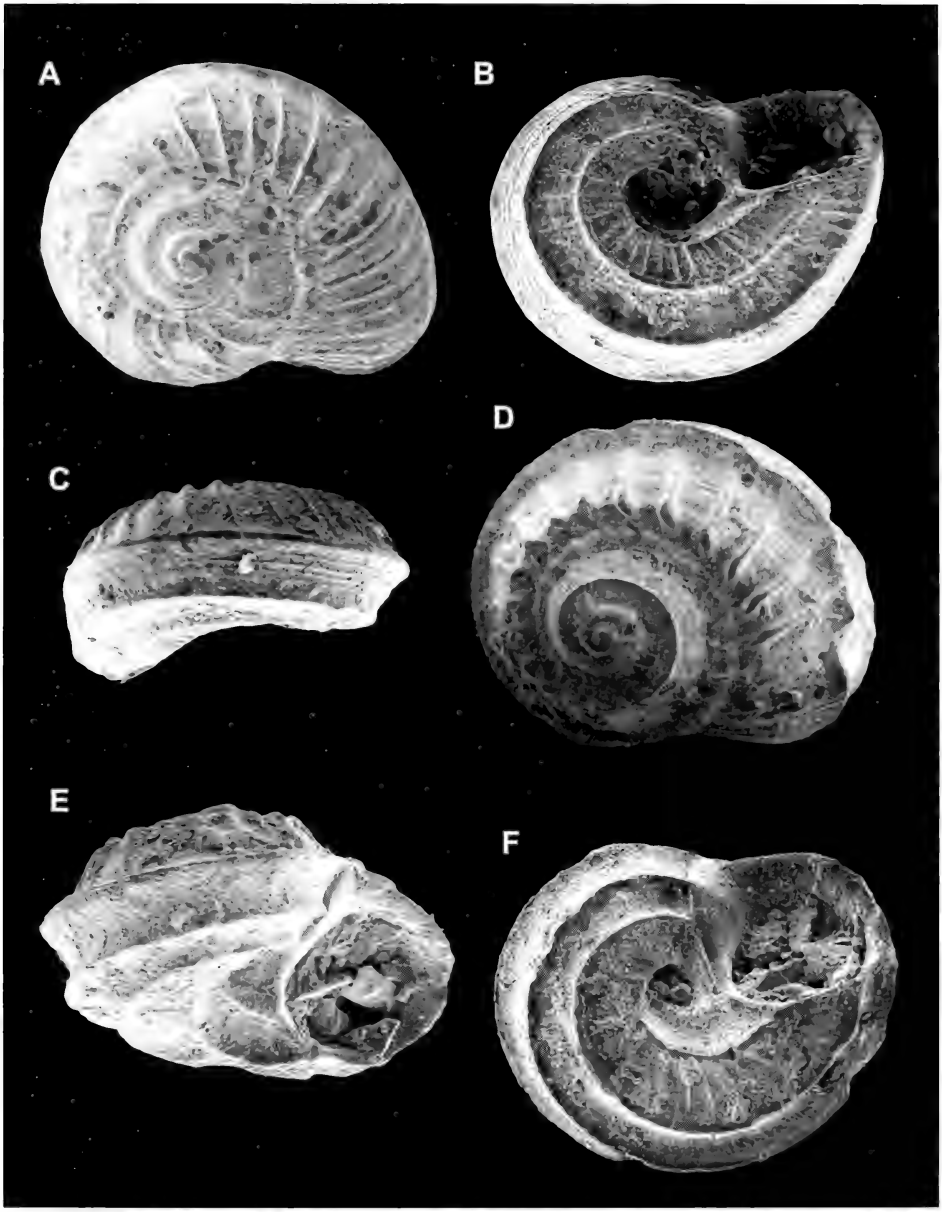
Parviturboides avitus Pilsbry, 1953.

Parviturboides avitus Pilsbry, 1953. *Monographs of the Academy of Natural Sciences of Philadelphia*, 18: 436, pl. 56, figs. 3-3a. [Type locality: Plio-Pleistocene, St. Petersburg, Florida].

Type material: In ANSP (18460).

Solariorbis eugenes Pilsbry, 1953 (Figures 111A-D)

Solariorbis eugenes Pilsbry, 1953. *Monographs of the Academy of Natural Sciences of Philadelphia*, 18: 418-419, pl. 54, figs. 1, 1a-b. [Type locality: Plio-Pleistocene, St. Petersburg, Florida].



Figures 111A-D. *Solariorbis eugenes* Pilsbry, 1953. A-C: shell, 4.3 mm (CHL); D: protoconch.
Figuras 111A-D. Solariorbis eugenes *Pilsbry, 1953. A-C: concha, 4,3 mm (CHL); D: protoconcha.*

Type material: In ANSP (18413).
Other material examined: USA, Florida: 1 s, fossil Pleistocene, ST. Petesburg (CHL).

Description: This is the original description in PILSBRY (1953): "*The shell is solid, somewhat lens-shaped, with low spire, rounded periphery and a rather narrow, deep umbilicus. There are 3 ½ whorls, the first 1 ½ relatively large, convex and smooth, the next whorl with about 8 or 9 narrow and* *shallow spiral grooves more or less distinctly interrupted by retractive radial striae crossing the grooves. On the last whorl this sculpture is nearly or wholly lost, leaving it almost smooth except for a distinct subsutural margin defined by a spiral groove. The aperture is oblique, subcircular but with a grooved upper angle. The peristome is rather thin. The columella is widened by a flat, triangular callus at the end of the rounded ridge which surrounds and contracts the umbilicus. The parietal callus is thin, its outer edge indistinct. Diameter 4.2 mm, height 2.5 mm".*

Remarks: Plio-Pleistocene fossil species of St. Petersburg, Florida. We do not know any current reference for this species. PILSBRY (1953) commented: *"This appears to be a typical* Solariorbis, *having sculpture on the penult whorl like the type, becoming almost smooth at the last whorl".* The shell figured does not appear to be a fossil shell.

Teinostoma caloosaense Dall, 1892

Teinostoma caloosaense Dall, 1892. *Trans. Wagner Free Inst. Sci.*, 3: 413, pl. 23, fig. 8. [Type locality: Plio-Pleistocene, Caloosahatchie River, Florida].

Type material: In USNM (113110).

Teinostoma tectispira Pilsbry, 1953

Teinostoma tectispira Pilsbry, 1953. *Monographs of the Academy of Natural Sciences of Philadelphia*, 18: 417, pl. 50, figs. 6-6c. [Type locality: Plio-Pleistocene, St. Petersburg, Florida].

Type material: In ANSP (18406).

SPECIES FROM NEIGHBOURING GEOGRAPHIC AREAS

Neusas marshalli (Sykes, 1925) (Figures 112A-C)

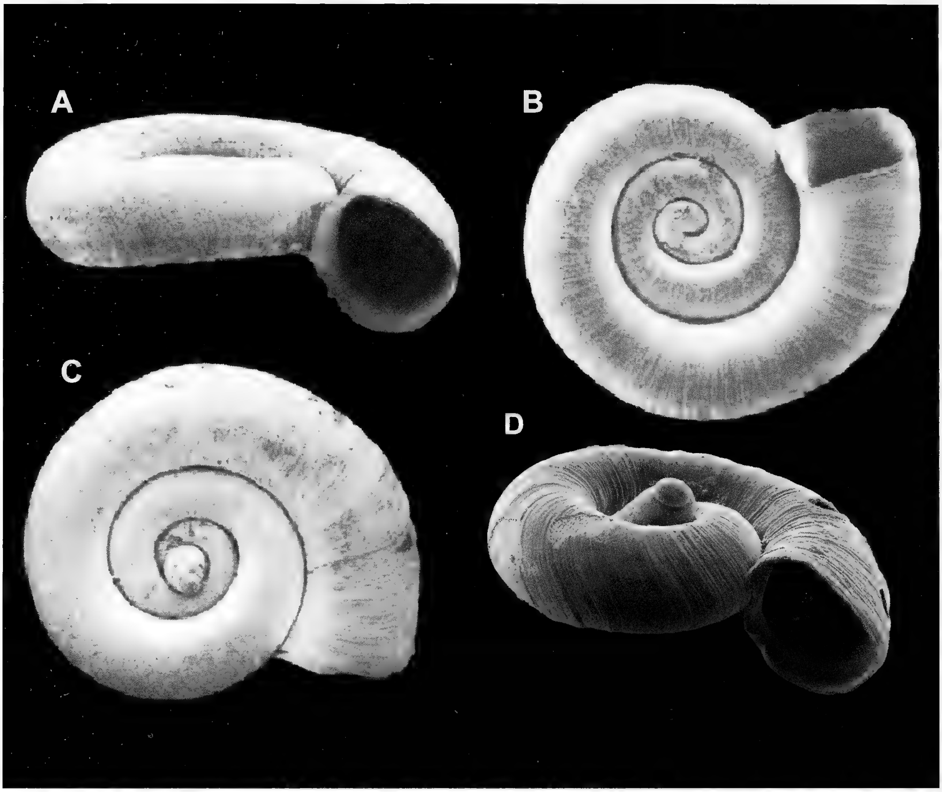
Homalogyra (?) marshalli Sykes, 1925: 193, pl. 9, fig. 9-9a [Type locality: off Portugal, 39°42'N, 09°43'W, 1092-1993 m, Porcupine Expedition sta. 17].

Description: SYKES (1925): *"Morphology: Shell planispiral, resembling a planorbid, with rounded and almost smooth whorls with a deep suture. Protoconch tall-spired and obliquely inserted, with slightly more than two whorls, smooth. Teleoconch with about three slightly irregularly coiled whorls. Operculum corneous, multispiral, round with central nucleus".*

Size: Shell diameter up to 2.06 mm.

Distribution: See WARÉN & BOUCHET (2001). Mid-Atlantic Ridge: Menez Gwen hydrothermal vent, Azores (37.84°N; 31.52°W to 9.72°W). Depth: 870 to 860 m (collected alive).

One shell (Fig. 112 D) of *Neusas* s.p (Absalão, pers. com.) showed the wide distribution of this genus in south Atlantic.



Figures 112A-D. *Neusas marshalli* (Sykes, 1925). A-C: shells, 2 mm, Menez Gwen hydrothermal vent, Azores, Atlantic Ocean (with authorization of A. Warén); D: *Neusas* sp., 1.1 mm, Campos Basin, Rio de Janeiro, Brazil (with authorization of R. Absalão).

Figuras 112A-D. Neusas marshalli *(Sykes, 1925). A-C: conchas, 2 mm, Menez Gwen hydrothermal vent, Azores, Atlantic Ocean (con la autorización de A. Warén); D:* Neusas *sp., 1.1 mm, Campos Basin, Rio de Janeiro, Brazil (con la autorización de R. Absalão).*

Ponderinella xacriaba Absalão, 2009 (Figures 113A-C)

Ponderinella xacriaba Absalão, 2009. *American Malacological Bulletin,* 27: 138, figs. 2E-H. [Type locality: BC Sul I, sta. 73, Campos Basin, Rio de Janeiro State, Brazil, 22°41'35"S, 40°00'45"W, 1950 m].

Description: ABSALÃO (2009). Maximum reported size: 1.23 mm.

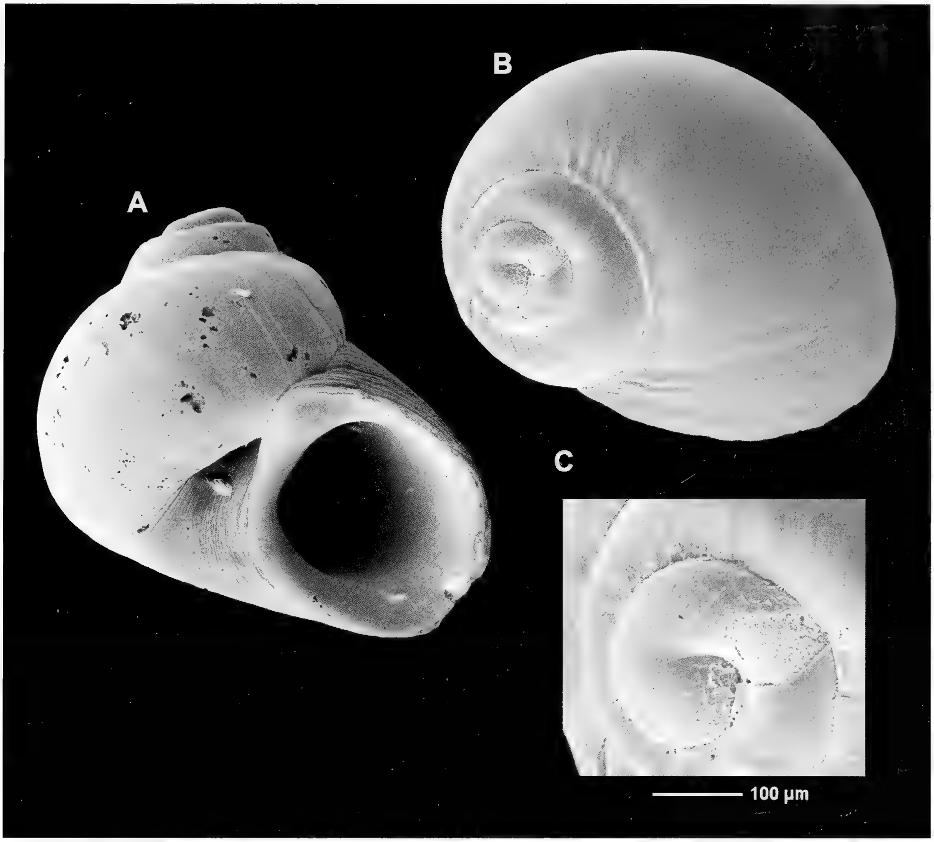
Distribution: Brazil: Rio de Janeiro. Depth: 1030 to 1950 m.

Teinostoma abnorme E.A. Smith, 1890

Teinostoma ?abnorme E.A. Smith, 1890. *Proceedings of the Zoological Society of London,* 1890: 293, pl. 24, fig. 5. [Type locality: St. Helena].

Description: In SMITH (1890). Maximum reported size: 1 mm.

Distribution: Eastern Atlantic: St. Helena. Only known from its type locality.



Figures 113A-C. *Ponderinella xacriaba* Absalão, 2009. (Photographs authorized by R. Absalão)
Figuras 113A-C. Ponderinella xacriaba *Absalão, 2009. (Fotografías autorizadas por R. Absalão)*

SPECIES RECORDED ERRONEOUSLY FROM THE CARIBBEAN

Adeorbis elegans (A. Adams, 1850)

Cyclostrema elegans A. Adams, 1850. *Proceedings of the Zoological Society of London,* 18: 44. [Type locality: Sibonga, island of Cebu, Philippines, 10 fathoms (18 m)].

Remarks: It has been reported from St. Thomas but this is a species described from the Philippines and so its presence in the Caribbean is very improbable.

Vitrinella regularis (C.B. Adams, 1852)

Remarks: Holotype in MCZ (156374). With the shell is a label indicating "Jamaica". Probably it is an error, because it is a Pacific (Panamic) species.

SUPPLEMENT

DUBIOUS SPECIES, APPARENTLY NOT TORNIDAE

These taxa are not the subject of the present work. Nevertheless, some of them have been recorded dubiously or positively in Vitrinellidae. As we obtained photographs, we present some of them as information for the reader.

"Aorotrema" erraticum Pilsbry & McGinty, 1945 (Figure 114A)

Aorotrema erraticum Pilsbry & McGinty, 1945a. *The Nautilus*, 59: 1, pl. 11. [Type locality: 1.5 miles off Cape Florida, 12 fms (22 m)].

Material examined: 1 s, Cienfuegos, Cuba (MHNS).

Remarks: Moore (1964: 189) said: *"the examination of the holotype of* A. erraticum *informs that it is a juvenile of* Turbo castaneus *Gmelin due to the coincidence of all the details, protoconch, shape and sculpture"*. We accept this opinion and represent a sample of this shell.

"Vitrinella tincta" C.B. Adams, 1850 (Figs. 114B-D)

Vitrinella tincta C.B. Adams, 1850. *Monograph of Vitrinella*: 8.

Type material: The lectotype in MCZ (156257) (figured in Clench & Turner, 1950, plate 35 fig. 6) and 1 second specimen (also figured in Clench & Turner, 1950, plate 35 fig. 3) labeled as paratype, in MCZ (186189).

Other material examined: Virgin Islands: 1 s, beach at Magens Bay, N coast of St. Thomas, Virgin Is. (CHL).

Remarks: This species is represented by some drawings of the types, and the description is commented on in Clench & Turner (1950). The appearance is not that of a valid species but rather a juvenile *Tegula* as suggested by its colored spots aligned spirally.

"Vitrinella" carinifex Dall, 1927 (Figures 115A-D)

Vitrinella? Carinifex Dall, 1927. *Proceedings of the United States National Museum*, 70(2667): 126. [Type locality: Off Georgia].

Type material: Lectotype in USNM (108399) (Figs. 115A-D).

Description: In Dall (1927).

Distribution: Only known from the type material, from Georgia, USA. Range: 30.73°N; 79.43°W. Depth: 805 m.

Remarks: Dall (1927) comments: *"This is probably not a true* Vitrinella *and may be immature but certainly is not the young of any of the species enumerated in this discussion".*

The lectotype of *Vitrinella carinifex* in USNM is not a *Vitrinella* or a tornid. In our opinion perhaps it is a young naticid (see the notch in the columella). Maximum reported size: 3.7 mm.

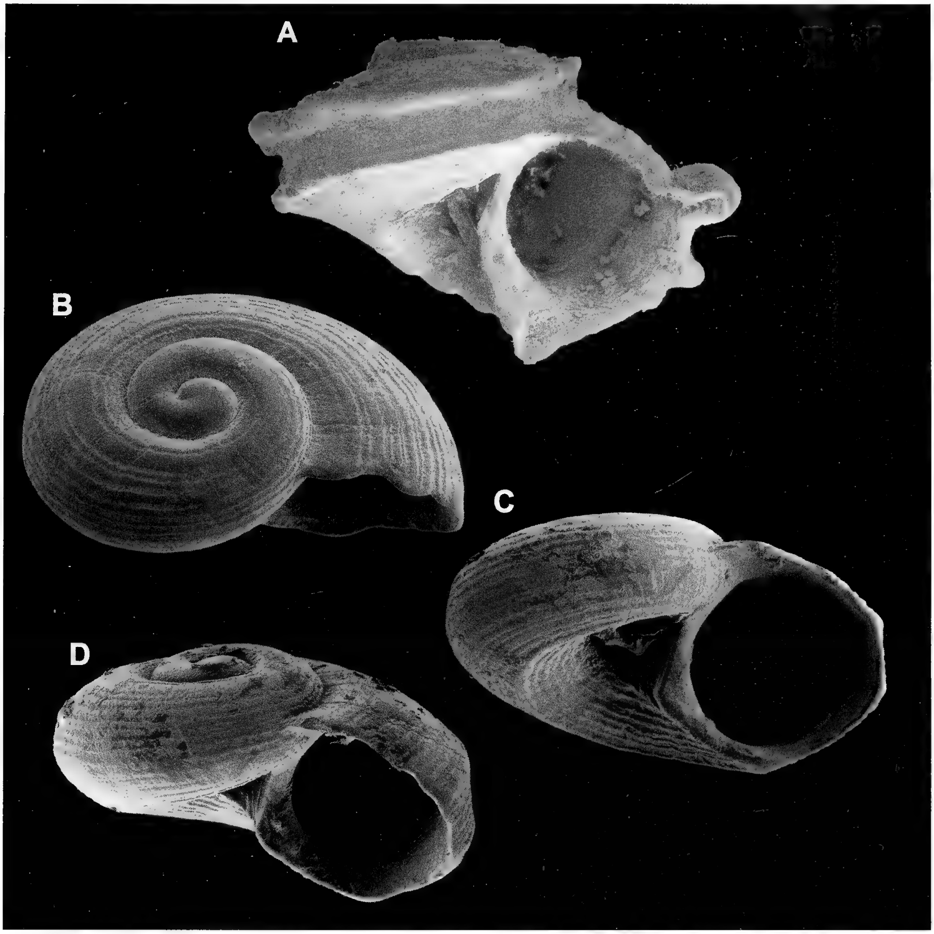


Figure 114A. "*Aorotrema*" *erraticum* Pilsbry & McGinty, 1945. A: shell, 5.1 mm, Cienfuegos, Cuba (MHNS). Figures 114B-D. *Vitrinella tincta* C.B. Adams, 1850. Lectotype (labeled as syntype) (MCZ 156257).

Figura 114A. "Aorotrema" erraticum *Pilsbry & McGinty, 1945. A: concha, 5,1 mm, Cienfuegos, Cuba (MHNS). Figuras 114B-D.* Vitrinella tincta *C.B. Adams, 1850. Lectotipo (etiquetado como sintipo) (MCZ 156257).*

Vitrinella cyclostomoides (L. Pfeiffer, 1840)

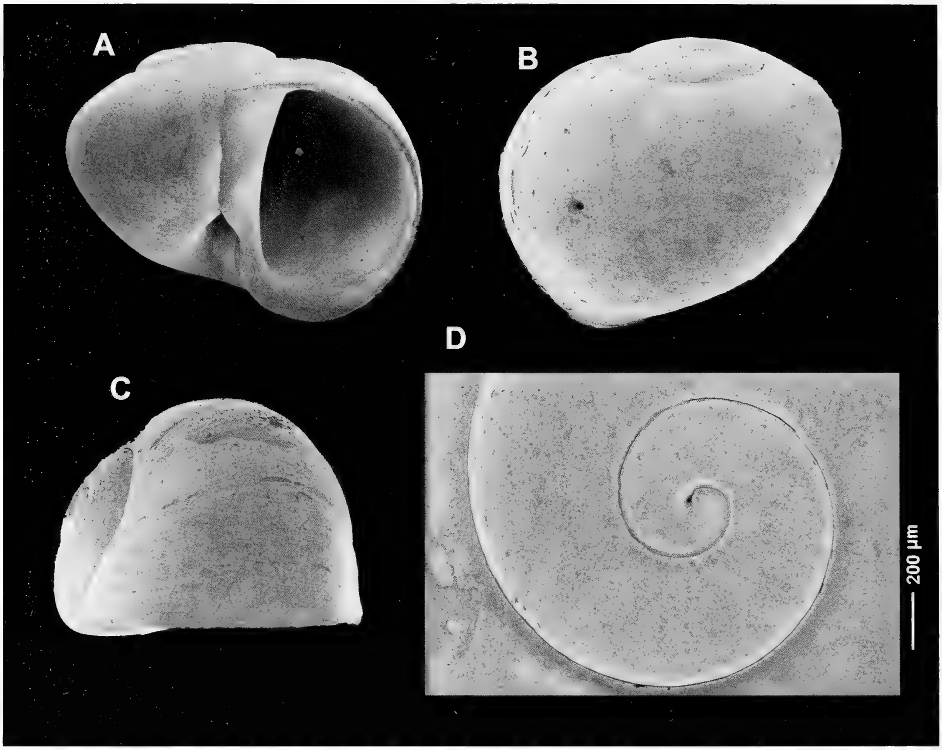
Helix (?) cyclostomoides Pfeiffer, 1840. *Archiv für Naturgeschichte* 6(1): 251, [Pfeiffer, 1850, pl. 85, figs. 24-26]. [Type locality: Cuba [Nordküste (L. PFEIFFER, 1839: 349); Matanzas (L. PFEIFFER, 1854c)].

Description: L. PFEIFFER (1840).

Maximum reported size: 3.2 mm.

Distribution: Cuba: North Matanzas: L. PFEIFFER (1840); L. PFEIFFER (1852). Depth: 0 m.

Remarks: This species has been treated as both terrestrial and marine. L. PFEIFFER (1840) named it a *Helix* but found his specimen(s) at the 'Seestrande'. He later expressed doubt



Figures 115A-D. "*Vitrinella*" *carinifex* Dall, 1927. A-C: lectotype, 3.5 mm in diameter (USNM 108399); D: protoconch. (SEM's by Yolanda Villacampa, USNM).
Figuras 115A-D. "Vitrinella" carinifex *Dall, 1927. A-C: lectotipo, 3,5 mm de diámetro (USNM 108399); D: protoconcha. (Fotografías al MEB de Yolanda Villacampa, USNM).*

that it was a landsnail (L. PFEIFFER, 1854: 179). ARANGO (1880) treated it as the valid name for *Adeorbis adamsii* and ESPINOSA *ET AL*. (1995) regarded it as a valid species of *Vitrinella*. TRYON (1887: 100), however, treated it as a *Microphysa* and RICHARDSON (1986) placed it in *Hojeda* (Sagdidae). It is not listed among the Cuban *Hojeda* by ESPINOSA & ORTEA (1999), and the only Cuban *Hojeda* with a range that includes Matanzas is *Hojeda boothiana* (L. Pfeiffer, 1839), a taxon that Pfeiffer clearly did not consider conspecific with his *Helix cyclostomoides*.

Vitrinella hyalina C.B. Adams, 1850

Vitrinella hyalina C.B. Adams, 1850e. *Monograph of Vitrinella, a New Genus of New Species of Turbinidae*: 5, Not figured. [Type locality: Port Royal, Jamaica].

Type material: Lost (CLENCH & TURNER, 1950).

Description: C.B. Adams (1850).
Maximum reported size: 1.7 mm.
Distribution: Jamaica: C.B. ADAMS (1850).

Remarks: Possibly this is a naticid (see MOORE, 1964: 51).

VITRINELLID SPECIES TRANSFERRED TO OTHER FAMILIES

Family TURBINIDAE Rafinesque, 1815

Some genera of this family are composed of small, lenticular or depressed shells with a low spire, and for these reasons they may be confused with Tornidae. Occasionally, some of them have been placed in this family so we make reference to them here.

Subfamily SKENEINAE Clark, 1851

Genus *Cirsonella* Angas, 1877

Cirsonella Angas, 1877: 38. Type species, by monotypy, *Cirsonella australis* Angas, 1877 (Fig. 11A), southern Australia.

Tharsis Jeffreys, 1883: 93 (not Giebel, 1847). Type species, by monotypy, *Oxistele romettensis* Granata, 1877, Mediterranean.

Tharsiella Bush, 1897: 113. Replacement name for *Tharsis* Jeffreys, 1883 not Giebel, 1847.

Porcupinia Cossmann, 1900: 43. Replacement name for *Tharsis* Jeffreys, 1883.

Porcupina Cossmann, 1925: 287. Misspelling.

Diagnosis: In WARÉN (1991: 159): *"Small skeneimorph gastropods with almost globular, smooth shell, almost round, prosocline aperture, with thickening at umbilicus. Protoconch finely and irregularly spirally striated. Operculum sturdy, yellowish with long growth zone. Radula with four to five undifferentiated lateral teeth and well developed basal plate on innermost marginal tooth. Propodial penis not present"*.

The operculum of *Cirsonella* differs from the typical species of *Skeneidae*, having its last 1/3 whorl slowly tapering, while in *Skeneidae*, it ends abruptly with an oblique edge covering about 1/20 of the whorl. Another differential characteristic is that species of *Cirsonella* retract the operculum only very slightly, or not at all, behind the peristome, contrary to most skeneids.

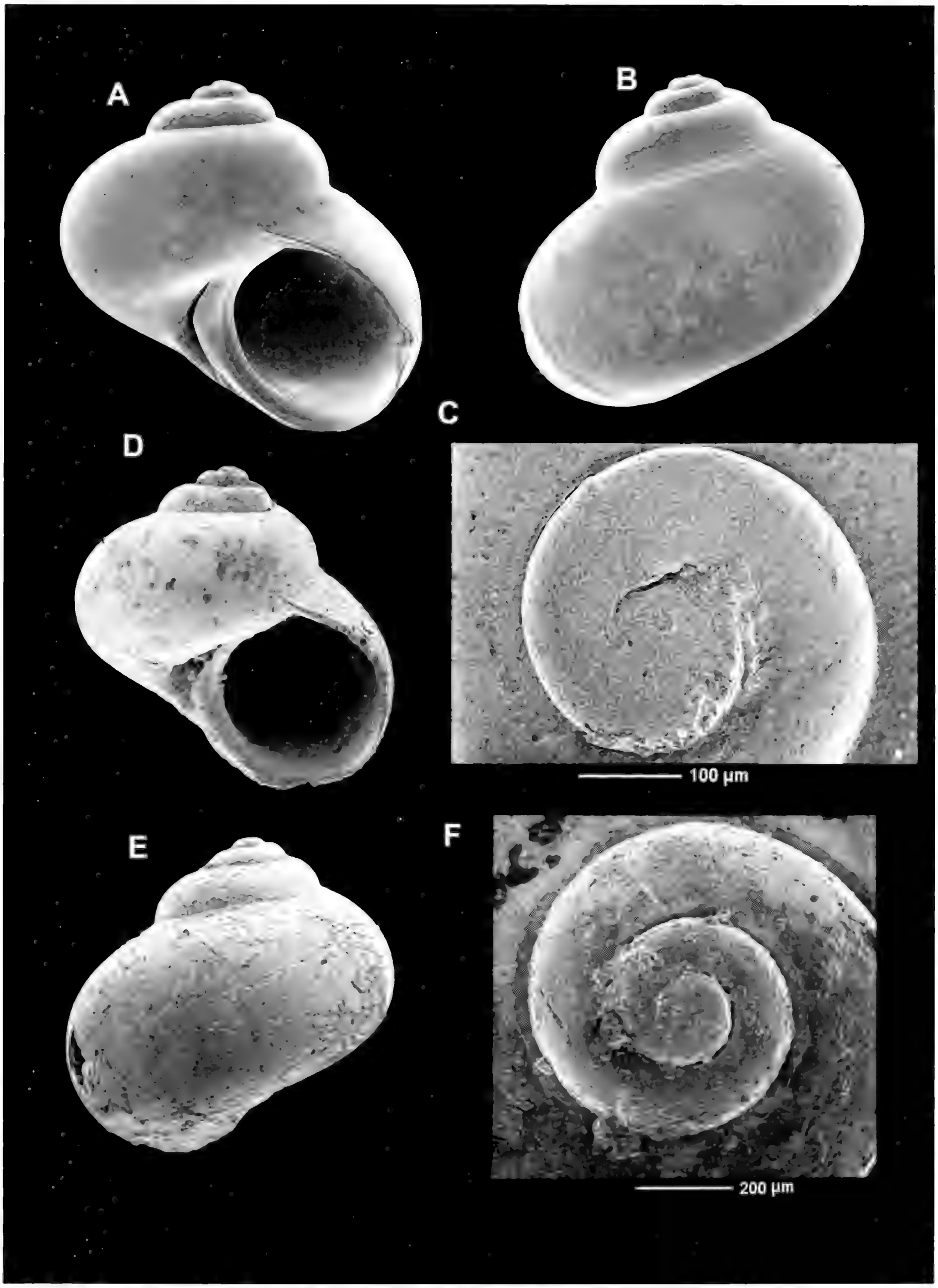
Cirsonella floridensis (Dall, 1927) (Figures 116A-C)

Pseudorotella floridensis Dall, 1927. *Proceedings of the United States National Museum* 70(2667): 126. [Type locality: *Albatross* sta. 2668, off Fernandina, Florida [actually off Georgia], 30°58′N, 79°38′W, 294 fathoms (529 m)].

Type material: Lectotype in USNM (108133). Examined by SEM microphotographs.

Original description: In DALL (1297): *"Shell small, porcelaneous white, smooth, polished, turbinate, with four well-rounded whorls; suture distinct, not deep; aperture nearly circular, the margin simple, continuous over the body with a marked deposit of enamel behind the body lip and over the umbilical region, completely closing the umbilicus and in the completely adult sometimes produced in subangulate form above and below. Height, 2 mm; maximum diameter, 3 mm"*.

We add the following: The protoconch measures 260 µm in maximum diameter, smooth and ¾ of a whorl. There is no sculpture. There are two fine spiral cordlets in the umbilicus and there is no umbilical cord bordering it. In the figured specimen the columellar callus reduces the umbilicus to a fine fissure, however, as is explained in DALL (1927), in other shells the callus totally covers the umbilicus. In the inner part of the aperture and along the columella and the inner lip there is a wide



Figures 116A-C. *Cirsonella floridensis* (Dall, 1927). A-B: lectotype, 2.2 mm in diameter (USNM, 108133); C: protoconch. (SEM's by Yolanda Villacampa, USNM). Figures 116D-F. *Cirsonella georgiana* (Dall, 1927); D-E: lectotype, 1.95 mm, (USNM, 329375); F: protoconch. (SEM's by Yolanda Villacampa, USNM).
Figuras 116A-C. Cirsonella floridensis *(Dall, 1927). A-B: lectotipo, 2.2 mm de diámetro (USNM, 108133); C: protoconcha. (Fotografías al MEB deYolanda Villacampa, USNM). Figuras 116D-F.* Cirsonella georgiana *(Dall, 1927); D-E: lectotipo, 1.95 mm, (USNM, 329375); F: protoconcha. (Fotografías al MEB de Yolanda Villacampa, USNM).*

fold which is like an "opercular stop", characterístic of the species of the genus *Cirsonella*.

The studied shell is 2.2 mm in diameter and 2.2 mm in height.

Habitat: Dredged from 678 meters depth, in gray sand and broken coral bottom. Abundant.

Distribution: From off Fernandina (actually off Georgia) (DALL, 1927); from North Carolina (PORTER, 1974); ODÉ (1987a).

Remarks: Actually this species has been placed in the genus *Teinostoma*. DALL (1927) mentions: *"This is much like* Pseudotorella solida, *but larger, more elevated, and with the umbilical pad heavier and more simple"*. As in *Lydipnis margaritiformis*, the morphologic characters of the shell make one think it is a skeneid, most probably in the genus *Cirsonella* Angas, 1877. The shell studied is very similar to *Cirsonella extrema* Thiele, 1912 (USNM 613041), in WARÉN (1991: 212, fig. 11B), being distinguished from it by the lower number of spiral striae around the umbilicus. It is also similar to *Cirsonella romettensis* (Granata, 1877) even to the number of the spiral fillets around the umbilicus, but from that species it differs by its smooth vs spirally striated, protoconch. Based on all the above, we propose the new combination *Cirsonella floridensis* (Dall, 1927).

Cirsonella georgiana (Dall, 1927) (Figs. 116D-F)

Vitrinella georgiana Dall, 1927. *Proceedings of the United States National Museum* 70(2667): 109. [Type locality: Off Georgia].

Type material: Lectotype and six paralectotypes in USNM (329375). The lectotype examined by SEM microphotographs.

Original description: *"Shell minute, glassy white, low turbiniform, with about three and a half smooth, well-rounded whorls; nucleus minute, suture distinct, not deep; aperture subcircular, the peristome interrupted by the body whorl, not reflected, sharp; base roundly convex, with a minute perforate umbilicus, partly shadowed by the inner lip. Height 1.6; diameter, 2 mm"*.

The lectotype is 1.95 mm in maximum diameter and 1.95 mm in height.

Habitat: Dredged from 805 meters depth, on a broken coral, coarse sand, and broken shell bottom.

Distribution: Only know from the USA: Georgia, the type locality.

Remarks: As in other described species, no spiral fine cordlets have been observed in the umbilicus; but there is a strong cord delimiting it. Due to the poor condition of the studied material, we can not determine if this is a previously known species. We believe that *Vitrinella georgiana,* the present species, as well as *Pseudorotella floridensis* and *Lydipnis margaritiformis,* all described by DALL (1927), are not tornids, but they may be placed in the subfamily *Skeneinae* Clark, 1851, genus *Cirsonella*. Thus the new combination should be *Cirsonella georgiana* (Dall, 1927).

Cirsonella margaritiformis (Dall, 1927) (Figures 117A-E)

Lydiphnis margaritiformis Dall, 1927. *Proceedings of the United States National Museum* 70(2667): 123-124. [Type locality: *Albatross* sta. 2668, off Fernandina, Florida [actually off Georgia], 30°58′N, 79°38′W, 294 fathoms (529 m)].
Circulus margaritiformis (Dall, 1927).

Type material: Lectotype (Figs. 117A-C) and a paralectotype in USNM (108146).

Description: This is the original description in DALL (1927: 123-124). *"Shell small, white, smooth, with nearly four whorls including a minute globular nucleus, having a general form much resembling* Margarites helicinus; *whorls moderately rounded, the last much the largest, suture distinct, not deep; surface smooth except for faint incremental lines, and on the base two strong widely spaced threads around the umbilical pit and a few faint spiral striae behind them; base rounded, umbilicus minutely perforate; aperture rounded with a small angulations above, the peristome continuous over the body, thin, and not reflected. Height, 3 mm; diameter, 4 mm"*.

Habitat: Dredged from 678 meters on a gray sand and broken coral bottom.

Distribution: Only known from the type material.

Remarks: DALL (1927) Remarked: *"This differs from typical* Lydipnis *in being less depressed and without carinae, but seems most nearly allied to that genus"*.

In our opinion this species is not a tornid. Its general appearance is that of a skeneid. The convex whorls, impressed sutures of the protoconch, smooth shell, prosocline aperture, and continuous peristome with a thickening near the umbilicus place it close to the genus *Cirsonella* Angas, 1877. *Cirsonella* characteristically has the operculum only very slightly, or not at all, behind the peristome. The margin of the inner lip edge of this species has a ledge that probably serves as an opercular stop. The spiral threads around the umbilicus place this species close to *Cirsonella extrema* Thiele, 1912 from the Antartic and to *C. australis* Angas, 1877 (WARÉN, 1992).

By its general form this species could be considered closely related to species of the genus *Skenea* Fleming, 1825, e.g., *Skenea larseni* Warén, 1993 and *Skenea trochoides* (Friele, 1876), but the shape of the protoconch and the umbilical thickening distinguish it. Thus this species is treated as *Cirsonella margaritiformis* (Dall, 1927).

Genus *Mikro* Warén, 1996

Mikro cerion (Dall, 1927) (Figures 118A-C)

Vitrinella cerion Dall, 1927. *Proceedings of the United States National Museum* 70(2667): 125. [Type locality: Off Georgia, 30.73°N; 79.43°W. Depth: 805 m].

Type material: Lectotype (Fig. 100A-C) in USNM (108433).

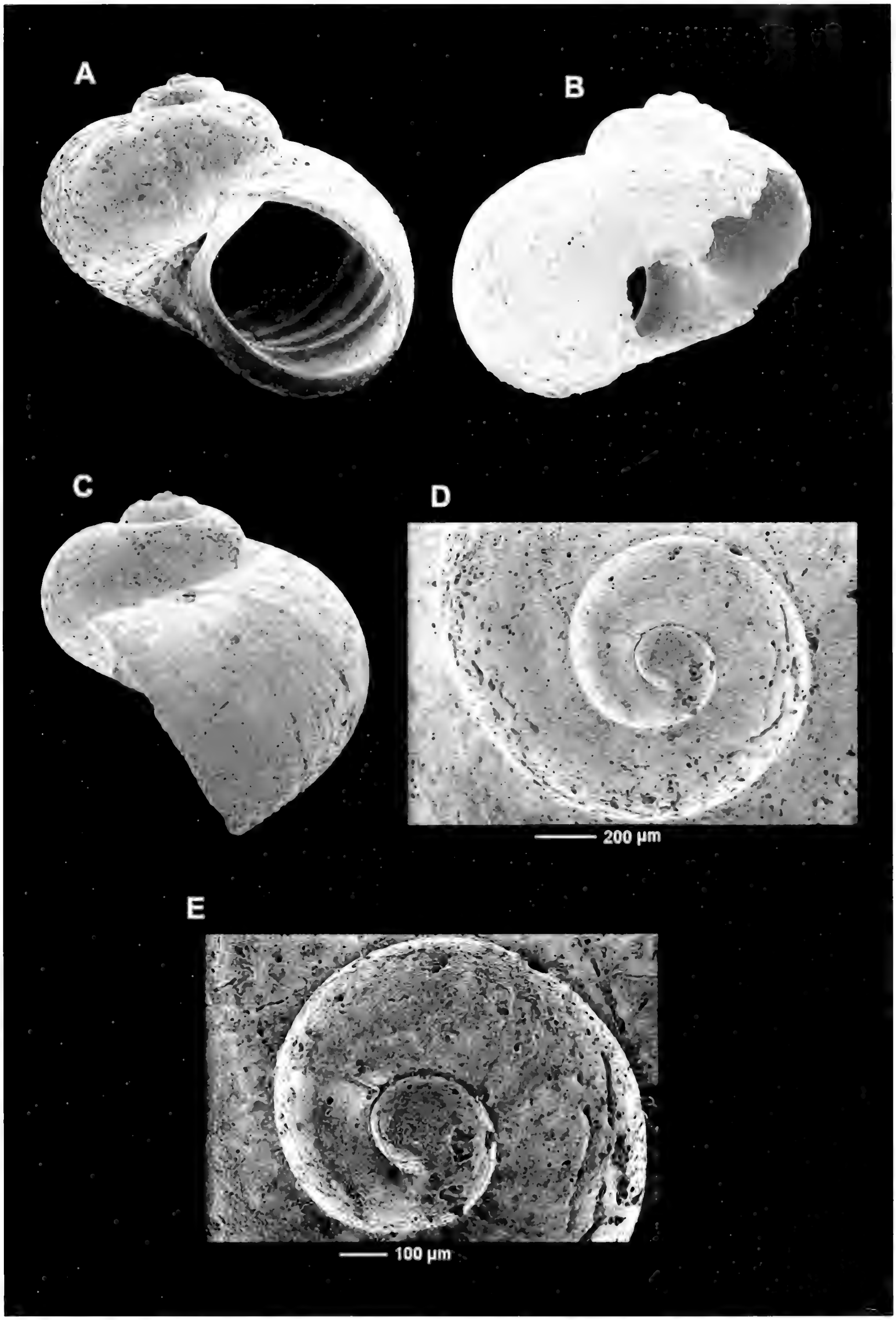
Description: In DALL (1927).

Maximum reported size: 1.8 mm.

Distribution: Only known from the type material, from Georgia, USA.

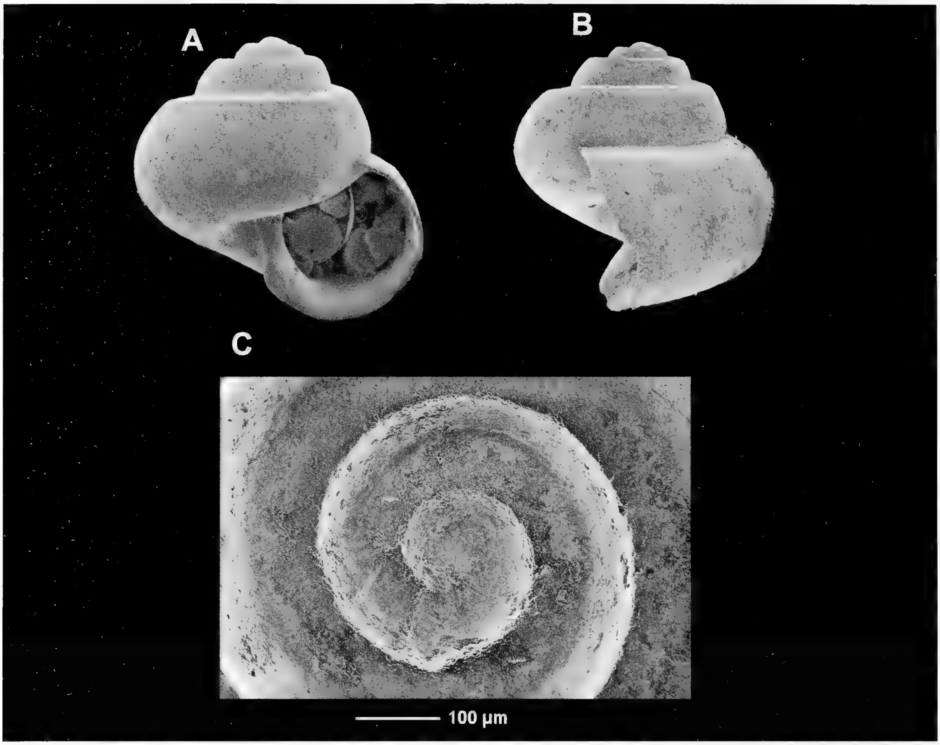
Remarks: DALL (1927) mentions: *"The general form recalls that of* Helix chersina *Say"*. After the examination of the photographs of the lectotype of *Vitrinella cerion* deposited in USNM, we reached the conclusion that it is not a *Vitrinella*. The smooth, bulbous and short protoconch (barely ½ whorl), the teleoconch apically keeled on the first whorl and angled apically on the following, the rounded aperture, the orthocline outer lip, and the strongly prosocline inner lip impel us to consider its placement in *Mikro* Warén, 1996, which is characterized by *"Very small, skeneid-like gastropods with smooth protoconch, apically keeled first teleoconch whorl and intraumbilical keel"*.

The bathymetric range of the species included in this genus is between 200 and 1100 m, and its distribution is known in Southern Iceland and the Mediterranean. The genus *Mikro* was placed provisionally in Skeneidae by WARÉN (1996), and its systematic position is not known with certainty, but it was placed in



Figures 117A-E. *Cirsonella margaritiformis* (Dall, 1927). A-C: lectotype, 4 mm in diameter (USNM, 108146); D-E: protoconch. (SEM's by Yolanda Villacampa, USNM).

Figuras 117A-E. Cirsonella margaritiformis *(Dall, 1927). A-C: lectotipo, 4 mm de diámetro (USNM, 108146); D-E: protoconcha. (Fotografías al MEB de Yolanda Villacampa, USNM).*



Figures 118A-C. *Mikro cerion* (Dall, 1927). A-B: lectotype, 1.6 mm in diameter (USNM, 108433); C: protoconch. (SEM's by Yolanda Villacampa, USNM).
Figuras 118A-C. Mikro cerion *(Dall, 1927). A-B: lectotipo, 1,6 mm de diámetro (USNM, 108433); C: protoconcha. (Fotografías al MEB de Yolanda Villacampa, USNM).*

Archaeogastropoda. This appears well founded, based on the presence of sensorial papillae on the cephalic tentacles. For these reasons we consider that the correct name is *Mikro cerion* (Dall, 1927). Other species known in the genus *Mikro* are: *Mikro giustii* (Bogi & Nofroni, 1989) from the Isle of Capri, Mediterranean Sea and *Mikro globulus* (Warén, 1996) from southern Iceland.

Genus *Xyloskenea* Marshall, 1988
Xyloskenea rhyssa (Dall, 1927) (Figures 119A-D)

Vitrinella rhyssa Dall, 1927. *Proceedings of the United States National Museum* 70(2667): 125. [Type locality: *Albatross* sta. 2668, off Fernandina, Florida [actually off Georgia], 30°58′N, 79°38′W, 294 fathoms (529 m)].

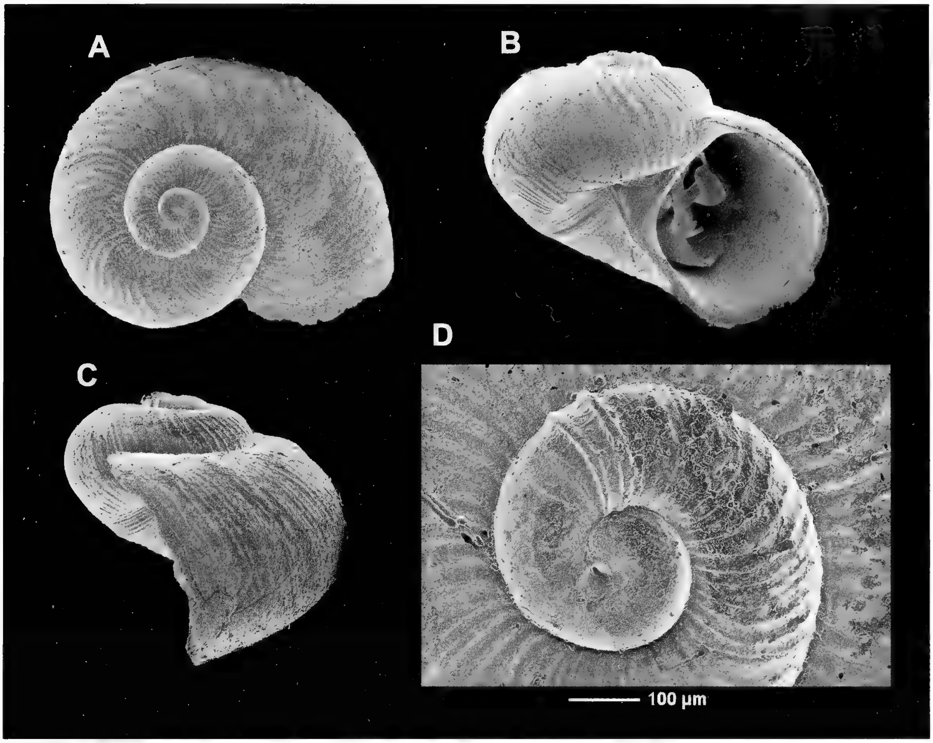
Type material: Lectotype in USNM (108127b).

Description: In Dall (1927).

Dimensions: lectotype, 2.1 mm.

Distribution: Only known from the type material: 30.98°N; 79.64°W.

Remarks: The morphological characters of *Vitrinella rhyssa* are very similar to those of the genus *Xyloskenea* Marshall, 1988. This genus was provision-



Figures 119. A-D. *Xyloskenea rhyssa* (Dall, 1927). A-C: lectotype, 2.1 mm in diameter (USNM, 108127b); D: protoconch. (SEM's by Yolanda Villacampa, USNM).
Figuras 119. A-D. Xyloskenea rhyssa *(Dall, 1927). A-C: lectotipo, 2,1 mm de diámetro (USNM, 108127b); D: protoconcha. (Fotografías al MEB de Yolanda Villacampa, USNM).*

ally placed in Skeneidae, having many species in bathyal depths, world wide, and is usually associated with sunken wood. Conchologically close species include *Xyloskenea costulifera* Marshall, 1988 from New Zealand (the type species of the genus) and *Xyloskenea naticiformis* (Jeffreys, 1883) from off southwestern Iceland to off Portugal (WARÉN, 1996: 202, figs. 3A-D).

Xyloskenea translucens (Dall, 1927) (Figures 120A-F)

Lydiphnis translucens Dall, 1927b. *Proceedings of the United States National Museum* 70(2667): 124. [Type locality: Off Georgia].
Circulus translucens (Dall, 1927).

Type material: Lectotype and paralectotype in USNM (108434).

Description: The original description in DALL (1927: 124) is as follows: "*Shell minute, translucent white, the spire flattened, with three moderately rounded whorls; axial sculpture of incremental lines only; spiral sculpture of a thread slightly in front of the suture and another beyond the periphery on the base; these are hardly prominent enough to be called* carinae; *the umbilical pit is wide and shallow, the umbilicus itself minutely perforate; aperture* *rather wide, rounded, oblique, the margin thin, continuous, straight near the umbilicus. Height, 1.5 mm; diameter, 2 mm".*

The protoconch (Figs. 102E-F) is about 210 μm in maximum diameter and is ¾ of a whorl, of which the first half has 4-5 spiral ribs the remaining part is smooth. A strong varix separates the protoconch from the teleoconch.

Habitat: Dredged from 805 meters depth on a broken coral, coarse sand, and broken shell bottom.

Distribution: Only known from the type material.

Remarks: DALL (1927) commented: *"Notwithstanding its small size it has the shell characters of the genus (*Lydiphnis*). The incremental lines are rather pronounced".*

In our examination of the shell of *Lydipnis translucens* we carefully noted the depressed spire and the bicarinate shell as well as the protoconch sculpture.

Based on these characters, *L. translucens* closely resembles species of *Xyloskenea* Marshall, 1988 such as *Xyloskenea naticiformis* (Jeffreys, 1883) and species of *Ventsia* Warén & Bouchet, 1993 such as *Ventsia tricarinata* Warén & Bouchet, 1993 in both protoconch and teleoconch characters. These two genera can be distinguished only by the radula, being very similar in shell and soft parts and considered closely related. Another related genus is *Trenchia* Knudsen, 1964, type species *T. wolffi* Knudsen, 1964, the species of which have a similar shell and radula, but their protoconch and teleoconch differ in being smooth (WARÉN & BOUCHET, 1993). It must be mentioned that *Xyloskenea naticiformis,* the species with the greatest similarity, was tentatively referred to *Tranchia* by MACLEAN (1992). WARÉN (1996) prefers a placement in *Xyloskenea* based on the similarities in protoconch sculpture and size.

Taking all the above, as well as the characters of the protoconch and teleoconch, into consideration, we consider that *Lydipnis translucens* must be placed in the genus *Xyloskenea*, thus the combination *Xyloskenea translucens* (Dall, 1927).

The genus *Xyloskenea* is comprised of numerous species in abyssal and bathyal depths, world wide, and in every case where the substratum is known, it is associated with sunken wood. Closely related genera are *Trenchia* Knudsen, 1964 (on sunken wood, southwestern Pacific) and *Ventsia* Warén & Bouchet, 1993 (hydrothermal vents off Fiji) (WARÉN, 1996).

"Vitrinella" massarita Dall, 1927

Vitrinella massarita Dall, 1927. *Proceedings of the United States National Museum* 70(2667): 125. [Type locality: *Albatross* sta. 2668, off Fernandina, Florida [actually off Georgia], 30°58′N, 79°38′W, 294 fathoms (529 m)].

Type material: In USNM (108137) (three specimens).

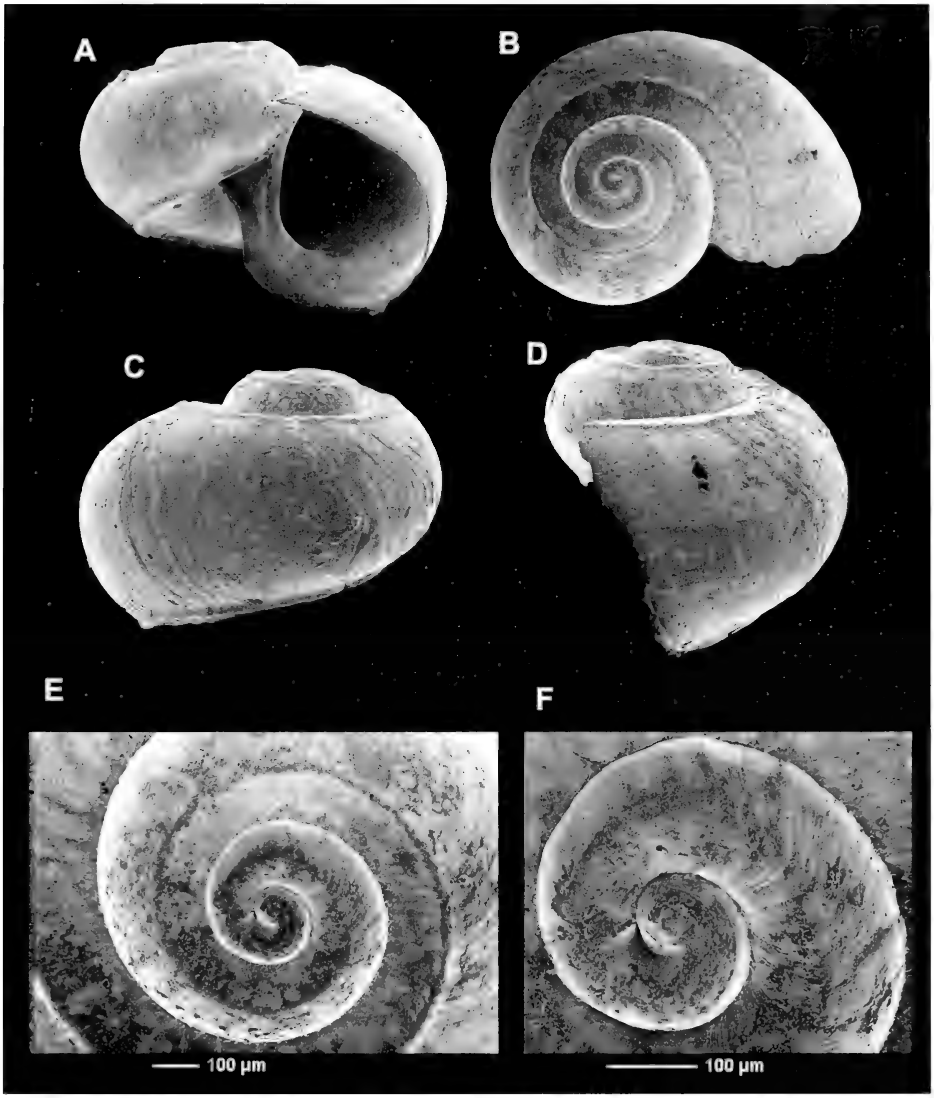
Description: DALL (1927).
Maximum Reported Size: 1.7 mm.

Distribution: USA: Georgia: DALL (1927)
Depth: 538 m.

CONCLUSIONS AND COMMENTS

In the present work, which is focused on the recent fauna of the family Tornidae, subfamilies Circulinae, Teinostomatinae, Torninae and Vitrinellinae, the following 13 genera were studied:

Circulus (4 species), *Teinostoma* (27 species), *Tornus* (2 species), *Anticlimax* (8 species), *Aorotrema* (2 species), *Cyclostremiscus* (14 species), *Cochliolepis* (9 species), *Episcynia* (1 species),



Figures 120A-F. *Xyloskenea translucens* (Dall, 1927). A-D: lectotye, 2.0 mm in diameter, (USNM, 108434); E-F: spire and protoconch. (SEM's by Yolanda Villacampa, USNM).
Figuras 120A-F. Xyloskenea translucens *(Dall, 1927). A-D: lectotipo, 2,0 mm de diámetro, (USNM, 108434); E-F: espira y protoconcha. (Fotografías al MEB de Yolanda Villacampa, USNM).*

Parviturboides (1 species), *Pleuromalaxis* (1 species), *Solariorbis* (16 species), *Vitrinella* (15 species), and *Vitrinorbis* (1 species).

In total, about 2700 specimens and shells were examined. This is a large number of shells, but if we consider that the number of species included in the work is about 100, it may seem less imposing. Furthermore, if we consider the fact that some of them are common, and that we have studied large lots such as *Cochliolepis parasitica* (more than 340 shells), *Vitrinella anneliesae* (about 290 shells) or *Parviturboides interruptus* (about 250 shells), it is clear that many other species were available only in small numbers. For example, almost 20 species were known from only 1 shell, and, in a little more than half of the total (57 species), each was represented by less than 9 shells.

This scarcity may be due to various causes: 1-the small size of most of the species; 2- the habitat (unknown for most of them) which could be in crevices among rocks or symbiotic with other organisms; 3- the small number of malacologists who give attention to micromolluscs; 4- the difficulty of finding these minute specimens in old collections, many times lost or suffering from problems in conservation due to fungi, humidity, acidic glass, etc.

Nonetheless we were able to study 101 species of Tornidae in the Caribbean and neighboring regions. Of this total, 86 were previously known, and 23 are described as new to science; 2 more are presented as "sp." because of doubts about their taxonomic validity or inadequacy of material.

A lectotype is here designated for each of the following species: *Teinostoma reclusum*, *Teinostoma solidum*, and *Parviturboides interruptus*, all in the MCZ, *Solariorbis petitii* in the MNHN, *Episcynia inornata* in the NHMUK, and *Cochliolepis parasitica* in the USNM.

A new name is proposed: *Vitrinella solaris* nom. nov. pro *"Cyclostrema" thomasi* Pilsbry, 1945 non *Vitrinella thomasi* Bartsch, 1918.

Three neotypes are designated: for *Teinostoma megastoma* and *Teinostoma semistriatum* in MCZ, and for *Circulus* orbignyi *in the MNHN*.

Some types from the Dall and K.J. Bush collections, all in USNM, are imaged for first time by SEM: *Teinostoma minuscula* (holotype); *Vitrinella diaphana* (d'Orbigny, 1842); *"Vitrinella" carinifex; Pseudorotella floridensis, Vitrinella georgiana, Lydiphnis margaritiformis, Vitrinella cerion, Vitrinella rhyssa, Lydiphnis hendersoni*, and *Lydiphnis translucens*. Also *Cochliolepis parasitica* and *Vitrinella tincta*.

From the examination of the types of Dall (1927), we concluded that *"Vitrinella" carinifex, Vitrinella cerion, Vitrinella rhyssa, Vitrinella georgiana, Pseudorotella floridensis, Lydiphnis margaritiformis* and *Lydiphnis translucens* are not tornids but skeneids included in the genera *Cirsonella*, *Micro* and *Xyloskenea*, thus creating the new combinations: *Cirsonella floridensis, Cirsonella georgiana, Cirsonella margaritiformis, Mikro cerion, Xyloskenea rhyssa*, and *Xyloskenea translucens*. We examined types of all these species except *Vitrinella massarita* and could not suggest a generic placement only for *"Vitrinella" carinifex*.

Many types of species belonging to different families were also studied in order to ascertain that they could not be placed in the Tornidae. Sometimes shell morphology is sufficient to allow placement in genus and family. On other occasions this determination is not easily made. For this reason, we have presented an annotated list of species which can be included in the Tornidae and of others which were excluded because they were fossil species or probably from other groups. This ancillary information is presented to provide future researchers with all the possible information on the species of this group and taxa with which they have been confused.

The following species, previously considered in synonymy, are treated as valid species:

Teinostoma nessaeum and *Teinostoma obtectum* are not synonyms of *Teinostoma biscaynense*.

Cyclostremiscus trilix is not a synonym of *Cyclostremiscus pentagonus*.

Cyclostrema thomasi is not a synonym of *Vitrinella filifera*.

On the other hand, *Teinostoma clavium* is herein considered a synonym of *Teinostoma semistriatum*.

Two species previously placed in the genus *Cyclostremiscus*: *Cyclostremiscus caraboboensis* and *C. schrammii* are placed in the genus *Tornus* on the basis of the similarity of the morphological characters of their shells with species of this genus in the West coast of Africa.

In relation with the bathymetric range, the tornids usually do not live in very deep water, most species inhabiting bottoms between the subtidal level and the first 30 meters of the infralitoral level. But in relation to the depth data of empty shells collected and in most bibliographic records, the conclusions could be different, appearing in deeper water, probably due to the orography of the bottom and marine currents. Of the species studied, 65 have been found between 0 and 60 m, and 18 more have been found also in circalitoral and bathyal levels, one of them (*Teinostoma reclusum*) having been recorded from 1170 m. For many species the bathymetry is unknown due to the dearth of bottom samples and predominance of beach drift in collections. The group of species of the genus *Cyclostremiscus* including *C. dalli, C. pentagonus, C. trilix,* and *C. hendersoni* seem to have a deeper bathymetric range, all of them reaching between 500 and 800 m.

APPENDIX

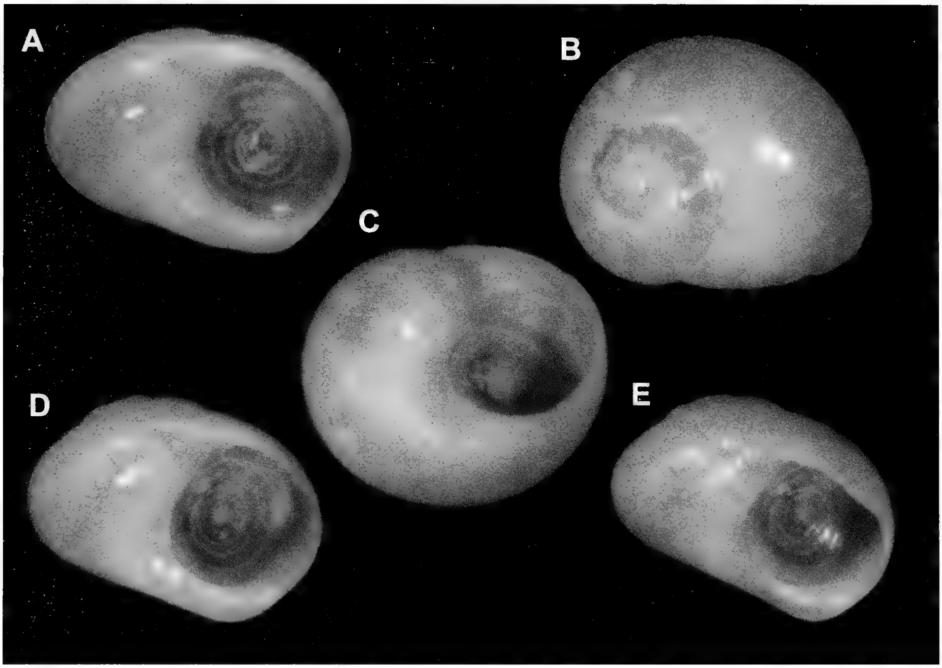
SPECIES THAT WERE INCLUDED IN TORNIDAE AND NOW BELONG TO OTHER FAMILIES

Family LIOTIIDAE Gray, 1850
Genus *Cyclostrema* Marryat, 1818

Cyclostrema cancellatum Marryatt, 1818
Cyclostrema fulgidum Jeffreys, 1883
Cyclostrema rugulosum G.O. Sars, 1878
Cyclostrema valvatoides Jeffreys, 1883
Cyclostrema pompholyx Dall, 1889 (is now placed in the genus *Parviturbo*)
Cyclostrema turbinum Dall, 1889

Family TURBINIDAE Rafinesque, 1815
Subfamily SKENEINAE Clark, 1851
Genus *Ganesa* Jeffreys, 1883

Ganesa proxima Tryon, 1888
Ganesa bushae Dall, 1927
Ganesa conica Dall, 1927
Ganesa depressa Dall, 1927
Ganesa valvata Dall, 1927
Ganesa diaphana A.E. Verrill, 1884
Ganesa striata Bush, 1897
Ganesa convexa Bush, 1897
Ganesa verrilli Tryon, 1888
Ganesa ornatam A.E. Verrill, 1884
Ganesa dalli A.E. Verrill, 1882
Ganesa abyssicola Bush, 1897



Figures 121A-E. *Dillwynella modesta* Dall, 1889. A-E: syntypes, 1.4, 1.6 mm (MCZ 007657).
Figuras 121A-E. Dillwynella modesta *Dall, 1889. A-E: sintipos, 1,4, 1,6 mm (MCZ 007657).*

Genus *Granigyra* Dall, 1889

Granigyra limata Dall, 1889
Granigyra radiata Dall, 1927
Granigyra spinulosa Bush, 1897

Genus *Dillwynella* Dall, 1889

Dillwynella modesta (Dall, 1889) (Figures 121A-E)

Dillwynella modesta Dall, 1889. *Bull. MCZ*, 18: 362-363, pl. 21, figs. 3-3a. [Type locality: Blake sta. 215, off St. Lucia, 226 fathoms].

Type material: Three syntypes, MCZ (007657).

Genus *Mollериopsis* Bush, 1897

Molleriopsis abyssicola Bush, 1897
Molleriopsis sincera Dall, 1889

Genus *Leptogyra* Bush, 1897

Leptogyra verrilli Bush, 1897
Leptogyra inconspicua Bush, 1897
Leptogyra eritmeta Bush, 1897

Family LEPETELLIDAE Dall, 1881

Genus *Choristella* Bush, 1897

Choristella leptalea Bush, 1897
Choristella brychia Bush, 1897

Family ODOSTOMIIDAE Pelseneer, 1928
Genus *Cyclostremella* Bush, 1897

Cyclostremella humilis Bush, 1897

ACKNOWLEDGEMENTS

The authors offer thanks to Dr. Jerry Harasewych and Yolanda Villacampa of the Smithsonian Institution (USNM) for their help in the study of *Cochliolepis parasitica* and many other types deposited in this institution. To Adam J. Baldinger, for the loan of material of Tornidae, including some types from MCZ, and his cooperation with the use of this material. To Marlo Krisberg of Merrit Islands for the loan of material from his collection. To Colin Redfern of Boca Raton for the same. To Flaviano for sending material from Itaparica, Brazil. To Jacques Pelorce, from Paris, for sending material collected on his trips to the Caribbean. Also to Dr. Harry G. Lee, of Jacksonville, Florida, who put his collection at our disposal, authorizing the photography of all the necessary material, and donating several types of the new species unique to his collection. Also for his revision during the editing period of this work.

The type material of *Cyclostremiscus multiliratus* was obtained through support by the National Science Foundation under Grant No. 0315995.

To Jesus Méndez and Inés Pazos of the Centro de Apoyo Científico y Tecnológico a la Investigación (CACTI) of the University of Vigo for most of the SEM images; also to Ramiro Barreiro Pérez of the Centro de Apoyo Científico y Tecnológico of the University of Santiago de Compostela (CACTUS) for some micrographs.

To the Museo de Historia Natural "Luis Iglesias", of the University of Santiago de Compostela, its director Dr. María Isabel Fraga Vila, for cooperation during the entire study supporting all the necessary material, microphotography, correspondence, etc.

To Ricardo Absalão and Petrobras S.A. (Brazilian Oil company) which authorized the use of photographs from Campos Basin, Rio de Janeiro.

To Anders Warén who authorized the use of *Neusas* photographs.

Javier Conde made the corrections to the English language.

BIBLIOGRAPHY

ABBOTT R.T. 1954. *American seashells*. D. Van Nostrand Company, Inc., Princeton, NJ, xiv + 541 pp, 40 pls.

ABBOTT R.T. 1974. *American seashells: the marine Mollusca of the Atlantic and Pacific coasts of North America*, 2nd ed. Van Nostrand Reinhold Company. New York, 663 pp, 24 pls.

ABBOTT R.T. & DANCE S. P. 1982. *Compendium of seashells: a color guide to more than 4,200 of the world's marine shells*. E. P Dutton, New York, x -I- 411 [+ 1] pp.

ABSALÃO R.S. 2009. New small deep-sea species of Gastropoda from the Campos Basin off Brazil. *American Malacological Bulletin*, 27: 133-140.

Absalão R.S. & Pimenta A.D., 2005. *Moluscos marinhos da Apa do Archipelago de Santana, Macaré, RJ.* Ciencia Moderna, Rio de Janeiro. 84 pp.

Adam W. & Knudsen J. 1969. Quelques genres de Mollusques prosobranches marins inconnus ou peu connus de l'Afrique occidentale. *Bulletin Institut Royal des Sciences Naturelles de Belgique*, 44(27): 1-69.

Adams A. 1850. Monographs of *Cyclostrema*, Marryat, and *Separatista*, Gray, two genera of gasteropodous mollusks. *Proceedings of the Zoological Society of London 1850*: 41- 45.

Adams C.B. 1850. *Monograph of Vitrinella, a New Genus of New Species of Turbinidae* 10 pp. Author, Amherst, Massachusetts.

Adams A. 1866. Monographs of the genera *Cyclostrema*, *Adeorbis*, and *Teinostoma*. *Thesaurus Conchyliorum*. Sowerby, G.B. (ed.) 3: 249-262.

Aguayo C.G. 1949. Tres nuevos moluscos marinos de las costas de Cuba. *Revista de la Sociedad Malacológica "Carlos de la Torre"* 6: 93-96, pl. 4.

Aguayo C. & Borro P. 1946a. Nuevos moluscos del Terciario Superior de Cuba. *Revista de la Sociedad Malacologica "Carlos de la Torre"* 4(1): 9-12, pl. 1.

Aguayo C. & Borro P. 1946b. Algunos moluscos Terciarios de Cuba. *Revista de la Sociedad Malacologica "Carlos de la Torre"* 4(2): 43-49, pl. 3.

Aguayo C. & Jaume M.L. 1936. Sobre algunos moluscos marinos de Cuba. *Memorias de la Sociedad Cubana de Historia Natural "Felipe Poey"* 10(2): 115-122.

Altena C.O. van R. 1966. Vitrinellidae (marine Mollusca Gastropoda) from holocene deposits in Surinam (Dutch Guiana). *Zoologische Mededelingen*, 41: 233-241.

Altena C.O. van R. 1975. The marine mollusca of Suriname (Dutch Guiana) Holocene and Recent. Part III. Gastropoda and Cephalopoda. *Zoologische Verhandelingen*, 139: 1-104, pls. 12.

Andrews J. 1977. Shell and Shore of Texas. University of Texas Press. Austin, United States. *Journal of Molluscan Studies*, 47: 248-2

Andrews J. 1994. *A field guide to shells of the Florida coast.* Gulf Publishing, Houston. 182 pp.

Arango R. 1880. *Contribucion a la Fauna Malacologica Cubana.* 137-280, 1-35. G. Montiel: Habana. 15 Jul.

Bieler R. & Mikkelsen P.M. 1988. Anatomy and reproductive biology of two western Atlantic species of Vitrinellidae, with a case of protandrous hermaphroditism in the Rissoacea. *The Nautilus*, 102(1): 1-29.

Bouchet P. & Rocroi J.P. (Ed.); Frýda J., Hausdorf B., Ponder W., Valdés Á. & Warén A. 2005. Classification and nomenclator of gastropod families. *Malacologia*, 47(1-2): 397 pp. ConchBooks, Hackenheim, Germany.

Boyko C.B. & Cordeiro J.R. 2001. Catalog of Recent type specimens in the division of invertebrate zoology , American Museum of Natural History . V . Mollusca , part 2 (class Gastropoda [exclusive of Opisthobranchia and Pulmonata], with supplements to Gastropoda [Opisthobranchia], and Bivalvia. *Bulletin of the American Museum of Natural History*, 262: 3-158.

Bush K.J. 1885. List of the shallow-water Mollusca dredged off Cape Hatteras by the "Albatross" in 1883. *Annual Report of the United States Commissioner of Fish and Fisheries*, 1883: 579-595.

Bush K.J. 1897. Revision of the marine gastropods referred to *Cyclostrema, Adeorbis, Vitrinella,* and related genera; with descriptions of some new genera and species belonging to the Atlantic fauna of America. *Transactions of the Connecticut Academy of Arts and Sciences,* 10: 97-144, pls. 22-23.

Campbell L.D. 1993. Pliocene molluscs from the Yorktown and Chowan river formations in Virginia. *Virginia Division of Mineral Resources, Publication* 127, 1–259.

Clarke H.C. 1962. On the composition, zoogeography, origin and age of the deep-sea mollusk fauna. *Deep Sea Research and Oceanographic Abstracts*, 9(7-10): 291-306.

Clench W.J. & Turner R.D., 1950. The western Atlantic marine mollusks described by C.B. Adams. *Occasional Papers on Mollusks*, 1(15): 233-403 incl. pls. 29-49.

Cooley N.P. 1978. An inventory of the estuarine fauna in the vecinity of Pensacola, Florida. *Florida Marine Research Publications*, 33: ii+119.

Corgan J.X. 1968. New name for *Vitrinella tenuisculpta* Aguayo y Borro (Gastropoda). *Nomenclatural Notes. Journal of Paleontology*, 43: 1298.

Cosel R. von 1986. Moluscos de la región de la Ciénaga Grande de Santa Marta (costa del Caribe colombiano) *Anales del Instituto de Investigaciones Marinas de Punta Betín,* 15-16: 79-370

Dall W.H. 1889a. Reports on the results of dredgings, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877-78) and in the Caribbean Sea (1879-80), by the U. S. Coast Survey Steamer 'Blake'. *Bulletin of the Museum of Comparative Zoology*, 18: 1-492, pls. 10-40.

DALL W.H. 1889b. A preliminary catalogue of the shell-bearing marine mollusks and brachiopods of the south-eastern coast of the United States, with illustrations of many of the species. *Bulletin of the United States National Museum*, 37: 221 p., pps. 1-74.

DALL W.H. 1892. Contributions to the Tertiary fauna of Florida, with especial reference to the Miocene silex-beds of Tampa and the Pliocene beds of the Caloosahatchie River. Part II. Streptodont and other gastropods, concluded. *Transactions of the Wagner Free Institute of Science of Philadelphia*, 3 [i-vii]: 201-473, 1 fold-out map, pls. 13-22.

DALL W.H. 1889. Report on the results of dredning by the U. S. Coast survey steamer "Blake". XXIX. Report on the Mollusca, part II. Gastropoda and Scaphopoda. *Bulletin of the Museum of Comparative Zoology*, 18: 1-492, pls. 10-40.

DALL W.H. 1903. Contributions to the Tertiary fauna of Florida with especial reference to the Silex Beds of Tampa and the Pliocene Beds of the Caloosahatchie River including in many cases a complete revision of the generic groups treated of and their American Tertiary species. Part VI. Concluding the work. *Transactions of the Wagner Free Institute of Science of Philadelphia*, 3(4): i-xiv, 1219- 1654, pls. 48-60.

DALL W.H. 1927. Small shells from dredgings off the southeast coast of the United States by the United States Fisheries steamer *Albatross* in 1885 and 1886. *Proceedings of the United States National Museum*, 70(2667): 1-134.

DÍAZ MERLANO J.M. & PUYANA HEGEDUS M. 1994. *Moluscos del Caribe colombiano. Un catálogo ilustrado*. Colciencias. Fundación Natura. Invermar. Santa Fé de Bogotá, 291 pp, 74 pls.

EMERSON W.K. & JACOBSON M.R. 1976. *The American Museum of Natural History, Guide to shells.* Alfred A. Knopf, New York. 482 pp, 47 pls.

ESPINOSA J., FERNÁNDEZ-GARCÉS R. & ROLÁN E. 1985. Catálogo actualizado de los moluscos marinos de Cuba. *Reseñas Malacológicas*, 9: 1-90.

ESPINOSA J. & ORTEA J. 2001. Moluscos del mar Caribe de Costa Rica: Desde Cahuita hasta Gandoca. *Avicennia* (Supl. 4): 1-77.

FABER M.J. 1995. New data on mollusk species described by Gordon W. Nowell-Usticke. *De Kreukel* 31: 59-69.

FABER M.J. 2007. Marine gastropods from the ABC Islands and other localities 20. *Solariorbis semipunctus* Moore, 1965 (Gastropoda: Vitrinellidae), first records for Florida, USA and Curaçao. *Miscellanea Malacologica*, 2(4): 84. Figs. 1-3.

FISCHER P. 1857. Études sur un groupe de coquilles de la famille des Trochidae. *Journal de Conchyliologie*, 6: 42-53, 168-176, 284-288, pl. 10.

FISCHER P. 1880-1887. *Manuel de conchyliologie et de paléontologie conchyliologique ou histoire naturelle des mollusques vivants et fossiles suivi d'un appendice sur les Brachiopodes.* Savy, Paris, xxiv + 1-1569 + 23 pls., facing pl. explanations. [1-112 (1880); 113-304 (1881); 305-416 (1882); 417-608 (1883); 609-688 (1884); 689-896 (1885); 897-1008 (1886); 1009-1369 (1887)].

FOLIN L. DE 1870. Vera-Cruz et Carmen. *Les Fonds de la Mer* 1: 181-191, pls. 23, 25-56 Savy: Paris.

FRETTER V. 1956. The anatomy of the prosobranch *Circulus striatus* (Philippi) and a review of its systematic position. *Proceedings of the Zoological Society of London*, 126: 369-381.

FRETTER V. 1984. *Prosobranchs.* In: Wilbur *et al.* (eds.). The Mollusca, Vol. 7, Reproduction. Academic Press, New York and London, p. 1-45.

FRETTER V. & GRAHAM A. 1962. *British prosobranch molluscs: their functional anatomy and ecology.* Ray Society, London, xvi -I- 755 pp.

FRETTER V. & GRAHAM A. 1964. Reproduction. In: Wilbur, K. M. and C. M. Yonge (eds). Physiology of Mollusca, Vol. 1. Academic Press, New York and London, p. 127-164.

FRETTER V. & GRAHAM A. 1978. The prosobranch molluscs of Britain and Denmark. Part 4 — Marine Rissoacea. *Journal of Molluscan Studies, Supplement* 6: 153-241.

GABB W.M. 1873. On the Santo Domingo Miocene and its Fossils. *Proceedings American Philosophy Society*, 12: 571-573.

GABB W.M. 1881. Descriptions of new species of fossils from Pliocene Clay Beds between Limon and Moen, Costa Rica, together with notes on previously known species from there and elsewhere in the Caribbean area. *Journal of the Academy of Natural Sciences of Philadelphia*, 8: 349-380, 4 pls.

GARCIA E.F. 2002. More discoveries from a collecting expedition off the Louisiana coast. *American Conchologist* 30(1): 6-7, 10.

GARCÍA-CUBAS A. 1970. Ecologia y distribución de los micromoluscos recientes de la Laguna Madre, Tamaulipas, Mexico. *Universidad Autonoma de Mexico, Instituto de Geologia, Boletin* 86: 1+1v+1-44, 2 foldouts tables, 8 pls.

GARCÍA-CUBAS A. 1971. Estudios oceanográficos y biológicos de reconocimiento en la Bahía de Guaymas. *Instituto de Biología, Universidad Nacional Autónoma de México.* 87 p., tablas, figs. y mapas.

García-Cubas A. & Reguero M., 1990. Moluscos del sistema lagunar Tupilco-Ostión, Tabasco, México: Sistemática y Ecología. *Anales del Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México,* 17(2): 309-343.

García-Cubas A., Escobar-De la Llata F., González L. V. & Reguero M. 1990. Moluscos de la laguna Mecoacán, Tabasco, México: Sistemática y Ecología. *Anales del Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México,* 17(1): 1-30.

Gardner J. 1948. Mollusca from the Miocene and lower Pliocene of Virginia and North Carolina. Part 2. Scaphopoda and Gastropoda. *U.S. Geological Survey Professional Paper,* 199-B: i-iii, 179-310, pls. 24-38.

Gofas S., Pinto Afonso J. & Brandão M. 1985. *Conchas e moluscos de Angola*. Universidad de Agostinho Neto / Elf Aquitaine. Angola. 139 pp.

Graham A. 1982. *Tornus subcarinatus* (Prosobranchia, Rissoacea), anatomy and relationships. *Journal of Molluscan Studies,* 48: 144-147.

Guppy R.J.L. 1866. On the Tertiary Mollusca of Jamaica. *Quarterly Journal of the Geological Society of London,* 22(l): 281-295, pls. 16-18.

Hickman C.S. & McLean J.H. 1990. Systematic revision and suprageneric classification of trochacean gastropods. *Natural History Museum of Los Angeles County, Science Series,* 35: 1-169.

Holmes F.S., 1858-1860 [published in parts]. *Post-Pleiocene Fossils of South Carolina.* Russell and Jones, Charleston, 1-98 p, 14 pls. [R. E. Petit offers a collation of this rare serial work: Title page (dated 1860); verso: name of printer and engraver. Dedication page; verso: Preface and acknowledgements. [i] - xii - Introduction, [i]-v - Index; v verso: Errata, 1-64, pls. 1-10 - Cover for Nos. 1 & 2 with printed date of 1858. "3, 4 + 5" plus "2 plates to a number" added in pen; 65-98, pls. 11-14 - Cover for "Nos. 6 and 7" with printed date of 1859.].

Houbrick J.R. 1967. Notes on *Cyclostremiscus schrammii. The Nautilus,* 80(4): 131-133.

Houbrick J.R. 1968. A survey of the litoral marine molluscs of the Caribbean coast of Costa Rica. *Veliger,* 11: 4-23.

Jacot A.P. 1921. Some marine shells of Beaufort and vicinity. *Journal of the Elisha Mitchell Scientific Society,* 36: 129-145, pls. 11-13.

Jaume M.L. & Borro P. 1946. Novedades en moluscos marinos Cubanos. *Revista de la Sociedad Malacologica "Carlos de la Torre",* 4(1): 13-22, pl. 2.

Jeffreys J.G. 1865. *British conchology, or an account of the Mollusca which now inhabit the British Isles and the surrounding seas. Vol. III. Marine shells, comprising the remaining Conchifera, the Solenoconchia, and Gasteropoda as far as Littorina.*]. van Voorst, London, 393 (+ 1) p., 8 pls.

Jeffreys J.G. 1883 On the Mollusca procured during the "Lightning" and "Porcupine" expeditions 1868-70. Part VI. *Proceedings of the Zoological Society of London, 1882*: 88-149.

Jong K.M. de & Coomans H.E. 1988. *Marine gastropods from Curaçao, Aruba and Bonaire. Studies on the Fauna of Curaçao and other Caribbean Islands,* 69. E.J. Brill. 261 pp, 47 pls.

Johnson C.W. 1934. List of marine Mollusca of the Atlantic coast from Labrador to Texas. *Proceedings of the Boston Society of Natural History,* 40(1): 1-204.

Johnson R.I. 1989. Molluscan taxa of Addison Emery Verrill and Katharine Jeannette Bush, including those introduced by Sanderson Smith and Alpheus Hyatt Verrill. *MCZ Publications on Mollusks, Occasional Papers on Mollusks*, 5: 1-143.

Keen A.M. 1960. In R. C. Moore (ed.), *Treatise on Invertebrate Paleontology, Part I, Mollusca 1. Mollusca - general features, Scaphopoda, Amphineura, Monoplacophora, Gastropoda - general features, Archaegastropoda, mainly Paleozoic Caenogastropoda and Opisthobranchia.* Geological Society of America & Univ. Kansas Press, Boulder, CO and Lawrence KS, xxiii + pp. 1-351.

Kurtz J.D. 1860. *Catalogue of Recent marine shells, found on the coasts of North and South Carolina*. Portland, David Tucker.ME 9 pp.

Lange-De-Morretes F. 1949. Ensaio de catálogo dos moluscos do Brasil. *Archos Mus. Paraná,* 7(1): 3-216.

Lee H. G. 2009. *Marine shells of northeast Florida*. Jacksonville Shell Club, Jacksonville, 204 pp., 19 pls.

Lyons W.G. 1989. Nearshore marine ecology at Hutchinson Island, Florida: 1971-1974. XI. Mollusks. *Florida Marine Research Publications,* 47: i+iv, 1-131.

Marshall B.A. 1988. Skeneidae, Vitrinellidae and Orbitestellidae (Mollusca: Gastropoda) associated with biogenic substrata from bathyal depths off New Zealand and New South Wales. *Journal of Natural History,* 22: 949-1004.

Maury C.J. 1922. Recent Mollusca of the Gulf of Mexico and Pleistocene and Pliocene species from Gult states. Part 2: Scaphopoda, Gastropoda, Amphineura, Cephalopoda. *Bulletins of American Paleontology,* 9(38): 33-172.

MELLO R.L.S. & PERRIER, L.L. 1986. Polyplacophora e Gastropoda do litoral sul de Pernambuco, Brasil. *Cadernos Ômega da Universidade Federal Rural de Pernambuco* 2: 107-144.

MIKKELSEN P.M., MIKKELSEN P.S. & KARLEN D.J. 1995. Molluscan biodiversity in the Indian River Lagoon, Florida. *Bull. Mar. Sci.*, 57: 94-127.

MOORE D.R. 1964. *The family Vitritiellidae in South Florida and the Gulf of Mexico*. Ph. D. dissertation. University of Miami, Coral Gables, FL, xi + 235 (+ 2) pl.

MOORE D.R. 1965. New species of Vitrinellidae from Gulf of Mexico and adjacent waters. *The Nautilus,* 78(3): 73-79, pls. 7-8.

MOORE D.R. 1969. *Cyclostrema miranda* Bartsch, a synonym of *Tornus subcarinatus* Montagu. *The Veliger,* 12(2): 169-170.

MOORE D.R. 1972. *Cochliolepis parasitica,* a non parasitic marine gastropod, and its place in the Vitrinellidae. *Bulletin of Marine Science,* 22(1): 100-112.

MORRIS P.A. 1973. *A field guide to shells of the Atlantic and Gulf coasts and the West Indies*. Hougton Mifflin Co., Boston. 330 pp, 76 pls.

NORDSIECK, F. 1968. *Die europäischen Meeres-Gehäuseschneken*. G. Fischer, Sttutgart. 273 pp.

NOWELL-USTICKE G.W. 1959. *A Check List of the Marine Shells of St. Croix, U. S Virgin Islands*. Lane Press, Burlington. 90 pp., 4 pls.

NOWELL-USTICKE G.W. 1971. *A Supplementary Listing of New Shells (Illustrated) Revised Edition. to be Added to the Check List of the Marine Shells of St. Croix*. Author: San Croix, Virgin Islands, 32 pp., 6 pls.

ODÉ H. 1969. *Cochliolepis parasitica* Stimpson. *Texas Conchologist* 5(7): 73-74.

ODÉ H. 1987a. Distribution and records of the marine Mollusca in the northwest Gulf of Mexico, families Skeneidae, Vitrinellidae. *Texas Conchologist,* 23(4): 110-121.

ODÉ H. 1987b. Distribution and records of the marine Mollusca in the northwest Gulf of Mexico, family Vitrinellidae. *Texas Conchologist,* 24(1): 21-40.

ODÉ H. 1988. Distribution and records of the marine Mollusca in the northwest Gulf of Mexico, family Vitrinellidae. *Texas Conchologist,* 24(2): 59-72.

OLIVER J.D. & ROLÁN E. 2011. The family Tornidae (Gastropoda, Rissooidea) in the East Atlantic, 2. Circulinae. *Iberus,* 29(1): 9-33.

OLSSON A.A. & HARBISON A. 1953. Pliocene Mollusca of southern Florida. *Monographs of the Academy of Natural Sciences of Philadelphia,* 18: 1-457 + 65 pls.

OLSSON A.A. & MCGINTY T. L. 1958. Recent marine mollusks from the Caribbean coast of Panama with the description of some new genera and species. *Bulletins of American Paleontology,* 39: 1-58, pls. 1-5.

ORBIGNY A. D' 1842. *Mollusques Histoire Physique, Politique et Naturelle de l'île de Cuba,* 2. Arthus Bertrand, Paris. pp 1-112, pls. 1-7.

ORTIZ-CORPS E. 1985. An annotated checklist of the Recent marine Gastropoda (Mollusca) from Puerto Rico. *Memorias del Quinto Simposio de la Fauna de Puerto Rico y el Caribe* ii + 220 pp.

PARKER R.H. 1959. Macro-invertebrate assemblages of central Texas coastal bays and Laguna Madre. *AAPG Bulletin,* 43: 2100-2166.

PARKER R.H. & CURRAY J.R. 1956. Fauna and bathymetry of banks on continental shelf, northwest Gulf of Mexico. *Bulletin of the American Association of Petroleum Geologists,* 40(10): 2428-2439.

PFEIFFER L. 1839. Bericht ber die Ergebnisse meiner Reise nach Cuba im Winter 1838-1839. *Archiv für Naturgeschichte* 5(1): 346-358.

PFEIFFER L. 1840. Uebersicht der im Januar, Februar und März 1839 auf Cuba gesammelten Mollusken. *Archiv für Naturgeschichte,* 6(1): 250-261.

PFEIFFER L. 1850. Die Schnirkelschnecken nebst den zunächst verwandten Gattungen. *Systematische Conchylien-Cabinet* 1: 1-32, pls. 12*, 85, 87, 89, 93, 96, 102-106, 110-112, 114.

PFEIFFER L. 1854. Zur Molluskenfauna der Insel Cuba. *Malakozoologische Blätter* 1: 170-213.

PILSBRY H.A. 1939. A new Floridan Cyclostrema. *The Nautilus,* 53: 53, pl. 8.

PILSBRY H.A. 1946. The type specimens of C.B. Adams's Jamaican species of *Vitrinella. MNotulae Naturae of the Academy of Natural Sciences of Philadelphia,* 1162: 1-5, figs. 1-6.

PILSBRY H.A. 1953. Pliocene Mollusca of Southern Florida. Part III-A. The Vitrinellidae. *Monographs of the Academy of Natural Sciences of Philadelphia,* 18: 411-438, pls. 49-56.

PILSBRY H.A. & AGUAYO C.G. 1933. Marine and freshwater mollusks new to the fauna of Cuba. *The Nautilus,* 46: 116-123, pl. 6.

PILSBRY H.A. & MCGINTY T.L. 1945a. "Cyclostrematidae" and Vitrinellidae of Florida. Part 1. *The Nautilus,* 59(1): 1-13, pls. 1, 2.

PILSBRY H.A. & MCGINTY T.L. 1945b. "Cyclostrematidae" and Vitrinellidae of Florida. Part 2. *The Nautilus,* 59(2): 52-59, pl. 6.

PILSBRY H.A. & MCGINTY T.L. 1946a. "Cyclostrematidae" and Vitrinellidae of Florida. Part 3. *The Nautilus,* 59(3): 77-83, pl. 8.

Pilsbry H.A. & McGinty T.L. 1946b. Vitrinellidae of Florida, Part 4. *The Nautilus*, 60(1): 12-18, pl. 2.

Pilsbry H.A. & McGinty T.L. 1950. Vitrinellidae of Florida: Part 5. *The Nautilus*, 63(3): 85-87, pl. 5.

Pilsbry H.A. & Olsson A.A. 1945. Vitrinellidae and similar gastropods of the Panamic Province. Part I. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 97: 249-278, pls. 22-30.

Pilsbry H.A. & Olsson A.A. 1952. Vitrinellidae of the Panamic Province: II. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 104: 35-88, pls. 2-13.

Ponder W.F. 1988. The Truncatelloidean (=Rissoacean) radiation- A preliminary phylogeny: Prosobranch phylogeny. *Malacological Review*, Supplement, 4: 129-164.

Ponder W.F. 1994. The Malacofauna of Hong Kong and Southern China III (ed. B. Morton). *Proceedings of the Third International Workshop on the Malacofauna of Hong Kong and Southern China, Hong Kong, 13 April – 1 May 1992*. Hong Kong University Press, 1994.

Ponder W.F. & Warén A. 1988. Classification of the Caenogastropoda and Heterostropha — a list of the family-group names and higher taxa. *Malacological Review*, Supplement 4: 288-317.

Porter H.J. 1974. *The North Carolina marine and estuarine mollusca: An atlas of Occurrence*. University North Carolina Institute of Marine Science, Morehead City, North Carolina, 351 pp.

Princz D. 1973. Los moluscos gasterópodos y pelecípodos del estado de Nueva Esparta, Venezuela. *Memoria, Sociedad de Ciencias Naturales La Salle*, 33: 169-222.

Princz D. 1977. Notas sobre algunos micromoluscos de la plataforma de Guyana. *Memoria, Sociedad de Ciencias Naturales La Salle*, 36(108): 283-293.

Princz D. 1978. Los moluscos marinos del Golfo de Venezuela. *Memoria, Sociedad de Ciencias Naturales La Salle*, 109: 51-76.

Princz D. 1982. Lista y bibliografia de los gasterópodos marinos vivos de los mares de Venezuela, Trinidad e Islas de Sotavento. *Boletín de la Sociedad Venezolana de Ciencias Naturales*, 37: 103-147.

Princz D. 1986. *Bionomie des micromollusques benthiques du nord-est du Venezuela*. Tesis de Doctorado, Université de Bretagne Occidentale, Brest, 176 pp.

Radwin G.E. 1969. A recent molluscan fauna from the Caribbean coast of southeastern Panama with special reference to those from north Saint Petersburg. *Monographs of the Academy of Natural Sciences of Philadelphia*, 8: 411-438, pls. 49-56.

Redfern C. 2001. *Bahamian seashells. A thousand Species from Abaco, Bahamas*. Bahamiansehlls.com Inc. Boca Raton, 280 pp, 124 pls.

Reed J.K. & Mikkelsen P.M. 1987. The molluscan community associated with the scleractinian coral *Oculina varicosa*. *Bulletin of Marine Science*, 40: 99-131.

Reguero M., García-Cubas A. & Zúñiga G., 1991. Moluscos de la laguna Tampamachoco, Veracruz, México: Sistemática y Ecología. *Anales del Instituto de Ciencias del Mar y Limnología, Universidad Nacional Autónoma de México*, 18(2): 289-328.

Rice W.H. & Kornicker L.S. 1965. Mollusks from the deeper waters of the northwestern Campeche Bank, Mexico. *Publications of the Institute of Marine Science*, 10: 108–172.

Richardson C.L. 1986. Polygyracea: Catalogue of species (Parts 1, Polygyridae; 2, Corillidae; 3 Sagdidae). *Tryonia*, 13: 1-139, 1-4, 1-38.

Rios E.C. 1975. *Brazilian marine mollusks iconography*. Museu Oceanografico, Fundação Universidade do Rio Grande, Rio Grande, 331 pp, 91 pls.

Rios E.C. 1994. *Seashells of Brazil*. Fundaçao Cidade do Rio Grande, Rio Grande, 345 pp, 113 pls.

Rios E.C. 2009. *Compedium of Brazilian Sea Shell*. Universidade Federal Rio Grande, 668 pp.

Robinson D.G. 1991. *The systematics and paleoecology of the prosobranch gastropods of the Pleistocene Moín formation of Costa Rica*. Doctoral dissertacion, Tulane University, New Orleans, Louisiana. 748 pp.

Robinson D.G. & Montoya M. 1987. Los moluscos marinos de la costa Atlántica de Costa Rica. *Revista Biología Tropical*, 35: 375-400.

Rolán E., Fernández-Garcés R. & Rubio F. 1997. Una nueva especie de Anticlimax (Gastropoda: Vitrinellidae) de Cuba. *Iberus*, 15: 31-34.

Rolán E. & Rubio F. 2002. The family Tornidae (Gastropoda, Rissooidea) in the East Atlantic. *Supl. Reseñas Malacologicas*, SEM: 1-98.

Rubio F. & Rodríguez Babío C. 1991. Sobre la posición sistemática de *Pseudorbis granulum* Brugnone, 1873 (Mollusca, Archaeogastropoda, Skeneidae) y descripción de *Pseudorbis jameoensis* n. sp. procedente de las Islas Canarias. *Iberus*, 9(1-2): 203-207.

Rubio F. & Rolán E. 1998. Una nueva especie de *Tomura* (Gastropoda, Heterobranchia, Cornirostridae) del Caribe. *Iberus*, 16(1): 119-123.

Rubio F. & Rolán R. 2009. Sobre la posición sistemática de *Teinostoma azorica* Dautzenberg & Fischer, 1896. *Noticiario SEM*, 52: 55-56.

SAGRA R. DE LA. 1831. *Historia Económico-Política y Estadística de la Isla de Cuba.* Arazoza y Soler. 12 Tomos. Segunda parte, Historia Natural. Atlas de Zoología, Tomo VIII. Paris. Librería de Arthus Bertrand.

SARASÚA H. 1970. Prosobranquios marinos nuevos para la fauna de Cuba (Mollusca: Prosobranchia). *Poeyana,* 72: 1-20.

SCHWENGEL J.S. & MCGINTY T.L. 1942. Some new and interesting marine shells from northwest Florida. *The Nautilus,* 56: 13-18, pl. 3.

SMITH E.A., 1871. A list of species of shells from West Africa, with description of those hitherto undescribed. *Proceedings of the Zoological Society of London, 1871*: 727-739.

SMITH E.A. 1890. Report on the marine molluscan fauna of the island of St. Helena. *Proceedings of the Zoological Society of London* 1890: 293, pl. 24, fig. 5. Type locality: St. Helena]

SMITH M. 1937. Further notes upon Tertiary and Recent mollusks from Florida together with descriptions of new species. *The Nautilus,* 51(2): 65-66, pi. 6.

STIMPSON W. 1858. On *Cochliolepis parasiticus. Proceedings of the Boston Society of Natural History*, 6: 307-309.

STIMPSON C.T. 1887. Contributions to the Mollusca of Florida. *Proceedings of the Davenport Academy of Natural Sciences,* 5: 45-72.

SYKES E.R. 1925. On the Mollusca procured during the "Porcupine" Expeditions, 1869-70. Supplemental notes, part V. *Proceedings of the Malacological Society of London* 16: 181-193, pl. 9.

THIELE J. 1929-1935. *Handbuch der Systematischen Weichtierkunde.* 2 vols. 1154 p., 584 figs.

TREECE G.D. 1980. Bathymetric records of marine shelled Mollusca from the Northeastern shelf and upper slope of Yucatan, Mexico. *Bulletin of Marine Science,* 30(3): 552-570.

TRYON G.W. 1887. *Manual of Conchology (second series). 3 Helicidae: - vol. 1.* Academy of Natural Sciences: Philadelphia. xii + [1]-313 + 63 pls.

TRYON G.W. 1888. Monograph of the families Neritidae, Neritopsidae, Adeorbiidae, Cyclostrematidae, and Liotiidae. *Manual of Conchology* 10. Academy of Natural Sciences: Philadelphia. 3-160, pls. 1-36.

TUNNELL J.W. & CHANEY A.H. 1970. A checklist of the mollusks of Seven and One-Half Fathom Reef, Northwestern Gulf of Mexico. *Cont. Marine Science University Texas.,* 15: 192-203.

VANATTA E.G. 1904. A list of shells collected in western Florida and Horn Island, Mississippi. *Proceedings of the Academy of Natural Sciences of Philadelphia*, 55: 756-759.

VANATTA E.G. 1913. Descriptions of new species of marine shells. *Proceedings of the Academy of Natural Sciences of Philadelphia,* 65: 22-27, pl. 2.

VERRILL A.E. 1882. Catalogue of marine Mollusca added to the fauna of the New England region, during the past ten years. *Transactions of the Connecticut Academy of Arts and Sciences,* 5: 451-587, pls. 42-44, 57-58.

VERRILL A.E. 1884. Second catalogue of Mollusca recently added to the fauna of the New England coast and the adjacent parts of the Atlantic, consisting mostly of deep-sea species, with notes on others previously recorded. *Transactions of the Connecticut Academy of Arts and Sciences*, 6: 139-294, pls. 28-32.

VOKES H.E. & VOKES E.H. "1983" [1984]. *Distribution of shallow-water marine Mollusca, Yucatan Peninsula, Mexico*. Mesoamerican Ecology Institute Monograph 1, Middle American Research Institute Publication, 54: viii, 183 pp, 50 pls.

WARÉN A. 1991. New and little known "Skeneimorph" gastropods from the Mediterranean Sea and the adjacents Atlantic Ocean. *Bolletino Malacologico*, 27(10-12): 149-248.

WAREN A. 1996. New and little known mollusca from Iceland and Scandinavia. Part 3. *Sarsia,* 81: 197-245.

WARÉN A. & BOUCHET P. 1993. New records, species, genera and a new family of gastropods from hydrothermal vents and hydrocarbon seeps. *Zoologica Scripta*, 22: 1-90.

WARÉN A. & BOUCHET P. 2001. Gastropoda and Monoplacophora from Hydrotermal vents and hydrocarbon seeps; new taxa and records. *The Veliger,* 44(2): 116-231.

WARMKE G.L. & ABBOTT R.T. 1961. *Caribbean seashells: a guide to the marine mollusks of Puerto Rico and other West Indian Islands, Bermuda and the Lower Florida Keys.* Livingston Publishing Company, Wynnewood, PA. 348 pp., 44 pls.

WASS M.L. 1972. A check list of the biota of lower. Chesapeake Bay. *Va. Inst. Mar. Sci. Spec. Sci. Rept.* No. 65, 290 p.

WEISBORD N.E. 1962. Late Cenozoic gastropods from northern Venezuela. *Bulletins of American Paleontology*, 42(193): 1-672, 48 pls.

WILEY G.N., CIRCÉ R.C. & TUNNELL J.W. JR. 1982. Mollusca of the rocky shores of east central Veracruz State, Mexico. *The Nautilus,* 96: 55-61.

WOODRING W.P. 1928. Miocene mollusks from Bowden, Jamaica. Part II: Gastropods and discussion of results. *Carnegie Institution of Washington. Publication*, 395: vii + 564 p., 40 pls.

WOODWARD M.F. 1898. On the anatomy of *Adeorbis subcarinatus*, Montagu. *Proceedings of the Malacological Society of London,* 3: 140-146, pl. 8.

ALPHABETICAL INDEX OF GENERA AND SPECIES

Plate numbers, page numbers

abnorme, Teinostoma 200
abyssicola, Ganesa 215
abyssicola, Molleriopsis 216
adamsii, Cochliolepis **57,** 108
Adeorbis **62,** 201
Adeorbis adamsii 108
Adeorbis beauii 84
Adeorbis elegans 201
Adeorbis infracarinata 139
Adeorbis nautiliformis **112,** 117
Adeorbis omalos 189
Adeorbis orbignyi 8
Adeorbis supranitidus 88
aguayoi, Vitrinella **101,** 178
altum, Teinostoma **23,** 46
anastomosis, Teinostoma **12,** 27
Anticlimax annae **40,** 76
anneliesae, Vitrinella **90,** 162
Annulicallus 61
anomala, Vitrinella **108,** 192
Anticlimax 67
Anticlimax annae **40,** 76
Anticlimax athleenae 195
Anticlimax crassilabris **35,** 68
Anticlimax decorata **37,** 70
Anticlimax glabra **36,** 70
Anticlimax hispaniolensis cratera **41,** 78
Anticlimax locklini **39,** 74
Anticlimax pilsbryi **38,** 73
Anticlimax proboscidea **37,** 73
Anticlimax schumoi 189
antillensis, Solariorbis **73,** 135
Aorotrema 80
Aorotrema cistronium **42,** 80
Aorotrema erraticum **114,** 202
Aorotrema gardnerae 197
Aorotrema pontogenes 81
aristata, Vitrinella **98,** 173
athleenae, Anticlimax 195
avitus, Parviturboides 197
avunculus, Teinostoma 191

Plate numbers, page numbers

baldingeri, Teinostoma **10,** 24
balesi, Parviturboides **72,** 133
bartschi, Cyclostremiscus **49,** 95
beauii, Cyclostremiscus **43,** 84
biscaynense, Teinostoma **14,** 29
blakei, Solariorbis **74,** 137
brychia, Choristella 216
bushae, Ganesa 215
calliglypta, Vitrinella **102,** 181
caloosaense, Teinostoma 199
canaliculata, Vitrinella **97,** 173
Canimarina 68
caraboboensis, Tornus **33,** 63
carinata, Vitrinella 192
carinicallus, Teinostoma **32,** 61
carinifex, "Vitrinella" **115,** 202
cerion, Mikro **118,** 208
Choristella 216
Choristella brychia 217
Choristella leptalea 217
cienfuegosense, Teinostoma **29,** 56
Circulus 5
Circulus bicarinatus 84
Circulus cubanus 103
Circulus dalli 88
Circulus gunteri **106,** 197
Circulus hendersoni 93
Circulus liratus **3,** 10
Circulus margaritiformis 207
Circulus orbignyi **2,** 8
Circulus quadricristatus 108
Circulus semisculptus **1,** 6
Circulus stirophorus 84
Circulus striatus 6
Circulus suppressus 97
Circulus texanus 11
Circulus translucens 211
Circulus trilix 91
Cirsonella 205
Cirsonella extrema 208
Cirsonella floridensis **116,** 205

Plate numbers, page numbers

Cirsonella margaritiformis **117,** 207
ciskae, Teinostoma **5,** 15
cistronium, Aorotrema **42,** 80
Climacia 67
Climacia athleenae 195
Climacia tholus 74
Climacina 67
Cochliolepis 108
Cochliolepis adamsii **57,** 108
Cochliolepis differens **66,** 123
Cochliolepis holmesii **58,** 109
Cochliolepis nautiliformis **59,** 112
Cochliolepis parasitica **60,61,62,** 112
Cochliolepis patricioi **65,** 120
Cochliolepis planispiralis **64,** 118
Cochliolepis sp. **67,** 123
Cochliolepis striata **63,** 118
Cochliolepis surinamensis 189
cocolitoris, Teinostoma **26,** 50
conica, Ganesa 215
contracta, Vitrinella **91,** 164
convexa, Ganesa 215
crassilabris, Anticlimax **35,** 68
cubanus, Cyclostremiscus **54,** 103
cupidinensis, Vitrinella **103,** 181
cyclostomoides, Vitrinella 203
Cyclostrema 215
Cyclostrema angulatum 84
Cyclostrema bartschi 95
Cyclostrema bicarinatum 84
Cyclostrema cistronium 80
Cyclostrema elegans 201
Cyclostrema gordana 86
Cyclostrema interruptum 129
Cyclostrema pontogenes 81
Cyclostrema sanibelense 128
Cyclostrema schrammii 64
Cyclostrema zacalles 129
"Cyclostrema" thomasi 186
Cyclostremella humilis 217
Cyclostremiscus 83
Cyclostremiscus bartschi **49,** 95
Cyclostremiscus beauii **43,** 84
Cyclostremiscus caraboboensis 63

Plate numbers, page numbers

Cyclostremiscus crassilabris 68
Cyclostremiscus cubanus **54,** 103
Cyclostremiscus dalli **45,** 88
Cyclostremiscus diminutus **53,** 100
Cyclostremiscus euglyptus **55,** 105
Cyclostremiscus fargoi **110,** 197
Cyclostremiscus gunteri 197
Cyclostremiscus hendersoni **48,** 93
Cyclostremiscus jeannae **50,** 97
Cyclostremiscus major 86
Cyclostremiscus microstriatus **56,** 105
Cyclostremiscus multiliratus **44,** 86
Cyclostremiscus olssoni 197
Cyclostremiscus pentagonus **46,** 10,88
Cyclostremiscus puntagordensis 103
Cyclostremiscus salvatierrensis 108
Cyclostremiscus suppressus **51,** 97
Cyclostremiscus trilix **47,** 91
Cyclostremiscus vanbruggeni **52,** 100
dalli, Cyclostremiscus **45,** 88
dalli, Ganesa 215
decorata, Anticlimax **37,** 70
Delphinoidea 181
Delpinula depressa 133
diaphana, Ganesa 215
differens, Cochliolepis **66,** 123
Dillwynella 215
Dillwynella modesta **121,** 216
diminutus, Cyclostremiscus **53,** 100
Discopsis omalos 189
Discopsis schumoi 189
elegans, Adeorbis 201
elegans, Solariorbis **75,** 139
elegans, Vitrinorbis **106,** 186
Ellipetylus 50
Episcynia 125
eritmeta, Leptogyra 216
erraticum, Aorotrema **114,** 202
Ethalia multistriata 145
Ethalia reclusa 21
Ethalia solida 48
eugenes, Solariorbis **111,** 197
euglyptus, Cyclostremiscus **55,** 105
expansum, Teinostoma **16,** 34

Plate numbers, page numbers

fargoi, Cyclostremiscus **110,** 197
filifera, Vitrinella **104,** 184
floridana, Vitrinella **96,** 171
floridensis, Cirsonella **116,** 205
funiculus, Vitrinella **92,** 165
Ganesa 215
Ganesa bushae 215
Ganesa conica 215
Ganesa convexa 215
Ganesa dalli 215
Ganesa depressa 215
Ganesa diaphana 215
Ganesa ornatam 215
Ganesa proxima 215
Ganesa valvata 215
Ganesa verrilli 215
gardnerae, Aorotrema 197
georgiana, Cirsonella **116,** 207
glabra, Anticlimax **36,** 70
goniogyrus, Teinostoma **6,** 16
Granigyra 216
Granigyra limata 216
Granigyra radiata 216
Granigyra spinulosa 216
guianensis, Solariorbis **73,** 135
gunteri, Cyclostremiscus 197
helicinum, Teinostoma **27,** 53
helicoidea, Vitrinella **94, 95,** 167, 195
Helix cyclostomoides 203
hemphilli, Vitrinella 192
hendersoni, Cyclostremiscus **48,** 93
hispaniolensis cratera, Anticlimax **41,** 78
holmesii, Cochliolepis **58,** 109
Homalogyra marshalli 199
hondurasensis, Solariorbis 190
humilis, Cyclostremella 217
hyalina, Vitrinella 204
Idioraphe 24, 29, 33
incertum, Teinostoma **11,** 24
inconspicua, Leptogyra 216
infracarinatus, Solariorbis **76, 77,** 139
inornata, Episcynia **68, 69,** 126
Interruptus, Parviturboides **70, 71,** 129
jeannae, Cyclostremiscus **50,** 97

Plate numbers, page numbers

lenticulare, Teinostoma **7,** 19
leptalea, Choristella 216
Leptogyra 216
Leptogyra eritmeta 216
Leptogyra inconspicua 216
Leptogyra verrilli 216
lerema, Teinostoma **21,** 43
limata, Granigyra 215
lineopunctatus, Solariorbis **86,** 155
liratus, Circulus **3,** 10
lituspalmarum, Teinostoma 61
locklini, Anticlimax **39,** 74
lunense, Teinostoma **25,** 50
Lydiphnis dalli 88
Lydiphnis hendersoni 93
Lydiphnis margaritiformis 207
Lydiphnis translucens 211
margaritiformis, Cirsonella **117,** 207
marshalli, Neusas **112,** 199
massarita, "Vitrinella" 212
megacallum, Teinostoma **31,** 59
megastoma, Teinostoma **28,** 54
microstriatus, Cyclostremiscus **56,** 105
Mikro 208
Mikro cerion **118,** 208
minusculum, Teinostoma **20,** 41
modesta, Dillwynella **121,** 216
Molleriopsis sincera 216
mooreanus, Solariorbis **78,** 143
morlierei, Teinostoma 191
multiliratus, Cyclostremiscus **44,** 86
multistriatus, Solariorbis **79,** 145
nautiliformis, Cochliolepis **59** 112
Nemafera compressa 112
nesaeum, Teinostoma **17,** 36
Neusas 199
Neusas marshalli **112,** 199
obtectum, Teinostoma **15,** 33
olssoni, Cyclostremiscus 197
Omalaxis funiculus 164
Omalaxis lirata 10
omalos, Discopsis 189
opsitelotus, Vitrinella **93,** 167
orbignyi, Circulus **2,** 8

	Plate numbers,	page numbers
ornatam, Ganesa		215
Paludinella helicoides		159
panamense, Teinostoma	**13,**	29
parasitica, Cochliolepis	**60,61,62,**	112
parvicallum, Teinostoma	**30,**	57
Parviturbo		132
Parviturbo zacalles		129
Parviturboides		128
Parviturboides avitus		197
Parviturboides balesi	**72,**	133
Parviturboides interruptus	**70, 71,**	129
parvum, Teinostoma		192
patricioi, Cochliolepis	**65,**	120
pauli, Pleuromalaxis		190
pelorcei, Vitrinella	**100,**	176
pentagonus, Cyclostremiscus	**46,**	88
petitii, Solariorbis	**107,**	190
pilsbryi, Anticlimax	**38,**	73
planispiralis, Cochliolepis	**64,**	118
Pleuromalaxis		132
Pleuromalaxis pauli		133, 190
Ponderinella		200
Ponderinella xacriaba	**113,**	200
pontogenes, Aorotrema		81
Porcupinia		205
proboscidea, Anticlimax	**37,**	73
proxima, Ganesa		215
pseudoaristata, Vitrinella	**99,**	176
Pseudomalaxis		132
Pseudomalaxis balesi		133
Pseudorbis granulum		132
Pseudorotella carinicallus		61
Pseudorotella floridensis		205
Pseudorotella minúscula		41
Pseudorotella pusilla		193
Pseudorotella semistriata		38
punctostriatus, Solariorbis	**87,**	157
pusilla, Vitrinella	**108G, 109,**	193
radiata, Granigyra		215
reclusum, Teinostoma	**8, 9,**	21
regularis, Vitrinella		201
rhyssa, Xyloskenea	**119,**	210
Rotella carinata		16
Rotella cryptospira		43

	Plate numbers,	page numbers
Rotella lenticularis		19
Rotella pusilla		193
Rotella umbellicata		43
ruris, Solariorbis	**85,**	153
schrammii, Tornus	**34,**	64
schumoi, Anticlimax		189
schumoi, Solariorbis	**81,**	147
semipunctus, Solariorbis	**82,**	149
semisculptus, Circulus	**1,**	6
semistriatum, Teinostoma	**18, 19,**	38
sincera, Molleriopsis		216
Skenea larseni		208
Skenea petitii		190
Skenea sulcata		84
Skenea trilix		91
Skenea trochoides		208
Solariorbis		133
Solariorbis aguayoi		178
Solariorbis antillensis	**73,**	135
Solariorbis bassilisus		143
Solariorbis blakei	**74,**	137
Solariorbis corylus		145
Solariorbis decipiens		68
Solariorbis elegans	**75,**	139
Solariorbis eugenes	**111,**	197
Solariorbis euzonus	**139,**	142
Solariorbis guianensis	**73,**	135
Solariorbis hondurasensis		190
Solariorbis infracarinatus	**76, 77,**	139
Solariorbis lineopunctatus	**86,**	155
Solariorbis mooreanus	**78,**	143
Solariorbis multistriatus	**79,**	145
Solariorbis opsitelotus		167
Solariorbis petitii	**107,**	190
Solariorbis punctostriatus	**87,**	157
Solariorbis ruris	**85,**	153
Solariorbis schumoi	**81,**	147
Solariorbis semipunctus	**82,**	149
Solariorbis solidus	**88, 89,**	159
Solariorbis sp.	**86,**	155
Solariorbis terminalis	**3, 84,**	150
Solariorbis truncatus	**80,**	145
solaris, Vitrinella	**105,**	186
Solarium inornatum		125

Plate numbers, page numbers

solidum, "Teinostoma" **24,** 48
solidus, Solariorbis **88, 89,** 159
sp. , *Cochliolepis* **67,** 123
sp. , *Solariorbis* **86,** 155
spinulosa, Granigyra 215
striata, Cochliolepis **63,** 118
striata, Ganesa 215
Striovitrinella **139,** 181
suppressus, Cyclostremiscus **51,** 97
surinamensis, Cochliolepis 189
tectispira, Teinostoma 199
Teinostoma 14
Teinostoma (Ethalia) suppressa 97
Teinostoma altum **23,** 46
Teinostoma anastomosis **12,** 27
Teinostoma avunculus 191
Teinostoma baldingeri **10,** 24
Teinostoma bartschi **139,** 142
Teinostoma biscaynense **14,** 29
Teinostoma caloosaense 199
Teinostoma carinicallus **32,** 61
Teinostoma cienfuegosense **29,** 56
Teinostoma ciskae **5,** 15
Teinostoma clavium 38
Teinostoma cocolitoris **26,** 50
Teinostoma expansum **16,** 34
Teinostoma funiculus 165
Teinostoma goniogyrus **6,** 16
Teinostoma helicinum **27,** 53
Teinostoma hondurasensis **149,** 190
Teinostoma incertum **11,** 24
Teinostoma lenticulare **7,** 19
Teinostoma lerema **21,** 43
Teinostoma lituspalmarum 61
Teinostoma lunense **25,** 50
Teinostoma megacallum **31,** 59
Teinostoma megastoma **28,** 54
Teinostoma millepunctata 15
Teinostoma minusculum **20,** 41
Teinostoma morlierei 191
Teinostoma nesaeum **17,** 36
Teinostoma obtectum **15,** 33
Teinostoma opsitelotus 167
Teinostoma panamense **13,** 29

Teinostoma parvicallum **30,** 57
Teinostoma parvum 192
Teinostoma pilsbryi 73
Teinostoma politum 14
Teinostoma proboscidea 73
Teinostoma reclusum **8, 9,** 21
Teinostoma schumoi 147
Teinostoma semistriatum **18, 19,** 38
"Teinostoma" solidum **24,** 48
Teinostoma tectispira 199
Teinostoma umbilicatum **22,** 44
terminalis, Solariorbis **83, 84,** 150
Texanus, Circulus 11
Tharsiella 205
Tharsis 205
tincta, Vitrinella **114,** 202
Tornus 63
Tornus caraboboensis **33,** 63
Tornus schrammii **34,** 64
translucens, Xyloskenea **120,** 211
trilix, Cyclostremiscus **47,** 91
Trochus (Rotella) anómala 192
Trochus (Rotella) carinata 192
Trochus (Rotella) diaphana 193
Trochus (Rotella) semistriata 38
Trochus inornatum 126
truncatus, Solariorbis **80,** 145
tryoni, Vitrinella 195
umbilicatum, Teinostoma **22,** 44
valvata, Ganesa 215
vanbruggeni, Cyclostremiscus **52,** 100
verrilli, Ganesa 215
verrilli, Leptogyra 216
Vitrinella 159
Vitrinella aguayoi **101,** 178
Vitrinella anneliesae **90,** 162
Vitrinella anomala **108,** 192
Vitrinella aristata **98,** 173
Vitrinella blakei 137
Vitrinella calliglypta **102,** 181
Vitrinella canaliculata **97,** 173
Vitrinella carinata 192
Vitrinella cerion 208
Vitrinella contracta **91,** 164

Plate numbers, page numbers

Vitrinella cupidinens **103,** 157, 181
Vitrinella cyclostomoides 203
Vitrinella diaphana 153
Vitrinella elegans 139
Vitrinella filifera **104,** 184
Vitrinella floridana **96,** 171
Vitrinella funiculus **92,** 165
Vitrinella georgiana 207
Vitrinella helicoidea **94, 95,** 167, 195
Vitrinella hemphilli 192
Vitrinella holmesii 109
Vitrinella hyalina 204
Vitrinella interrupta 128, 129
"Vitrinella" massarita 212
Vitrinella megastoma 54
Vitrinella mooreana 143
Vitrinella multicarinata 126
Vitrinella opsitelotus **93,** 167
Vitrinella panamensis 83, 97
Vitrinella pelorcei **100,** 176
Vitrinella pentagonus 88
Vitrinella praecox 167
Vitrinella pseudoaristata **99,** 176

Plate numbers, page numbers

Vitrinella pusilla **108G, 109,** 193
Vitrinella regularis 201
Vitrinella rhyssa 210
Vitrinella semisculpta 6
Vitrinella solaris **105,** 186
Vitrinella tenuisculpta 178
Vitrinella terminalis 150
Vitrinella texana 11
Vitrinella thomasi 185
Vitrinella tincta **4,** 202
Vitrinella truncata 145
Vitrinella tryoni 195
Vitrinella tryoni 195
"Vitrinella" carinifex **115,** 202
Vitrinorbis 186
Vitrinorbis callistus 186
Vitrinorbis elegans **106,** 186
xacriaba, Ponderinella **113,** 200
Xyloskenea 210
Xyloskenea costulifera 211
Xyloskenea naticiformis 211
Xyloskenea rhyssa **119,** 210
Xyloskenea translucens **120,** 211

NORMAS DE PUBLICACIÓN

- La revista *Iberus* publica artículos de fondo, notas y monografías que versen sobre cualquiera de los aspectos relacionados con la Malacología. Se entiende por artículo un trabajo de investigación de más de 5 páginas de texto, incluidas láminas, gráficos y tablas. Las notas son trabajos de menor extensión. Las monografías son trabajos sobre un tema único, de extensión superior a las 50 páginas de la revista y que serán publicadas, si procede, como un suplemento de *Iberus*. Los autores interesados en publicar monografías deberán ponerse previamente en contacto con el Editor de Publicaciones. Se entiende que el contenido de los manuscritos no ha sido publicado, ni enviado simultáneamente a otra revista para su consideración.
- Los manuscritos, así como toda la correspondencia relacionada con los mismos, deberán ser remitidos a: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, España y/o al correo electrónico <sgofas@uma.es>.
- El texto del trabajo podrá estar redactado en español, inglés, italiano, francés o portugués.
- Los artículos, notas y monografías deberán presentarse sobre DIN A-4, por una sola cara a doble espacio (incluyendo referencias, pies de figura y tablas), con al menos 3 centímetros de margen por cada lado. Los trabajos se entregarán por triplicado (original y dos copias) y se incluirá una versión en un CD, o bien remitida por correo electrónico, utilizando procesadores de texto en sus versiones de corrientes de Windows (pero no en el formato .docx de Word 2007, el habitual de Windows Vista) o Macintosh. En caso de autoría compartida, uno de los autores deberá hacerse responsable de toda la correspondencia.
- Junto con el trabajo debe incluirse una lista de al menos 4 posibles revisores del mismo, sin perjuicio de los que el propio Editor considere oportunos.
- Los manuscritos se presentarán de acuerdo al siguiente esquema:

Primera página. Deberá incluir un título conciso, pero sugerente del contenido del trabajo, así como una traducción al inglés del mismo (si el artículo no está escrito en inglés). Cuando sea preciso, deberá incluir referencia a familia o taxones superiores. A continuación figurarán, por este orden, el nombre y apellidos completos del autor o autores, las direcciones completas de los mismos, y un resumen del trabajo y su traducción al inglés. Dicho resumen deberá sintetizar, en conjunción con el título, tanto los resultados como las conclusiones del artículo; se sugiere una extensión de 100 a 200 palabras.

Páginas siguientes. Incluirán el resto del artículo, que debe dividirse en secciones precedidas por breves encabezamientos. Siempre que sea posible, se recomienda seguir el siguiente esquema: Introducción, Material y métodos, Resultados, Discusión, Conclusiones, Agradecimientos y Bibliografía. Si se emplean abreviaturas no habituales en el texto, deberán indicarse tras el apartado de Material y Métodos.

- Las notas breves deberán presentarse de la misma forma, pero sin resumen.
- Deberán evitarse notas a pie de página y referencias cruzadas. Deberán respetarse estrictamente los Códigos Internacionales de Nomenclatura Zoológica y Botánica (últimas ediciones). Cuando un taxón aparezca por primera vez deberá citarse su autor y fecha de su descripción. En el caso de artículos sistemáticos, cuando se den las sinonimias de los taxones, éstas deberán citarse COMPLETAS, incluyendo en forma abreviada la publicación donde fueron descritas, y la localidad tipo si es conocida entre corchetes, según el siguiente esquema (préstese especial cuidado a la puntuación):

Dendrodoris limbata (Cuvier, 1804)
Sinonimias
Doris limbata Cuvier, 1804, *Ann. Mus. Hist. Nat. Paris*, 4 (24): 468-469 [Localidad tipo: Marsella].
Doris nigricans Otto, 1823, *Nov. Act. Ac. Caes. Leop.-Car.*, 10: 275.

Dichas referencias no deberán incluirse en la lista de Bibliografía si es la única vez que se nombran en el texto. Si se incluyen una lista completa de referencias de un taxón inmediatamente tras éste, deberá seguirse el mismo esquema (sin incluir en Bibliografía las referencias que no se mencionen en otro lugar del texto).

- Sólo los nombres en latín y los de taxones genéricos y específicos deberán llevar subrayado sencillo o preferentemente ir en cursiva. En ningún caso deberá escribirse una palabra totalmente en letras mayúsculas, ni siquiera el Título. Las unidades a utilizar deberán pertenecer al Sistema Métrico Decimal, junto con sus correctas abreviaturas. En artículos escritos en castellano, en los números decimales sepárese la parte entera de la decimal por una coma inferior (,), NUNCA por un punto (.) o coma superior (').
- Las referencias bibliográficas irán en el texto con minúsculas o versalitas: Fretter y Graham (1962) o FRETTER Y GRAHAM (1962). Si son más de dos autores se deberán citar todos la primera vez que aparecen en el texto [Smith, Jones y Brown (1970)] empleándose *et al.* las siguientes veces [Smith *et al.* (1970)]. Si un autor ha publicado más de un trabajo en un año se citarán con letras: (Davis, 1989a; Davis, 1989b). No deberá emplearse op. cit. La lista de referencias deberá incluir todas las citas del texto y sólo éstas, ordenadas alfabéticamente. Se citarán los nombres de todos los autores de cada referencia, sea cual sea su número. Los nombres de los autores deberán escribirse, en letras minúsculas o Versalitas. No deberán incluirse referencias a autores cuando éstos aparezcan en el texto exclusivamente como autoridades de un taxón. Los nombres de las publica-

ciones periódicas deberán aparecer COMPLETOS, no abreviados. Cuando se citen libros, dése el título, editor, lugar de publicación, nº de edición si no es la primera y número total de páginas. Deberán evitarse referencias a Tesis Doctorales u otros documentos inéditos de difícil consulta. Síganse los siguientes ejemplos (préstese atención a la puntuación):

Fretter V. y Graham A. 1962. *British Prosobranch Molluscs*. Ray Society, London, 765 pp.

Ponder W.F. 1988. The Truncatelloidean (= Rissoacean) radiation - a preliminary phylogeny. En Ponder, W.F. (Ed.): Prosobranch Phylogeny. *Malacological Review*, suppl. 4: 129-166.

Ros J. 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoológica*, 3 (5): 21-51.

- Las gráficas e ilustraciones deberán ser originales y presentarse preferentemente en formato electrónico al formato de caja de la revista o proporcional a éste. Este formato es de 57 mm (una columna) o 121 mm (dos) de anchura y hasta 196 mm de altura, si bien se recomienda utilizar el formato a dos columnas. Es importante que todas las figuras sean remitidas en su formato original (por ejemplo, las fotografías en .jpg de alta calidad o .tif, las gráficas en hojas de cálculo Excel o documentos de CorelDraw), puesto que las ilustraciones insertadas en el manuscrito WORD son inservibles en la fase de imprenta. Las imágenes digitales deben ser formateadas en su tamaño de impresión con una resolución mínima de 300 ppp para imágenes en color o escala de grises y de 600 ppp para las de blanco y negro. Considérese la reducción que será necesaria a la hora de decidir el tamaño de las escalas o letras en las figuras, que no deberán bajar de los 2 mm. En figuras compuestas, cada parte deberá etiquetarse con letras mayúsculas, el resto de las letras deberán ser minúsculas. Las escalas de dibujos y fotografías deberán ser gráficas, utilizando unidades del sistema métrico decimal; no deberán hacerse referencias a los aumentos de una determinada ilustración, ya que éstos cambian con la reducción. En su caso, se recomienda la utilización de mapas con proyección UTM. Cada figura, gráfica o ilustración deberá presentarse en hojas separadas y con numeración arábiga (1, 2, 3,...), sin separar "Figuras" y "Láminas". Los pies de figura, en una hoja aparte, deberán acompañarse de su traducción al inglés (o español si el inglés es la lengua del trabajo). Utilícese el esquema siguiente:

Figura 1. *Neodoris carvi*. A: animal desplazándose; B: detalle de un rinóforo; C: branquia.

Las abreviaturas empleadas en las ilustraciones deberán incluirse en los pies de figura.

Los autores interesados en incluir láminas en color deberán consultar con el editor y sufragar el sobrecoste con una contribución de 30 € por página. Por lo demás, deberán ajustarse a los mismos requisitos indicados para las figuras.

Si se pretende enviar gráficas o ilustraciones en impresión de papel es imprescindible presentar originales de buena calidad. Las imágenes en semitonos deben estar bien contrastadas y ajustarse al tamaño definitivo de impresión; al componer fotografías sobre una hoja, procúrese que los espacios entre ellas sean regulares y que estén debidamente alineadas. Téngase en cuenta que incluir fotografías de distinto contraste en una misma página conlleva una pobre reproducción final. Las gráficas de ordenador deberán imprimirse con impresora láser sobre papel de buena calidad.

- Las Tablas se presentarán en hojas separadas, siempre con numeración romana (I, II, III,...). Las leyendas se incluirán en una hoja aparte acompañándose de una traducción al inglés. Deberán evitarse las tablas particularmente complejas. Se recomienda reducir el número y extensión de ilustraciones, láminas o tablas al mínimo necesario.
- Los artículos que no se ajusten a las normas de publicación serán devueltos al autor con las indicaciones de los cambios necesarios.
- El Comité Editorial comunicará al autor responsable del trabajo la fecha de recepción del trabajo y la fecha de envío a revisión. Cada original recibido será sometido a revisión por al menos dos investigadores. El Comité Editorial, a la vista de los informes de los revisores decidirá sobre la aceptación o no de cada manuscrito. El autor recibirá en cada caso copia de los comentarios de los revisores sobre su artículo. En caso de aceptación, el mismo Comité Editorial, si lo considera conveniente, podrá solicitar a los autores otras modificaciones que considere oportunas. Si el trabajo es aceptado, el autor deberá enviar una copia impresa del mismo corregida, acompañada por una versión en un CD, utilizando procesadores de texto en sus versiones corrientes de Windows (pero no el formato .docx generado por Word 2007, el habitual de Windows Vista) o Macintosh. La fecha de aceptación figurará en el artículo publicado.
- Las pruebas de imprenta serán enviadas por correo electrónico al autor responsable, exclusivamente para la corrección de erratas, y deberán ser devueltas en un plazo máximo de una semana. Se recomienda prestar especial atención en la corrección de las pruebas.
- De cada trabajo se entregarán gratuitamente 50 separatas, además de una versión electrónica en formato .pdf. Aquellos autores que deseen un número mayor, deberán hacerlo constar al devolver las pruebas de imprenta, y nunca posteriormente. El coste de las separatas adicionales será cargado al autor.

INSTRUCTIONS TO AUTHORS

- *Iberus* publishes research papers, notes and monographs devoted to the various aspects of Malacology. Papers are manuscripts of more than 5 typed pages, including figures and tables. Notes are shorter papers. Monographs should exceed 50 pages of the final periodical, and may be published as Supplements. Authors wishing to publish monographs should contact the Editor. Manuscripts are considered on the understanding that their contents have not been published or simultaneously submitted for publication elsewhere.
- Manuscripts and correspondence regarding editorial matters must be sent to: Serge Gofas, Editor de Publicaciones, Departamento de Biología Animal, Universidad de Málaga, Campus de Teatinos, s/n, 29071, Málaga, Spain and/or to the e-mail <sgofas@uma.es>.
- Manuscripts may be written in Spanish, English, Italian, French or Portuguese.
- Manuscripts must be typed double spaced (including the references, figure captions and tables) on one side on A-4 (297x210 mm) with margins of at least 3 cm. An original and two copies must be submitted, together with a CD or e-mail remittance containing the article written with a current Windows (but not .docx format generated by Word 2007, mainly used with Windows Vista) or Macintosh word processor. When a paper has joint authorship, one author must accept responsibility for all correspondence.
- The authors must include a list of at least 4 possible referees; the Editor can choose any others if appropriate.
- Papers should conform the following layout:

First page. This must include a concise but informative title, with mention of family of higher taxon when appropriate, and its Spanish translation. It will be followed by all authors' names and surnames, their full address(es), an abstract (and its Spanish translation) not exceeding 200 words which summarizes not only contents but results and conclusions.

Following pages. These should content the rest of the paper, divided into sections under short headings. Whenever possible the text should be arranged as follows: Introduction, Material and methods, Results, Discussion, Conclusions, Acknowledgements and References. Unusual abbreviations used in the text must be grouped in one alphabetic sequence after the Material and methods section.

- Notes should follow the same layout, without the abstract.
- Footnotes and cross-references must be avoided. The International Codes of Zoological and Botanical Nomenclature must be strictly followed. The first mention in the text of any taxon must be followed by its authority including the year. In systematic papers, when synonyms of a taxon are given, they must be cited IN FULL, including the periodical, in an abbreviate form, where they were described, and the type localities in square brackets when known. Follow this example (please note the punctuation):

Dendrodoris limbata (Cuvier, 1804)

Synonyms

Doris limbata Cuvier, 1804, *Ann. Mus. Hist. Nat. Paris*, 4 (24): 468-469 [Type locality: Marseille].

Doris nigricans Otto, 1823, *Nov. Act. Ac. Caes. Leop.-Car.*, 10: 275.

These references must not be included in the Bibliography list, except if referred to elsewhere in the text. If a full list of references of the taxon is to be given immediately below it, the same layout should be followed (also excluding from the Bibliography list those which are not cited elsewhere).

Only Latin words and names of genera and species should be underlined once or be given in italics. No word must be written in UPPER CASE LETTERS. SI units are to be used, together with their appropriate symbols. In Spanish manuscripts, decimal numbers must be separated with a comma (,), NEVER with a point (.) or upper comma (').

- References in the text should be written in small letters or Small capitals: Fretter and Graham (1962) or FRETTER AND GRAHAM (1962). The first mention in the text of a paper with more than two authors must include all of them [Smith, Jones and Brown (1970)], thereafter use *et al.* [Smith *et al.* (1970)]. If an author has published more than one paper per year, refer to them with letters: (Davis, 1989a; Davis, 1989b). Avoid op. cit.

The references in the reference list should be in alphabetical order and include all the publications cited in the text but only these. ALL the authors of a paper must be included. These should be written in small letters or Small capitals. The references need not be cited when the author and date are given only as authority for a taxonomic name. Titles of periodicals must be given IN FULL, not abbreviated. For books, give the title, name of publisher, place of publication, indication of edition if not the first and total number of pages. Keep references to doctoral theses or any other unpublished documents to an absolute minimum. See the following examples (please note the punctuation):

Fretter V. and Graham A. 1962. *British Prosobranch Molluscs*. Ray Society, London, 765 pp.

Ponder W.F. 1988. The Truncatelloidean (= Rissoacean) radiation - a preliminary phylogeny. In Ponder W.F. (Ed.): Prosobranch Phylogeny. *Malacological Review*, suppl. 4: 129-166.

Ros J. 1976. Catálogo provisional de los Opistobranquios (Gastropoda: Euthyneura) de las costas ibéricas. *Miscelánea Zoológica*, 3 (5): 21-51.

- Figures must be original and provided preferably in electronic format and adjusted to page format and column size. These should be one column (57 mm) or two columns (121 mm) wide and up 196 mm high, or be proportional to these sizes. Two columns format is recommended. It is essential that all figures be supplied in their original format (e.g. photographs as high-grade .jpg or as .tif files, graphs as Excel spreadsheets or Corel-Draw files), as the files inserted into WORD documents cannot be used for printing. Digital images must be given their final printing size with a resolution at least 300 dpi for colour and halftones, and at least 600 dpi for black/white.

Take into account possible reduction in lettering drawings; final lettering must be at least 2 mm high. In composite drawings, each figure should be given a capital letter; additional lettering should be in lower-case letters. A scale line, labelled with SI units, must be used to indicate size; magnification ratio must be avoided as it may be changed during printing. UTM maps are to be used if necessary. Figures must be submitted on separate sheets, and numbered with consecutive Arabic numbers (1, 2, 3,…), without separating 'Plates' and 'Figures'. Legends for Figures must be typed in numerical order on a separate sheet, and a Spanish translation must be included. Follow this example (please note the punctuation):

Figure 1. *Neodoris carvi*. A: animal crawling; B: rhinophore; C: gills.

If abbreviations are to be used in illustrations, they should be included in the figure captions.

Authors wishing to publish illustrations in colour should consult with the editor and will be charged a contribution of 30 € per page. They should otherwise follow the same standards as black and white prints.

If the authors want to send Figures in printed format, it is essential to supply good quality originals. Half-tone images must be of good contrast, and should be submitted in the final printing size. When mounting photographs in a block, ensure spacers are of uniform width. Remember that grouping photographs of varied contrast results in poor reproduction. Computer graphics must be printed on high quality white paper with a laser printer.

- Tables must be numbered with Roman numbers (I, II, III,…) and each typed on a separate sheet. Headings should be typed on a separate sheet, together with their English translation. Complex tables should be avoided. As a general rule, keep the number and extension of illustrations and tables as reduced as possible.
- Manuscripts that do not conform to these instructions will be returned for correction before reviewing.
- Authors submitting manuscripts will receive an acknowledgement of receipt, including receipt date, and the date the manuscript was sent for reviewing. Each manuscript will be critically evaluated by at least two referees. Based of these evaluations, the Editorial Board will decide on acceptance or rejection. Anyway, authors will receive a copy of the referees' comments. If a manuscript is accepted, the Editorial Board may indicate additional changes if desirable. Acceptable manuscripts will be returned to the author for consideration of comments and criticism; a finalized manuscript must then be returned to the Editor, together with a CD containing the article written with current Windows (but not a .docx format generated by Word 2007, mainly used under Windows Vista) or Macintosh word processor. Dates of reception and acceptance of the manuscript will appear in all published articles.
- Proofs will be e-mailed to the author for correcting errors and must be returned corrected within one week. At this stage no stylistic changes will be accepted. Pay special attention to references and their dates in the text and the Bibliography section, and also to numbers of Figures and Tables appearing in the text.
- Fifty reprints per article and a .pdf file will be supplied free of charge. Additional reprints must be ordered when the page proofs are returned, and will be charged at cost. NO LATER orders will be accepted.

LA SOCIEDAD ESPAÑOLA DE MALACOLOGÍA

La *Sociedad Española de Malacología* se fundó el 21 de agosto de 1980. La sociedad se registró como una asociación sin ánimo de lucro en Madrid (Registro Nº 4053) con unos estatutos que fueron aprobados el 12 de diciembre de 1980. Esta sociedad se constituye con el fin de fomentar y difundir los estudios malacológicos mediante reuniones y publicaciones. A esta sociedad puede pertenecer cualquier persona o institución interesada en el estudio de los moluscos.

SEDE SOCIAL: Museo Nacional de Ciencias Naturales, c/ José Gutierrez Abascal 2, 28006 Madrid, España.

CUOTAS PARA 2012:
DESDE ABRIL

Socio numerario	(en Europa):	40 euros	45 euros
	(fuera de Europa):	50 euros	55 euros
Cuota reducida estudiante		30 euros	34 euros
Socio Familiar:	(sin recepcion de revista)	5 euros	10 euros
Socio Protector:	(mínimo)	50 euros	60 euros
Socio Corporativo	(en Europa):	50 euros	60 euros
	(fuera de Europa):	60 euros	70 euros
Cuota Conjunta	SEM+SIM:	73 euros	78 euros

INSCRIPCIÓN: 6 euros, además de la cuota correspondiente.

A los socios residentes en España se les aconseja domiciliar su cuota. Todos los abonos deberán enviarse al Tesorero (dirección reseñada anteriormente) el 1 de enero de cada año. Los abonos se harán sin recargos para la sociedad y en favor de la *Sociedad Española de Malacología* y no de ninguna persona de la junta directiva. Aquellos socios que no abonen su cuota anual dejarán de recibir las publicaciones de la Sociedad. Los bonos de inscripción se enviarán junto con el abono de una cuota anual al Tesorero.

A los residentes en el extranjero se les ruega que abonen su cuota mediante giro postal en euros (international postal money orders in euros sent to the Treasurer). Members living in foreing countries can deduce 6 euros if paid before 15 April.

Cada socio tiene derecho a recibir anualmente los números de *Iberus, Reseñas Malacológicas* y *Noticiarios* que se publiquen.

Iberus 29 (2) 2011

RUBIO F., FÉRNÁNDEZ- GARCÉS, R. and ROLÁN E. The family Tornidae (Gastropoda, Rissooidea) in the Caribbean and neighboring areas.
La familia Tornidae (Gastropoda, Rissooidea) en el Caribe y áreas vecinas................................ 1-240

ISSN 0212-3010