y $H_B = 20$ m, la ecuación anterior se transforma en:

$$30R^2 + 8R - 240 = 0$$

donde $R = 2{,}70$ m

Para fines prácticos tomemos $R = 2{,}5$ m
entonces:

$E = 1{,}25R = 3{,}12$ m
$T = R \quad = 2{,}50$ m ver fig. (4)
$S_p = \text{Sobre-perforación} = R/3 = 0{,}80$ m

$$H_c = \left(\frac{3H_B - 2R}{3} \right) = 18{,}33 \text{ m}$$

Siendo entonces la carga por barreno:

$$Q = q \times H_c = 3{,}9 \text{ Kg/m} \times 18{,}33 = 71{,}5 \text{ Kg.}$$

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THE GENUS ARCINELLA (MOLLUSCA: BIVALVIA) IN VENEZUELA AND SOME ASSOCIATED FAUNAS

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RESUMEN

Las cuatro especies vivientes y los numerosos fósiles del género de bivalvos marinos *Arcinella* Schumacher, de la familia Chamidae, están restringidas a la América tropical y subtropical, encontrándose las formas más antiguas en sedimentos del Mioceno medio de toda esta región. El género fue revisado por Nicol (1952) que estableció dos linajes, uno Caribe y otro de Florida con *Pseudochama draconis* Dall, de la Formación Chipola (Mioceno inferior de Florida) como ancestro común a ambos. Varios autores Weisbord 1964; Jung 1965; Macsotay 1965 y Pérez Nieto 1965) han reportado previamente al género en Venezuela. En base al estudio de nuevo material, la forma identificada como *Arcinella yaquensis* (Maury) por Jung (1965), proveniente de la Formación Cantaure del Mioceno inferior de la península de Paraguaná, se considera una especie nueva, *A. jungi.* Otra especie nueva, *A. candelariana,* de las capas de La Candelaria, posiblemente infrayacentes a la Formación Cantaure, resulta ser la forma más primitiva del género hasta la fecha. Además, las formas venezolanas parecen constituir un tercer linaje propio de América del Sur septentrional, de importancia bioestratigráfica. De la reconsideración de posibles ancestros, se concluye que *Pseudochama draconis* es en realidad una *Arcinella* que se asigna aquí a un nuevo subgénero, *Nicolia,* quedando aún por descubrir el ancestro común a los tres linajes.

Se incluyen listas anotadas de algunos moluscos que se encuentran asociados con *Arcinella* en varias localidades. Estos ayudan a establecer la edad o afinidades regionales de dichas capas. En el caso de la Formación Mare de Cabo Blanco, Distrito Federal, hay una elevación importante en el porcentaje de taxa sobrevivientes en su fauna, acercando así la edad Lyelliana a la indicada por los foraminíferos planctónicos: Plioceno más superior, Zona de *Globorotalia tosaensis tenuitheca.*

ABSTRACT

Miocene to Recent forms of *Arcinella,* as they occur in Venezuela, are described, including two, new, early Miocene species one being the most primitive form so far known. A single lineage is involved, having biostratigraphic significance. Relationships within the Western Atlantic —Caribbean region are considered and a new subgenus, *Arcinella (Nicolia)* is erected for *Pseudochama draconis* (Dall, 1903) from the early Miocene Chipola Formation, Florida. Under the heading Associated Faunas, the accompanying molluscan assemblages at the various Venezuelan localities, are mentioned briefly. In the case of the Mare Formation, Cablo Blanco, an important increase in the percentage of surviving taxa is documented and a new species named.

INTRODUCTION

> "The generic name *Arcinella* [Schumacher, 1817] having been considered a homonym of *Arcinella* Oken, 1815, *Echinochama* [Fischer, 1887] has long been used instead. However, a ruling of the International Commission on Zoological Nomenclature (Opinion 417, 1956) has suppressed Oken's work as nonbinomial; thus, *Arcinella* Schumacher —the type of which is *A. arcinella* (Linnaeus, 1767)—must be reinstated." —Keen (1971:149).

This marine genus is restricted essentially to tropical America; it appeared first early in the Miocene and spread rapidly throughout the Caribbean and beyond. Amongst the Chamidae, the genus *Chama* Linné lives permanently attached by the left valve whereas *Arcinella,* in common with *Pseudochama,* attaches itself by the right valve, but for a short period of time only, becoming thereafter free-living.

There are four living species: *A. cornuta* Conrad, South Carolina to Florida, and Gulf of México to Yucatán; *A. arcinella* (Linné), Caribbean to northern Brazil; *A. brasiliana*

(Nicol), southern Brazil and *A. californica* (Dall), Baja California to Panamá.

Species already reported from Venezuela are the following:

A. yaquensis (Maury). Jung (1965:450). Cantaure Formation, Paraguaná Peninsula, early Miocene.

A. trachyderma (Pilsbry & Johnson). Nicol (1952:808), no locality given.

A. antiquata (Dall). Macsotay (1965:44), Cerro Negro Member, Cubagua Formation, Araya Peninsula, late Miocene.

A. arcinella (Linné). Pérez Nieto (1965:14), Cumaná Formation, Cumaná, Pliocene.

Arcinella species "a", "b". Weisbord (1964:247, 248), Mare Formation, Cabo Blanco, Pliocene.

The genus was reviewed by Nicol (1952, 1953); he found that, in the southeastern United States, only one species is present, *A. cornuta,* having remained essentially unchanged from middle Miocene times to the present. Similarly, the Caribbean forms he found to be mainly akin to the extant species of that area, *A. arcinella,* to which is also closely related the Panamic form, *A. californica*. Thus, he recognised two lines of differentiation as being established by late Miocene times. He pointed out that *A. arcinella* is preceded by more primitive forms, the most primitive being *A. yaquensis* from the middle Miocene Gurabo Formation, Dominican Republic. In the north, on the contrary, a different situation obtains: *A. cornuta* appeared fully developed in the middle Miocene Shoal River Formation, Florida, if not by late early Miocene times in the Chipola Formation, Florida, based on a single reported specimen requiring confirmation (Nicol, 1952:811). He deduced that its ancestor must have been a *Pseudochama,* but with a nodulose surface similar to that of *Arcinella*. After considering six possible candidates, he concluded that the ancestor was, in all likelihood, *Pseudochama draconis* (Dall) from the Chipola Formation.

Important earlier work on the Chamidae was that of Odhner (1917, 1919). On anatomical and morphological grounds he recognised that more than one genus was involved, leading to the establishment of a second genus, *Pseudochama* Odhner 1917, with *Echinochama* and *Eopseuma* Odhner, 1919, as subgenera. Both works are extensively quoted in Gardner (1926:92-94). Later, Odhner (1955:2) transferred *P. draconis* to *Eopseuma*.

New Venezuelan material, collected by the authors, comes from six Miocene localities in the State of Falcón and additional material has also been obtained from the previously reported Cantaure and Mare Formations. In the Universidad Central collections there is an unreported suite from Isla Cubagua as well as the reported material from the Araya Peninsula. A few worn specimens, of little diagnostic value, are to hand from the Tubará Formation, Colombia, and the Gatun Formation, Panamá.

Two of the Venezuelan forms of *Arcinella* have been referred to new species, one still more primitive than *A. yaquensis*. Phylogenetically, a single lineage of biostratigraphic significance appears to be present in Venezuela. A reconsideration of relationships between *Arcinella* and *Pseudochama draconis* leads to the conclusion that *draconis* itself is an *Arcinella;* it is reassigned to a new subgenus *Arcinella (Nicolia);* it is not, therefore, ancestral to *Arcinella*. A review of the Caribbean forms of *Arcinella s.s.* suggests the probability that there are, in fact, two lineages: a Greater Antillean, or West Indian, lineage and a northern South American lineage. This raises a question as to the true identity of the genotype.

Until such time as the planned monographs on the faunas at the several localities are completed, the assemblages are discussed briefly in support of age determinations and regional affinities (see Associated Faunas).

For additional stratigraphical information reference should be made to the Léxico Estratigráfico de Venezuela (2ª Edición), 1970.

TAXONOMY

Family CHAMIDAE Lamarck, 1809

Genus ARCINELLA Schumacher, 1817

Schumacher, 1817, Essai d'un nouveau systeme des habitations des vers testaces, p. 142.

Type species (by tautonymy), *Chama arcinella* Linné, Recent, Caribbean.

Subgenus ARCINELLA s. s.

Arcinella (Arcinella) candelariana n. sp. Pl.1, figs. 1-5

Description. Right valve higher than long, subquadrate in outline, greatly inflated; left valve longer than high, flatter and subcircular. Umbones strongly prosogyrate, curled under in the right valve. Prodissoconch (nepionic shell) large, rectangular, sculptured with a few, widely spaced, concentric ribs. Central portion of disc raised in right valve, a broad, shallow sulcus between it and the anterior rounded ridge; posterior portion depressed along a pronounced edge running from the umbo to the postero-ventral margin; lunule entirely lacking, resulting in straight antero-dorsal margin; anterior margin sharply rounded, hardly produced; posterior margin broadly arcuate, merging with deeply convex ventral margin. Surface of right valve nodulose, the nodules arranged as close-set, fine radial riblets over the central disc and anterior portion, and as transverse riblets on the posterior area; 4 or 5 spined ribs, comprising a median pair of which the posterior is dominant, a second pair along the posterior edge of the central disc and, in one specimen, a few small spines hint at a rudimentary rib on the posterior slope; spines tend to be intermittent and there are no spines ahead of the median pair; a small attachment scar is present. The left valve, assumed to belong to the same species, is still moderately convex; it also has fine, radiating, nodulose riblets, of which as many as 9 are intermittently spined. The large, protruding cardinal tooth of the right valve has one or two deep grooves on its face; its upper surface and the overlying elongate socket are grooved and pustulose; ligament deeply inset. The left valve cardinal is flattened and lacks any grooves; the socket anterior to it is deep and grooved. Inner margins of the valves are finely crenulate.

Holotype. A right valve. Paleontological Research Institution (PRI), Ithaca, N.Y. Nº 8220.

Dimensions of Holotype. Length 27.3 mm, height 34,6 mm.

Paratypes. PRI Nº 8221, a left valve; Natural History Museum Basel, a left valve; Escuela de Geología, Universidad Central de Venezuela, one right and two left valves, Nº UCVG 7051.

Type Locality and Age. Locality GS-33-PGNA, Paraguaná Peninsula, near Casa La Candelaria which lies 1600 m due west of the new (1952) Casa Cantaure along a secondary road from Pueblo Nuevo through San José de Cocodite to San Isidro. Some 50 m north of Casa La Candelaria is a small reservoir adjacent to which fossils lie loose on the surface. The beds themselves are exposed in Quebrada El Socorro, about 50 m further north again, and consist of gypsiferous grey shale and marl with a thin (15 to 50 cm) fossiliferous limestone intercalation; the dip is low and no more than 5 m are exposed (localities GS-34,-a,-b-PGNA). The beds are referred to here informally as the La Candelaria beds. Of the more than 100 molluscan taxa at least 70 occur in the Cantaure Formation, of the same age according to the planktonic foraminifers, i.e. early Miocene (Burdigalian), Zone of *Globigerinatella insueta,* the Cantaure beds being said to be equivalent to the Cerro Pelado Formation of the Falcón basin to the south (Díaz de Gamero 1974:46; Hunter & Bartok 1974:147). Field relationships are not entirely clear but some taxa not common with Cantaure suggest that the La Candelaria beds are somewhat older. In particular, *Arcinella (A.) candelariana* n.sp. is much more primitive than its successor at Cantaure, to be discussed next. Other taxa (see Associated Faunas), moreover, strongly suggest that the La Candelaria beds are to be equated with the Agua Clara Formation which, to the south, underlies the Cerro Pelado Formation. The Agua Clara Formation was believed by Wheelfr (1963:57) to range up into the upper early Miocene (Burdigalian) and Bolli (1972, fig. 5) placed the entire formation in the *Catapsydrax stainforthi* Zone, a placement tentatively accepted by Díaz de Gamero (1977a:17, 18; fig. 4). This last author (1977b: 3; fig. 1), however, in a recent revision (to be presented at the V Congreso Geológico Venezolano, 19th November 1977; preprint to hand) concludes that the Agua Clara Formation continues to the very top of the early Miocene, thus supporting the above contention with respect to the La Candelaria beds. However, her view conflicts with that of Hunter & Bartok (1974:147) who place the overlying Cerro Pelado and Querales Formations also in the early Miocene. This is the first recognition of a possible Agua Clara equivalent on the Paraguaná Peninsula (see Wheeler 1963, fig. 5).

Remarks. It can be said that *A. candelariana* is the earliest and most primitive representative of the subgenus known from the region. Diagnostic characteristics are its few spined ribs, none of which lie on the anterior ridge, and its lack of a lunule, features which distinguish it from the hitherto most primitive form *A. (A.) yaquensis*. Its apparent successor in the Cantaure Formation has a lunule and more ribs but is similar in that none of the ribs lie on the anterior ridge. The material consists of 2 left and 4 right valves, the holotype being the largest and most complete right valve.

Arcinella (Arcinella) jungi n.sp. Pl. 1, figs. 6-8

1965. *Arcinella yaquensis* (Maury). Jung, Bull. Amer. Paleont., Vol. 49, Nº 223, p. 450, pl. 57, figs. 3, 4.

Remarks. Jung's description was based on a single right valve slightly higher than long and having 7 spined ribs. A second right valve is now available from the same locality and also a fragmentary right valve but the left valve is still unknown. The new complete specimen is longer than high and has 9 spined ribs. All three specimens differ consistently from *A. (A.) yaquensis* in lacking spined ribs on the anterior ridge and in having a moderately developed lunule, which is only incipient in the latter and which may have one or two fewer ribs. For these reasons it is assigned to *A. (A.) jungi* n. sp. It does not fit easily in the *yaquensis-trachyderma* sequence of the Dominican Republic but seems a logical successor to *A. candelariana*. The NHMB specimen as described and illustrated by Jung is here designated the holotype.

Holotype. Natural History Museum Basel, Nº G.11322.

Dimensions of Holotype. Length 26.6 mm, height 28.1 mm.

Paratypes. Escuela de Geología, Universidad Central de Venezuela, Caracas, UCVG Nº 7052.

Locality and Age. Cantaure Formation, Paraguaná Peninsula (loc. GS-1-PGNA). This is also locality Nº 2207 of Hodson & Hodson (1931:6) and the locality from whence came the collections of Wiedenmeyer and O. Renz described by Jung (1965). The age assigned by the Hodsons was early Miocene and by Jung late middle Miocene. As already mentioned, the age indicated by the planktonic foraminifers is early Miocene (Burdigalian).

Regarding the 146 taxa identified by him, Jung (1965: 397) commented that, "Further systematic collecting... would certainly yield another large number of species especially of Micromollusca." The total now stands at almost 500 taxa, making Cantaure one of the more important Miocene localities of the Caribbean. As predicted, there are many small species in the new material but also a goodly proportion of larger forms, among them taxa previously missing from the Venezuelan Miocene faunas or, even, from those of the northern South American province in general, as well as some new "paciphile" taxa (Woodring 1966: 426). A much closer relationship with the early Miocene Quiroz assemblage (Hodson locality Nº 6) of the La Rosa Formation in the Maracaibo basin is now apparent.

Arcinella (Arcinella) spec. indet. Pl.1, figs. 9-11

Remarks. The single, broken, right valve has a weak lunule and may have had 8 spined ribs, none of which are present on the anterior ridge. It resembles, therefore, *A. jungi* but differs in having fine, radial, nodulose riblets on the anterior ridge, much as in *A. candelariana* but absent in *A. jungi* where, as noted by Jung (1965:450) the nodules are randomly arranged.

Locality and Age. Locality GS-113-PGNA, Paraguaná Peninsula. It lies on the north side of the igneous-metamorphic complex of the Mesa de Cocodite described by MacDonald (1968), about 100 m from the foot of the scarp and just to the west of a reservoir in the area of Buenevara. About 1 km to the west and about the same distance from the scarp is locality GS-94-PGNA to be discussed next. Both localities can be placed on MacDonald's map where they lie on the downthrown side of the "Falla de Pueblo Nuevo" at approximately the positions indicated by the underlined letters. The beds at GS-113-PGNA consist of gently north-dipping shales and marls and coral debris litters the ground on the approach to the locality. So far, just over 100 molluscan taxa have been collected. The primitive form of *Arcinella* and the associated fauna and field relationships suggest that the beds may be early Miocene but younger than Cantaure. A sample analysed for foraminifers gave an indeterminate result.

Arcinella (Arcinella) cf. *trachyderma* (Pilsbry & Johnson)

Material from three localities is included here:

El Porvenir beds, Paraguaná Peninsula Pl. 1, figs. 12-16

There are 10 right valves, 6 left valves and a paired specimen. The shells have been recrystallised and preservation is reminiscent of that in the Punta Gavilán Formation. Spined ribs on 6 specimens number from 10 to 14, two or three of which lie along the anterior ridge; the surface is still mainly nodulose. The lunules are rudimentary except in one with a well-defined circumscribing groove. This form is more advanced than the single specimen described from the previous locality (GS-113-PGNA) and more primitive than *A. trachyderma* with its well-developed lunule.

Locality and Age. Locality GS-94-PGNA, Paraguaná Peninsula, some 200 m south along a track leading from El Porvenir (two houses) to the northern scarp of the igneous-metamorphic complex of the Mesa de Cocodite (MacDonald 1968) and about 100 m north of the scarp. The approximate position on MacDonald's map has already been given. The poorly exposed outcrop consists of an ochreous weathering limestone, dipping gently north and lying unconformably on the granite. This is an analogous position to that of the Cantaure Formation which onlaps the granite along the southern edge of the complex at about the same elevation (ca. 140 m above sealevel). No detailed mapping has been done and the beds are identified here informally as the El Porvenir beds. The molluscan assemblage consists of some 60 gastropods and 30 bivalves, showing a close affinity with the adjacent fauna at GS-113-PGNA; despite the more advanced form of *Arcinella,* these beds may still be early Miocene in age.

Caujarao Formation, Estado Falcón Pl. 2, figs. 1-3

There are 16 right valves and 12 left valves in the collection. On nine of these the spined ribs number between 11 and 15. Compared to the El Porvenir specimens they average one more rib and the lunule is well-developed in all adults, features which bring it closer to, or identical with, *A. trachyderma*. Some right valves lack an attachment area as such, except for the protruding stumps of one to three spines of another specimen of the species on which they had settled.

Locality and Age. El Busco, near La Trinidad and San Rafael, some 4 or 5 km south of Puerto Cumarebo. The attention of the authors was drawn by Dr. Peter Jung to a collection in the Natural History Museum Basel from locality: Leutzinger 5287 at El Busco. Our material comes from this locality, or very close by (loc. GS-3-FLCN). The outcrop is poorly exposed some 30 m south of the road between houses of the village; immediately north of the road is the south-facing scarp of the massive Cumarebo reef-limestone. The fossil bed is a poorly consolidated, fine-grained sandstone of angular quartz. The outcrop was previously referred to the Cumarebito Member (Gibson-Smith & Gibson-Smith 1974:56) but, on the advice of Dr. Clemente González de Juana, it is referred now simply to a position near the base of the Caujarao Formation. A middle Miocene age is suggested by the molluscs and although a sample proved undiagnostic as regards the planktonic forminifers they, presumably, would indicate a late middle Miocene age (Bolli 1972, fig. 5; Díaz de Gamero 1977b, fig. 1). It is unfortunate that no adequate collection is available from the underlying Socorro Formation, also of middle Miocene age, with a fauna, presumably, intermediate between that of El Busco and those of the Paraguaná Peninsula previously discussed. Whilst many of the Paraguaná forms still occur here, it is of greater interest to note the advent of new taxa as discussed under Associated Faunas.

Gatun Formation, Panamá Pl. 3, figs. 11, 12

A single left valve to hand has 11 spined ribs and a distinctly elementary lunule; it is similar to the early form of *A. trachyderma* from El Porvenir. The specimen is in a collection donated by the former Compañía Shell (now Maraven) to Universidad Central and was collected by R. W. Barker. It is labelled "Bk 121-122 (Fort Davis, Gatun)".

Arcinella (Arcinella) arcinella (Linné)

1767. *Chama arcinella* Linné, Syst. Nat., ed. 12, pp. 1139, 1140.

1866. *Chama arcinella* Linné. Guppy, Quart. Journ. Geol. Soc., London, vol. 22, p. 294.

1903. *Echinochama antiquata* Dall, Trans. Wagner Free Inst. Sci., Philadelphia, vol. 3, pt. 6, p. 1404, pl. 54, fig. 9.

1938. *Echinochama arcinella* (Linné). Pilsbry & McGinty. The Nautilus, vol. 6, Nº 5, pp. 805, 806, pl. 119, fig. 6.

The form from the Bowden Formation, Jamaica, was referred originally to *Ch. arcinella* and, in the same year, the form from the southeastern United States, previously identified as *Ch. arcinella* by Tuomey & Holmes (1857:22, 23), was recognised as a new species: *Arcinella cornuta* Conrad, 1866. Nevertheless, later authors still continued to regard the latter as the species of Linné, an error only corrected by Pilsbry & McGinty (1938). But for this confusion it is, perhaps, unlikely that the Bowden form would have received separate recognition as *A. antiquata* (Dall), Guppy's original assignment being essentially correct. On the other hand, Nicol (1952:808) felt that he could distinguish between *A. antiquata* and *A. arcinella,* the latter being smaller,

PLATE 1

Fig. 1-5. *Arcinella* (*A.*) *candelariana* J. & W. Gibson-Smith, n.sp. 1-3. Holotype, a right valve, length 27.3 mm, height 34.6 mm. La Candelaria beds, Paraguaná Peninsula (loc. GS-33-PGNA). Early Miocene. PRI Nº 8220. 4,5. Paratype, a left valve, length 18.6 mm, height 17.4 mm. Same locality. PRI Nº 8221

Fig. 6-8. *Arcinella (A.jungi)* J. & W. Gibson-Sith, n. sp. 6-8 Paratype, a right valve, length 21.8 mm (incomplete), height 21.6 mm. Cantaure Fm., Paraguaná Peninsula (loc. GS-1-PGNA). Early Miocene. UCVG Nº 7052

Fig. 9-11. *Arcinella* (*A.*) spec. indet. 9-11. Right valve, length 29.1 mm, height 29.8 mm (both incomplete). Early Miocene (?) beds, Paraguaná Península (Loc. GS-113-PGNA). UCVG Nº 7053

Fig. 12-16. *Arcinella* (*A.*) cf. *trachyderma* (Pilsbry & Johnson) 12,13. Left valve, length 33.5 mm, height 34.6 mm. 14-16. Right valve, length 40.5 mm, height, 41.0 mm (incomplete). Early Miocene (?) El Porvenir beds, Paraguaná Peninsula (loc. GS-94-PGNA). UCVG Nº 7054

⟶

PLATE 1

having fewer spined ribs and having a more circular outline. The first two differences are retrogressive and, perhaps, hardly to be expected, suggesting that, with the examination of more material, they might disappear. A large Venezuelan specimen, admittedly from the Holocene, already bridges the gap between the two species: in height and number of ribs (58.7 mm, 32) it falls between the maxima given by Nicol (1952:806, 808) for *A. arcinella* (53.3 mm, 31) and *A. antiquata* (63.5 mm, 37); it is, furthermore, markedly subquadrate in outline and is hardly closer to the one than to the other. It has been thought expedient, therefore, to place *A. antiquata* in the synonymy of *A. arcinella*, although with some reservations as discussed under Evolution. Material from five Venezuelan localities is included here ranging in age from late middle Miocene to Pliocene; it carries from 17 to 20 ribs on specimens of about 40 mm in height. It is noteworthy that Olsson (1964:52) assigned a form with 14, or fewer, ribs to *A. arcinella;* it is from the Angostura Formation, Ecuador, said to be equivalent to the lower part of the Gatun Formation, Panamá; it is possibly closer to *A. trachyderma.* Two poorly preserved specimens from the Tubará Formation, Colombia, are included here for the sake of completeness.

The species *A. (A.) arcinella* occurs fossil as follows:

Tubará Formation, Colombia Pl.3, figs. 8-10

Both Weisbord (1929:19) and Anderson (1929:161) report *A. antiquata* from this formation, the former with some hesitancy based on a single, broken valve, illustrated but not described. Anderson's material is neither illustrated nor described. Nicol (1952:808), however, records *A. antiquata* from Bowden only and includes Colombia within the geographic range of *A. trachyderma,* but without locality data or reference to the above authors; thus one is left in some doubt as to the true nature of the Tubará form(s). However, Barrios (1961:249) assigns a form with 22 to 31 ribs, from near Tubará, to *A. antiquata,* an assignment which is doubtless correct, but the level within the more than 2,500 feet thick formation (Anderson 1929:92) is not indicated. The two specimens to hand are no help, except to say that, as indicated by a well developed lunule and numerous ribs, it is a more advanced form than either *yaquensis* or *jungi*. The specimens were collected by R.W. Barker and A.N.C. ten Broek; no locality details are known, only that collections were made near Tubará and along the coast west of Puerto Colombia.

Mataruca Member, Caujarao Formation,
Estado Falcón Pl.2, figs. 4, 5

The material consists of 2 paired specimens and 6 and 15 fragmentary left and right valves. The left valve is less convex (13 mm versus 16 mm) and slightly less high; the ratio of convexity to height for the paired specimens is 0.68. Spined ribs number 20, the outline is subcircular and the lunule is deeply incised.

Locality and Age. The outcrop is a limestone dipping steeply west and lying some 30 m west of the Cementerio de Carrizal, near La Vela de Coro. This is thought to be Hodson locality Nº 185 (Gibson-Smith & Gibson-Smith 1974:50) from which some 40 taxa were described and a late middle Miocene age assigned. The area was mapped by Petzall (1959:287) who gave the same age based on the foraminifers. Later, however, Bolli (1972, fig. 5) placed the unit in the *Globorotalia acostaensis* Zone of late Miocene age. Some particularly fresh samples (bulldozed) collected by the authors has enabled Díaz de Gamero (1977b:3) to assign the beds to the lower part of this zone. The collection of molluscs from this locality (GS-1-FLCN) amounts to 160 gastropods, 60 bivalves and 1 scaphopod. The new material does not conflict with a late middle Miocene age.

Punta Gavilán Formation, Estado Falcón Pl.2, figs. 6, 7

A single right valve is available; it is rather small but already bears 14 strong ribs, presumably with more in a larger specimen. The lunule is well developed and deeply incised although somewhat obscured by a bryozoan.

Locality and Age. Type locality of the formation at Punta Gavilán. The gastropod fauna was described by Rutsch (1934) who assigned a Mio-Pliocene age which he later ammended to upper Miocene only (Rutsch 1942, fig. 2 and p. 179). Based on the planktonic foraminifers an age at about the Mio-Pliocene boundary was also proposed by Díaz de Gamero (1970:85). Later, Bolli (1972, fig. 5) extended the age range up into the *Globorotalia miocenica* Zone of the middle Pliocene. The collection of molluscs amounts to 120 gastropods, 30 bivalves and a scaphopod; they lend support to a Pliocene age.

Cubagua Formation, Isla Cubagua Pl.2, figs. 8-12

There are 5 right and 3 left valves in the University collections from which the outer surface has mostly gone. There are 17 or 18 spined ribs, a well developed lunule and strong anterior protuberance. The largest specimen is illustrated.

Locality and Age. Cañón La Caldera, where a section of some 70 m is exposed; the exact horizon from which the examples came is not known. The beds have been placed by Bolli (1972:1324; fig. 6) in the *Globorotalia exilis* Subzone of the middle Pliocene.

Cerro Negro Member, Cubagua Formation,
Araya Peninsula Pl.2, figs. 13-17

There are 4 right valves and 1 left in the University collections. They have 19 ribs, a subquadrate to subcircular

PLATE 2

Fig. 1-3. *Arcinella* (*A.*) cf. *trachyderma* (Pilsbry & Johnson) 1-3. Right valve, lenth 33.1 mm, height 35.8 mm. Basal Caujarao Fm., El Busco, nr. San Rafael, Edo. Falcón (loc. GS-3-FLCN). Middle Miocene. UCVG Nº 7055

Fig. 4-17. *Arcinella* (*A.*) *arcinella* (Linné) 4,5. Paired specimen with view of right valve, length 42.9 mm, height 41.8 mm. Mataruca Mb., Caujarao Fm., Cementerio de Carrizal, Edo. Falcón (loc. GS-1-FLCN). Late middle to late Miocene. UCVG Nº 7056. 6,7 Right valve, length 29.8 mm, height 29.1 mm. Punta Gavilán Fm., type locality, Edo. Falcón (loc. GS-2-FLCN). Mio-Pliocene. UCVG Nº 7057. 8-12. Right valve, length 40.4 mm, height 41.5 mm. Left valve, length 40.3 mm (incomplete), height 40.1 mm. Cubagua Fm., Cañón La Caldera, Is. Cubagua. Middle Pliocene. UCVG Nº 6727. 13-17. Right valve, length 41.6 mm, height 40.0 mm. Left valve, length 35.5 mm, height 37.7 mm. Cerro Negro Mb., Cubagua Fm., Cerro Guamache, Araya Peninsula. Pliocene. UCVG Nº 3885

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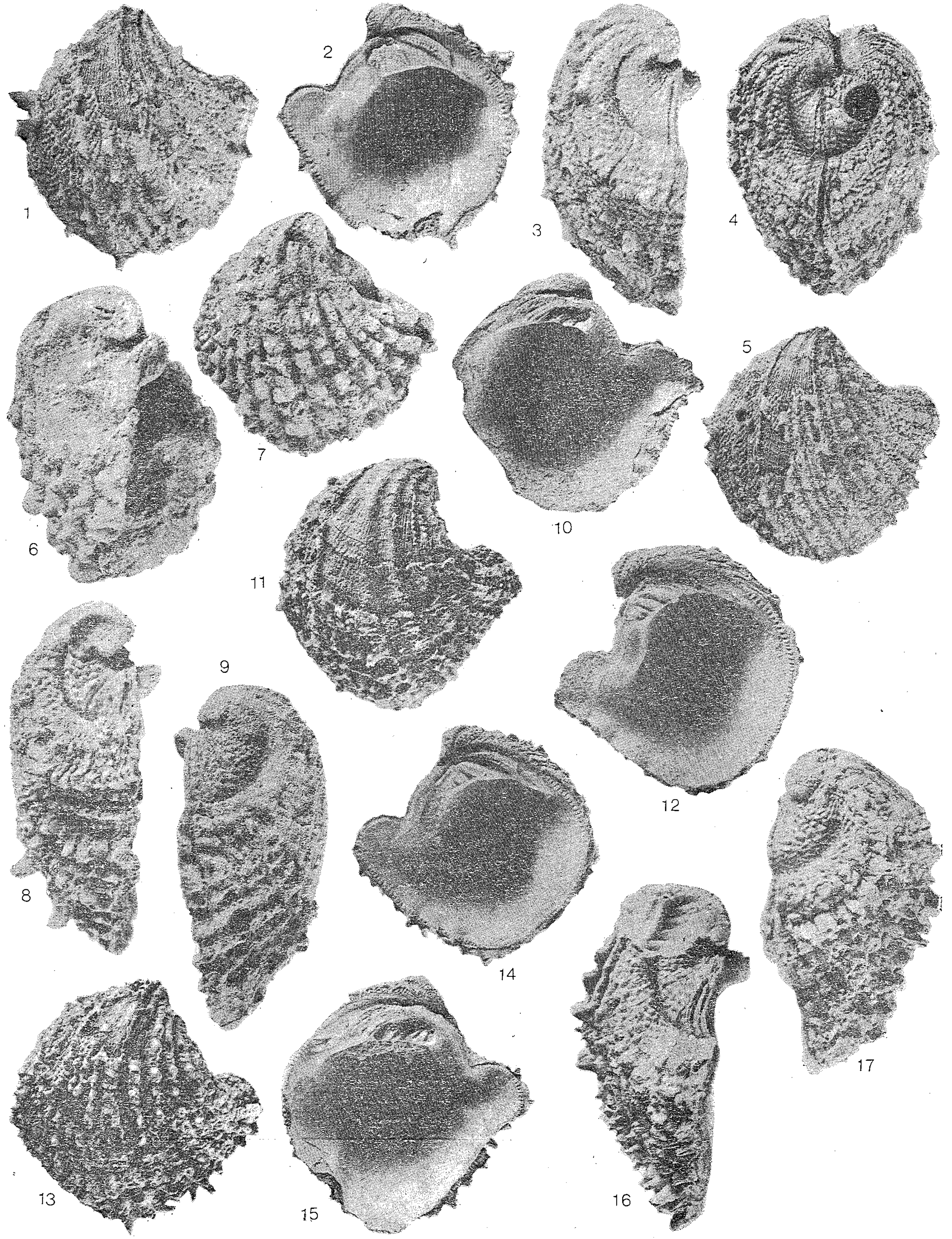
PLATE 2



outline, strong anterior protuberance and deeply incised lunule. They were referred to *A. antiquata* by Macsotay (1965:44).

Locality and Age. Cerro Guamache shown on a geological map of the area by Vignali (1965:23) who assigned a late Miocene age to the unit. Based on a collection of molluscs, Macsotay (1965:45) also proposed a late Miocene age. A Pliocene age, based on the planktonic foraminifers, has been proposed by Bolli (1972:1324).

Mare Formation, Cabo Blanco Pl. 3, figs. 1-3

Weisbord (1964:247, 248) described fragmentary right and left valves as *Arcinella* species "a" and "b", recognizing that they possibly belonged to the same species. New material of 1 right and 2 left valves is little better preserved and the number of ribs cannot be counted. The lunule is well developed, deeply incised and there is a strong anterior protuberance. Bearing in mind the age of the formation, these examples are, presumably, to be assigned to *A. arcinella.* The largest specimen, a right valve, has a height of 48.0 mm.

Locality and Age. Type locality of the Mare Formation at Mare Abajo. Based principally on 34% of surviving species in the molluscan fauna, Weisbord (1964:30, 31) accorded an early Pliocene age. Later the beds were assigned to the *Globorotalia truncatulinoides* Zone of Pleistocene age. In a more recent revision, however, a late Pliocene age has been proposed by Dr. Fred Rögl (Gibson-Smith 1976:4).

Holocene, Estado Miranda

The single right valve has already been discussed.

Locality. Unconsolidated beach deposits some 400 m behind the present shoreline at Carenero.

Recent Pl. 3, figs. 4-7

Found uncommonly as beach material or in shallow water and only poorly represented in the collection; it clearly lives in deeper water. The illustrated specimens with heights of 50.0 and 44.9 mm have 22 and 23 ribs, respectively. A juvenile shell attached to *Aequipecten lineolaris* (Lamarck) is remarkable in possessing the largest attachment area seen in any specimen of *Arcinella* s.s., occupying almost the entire anterior half of the right valve (height 21.4 mm); a response, no doubt, to the smooth foundation on which the animal found itself.

Arcinella cornuta Conrad Pl. 3, figs. 13-15

1857. *Chama arcinella* (Linné). Tuomey & Holmes, Pliocene fossils of South Carolina, pp. 22, 23, pl. 7, figs. 4-6.

1866. *Arcinella cornuta* Conrad, Am. Jour. Conch., vol. 2, pt. 2, p. 105.

1903. *Echinochama arcinella* (Linné). Dall, Wagner Free Inst. Sci., Trans. vol. 3, pt. 6, pp. 1405, 1406.

1938. *Echinochama arcinella cornuta* (Conrad). Pilsbry & McGinty, The Nautilus, vol. 51, Nº 3, pp. 78, 79, pl. 7, fig. 7.

1943. *Echinochama arcinella* (Linné). Bayer, The Nautilus, vol. 56, Nº 4, pp. 117-119, pl. 13, figs. 13, 14.

1952. *Echinochama cornuta* (Conrad). Nicol, Journ. Paleont., vol. 26, Nº 5, pp. 809, 810, pl. 118, fig. 2, pl. 119, fig. 7.

For completeness a specimen from Sanibel Island, Florida is illustrated. In a private Caracas collection from adjacent Captiva Island it is a common element in the beach material, suggesting that it may live in shallower water than the Venezuelan form.

Subgenus NICOLIA n. subgen.

Type species, here designated: *Chama draconis* Dall, 1903, Chipola Formation, Florida; Miocene.

This new subgenus is erected for those chamids having a large, equivalve, nepionic (dissoconch) stage; which later attach by the right valve and remain attached and which, in the adult, have a vermicular or nodulose surface and concentric foliaceous lamellae. The subgenus has, therefore, some of the characters of *Arcinella* s.s. but differs in that, once attached it remains attached and it has concentric, foliaceous sculpture instead of radial, spined ribs. It has also some of the characters of *Pseudochama,* to which *draconis* was later referred, but differs in having an equivalve nepionic shell and a vermicular surface in the adult. It is closer to *Arcinella* and it is suggested that they shared an immediate common ancestor (see under Evolution). The new subgenus is monotypic.

EVOLUTION

The views of Nicol on the evolution of *Arcinella* have been summarised in the Introduction, his conclusion being that *Pseudochama draconis* was the probable ancestor, noting that the juveniles are indistinguishable. Is another interpretation possible?

One of the rejected possible ancestors *was Pseudochama quirosana* (F. Hodson) from the Venezuelan Miocene, rejected as being too thin-shelled and lacking crenulated interior margins. Specimens from Cantaure were redescribed by Jung (1965:448) and from this locality almost 80 specimens have been collected, including 30 juveniles at the nepionic or early nealogic stage. There are two important additional characters which distinguish them from the young of *Arcinella,* providing more cogent reasons for the rejection of this species as the ancestor: the nepionic shell is inequivalve, the right

PLATE 3

Fig. 1-10. *Arcinella* (*A.*) *arcinella* (Linné) 1-3. Right valve, length 26.1 mm, height 23.7 mm (incomplete). Left valve fragment height 22.7 mm (incomplete). Mare Fm., type locality, Cabo Blanco. Late Pliocene. UCVG Nº 7058. 4-7. Right valve, length 47.1 mm, height 50.0 mm. Left valve, length 45.1 mm (incomplete), height 44.9 mm. Recent, Venezuela. 8-10. Right valve (8) fragment, height 21.5 mm Paired specimen, length 19.8 mm, height 19.2 mm. Tubará Fm., Colombia (Barker 104, ten Broek 243)

Fig. 11, 12. *Arcinella* (*A.*) cf. *trachyderma* (Pilsbry & Johnson) 11, 12. Left valve length 29.4 mm, heigth 32.1 mm. Gatun Fm., Fort Davis, Panamá (Barker 121-122)

Fig. 13-15. *Arcinella* (*Nicolia*) *cornuta* Conrad 13-15. Paired specimen, length 32.5 mm, height 32.5 mm (excluding spines). Recent, Sanibel Is., Florida

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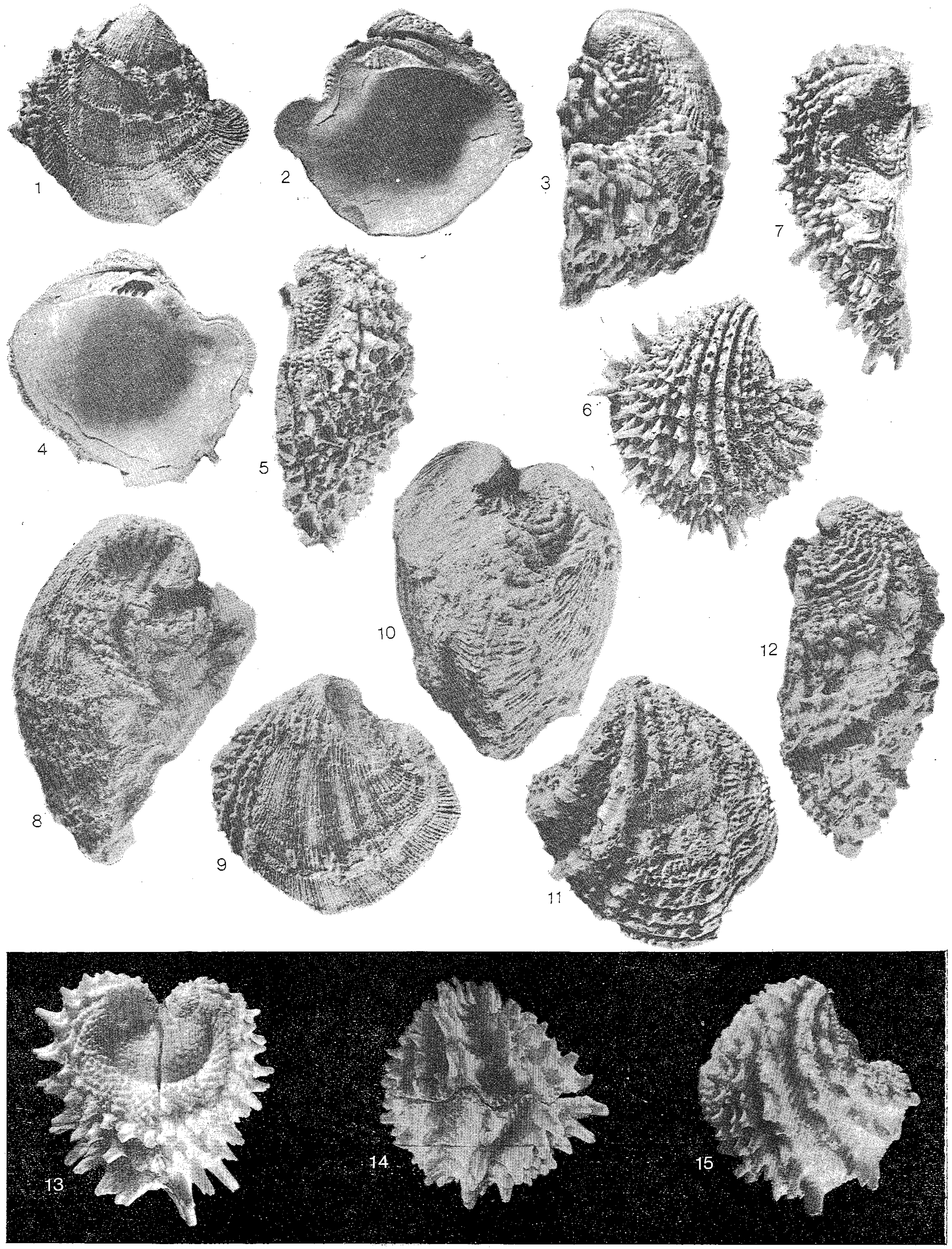
PLATE 3



valve being deeper than the left, and the earliest nealogic sculpture is concentrically foliated not vermicular. These juveniles, in fact, are indistinguishable from those of *P. radians* (Lamarck) to hand from Venezuelan waters. It follows, therefore, that the placing of *draconis* in *Pseudochama* s.s. is unacceptable. It may have been recognition of this problem which led Odhner (1955:2, not to hand) to refer it to *P. (Eopseuma)* a subgenus, however, now restricted to the East Indies (Keen in Moore 1969: N518).

The singularly large dissoconchs (length 2.5 mm, height 1.75 mm) of *Arcinella, Pseudochama* and *draconis* have been referred to a nepionic stage by Odhner (1919:91-94) and Nicol (1952:804). The former regarded, "This nepionic stage as interjacent between the prodissoconch and the permanent stage... as a... coenogenetical larval stage... without any correspondence in their early ancestors." (quoted in Gardner 1926:93). However, because the character appears at about the same time in three, admittedly related, taxa living in two environments it might be taken to have palingenetic significance; the common ancestor of the three taxa might be presumed to resemble their free-living, nepionic stages.

The habitats of *Arcinella* and *Pseudochama* do not overlap: according to Nicol (1952:811), *Arcinella* lives in somewhat deeper water (18 to 45 m preferred) on rubble bottoms (pebbles, broken shell, etc.), capable of shifting, therefore. *Pseudochama,* on the other hand, favours a solid, immovable substrate (rock, coral) and prefers the intertidal zone. The sculpture of the nepionic shells consists of up to 7 concentric lamellae carrying, posteriorily, 2 to 5 rows of sharp foliations which, of course, can also be regarded as incipient spines. At whatever moment in time (late Oligocene?) the change was made to a settled existence, it might be surmised that some *Arcinella* larvae fell in one environment and some in the other and were successful in both. Those falling on solid bottoms grew ever larger areas of attachment and developed the lamellar element of the nepionic sculpture to provide buttressing support, particularly along the margin of attachment, as exemplified in *draconis* (vide Dall 1903, pl. 56, fig. 17) and to be seen also in *Pseudochama* (vide Hodson & Hodson 1931, pl. 30, fig. 5). To improve the purchase in this high energy environment, the attached valve became deep and the shell highly inequivalve. Thus may *draconis* have originated. The larvae attached to a shifting substrate developed the incipient spinose element of the nepionic sculpture to achieve stability, thus eliminating the need for continued attachment; with increasing size and weight the attachment breaks and the animal becomes, once again, free-living. Thus may *Arcinella* s.s. have originated. Early forms, however, have few spined ribs and stability was again increased by the development of a highly inequivalve shell with deep lower valve, this time to bury in the substrate. With the development of an increasing number of spined ribs, the purchase was increased and the shell could gradually resume an equivalve condition, as in its ancestor; both valves, moreover, became equally spinose with the result that, to answer a question posed by Nicol (1952:211), it may be immaterial on which valve the animal lies.

To answer our own question, an alternative interpretation of the relationship between *P. draconis* and *Arcinella* is possible: with a shared parent, *P. draconis* is not the ancestor of *Arcinella* but its "twin"; which is not to say that it arose at exactly the same moment in time, although it may have. This change in status is formalised by the assignment of *P. draconis* to the new subgenus *Arcinella (Nicolia)*. The ancestor of *Pseudochama* was, of course, congeneric and one wonders whether an identical situation may not have arisen here also, with a spiny, free-living form still to be discovered.

As mentioned in the Introduction, Nicol (1952:815) considered the Caribbean forms of *Arcinella* s.s. to constitute one of the two principal lines of differentiation. It is possible, however, that the Caribbean forms themselves represent two lineages, making three in all: the lineage of the southeastern United States (the species *cornuta* with no known ancestor), a West Indian lineage *(yaquensis, trachyderma, antiquata, "arcinella")* and a southern Caribbean lineage *(candelariana, jungi,* cf. *trachyderma, "arcinella").*

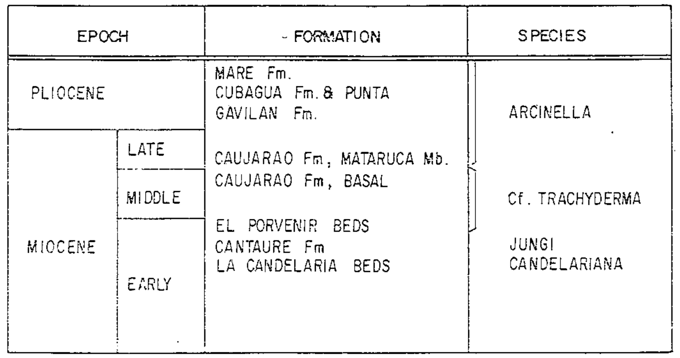
Consideration of molluscan genera and subgenera within the extended Caribbean of Miocene times led Woodring (1974) to define several subprovinces. Those along the southern shore show a degree of overlap and the new collections from the Venezuelan Miocene fill gaps or provide new links with Central América and Perú, as reference to the Associated Faunas will show. By the same token, however, new links are also forged with the West Indian subprovince. That subprovinces existed in the Miocene is, perhaps, not surprising when there is still a divergence between the living faunas of the northern and southern Caribbean (Moore 1974:17, 18; Petuch 1976:322). The difficulty of integrating the forms of *Arcinella* s.s. from Venezuela with those from the Dominican Republic and Jamaica suggests that two lineages may be represented.

This brings us to the basic problem of the true identity of *A. arcinella* and, in particular, its provenance. Is the species really identical throughout the Caribbean today? Whether it is, or not, is it the descendant, possibly retrogressive, of the Bowden form, or does it stem from a distinct, southern Caribbean lineage? The reason for the reservation with regard to the placing of *antiquata* in the synonymy of *arcinella* is now apparent.

The suggested phylogenetic relationships of the genus *Arcinella* are shown in Figure 2. The Venezuelan biostratigraphic relationships for the subgenus *A. (Arcinella)* are demonstrated in Figure 1.

ASSOCIATED FAUNAS

These annotated faunal lists, covering some of the stratigraphic units discussed, are appended in support of age determinations, or to help relate the fauna to others in the region. Some taxa are included as a matter of general interest. The order followed is chronological, as in the text, beginning with the early Miocene.



EPOCH		FORMATION	SPECIES
PLIOCENE		MARE Fm. CUBAGUA Fm. & PUNTA GAVILAN Fm.	ARCINELLA
MIOCENE	LATE	CAUJARAO Fm, MATARUCA Mb.	
	MIDDLE	CAUJARAO Fm, BASAL EL PORVENIR BEDS	Cf. TRACHYDERMA
	EARLY	CANTAURE Fm LA CANDELARIA BEDS	JUNGI CANDELARIANA

Figure 1. Biostratigraphic relationships of the subgenus *Arcinella (Arcinella)* in Venezuela

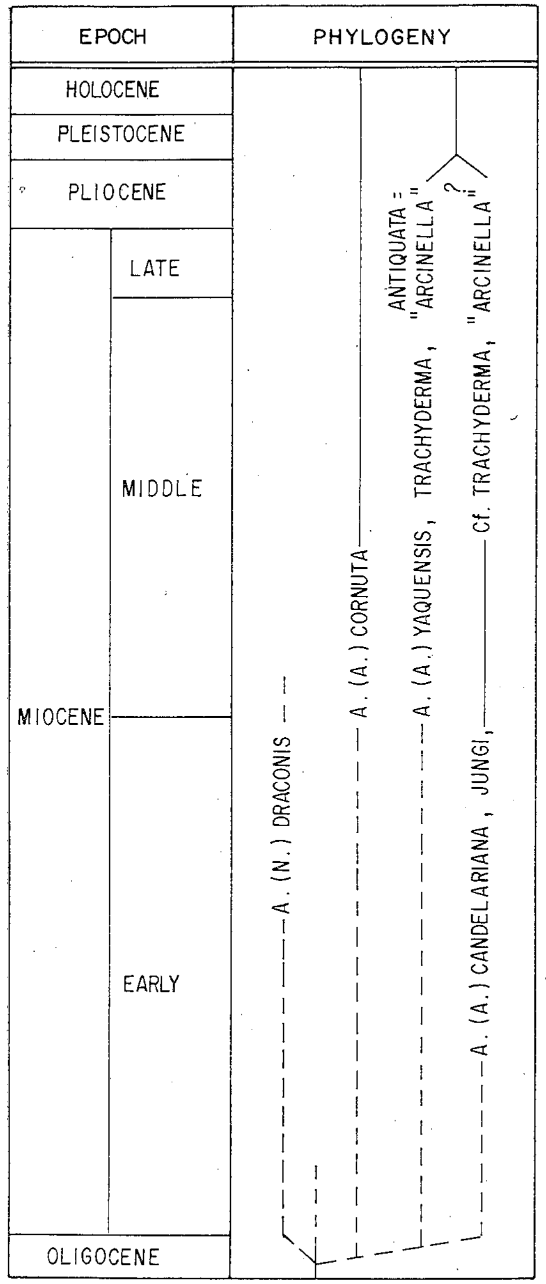


Figure 2. Phylogenetic relationships in the genus *Arcinella*

La Candelaria beds (GS-33-PGNA). In support of the earlier suggestion that these beds are older than Cantaure and equivalent to the Agua Clara Formation, the following additional evidence is presented. *Vasum haitense* (Sowerby), widespread in the early and middle Miocene of the western Atlantic region, occurs in both faunas but at La Candelaria a second, high-spired form is also present which is referred to *V.* cf. *tuberculatum* Gabb of the Dominican Republic which E.H. Vokes (1966:9) suspects may be from the Baitoa Formation whose age she suggests, very tentatively, may be Aquitanian. Amongst typical forms from the Agua Clara Formation, Wheeler (1963:57, 58) included *Turritella larensis* F. Hodson, *Turbinella tirantensis* (H.K. Hodson) and *Nucula* (?) *paraguanana* F. Hodson; the first and last occur at La Candelaria and a subspecies of the second, intermediate between that and *T. falconensis* (H.K. Hodson) from Cantaure. In a yet older sequence of beds, apparently underlying the La Candelaria beds, a common fossil is *Turbinella tirantensis* s.s. It is likely, therefore, that the La Candelaria beds are older than the Cantaure Formation and equivalent to the Agua Clara Formation. Whether the Cantaure Formation should now be equated with a yet higher level in the Agua Clara Formation, rather than, as hitherto, with the Cerro Pelado Formation now placed in the early middle Miocene *Globorotalia fohsi peripheroronda* Zone by Díaz de Gamero (1977b:3: fig. 1), cannot be corroborated by the molluscs, no Agua Clara assemblages being to hand. A comment is relevant here with regard to *Ostrea aguaclarensis paraguanensis* F. Hodson (1931b:5), named from a single lower valve (height 110 m) and said to be the forerunner of the larger *O. aguaclarensis* F. Hodson. The former occurs at several localities around Cantaure in the shale (10 m) overlying the Cantaure shell beds which was assigned to the *Praeorbulina glomerosa* Zone (Hunter & Bartok 1974:145, 147); it cannot, therefore, be the ancestor of *aguaclarensis* a typical form from the Agua Clara Formation (Wheeler 1963:58) which, in part, is of equivalent age to the shale (Díaz de Gamero 1977b:3: fig. 1) or somewhat older (Hunter & Bartok 1974:147). Paired specimens of *O. paraguanensis* are as large (height and length 175 mm) as *aguaclarensis* and seen indistinguishable; the former is a junior synonym. This is a weak indication that the Cantaure shell beds and overlying shale (as well as the underlying La Candelaria beds, discussed earlier) represent the Agua Clara Formation rather than the Cerro Pelado and Querales Formations.

The type locality of *Nucala (?) paraguanana* is Cantaure where, despite the comment of the author that, "the interior of all our specimens is concealed", no others have been found; none were in the collections of Wiedenmeyer and O. Renz described by Jung (1965) and none are in the collection of the authors. From La Candelaria, however, 35 paired specimens with solid fill are to hand; it is likely that the type material came from there.

Cantaure Formation (GS-1-PGNA). A closer relationship with the early Miocene La Rosa Formation fauna from Quiroz (Hodson locality Nº 6) can now be established. The number of taxa from that locality is 47 but several variations are given subspecific rank, some of which have already been placed in synonymy: Woodring (1957:106) assigned to *Turritella venezuelana* F. Hodson its two subspecies *quirosana* F. Hodson and *watkinsi* F. Hodson. Others to be placed in synonymy are *Prunum quirosensis* (F. Hodson) with its juvenile form *P. saladilloensis* (F. Hodson) which has page preference and, as suggested by a suite of 150 specimens from Cantaure, *Persicula mirandana* (F. Hodson), and probably *P. zuliana* (F. Hodson), with the juvenile form *P. maracaibensis* (F. Hodson) which again has page preference; there are likely to be others. The total number of taxa at Quiroz, therefore, may be no more than 40. Of these, Jung (1965, table 1) listed 13 as occurring at Cantaure; another 10 or 11 can now be added. They are: *Plicatula densata* Conrad, *Lucina mirandana* F. Hodson, *Tellina quirosana* F. Hodson, ? *Semele quirosana* H.K. Hodson, *S. zuliana* H.K. Hodson, *Varicorbula zuliana* (F. Hodson), ? *Natica precanrena* F. Hodson, *Sinum quirosanum* F. Hodson = *S. gabbi* (Brown & Pilsbry), *Vasum quirosense* F. Hodson = *V. haitense* (Sowerby), *Persicula maracaibensis* (F. Hodson) and *P. venezuelana* (F. Hodson). E.H. Vokes (1966:7) regarded *Vasum quirosense* as possibly a dwarfed form of *V. haitense;* the material to hand from Cantaure and La Candelaria shows that it can be regarded as a juvenile *V. haitense.*

Other taxa new to Cantaure are:

Ancistromesus aff. *mexicanus* (BRODERIP & SOWERBY), known only from the eastern Pacific as a Pleistocene fossil and living from México to Perú. Cantaure specimens reach 90 mm in greatest diameter.

"Amauropsis" cf. *burnsii meridionalis* PILSBRY. Miocene Dominican Republic.

Turritella abrupta SPIEKER.

Pseudomalaxis (Spirolaxis) centrifuga MONTEROSATA. Previously only known fossil from the Bowden Formation, Jamaica.

Siphocypraea (Muracypraea) mus LINNÉ. See under Mare Formation.

Morum (Cancellomorum) aff. *chipolanum* MAURY.

Semicassis (Tylocassis) cf. *aldrichi* (DALL). Chipola Formation, Florida.

Semicassis (Echinophoria) aff. *tostoma* WOODRING. Early Miocene La Boca Formation, Canal Zone, Panamá.

Chicoreus (C.) cf. *dujardinoides* (VOKES). Chipola Formation.

Poirieria (Panamurex) cf. *lychnia* (GARDNER). Chipola Formation.

Thais (Stramonita) aff. *biserialis* (BLAINVILLE). A Recent west coast form from Baja California to Chile. The fossil assigned here reaches a size (height 125 mm, diameter, 61 mm) as great as the largest American form *T. haemastoma canaliculata* (GRAY) living in the Gulf of México.

Thais (Stramonita) cf. *rustica bicarinata* (BLAINVILLE), living on St. Helena and Ascension Islands.

Acanthina (Chorus) cf. *sula cruziana* OLSSON. Apart from its larger size (height 60 mm) it appears very similar to the form from the early Miocene Lower Zorritos Formation, Perú. It occurs also at La Candelaria.

Cymia aff. *henekeni* MAURY. Miocene, Dominican Republic.

Macron orcutti DALL? A common Cantaure form resembling *Pseudoliva,* but it is not that. The only similar taxon appears to be *M. orcutti* known only living in Magdalena Bay, Baja California. Mrs. Mary D'Aiuto, Palo Alto, California, was unable to provide a specimen for comparison and informed us that none were in the Stanford University collections either. Should this unlikely assigment be confirmed it would represent another "paciphile".

Metula cf. *cancellata* GABB, from the Gurabo Formation, Dominican Republic.

Fasciolaria cf. *kempi* MAURY. Miocene, Dominican Republic.

Fasciolaria cf. *carminamaris* MAURY. Miocene, Dominican Republic.

Harpa cf. *americana* PILSBRY. Miocene, Dominican Republic.

Oliva (Omogymno) gradata GABB. Miocene, Dominican Republic.

Gemmula vaningeni (BROWN & PILSBRY). Gatun Formation, Panamá.

Gemmula machapoorensis (MAURY) ? Miocene, Trinidad.

Glyphostoma (Euglyphostoma) sp. Known previously only from the Gatun Formation, Panamá, and living in the Gulf of California. Another "paciphile".

Microdrillia trina MANSFIELD. Brasso Formation, Trinidad.

Tralia cf. *ovula* (BRUGUIERE). Known as a fossil previously only from the Bowden Formation.

Pedipes cf. *mirabilis* (MÜHLFELD). This seems to be the first fossil record, for the Tertiary at least.

Semeloidea (Temblornia) sp. The range of this subgenus is given by CHAVAN (in MOORE 1969:N527) as Eocene to Plicene, North and South America, there being only 3 species according to MARKS (1951:71). The Cantaure form (100 valves to hand) is relatively more elongate (length 6.1 mm, height 3.6 mm) than *S. keenae* (MARKS) from the early Miocene Subibaja Formation, Ecuador, and it has a few more anterior and posterior radial ribs. Wheter a Recent form from the Gulf of Venezuela is to be assigned to this subgenus is uncertain; it is similar in outline and sculpture but the dentition is weaker and possibly distinct (length 6.6 mm, height 5.0 mm); it resembles *Bornia virgata* GARDNER from the Shoal River Formation, Florida.

Ensitellops cf. *protexta* (CONRAD). Beak not so far anterior as in Recent West Coast species.

Mactrellona cf. *exoleta* (GRAY). This living West Coast species is known as a fossil in the Miocene of Perú and Costa Rica.

It should be pointed out that the fauna from the upper 2 or 3 m of the Cantaure section is a little different from that in the lower part; some new taxa appear and others show some variation. At Cantaure itself (GS-1-PGNA), the faunas may become slightly mixed as the upper material slides down and intermingles. Whether there is a significant hiatus between the two faunas has yet to be determined; the contact is not seen. Four species in the assemblage described by JUNG (1965) which are confined to the upper bed are: *Turritella gilbertharrisi* F. HODSON, *Architectonica nobilis karsteni* RUTSCH, *Chicoreus cornurectus* (GUPPY) and *Cymatophos paraguanensis* (F. HODSON), the last being useful in tracing the bed in this poorly exposed terrain. The best exposure (GS-6-PGNA) is about 1 km west of Casa Cantaure, i.e. the section described by HUNTER & BARTOK (1974:145); the collection from there amounts to 250 taxa, including *Semicassis (Echinophoria)* cf. *apenes* WOODRING and *Lyria* aff. *pulchella* (SOWERBY).

Locality GS-113-PGNA. A few of the taxa encountered here are the following: *Cyclostremiscus pentagonus* (GABB),* *Turritella a. altilira* CONRAD,* *Strombus* cf. *gatunensis* TOULA,**Distorsio gatunensis* TOULA, *D. simillima* (SOWERBY), *Bursa amphitrites* MAURY, *Ficus c. carbasea* (GUPPY), *Oliva (Omogymno) gradata* GABB, *Vasum haitense* (SOWERBY), *Lyria* cf. *pulchella* (SOWERBY), *Gemmula vaningeni* (BROWN & PILSBRY), *Polystira tenagos* GARDNER, *Fusiturricula* cf. *jaquensis* (SOWERBY), *Terebra* cf. *isaacpetiti* MAURY,* *Terebra spirifera* DALL* and *Eucrassatella* cf. *mediamericana* (BROWN & PILSBRY).* Those marked with an asterisk do not occur at Cantaure.

El Porvenir beds (GS-94-PGNA). This assemblage has much in common with that above from GS-113-PGNA. Some of the taxa present are: *Turritella a. altilira* CONRAD,* *Ficus c.carbasea* (GUPPY), *Xenophora delecta* (GUPPY), *Cassis sulcifera* SOWERBY,* *Cypraecassis* cf. *testiculus* (LINNÉ),* *Distorsio gatunensis* TOULA, *D. simillima* (SOWERBY), *Solenosteira* cf. *d. dalli* (Brown & Pilsbry),* *Perunassa* aff. *zorritensis* (Nelson),* *Oliva cylindrica* Sowerby, *Oliva (Omogymno) gradata* Gabb, *Subcancilla* cf. *venezuelana* (F. Hodson), *Enaeta* cf. *ecnomia* Woodring,* *Fusiturricula* cf. *jaquensis* (Sowerby), *Gemmula vaningeni* (Brown & Pilsbry), *Polystira tenagos* Gardner, *Terebra* "bipartita" Maury,* *Terebra subsulcifera* Brown & Pilsbry,* *T. spirifera* Dall,* and *Eucrassatella* cf. *mediamericana* (Brown & Pilsbry).* Those not at Cantaure are again marked with an asterisk. A surprise find here is *Cypraecassis* cf. *testiculus,* the only other Tertiary record being from the Miocene of the Dominican Republic. The single specimen has a height of 25.8 mm, i.e. slightly smaller than Gabb's specimens. Three taxa present in all four Paraguaná faunas, often prolifically so, but noticeably absent in the later faunas to hand, which does not include any from the early middle Miocene Socorro Formation of the Falcón basin, are: *Distorsio gatunensis, Oliva (Omogymno)* and *Gemmula.*

Basal Caujarao Formation (GS-3-FLCN). Some interesting new taxa to appear here are: *Trajana,* more typically occurring in the late Miocene and Pliocene (E.H. Vokes 1969:75; Gibson-Smith & Gibson-Smith 1974:49); *Aphera islacolonis* (Maury), this form having a thick, finely denticulate outer lip similar to the form from the Gatun Formation (Woodring 1970:344); *Cancellaria (Pyruclia),* a subgenus confined to the middle Miocene of the present Caribbean region (Woodring 1970:338); *Cochlespira elegans* (Dall), one of only three known Recent species which appear abruptly in the middle Miocene (Woodring 1970:371); it has been reported from off Brazil (Ríos 1975:128) although the figure is more reminiscent of *C. radians* (Dall). A fine specimen of *C. elegans* (height 47.8 mm, diameter 18.0 mm) is in a private Caracas collection; it was dredged off the north coast at a depth of about 1.000 m; *Nucinella,* which, after an early Tertiary record in the middle Eocene, reappeared only in the late Miocene of Florida (H.E. Vokes 1966:38) and Ecuador (Olsson 1964:23), but it is a small and easily overlooked taxon; *Laevicardium,* which first became prominent in the middle Miocene, the form, *L. compressum* (Dall) from the early Miocene Chipola Formation being, perhaps, untypical of the genus in having an uncharacteristic posterior slope.

Mataruca Mb., Caujarao Fm., Carrizal (GS-1-FLCN). To the 40 taxa described originally from this Hodson locality (Nº 185) a selection from the new collection is added here: *Turritella agrupta* Spieker, *Cerithium* cf. *russelli* MAURY, *Balcis (B.) cetia* WOODRING, *Niso (N.)* cf. *mesata* WOODRING, *Xenophora delecta* (GUPPY), *Strombus* cf. *bifrons* SOWERBY, *Cassis* cf. *sulcifera* SOWERBY, *Cypraecassis* cf. *testiculus* (LINNÉ), *Semicassis (Tylocassis) reclusa* (GUPPY), *Bursa amphitrites* MAURY, *Malea camura* GUPPY, *Ficus c. carbasea* (GUPPY), *Chicoreus (Siratus)* aff. *polynematicus* (BROWN & PILSBRY), *Solenosteira* cf. *dalli mediamericana* OLSSON, *Trajana (Nerva)* sp., *Fusinus* cf. *henekeni* (SOWERBY), *Cançellaria (Pyruclia) diadela* WOODRING, *Aphera islacolonis* (MAURY), *Polystira tenagos* GARDNER, *Glyphostoma dentiferum* GABB, *Terebra spirifera* DALL and *Clementia dariena* CONRAD.

Punta Gavilán Formation, type locality (GS-2-FLCN). Some taxa to be added to the gastropod assemblage described by RUTSCH (1934) are the following: *Crucibulum (Dispotaea) springvaleense* RUTSCH; *Crepidula* cf. *aculeata* (GMELIN); *Cymatium (Septa)* aff. *krebsii* MÖRCH; *C. (Linatella) cingulatum* (LAMARCK); *C. (Monoplex) parthenopeum* (VON SALIS); *Chicoreus (C.) brevifrons* (LAMARCK); *Murexiella* cf. *macgintyi faceta* VOKES; *Strombinophos* aff. *perdoctus* JUNG and *Conomitra* aff. *lavelana* F. HODSON. Three others of special interest are: *Tugurium (Tugurium)* n.sp., seemingly the first American fossil record of the subgenus; it is more coarsely sculptured and lower spired than the Recent *T. caribaeum* (PETIT); *T. imperforata* (GABB) from the Miocene of the Dominican Republic lacks spiral decoration on the base and is to be assigned, presumably, to the subgenus *Trochotugurium* SACCO. Next is *Bathygalea (Miogalea) hadra* WOODRING & OLSSON (1957:23) and WOODRING (1959: 198), known only from the late Miocene Chagres sandstone of the Caribbean coast of Panamá and, finally, *Trigonostoma (Extractrix)* cf. *hoerlei* OLSSON (1967:24) of the late Miocene Pinecrest beds, Florida, that being the only previous fossil record of the subgenus in the Americas although it survives in the eastern Pacific as *T. (E.) milleri* BURCH.

A few alternative assignments to those proposed by RUTSCH (1934) have been made by more than one author; one of these requires further comment and another species must be reassigned. Discussing the latter first, it is not long since two new muricids were identified living in the Caribbean: *Murex (M.) donmoorei* BULLIS (1964:101) from off the Guianas, but also along the Venezuelan coast (specimen to hand from the Golfo de Venezuela) and *M. (M.) blakeanus* E.H. VOKES (1967:88) from off the Goajira Peninsula, Colombia/Venezuela. The similarity between these two species has not been remarked; in particular, the fact that they both have 3 or 4 spines along the anterior canal and a protoconch of 1¾ turns, the last turn being flattened and keeled; significantly, however, the protoconch of *blakeanus* is appreciably larger than that of *donmoorei.* Considering their provenance, it is not surprising that their ancestors occur together at Punta Gavilán where one, or both, were referred to *M. recurvirostris* BRODERIP by RUTSCH (1934: 64). More recently, E.H. VOKES (1967:84) referred this form to a new species, *M. (M.) olssoni* which, however, lacks a keeled protoconch. The two forms may require identification at the subspecies level: *M.* aff. *donmoorei* is smaller and shorter spined than the Recent form and *M.* cf. *blakeanus,* although as large as the Recent form, is, again shorter spined and carries a fourth spine on the canal.

The other amendment concerns the *Hindsiclava consors* group. JUNG (1965:565; 1969:209) has mentioned the taxonomic problems within the group and relationships have also been discussed by WOODRING (1970:379, 380). JUNG (1969: 209) thought that the form from Punta Gavilán, referred to *H. consors* (SOWERBY) by Rutsch, probably was not that species. The correctness of this view is proven by the fact that a second form is present which is truly representative of the *H. consors* line, there being, therefore, two *Hindsiclava* lines. This is borne out in the La Candelaria beds where the Cantaure form referred by JUNG (1965:565) to *H.* aff. *consors* is present, but together with a second, slimmer form much closer to *H. consors.* The *H.* aff. *consors* line (if we may so call it for the moment) is distinguished by its more turretted spire, less slender outline and a bodywhorl which, in larger adults, tends to lose the earlier reticulate sculpture and which has a less tapered base and broader canal. The two lines seem to be present also in the Chipola Formation, Florida, as *H. paraconsors* (GARDNER) and *H. calligona* (MAURY). A successor to the Punta Gavilán *H. consors* line is present in the Mare Formation, a form which still survives in Venezuelan waters (Punta Mangle, Isla Margarita); a Recent specimen was sent to Dr. W.P. Woodring who reports (in litt.) that it is neither *H. macilenta* (DALL) from the Gulf of México, nor *H. alesidota* (DALL) from off Cape Hatteras to southern Florida. Whether it can be asigned to *H. chazaliei* (DAUTZENBERG) mentioned by ABBOTT (1974: 278) or to *H. appelii* (WEINKAUFF) listed in RÍOS (1975: 133), both said to be from the southern Carribean, is not known. It measures: height 40.5 mm, diameter 11.6 mm.

Mare Formation, Cabo Blanco. Unexpected taxonomic problems have been encountered with regard to the Recent Venezuelan fauna; unexpected, that is, in the sense that we had considered the area simply as part of the well documented Caribbean province. That this is not so has already been discussed, the area belonging, in fact, to a distinct subprovince covered only sporadically in the literature which refers, in the main, to the northern Caribbean, the Gulf of México and the southeastern United States. The first indication that all was not plain sailing was the discovery that some Recent forms, thought to represent common Caribbean taxa, were identical with Mare forms described as new taxa by WEISBORD (1962, 1964). Three examples will suffice to illustrate the problem. In his study of the fauna of Amuay Bay, Paraguaná Peninsula, PETUCH (1976:322, footnote 2) thought that the *Fasciolaria tulipa* (LINNÉ) population represented a new subspecies; the form is, in fact, *F. hollisteri* WEISBOARD. A second example concerns *Oliva reticularis* LAMARCK to which WEISBORD (1962:368) referred a single, worn beach specimen but, with better material to hand, it is seen to be identical to the fossil referred to a new species, *O. schepmani* WEISBOARD (1962:370). Lastly, the features said by WEISBORD (1964:128) to distinguish the fossil, *Pecten (Euvola) ziczag caboblancoensis* DRUCKERMAN, from the Recent *P. (E.) ziczac* LINNÉ, identify it with the Recent Venezuelan form; specimens to hand of both are indistinguishable.

Weisbord had only a small collection of the Recent Venezuelan fauna and his comparisons, perforce, were made mainly with northern forms. Perhaps this was fortunate because, otherwise, he might not have carried his research to the point of identifying the new taxa in the Mare fauna. Some of these have been placed in synonymy by other authors, which may be risky without southern Caribbean material for comparison. The following comments are made with the benefit of a collection of the Venezuelan Recent fauna to hand.

The geology of the Cabo Blanco area was described by RIVERO (1956:91) and was revised by WEISBORD (1957:1). A further revision by the senior author (unpublished) has a bearing on the discussion of the Mare fauna. At Punta Gorda the two fossiliferous beds separated by 20 feet of barren conglomerates (WEISBORD 1957:14) were assigned, respectively, to the Maiquetía Member, Playa Grande Formation (locality W-23=GS-7-CB), and to the overlying Mare Formation (locality W-25=GS-9-CB) with an unconformity between. As seen today the beds present a continuous section, without discordance, which can be traced westwards along strike, without evident interruption, but with a gradual change of facies, into the Mare type section of Quebrada Mare Abajo, a more seaward facies. This means that the fauna from W-23 also forms an integral part of the Mare fauna, thus adding 6 more gastropods and 13 bivalves to that fauna.

In arriving at a figure of 34% for still living gastropods and 46% for still living bivalves in the Mare fauna, WEISBORD (1964:24) included in his total for the gastropds 15 borderline taxa and 10 yet to be found in the Recent, equivalent figures for the bivalves being 4 and 2 respectively. The following list of gastropods contains 35 taxa not previously reported of which 28 are still living and 18 taxa previously represented of which 5 have been found to be still living and 13 have been placed in the synonymy of Recent taxa:

Fissurella nimbosa (LINNÉ)

Tegula (Agathistoma) puntagordana WEISBORD. Three trilirate species were established by Weisbord based on a total of 6 specimens: *puntagordana, trilirata* and *phalera.* With more material (30 specimens) they can all be referred to *puntagordana* which has page preference; it occurs also in the Recent. *T. trilirata* was distinguished in lacking a basal sulcus, in having a lower spire and more sharply terraced whorls. The sulcus is seen in only one of the new specimens in which the outer shell layer is missing as in the figure of WEISBORD (1962, pl.5:10); it is not seen in complete shells. Furthermore, in all larger adults the last whorl is more loosely coiled, the suture dropping sharply from the shoulder to below the periphery, the spire thus becoming relatively higher with age; at the same time the ramp becomes more inclined, or less terrace-like, and the three lirae become broadly and irregularly noded; *trilirata* is simply a less adult version of *puntagordana. T. phalera* is the juvenile of *puntagordana;* it was distinguished in having a strong groove between columella and base. However, in suites of four Recent Tegeluas: ? *maculostriata* C.B. ADAMS, *puntagordana* WEISBORD, *viridula* Gmelin and *excavata* LAMARCK, the juveniles all have this groove, more pronounced in the first two, which disappears rapidly with increasing shell size. *T. puntagordana* was dredged in 6 m on sand off the eastern end of Isla Cubagua and occurs on beaches in the Golfo de Cariaco; the largest (height 7.9 mm, diameter 10.0 mm) is smaller than the fossil and still lacks the loosely coiled last whorl; greyish brown to almost black opisthocline colour bars are present as well as colour beading of the spiral cords; some fossils still retain the colour bars.

Tegula (Agathistoma) maculostriata (C.B. ADAMS)? A single Recent specimen was referred here by WEISBORD (1962:75) who pointed out that this form was made synonymous with *fasciata* BORN by ABBOTT (1958:25), a procedure apparently adopted by HUMFREY (1975:57) who does not report it from Jamaica, the type locality. Certainly the Venezuelan form is totally distinct, juvenile to adult, from *fasciata,* to hand from the offshore islands only. The juveniles are strongly bicarinate, a feature essentially lost in the adult, the periphery becoming rounded; mottled in shades of brown, some entirely dark brown to almost black. It probably should be referred to *T. lividomaculata* (C.B. ADAMS). It does not occur at Mare.

Turbo caboblanquensis WEISBORD = *Tricolia bella* M. SMITH. The former was distinguished from *Tricolia pulchella* C.B. ADAMS *(=T. bella)* in having an umbilicus with strong fasciolar ridge, *T. pulchella* having been described as non-umbilicate. In large suites of fossil and Recent material, which are identical, the size of the umbilicus and ridge are variable, being virtually absent in some specimens; the umbilicus of *T. bella* has been described as, "a mere chink" by ABBOTT (1974:62).

Turbo (Marmorastoma) crenulatus venezuelensis WEISBORD =*T. crenulatus* GMELIN. The former, based on a single specimen, was said to differ from Recent Florida specimens of *crenulatus* in sculptural details; this is not supported by 10 fossil specimens vis-a-vis the Recent Venezuelan form of *crenulatus.* In a suite of 150 of the appropriate opercula (=*Turbo* sp. "a" WEISBORD) from the type locality of the Mare Formation there is a complete gradation from imperforate (20%) with outer groove only showing, to umbilicate with both circumscribing grooves visible, a situation resulting, presumably from the progressive removal of the normally heavy callus. The imperforate opercula are identical with those of the Recent *crenulatus.* It was not found possible to distinguish the similar operculum, *Turbo* sp. "b" WEISBORD. *T. crenulatus* is placed in the synonymy of *T. castanea* GMELIN by some authors.

Turbo (Marmorastoma) n. sp. Five specimens of an imperforate, finely beaded form (height 23 mm) have 10 subequal primary spirals, slightly heavier at suture and shoulder, with a single interspaced secondary except between the three basal cords; the anterior fasciole is not covered by callus as in *Taeniaturbo*. The operculum is judged to be the steep-sided, 4 grooved *Turbo* sp. "c" WEISBORD; the largest of 3 measures 22.0 mm and is from a somewhat larger shell than any to hand. There are several beaded fossil forms but none with similar operculum. Could it be that the Recent beaded *castanea* is its successor?

Turbo (Taeniaturbo) sp. Represented only by 3 large opercula (31.8 mm); they resemble the operculum of *T. (T.) canaliculatus* HERMANN but the grooves are much more profound with the attendant ribs overhanging along their outer edges. The shell height can be estimated at some 65.0 mm but none have been found. *T. marensis* WEISBORD, identified from a single worn specimen, was said to be reminiscent of *canaliculatus.*

Astraea (Liotiastralium) venezuelana WEISBORD with its peripheral carina (diameter 2.7 mm) is judged to be a juvenile of one of the two forms of *Marmorastoma* also present.

Astraea (Astralium) brevispina (LAMARCK). The largest of three specimens measures: height 24.0 mm, diameter 30.0 mm (both incomplete). This, the form from the Venezuelan Recent, is distinguished from *A. phoebia* RÖDING only in having an orange stain on the base, not to be seen in the fossil, of course. Perhaps *A. diffidentia* WEISBORD is to be referred here. As a fossil, *A.brevispina* is known from the Pleistocene only of the Panamá Canal Zone according to WEISBORD (1962:94).

Nerita fulgurans GMELIN.

Alvania auberiana (ORBIGNY).

Alvania medioamericana WEISBORD.

Rissoina (Phosinella) puntagordana WEISBORD.

Macromphalina pilsbryi OLSSON & MCGINTY. This has been incorrectly placed in the synonymy of *Vanikoro oxychone* MÖRCH by ABBOTT (1974:90, 137).

Planaxis nucleus (BRUGUIERE).

Modulus modulus (LINNÉ).

Modulus carchedonius (LAMARCK).

Alabina venezuelana WEISBORD=?*Finella dubia* (ORBIGNY).

Alaba insculpta WEISBORD=?*A. incerta* (ORBIGNY).

Seila adamsi H.C. LEA.

Triphora decorata C. B. ADAMS.

Parviturbo venezuelensis WEISBORD (1962:99). Seven Mare specimens conform to the description of this species except that there are no fine spirals above and below the strongly noded shoulder ridge, nor are the ridges compounded. Recent specimens identical to our fossils come from Tucacas and off Isla Cubagua, from about 6 m at both and on sand.

Calyptraea (C.) centralis (CONRAD).

Erato venezuelana WEISBORD=*E. maugeriae* GRAY. This synonymy was proposed by JUNG (1969:476) and is here confirmed.

Siphocypraea (Muracypraea) henekeni (SOWERBY)=*S. (M.) mus* (LINNÉ). The two were placed in synonymy by GIBSON-SMITH (1976:10). The adult colour pattern of brown bars on the flanks and mottling over the dorsum is similar in both fossil and Recent specimens; size was thought by WOODRING (1959:194) to be diagnostic, *S. mus* being smaller, but it transpired that the USNM collections of the latter were not fully representative: the largest of 38 in 9 lots has a height of only 48.6 mm (Dr. W.P. Woodring, in litt.), whereas it actually reaches a height of (67.9 mm, just surpassing a Mare specimen of 67.0 mm (WEISBORD 1962, pl.22, figs. 5, 6). Seven from the early Miocene Cantaure Formation, the earliest known form, are small: three from the lower part of the section have heights between 31.2 and 34.0 mm and the others from the upper part, measure between 38.0 and 42.3 mm. The available evidence indicates that there has been a significant increase in maximum size, but it should be noted that Recent specimens may reach maturity at a height of only 37.0 mm. Some specimens from the Gatun Formation, a Panamá, have exceptionally protuberant flanges bordering the siphonal canal (WOODRING 1959, pls. 31, 32); none of the Venezuelan material shows this feature. The colour pattern of juvenile *S. mus* from the Recent is entirely distinct: it consists of pale brown axial zig-zags on a pale grey-blue ground and is similar, apart from colour, to that of *Cypraea diliculum* (REEVE) from the Indian Ocean.

Polinices lacteus (GUILDING). Comparing Recent material, apart from the difference in colour, this species has a stronger funicle than *P. hepaticus* (RÖDING) with a correspondingly reduced umbilicus; it is also smaller but the ratio height: diameter is the same, averaging 1.15. The Mare material falls into two suites, one with the attributes of *lacteus* and the other distinguished from *hepaticus* in being relatively higher (ratio 1.25) and in having a stronger umbilical ridge and consequently a smaller umbilicus. Weisbord (1962:241) noted the umbilical differences in the fossils but referred both forms to *P. subclausus* (SOWERBY); the latter can still be retained for the second form although the lectotype has a ratio of only 1.07 (PFLUG 1961:32).

Ficus communis RÖDING.

Murex (M.) recurvirostris BRODERIP of Weisbord = *M. (M.) donmoorei* BULLIS. The form from both the Mare and Punta Gavilán Formations (RUTSCH 1934:64) was referred to the new species *M. (M.) olssoni* E.H. VOKES (1967:84), but the small, keeled protoconch is that of *M. donmoorei* to which the Mare form can, with certainty, be assigned; the Punta Gavilán form differs only in being smaller.

Latirus (Polygona) recticanalis WEISBORD is referred to *Poirieria (Panamurex) recticanalis* (WEISBORD). It is the ancestor of the recently described *P. (P.) velero* E.H. VOKES (1970:47) found off the Colombian and Venezuelan coasts; a similar form occurs in the Punta Gavilán Formation at the type locality. Eight specimens of *P. velero* are to hand (beach material). The main difference between the three forms is one of size, the height reducing from 24 mm (Punta Gavilán) to 20 mm (Mare) to 16 mm (Recent); this results from a reduction in the number of whorls, a juvenile from Punta Gavilán being identical with the Recent form. In addition, however, the fossils develop at the aperture in adult specimens, a small, open spine on the three lowest cords around the base of the bodywhorl, a feature not seen in *P. velero*.

Purpura weisbordi n. sp. The two specimens of *Purpura* available to him were thought by WEISBORD (1962:297) to be adventitius; they were referred to *P. patula* (LINNÉ). However, his description of the inner lip is not diagnostic for that species: "the inner edge sharp and angularly sinuous"; in *patula* the columella is straight and pillar-like. Of three new specimens from two localities, two were believed to be fossil and the other doubtful; the columella of the last was found to be as in *patula* and in the other two it is identical with that described by Weisbord; viewed across the edge of the outher lip, the under surface of the columella is seen to be excavated to produce the sharp, sinuous edge. It is here referred to a new species, *weisbordi*. His figured specimen (pl. 26:15, 16; Nº 26206 PRI) is designated the holotype, the type locality being the type locality of the Mare Formation at Mare Abajo. The two paratypes are registered as Nº UCVG 7059; the larger comes from Mare Abajo and measures: height 59,2 mm, diameter 39.5 mm; the smaller (bodywhorl only) is from the *Lithothamnium* reef at Punta Gorda (GS-7-CB=W-23). Without verifying that Weisbord's second specimen is identical it cannot be accorded paratype status. Weisbord notes that there is no pre-Quaternary record for *P. patula;* it may be that *P. weisbordi* is more closely related to *P. columellaris* (LAMARCK) from the eastern Pacific, described as having two raised nodes near the centre of the columella; in the figure of KEEN (1971:553: 1087), however, this feature cannot be clearly seen.

Columbella williamgabbi Weisbord = *C. mercatoria* (LINNÉ). The former, based on the holotype and a broken specimen, was said to be more pyriform than *C. mercatoria.* Variations of relative widths amongst a fossil suite of 19 specimens are matched in the Recent form; they are indistinguishable.

Nitidella laevigata (LINNÉ).
Mitrella lunata (SAY).
Latirus infundibulum (GMELIN).
Leucozonia cf. *ocellata* (GMELIN).
Fasciolaria hollisteri WEISBORD. Referred to earlier.

Fusinus closter caboblanquensis WEISBORD=*F. closter* PHILIPPI. The former was distinguished in having a sinuous, rather than a straight, anterior canal. In many specimens of the latter from Isla Coche, lying adjacent to Isla Margarita, the type locality, the canal may be either straight or sinuous, as in a suite of the fossil.

Oliva scripta LAMARCK.

Oliva schepmani WEISBORD. Referred to earlier.

Ancilla venezuelana WEISBORD = *A. tankervillei* (SWAINSON). The former was distinguished in being stouter, less prominently shouldered and with the glaze extending down only to the middle of the bodywhorl. These distinctions are not supported by material to hand consisting of 15 Recent and 28 Mare specimens; in both suites the degree of stoutness and shouldering is variable and the glaze, invariably, extends down only to the level of the suture or just below the top of the aperture. A completely glazed bodywhorl is a feature of *A. glabrata* (LINNÉ) also present in Venezuelan waters. The retention of *A. venezuelana* on account of its apparently smaller size (height 53.0 mm, diameter 23.0 mm) than the Recent form (height 72.0 mm, diameter 32.7 mm) is not considered warranted.

Mitra cf. *nodulosa* (GMELIN).

Cancellaria (C.) torula WEISBORD = *C. reticulata* (LINNÉ. The former was distinguished by its strong parietal ridge, missing in the latter. Two specimens only are to hand from Mare with heights of 39.0 mm and 23.0 mm whilst Weisbord's specimen measured 13.0 mm. The parietal ridge is present in both of the smaller, juvenile specimens but not in the adult, which is the answer to the problem. In a large suite of the Recent *C. reticulata,* the parietal ridge is seen to be an intermittent, resting stage feature in the juveniles but is absent in the adults.

Trigonostoma (Ventrilia) cf. *carolinensis* EMMONS from the late Miocene Pinecrest beds, Florida.

Marginella (Prunum) circumvittata WEISBORD.

Persicula hodsoni WEISBORD is the adolescent of his *P. interrupta mareana* both thought by COAN & ROTH (1966: 284) to be referrable to *P. interruptolineata* (MEGERLE VON MÜHLFELD), a moot point. Both the fossil and the Recent form reach a height of 20 mm but the fossil is, on average larger and more heavily callused with a pinched up knob or short ridge at mid-ventrum only hinted at in one or two Recent specimens. These are the only differences. The form from Isla Margarita has a similar colour pattern but is stubbier, smaller and more heavily callused with a callus knob on the ventrum; the callus also produces a hump across the dorsum not apparently present in the shell itself and tending to impart a rhomboidal, rather than ovate, outline. It might be considered a variant but a similar form is present in the Mare at Punta Gorda.

Persicula venezuelana lavelana (F. HODSON) of WEISBORD = *P. obesa* (REDFIELD). WEISBORD (1962:413) thought the fossil could be the same as the Recent *P. obesa;* we agree, it is the same. The doubt he had may have been occasioned by the fact that his suite was mixed; his few specimens described as having a mammiliform nucleus with sunken first post-nuclear whorl, as well as those having 11 columellar plaits, belong to *Pachybathron* (?) sp., there being usually 7 (sometimes 8) plaits in *P. obesa*. The stout form from the early Miocene Matura shell bed, Trinidad, assigned by JUNG (1969:537) to *P.* cf. *interruptolineata* is probably to be referred to *P. lavelana* if not to *P. obesa.*

Pachybathron (?) sp. Very similar to *P. obesa* but more pyriform and apex more sunken as mentioned above (height 18.5 mm, diameter 12.7 mm). The outer lip thickened and finely denticulate; the inner lip *Cypraea*-like, with weak fossula and 9 (sometimes 10) plaits, the second lowest bipartite but not so heavy as in *P. obesa.* Aperture very narrow, outer lip parallel to inner and not emarginate. Colour pattern of 3 narrow, widely and evenly spaced bands of horseshoe markings and a brown band around the apex. It may be *Marginella kieneriana* PETIT as described by REEVE (1864-1865, 15, species 63) whose habitat is given as Venezuela but which we have yet to encounter in the Recent.

Pachybathron cf. *cypraeoides* (C.B. ADAMS). This occurs on Isla La Orchila; it is milk-white with 4 narrow, whiter, evenly spaced spiral bands bordered by paired brown dots, widely spaced, and a brown band around the sunken apex; juveniles are axially ribbed similar to *P. cassidiforme* GASKOIN. It has not been found as a fossil.

Conus mappa LIGHTFOOT ? Identical to the illustration of VINK (1977, pl. 3, fig. 1) of a specimen from the Gulf of Venezuela. A similar specimen in a private Caracas collection has been compared. Vink advises (pers. comm.) that this may be *C. granarius* KIENER.

Conus ermineus BORN. The species *C. planitectum* WEISBORD from the Playa Grande Formation, based on a single worn specimen, is probably to be referred here.

Conus jaspideus caboblanquensis WEISBORD. With large suites of the fossil and Recent form to hand they are found to be indistinguishable. The Mare form was said to differ from the *jaspideus* clan in being generally broader.

Hindsiclava sp. Discussed earlier.

Clathrodrillia mareana WEISBORD = juvenile *C. gibbosa* (BORN) as was pointed out by WOODRING (1970:383).

Microdrillia trina MANSFIELD. The example lacks the protoconch and is a bit worn. Its identification, however, is supported by a Recent, pale straw-coloured specimen from Tucacas. *M trina* occurs also in the early Miocene La Rosa and Cantaure Formations (mentioned earlier), the middle Miocene Gatun Formation, Panamá and the Brasso Formation, Trinidad (type locality).

Glyphostoma aff. *sculptile* JUNG from the late Miocene Melajo Clay, Trinidad.

Odostomia (Miralda) abbotti OLSSON & MCGINTY.

Triptychus niveus MÖRCH.

Ringicula (Ringiculella) cf. *guppyi* DALL. Similar in size and sculpture to *R. maiquetiana* WEISBORD but has a parietal ridge and toothed outer lip lacking in that. No specimen of *Ringicula* is present in our Recent, shallow water, Venezuelan collection but a specimen of *R. semistriata* ORBIGNY from off Florida is to hand. *R. maiquetiana* is from the Playa Grande Formation.

Acteocina candei (ORBIGNY).

Cylichnella mareana WEISBORD. = *C. bidentata* (ORBIGNY). The former was based on a single specimen but, in a suite of more than 50, it is found to be the same as *C. bidentata,* a large suite of which from the Recent is also to hand.

Bulla solida (GMELIN).

Volvulella persimilis (MÖRCH).

With regard to the bivalves, the new collection contains 39 Recent taxa not previously represented in the Mare fauna as described by WEISBORD (1964) and 11 previously represented, of which 6 have been found to be still living and 5 have been placed in the synonymy of Recent forms. The following annotated list also proposes other synonyms:

Nucula (N.) venezuelana WEISBORD, already recognised in the Recent of Brazil (RÍOS 1975:187).

Nucula (Leionucula) mareana WEISBORD.

Nuculana (Saccella) axelolssoni WEISBORD = *N. (S.) karlmartini* WEISBORD. The former was said to be less inflated and to have fewer ribs but, as seen in a large suite (more than 200), these characters are part of the variability, to be seen also in the Recent successor *N. acuta* (CONRAD). This last is more elongate, more rostrate and has a less convex ventral margin.

Nuculana (Saccella) marella WEISBORD. Described from the posterior half of a juvenile valve. A large suite to hand shows it to differ from *N. karlmartini* and *N. acuta* in being smaller (length 6.6 mm, height 4.25 mm), more inflated, less elongate, less rostrate and the ventral margin more convex; sculpture of finer, closer concentric ribs which, in the juvenile and adolescent, stop well short of the posterior ridge bordering the escutcheon but cross in the adult; anterior ridge narrower and more sharply defined. Recent specimens from Tucacas, Edo. Falcón and Is. Los Testigos are smaller (length 4.6 mm, height 2.75 mm) but are otherwise indistinguishable.

Arca (Arca) imbricata BRUGUIERE.

Barbatia (Acar) domingensis (LAMARCK).

Anadara (Larkinia) notabilis (RÖDING).

Glycymeris decussata (LINNÉ) of WEISBORD = *Glycymeris castanea* (LAMARCK) of REEVF. In the Venezuelan Recent there are three forms of radially and concentrically striate *Glycymeris* to hand; in one, *undata* LINNÉ, the beaks are orthogyrate, in the second they are strongly opisthogyrate (ligament prosodelic) and in the third they are only slightly opisthogyrate, this form having, in addition, microscopic oblique striae. These last two have both been referred to *G. decussata,* respectively by WORK (1969:682) from Islas Los Roques and WEISBORD (1964:92) from the north coast and fossil at Mare. Comparison with material in the Cuming collection of the BM(NH) shows the island form to be *G. pennaceus* (LAMARCK) (REEVE 1843, vol. 1, pl. 5, species 24) long recognised as *G. decussata;* it occurs also on Isla La Tortuga. The mainland-Mare form is identified as *G. castanea* (LAMARCK) (REEVE 1843, vol. 1, pl. 6, species 32); no recent reference to this species has been found in the literature to hand, unless it be *spectralis* NICOL which, however, is half the size and is not said to have oblique striae, and whether it is truly *castanea* may be a moot point; its lineage can be traced back from the late Pliocene Mare Formation, through the Punta Gavilán Formation to the early Miocene Cantaure Formation, where it was referred to *G.* aff. *jamaicensis* DALL by JUNG (1965:438), these earliest fossils being indistinguishable from Recent specimens except for a somewhat smaller size (length 35 mm versus 52 mm). The form from the early Pliocene Matura shell beds, Trinidad, referred by JUNG (1969:340) to *G.* cf. *undata,* should also probably be assigned to *G. castanea.* With regard to *G. decussata,* this has recently been found on the mainland by Sra. Juanita O'Kelly, at Tucacas, Edo. Falcón.

Glycymeris (Tucetona) pectinata (GMELIN) of WEISBORD= *Glycymeria (Tucetona)* n. sp. In the Venezuelan Recent there are two forms of *Tucetona*. The smaller (length 24.5 mm, height 23.5 mm) has very narrow interspaces between the ribs and, except for having more ribs (30 to 40 versus 24) seems identical with *G. pectinata* (Gmelin) as described and illustrated by PERRY & SCHWENGEL (1955; 38:3:14). The larger (length 37.5 mm. height 41.2 mm) is relatively higher, has wider interspaces and the hinge plate is deeper and more acutely arcuate; it is the descendant of the Mare form and is referred to *G. (T.) oculata* (REEVE) of the West Indies. Two paired syntypes are in the Cuming collection at the BM(NH); one matches the figure of REEVE (1843; vol. 1, pl. 6, species 38) and is here designated the lectotype (length 21.63 mm, height 22.05 mm; Reg. Nº 1953.4.20. 4/1); both are adolescent specimens more orbicular than the adult. This is another species which seems not to have been recognised in recent years. The new material, collected only recently, was found live at a depth of 15 m on sand in a coralline environment at Cayo Sombrero, Punta Tucacas, Estado Falcón; it occurs also at Borburata, Estado Carabobo, some 70 km to the southeast, in a similar environment, young specimens from there, collected earlier, having been confused with *G. pectinata,* a confusion which possibly exists in the literature. A paired adult specimen has been deposited in the BM(NH). The successor to *G. canalis* BROWN & PILSBRY and similar forms, common throughout the Caribbean since Miocene times, is generally considered to be *G. pectinata* (vide WOODRING 1973:521), but it seems that role must pass to *G. oculata*. The antecedents of *G. pectinata* are, presumably, those forms with linear interspaces such as *G. epacra* WOODRING from the Gatun Formation, Panamá.

Amusium marensis WEISBORD = *A.* cf. *laurenti* (GMELIN). It was described from two, small, left valves; the right valve is deeper and both match the valves of *A. laurenti,* a locally common species on sale in any supermarket. Lacking adult fossil specimens, the assignment is made tentative.

Pecten (Euvola) ziczag caboblancoensis DRUCKERMAN. Referred to earlier.

Pecten (P.) maiquetiana WEISBORD = *P. (P.) caribeus* WEISBORD, the two species being represented by left and right valves respectively which, lacking paired specimens, the author did not feel justified in assigning to a single species; paired specimens are to hand.

Lyropecten (Nodipecten) cf. *nodosus* (LINNÉ), fragments only.

Spondylus americanus HERMANN.

Plicatula venezuelana Weisbord and *P. caribbeana* WEISBORD, the former ocurring together with *P. gibbosa* LAMARCK at W-23, are two forms which are duplicated in a Recent suite assigned to the last. Some Recent specimens have open spines on the lower valve and might be assigned to *P. penicillata* CARPENTER, an Eastern Pacific form, but reported also from the Caribbean coast of Panamá by OLSSON & McGINTY (1958:20); others, when growing on a smooth surface (bivalve shell) may reach a large size with no radial ribs at all except at the crenulate margin. The view is taken that these variants, both fossil and Recent, are to be assigned to *P. gibbosa.*

Anomia mareana WEISBORD. Distinguished from *A. simplex* ORBIGNY in having radial ribs. In a Recent Venezuelan suite ribs may be present or absent.

Lima (L.) caribaea ORBIGNY.

Ctenoides floridana OLSSON & HARBISON.

Codakia orbicularis (LINNÉ).

Divalinga cf. *quadrisulcata* (ORBIGNY), fragments only.

Divalinga weberi OLSSON & McGINTY.

Diplodonta (D.) punctata SAY. In the Venezuelan Recent there are two punctate forms of *Diplodonta:* the larger (length 22.1 mm, height 20.3 mm) and very inflated form has microscopic, crowded, punctate radial striae and is assigned to *D. (D.) punctata* SAY, well described by DALL (1900: 1187) and by PERRY & SCHWENGEL (1955:63:11:63a, b.); it is also described and illustrated as *D. rehderi* ALTENA (1968:149). Although DALL (loc. cit.) placed *D. venezuelensis* DUNKER in the synonymy of *D. punctata,* later authors continue to regard it as a valid species (JOHNSON 1934:41; ABBOTT 1974:465) which seems incorrect. The smaller (length 13.0 mm, height 12.5 mm) much less inflated form is further distinguished by its coarser punctations which are arranged concentrically; it is referred to *D. soror* C.B. ADAMS from Jamaica. Both are present at Mare, a very few specimens of each being to hand; the largest of 3 specimens of *D. punctata* measures only: length 11.0 mm, height 9.9 mm. It is a moot point to which of the two *D. mareana* WEISBORD (1964:211), described from a single juvenile valve (length 3.8 mm, height 3.7 mm), is to be assigned; despite the "ephemeral radii" which might relate it to *D. punctata,* the rather strongly pitted surface suggests that it is, in fact, *D. soror.*

Diplodonta (Phlyctiderma?) soror C.B. ADAMS. Discussed above.

Diplodonta (Phlyctiderma) semiaspera PHILIPPI.

Chama macerophylla (GMELIN).

Pseudochama radians (LAMARCK).

Bornia tacaguana WEISBORD. Still living. =? *B. longipes* (STIMPSON).

Trachycardium isocardia (LINNÉ). Only tentatively assigned by WEISBORD.

Basterotia (B.) quadrata (HINDS).

Basterotia (Basterotella) elliptica (RÉCLUZ).

Eucrassatella (Hybolophus) n. subsp. Assigned by WEISBORD (1964:194) to *E. antillarum* (REEVE) noting, however, that he was comparing adolescents. Three Mare adults (81 to 96 mm in length) are remarkably more elongate than Recent adults, the heights being 68% and 73% of the lengths, respectively. In the fossil the postero-dorsal margin is less excavated and the anterior margin less broadly rounded; it can be regarded as a subspecies.

Crassinella lunulata CONRAD.

Crasinella triquetra WEISBORD (1964:197) = *C. aduncata* WEISBORD (1964:199). The former, described from a single left valve, is seen, in a suite of more than 200 specimens, to represent the adult of *C. aduncata* which has page preference. The same variation from juvenile to adult is seen in a large suite of *C. aduncata* from the Recent.

Papyridea soleniformis (BRUGUIERE). This was only tentatively assigned by WEISBORD (1964:266).

Papyridea cf. *semisulcata* (GRAY). The Recent form is possibly more inflated.

Laevicardium laevigatum (LINNÉ).

Laevicardium sybariticum DALL?

Mactra (Simomactra?) quirosana H.K. HODSON. Represented by a single right valve. It was known previously only from its type locality in the La Rosa Formation (HODSON & HODSON 1931a:20, locality Nº 6, Quiroz) and from the Cantaure Formation (JUNG 1965:470), both early Miocene in age. Surprisingly, it occurs in the Recent at north coast localities.

Solen rosewateri ALTENA. Referred to *Solen* sp. by WEISBORD (1964:378).

Tellina (Merisca) juttingae ALTENA.

Strigilla (S.) carnaria (LINNÉ) of Weisbord = *S. (S.) producta* TRYON.

Semele (S.) bellastriata (CONRAD).

Semele (Semelina) nuculoides (CONRAD).

Cumingia coarctata SOWERBY.

Ventricolaria rigida (DILLWYN), only tentatively assigned by Weisbord.

Chione (C.) intapurpurea CONRAD, of which a fragment was assigned by Weisbord to *Periglypta* aff. *listeri* (GRAY) and, of which, *Chione (Chione?) laciniosa* WEISBORD, is the juvenile.

Chione (Lirophora) cultellata WEISBORD = *C. (L.) riomaturensis* MAURY of Weisbord. It has been pointed out by JUNG (1969:380, 381) that *C. cultellata* was, "based on a few immature valves". It is regarded here as the juvenile of the accompanying *C. riomaturensis* which MAURY (1925: 314) considered to be intermediate between the Miocene to Recent *C. latilirata* Conrad and the Recent *C. paphia* (LINNÉ), a position unquestionably occupied by the Mare form. JUNG (loc. cit.), however, also pointed out that *C. riomaturensis* was based on an inadequate sample, in which case *C. cultellata* would be available for the intermediate form.

Gouldia venezuelana Weisbord = *G. cerina* (C.B. ADAMS), being the orbicular juvenile form of the more trigonal adult.

Dosinia concentrica prosapia WEISBORD = *D. concentrica* BORN. The former was distinguished from the latter in being higher than long, although the reverse is true of the holotype. In only one of eight measurements of new fossil material is it higher than long; it is indistinguishable from a suite of *D. concentrica* from the Venezuelan Recent.

Pleiorytis venezuelensis WEISBORD = juvenile *Petricola (P.) lapicida* (GMELIN).

Gastrochaena hians (GMELIN).

Gastrochaena ovata SOWERBY.

Hiatella arctica LINNÉ.

Pholadomya cf. *candida* SOWERBY.

Pandora (Pandorella) bushiana DALL.

Cyathodonta semirugosa (REEVE).

Cyathodonta magnifica (JONAS). This is represented solely by an umbo with massive chondrophore. The only recent mention of this species is that of KEEN (1971:297) who regards it as the homologue of *C. undulata* Conrad of the Panamic province. The type of *C. magnifica* is in the BM (NH), Reg. Nº 1977177; it is a perfect paired specimen (length 73.45 mm, height 47.22 mm). In the year of publication it was communicated also by CUMING (1850:170: 6:7), habitat unknown, and later by REEVE (1859: pl. 2, species 11), the habitat being then given as Honduras. Beach specimens are to hand from the west coast of the Paraguaná Peninsula.

Periploma margaritacea (LAMARCK) of WEISBORD =? *Periploma* n.sp. The species presents a problem. ABBOTT (1954; 473) referred the "Unequal Spoon Clam" of the southeastern United States to *P. inequale* (C.B. ADAMS), noting that *P. inaequivalve* SCHUMACHER from the West Indies had been confused with it. In referring a Recent Venezuelan form and a Mare fragment to *P. margaritacea,* WEISBORD included in its synonymy, *P. inequale, P. inaequivalve* and *P. trapezoides* (LAMARCK). Later authors confirmed this synonymy: KEEN in MOORE 1969:N849; ABBOTT 1974: 560; RÍOS 1975:258, extending the range to Brazil. The difficulty arises from the fact that the form described by Weisbord (12 specimens to hand) hardly resembles *P. inequale* which is common on Venezuelan beaches and from which it differs in having non-slit umbones, a shorter, more semicircular chondrophore and a thicker, rugose shell of varying shape; it is clearly of nestling habit, being found, in fact, on coral or beach-rock. Unless the above synonymy is in error, it is an unnamed taxon. That it possibly occurs at Mare, together with *P. inequale,* is suggested by the posterior halves of two valves carrying the respective chondrophores. WEISBORD'S fragment may be one or the other.

Verticordia (Trigonulina) sp.

Cardiomya ornatissima (ORBIGNY).

Cardiomya surinamensis ALTENA.

Another two Mare taxa of more than ordinary interest are:

Pythinella cf. *sublaevis* CARPENTER of which 24 specimens are to hand. According to CHAVAN (in MOORE 1969: N532) the genus is restricted to two Recent North American species: *P. cuneata* (VERRILL & BUSH) from south Massachusetts to Florida and *P. sublaevis* from the Panamic province. Nevertheless, what seems to be a valid fossil form was described from the Pliocene Yorktown Formation, Virginia, as *P. filicaticola* (OLSSON). A successor to the Mare form is present in the Gulf of Venezuela; both Venezuelan forms are possibly closer to *sublaevis* than to *cuneata* which, however, are themselves difficult to distinguish according to ABBOTT (1974:474).

Tryphomyax sp., represented by a single left valve with dorsal margin and hinge missing; it may be the same as a Recent paired specimen and a single left valve (length 3.8 mm, height 2.6 mm) from the Cumaná coast. The genus was established to accomodate a living Panamic form, *T. lepidoformis* OLSSON (1961:135); a second Panamic form, *T. mexicanus* (BERRY, 1959), was referred later but may be synonymous (KEEN 1971:135). The Venezuelan form is distinct, the dorsal margin merging smoothly into the anterior and posterior margins without the angulations to be seen in the other two.

Only some 20 bivalves new to Mare have still to be assigned and a significant increase in the percentage of surviving taxa as a result of the revision is seen: the total number of taxa present increases from 82 to about 150 of which 83 or 55% still survive, as against 39% previously. In the case of the gastropods the revision is less complete and there are, furthermore, some 80 still unassigned new taxa: the total increases from 141 to about 270 of which 71 or 26% still survive as aginst 17% previously. Both new percentages are conservative, making no allowance for some forms which might be considered by others to be the same as the Recent, nor allowing for the finding of other surviving taxa. A middle to late Pliocene age for the fauna seems now more likely, in closer agreement, in any case, with the dating by the planktonic foraminifers: *Globorotalia tosaensis tenuitheca* Zone.

Further evidence on the age is provided by a pollen analysis of a sample (GS-17 -CB) from the terrestrial beds underlying the Mare type section with a 30 degree discordance. These beds were included by Weisbord (1957:58) in his Maiquetía Member, Playa Grande Formation but, in the geological revision mentioned earlier, the beds are assigned to a new formation. The pollen analysis was made by Estella de di Giacomo (palynologist with Maraven) who assigns a late Pliocene age (personal communication) based on the presence in the pollen assemblage of a qualitative sporomorph belonging to the genus *Psilatricolporites* which, in the area of northern Venezuela and Trinidad, is not found earlier than the base of the late Pliocene. The assemblage from a sample (GS-28-CB) from the Las Pailas Formation (Rivero 1956: 94) she assigns to the early or middle Pliocene; this formation is now also interpreted as being transgressed by the Mare Formation again with strong angular discordance, in the area immediately east of the Costa fault, rather than by the Playa Grande Formation as presently understood (Weisbord 1957, map).

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ADDENDUM

Fulfilling a long expressed wish to collect at Cantaure we were visited in December 1977 by Drs. H.E. and E.H. Vokes of Tulane University. After studying the collections, in part at least, and reading a copy of this manuscript (already in press) we are indebted to them for the following comments or additional information: the age of the Pinecrest beds is correctly middle Pliocene, not late Miocene as stated, i.e. the same age as the Punta Gavilán Formation; our tentative identification of *Vasum tuberculatum* Gabb was confirmed and a specimen found by them in the Cantaure shell beds proves that it is not confined to the underlying La Candelaria beds as we had thought; the provenance of *Fasciolaria kempi* Maury is the Baitoa Formation, specimens having been obtained by them on a recent visit to the Dominican Republic; regarding *Poirieria (Panamurex) recticanalis* (Weisbord) from Mare, which we had attempted to maintain distinct from the Recent *P. (P.) velero* E.H. Vokes, it was considered very likely to be the same.

During the same visit to Cantaure the junior author found the missing left valve of *Arcinella (A.) jungi* n. sp. (paratype Nº UCVG 7052). The sole specimen measures: height 17.6 mm, length 19.1 mm. It is only slightly less inflated than the lower valve but the lunule is more rudimentary; sculpture consists of 7 strong spined ribs, one of which lies along the anterior ridge.

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INVESTIGACION DE LA FAJA PETROLERA DEL ORINOCO EN EL ESTADO GUARICO POR METODOS GEOFISICOS NO CONVENCIONALES. FASE I *

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RESUMEN

La Faja Petrolífera del Orinoco, ubicada en el flanco sur de la Cuenca Oriental de Venezuela, al norte del río Orinoco, ha sido y es objeto de numerosos estudios geológicos y geofísicos, tanto más en el momento actual por su importancia estratégica para el desarrollo petrolero futuro del país. De allí que se esté implementando, cada vez con mayor interés, la utilización de diversas técnicas modernas de prospección, tendientes al mejor conocimiento del subsuelo en esta área.

En tal sentido, los resultados de este trabajo constituyen un aporte preliminar para la etapa de exploración de la Faja Petrolífera del Orinoco en el Estado Guárico, mediante métodos geoeléctricos de investigación geofísica.

Previa recopilación de la información gravimétrica, se elaboraron mapas de Anomalías de Bouguer y Residuales, para la densidad $P_B = 2.23$ gr/cm^3 (Mapas Nos. 1 y 2), en base a los cuales, conjuntamente con los datos magnetométricos y eléctricos de perforaciones, se construyó un mapa de contornos estructurales del Tope del Basamento (Fig. N° 11). En lo concerniente a la información geoeléctrica, se seleccionaron 14 pozos para el análisis estadístico y cálculo de parámetros eléctricos distintivos y se consideró la posibilidad teórica de determinar interfases eléctricas entre medios de resistividad contrastantes, empleando diferentes dispositivos electródicos. Por último, se delimitaron geográficamente áreas factibles de ser prospectadas con métodos eléctricos, para la detección del basamento o la Unidad petrolífera "M", quedando sólo por comprobar experimentalmente estos resultados, para lo cual se recomienda la realización de una Fase II o continuación de este estudio.

ABSTRACT

The Petroleum Belt of the Orinoco River is on the south side of the Cuenca Oriental of Venezuela, and to the north of the Orinoco River. It has been the subject of many geological and geophysical studies, especially now when its reserves are very important for the future development of the oil industry of the country. This is the reason for trying new techniques and methods in the study of the subsurface of this area.

This study presents preliminary results of the application of geoelectric methods in the Orinoco petroleum belt of the Guarico state. Also, gravity information was compiled and Bouguer and residual maps were prepared using density $P_B = 2.23$ gr/cm^3 (Map N° 1 and 2). Magnetometric information and electric well logs were also used together with the gravity data to determine structural maps of the Basement Top (Fig. N° 11). Fourteen wells were selected and the geoelectric information of each was statistically analized.

Various electric parameters were calculated. The theoretical possibility of identifying electric interfaces by appliying different electrode arrays was examined. Using this criterium, the region was subdivided into several areas according to the possibilities of detecting the basement of the petroliferous Unit "M".

The experimental results of this method have to be checked. In order to do this, it is recommended that the phase II of the Orinoco Petroleum Belt study be continued.

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* Este trabajo es una versión reducida del estudio realizado por la autora en la Fase I del Proyecto de "Investigación de la Faja Petrolífera del Orinoco por métodos geofísicos no convencionales", por contrato suscrito entre Foninves y la UCV.