

# The genera *Megalomphalus* and *Macromphalina* (Mollusca, Caenogastropoda, Vanikoridae) in the Caribbean area, with the description of thirteen new species

Los géneros *Megalomphalus* y *Macromphalina* (Mollusca, Caenogastropoda, Vanikoridae) en la región del Caribe, con la descripción de trece especies nuevas

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## ABSTRACT

Twenty-three species and some dubious forms of small vanikorids from the Caribbean region have been studied. Seven of these species belong to the genus *Megalomphalus*, six of which were previously known (*M. pilsbryi*, *M. oxychone*, *M. troudei*, *M. lamellosus*, *M. millerae*, and *M. caro*), and one is described as new. In addition, some dubious forms close to *M. pilsbryi* are also studied. A neotype for *M. oxychone* and a lectotype of *M. lamellosus* are designated. Sixteen of the species studied are considered belonging to the genus *Macromphalina*, two were previously known (*M. floridana* and *M. palmalitoris*), twelve are described as new, and the other two remain undescribed pending additional material. Two tables summarizing the more important differential features of the protoconch and teleoconch of all these species are provided, and some comments on their range of distribution are given.

## RESUMEN

Se estudian veintitrés especies y algunas formas dudosas de pequeños vanicóridos de la región caribeña. Siete de estas especies pertenecen al género *Megalomphalus*, seis de las cuales eran previamente conocidas (*M. pilsbryi*, *M. oxychone*, *M. troudei*, *M. lamellosa*, *M. millerae*, y *M. caro*), y una más es descrita como nueva. Además, son estudiadas algunas formas próximas *M. pilsbryi*. Se nombra un neotipo para *M. oxychone* y se designa el lectotipo de *M. lamellosus*. Diez y seis especies pertenecen al género *Macromphalina*, dos eran previamente conocidas (*M. floridana* y *M. palmalitoris*), doce son descritas como nuevas especies, y otras dos permanecen sin describir a la espera de material adicional. Se resumen en dos tablas los más importantes aspectos diferenciales de la concha y protoconcha de todas estas especies y se hacen algunos comentarios sobre sus áreas de distribución.

KEY WORDS: Vanikoridae, *Megalomphalus*, *Macromphalina*, Caribbean, new species.

PALABRAS CLAVE: Vanikoridae, *Megalomphalus*, *Macromphalina*, Caribbean, especies nuevas.

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## INTRODUCTION

Our study of the very small molluscs of the Caribbean began several years ago, based on radular and SEM studies. Nevertheless a lot of difficulties are present in these groups and many families and genera still await revision.

The family Vanikoridae Gray, 1840 had originally a single genus, *Vanikoro* Quoy and Gaimard, 1832. WARÉN AND BOUCHET (1988) revised and presented some generic studies on the Vanikoridae, referring to the original concept of the family by early taxonomists and paleontologists. They amplified the concept of this family including in it genera and species previously considered in Fossaridae (*Macromphalus*, *Megalomphalus* and *Talassia*). Later, RUBIO AND ROLÁN (1993) studying the West African species added the genus *Macromphalina*, usually considered close to Fossaridae, providing information on the protoconch, soft parts and radula. PONDER AND WARÉN (1988) established the family Vanikoroidea in which are included Hipponicidae and Vanikoridae, and which is located between Stromboidea and Calyptraeoidae.

A good understanding of this group has previously been made difficult by the very small size of most of the species and the lack of information on soft parts. Besides the original descriptions of the Caribbean species (cited below), there is information on the small Vanikoridae in the following: WARMKE AND ABBOTT (1961) cite one species of *Macromphalina*; ABBOTT (1974) mentions six species; DE JONG AND COOMANS (1988) only one species considering three taxa to be synonyms, and DÍAZ MERLANO AND PUYANA HEGEDUS (1994), two species in *Macromphalina* and one in *Vanikoro*. Some fossil species are known from areas close to the Caribbean Sea, as in DALL (1927), PILSBRY (1953) and GARDNER (1948).

*Megalomphalus* and *Macromphalina* are genera very well represented in the Caribbean area and they are in need of revision.

The collection of material from the "Expediciones Hispano-Cubanas" during the years 1984, 1988 and 1992, and the availability of supplementary material provided by individuals and institutions allowed a better study of the family in this area.

## MATERIAL AND METHODS.

A major part of the material employed in this study was collected from sediment samples obtained by diving or dredging during expeditions. Other material was loaned from museums or from some private collections. The origin of each sample of studied material is indicated, except where the material comes from the collection of E. Rolán (most material from south Cuba, ex-CFG).

The nucleus and the number of whorls of the protoconch were measured by the VERDUIN'S method (1976), in which the measurement begins after the nucleus.

The SEM photographs were made in a Philips XL30 Microscope in several institutions (mentioned in acknowledgements), with previous metalization of the samples. Some shells were cleaned in an Ultrasonic Bath GN 1/6, EN 631.

### Abbreviations:

- AMNH: American Museum of Natural History, New York.
- ANSP: Academy of Natural Sciences, Philadelphia.
- CER: collection of E. Rolán, Vigo.
- CFG: collection of R. Fernández Garcés, Cienfuegos.
- CFR: collection of F. Rubio, Valencia.
- CHL: collection of H. G. Lee, Jacksonville, Florida.
- CJB: collection of J. Boyle, Tobago.
- CRC: collection of C. Redfern, Boca Raton, Florida.
- DZUA: Departamento de Zoología, Universidad Autónoma, Madrid.
- FLMNH: Florida Museum of Natural History, Gainesville.

IES: Instituto de Ecología y Sistemática,  
La Habana.  
IIMC: Instituto de Investigaciones  
Marinas y Costeras, Santa Marta.  
MNCN: Museo Nacional de Ciencias  
Naturales, Madrid.

MNHN: Muséum National d'Histoire  
Naturelle, Paris.  
USNM: United States National  
Museum, Washington.  
ZMUC: Zoologisch Museum of the Uni-  
versity, Copenhagen.

## RESULTS

### Genus *Megalomphalus* Brusina, 1871

Type species: *Stomatia azonea* Brusina, 1864, by monotypy. Recent, Mediterranean. Shell and protoconch figured by WARÉN AND BOUCHET (1988).

*Diagnosis:* Shell small, with prominent apex, umbilicus open not very wide, a little keeled, with spiral sculp-

ture smaller than the axial, the latter being more prominent into the umbilicus. The radula lacks anterodorsal jaws.

### *Megalomphalus pilsbryi* Olsson and McGinty, 1958 (Figs. 1-5, 17, 105)

*Macromphalina pilsbryi* Olsson and McGinty, 1958. *Bull. Amer. Paleont.*, 39: p. 34, pl. 3, fig. 6. [Type locality: Bocas Is., Panama].

**Type material:** Holotype (ANSP 211898) and three paratypes, Bocas Is. Panama (ANSP 211899); 9 paratypes, Bocas Toro, East Colon I., Panama (FLMNH 160472);

**Other material examined:** Panama: 1 shell, Bocas Toro, East Colon I. (FLMNH 143892); 5 juveniles, (FLMNH 231549). Bahamas: Grand Bahama: 1 shell, 26° 31' 00" N, 78° 46' 30" W (ANSP 373983); Abaco: 1 shell, Whale Cay (CRC 800); 3 shells, Treasure Cove (CRC 801); 1 specimen, Roberts Boatyard (CRC 3847); 2 shells, Guana Cay (CRC 4718); 2 shells, Guana Cay (CRC 5062); 5 shells, Guana Cay (CRC 5500); 1 shell, Abaco beach drift (CRC 5744); 12 shells, Treasure Cove (CRC 5747); 2 shells, Guana Cay (CRC 7600); 15 shells, Chub Rocks (CRC 7671); 2 shells, Chub Rocks (CRC 7672); 2 shells, Chub Rocks (CRC 8343); 6 shells, Chub Rocks, (CRC 9910). Florida: 3 shells, Pompano Beach (AMNH); 1 shell, Missouri Key (ANSP 220670); 3 shells, Key West (ANSP 119205). Virgin Islands: 1 shell, Hams Bay, Saint Croix (AMNH); 3 shells, 2-3 m, White Bay, Guana I. (ANSP 338570). Grand Cayman I.: 1 shell, 7 m, Channel to Bluff Bay (ANSP 200077). Lesser Antilles: 4 shells, Antigua (AMNH); 1 shell, Barbuda (AMNH). Bermuda: 4 shells, (AMNH); 43 shells, Gibbons Bay (CHL). Mexico: 4 shells, 12 m, Puerto Morelos, Quintana Roo. Cuba: 1 shell, Cayo Matías, Los Canarreos (DZUA); 3 shells, 40 m, Punta Francés, Juventud I.; 6 shells (CFG) and 5 shells, 25-20 m, Rancho Luna, Cienfuegos; 2 shells, 30 m, La Habana. Nicaragua: 1 shell, 8 m, Cayo Witties; 2 shells, 5 m, Cayo Edinburg.

*Description:* OLSSON AND MCGINTY (1958) described the holotype, a shell 2.7 mm in height and 2.8 mm in diameter (Figs. 1, 2).

The protoconch of this species was mentioned in the original description on the basis of the protoconch of the holotype, which is polished. Also two whorls are mentioned, but by the VERDUIN (1976) method there is really only a little more than one whorl after the nucleus. The protoconch of the

holotype was examined under magnification and we can not find differences in characters from those of the Bahamian material, except for the fact that the nucleus of the holotype is smooth from erosion. Therefore, the protoconch of this species must be redescribed, adding the following information after the study of shells with white protoconchs: the protoconch of the holotype has a nucleus with a diameter of 0.124 mm. The shells studied from the Bahamas

(Fig. 4) have a nucleus measuring between 0.109 and 0.130 mm, and with only  $1 \frac{1}{8}$  subsequent whorls; the nucleus and a  $\frac{1}{4}$  of the subsequent whorl are sculptured very irregularly with excavations and some transverse irregular elevations; these are followed by 5-6 strong spiral cords; the two upper ones being more irregular, with their borders minutely denticulate (Fig. 5). The colour of the protoconch is white in the holotype, and also in the rest of the shells included in this taxon. In the material from Mexico, the protoconch (Fig. 17) has a nucleus a little bigger and more similar to those which will be included in the following group as *M. cf. pilsbryi*. In the Bermuda shells, the nucleus is scarcely roughened and the space between the cords shows small axial threads. When the present work was almost finished we had the opportunity to study shells from Panama (type locality), which showed a white protoconch with similar sculpture (Fig. 105).

The teleoconch begins with axial ribs numbering between 30 and 42 on the first whorl (40 on the holotype), and about 60 on the body whorl of shells with  $1 \frac{1}{2}$  whorls. When the shell is big, it can reach  $3 \frac{1}{2}$  whorls; in that case, the number of the axial ribs is very high, because they are smaller and very close. At the beginning of the teleoconch it is very difficult to see the spiral sculpture

in the interspaces, but later it can be seen as very small discontinuous lines formed by tubercles. Only after the first whorl of the teleoconch the spiral lines are more clearly defined.

*Dimensions:* Small shells are about 2.5-3.0 mm in diameter. An exceptionally large shell collected in Cuba measured 6.3 x 5.5 mm (Fig. 3), differing a little in appearance from the small specimens.

*Distribution:* Apparently this species is distributed throughout the Caribbean, from a few meters down to 50 m.

*Remarks:* All material included here has a white protoconch.

The material studied is perfectly compatible with the description and appearance of the holotype. The shells with white protoconchs similar to that of the holotype were found in many places in the Caribbean. Some variations in the protoconch characters are not sufficiently important to separate them into different species.

Small shells of *Megalomphalus margaritae* spec. nov. (see below) (Fig. 33) can be confused with *M. pilsbryi*, but in both species the protoconch has a very different microsculpture (Figs. 4, 35).

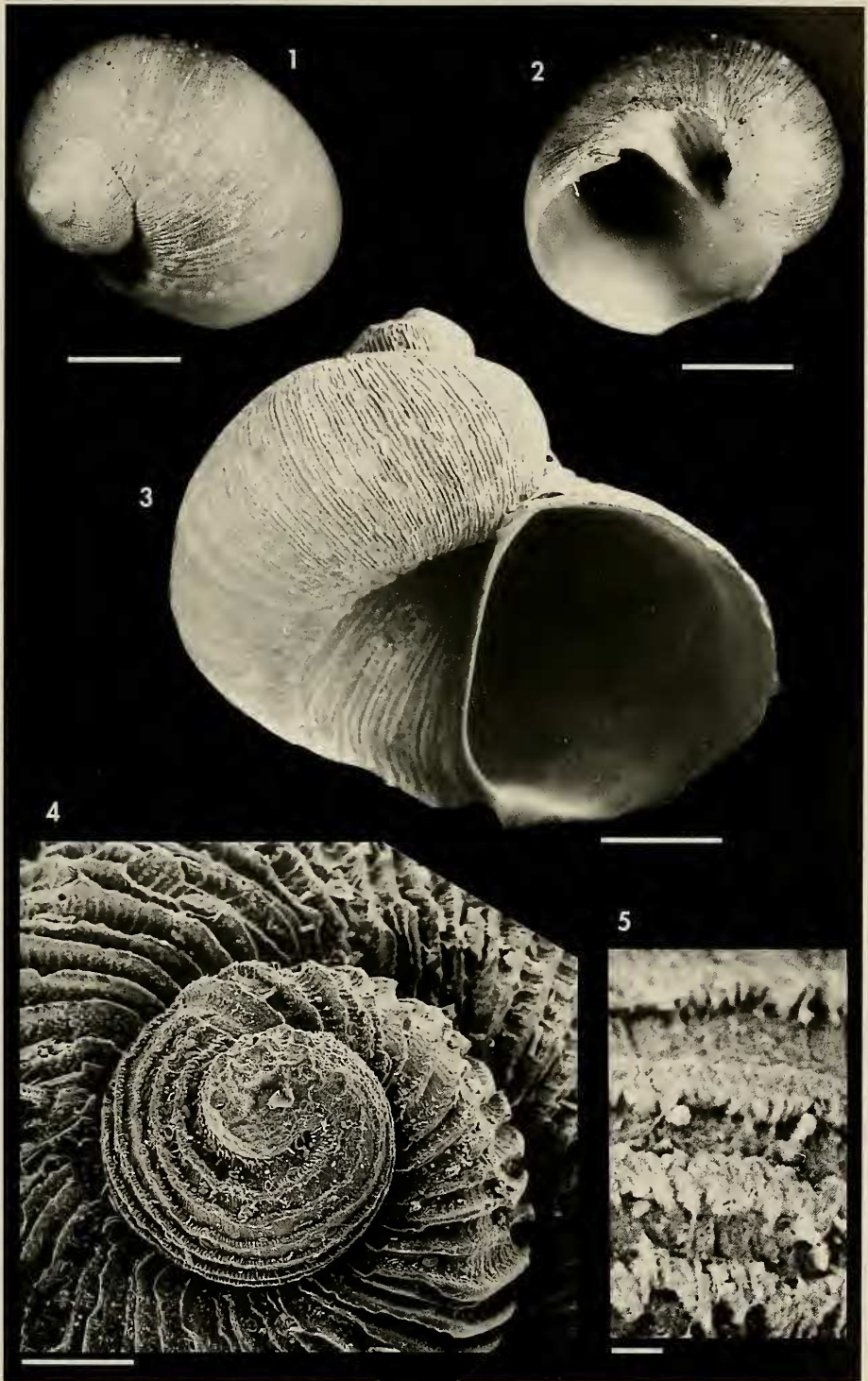
Most of the shells studied are small, but are presumed to be adult. The occurrence of the very large shell shown in Fig. 3 is therefore problematic, unless it represents an uncommon giant form of this species.

### *Megalomphalus cf. pilsbryi* Olsson and McGinty, 1958 (Figs. 6-15, 108)

**Material examined** (the colour mentioned refers to that of the protoconch): **Bahamas:** Grand Bahama: 1 specimen (brown), North Riding Point (ANSP 371504); 1 shell (cream) "Garbage Hole", Eight Mile Rock (ANSP 370377); 17 shells (2 cream, with the rest brown), 26° 31' 00" N, 78° 46' 30" W (ANSP 373983); 1 shell (brown), Caravel Beach (John Jack Point), Freeport (ANSP 375416); 18 shells (brown), Dead Man's Reef (Sandy Beran's Cay) (ANSP 371113); 2 shells (ANSP 368054), Lucaya; 1 shell, Lucaya, (ANSP 372463); 3 shells (1 cream, 2 brown), Indian Cay (ANSP

(Right page). Figures 1-5. *Megalomphalus pilsbryi*. 1, 2: holotype (ANSP); 3: big shell, Cayo Matías, Los Canarreos, Cuba; 4: protoconch, Abaco, Bahamas (CRC); 5: microsculpture, Abaco, Bahamas. Scale bar, shells: 1.00 mm; protoconch: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 1-5. *Megalomphalus pilsbryi*. 1, 2: holotipo (ANSP); 3: gran concha, Cayo Matías, Los Canarreos, Cuba; 4: protoconcha, Abaco, Bahamas (CRC); 5: microescultura, Abaco, Bahamas. Escala, conchas: 1,00 mm; protoconcha: 0,1 mm; microescultura: 0,01 mm.



367106); 3 shells (1 brown, 2 cream), Indian Cay (ANSP 367064). Abaco: 1 specimen (brown), Treasure Cay (CRC 3326); 1 specimen (brown), Joe's Creek (CRC 3594); 1 shell (cream), Guana Cay (CRC 5062); 2 shells (brown), Treasure Cove (CRC 5747); 1 shell (brown), Treasure Cove (CRC 5748); 1 shell (brown), Treasure Cove (CRC 5749); 5 shells (1 cream, the rest brown), Treasure Cove (CRC 5751); 5 shell (brown), Treasure Cove (CRC 5752); 1 shell (cream), Treasure Cove (CRC 5753); 6 shells (brown), Treasure Cove (CRC 5754); 3 shells (brown), Treasure Cove (CRC 5755); 3 shells (brown), Treasure Cove (CRC 5756); 2 shells (brown), Treasure Cove (CRC 5757); 23 shells (brown), Abaco beach drift (CRC 5758); 3 shells (1 cream, 2 brown), Abaco beach drift (CRC 7599); 1 shell (cream), Chub Rocks (CRC 7670); 7 shells (cream), Chub Rocks (CRC 7671); 2 shells (cream or light brown), Chub Rocks (CRC 7671); 2 shells (cream), Chub Rocks (CRC 8343). Cuba (all with cream protoconch): 9 shells, 56 m, Faro de los Colorados, Cienfuegos; 1 shell, Cienfuegos Bay; 3 shells, 50 m, Punta Tamarindo; 11 shells, 15-20 m, Rancho Luna (CFG), Cienfuegos; 4 shells, Cayo Ávalos, Los Canarreos; 8 shells, 20 m, Cayo Matías, Los Canarreos; 1 shell, Cayo Diego Pérez, Los Canarreos (DZUA); 2 shells, 40 m, between Punta Francés y Los Indios, Isla de la Juventud; 1 shell, Cayería Norte; 4 shells, Jibacoa, La Habana.

*Description:* The shell is quite similar to that of *M. pilsbryi*, but more variable. In fact, the external appearance of the shell is very different when young or small (Figs. 13, 14), being relatively higher and more erect than when it is larger (Figs. 6, 7). In the latter case, the last whorl is very extended, giving the impression of a more depressed shell. Also there are differences between the shells from Cuba, usually smaller (Figs. 13, 14), and those from the Bahamas, usually bigger (Figs. 6, 7).

The protoconch (Figs. 8-12) is more variable than usual and consists of about  $1 \frac{1}{8}$  whorls, with the apex sometimes appearing pointed and sometimes not so. It can be dark brown in colour, sometimes light and sometimes only cream. The diameter of the nucleus ranges from 0.120 to 0.155 mm. The sculpture may be irregular and usually slightly elevated (Figs. 9, 12), but is sometimes a little more prominent. Usually after the nucleus, there is an area of less than a half whorl with the same sculpture, after which the spiral cords either begin immediately or sometimes follow a small area that lacks sculpture (Figs. 10, 11). The two upper cords are a little undulating and irregular, sometimes appearing zigzagged; all the

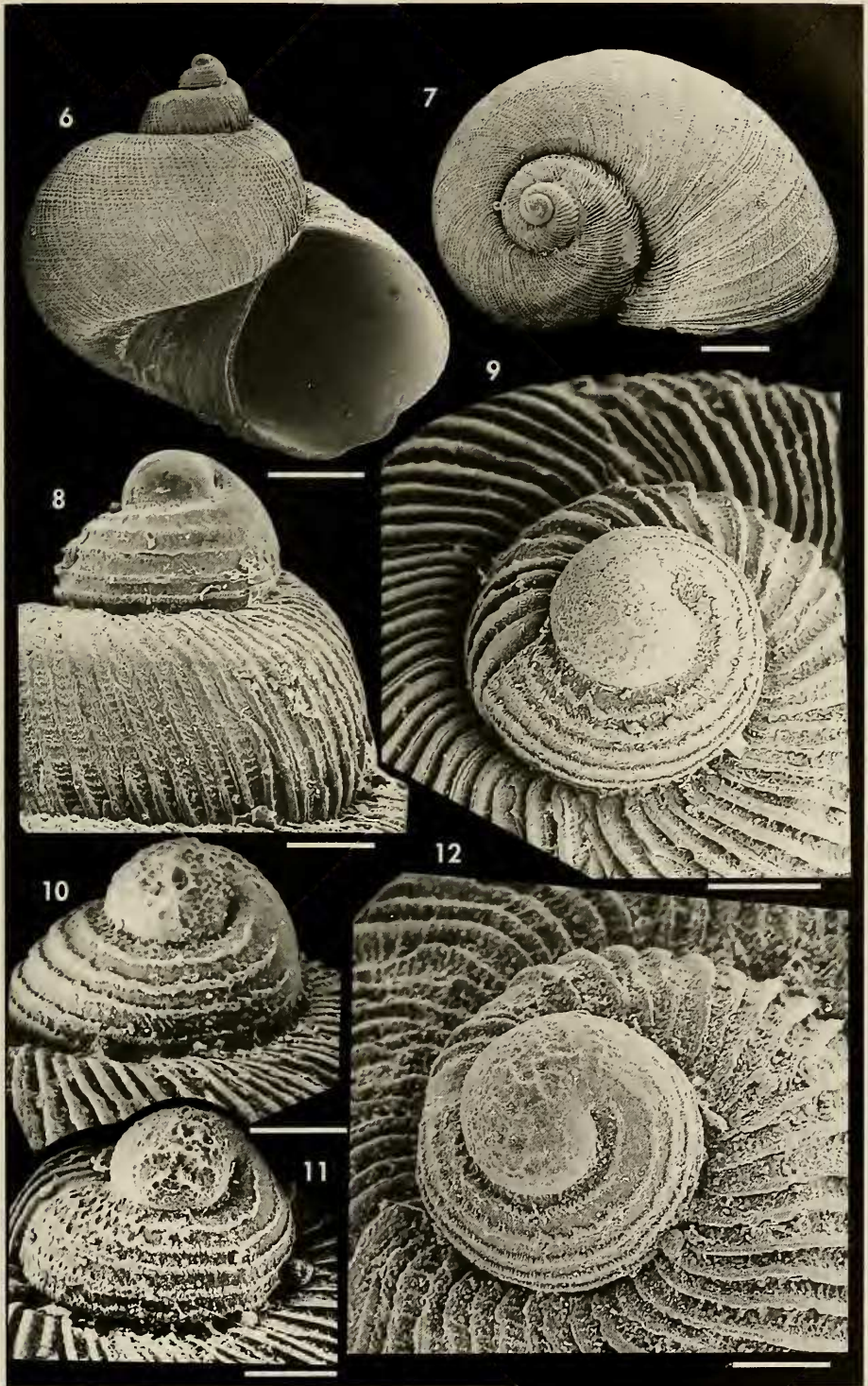
cords have very small transverse lines giving the appearance of denticulation at the border. The relationship between the diameter of the nucleus and the size of the protoconch is variable. The colour varies from light brown to cream, becoming faded in beached shells. There is no connection between the colour of the protoconch and either the kind of sculpture or size of nucleus.

Aperture rounded, more attenuated towards the inner lip, which is almost vertical and is separated from the last whorl except for a small area of contact. The umbilicus is deep, and it is demarcated by a prominent keel outside of which, on small shells, there is a depression that is bordered by another more attenuated keel. The axial ribs cross the keels and continue very clearly into the umbilicus. The colour of the shell is milk-white.

The radula (studied in the specimens ANSP 371504 and 370377, and also from CRC 3326) is very characteristic (Fig. 108). The rachidian tooth has very wide basal supports, and lacks denticles; the sharp border has pointed, irregularly alternating denticles of different size. The central one is larger and prominent. Lateral teeth with wide sharp border

(Right page). Figures 6-12. *Megalomphalus cf. pilsbryi*. 6, 7: shells with brown protoconch, Bahamas (CRC); 8, 9: brown protoconch, Bahamas (CER); 10-12: cream protoconch, Cienfuegos, Cuba. Scale bar, shells: 0.5 mm; protoconchs: 0.1 mm.

(Página derecha). Figuras 6-12. *Megalomphalus cf. pilsbryi*. 6, 7: conchas con protoconcha marrón, Bahamas (CRC); 8, 9: protoconcha marrón, Bahamas (CER); 10-12: protoconcha crema, Cienfuegos, Cuba. Escala, conchas: 0,5 mm; protoconchas: 0,1 mm.



where, as with the central tooth, there are alternating denticles of different size. The internal marginal teeth are elongated and robust, strongly curved towards the external part in their upper third, with a prominent cusp and with several smaller denticles on each side. The external marginal teeth are oar-shaped, curved at their upper third and apparently smooth at the inner and outer margins.

The presence of anterodorsal jaws has not been observed.

The operculum (Fig. 15), studied in a specimen with brown protoconch, is slightly yellowish, translucent, with the nucleus eccentric.

*Dimensions:* Usually, shells from the Bahamas reach 4 mm in diameter. Elsewhere, they are smaller than 3 mm.

*Distribution:* Due to the uncertainty as to whether this is a single species or a group of species, it is not possible to discuss the range of distribution. Usually between 10-60 m.

*Remarks:* The lack of anterodorsal jaws in the radula, as well as the shell morphology, confirm the inclusion of these forms in *Megalomphalus*.

The shells collected in the Bahamas had given us the first impression of being the same species as those from Cuba, with all appearing similar to the holotype of *M. pilsbryi*. After a detailed study we found many differences, not only in the shell but especially in the protoconch. Finally, we decided that the shells with white proto-

conchs are exactly like that of the holotype, while the rest were separated in this study as *M. cf. pilsbryi*.

The specimens from Cuba, considered here under *M. cf. pilsbryi*, have very constant protoconch characters (Figs. 10, 11); on the other hand, the Bahamas shells, also considered here under *M. cf. pilsbryi*, have more variable protoconch characters that are usually somewhat different from the Cuban ones (nucleus less rough and bigger diameter). In view of this variability, it is possible that these forms belong to a complex of species, but it was not possible to separate them at this time, since most of the material studied consisted only of empty shells, and most of them had eroded protoconchs. Future research may resolve our doubts, but meanwhile we are considering all shells in this group to belong to a taxon close to *M. pilsbryi*.

The radula shown by WARÉN AND BOUCHET (1988, figs. 16, 17) for *Megalomphalus disciformis* (Grillo in Tiberi, 1877) is not similar to that of *M. cf. pilsbryi* (Fig. 108), but instead is similar to that of *Macromphalina palmalitoris* Pilsbry and McGinty, 1950 (Figs. 109-111) and *M. worsfoldi* spec. nov. (Fig. 112). We think that it is probable that some species considered by these authors within *Megalomphalus* (*M. disciformis* and *M. depressus*) really belong to *Macromphalina*. In this case, the radula here represented for *Megalomphalus* would be the first one known for this genus.

### *Megalomphalus oxychone* (Mörch, 1877) (Figs. 18-23)

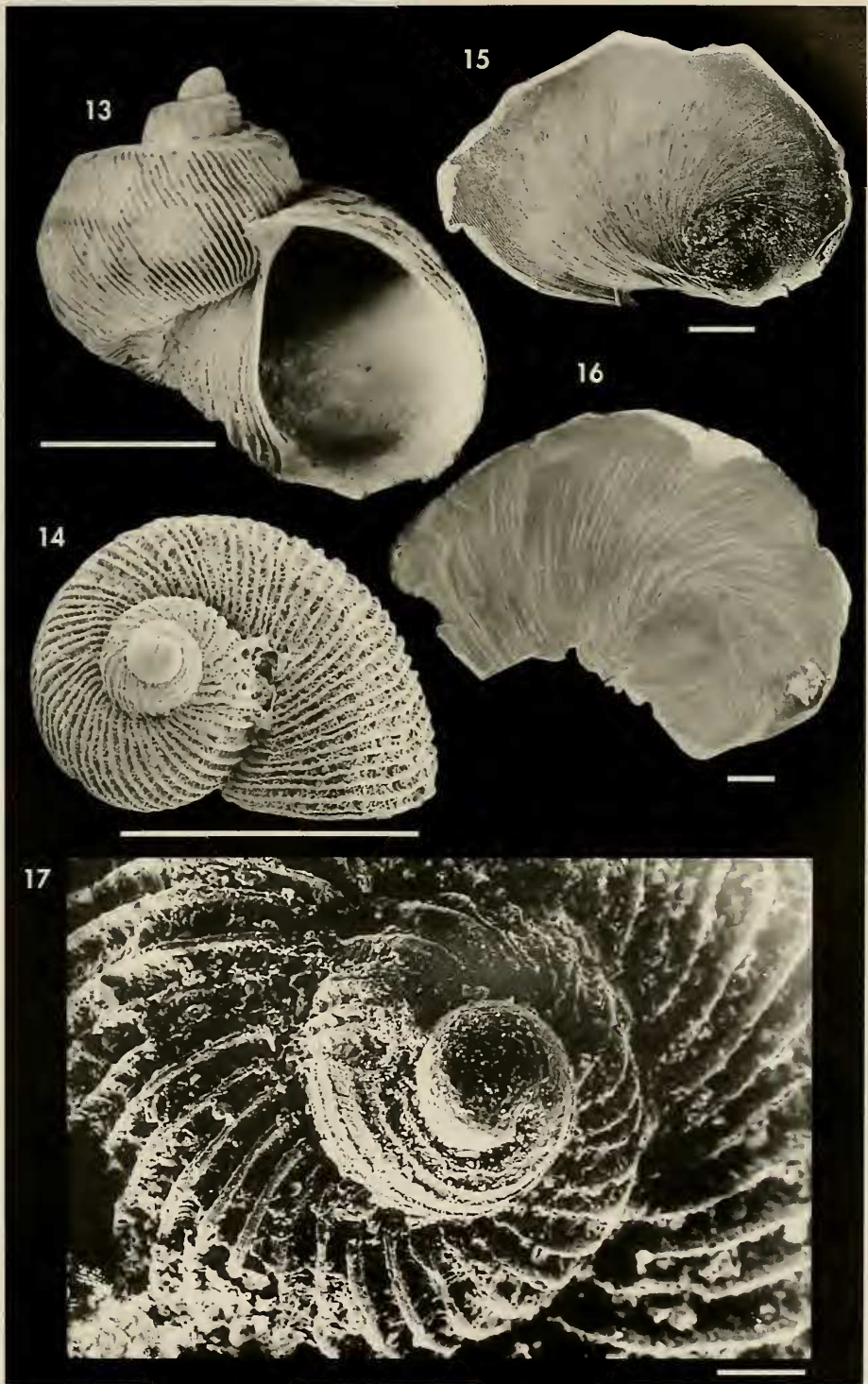
*Vanikoro oxychone* Mörch, 1877. *Malak. Blätt*, 24: 94. [Type locality: unknown].

**Type material:** Neotype (Fig. 19), here designated, of 2.08 in height x 1.95 mm in width, from Cienfuegos, Cuba, deposited in MNCN (15.05/24888).

(Right page). Figures 13-15. *Megalomphalus cf. pilsbryi*. 13, 14: shells with cream protoconch, Los Canarreos, Cuba; 15: operculum, Abaco, Bahamas (CRC). Figure 16. Operculum of *M. worsfoldi* spec. nov., Grand Bahama (ANSP 371115). Figure 17. *M. pilsbryi*, protoconch, Puerto Morelos, México (CER). Scale bar, shell: 1.00 mm; operculum: 0.5 mm; protoconch: 0.1 mm.

(Página derecha). Figuras 13-15. *Megalomphalus cf. pilsbryi*. 13, 14: conchas con protoconcha crema, Los Canarreos, Cuba; 15: opérculo, Abaco, Bahamas (CRC). Figura 16. Opérculo de *M. worsfoldi* spec. nov., Grand Bahama (ANSP 371115). Figura 17. *M. pilsbryi*, protoconcha, Puerto Morelos, México (CER). Escala, concha: 1,00 mm; opérculo: 0,5 mm; protoconcha: 0,1 mm.





**Other material examined:** Cuba: 2 shells, at 56 m, Faro de los Colorados; 4 shells, at 50 m, Punta Tamarindo, Cienfuegos; 25 shells, in the middle of the Cienfuegos Bay; 2 shells, 15-30 m, Rancho Luna (CFG); 5 shells, Jibacoa, La Habana; 1 shell, Cayo Matías, (DZUA). Virgin Islands: 1 shell, Hams Bay, Saint Croix (AMNH). Bahamas: Abaco: 1 shell, (CRC 4202).

**Type locality:** There is not any type locality in the original description. The mention in MÖRCH (1877) of "Hab. St. Thomas", is in reference to the taxon *Narica acuta* Recluz, supposed by the author to be a synonym, but as these two taxa are not the same species, we must consider that there is not any original type locality. Cienfuegos is the locality where the neotype was collected.

*Description:* Shell (Figs. 18-20) globose, white, with a projecting apex.

Protoconch (Fig. 21, 22) with  $1\frac{1}{3}$  to  $1\frac{1}{2}$  whorls. It begins with a nucleus with a diameter of 0.082 to 0.096 mm. On the nucleus and on a little more than the subsequent  $\frac{1}{2}$  whorl, the sculpture is formed by different small and irregular excavations; it continues with five spiral elevated cords, which are densely sculptured with very small irregular axial lines, like a saw (Fig. 23). These lines are intercalated between the cords, and do not usually reach from one cord to another. The colour of the protoconch is consistently dark brown.

Teleoconch with  $1\frac{1}{2}$  to 2 whorls, exceptionally big shells can have 3; its surface has well defined and slightly oblique ribs, numbering between 25 and 34 on the first whorl and about 80 or more on the last one, where they are very close. Bigger shells can have 100 or more. Very fine spiral sculpture is visible in the interspaces. A peripheral keel is present on the first whorls, forming a subsutural angle. The shell is milk-white, contrasting with the brown colour of the protoconch.

Aperture rounded, more attenuated towards the inner lip, which is almost vertical and has a short contact with the last whorl. There is a deep umbilicus, demarcated by two prominent keels. The axial ribs cross the keels and are present in the umbilicus.

*Dimensions:* Our biggest shell was 2.8 mm in height and 2.6 mm in width.

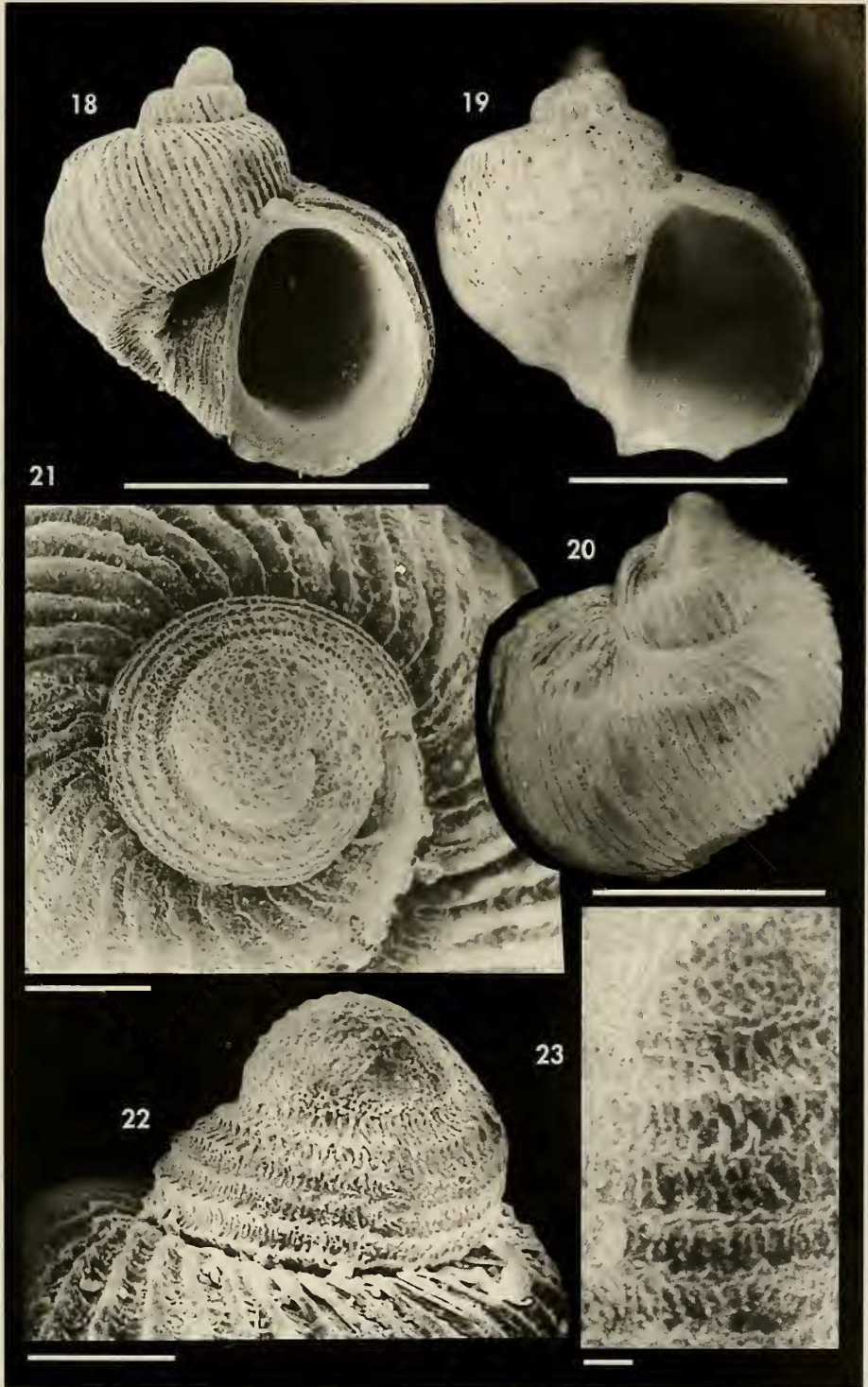
*Distribution:* Most of the material studied is from Cuba, but isolated shells were collected from nearby areas.

*Remarks:* The description of *Vanikoro oxychone* Mörch is too short and there are insufficient details to be sure to which species of this complex Caribbean group with similar shells it refers. The type must be considered lost, as indicated by the information received by DE JONG AND COOMANS (1988) from the ZMUC. Information from BMNH indicates that it is not there. The species is represented in VERRILL AND BUSH (1900), but only by two small drawings, without details or description; anyway the spiral keel close to the umbilicus and the peripheral angle are represented, but the protoconch is not indicated as being dark, possibly because it was lost or because it is decolorated. DE JONG AND COOMANS (1988) mentioned the name of this species and included a description, but the figures in their plate 13 are not this species, but probably *M. troudei* Bavay, 1908. *Vanikoro oxychone* Mörch figured in VOKES AND VOKES (1983, pl. 28, fig. 4) is not this species.

For nomenclatural stability, due to the similarity with *M. pilsbryi*, it was necessary to designate a neotype, which was selected from the material from Cuba.

(Right page). Figures 18-23. *Megalomphalus oxychone*. 18: shell from Cienfuegos, Cuba (CER); 19: neotype, Cienfuegos, Cuba (MNCN); 20: shell from Cienfuegos, Cuba (CER); 21, 22: protoconchs, Cuba; 23: microsculpture of the protoconch. Scale bar, shells: 1.00 mm; protoconchs: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 18-23. *Megalomphalus oxychone*. 18: concha de Cienfuegos, Cuba (CER); 19: neotipo, Cienfuegos, Cuba (MNCN); 20: concha de Cienfuegos, Cuba (CER); 21, 22: protoconchas, Cuba; 23: microescultura de la protoconcha. Escala, conchas: 1,00 mm; protoconchas: 0,1 mm; microescultura: 0,01 mm.



Protoconch characters separate *M. oxychone* from *M. pilsbryi*: *M. oxychone* has a consistently dark brown protoconch, in contrast to the white colour of *M. pilsbryi* (or even to the cream to light brown of most of the shells of *M. cf.*

*pilsbryi* previously mentioned). The nucleus of the protoconch of *M. oxychone* is smaller, with finer but more extensive sculpture; the spiral cords are not as smooth, and the protoconch is larger by almost a half whorl.

*Megalomphalus troudei* (Bavay, 1908) (Figs. 24-27)

*Stenotis troudei* Bavay, (1907) 1908. *Journal of Conchylologie*, 60 (4): 342-343, figs. 1-3. [Type locality: La Pointe-à-Pitre, Guadeloupe].

**Type material:** Holotype, of 2.34 in height x 2.78 mm in width, from Guadeloupe, in MNHN.

**Other material examined:** Bahamas: Grand Bahama: 1 shell, Gold Rock (ANSP 369322); 1 shell, Gold Rock (ANSP 369501); 1 shell, Tamarind (ANSP 368276); 1 shell, Tamarind (ANSP 368319); 6 shells, Dead Man's Reef (Sandy Beran's Cay) (ANSP 371116); 3 shells, Dead Man's Reef (373982, ANSP); 1 shell, Indian Cay (ANSP 367021); 1 shell, Lucaya (372462, ANSP). Abaco: 1 shell, Chub Rocks (CRC 3848); 1 shell, Chub Rocks (CRC 4860); 7 shells, Guana Cay (CRC 5501); 1 fragment, Guana Cay (CRC 7598); 5 shells, Chub Rocks (CRC 7667); 1 shell, Chub Rocks (CRC 7668); 1 shell, Chub Rocks (CRC 7669); 1 shell, Chub Rocks (CRC 8344); 1 shell, Chub Rocks (CRC 9911); 2 shells, Chub Rocks (CRC 9912). Berry Is.: 1 shell, West End Beach, Chub Cay (ANSP 324292). Cuba: 1 shell, Cayería norte, near Varadero.

**Description:** See BAVAY (1908). Shell (Fig. 24) rounded, conoid and fragile.

Protoconch (Figs. 25, 26) elevated. The nucleus has a diameter of 0.100 mm; subsequently there are 1 <sup>1</sup>/<sub>4</sub> whorls, sculptured with seven spiral cords, which are narrow and somewhat irregular; they begin on the nucleus and continue uninterrupted until the end of the protoconch. The colour is light brown, sometimes faded.

The teleoconch begins with flat cords with very narrow intervals (Fig. 27). The shell is white and the protoconch white or slightly cream. The axial and spiral sculpture is very attenuated on the body whorl of larger shells.

**Dimensions:** From 2 to 3 mm in diameter.

**Distribution:** The species was described from Guadeloupe Island. The specimens examined here are limited to the

Bahama Islands, except one shell collected in the north of Cuba.

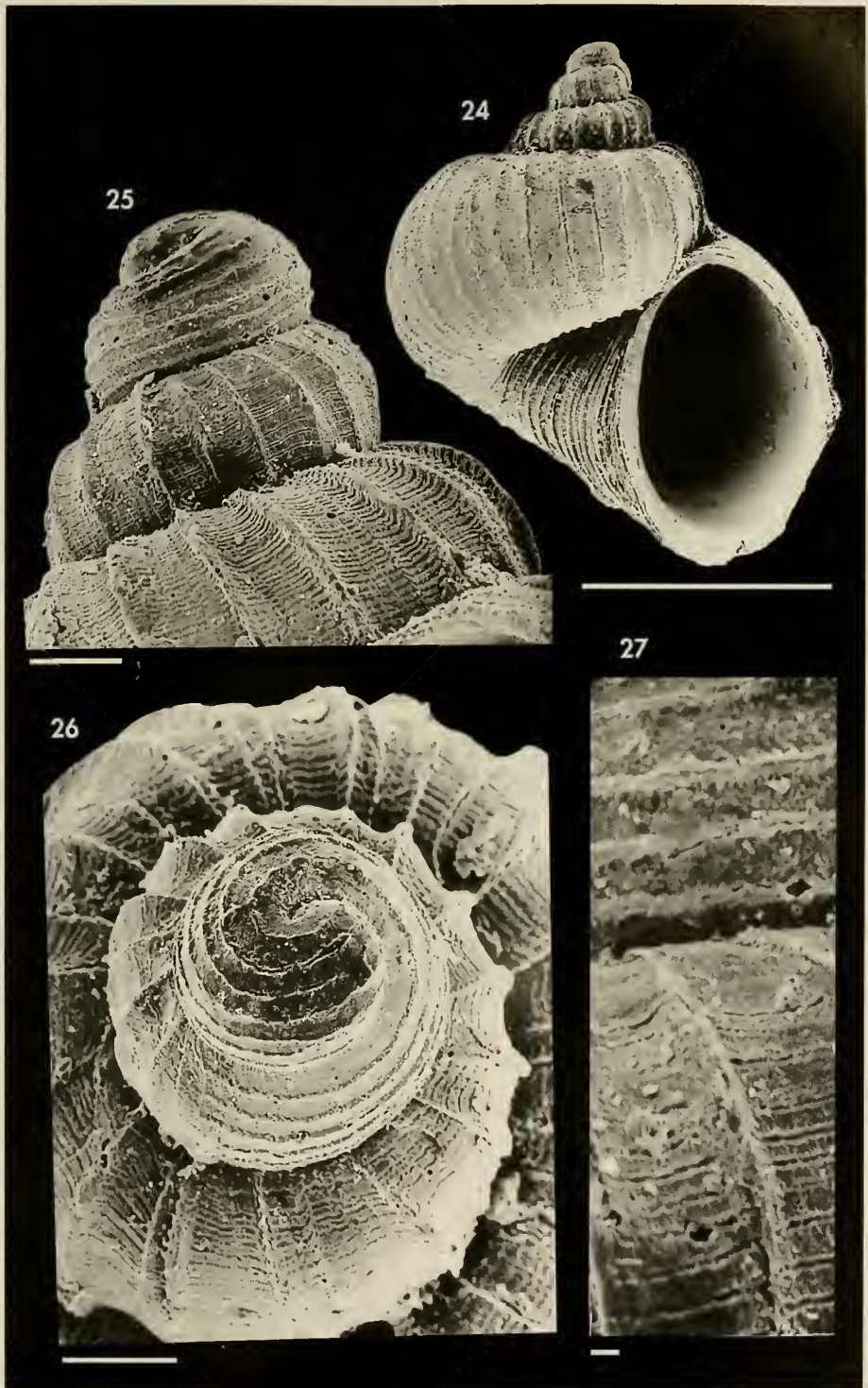
**Remarks:** This species was kept in the genus *Megalomphalus* because of its elevated profile, although it lacks the periumbilical keel.

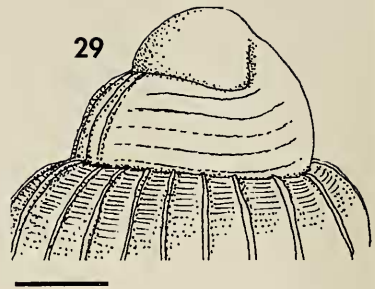
We have had some doubts about the relation of the type species described from Guadeloupe Is. and the population studied from Bahamas, considering the distance separating these locations. The type was examined and it has an external form similar to that of the shells from the Bahamas, but the shell and its protoconch are a little eroded, though it seems to have fewer and finer spiral cords than in the Bahamas population. So, some doubts remain, and only by studying material from the type locality could it be decided if they are conspecific or not.

The profile of the shell is very different from the species of *Macromphalina* in

(Right page). Figures 24-27. *Megalomphalus troudei*. 24: shell, Bahamas (CRC); 25, 26: protoconchs; 27: microsculpture of the protoconch. Scale bar, shell: 1.00 mm; protoconchs: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 24-27. *Megalomphalus troudei*. 24: concha, Bahamas (CRC); 25, 26: protoconchas; 27: microescultura de la protoconcha. Escala, concha: 1,00 mm; protoconchas: 0,1 mm; microescultura: 0,01 mm.





Figures 28, 29. *Megalomphalus lamellosus*. 28: holotype (BMNH), Cuba; 29: drawing of the protoconch of the holotype. Scale bar, shell: 1.00 mm; protoconch: 0.1 mm.

*Figuras 28, 29. Megalomphalus lamellosus*. 28: *holotipo* (BMNH), Cuba; 29: *dibujo de la protoconcha del holotipo*. Escala, concha: 1,00 mm; protoconcha: 0,1 mm.

the studied area. It can be differentiated from the more elevated shells of *Megalomphalus* by the lack of an umbilical keel.

The only shell collected in Cuba has a similar protoconch but a slightly different shell, with a more expanded body whorl.

### *Megalomphalus lamellosus* (d'Orbigny, 1842) (Figs. 28, 29)

*Narica lamellosa* D'Orbigny in Sagres, 1842. *Hist. Natur. de l'île de Cuba*. Moll. 2, p. 41, t. 17, figs. 32-34. [Type locality: Cuba].

**Type material:** Lectotype (Fig. 28), here designated, and 4 paralectotypes, Cuba (BMNH 1854.10.4.233).

*Description:* The original description of the species is too short and without differentiating details, so additional information is given here.

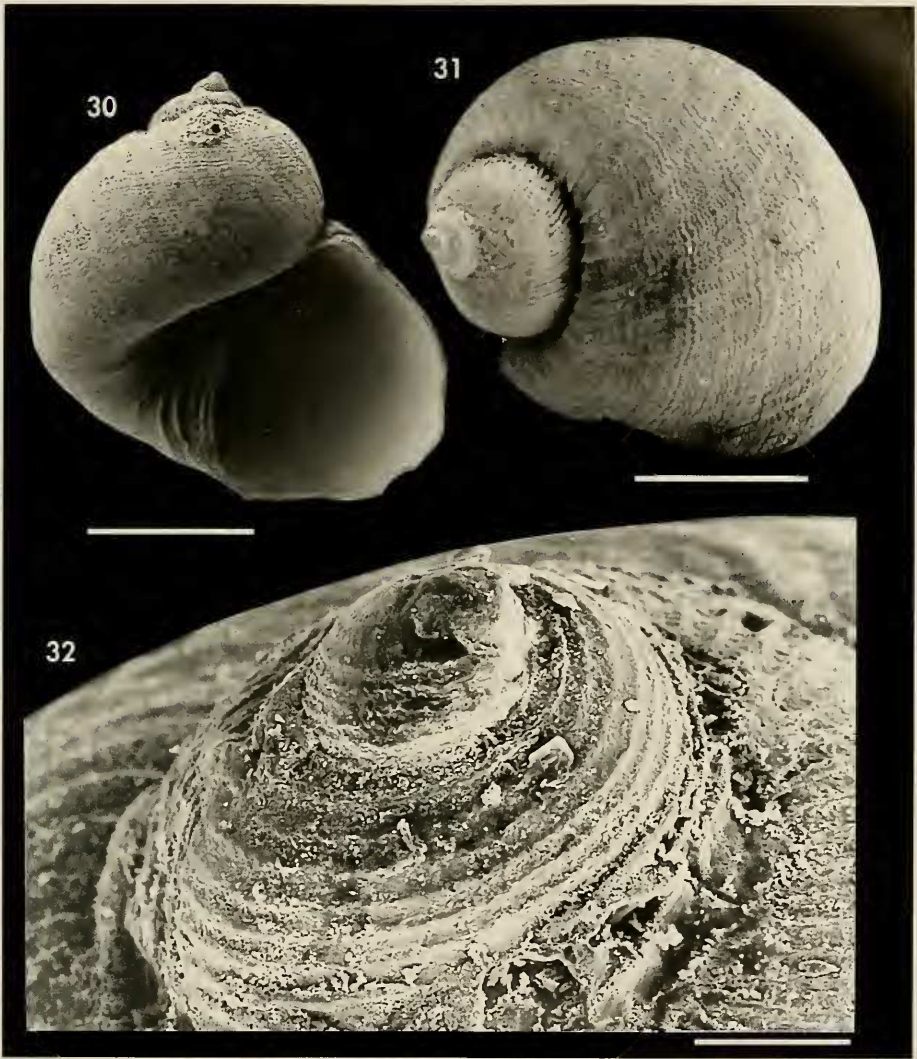
Shell (Fig. 28) globose, white, striated, with the apex a little elevated.

Protoconch (Fig. 29) of only one whorl. It was examined directly at SEM without metalization and the following could be observed: the nucleus has 0.120 mm in diameter; the nucleus and the adjacent area are smooth (or polished); subsequently, on the last half whorl of the protoconch, there are 5 narrow, slightly elevated threads, without any other sculpture. Axial ribs are clearly

defined at the beginning of the teleoconch, which has 2 1/2 whorls. On the first whorl there are 19 ribs, with very fine spiral striations crossing the ribs but more evident in the interspaces.

*Distribution:* The species was described from Cuba. There is no other information on its range of distribution.

*Remarks:* The lot sent by the BMNH was labeled as "syntypes", but only one of them has the dimensions indicated in the description; for this reason, we have designated as lectotype the biggest of the syntypes, which measures 2 mm in width, and is very similar to d'Orbigny's figure.



Figures 30-32. *Megalomphalus millerae*. 30, 31: shells, paratypes (AMNH), St. Croix, Virgin Islands; 32: protoconch. Scale bar, shells: 1.0 mm; protoconch: 0.1 mm.

*Figuras 30-32. Megalomphalus millerae. 30, 31: conchas, paratipos (AMNH), St. Croix, Virgin Islands; 32: protoconcha. Escala, conchas: 1,0 mm; protoconcha: 0,1 mm.*

The species with the most similar shell seems to be *Macromphalina redferni* spec. nov. described below, but on this last species the spiral cords of the protoconch are more numerous and irregular; other species with spiral cords on the protoconch differ for other reasons: very strong, with additional sculpture, in

*Megalomphalus pilsbryi* and *M. oxychone*; and continuing onto the nucleus in *Megalomphalus troudei*, *Macromphalina worsfoldi* spec. nov., and *M. canarreos* spec. nov.; *Megalomphalus millerae* has the nucleus smaller and prominent.

It is surprising that no specimen of *M. lamellosus* was found when we were

collecting in Cuba. In view of the probable lecithotrophic development of this species, it may be that *M. lamellosus* lives

in only a small area. Another possibility is that this species was incorrectly recorded from the Caribbean.

*Megalomphalus millerae* (Nowell-Usticke, 1959) (Figs. 30-32)

*Vanikoro millerae* Nowell-Usticke, 1959. *A check list of the marine shells of St. Croix*, p. 48, pl. 3, fig. 3. [Type locality: Ham Bay, St. Croix, Virgin Islands].

**Type material:** Holotype (AMNH 195423) and many paratypes (AMNH 192805) (Nowell-Usticke coll.), Virgin Islands.

*Description:* See NOWELL-USTICKE (1959). Shell (Figs. 30, 31) globose, white, with the apex a little prominent.

The protoconch of the holotype has the nucleus eroded, but one paratype was found to have a protoconch with a very prominent, smooth nucleus of about 0.1 mm in diameter; there are 7 small spiral cords on the remainder of the protoconch, which has a total of 1  $\frac{1}{4}$  whorls. A photograph was taken of another paratype (Fig. 32), that had a broken apex and showed 8 spiral cords continuing to the beginning of the teleoconch.

The teleoconch can reach 2  $\frac{1}{2}$  whorls and up to 40 axial ribs are present on the first whorls, with very fine spiral striations. Later the axial ribs almost disappear, being visible only in the umbilicus and in the suture, with the spiral striations more evident.

*Dimensions:* Maximum diameter of the holotype is 4.5 mm, and some paratypes reach 5.5 mm.

*Distribution:* The species is only known from the Nowell-Usticke material of Saint Croix, Virgin Islands.

*Remarks:* No other species shows these characters in shell and protoconch.

*Megalomphalus caro* Dall, 1927 (Figs. 106, 107)

*Megalomphalus caro* Dall, 1927. *Proceedings of U. S. National Museum*, 70, art. 18: 120 [Type locality: off Fernandina, Florida].

**Type material:** Holotype (USNM 108103) (Figs. 106, 107). Examined only in SEM photography (sent by T. Nickens of USNM).

**Other material examined:** Only known from the holotype.

*Description:* See DALL (1927).

*Dimensions:* Maximum diameter of the holotype, 1.2 mm.

*Distribution:* The species is only known from the type locality, in the

limit of the area of this study. Deep water.

*Remarks:* The holotype is a fragile shell with three peripheral spiral threads.

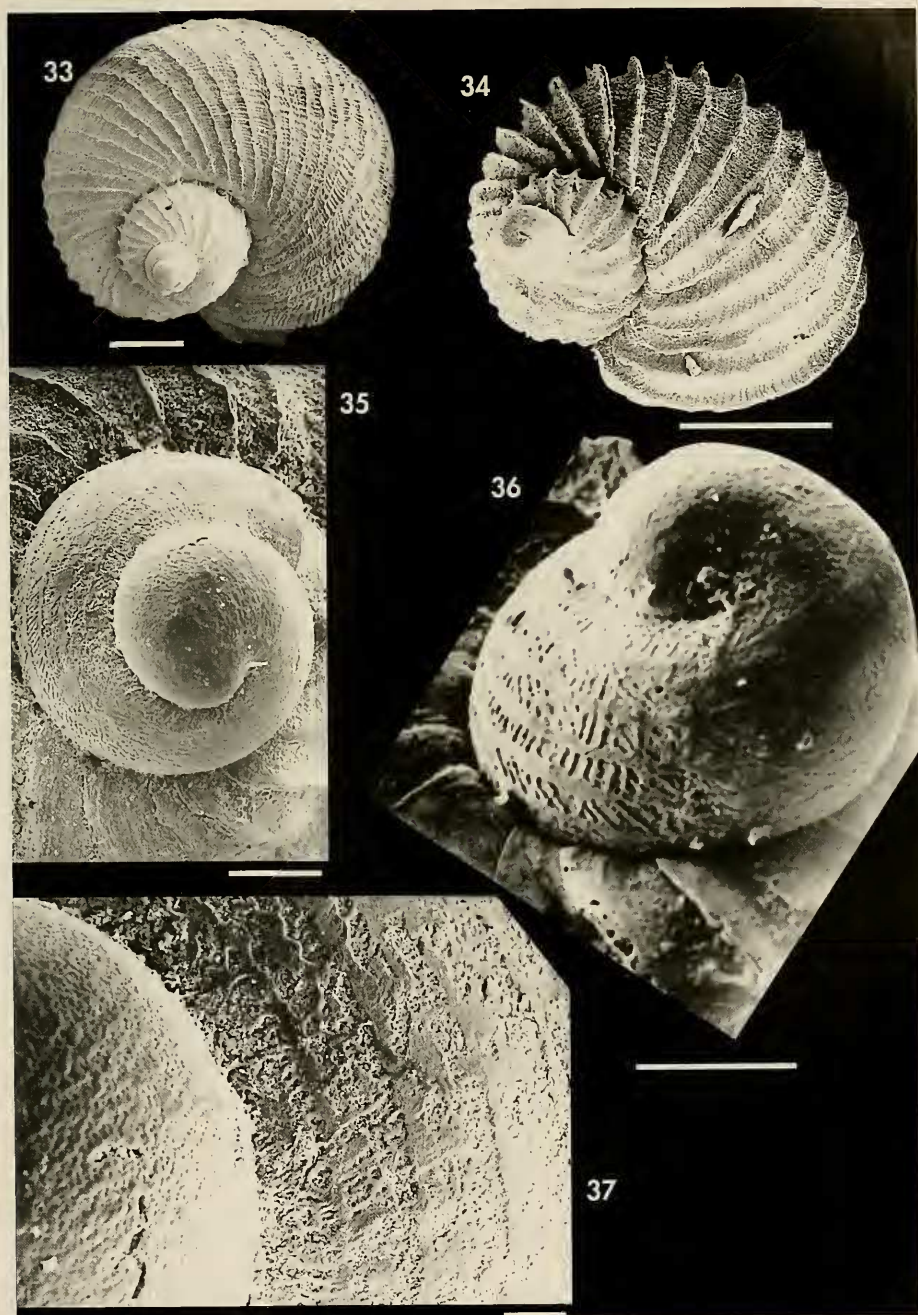
*Megalomphalus margaritae* spec. nov. (Fig. 33-37)

**Type material:** Holotype (Fig. 33) of 2.8 mm (FLMNH 257271), SE of Sand Key off Key West, Florida, USA. 1 paratype (juvenile) (Fig. 34) (ANSP 372462), off Lucaya, Grand Bahama, Bahamas.

**Other material examined:** Only known from the type material.

**Type locality:** Key West, Florida, U. S. A.





Figures 33-37. *Megalomphalus margaritae* spec. nov. 33: holotype (FLMNH), Key West, Florida; 34: paratype (ANSP), Lucaya, Grand Bahama; 35: protoconch, holotype; 36: protoconch, paratype; 37: microsculpture, holotype. Scale bar, shells 0.5 mm; protoconchs: 0.1 mm; microsculpture: 0.02 mm.  
 Figuras 33-37. *Megalomphalus margaritae* spec. nov. 33: holotipo (FLMNH), Key West, Florida; 34: paratipo (ANSP), Lucaya, Grand Bahama; 35: protoconcha, holotipo; 36: protoconcha, paratipo; 37: microescultura, holotipo. Escala, conchas: 0,5 mm; protoconchas: 0,1 mm; microescultura: 0,02 mm.

**Etymology:** Named after Margarita Mosquera, mother of the first author, who in spite of being ninety years old, worked hard separating shells from large quantities of sand grit. She found there part of the material used in the present study.

**Description:** Shell (Figs. 33, 34) oval lenticular, with an erect apex, white, fragile and not translucent.

Protoconch (Figs. 35, 36) of 1 1/2 whorls. The nucleus has a diameter of 0.125 mm, and together with the first subsequent 1/2 whorl (embryonic) has a very slightly irregular surface; the rest is sculptured with five very irregular spiral threads with oblique excavated lines in the intervals (Fig. 37).

Teleoconch with about 2 whorls or a little more, not enlarging as rapidly as other species; the shell has prominent axial sculpture and very fine and numerous spiral threads. The axial ribs number about 18 on the first whorl and 38 on the body whorl, being elevated and narrower towards the end of the

body whorl. These ribs are stronger and more elevated near the umbilicus where they resemble a keel.

Aperture ovoid, with the outer lip sharp, only contacting the penultimate whorl for a short distance. Open umbilicus with a small keel, showing the previous whorls. Shell totally white.

Adult dimensions only known from the holotype.

**Distribution:** The species is known from Florida and the Bahamas.

**Remarks:** *M. margaritae* spec. nov. has a shell more similar to those of the genus *Macromphalina*, but we keep it in the genus *Megalomphalus* due to the existence of the periumbilical keel. The protoconch has a sculpture very different from any of the other species studied.

## Genus *Macromphalina* Cossmann, 1888

Type species: *Sigaretus problematicus* Deshayes, 1864. Medium Eocene (Lutetien), Paris Basin.

**Diagnosis:** Shell small, depressed, whorls enlarging rapidly, axial and spiral sculpture, apex erect, sometimes oblique in relation to the shell. Open umbilicus. Large oblique aperture.

Outer lip simple. Anterodorsal jaws in the radula.

A more detailed description of this genus can be seen in RUBIO AND ROLÁN (1993).

## *Macromphalina floridana* Moore, 1965 (Figs. 38-42)

*Macromphalina floridana* Moore, 1965. *The Nautilus*, 78 (3): 75, pl. 7, figs. 1-3. [Type locality: Madeira Beach, St. Petersburg, Florida, USA].

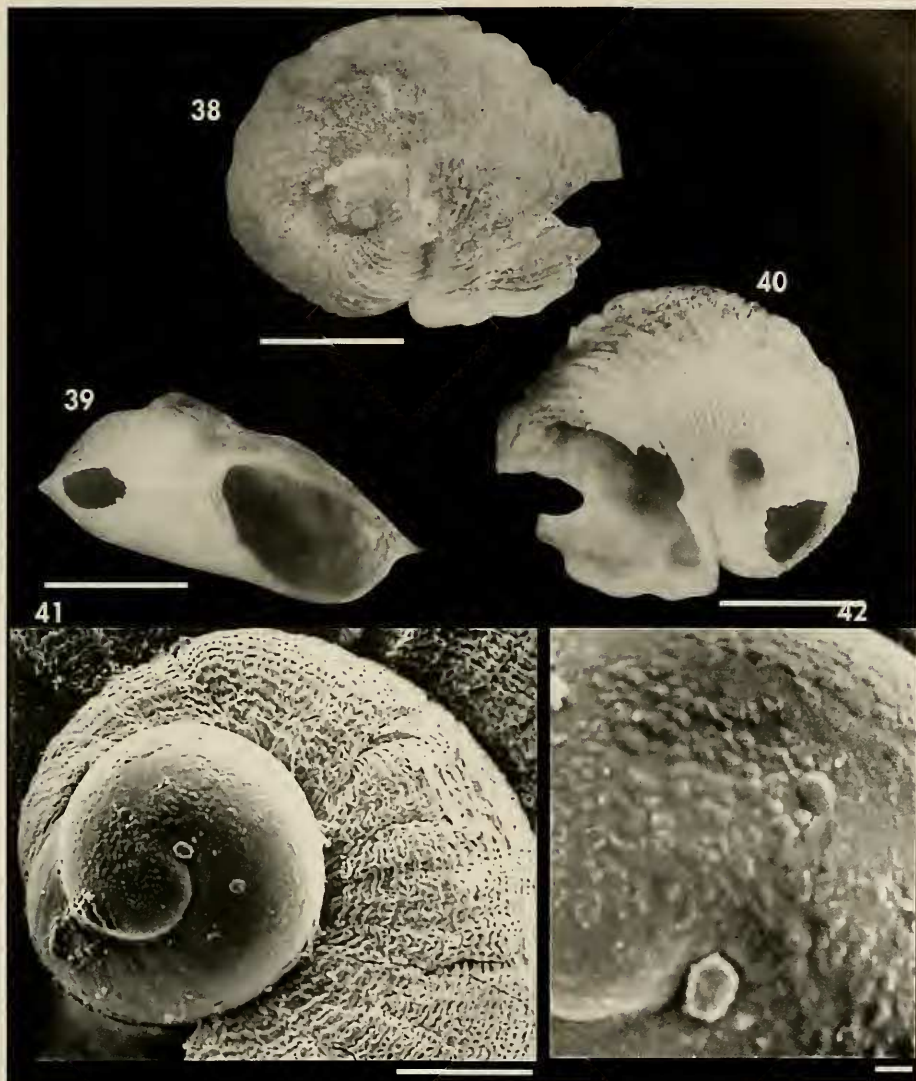
**Type material:** Holotype (USNM 636310) (Figs. 38-40) and 1 paratype (juvenile) (ANSP 295621) Madeira Beach, St. Petersburg, Florida, USA.

**Other material examined:** Florida: 1 shell, St. Augustine, St. Johns (CHL).

**Description:** See MOORE (1965) (Figs. 38-40).

The protoconch (Fig. 41) is described as smooth with 1 1/2 whorls. No information can be obtained from the protoconch of the holotype, which has calcareous incrustations. The paratype examined had a protoconch with 1 whorl, measured by the method of VERDUIN

(1976). The nucleus is about 0.100 mm in diameter and it is enlarged immediately. The protoconch is white and apparently smooth (not authorized to be metalized for study). A juvenile shell from CHL shows a protoconch (Fig. 41) with a rough tuberculated nucleus (Fig. 42) and first half whorl, being smooth elsewhere.



Figures 38-42. *Macromphalina floridana*. 38-40: holotype (ANSP), Madeira Beach, Florida; 41: protoconch, shell from Sta Luzia, Florida (CHL); 42: microsculpture of the protoconch (CHL). Scale bar, shell 0.5 mm; protoconch: 0.1 mm; microsculpture: 0.01 mm.

*Figuras 38-42. Macromphalina floridana. 38-40: holotipo (ANSP), Madeira Beach, Florida; 41: protoconcha, concha de Sta Luzia, Florida (CHL); 42: microescultura de la protoconcha (CHL). Escala, concha 0,5 mm; protoconcha: 0,1 mm; microescultura: 0,01 mm.*

The teleoconch begins with a very fine irregular spiral microsculpture almost lacking axial ribs on the first whorl.

*Distribution:* Only known from the type material and a single shell, all from Florida.

*Remarks:* There is no trouble in separating this species from others of the Caribbean Sea, because of the shell's peripheral angulation. The only similar species is *M. thompsoni* spec. nov. (see below).

*Macromphalina palmalitoris* Pilsbry and McGinty, 1950 (Figs. 43-49, 109-111)

*Macromphalina palmalitoris* Pilsbry and McGinty, 1950. *The Nautilus*, 63: 85, pl. 5, figs. 6, 6a. [Type locality: Palm Beach, Florida, USA].

*Macromphalina* sp. Warmke and Abbott, 1961. *Caribbean seashells*, text fig. 14 f.

**Type material:** Holotype (ANSP 185813) (Figs. 43, 44), off Palm Beach, Florida, USA.

**Other material examined:** Florida: 1 shell, Palm Beach (ANSP R1744); 7 shells 100 m, St. Augustine (CHL); 3 shells, Fort Pierce (CHL); 2 shells, Okaloosa Co., off Destin (FLMNH 143894, 143895); 1 shell, 35 m, Palm Beach (FLMNH 185447); 1 shell, Fort Pierce (FLMNH 257442), 1 shell, Captiva I. (FLMNH 257444); 2 shells (1 juvenile) St. Augustine (FLMNH 47384, 257443). Cuba: 37 shells, between 10-30 m, Cienfuegos Bay. 5 shells, 56 m, Faro de los Colorados; 8 shells, 45 m, Punta Tamarindo. Puerto Rico: 1 shell, Enrique Reef (FLMNH 162266). Panama: 1 shell, Bocas Toro, East Colon I. (FLMNH 160601).

*Description:* See PILSBRY AND MCGINTY (1950). Shell (Figs. 43-47) oval lenticular, with an erect apex, white, somewhat solid and slightly translucent.

The protoconch of the holotype was examined under magnification, and it has a nucleus with a diameter of 0.082 mm and about 1 1/2 whorls, but it is difficult to see the microsculpture, because it is a little eroded. For this reason, in the description it was mentioned as smooth. The mention of two whorls of the protoconch depends on the method of measurement employed. The protoconch in the Cuban material (Figs. 48, 49) begins with a nucleus of about 0.070 mm. This nucleus and the first half whorl (embryonic) are smooth, followed by 4 low, very fine spiral threads. The end of the protoconch is not clearly defined, because the axial ribs are preceded by a 1/2 whorl that could belong either to the protoconch or to the teleoconch. The colour is white.

The beginning of the teleoconch is not well defined. There is a portion of the preceding 1/2 whorl where the threads change into grooves. This part is considered by us as teleoconch; after this 1/2 whorl, the axial ribs begin. The teleoconch has 1 1/2 whorls, with rapid development; it is sculptured by strong axial

ribs which are oblique and S-shaped. They are very variable, numbering, on the less sculptured shells, about 13 on the first whorl and between 15 and 18 on the body whorl. Many spiral striae are present on the entire shell and can be seen to continue over the ribs.

Aperture ovoid, with the outer lip a little angulated towards the periphery. The early whorls are visible in the large umbilicus. Many specimens have the aperture totally separated from the previous whorl.

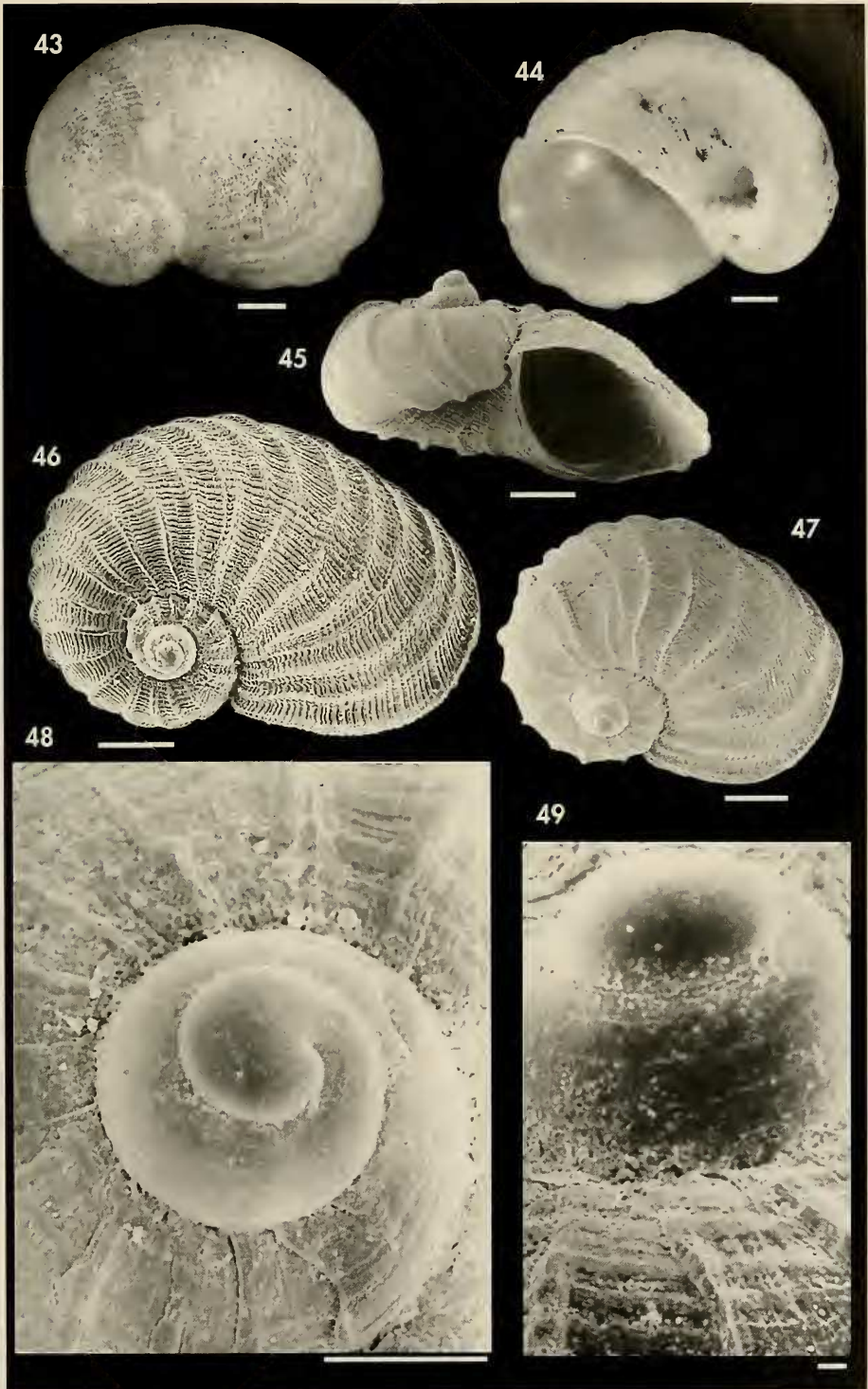
The radula (Fig. 109) was obtained from a specimen from Cienfuegos, Cuba: the rachidian tooth (Fig. 110) presents three small denticles on each of the basal supports; the lateral teeth are trapezoid in form, wide basally, with the sharp area also wide, where there is a central gross and blunt denticle, 8-9 smaller denticles on its external border and 4-5 on the internal one. Marginal internal teeth (Fig. 111) oar-shaped, strongly curved and pointed, with their external margin smooth and slight incisions in their internal margin.

*Dimensions:* From 1.5 to 2.2 mm in diameter.

*Distribution:* The species was described from Florida. We have studied

(Right page). Figures 43-49. *Macromphalina palmalitoris*. 43, 44: holotype (ANSP), Florida; 45-47: shells from Cienfuegos, Cuba (CER); 48: protoconch; 49: detail of the microsculpture of the protoconch. Scale bar, shells: 0.25 mm; protoconch: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 43-49. *Macromphalina palmalitoris*. 43, 44: holotipo (ANSP), Florida; 45-47: conchas de Cienfuegos, Cuba (CER); 48: protoconcha; 49: detalle de la microescultura de la protoconcha. Escala, conchas: 0,25 mm; protoconcha: 0,1 mm; microescultura: 0,01 mm.



material from Cuba, and WARMKE AND ABBOTT (1961) drew a shell from Puerto Rico. So the species is probably distributed at least in the middle Caribbean.

*Remarks:* The morphology of the shell and radula confirm that it belongs to the genus *Macromphalina*.

At the beginning of this study we had some doubts about the conspecificity of the holotype of *M. palmalitoris* and the material collected in Cuba (similar to the form figured from Puerto Rico by WARMKE AND ABBOTT, 1961), because the number of axial ribs was lower in the Cuban shells but higher on the holotype: this can be shown by comparing the last  $1/4$  whorl of the holotype (with 18 ribs),

to most of the shells from Cuba (Figs. 45-47) with only 8. The sculpture of the protoconch was not compared because of the bad condition of that of the holotype. Nevertheless, we did not find differences in most of the other characters: the number of whorls of the protoconch, the beginning of the teleoconch, and the sculpture and profile of the shell. So, finally, we decided to consider the specimens from Cuba merely a form, especially because we found some specimens which seemed to represent intergrades, and also because in the material from CHL we found high variability; one shell had scarcely any axial sculpture but was otherwise similar to shells from Cuba.

### *Macromphalina garcesi* spec. nov. (Figs. 50-53)

**Type material:** Holotype (Fig. 50) of 2.58 mm in maximum diameter, and 1 paratype (MNCN 15.05/23751). Two paratypes in each of the following collections: AMNH (226544), ANSP (399245), BMNH (1996032), CFR, CRC, FMNH, IES, MNHN, USNM (890427), ZMA, 33 in CFG, and 61 in CER. All are from type locality (ex CFG).

**Other material examined:** Cuba: 10 shells, at 56 m, Faro de los Colorados; 1 shell, at 50 m, Punta Tamarindo; 8 shells, at 10-20 m, Rancho Luna; 2 shells, in 10-20 m in the middle of the bay of Cienfuegos; all these localities in Cienfuegos area. Puerto Rico: 1 shell, Punta Codena (FLMNH 163335). Panama: 1 juvenile, Bocas del Toro (FLMNH 1605997).

**Type locality:** Cienfuegos Bay, South of Cuba.

**Etymology:** Named after Raúl Fernández Garcés, malacologist of Cienfuegos, who collected most of the material of this species.

*Description:* Shell (Figs. 50, 51) oval lenticular, with an erect apex, white, fragile and not translucent.

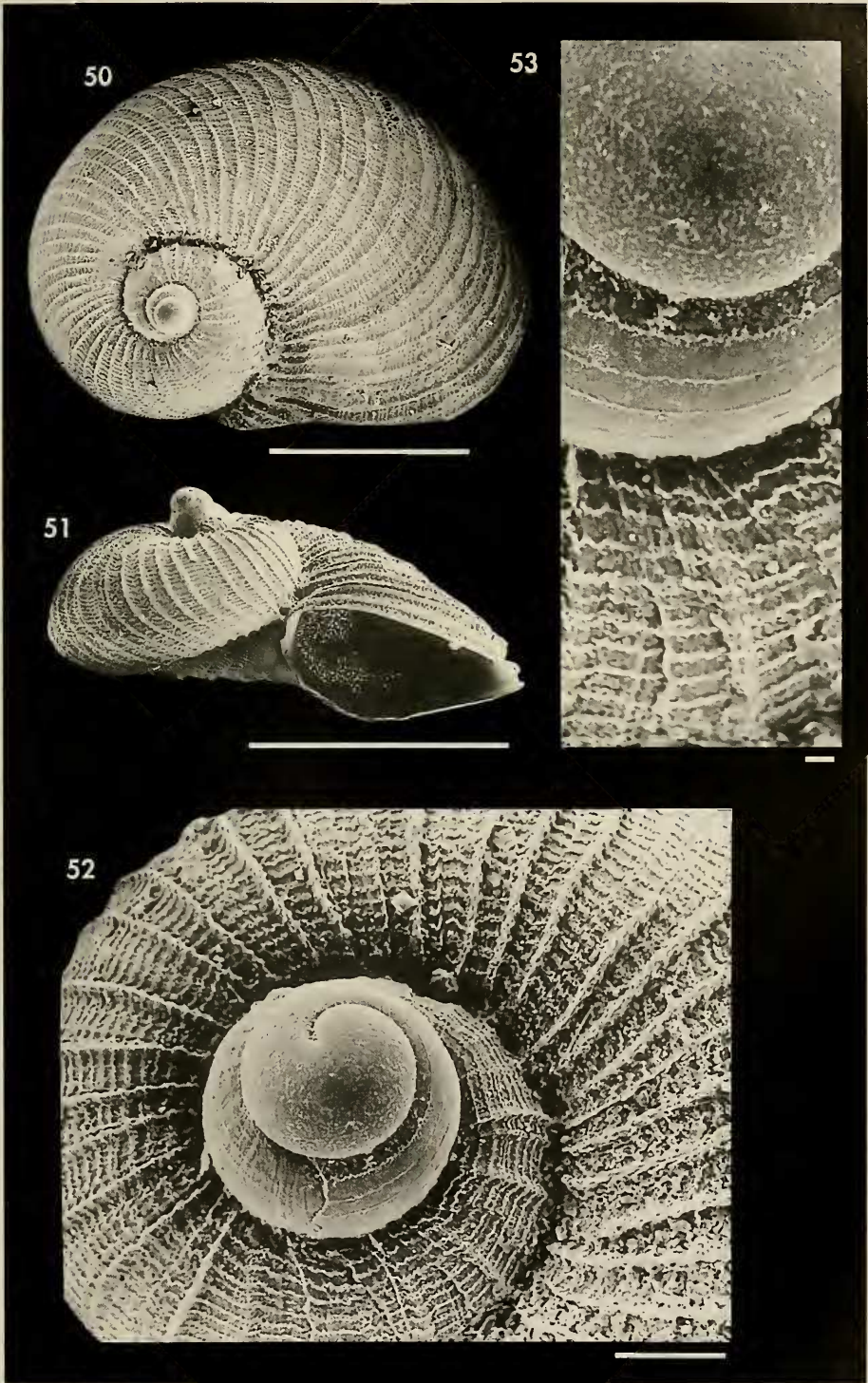
The protoconch (Fig. 52) gives the appearance of having 2 whorls, but it only has about  $1\frac{1}{4}$ , the following  $\frac{1}{2}$  whorl with only spiral sculpture, probably belonging to the teleoconch. The nucleus has a diameter of 0.096 mm, and together with the first subsequent  $\frac{1}{2}$  whorl (embryonic) has very small irregular tubercles, with some spiral lines; the rest is sculptured with five very fine spiral threads,

which later are more prominent. These threads (Fig. 53) have some irregularities. The protoconch is tilted at an angle that changes with the development of the shell, and the axis of the protoconch differs from that of the teleoconch.

Teleoconch with about  $2\frac{1}{2}$  whorls or a little more, not enlarging as rapidly as other species. The first part, which lacks axial sculpture and has only spiral threads, could be misidentified as a part of the protoconch; after a half whorl it is sculptured with many fine axial ribs

(Right page). Figures 50-53. *Macromphalina garcesi* spec. nov. 50: holotype (MNCN), Cienfuegos, Cuba; 51: paratype (AMNH); 52: protoconch; 53: microsculpture of the protoconch. Scale bar, shells: 1.00 mm; protoconch: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 50-53. *Macromphalina garcesi* spec. nov. 50: holotipo (MNCN), Cienfuegos, Cuba; 51: paratipo (AMNH); 52: protoconcha; 53: microescultura de la protoconcha. Escala, conchas: 1,00 mm; protoconcha: 0,1 mm; microescultura: 0,01 mm.



which are slightly curved. They number about 28-32 on the first whorl and from 40 to 52 on the body whorl. These ribs are elevated, and they are broader towards the end of the body whorl. Many tiny undulating spiral striae cover the entire shell, crossing the ribs but only visible on the summits under magnification.

Aperture ovoid, with the outer lip sharp, only contacting the penultimate whorl for a short distance. Open umbilicus without any keel, showing the previous whorls. Shell totally white.

*Dimensions:* From 2.00 to 2.50 mm in diameter.

*Distribution:* The species is known from the south of Cuba and Puerto Rico, and one juvenile from Panama (FLMNH) seems to belong to this species.

*Remarks:* By the oblique position of its apex, *Macromphalina garcesi* can be differentiated from the rest of the congener-

ric species in the area. Furthermore, *M. palmalitoris* has its axial ribs curved, fewer in number and less elevated, and the development of the spire is more rapid. Other species, such as *Macromphalina robertsoni* n. sp (see below), have a more similar shell but different protoconch sculpture, having tubercles between the threads and beginning on the nucleus; also, the axial ribs of the teleoconch begin immediately. *M. paradoxa* spec. nov. (see below) has the protoconch erect but not tilted, with two whorls, the nucleus smooth, and with the spiral threads of the protoconch more irregular and with many interconnections between them. The other Caribbean species of this genus have very different protoconch sculpture. The species of *Megalomphalus*, *M. lamellosus* and *M. troudei* have the shell globose and not depressed and with a shorter protoconch. *M. oxychone* and *M. pilsbryi* are also more globose and their protoconchs are different.

### *Macromphalina robertsoni* spec. nov. (Figs. 54-57)

**Type material:** Holotype (Fig. 54) of 2.13 mm in diameter, MNCN (15.05/23752). One paratype in the following collections: AMNH (226541), ANSP (399244), BMNH (1996029), CRC, CFR, IES, MNHN, USNM (890425), 4 in CFG, and 12 in CER. All were collected between 15-56 m, in Cienfuegos Bay and nearby (ex CFG).

**Type locality:** Cienfuegos Bay, South Cuba.

**Etymology:** Named after Robert Robertson, recognized American malacologist, for his help in the study of this group.

*Description:* Shell (Figs. 54, 55) oval-lenticular, with an erect apex, white, fragile and not translucent.

Protoconch (Fig. 56) with 1  $\frac{1}{4}$  whorls. The nucleus, with a diameter of 0.088 mm, is almost smooth, showing the faint beginnings of spiral threads. Six very fine, regular spiral threads start immediately thereafter and extend along the protoconch, with many small tuber-

cles in the interspaces (Fig. 57). The end of the protoconch is not abrupt, with more spiral threads and gradual formation of the axial ribs of the teleoconch.

Teleoconch with between 1  $\frac{1}{2}$  and 1  $\frac{3}{4}$  whorls, with less rapid development except in the last quarter whorl; it is sculptured by many fine axial ribs which are slightly curved. They number about 10 on the first half whorl, 23 on

(Right page). Figures 54-57. *Macromphalina robertsoni* spec. nov. 54: holotype (MNCN), Cienfuegos, Cuba; 55: paratype (AMNH); 56: protoconch; 57: microsculpture of the protoconch. Scale bar, shells: 1.00 mm; protoconch: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 54-57. *Macromphalina robertsoni* spec. nov. 54: holotipo (MNCN), Cienfuegos, Cuba; 55: paratipo (AMNH); 56: protoconcha; 57: microescultura de la protoconcha. Escala, conchas: 1,00 mm; protoconcha: 0,1 mm; microescultura: 0,01 mm.



54



57



55



56



the second half and between 60 and 80 on the body whorl. These ribs are elevated, and they are finer at their ends. Many fine spiral striae cross the ribs, although at first they are only visible on the summits under magnification, and they are more evident at the end of the last whorl in the interspaces.

Aperture ovoid, with the outer lip sharp, only contacting the penultimate whorl for a short distance. An open umbilicus without any keel shows the previous whorls. The whole shell, including the protoconch, is white.

*Dimensions:* From 1.7 to 2.3 mm in diameter.

*Distribution:* Only known from Cienfuegos, South Cuba, between 15 to 65 m.

*Remarks:* The following similar species of the genus *Macromphalina* can be differentiated from *M. robertsoni*: *M. palmaritoris* has the nucleus and the subse-

quent half whorl of the protoconch smooth and lacks the tiny tubercles between the spiral threads. *M. garcesi* has the nucleus and the beginning of the first half whorl of the protoconch with only small tubercles and it lacks the tubercles between the spiral threads. Also the axis of the protoconch is not vertical, but oblique. *M. paradoxa* spec. nov. (see below) has a protoconch of up to two whorls, with the first part smooth and the subsequent threads very irregular. *M. jibacoa* spec. nov. (see below) has a more irregular sculpture with bigger tubercles and irregular lines. Other species of *Macromphalina* mentioned in the present work have a very different sculpture of the protoconch.

The species of the genus *Megalomphalus* have a more globose shell, different umbilicus and also different protoconch sculpture.

### *Macromphalina paradoxa* spec. nov. (Figs. 58-61)

**Type material:** Holotype (Fig. 58) of 1.90 mm in maximum diameter, and 1 paratype in MNCN (15.05/23753). Two paratypes in AMNH (226542), ANSP (399246), BMNH (1996030), CFR, CRC, IES, MNHN, 10 in CFG, and 46 in CER. All from type locality (ex CFG).

**Other material examined:** Cuba: 1 shell, 56 m, Faro de los Colorados; 2 shells, 50 m, Punta Tamarindo; 2 shells, in the middle of the bay of Cienfuegos; 1 shell, 10-20 m, Rancho Luna; all these localities in Cienfuegos area (ex CFG).

**Type locality:** Cienfuegos Bay, South Cuba.

**Etymology:** The specific name is derived from the latin word *paradoxon*, which means paradox, because the present species was found in a small locality with several other very similar species of this group.

*Description:* Shell (Figs. 58, 59) oval-lenticular, white, fragile and not translucent, with an erect vertical apex.

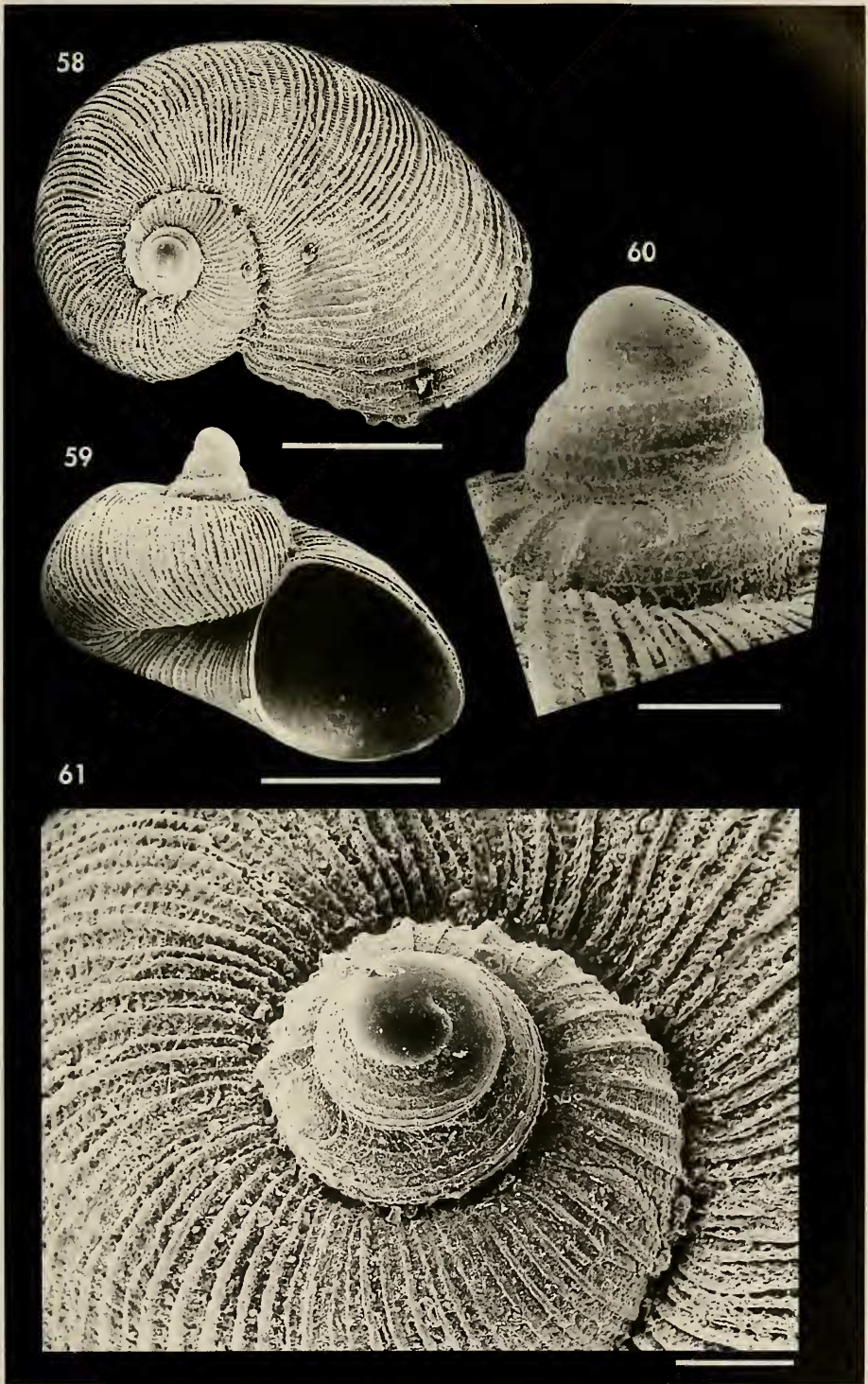
Protoconch (Figs. 60, 61) with 2 or almost 2 whorls. The nucleus and at least the first half whorl of the protoconch are smooth; later with five very fine, occasionally undulating spiral threads and, especially at its end, with fine intercon-

necting lines forming a net-like pattern. The colour of the protoconch is cream with light brown at the borders.

Teleoconch with about  $1\frac{3}{4}$  whorls, with rapid development; it is sculptured by many fine axial ribs which are slightly curved, numbering about 13 on the first half whorl, 45-55 on the second half and from 90 to 110 on the body

(Right page). Figures 58-61. *Macromphalina paradoxa* spec. nov. 58: holotype (MNCN), Cienfuegos, Cuba; 59: paratype (AMNH); 60, 61: protoconchs. Scale bar, shells: 1.00 mm; protoconchs: 0.1 mm.

(Página derecha). Figuras 58-61. *Macromphalina paradoxa* spec. nov. 58: holotipo (MNCN), Cienfuegos, Cuba; 59: paratipo (AMNH); 60, 61: protoconchas. Escala, conchas: 1,00 mm; protoconchas: 0,1 mm.



whorl, with very small spaces between them. With many fine spiral striae throughout, evident in the spaces between the ribs.

Aperture ovoid, with the outer lip sharp, only contacting the penultimate whorl for a short distance. An open umbilicus without any keel shows the previous whorls.

*Dimensions:* From 1.7 to 2.3 mm in diameter.

*Distribution:* Only known from Cienfuegos, south Cuba.

*Remarks:* The shells of the species of *Macromphalina* from the area of study that are similar in appearance can be differentiated from *M. paradoxa*: all of them

have protoconchs of less than 2 whorls; furthermore, *M. robertsoni* has a protoconch with the spiral threads beginning on the nucleus; *M. garcesi* has microtubercles on the nucleus and first whorl of the protoconch, the threads are finer and, on the teleoconch, the number of axial ribs is smaller. *M. palmalitoris* has the spiral threads of the protoconch finer and more simple, and on the teleoconch the axial and spiral sculpture is stronger and less crowded. *M. jibacoa* has more irregular sculpture. Other species have much stronger cords on the protoconch.

Shell and protoconch of the present species are clearly distinct from those of the genus *Megalomphalus*.

### *Macromphalina worsfoldi* spec. nov. (Figs. 62-66, 112)

**Type material:** Holotype (Fig. 62) of 1.65 mm in diameter, (ANSP 371115). 23 paratypes in ANSP: 22 from Dead Mans Reef (Sandy Beran's Cay) (ANSP 371115) and 1 from Dead Mans Reef (Sandy Beran's Cay) (ANSP 371114).

**Other material examined:** Only known from the type material.

**Type locality:** Dead Mans Reef, Grand Bahama I., Bahamas.

**Etymology:** Named after J. Worsfold, who collected the type material and studied this group in the Bahamas, giving us ideas and information.

*Description:* Shell (Figs. 62, 63) oval-lenticular, white, fragile and not translucent, with depressed apex.

Protoconch (Figs. 64, 65) with only 1 whorl. The nucleus has a diameter of about 0.100 mm, sculptured from the beginning with 6 spiral undulating cords; subsequently the lower one or two cords are immersed in the suture, with only four visible at the end. In the interspaces there are many fine microscopic axial lines, which originate obliquely from these cords (Fig. 66). The colour of the protoconch is white.

Teleoconch with about 1 1/2 whorls, with a fairly rapid development. It is sculptured with fine prominent axial

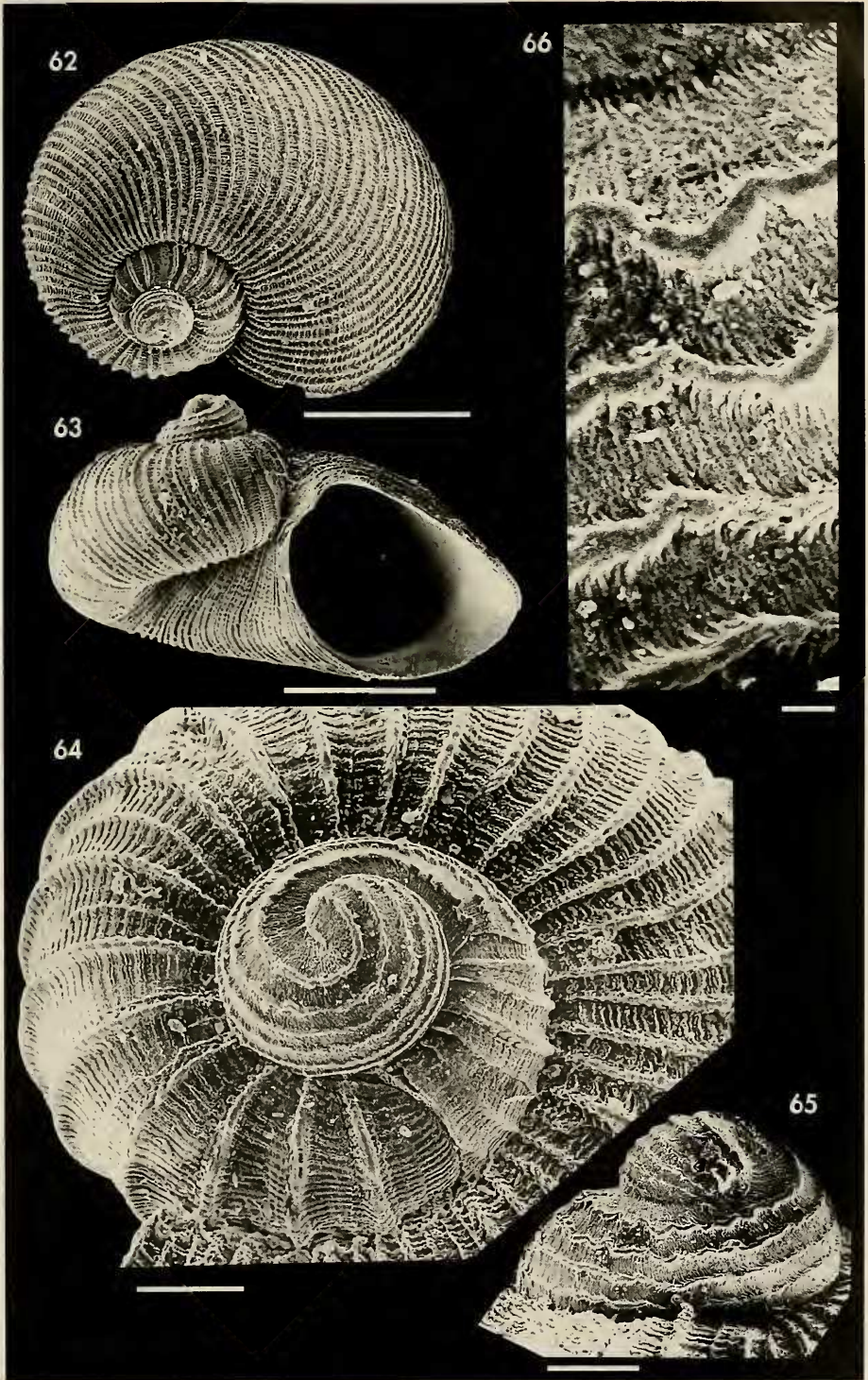
ribs, which are slightly curved; they number only about 12 on the first half whorl, but later they are closer and can reach 60 or more on the last whorl. Many fine spiral striae cover the shell and are evident in the interspaces, crossing the ribs to make them appear granular.

Aperture ovoid, with the outer lip sharp, only contacting the penultimate whorl for a short distance. Previous whorls and the ends of the crowded axial ribs are visible in the open umbilicus, which lacks a peripheral keel.

Radula (Fig. 112) (from ANSP 371115) with a rachidean tooth which has 1-2 small denticles on the base of the basal supports, a triangular sharp area

(Right page). Figures 62-66. *Macromphalina worsfoldi* spec. nov. 62: holotype (ANSP), Grand Bahama I.; 63: paratype (ANSP), Grand Bahama I.; 64, 65: protoconch; 66: microsculpture of the protoconch. Scale bar, shells: 0.5 mm; protoconchs: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 62-66. *Macromphalina worsfoldi* spec. nov. 62: holotipo (ANSP), Grand Bahama; 63: paratipo (ANSP), Grand Bahama; 64, 65: protoconcha; 66: microescultura de la protoconcha. Escala, conchas: 0,5 mm; protoconchas: 0,1 mm; microescultura: 0,01 mm.



with a prominent central cusp, and 5-6 smaller on each side. Lateral teeth very wide, with a gross and blunt denticle in the middle of its sharp area, 12 more on its external margin and 5-6 on the internal one. Marginal internal teeth narrower and longer than the lateral ones, strongly curved in the upper third, with numerous denticles (30-32) on their margin. Marginal external teeth oar-shaped, strongly curved and pointed, with the external margin smooth and denticles on the internal one.

*Dimensions:* From 1.40 to 1.70 mm.

*Distribution:* Only known from the type locality.

*Remarks:* The shell of *M. worsfoldi* can be differentiated from *M. robertsoni*, *M. garcesi*, *M. palmalitoris* and *M. paradoxa* by its not very prominent protoconch. The most similar shell is that of *M. canarreos* spec. nov. (see below), but the latest species has the interval between the cords of the protoconch smooth and not with microscopic lines; also, it has 7 spiral cords, instead the 5-6 of *M. worsfoldi* (only 4-5 visible at the end of the protoconch). The teleoconch of *M. canarreos* has more ribs, and they are also more attenuated. The species of *Megalomphalus* have a different teleoconch and protoconch.

### *Macromphalina canarreos* spec. nov. (Figs. 67-71)

**Type material:** Holotype (Fig. 67) of 1.82 mm, in MNCN (15.05/23754) (it was partially broken during its study). 1 paratype in FLMNH and 1 in AMNH, from type locality; 2 (one juvenile) (Fig. 68) in CER and 1 in CFG, from 20 m, Rancho Luna, Cienfuegos, Cuba.

**Other material examined:** Only known from type material.

**Type locality:** Cayo Ávalos, in Los Canarreos Archipelago, south-western Cuba.

**Etmology:** The specific name refers to Los Canarreos, the archipelago of south-western Cuba where the first shells of this species were collected.

*Description:* Shell (Figs. 67, 68) oval-lenticular, white, fragile and not translucent, with not very prominent apex. Protoconch (Figs. 69, 70) with only 1 whorl or a little more. There are 6 spiral undulating cords on the nucleus, occasionally interrupted, and one more appears near the suture, so that there are 7 at the middle of the protoconch and 5-6 at its end. The surface between them is irregular, but without microscopic axial lines. The colour of the protoconch is white.

Teleoconch with about  $1\frac{1}{2}$  to  $1\frac{3}{4}$  whorls, with a fairly rapid development; it is sculptured by fine axial ribs which

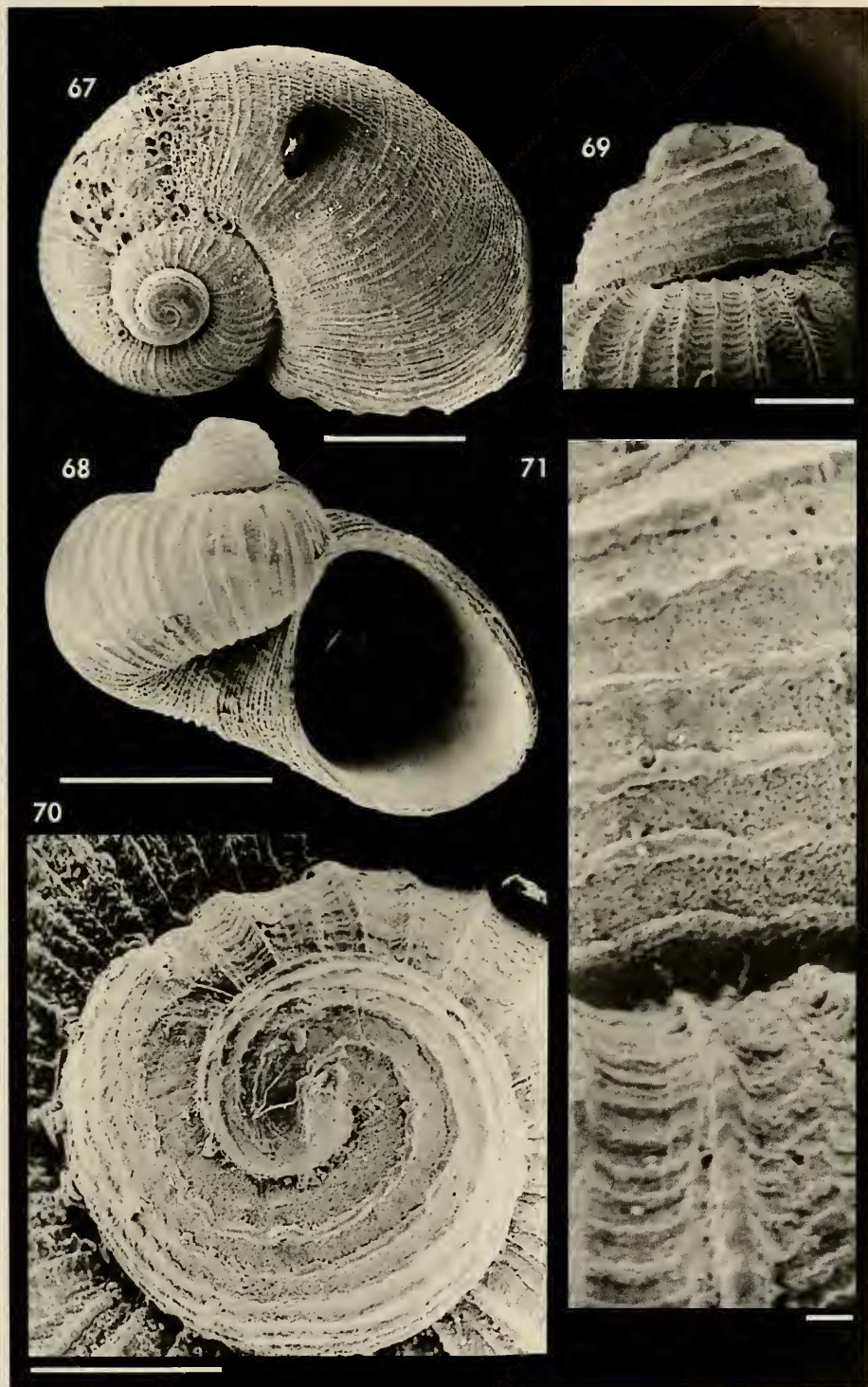
are slightly curved; they number only about 14 on the first half whorl, but later they are more crowded and can reach more than 100 on the last whorl. Many fine spiral striae cover the shell and are evident in the interspaces, crossing the ribs to make them appear granular.

Aperture ovoid, with the outer lip sharp, only contacting the penultimate whorl for a short distance. Previous whorls and the ends of the crowded axial ribs are visible in the open umbilicus, which lacks a peripheral keel.

*Dimensions:* the holotype is the largest of the few shells available for study.

(Right page). Figures 67-71. *Macromphalina canarreos* spec. nov. 67: holotype (MNCN), Los Canarreos Archipelago, Cuba; 68: paratype (CER), Rancho Luna, Cienfuegos, Cuba; 69, 70: protoconch of the paratype; 71: microsculpture of the protoconch. Scale bar, shells: 1.00 mm; protoconchs: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 67-71. *Macromphalina canarreos* spec. nov. 67: holotipo (MNCN), Los Canarreos, Cuba; 68: paratipo (CER), Rancho Luna, Cienfuegos, Cuba; 69, 70: protoconcha del paratipo; 71: microescultura de la protoconcha. Escala, conchas: 1,00 mm; protoconchas: 0,1 mm; microescultura: 0,01 mm.



*Distribution:* Only known from Los Canarreos Archipelago and Cienfuegos.

*Remarks:* The few prominent cords on the protoconch of *M. canarreos* easily differentiate its shell from that of *M. robertsoni*, *M. garcesi*, *M. palmititoris* and *M. para-*

*doxa*. The most similar shell is that of *M. worsfoldi*, but the latest species has microscopic lines between the cords on the protoconch; also, it has fewer spiral cords on the protoconch. The teleoconch of *M. worsfoldi* has fewer and more prominent ribs.

### *Macromphalina redferni* spec. nov. (Figs. 72-76, 104)

**Type material:** Holotype (Fig. 72) of 4.00 mm in maximum diameter and 1 paratype (Fig. 73) (both ex CRC), in ANSP (399247). Paratypes: 1 in each of the following (ex CRC): AMNH (26543), CFR, CFG, CHL, IES, MNHN, MNCN (15.05/23755), BMNH (1996031) and 8 in CER. One more in USNM (890426); 10 in ANSP (374131, 398254, 375380), and 74 in CRC. All them from type locality.

**Other material examined:** **Bahamas:** Grand Bahama: 8 shells, 26° 31' 00" N, 78° 46' 30" W (ANSP 374131); 1 shell, Lucaya, (ANSP 398254); 1 shell, Fleming Road, Mosquito Point (ANSP 375380). Abaco: 20 shells, Treasure Cove, (CRC 799); 6 shells, Treasure Cove (CRC 1758); 9 shells, Treasure Cove (CRC 1991); 4 shells, Treasure Cove (CRC 2522); 6 shells, Treasure Cove (CRC 2793); 18 shells, Treasure Cove (CRC 2819); 4 shells, Treasure Cove (CRC 3120); 11 shells, Treasure Cove (CRC 3121); 3 shells, Treasure Cove (CRC 3172); 2 shells, Treasure Cove (CRC 3173); 7 shells, Treasure Cove (CRC 3175); 1 shell, Treasure Cove (CRC 3303); 1 shell, Chub Rocks (CRC 7673); 7 shells, Treasure Cove (CRC 5751); 1 shell, Treasure Cove (CRC 5745); 1 shell, Treasure Cove (CRC 5746); 246 shells, Treasure Cove (CRC 5747); 1 juvenile, Chub Rocks (CRC 9909); 1 shell (CHL). **Panama:** 1 shell, Bocas del Toro (FLMNH 231547); 2 shells, East Colon Is., Bocas del Toro (FLMNH 160597) (these last being in not perfect condition).

**Type locality:** Treasure Cove, Abaco I., Bahamas.

**Etymology:** Named after the malacologist Colin Redfern, who collected material from the Bahamas and has helped us in many works on the Caribbean fauna.

*Description:* Shell (Figs. 72, 73) rounded, slightly depressed, white, with the protoconch a little prominent.

Protoconch (Figs. 74, 75) of one whorl which begins with a nucleus of about 0.1 mm and a first half whorl that appear smooth, but in fresh specimens can be seen to be irregularly roughened (Figs. 75, 76). Subsequently there are about 12-13 irregular spiral lines; in some places they are interrupted and in other have prominences. Beached shells have a smooth protoconch with the spiral lines almost absent. The protoconch has a translucent brown colour. This brown colour of the protoconch is very constant, even in very eroded shells.

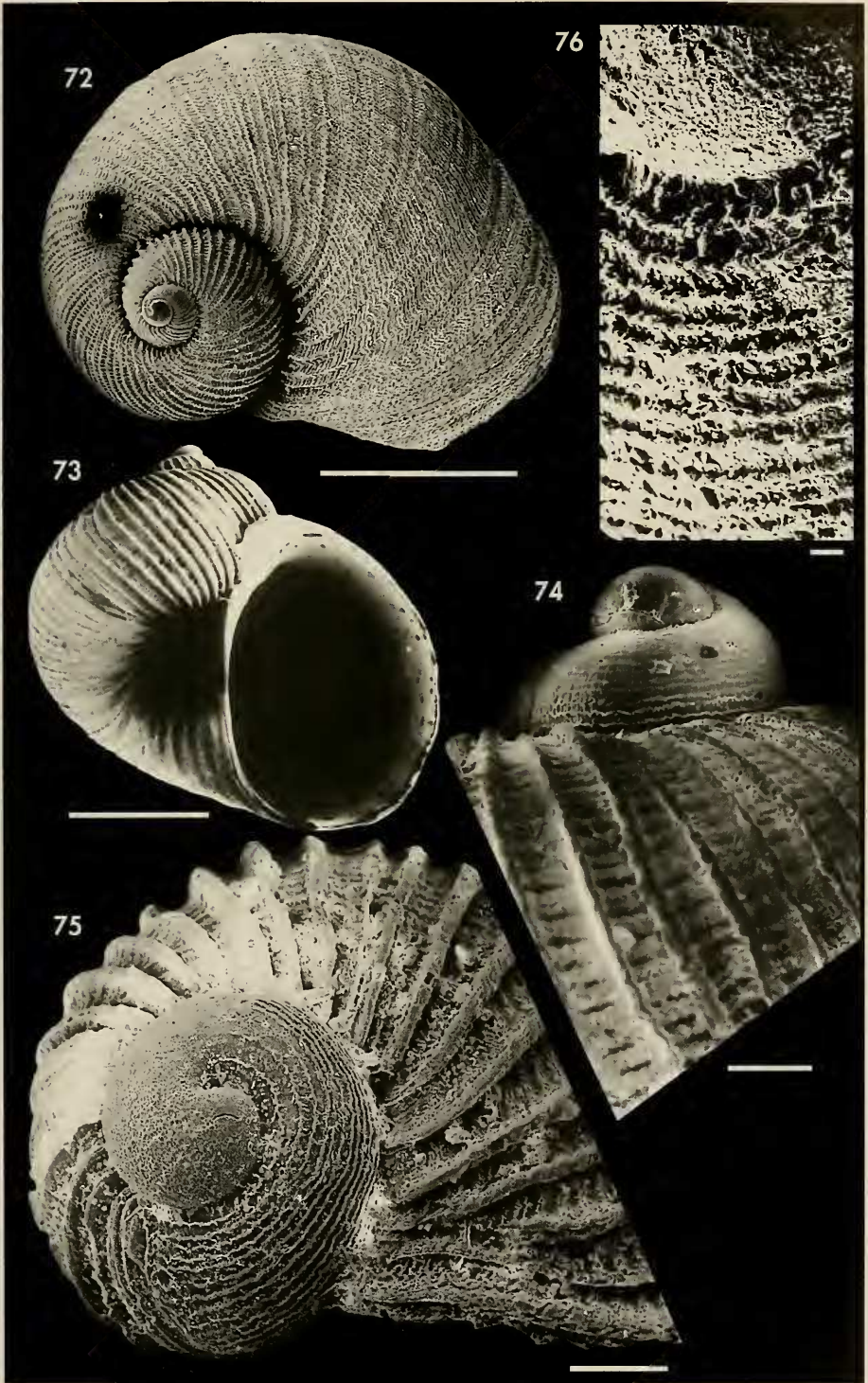
The teleoconch has between 2 <sup>1</sup>/<sub>4</sub> and 2 <sup>1</sup>/<sub>2</sub> whorls. They have fine and slightly oblique axial ribs which initially are a little more separated, with very fine spiral striations in the interspaces. The number of the axial ribs on the first whorl ranges from 24 to 30. These ribs are also present on the second whorl, later almost disappearing on some of the largest shells, but remaining visible near the suture. On these shells the rest of the surface of the shell shows only fine, undulating spiral striae, crossed by irregular and crowded growth lines.

The aperture is pyriform, with an extension in the upper part forming the only point of contact with the previous

(Right page). Figures 72-76. *Macromphalina redferni* spec. nov. 72: holotype (ANSP), Abaco I., Bahamas; 73: Paratype (CER ex CRC), Abaco I., Bahamas; 74, 75: protoconchs; 76: microsculpture of the protoconch. Scale bar, shells: 1.00 mm; protoconchs: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 72-76. *Macromphalina redferni* spec. nov. 72: holotipo (ANSP), I. Abaco, Bahamas; 73: Paratipo (CER ex CRC), I. Abaco, Bahamas; 74, 75: protoconchas; 76: microescultura de la protoconcha. Escala, conchas: 1,00 mm; protoconchas: 0,1 mm; microescultura: 0,01 mm.





whorl. The umbilicus is wide and deep, with axial lamellae, but never a visible peripheral keel.

**Dimensions:** maximum size of the largest shells is 5.5 mm in width and 4.5 mm in height.

**Distribution:** Only known from the Bahama Islands, as the shells from Panama are dubious, and it will be necessary to examine better material to confirm their identity.

**Remarks:** Placement of this species in *Macromphalina* and not in *Megalomphalus* may be only a provisional option, because it seems to be in an intermediate situation. Future study of the soft parts and radula could confirm or change the actual placement.

*M. redferni* is differentiated from most of the species of the genus *Macromphalina* in this area by its more elevated form and the 12-13 spiral lines on its protoconch;

furthermore, most of the species of *Macromphalina* have a white protoconch. In the genus *Megalomphalus*, *M. oxychone*, *M. pilsbryi* and *M. cf. pilsbryi* differ by having umbilical keels. *M. millerae* has a white protoconch, which also has fewer spiral cords; *M. lamellosus* is close but it also has a white protoconch with fewer spiral cords.

*Gyrodus duplinensis* Dall, 1896 (USNM 114430) (Figs. 117-119), fossil of the Miocene, from Duplin County, North Carolina, is bigger, more elevated and with axial sculpture more evident over the entire shell, having a bigger nucleus (0.146 mm) and the spiral cords on the protoconch (Fig. 120) reaching the nucleus.

The protoconchs of the 3 specimens collected in Panama were not perfect, but compatible with that of *M. redferni* (Fig. 104); for this reason we consider them provisionally being conspecific, in spite of the distance of this population.

### *Macromphalina jibacoa* spec. nov. (Figs. 77-80)

**Type material:** Holotype (Fig. 77-78) of 1.82 mm in diameter, in MNCN (15.05/23756); 1 paratype in AMNH (226548) and 1 in CER.

**Other material examined:** Only known from the type material.

**Type locality:** Jibacoa, north of Cuba, between La Habana and Varadero.

**Etiymology:** The specific name refers to Jibacoa, in the north of Cuba, where the type material was collected in 4 m.

**Description:** Shell (Figs. 77, 78) oval lenticular, white, fragile and not translucent, with the apex not very prominent.

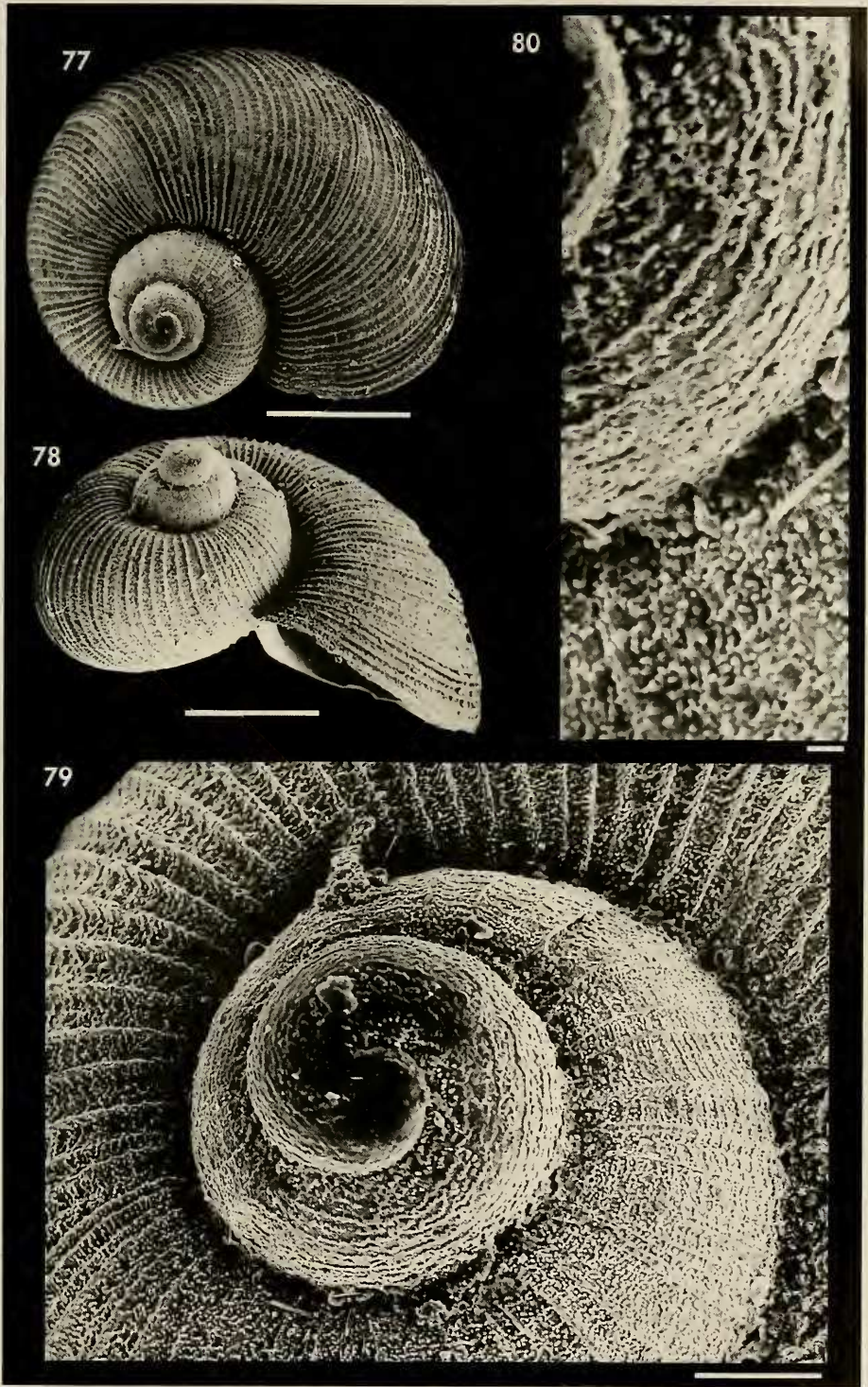
The demarcation between the protoconch (Fig. 79) and the teleoconch is not clear, but there is a change of the microsculpture, which may correspond with the end of the protoconch. So, the protoconch probably has only a little more than 1 whorl. On the nucleus there is a part without sculpture. Subsequently, there are many interrupted, irregular lines that are fused together in places,

interspersed with tubercles along the supposed protoconch (Fig. 80).

Teleoconch with about 1 1/2 whorls, with a fairly rapid development; it is sculptured by fine axial ribs which are slightly curved; they number only about 14 on the first half whorl, but later they are, more crowded and can reach more than 100 on the last whorl. Many fine spiral striae cover the shell and are evident in the interspaces, crossing the ribs to make them appear granular.

(Right page). Figures 77-80. *Macromphalina jibacoa* spec. nov. 77, 78: holotype (MNCN), Jibacoa, Cuba; 79: protoconch; 80: microsculpture of the protoconch. Scale bar, shells: 1.00 mm; protoconch: 0.1 mm; microsculpture: 0.01 mm.

(Página derecha). Figuras 77-80. *Macromphalina jibacoa* spec. nov. 77, 78: holotipo (MNCN), Jibacoa, Cuba; 79: protoconcha; 80: microescultura de la protoconcha. Escala, conchas: 1,00 mm; protoconcha: 0,1 mm; microescultura: 0,01 mm.



Aperture ovoid, with the outer lip sharp, only contacting the penultimate whorl for a short distance. Previous whorls and the ends of the crowded axial ribs are visible in the open umbilicus, which lacks a peripheral keel.

*Dimensions:* The holotype is the largest of the few shells examined.

*Distribution:* Only known from the type locality, from 4 m deep.

*Remarks:* The shell of *M. jibacoa* spec. nov. can be differentiated from *M. garcesi*, *M. palmalitoris* and *M. paradoxa*

by its less prominent protoconch. The same applies to *M. robertsoni* which has finer sculpture on the protoconch, with very fine and clearly separated spiral lines. The shells of *M. worsfoldi* and *M. canarreos* are the most similar, but these two species differ by having several distinct cords visible on the protoconch instead of the fine irregular lines. Also, *M. jibacoa* has abundant tubercles at the beginning of the teleoconch and, in this area, fewer and less prominent ribs (Figs. 79, 80).

### *Macromphalina apexplanum* spec. nov. (Figs. 81-83)

**Type material:** Holotype (Fig. 82) AMNH (194779) of 1.52 mm in maximum diameter, and 1 paratype (Fig. 81), both from St. Johns, Antigua, Lesser Antilles, in AMNH (226549) (Nowell-Usticke coll.). Paratypes: 3 from Bocas del Toro (FLMNH 231594); 1 (CER) (ex FLMNH) and 5 (FLMNH 160484), East Colon I., Panama; 3 more, collected in 10-25 m, Nenguange Bay, Santa Marta, Colombia (IIMC); 1 more, off Angel Reef, Tobago (CHL).

**Other material examined:** Only known from the type material.

**Type locality:** St. Johns, Antigua, Lesser Antilles.

**Etymology:** The specific name is derived from the latin words *apex*, *apex*, and *planum*, flat, because of the form of its protoconch and spire.

*Description:* Shell (Figs. 81, 82) small, depressed, circular. Protoconch (Fig. 83) with a little more than 1 1/2 whorls. Examination of the holotype showed the protoconch to be a little eroded, appearing smooth. Examination of the material from Colombia showed a similar protoconch with a few very fine spiral lines. The axis of the protoconch is tilted obliquely in relation to that of the shell.

Teleoconch with about 1 1/2 whorls. Spiral sculpture is evident on the first half whorl, but only a few axial ribs are visible. Subsequently both spiral and axial sculpture are well defined, giving a reticulated appearance. The last whorl is somewhat angulated peripherally. The umbilicus is deep. The aperture wide, oblique, with a narrow peristome.

*Dimensions:* Around 1.5 mm in diameter.

*Distribution:* The presence of the species in several separated localities suggests a wide distribution area, at least in the south Caribbean. It was found in depth less than 50 m.

*Remarks:* This species is different from all those previously mentioned in the present study because of its depressed spire and protoconch. It can be differentiated from one fossil species with similar protoconch, *Macromphalina pierrot* Gardner, 1948 (USNM 325462), from the Pliocene of North Carolina, which has a similar number of whorls but is larger and higher, and with a more elevated spire (see GARDNER, 1948 and photographs in PILSBRY, 1953, p. 435, pl. 52, figs. 6, 6a and 6b).

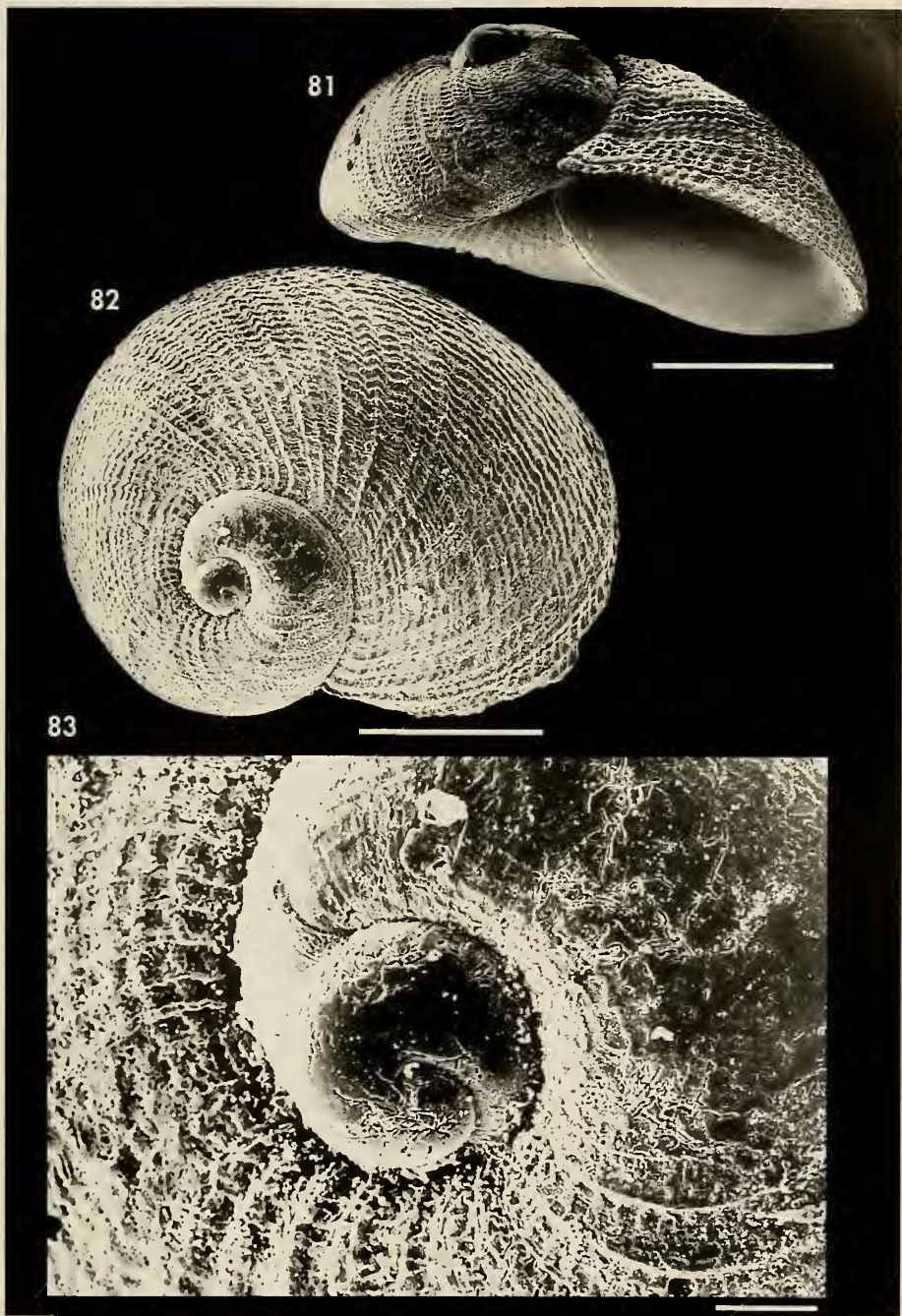
### *Macromphalina diazmerlanoi* spec. nov. (Figs. 84-87, 113)

**Type material:** Holotype (Figs. 84-87), of 4.9 x 4.0 mm deposited in USNM (880117) (ex IIMC).

**Other material examined:** Only known from the holotype.

**Type locality:** Bahía Nenguange, Santa Marta, Caribbean coast of Colombia.

**Etymology:** Named after J. Manuel Díaz Merlano, malacologist of Santa Marta, Colombia, who collected the single known specimen of this species.



Figures 81-83. *Macromphalina apexplanum* spec. nov. 81: paratype (AMNH), Antigua, Lesser Antilles; 82: holotype (AMNH), Antigua, Lesser Antilles; 83: protoconch. Scale bar, shells: 0.5 mm; protoconch: 0.1 mm.

*Figuras 81-83. Macromphalina apexplanum spec. nov. 81: paratipo (AMNH), Antigua, Antillas Menores; 82: holotipo (AMNH), Antigua, Antillas Menores; 83: protoconcha. Escala, conchas: 0,5 mm; protoconcha: 0,1 mm.*

*Description:* Shell (Figs. 84, 85) oval globose, with an erect apex, white, somewhat solid and slightly translucent.

Protoconch (Fig. 86) with 1 1/2 whorls. The nucleus has a diameter of 0.08 mm, with a microscopically roughened surface that extends for a little more than a half whorl. This sculpture is then replaced by several fine spiral threads, with intermediate axial extensions, that do not reach the thread above. Colour white.

The teleoconch of the holotype has 2 1/2 whorls with rapid development; it is sculptured by elevated axial ribs which are crossed by many small spiral threads; the axial ribs number 22 on the first whorl and about 53 on the body whorl. Well defined nodules are formed at the points of intersection of the spiral and axial sculpture (Fig. 87). Magnification reveals very fine spiral microsculpture on and between the spiral threads.

Aperture ovoid, wide, with the outer lip a little angulated towards the periphery. Previous whorls are visible in the large umbilicus.

Radula (Fig. 113) with the rachidian tooth showing three small denticles on each basal support; the lateral teeth are trapezoid in form, wide basally, with the

sharp area also wide, where there is a central gross and blunt denticle. There are 8-9 smaller denticles on its external border and 4-5 on the internal one. Marginal internal teeth oar-shaped, strongly curved and pointed, with their external margin smooth and slight incisions in their internal margin.

*Dimensions:* Those of the holotype.

*Distribution:* Only known from the type locality.

*Remarks:* The morphology of the shell and radula confirms that this species belongs to the genus *Macromphalina*.

It can be separated from *Megalomphalus pilsbryi* by its lack of an umbilical keel. The teleoconch is more elevated than in most of the species described in the genus *Macromphalina* from Caribbean waters. Furthermore, its protoconch has a sculpture very different from that of the other species in this genus, with those of *Megalomphalus pilsbryi* and *M. oxychone* being the most similar. However, the spiral lines of *M. diazmerlanoi* are finer, with the axial extensions longer and fewer than those on *M. pilsbryi* and also fewer than on *M. oxychone*.

### *Macromphalina harryleei* spec. nov. (Figs. 88-91)

**Type material:** Holotype (Fig. 88), of 4.3 x 3.0 mm (FLMNH 257445); Paratypes: 1 shell, Courland Bay (CHL); 4 shells, Goat Is., Scarborough Bay (CJB); 1 shell (Fig. 89), Goat Is., Scarborough Bay (CER, ex-CJB). All the localities from Tobago.

**Other material examined:** Only known from the type material.

**Type locality:** Tobago, Lesser Antilles.

**Etymology:** Named after Harry G. Lee, malacologist of Jacksonville, Florida, who sent us the first shell of this species and cooperated in the loan of the type material.

*Description:* Shell (Figs. 88, 89) oval globose, with the apex not prominent, white, fairly solid and not translucent.

Protoconch (Fig. 90) with 1 1/8 whorls. The nucleus has a diameter of 0.09 mm, with a microscopically rough-

(Right page). Figures 84-87. *Macromphalina diazmerlanoi* spec. nov. 84, 85: holotype (USNM), Santa Marta, Colombia; 86: protoconch; 87: microsculpture of the teleoconch. Scale bar, shells: 1.00 mm; protoconch: 0.1 mm; microsculpture: 0.2 mm.

(Página derecha). Figuras 84-87. *Macromphalina diazmerlanoi* spec. nov. 84, 85: holotipo (USNM), Santa Marta, Colombia; 86: protoconcha; 87: microescultura de la teleoconcha. Escala, conchas: 1,00 mm; protoconcha: 0,1 mm; microescultura: 0,2 mm.



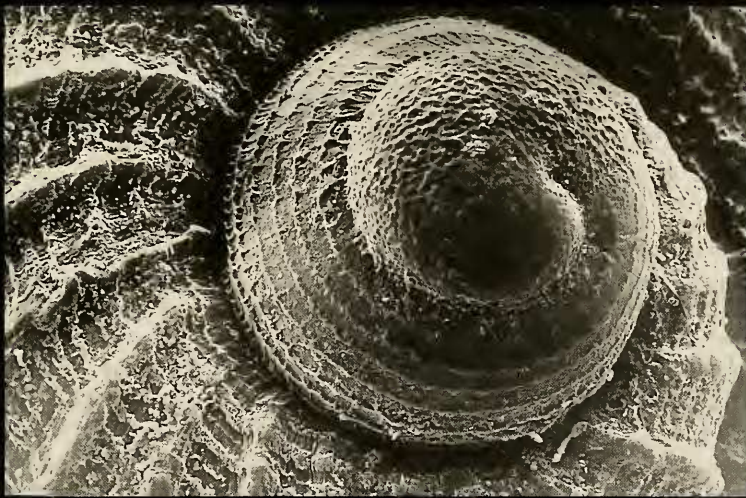
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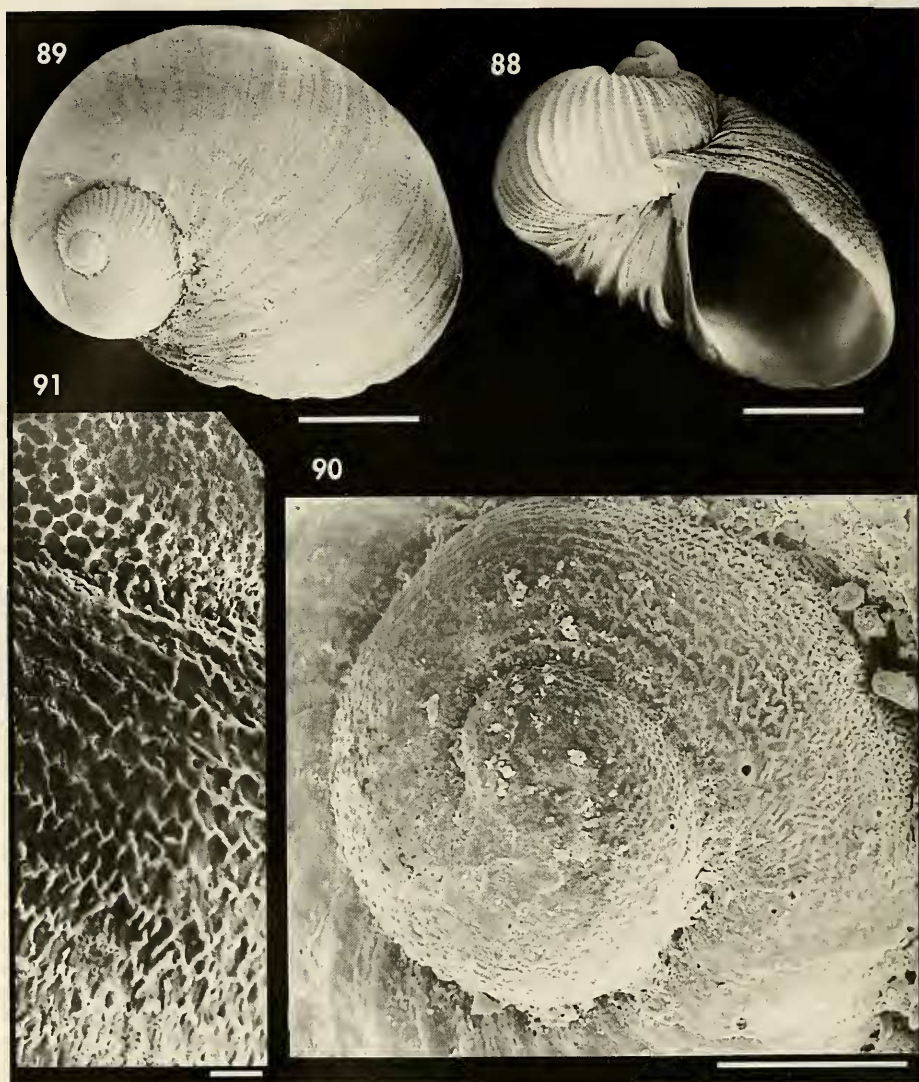


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Figures 88-91. *Macromphalina harryleei* spec. nov. 88: holotype (FLMNH), Tobago, Lesser Antillas; 89: paratype (CER), Tobago, Lesser Antillas; 90: protoconch of the paratype; 91: microsculpture of the protoconch. Scale bar, shells: 1 mm; protoconch: 0.1 mm; microsculpture: 0.01 mm.

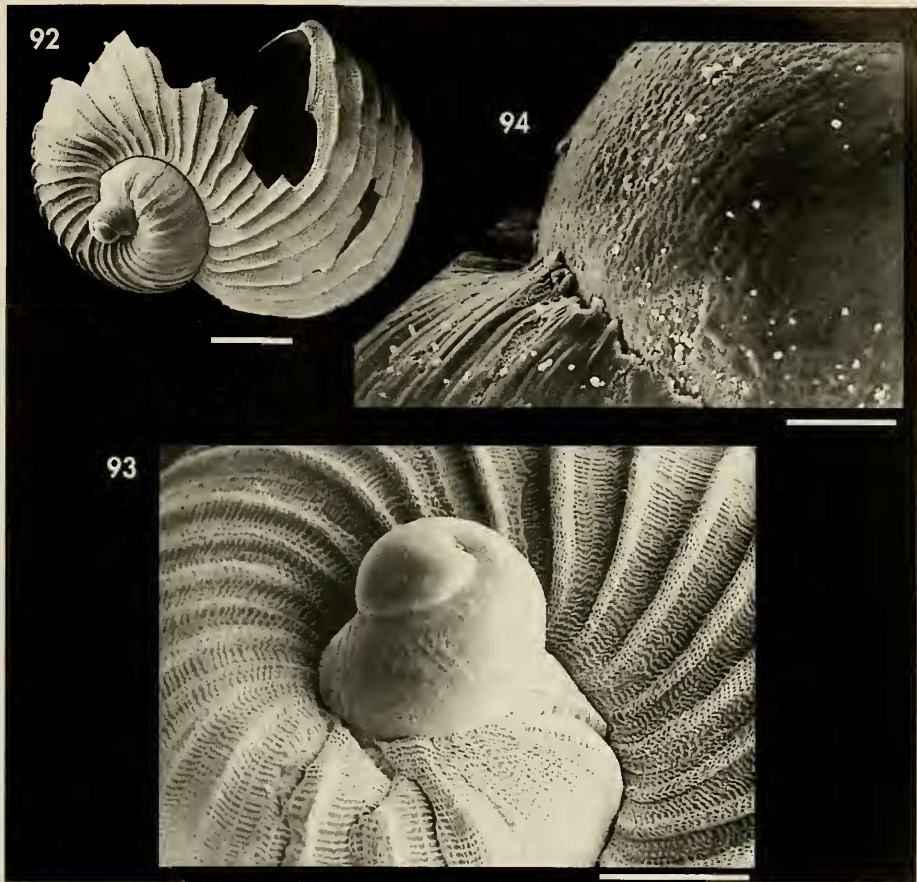
Figuras 88-91. *Macromphalina harryleei* spec. nov. 88: holotipo (FLMNH), Tobago, Antillas Menores; 89: paratipo (CER), Tobago, Antillas Menores; 90: protoconcha del paratipo; 91: microescultura de la protoconcha. Escala, conchas: 1 mm; protoconcha: 0,1 mm; microescultura: 0,01 mm.

ned surface, that extends for a little more than a half whorl. This sculpture is then replaced by several fine spiral threads, very irregular and more numerous than usual (about 14), which are more irregular near the end of the proto-

conch and are fused with other nearby extensions (Fig. 91). Colour white.

Teleoconch. The holotype has  $2 \frac{1}{4}$  whorls with rapid development; it is sculptured with elevated axial ribs which are crossed by many small spiral





Figures 92-94. *Macromphalina susoi* spec. nov. 92: holotype (FLMNH), Destin, Florida; 93: protoconch; 94: microsculpture of the protoconch. Scale bar, shells 0.5 mm; protoconchs: 0.2 mm; microsculpture: 0.02 mm

*Figuras 92-94. Macromphalina susoi* spec. nov. 92: holotipo (FLMNH), Destin, Florida; 93: protoconcha; 94: microescultura de la protoconcha. Escala, conchas 0,5 mm; protoconchas: 0,2 mm; microescultura: 0,02 mm

threads; the axial ribs number 34 on the first whorl, later disappearing on the body whorl, where they are replaced by very numerous crowded lines.

Aperture ovoid, wide, with the outer lip a little sharp. 18 prominent ribs extend into the wide umbilicus.

*Dimensions:* Those of the holotype.

*Distribution:* Only known from Tobago.

*Remarks:* The morphology of the shell and protoconch is enough to consider the species in the genus *Macromphalina*.

The species with the most similar shell is *M. redferni*, but the protoconch of this last species is brown and the spiral lines in the protoconch more regular, finer and without supplementary connections between them. *M. diazmerlanoi* has its protoconch with a different sculpture, the threads fewer and with only axial extensions. Another species with irregular spiral threads on the protoconch is *M. jibacoa*, which is differently sculptured, with many tubercles and it has the supplementary lines in a spiral direction.

*Macromphalina susoi* spec. nov. (Figs. 92-94)

**Type material:** Holotype (Fig. 92) of about 3.2 mm, off Destin, Florida (FLMNH); 1 paratype (juvenile), Pompano Beach, Florida (FLMNH 143897); 1 paratype (juvenile shell), Fort Pierce, Florida (CHL).

**Other material examined:** Only known from the type material.

**Type locality:** Destin, Florida, USA.

**Etymology:** Named after Jesús Méndez "Suso", biologist of the CACTI, in the Vigo University, for his help with the SEM study of this group and in other research projects.

*Description:* Shell (Fig. 92) oval-lenticular, white, fragile and not translucent, with an erect and vertical apex.

Protoconch (Figs. 93) with 1 elongate whorl without any sculpture. The nucleus and the rest of the protoconch appears smooth, although with higher magnification shows a rough surface (Fig. 94). The axis is slightly tilted in relation to that of the shell. Colour white.

Teloconch with about 2 <sup>1</sup>/<sub>2</sub> whorls, with rapid development; it is sculptured by fine axial ribs which are slightly curved, numbering about 20 on the first whorl, with wide spaces between them. The spiral striae are very small and numerous, crossing the ribs to form a reticulated pattern.

Aperture ovoid, with the outer lip sharp, only contacting the penultimate whorl for a short distance. An open umbilicus without any keel shows the previous whorls.

*Dimensions:* Only known from the holotype.

*Distribution:* Only known from Florida.

*Remarks:* The small paratype of *M. palmalitoris* in the same lot as the holotype (ANSP 185813) may be this species, because of the size and shape of the protoconch, but it is too small to allow a good comparison.

The holotype of *M. susoi* spec. nov. was broken during the preparation for SEM photography. Maximum size of the complete shell was 3.2 mm, but the fragment in Fig. 92 has 2.8 mm.

The protoconch of *M. susoi* is very characteristic and differs from those of the rest of the species of the Caribbean. Only four species of this area have the protoconch tilted: *M. floridana*, *M. garcesi*, *M. apexplanum* and *M. thompsoni*, these being very different in the shell characters, especially in the microsculpture of the protoconch and teloconch. These important differences allowed us to describe this species in spite of the small amount of available material.

*Macromphalina thompsoni* spec. nov. (Figs. 95-99)

**Type material:** Holotype (Fig. 95) of about 2.6 mm in diameter, (FLMNH 143893), East Colon Is., Bocas Toro, Panama; 4 paratypes (Fig. 96), East Colon Is., Bocas Toro, Panama (FLMNH 160485); 1 paratype, East Colon Is., Bocas Toro, Panama (CER ex-FLMNH).

**Other material examined:** Only known from the type material.

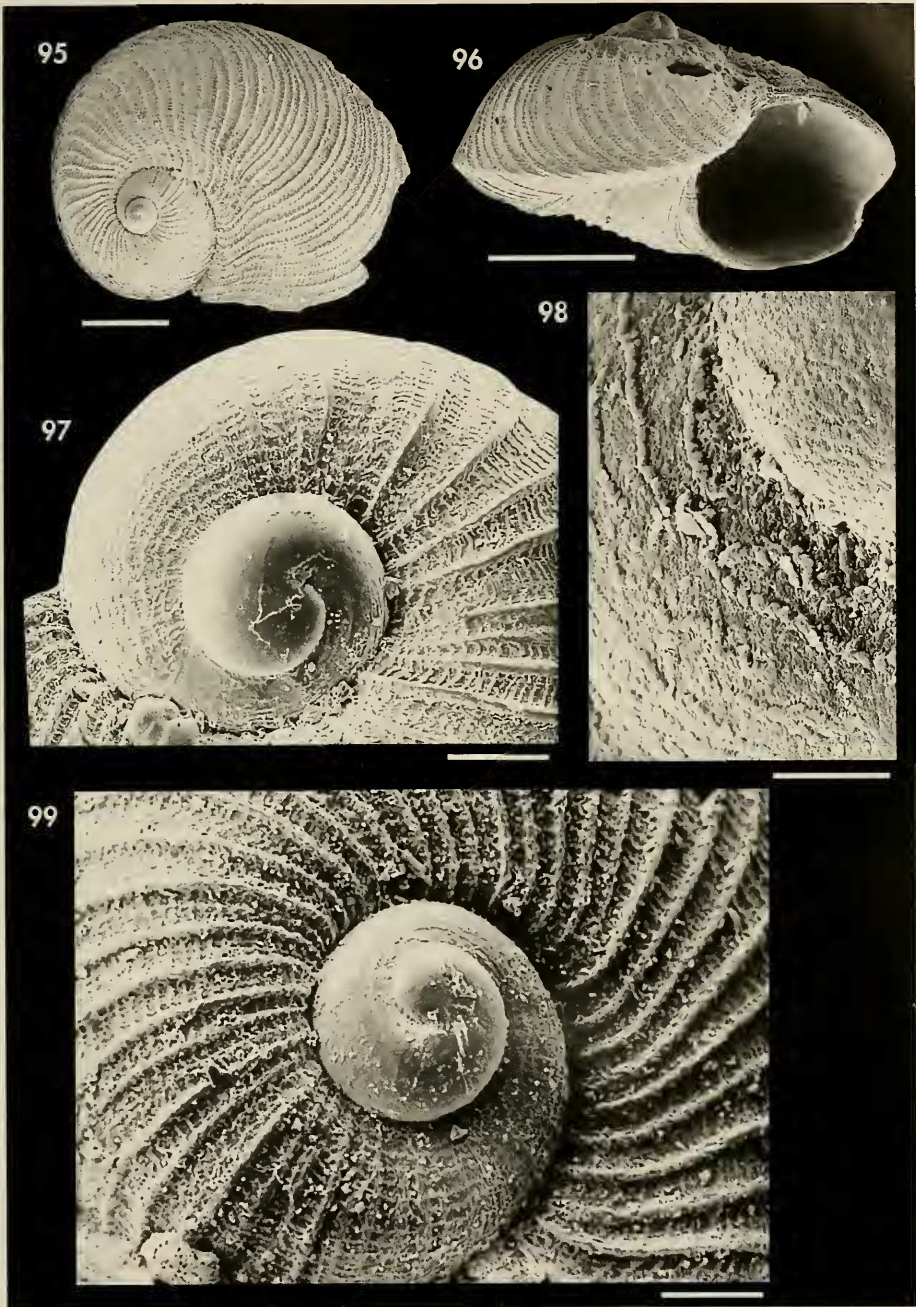
**Type locality:** East Colon-Is., Bocas Toro, Panama.

**Etymology:** Named after Fred G. Thompson, curator of the FLMNH for his help sending material used in the present work.

*Description:* Shell (Figs. 95, 96) oval-lenticular, white, fragile and not translucent.

Protoconch (Figs. 97, 99) not prominent, with little more than 1 whorl. The nucleus appears smooth, but magnification shows a slightly rough surface (Fig.

98); the subsequent half whorl is smooth and on the last half whorl there are irregular nodular spiral lines that are only visible under high magnification (Fig. 98). The axis of the protoconch is slightly tilted in relation to that of the teloconch. The colour of the protoconch is white.



Figures 95-99. *Macromphalina thompsoni* spec. nov. 95: holotype (FLMNH), Bocas Toro, Panama; 96: paratype (FLMNH), Bocas Toro, Panama; 97: protoconch of a paratype (CER); 98: microsculpture; 99: protoconch of the holotype. Scale bar, shells: 0.5 mm; protoconchs: 0.1 mm; microsculpture: 0.02 mm.

Figuras 95-99. *Macromphalina thompsoni* spec. nov. 95: holotipo (FLMNH), Bocas Toro, Panamá; 96: paratipo (FLMNH), Bocas Toro, Panamá; 97: protoconcha del paratipo (CER); 98: microescultura; 99: protoconcha del holotipo. Escala, conchas: 0,5 mm; protoconchas: 0,1 mm; microescultura: 0,02 mm.

Teleoconch with about  $1\frac{1}{2}$  whorls, with rapid development; it is sculptured by fine axial ribs which are slightly curved, numbering about 18-25 on the first whorl, with wide spaces between them, but being almost imperceptible on the first half whorl. The spiral striae are small and numerous, and are evident in the intervals between the ribs. There is a distinct angulation at the periphery.

Aperture ovoid, with the outer lip sharp, only contacting the penultimate whorl for a short distance. An open umbilicus without any keel shows the previous whorls.

*Dimensions:* The biggest specimen studied was the holotype.

*Distribution:* Only known from the type locality.

*Remarks:* *M. thompsoni* spec. nov. may be differentiated from most of the Caribbean species by its peripheral angulation, being similar only to *M. floridana*. The differences with this last species are: *M. thompsoni* has the peripheral angulation less pronounced; its spiral striation is formed by threads more separated and differentiated; its protoconch is less tilted than that of *M. floridana*. Also the sculpture of its protoconch is different, having spiral irregular nodular threads on the last half whorl, instead of the smooth surface of *M. floridana*.

As both species have direct larval development, the distance of both areas of distribution precludes contact between them.

### *Macromphalina* sp. 1 (Figs. 100, 101)

**Material examined:** Bahamas: Abaco: 1 shell (Fig. 100), Chub Rocks (CRC 9913).

*Dimensions:* 2.0 mm in diameter.

*Remarks:* The shell (Fig. 100) has a form similar to others from the area. Its protoconch (Fig. 101) has 6 spiral threads on the nucleus decreasing to 5 at its end. The most similar species are: *M. worsfoldi*, which has stronger cords on the protoconch and different spiral sculpture on the first whorl of the teleoconch; *M.*

*canarreos*, with more spiral cords on the protoconch and also different spiral sculpture on the first whorl of the protoconch; *Megalomphalus troudei*, which is more elevated and has more spiral cords on the protoconch. As the species is represented by only one shell, with no important distinguishing characters, we await more material or information.

### *Macromphalina* sp. 2 (Figs. 102-103)

**Material examined:** Mexico: 1 shell (Fig. 102), 6 m, Puerto Morelos, Quintana Roo.

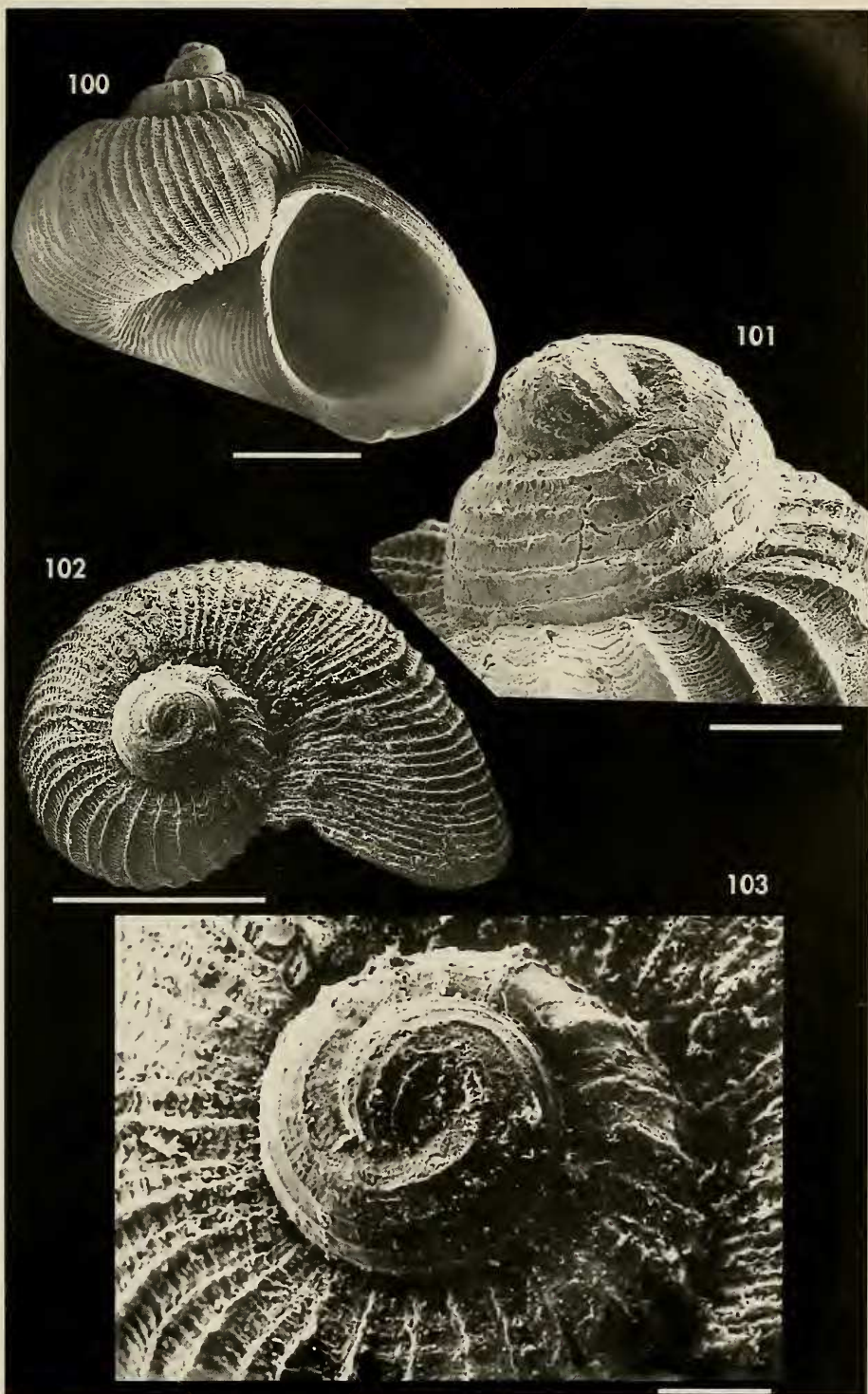
*Dimensions:* 1.2 mm in diameter.

*Remarks:* This shell has a similar protoconch (Fig. 103) to that of *Macromphalina* sp. 1, and for this reason is different from the other species mentioned in the present study, but it is distinguished

from *Macromphalina* sp. 1 by its more depressed spire. Also the protoconch (Fig. 103) suggests direct development, and it is unlikely that they are conspecific in view of the widely separated collecting localities.

(Right page). Figures 100, 101. *Macromphalina* sp. 1. 100: shell from Bahamas (CRC); 101: protoconch. Figures 102, 103. *Macromphalina* sp. 2. 102: shell from Yucatán, Mexico (CER); 103: protoconch. Scale bar, shells: 0.5 mm; protoconchs: 0.1 mm.

(Página derecha). Figuras 100, 101. *Macromphalina* sp. 1. 100: concha de Bahamas (CRC); 101: protoconcha. Figuras 102, 103. *Macromphalina* sp. 2. 102: concha de Yucatán, México (CER); 103: protoconcha. Escala, conchas: 0,5 mm; protoconchas: 0,1 mm.



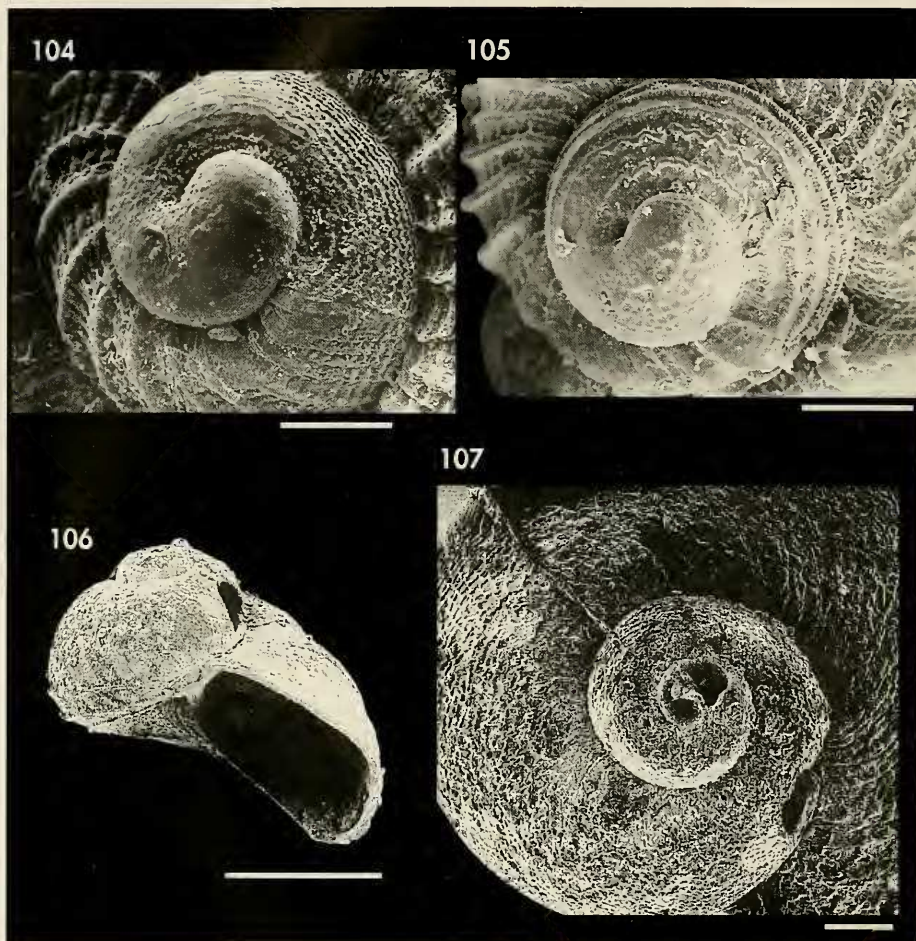


Figure 104. Protoconch of *Macromphalina redferni*, Bocas del Toro, Panama (FLMNH). Figure 105. Protoconch of *Megalomphalus pilsbryi*, Bocas del Toro, Panama (FLMNH). Figures 106, 107. *Megalomphalus caro*. 106: holotype (USNM), Fernandina, Florida; 107: protoconch of the holotype. Scale bar, shell: 0.5 mm; protoconchs: 0.1 mm.

Figura 104. Protoconcha de *Macromphalina redferni*, Bocas del Toro, Panamá (FLMNH). Figura 105. Protoconcha de *Megalomphalus pilsbryi*, Bocas del Toro, Panamá (FLMNH). Figuras 106, 107. *Megalomphalus caro*. 106: holotipo (USNM), Fernandina, Florida; 107: protoconcha del holotipo. Escala, concha: 0,5 mm; protoconchas: 0,1 mm.

(Right page). Figure 108. Radula of *Megalomphalus cf. pilsbryi* (ANSP). Figures 109-111. Radula of *Macromphalina palmalitoris*, Cienfuegos, Cuba. 109: radula; 110: detail of the rachidian tooth; 111: detail of the lateral and marginal teeth. Figure 112. Radula of *Macromphalina worsfoldi*. Scale bar 0.001 mm.

(Página derecha). Figura 108. Rádula de *Megalomphalus cf. pilsbryi* (ANSP). Figuras 109-111. Rádula de *Macromphalina palmalitoris*, Cienfuegos, Cuba. 109: rádula; 110: detalle del diente raquídeo; 111: detalle de los dientes laterales y marginales. Figura 112. Rádula de *Macromphalina worsfoldi*. Escala 0,001 mm.

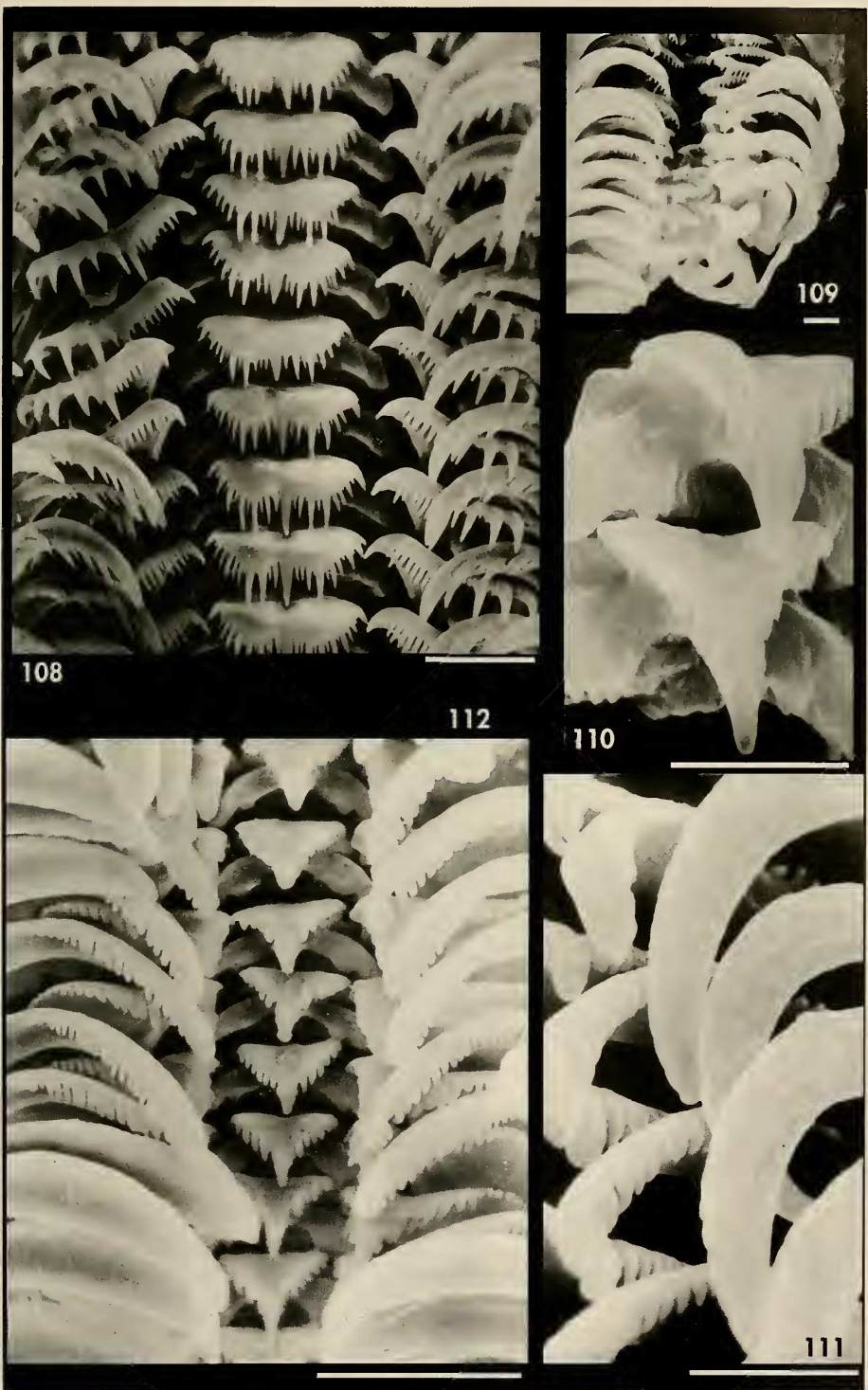




Figure 113. Radula of *Macromphalina diazmerlanoi* spec. nov. (USNM). Scale bar 0.001 mm  
 Figura 113. Rádula de *Macromphalina diazmerlanoi* spec. nov. (USNM). Escala 0,001 mm

## CONCLUSIONS

Twenty-three species (seven of *Megalomphalus* and sixteen of *Macromphalina*) and some doubtful forms have been studied. The species of *Megalomphalus* include six taxa already known, another one described as new, and the doubtful forms that we consider close to *Megalomphalus pilsbryi* and which may all constitute a species-complex.

Within *Macromphalina*, only two species were previously known taxa; two more are not described because of insufficient material for study; and the other twelve species are described as new.

With regard to the distribution, only a few species are widely dispersed: *Megalomphalus pilsbryi* seems to be the species with the widest range of distribution (from Florida and Bermuda to Nicaragua), in spite of having a short protoconch; but this taxon may represent a complex of species, which will need future investigation.

Two more species have large distribution areas (*Macromphalina palmalitoris* and *M. apexplanum*). The first one from Florida, Cuba, Puerto Rico and Panama, and the second in the southern Caribbean.

Another four species predominate in some areas, but some isolated shells were found elsewhere: a problem is that one of these species, *Megalomphalus troudei*, was described from Guadeloupe, far from the present collecting area, suggesting either a large area of distribution, or the existence of two different species; *Macromphalina garcesi*, mostly from Cuba, one shell from Puerto Rico, but with a few similar shells from Panama; *M. redferni*, mostly from the Bahamas, but with a few similar shells from Panama; *M. oxychone*, mostly from Cuba but with one shell from the Virgin Islands and one from the Bahamas.

(Right page). Figures 114-116. *Macromphalina pierrrot* Gardner, holotype (USNM). Figures 117-120. *Gyrodus duplinensis* Dall. 117-119: holotype (USNM); 120: drawing of the protoconch of *G. duplinensis*. Scale bars, shells: 1.00 mm; protoconch: 0.1 mm.

(Página derecha). Figuras 114-116. *Macromphalina pierrrot* Gardner, holotipo (USNM). Figuras 117-120. *Gyrodus duplinensis* Dall. 117-119: holotipo (USNM); 120: dibujo de la protoconcha de *G. duplinensis*. Escalas, conchas: 1,00 mm; protoconcha: 0,1 mm.



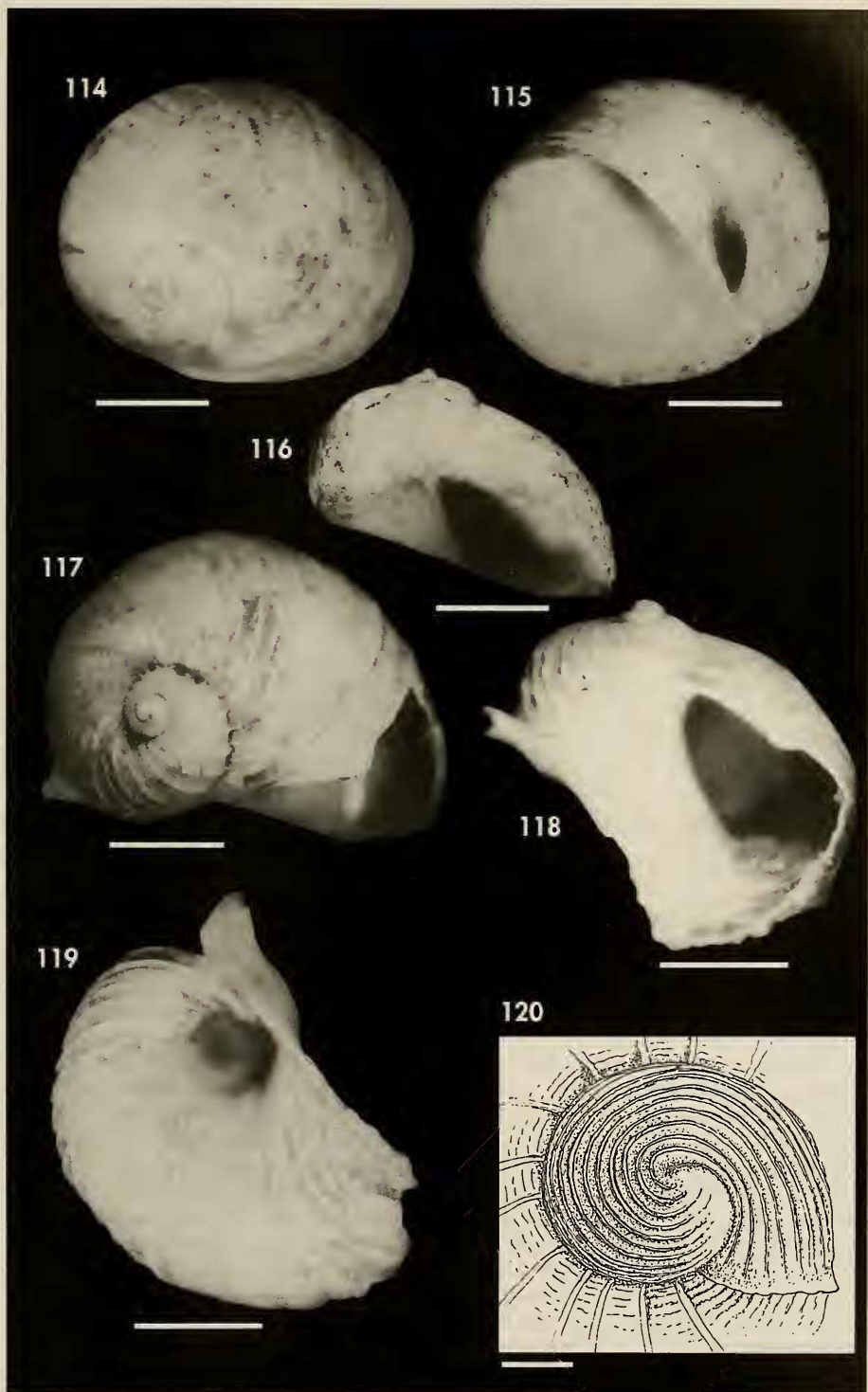


Table I. Characters of the protoconchs of the Caribbean *Megalomphalus* and *Macromphalina*.  
 Tabla I. Caracteres de las protoconchas de las especies caribeñas de *Megalomphalus* y *Macromphalina*.

Genus	species	colour of larval whorls	number of whorls of the protoconch	axis of the protoconch in relation to the shell	sculpture of the nucleus of the protoconch	sculpture of the rest of the protoconch
<i>Megalomphalus</i>	<i>pilsbryi</i>	white	1	vertical	strongly rough	5 strong cords lined at borders
	cf. <i>pilsbryi</i>	cream to brown	1 - 1 1/8	vertical	rough (variable)	5 strong cords lined at borders
	<i>oxychane</i>	brown	1 1/2	vertical	rough	5 rough and denticulated cords
	<i>traudei</i>	light brown	1 1/4	vertical	spiral lines	6-7 spiral cords
	<i>lamellosus</i>	white	1	vertical	smooth?	5 threads
	<i>millerae</i>	white	1 1/4	vertical	smooth?	7-8 small cords
	<i>caro</i>	white	?	vertical?	?	?
	<i>margaritae</i>	white	1 1/4	vertical	rough	5 threads with depressed lines
<i>Macromphalina</i>	<i>floridana</i>	white	1	oblique	smooth	smooth
	<i>palmolitoris</i>	white	1 3/4	vertical	smooth	4 fine threads; later striae
	<i>garcesi</i>	white	1 1/4	oblique	small tuberc.	5 fine threads
	<i>robertsoni</i>	white	1 1/8	vertical	smooth-lines	6 threads with tubercles between
	<i>paradoxa</i>	light brown	2	vertical	smooth	5 undulating threads with lines between
	<i>worsfoldi</i>	white	1	vertical	6 cords	4-5 cords with very numerous lines between
	<i>canarreos</i>	white	1 1/8	vertical	6 cords	7 cords
	<i>redferni</i>	brown	1	vertical	thinly rough	12-13 irregular threads
	<i>jibacoa</i>	white	1	vertical	smooth	irregular lines and tubercles
	<i>apexplanum</i>	white	1 1/2	oblique	smooth?	fine spiral lines
	<i>diazmerlanoi</i>	white	1 1/2	vertical	rough	6 spiral threads, axial lines
	<i>harryleei</i>	white	1 1/8	vertical	rough	15 spiral irregular and interlaced threads
	<i>susoi</i>	white	1	oblique	smooth	smooth
<i>thompsoni</i>	white	1	slightly oblique	almost smooth	few irregular nodular spiral threads	
sp. 1	white	1	vertical	spiral lines	5 spiral threads	
sp. 2	white	1	vertical	spiral lines	4 spiral threads	

Most of the species studied (13) are limited to small areas:

Five species are apparently limited to Cuba: *Megalomphalus lamellosus* is only known from the type material and it was not found in the material examined for the present study; another four species (*Macromphalina canarreos*, *M. paradoxa*, *M. robertsoni*, *M. jibacoa*) were collected only in Cuba; curiously, *M. paradoxa* is a species which has more than 1 whorl of protoconch, and so it is supposed that, for this reason, it could have more possibilities of dispersion.

Three more species seem to be limited to Florida (*Megalomphalus caro*, *Macromphalina floridana*, *M. susoi*); one more to Florida and the Bahamas (*Megalomphalus margaritae*); one to the Virgin Islands (*Megalomphalus millerae*); one to Tobago (*Macromphalina harryleei*); one to Colombia (*Macromphalina diazmerlanoi*); one to Panama (*Macromphalina thompsoni*); and, finally, one species to the Bahamas (*Macromphalina worsfoldi*).

The genera studied have shown to comprise a group with a very important diversification. They probably were ori-

Table II. Characters of the teleoconchs of the Caribbean *Megalomphalus* and *Macromphalina*.  
 Tabla II. Caracteres de las teleoconchas de las especies caribeñas de *Megalomphalus* and *Macromphalina*.

Genus	species	axial ribs on first whorl	axial ribs on body whorl	spiral sculpture	strength of the sculpture	umbilicus
<i>Megalomphalus</i>	<i>pilsbryi</i>	30-42	60-100	fine	axial predominates	small, keeled
	cf. <i>pilsbryi</i>	40	60-100	fine	Spiral stronger on large shells	small, keeled
	<i>oxychone</i>	25-34	80-100	fine	axial predominates	small, keeled
	<i>traudei</i>	15	24	fine	spiral visible	medium, not keeled
	<i>lamellulus</i>	19	many?	fine	weak	medium, not keeled
	<i>millerae</i>	43	fading	very fine	almost exclusively spiral	large, strong axial ribs
	<i>caro</i>	no	incomplete?	undulating	spiral	medium
	<i>margaritae</i>	18	38	very fine	strong axial predominates	medium, keeled
	<i>Macromphalina</i>	<i>flaridana</i>	17-25	50	tiny	strong axial predominates
<i>palmaritoris</i>		13-15	15-35	well defined	axial predominates	large
<i>garcesi</i>		28-32	40-52	fine	axial predominates	very large
<i>rabertsoni</i>		33	60-80	fine	axial predominates	very large
<i>paradoxa</i>		45-55	90-110	very fine	axial predominates	large
<i>warsfoldi</i>		12	60	fine	axial predominates	large
<i>canarreas</i>		14	110	fine	axial predominates	large
<i>redferni</i>		24-30	60-90	fine	axial obsolescent	large
<i>jibacaa</i>		14	100	fine	axial predominates	large
<i>apexplanum</i>		few	44	well defined	almost reticulated	large
<i>diazmerlanai</i>		22	53	well defined	axial predominates	large
<i>harryleei</i>		25	50	very fine	almost exclusively spiral	large
<i>susoi</i>		21	30	tiny	axial predominates	large
<i>thompsoni</i>		22-28	55	fine	axial predominates	large
sp. 1		24	65	weak	axial predominates	large
sp. 2	42	65	weak	axial predominates	large	

ginated from a few species with pelagic development, later changing to direct development, because of a process of speciation by isolation, typical in oceanic islands.

Since most of them are species with a small area of distribution, and since it has been impossible to study material from all of the Caribbean islands, it is possible that more species remain unknown and await future studies.

Many species are quite similar with small differences, and these differences have been shown in two tables, one of them referring to the characters of the protoconch (Table I) and the other to those of the teleoconch (Table II).

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