Paleontological Notes on some Foraminifera from the Cretaceous of the Upper Magdalena Valley, Colombia.

LUIS VERGARA S.
Departamento de Geociencias, Universidad Nacional de Colombia, Apartado Aéreo 14490, Santafé de Bogotá.
E-mail: lvergara@ciencias.ciencias.unal.edu.co
Present address: Deminex Colombia Petroleum, Calle 114 No. 9-45, Torre A, Of. 611, Bogotá. Fax: 6292901.

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Abstract: Foraminifera from the Quebradas Ocal and Bambucá, and from the Girardot-Melgar section of the Upper Magdalena Valley are reported. Planktic foraminifera recovered from a few samples allowed their age determination. In the Quebrada Ocal, three samples date early Albian, late Albian and in the Santonian/Campanian transition. A sample from the Quebrada Bambucá is assigned to the early Albian. Three samples from the Girardot-Melgar section are of late Campanian age, while other two bear Maastrichtian foraminifera. Taxonomical and chronological aspects of key species, especially those belonging to the genera *Marginotruncana*, *Rugoglobigerina* and *Ticinella* are discussed, as well as their occurrence in Colombia. Stratigraphic implications of the age assessments are addressed.

Key words: Foraminifera, Taxonomy, Biostratigraphy, Cretaceous, Upper Magdalena Valley, Colombia.

Resumen: Se reportan foraminíferos obtenidos de las Quebradas Bambucá y Ocal y de la sección Girardot-Melgar en el Valle Superior del Magdalena. Foraminíferos planctónicos obtenidos de algunas muestras permiten la datación de las mismas. En la Quebrada Ocal, tres muestras pudieron ser datadas como de edad Albiense temprano, Albiense tardío, y de una edad cercana al límite Santoniense/ Campaniense. Una muestra de la Quebrada Bambucá se asigna al Albiense temprano. De la sección Girardot-Melgar, tres muestras son del Campaniense tardío y otras dos del Maastrichtiense. Se discuten aspectos taxonómicos y cronológicos de especies con significado cronológico, especialmente de los géneros *Marginotruncana*, *Rugoglobigerina* y *Ticinella*, así como su ocurrencia en Colombia. Se señalan las implicaciones estratigráficas de las dataciones aquí presentadas.

Palabras claves: Foraminíferos, Taxonomía, Bioestratigrafía, Cretáceo, Valle Superior del Magdalena, Colombia.

INTRODUCTION

While revising old, but extremely valuable literature, I found inspiration to write these notes in a statement, written by CUSHMAN & HEDBERG (1930) to introduce one of their papers: "There is so little known concerning the fossil foraminifera of South America that a few notes on some interesting species may not be out of place". Although rather slowly, significant progress has been achieved over the following decades. Even so, this statement sounds presently as appropriate as it did back in 1930 and is certainly not out dated, at least for Colombia. The fact that some species are reported here for the first time in the study area supports this assertion.

This contribution documents foraminifera obtained while exploring the micropaleontological potential of some Cretaceous sections in the Upper Magdalena Valley. The information provided here comes from known exposures, the Quebradas Ocal and Bambucá, from where I took a few samples whose stratigraphic location was easily tied to published stratigraphic columns (see below). These samples were obtained in September 1994 during a field trip of the Universidad Nacional de Colombia. Other samples were collected in the following November from the Girardot-Melgar section during an excursion carried out by the author during his appointment to Ingeominas. They were prepared for microfossils at Ingeominas by heating and pouring a strong detergent ("Varsol"), prior to screening and isolation of specimens. Below, only the samples with a foraminiferal content worth mentioning are listed, and their stratigraphic implications are discussed.

PROVENANCE AND AGE OF THE SAMPLES

Quebrada Ocal (Yaguará)

This section has become pretty well known in the past years through several studies. Access and geological situation is found in FLÓREZ & CARRILLO (1994) and ETAYO-SERNA & CARRILLO (1996), among others. Fig. 1 shows a simplified version of this section with the localization of the samples dealt with below.

Sample 290905: Dark shale, Hondita Formation, Segment 1 of VERGARA (1994: Fig. 14). The sample comes some 15 m above the contact to the Caballos Formation. This interval is regarded as the El Ocal Formation, initially dated middle Aptian by FLÓREZ & CARRILLO (1994). Discussion of this is provided by VERGARA *et al.* (1995). These strata were dated Albian by VERGARA (1994) and VERGARA *et al.* (1995), and early Albian by ETAYO-SERNA & CARRILLO (1996). Foraminifera found in this sample are mainly agglutinated specimens with limited chronological significance.

Sample 290906: Dark shale, Hondita Formation, Segment 2, Interval B, between samples 220715 and 230712 (Fig. 14 of VERGARA, 1994), 8 m below a fault whose drag folds indicate a left lateral slip. This corresponds to the interval between 150 and 160 m of Fig. 3 of ETAYO-SERNA & CARRILLO (1996), denoted as "Calizas del Tetuán" of the Villeta Group. The age suggested in Fig. 14 of VERGARA (1994) is slightly younger than middle Albian. Here a late Albian age is established, based on the occurrence of *Ticinella primula* (Pl. I, Fig. 6) and *T. madecassiana* (Plate I: Fig. 8), according to the zonations of CARON (1985) and SLITER (1989). This is in agreement with the age determination of ETAYO-SERNA & CARRILLO (1996) for the above mentioned interval in the Quebrada Ocal section.

Sample 290914: Dark shale, Lomagorda Formation. The sample comes from strata 1 m above the "carbonate member" of the Lomagorda Formation, as named by VERGARA (1994). The petrography of these carbonates was studied by RAMÍREZ & RAMÍREZ (1994), whose Fig. 2, section 3 shows their stratigraphic position in the Quebrada Ocal section. They were also mapped by ETAYO-SERNA & CARRILLO (1996: Fig. 1) as "Calizas de la Frontera".

The co-occurrence of *Marginotruncana sinuosa* (Pl. I: Fig. 4) and *Rugoglobigerina rugosa*, (Plate I: Figs. 1-3) permits an accurate age determination for this sample. According to CARON (1985), the former taxon became extint during the late Santonian (*asymetrica* Zone), whilst the latter appeared during the early Campanian (*elevata* Zone). Thus, a slight extension of both biochrons to the top of the Santonian is necessary to explain their coexistence. In addition, the presence of a further *Rugoglobigerina* with evident affinity to *R. pilula* (Pl. I, Fig. 5) is relevant because this species is the only Santonian *Rugoglobigerina* according to ROBASZYNSKI *et al.* (1984).

A similar case of faunal association was reported recently by WILLEMS *et al.* (1996: Fig. 20), where *R. rugosa* appears just above (at most 2 m) the last occurrence of *M. sinuosa*. In this case, WILLEMS *et al.* assigned both occurrences to the *asymetrica* Zone of Santonian age, due to the association of *M. sinuosa*, *marginata*, *coronata* and *pseudolinneana*, indicative of this Zone.

To conclude the age of sample 290914, a conciliation of the known ranges of the taxa mentioned, would render an age very close to the Santonian/Campanian boundary. However, the stratigraphic position below the Lidita Inferior, essentially of Santonian age, suggests the sample dates late Santonian. As discussed above, there are more hints for a Santonian than for a Campanian age. Indeed, VERGARA (1994: Fig. 14) suggested a Coniacian age for the aforementioned carbonate member and a ?Santonian age for the superseding shales, which is consistent with the late Santonian age of the sample favored here.

Quebrada Bambucá (Aipe)

The reader is referred to ETAYO-SERNA *et al.* (1994) and VERGARA (1994) for description of the location and access to this section. The samples taken were localized in the stratigraphic column published by ETAYO-SERNA *et al.* (1994), summarized here in Fig. 1.

Sample 300908: Dark shale, Caballos Formation, Segment 4. The sample was taken exactly 2 m above sample MRC 9 of ETAYO-SERNA *et al.* (1994, Fig. 2) in strata ascribed by them to the El Ocal Formation and dated middle Aptian, based on ammonites. However, the occurrence of *Ticinella primula* (Plate I: Fig. 9) (early-middle Albian) in this sample, together with the Aptian ammonites reported by ETAYO-SERNA *et al.* (1994) 15 m below, permits to trace the Aptian-Albian limit within this segment (between samples MCR-5 and 300908), as argued by VERGARA *et al.* (1995). The first appearance of *T. primula* is dated early Albian (BRALOWER *et al.* 1993). *T. primula* in this segment was already documented by VERGARA (1994: Plate I: Fig. 11) from the Quebrada Palmorosa, a tributary of the Quebrada Bambucá, some 300 m away from the outcrop sampled.

Girardot-Melgar highway

This section is located along km 11 of the Girardot-Melgar highway, at the triple junction of the highway that comes from El Espinal bypassing Girardot, and the road to Carmen de Apicalá, adjacent to a gorge of the Sumapaz

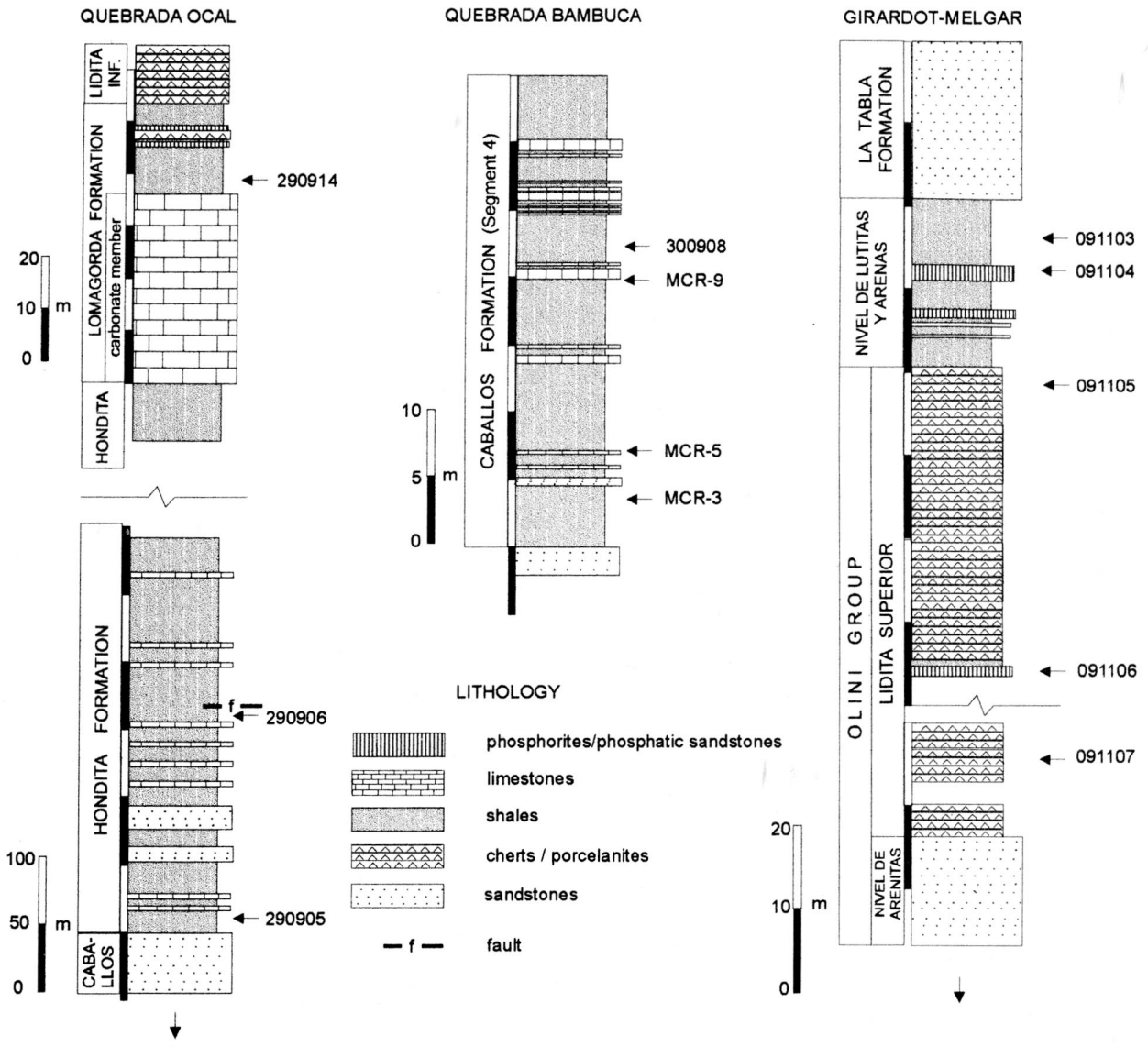

Fig. 1. Generalized stratigraphic columns of the sections with the samples discussed in the text. The lithology of the lower portion of the Quebrada Ocal section is synthesized after Etayo-Serna & Carrillo (1996) and the one of the Quebrada Bambucá after Etayo-Serna *et al.* (1994), where their sample localities MCR-3 and MCR-5 bear ammonites.

river. The section and its foraminiferal content was previously published by Bürgl & Dumit Tobón (1954).

Samples were obtained from the upper half of the section exposed, from units correlatable to the Lidita Superior of the Olini Group, and the Nivel de Lutitas y Arenas, which are overlain by sandstones ascribable to the La Tabla Formation. A very generalized column was done quickly in the field in order to locate the samples (Fig. 1), corresponding roughly to the upper half of the column of Bürgl & Dumit Tobón (1954: sheet 4). At the highway to El Espinal, below the unit of sandstones denoted here informally as "nivel de arenitas" in Fig. 1, a set of porcelanites and siliceous beds are exposed, which represent the Lidita Inferior.

Sample 091107: Porcelanite, Lidita Superior, Olini Group. The foraminiferal content is virtually the same of the Lidita Superior at the Ataco section reported by Vergara (1994). Buliminids predominate, especially *Buliminella*, *Neobulimina*, *Pyramidina*, *Siphogenerinoides* and *Praebulimina*. The Lidita Superior was assigned to the late Campanian (e.g. Jaramillo & Yepes 1994; Vergara 1994). The close similarity in the faunal content points toward a late Campanian age of the Lidita Superior also in this section. A Maastrichtian age was given by Bürgl & Dumit Tobón (1954) for this and the following two samples.

Sample 091106: Phosphorite, some 40 m above the

former sample. The population does not differ greatly from that of sample 091107, but the tests of the foraminifera are phosphatized.

Sample 091105: Porcelanite, Lidita Superior, Olini Group. Abundant inner molds of *Siphogenerinoides* sp. and some rotaliids. The appearance of *S. bramlettei* is noteworthy in this sample because it has received chronological significance, yet without consensus among biostratigraphers. MARTÍNEZ (1995) revived the problem and favored a late Maastrichtian age for Colombia, though it appeared at the Santonian/Campanian in Brazil as noted by this author. Furthermore, *S. bramlettei* in the Tausa section occurs together with late Campanian ammonites, particularly *Libycoceras* sp. (FÖLLMI *et al.* 1992). This and the occurrence of *S. bramlettei* in the late Campanian Lidita Superior reported here does not support the restriction of this species to the Maastrichtian.

Sample 091104: Phosphorite, Nivel de Lutitas y Arenas, some 12 m above the former sample. The presence of *Rugoglobigerina macrocephala* and *R. ornata* warrants a Maastrichtian age. The former taxon appeared during the early Maastrichtian (SLITER 1989). Other associated microfauna are *Siphogenerinoides*, especially *S. bramlettei*.

Sample 091103: Gray shale, Nivel de Lutitas y Arenas, some 4 m above the former sample. This sample presented poor recovery, barely agglutinated foraminifera and abundant individuals of *Siphogenerinoides bramlettei*, among other benthics.

PALEONTOLOGICAL NOTES

The following notes are not meant to cover rigorously the nomenclatural history of each taxon. Instead, the list of synonyms below grants emphasis on published reports from Colombia. Identifications with "cf." or "aff." do not allow the use of synonyms. Because most of the foraminifera reported here are well known world wide, I deem unnecessary to provide detailed descriptions, which are found extensively in the specialized literature.

Planktic Foraminifera

Hedbergella sp.
Plate II, Fig. 10

Remarks: Resembles a low trochospire *Hedbergella* of six chambers in the last whorl, similar to those that appear abundantly in the "middle" to late Cretaceous of Colombia until the early Maastrichtian. This specimen comes from the Campanian of the Olini Group.

Marginotruncana sinuosa PORTHAULT
Plate I, Fig. 4

1970* *Marginotruncana sinuosa* nov. sp.-Porthault *in* DONZE *et al.* (1970): 81, Pl. 11, Figs. 11-13 (holotype)
1994 *Marginotruncana sinuosa* Porthault-Vergara:115, Pl. 3, Figs. 1, 3

Range: *sigali* to *asymetrica* Zones (Late Turonian-Late Santonian) (CARON 1985)
Remarks: The only documentation of this form in Colombia is reported by VERGARA (1994) from the Lomagorda Formation at the Ataco section, Upper Magdalena Valley.

Rugoglobigerina macrocephala BRÖNNIMANN
Plate II, Fig. 7

1952* *Rugoglobigerina (Rugoglobigerina) macrocephala* n. sp.- Brönnimann: 25-27, Pl. 2, Figs. 1-6 (holotype)
1994 *Rugoglobigerina macrocephala* Brönnimann-Vergara: 116, Pl. 2, Fig. 5
1995 *Rugoglobigerina macrocephala* Brönnimann-Tchegliakova: 121, Pl. 7, Fig. 2 (see for further synonyms, especially those of GANDOLFI 1955)

Range: *aegyptiaca* to *mayaroensis* Zone (Early-Late Maastrichtian) (CARON 1985)
Remarks: Differs clearly from *R. ornata* and *R. rugosa* in the youngest chamber comprising almost half of the test. Previously illustrated in Colombia from the Colón shale (GANDOLFI 1955), the Umir Formation (TCHEGLIAKOVA 1995) and the Nivel de Lutitas y Arenas (VERGARA 1994).

Rugoglobigerina ornata GANDOLFI
Plate II, Fig. 6

1952* *Rugoglobigerina macrocephala ornata* n. sp., n. subsp. Brönnimann: 27, Pl. 2, Fig. 4-6 (holotype)
1955 *(Rugoglobigerina) ornata ornata* - Gandolfi: 49-50, Pl. 3, Fig. 7
1955 *(Rugoglobigerina) ornata subornata* - Gandolfi: 49-50, Pl. 3, Fig. 6
1994 *Rugoglobigerina ornata* Gandolfi -Vergara: 116, Pl. 2, Fig. 9

Range: Campanian-Maastrichtian (GANDOLFI 1955)
Remarks: The subspecies of BRÖNNIMANN (1952) was raised to species and separated from *R. macrocephala* by GANDOLFI (1955). TCHEGLIAKOVA (1995) listed this species as synomyn of *R. rugosa*, which appears appropriate from the point of view of their coincident biochrons. Yet, because it differs from *R. rugosa* in the lower trochospire and protruding penultimate chamber, as evident in the material before me,

R. ornata is retained here. Additionally, the exemplars of *R. ornata* I know of have only four chambers in the final whorl.

Rugoglobigerina rugosa (PLUMMER)
Plate I, Figs. 1,2,3

1926* *Globigerina rugosa* Plummer: holotype reproduced by CARON (1985, Fig. 34, # 9)
1955 *Globotruncana (Rugoglobigerina) rugosa rugosa* (Plummer) GANDOLFI: 72, Pl. 7, Fig. 6, text-fig. 11c
1987 *Rugoglobigerina rugosa* (Plummer) - MARTÍNEZ: Pl. 3, Fig. 4
1995 *Rugoglobigerina rugosa* (Plummer) - TCHEGLIAKOVA:120-121, Pl. 7, Fig. 1, non Pl.6, Fig. 3b (with detailed list of synonyms)
1995? *Rugoglobigerina rugosa* (Plummer) - Martínez: 79, Pl. 3, Fig. 7

Range: *elevata-mayaroensis* Zones (Campanian-Maastrichtian) (CARON 1985)
Remarks: The longitudinal costae proper of the genus are conspicuous. The species exhibits a broad and rather deep umbilicus, especially noted in the exemplar of pl. 1, fig. 1. The other two specimens figured show some affinity to the youngest *R. macrocephala* on the less number of chambers in the last volution, but I envisage these forms to fall into the intraspecific variability of *R. rugosa* (see e.g. PERYT 1980: Pl. 22, Fig. 8).

In Colombia *R. rugosa* is known only from the Colón Formation of the Cesar-Ranchería basin (GANDOLFI 1955; MARTÍNEZ 1987), the Umir Formation (TCHEGLIAKOVA 1995) and the Cimarrona Formation of the Middle Magdalena Valley (DE PORTA 1965). The exemplar encountered by MARTÍNEZ (1995) in the Guaduas Formation at the Tausa section is a pyritized internal cast, thus not warranting a robust identification. Specimens figured here represent the species first documentation in the Upper Magdalena Valley.

Rugoglobigerina aff. *pilula* BELFORD
Plate I, Fig. 5

Remarks: The species is easily comparable to those denoted as *Rugoglobigerina* aff. *pilula* by ROBASZYNSKI *et al.* (1984: Pl. 49, Figs. 2-3) and *R. pilula* by DOUGLAS (1969: Pl. 6, Fig. 8), in particular in the lower number of chambers (4) than usual (5 to 6 in the final whorl according to SLITER 1976). It also resembles closely *R.* aff. *bulbosa* as figured by DONZE *et al.* (1970). As they remarked, this form could be synonymous to *R. pilula*, the difference being a fifth chamber in the last whorl of the latter species. The form was hitherto unknown in Colombia.

Ticinella madecassiana SIGAL
Plate I, Fig. 8

1966* *Ticinella madecassiana* n.sp. - Sigal: 197, Pl. III, Figs. 7-10 (holotype)
1993 *Ticinella madecassiana* Sigal.-Blau *et al.*:197, Fig. 6, #6 (with list of synonyms) (reproduced by VERGARA 1994: Pl. 1, Fig. 4)

Range: *ticinensis* to *appenninica* Zones (Late Albian) (CARON 1985)
Remarks: This is another poorly known form in Colombia, only reported from the Quebrada Bambucá (BLAU *et al.* 1993). The present exemplar is more representative of the species than the previously illustrated, whose preservation of the umbilical side is not optimal.

Ticinella primula LUTERBACHER
Plate I, Fig. 6, 9

1963* *Ticinella primula* n. sp. Luterbacher, in RENZ *et al.*(1963): 1085-1086, Text-fig. 4 (holotype)
1993 *Ticinella primula* Luterbacher.-BLAU *et al.*:199, Fig. 5, #3, Fig. 6, #8 (the latter reproduced by VERGARA, 1994, Pl. 1, Fig. 7; see also his Pl. 1, Fig. 11)

Range: *primula* to *ticinensis* Zones (Early to Late Albian) (CARON 1985)
Remarks: For *Ticinella*, in the absence of preserved supplementary apertures the large umbilicus with a tendency to penetrate into the sutures is diagnostic. Furthermore, species of this genus normally exhibit greater number of chambers in the final whorl than species of *Hedbergella*, at least those illustrated from Colombia. The "typical" *T. primula* develops seven chambers in the last whorl, as in the specimens figured here.

Benthic Foraminifera

Ammobaculites sp.
Plate I, Fig. 14

Remarks: Early stage clearly coiled, coarsely agglutinated; not illustrated from Colombia so far.

Asanospira sp.
Plate I, Fig. 13

Remarks: This finely agglutinated exemplar is ascribed to *Asanospira* because it exhibits a lenticular form, subangular periphery and rounded margin, instead of the more inflated chambers and lobulate outline of *Haplophragmoides*

(Loeblich & Tappan 1988).

"Gyroidina" cretacea (CARSEY)
Plate II, Fig. 5

1968 *Gyroidina cretacea* (Carsey)- Sliter: 117, Pl. 21, Fig. 7-8

Range: Campanian-Maastrichtian at the American Gulf Coast (Sliter 1968)
Remarks: There are a great number of rotaliids included in diverse genera (*Cibicides*, *Gyroidinoides*, *Gavelinella*, etc) which appear difficult to separate and have nomenclatural complications. Related species were reported from the Cesar-Ranchería basin by Martínez (1987).

"Gyroidina" cf. *depressa* (Alth) CUSHMAN & CHURCH
Plate II, Fig. 12

Remarks: This and similar forms occur sparsely in the Late Cretaceous of the Upper and Middle Magdalena Valley (see Vergara 1994; Tchegliakova 1995), as well as in the Girardot-Melgar section.

Haplophragmoides calcula CUSHMAN & WATERS
Plate II, Fig. 11

1927* *Haplophragmoides calcula* new species- Cushman & Waters: 83, Pl. 10, Fig. 5 (holotype)

Range: Coniacian-Santonian (Austin) to Maastrichtian (Navarro) (Cushman 1946)
Remarks: It may be synonym of *Haplophragmoides rugosus*, as claimed by Tchegliakova (1995), based on her material of the Umir Formation. Occurs also in the Chipaque Formation close to Lake Tota (Vergara *et al.* in press).

Osangularia cordieriana (D'ORBIGNY)
Plate II, Fig. 9

1968 *Osangularia cordieriana* (d'Orbigny)- Sliter: 118-119, Pl. 21, Fig. 9
1994 *Osangularia cordieriana* (d'Orbigny)- Vergara: 125, Pl. 5, Fig. 22

Range: Santonian to lower Maastrichtian (Sliter 1968)
Remarks: It is distinguished here from the very similar taxon known as *Hoeglundina supracretacea* (ten Dam) (reported in Colombia by Martínez 1995) in the conspicuous V-shaped aperture around the base of the final chamber (cf. Sliter 1968). Despite the exemplars from the Magdalena Valley bear commonly a phosphatic coat that healed the apertures, the outline of the opening of *O. cordieriana* is striking and allows to distinguish both taxa.

Praebulimina carseyae PLUMMER
Pl. II, Fig. 8

1946 *Buliminella carseyae* - Cushman: 119-120, Pl. 50, Figs. 17-20
1946 *Buliminella carseyae* var. *plana*-Cushman: 120, Pl. 5, Fig. 16, 21, 22
1994 *Praebulimina carseyae* (Plummer) - Vergara: 126, Pl. 4, Fig. 20,12; Pl. 5, Fig. 7

Range: Santonian-Maastrichtian
Remarks: This small and rapidly tapering multiserial form may correspond to the megalospheric stage. Vergara (1994) remarked *P. carseyae* as the most common foraminifera encountered in his samples of the Upper Magdalena Valley.

Siphogenerinoides bramlettei CUSHMAN
Plate II, Fig. 3

1941 *Siphogenerinoides bramlettei* Cushman- Cushman & Hedberg: 93, Pl. 22 , Fig. 19
1958 *Siphogenerinoides bramlettei* Cushman- Bürgl: 142-143, Pl. XVII, Fig. 8
1995 *Siphogenerinoides bramlettei* Cushman- Martínez: 74, Pl. 1, Figs. 6-8, 10-11 (with list of synonyms)

Range: Campanian-Maastrichtian (see discussion above, under sample 091105)
Remarks: Easily identifiable on its costae and crenulated sutures, or sharp longitudinal edges if these features are not evident. Morphometric analyses of this species (and of other *Siphogenerinoides*) carried out by González & Martínez (in press) resulted in an average of 0.7 mm in the length of the tests, in the material they studied.

Siphogenerinoides clarki CUSHMAN & CAMPBELL
Plate II, Fig. 1

1946 *Siphogenerinoides clarki* Cushman & Campbell- Stone: 472-473 (not figured)
1958 *Siphogenerinoides clarki* Cushman & Campbell- Bürgl: 141-143, Pl. XVII, Fig. 10
in press *Siphogenerinoides clarki* Cushman & Campbell- González & Martínez, Pl. 1, figs. 8-14 (with detailed list of synonyms)

Range: Turonian-Maastrichtian in South America (Loeblich & Tappan 1988)
Remarks: Comments regarding its morphology are found González & Martínez (in press), who stated its synonymy

to an exemplar denoted as *S. uhli* by VERGARA (1994). *S. clarki* is typically about 1.3 mm long, with a cylindrical, smooth test.

Siphogenerionoides whitei CHURCH
Plate II, Fig. 2

1946 *Siphogenerinoides whitei* Church.-Stone: 473, Pl. 72, Figs. 8-12

Range: late Cretaceous (STONE 1946)
Remarks. The outer morphology of the exemplar figured matches closely the description of STONE (1946), except for the ornamentation, due to the loss of the test. The rounded proloculus indicates its megalospheric generation.

Siphogenerinoides sp.
Plate II, Fig. 4

Remarks: The test is phosphatic coated and the superficial features partially obliterated, which obscures its probable affinity to *S. cretacea*, as suggested by its size.

Trochammina sp.
Plate I, Fig. 12

Remarks: This finely agglutinated form resembles closely *Saccamina globosa* Crespin, but its low trochospiral coiling and shallow umbilicus is evident.

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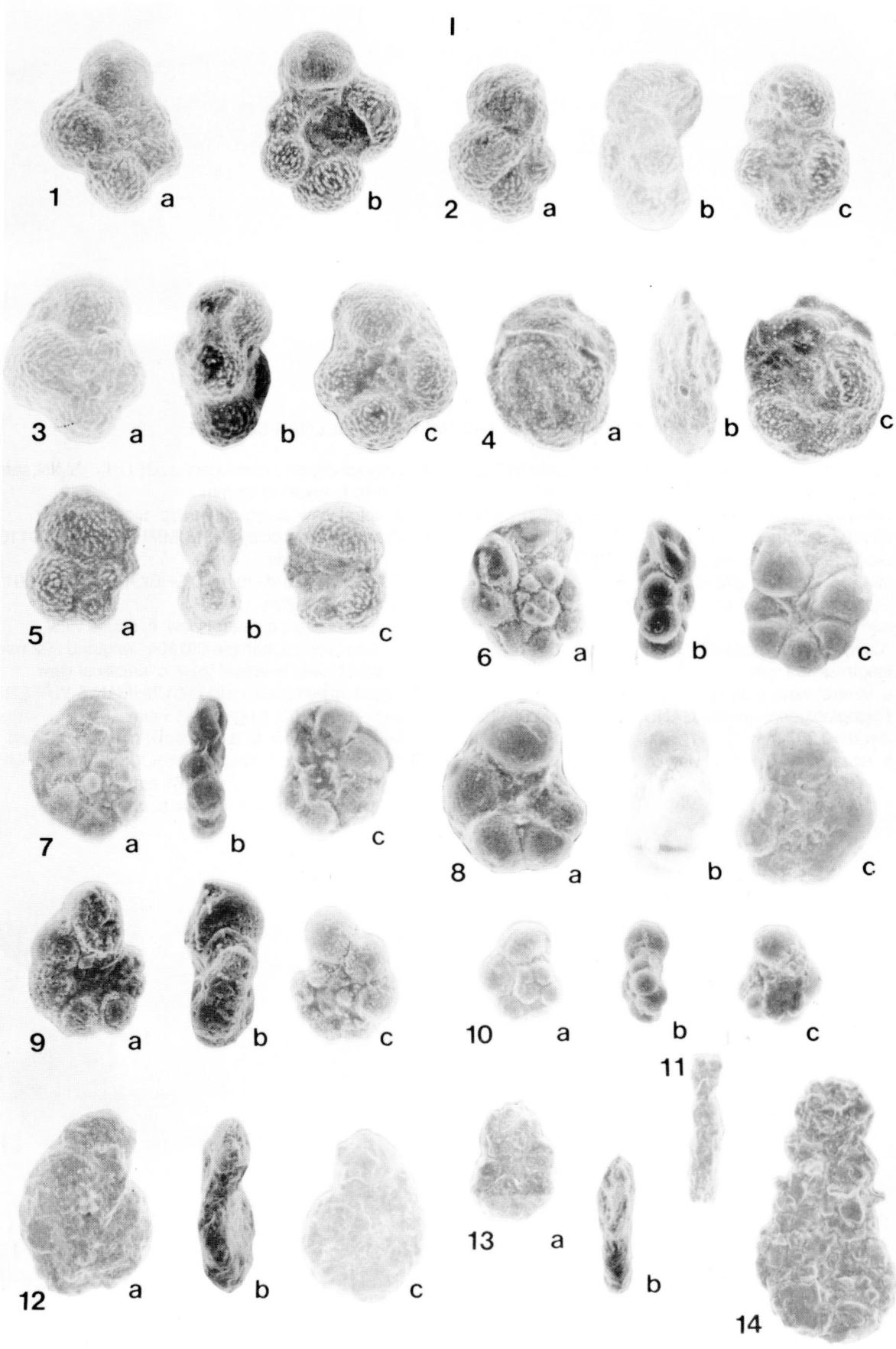
PLATE I
FORAMINIFERA FROM THE QUEBRADAS OCAL AND BAMBUCA

1. *Rugoglobigerina rugosa* PLUMMER; sample 290914; length= 0.45 mm
   a. spiral view; b. umbilical view
2. *Rugoglobigerina rugosa* PLUMMER; sample 290914; length= 0.41 mm
   a. spiral view; b. lateral view; c. umbilical view
3. *Rugoglobigerina rugosa* PLUMMER; sample 290914; length= 0.38 mm
   a. spiral view; b. lateral view; c. umbilical view
4. *Marginotruncana sinuosa* PORTHAULT; sample 290914; length=0.38 mm
   a. spiral view; b. lateral view; c. umbilical view
5. *Rugoglobigerina* aff. *pilula* BELFORD sample 290914; length= 0.31 mm
   a. spiral view; b. lateral view; c. umbilical view
6. *Ticinella primula* LUTERBACHER; sample 290906; length= 0.33 mm
   a. spiral view; b. lateral view; c. umbilical view
7. *Ticinella* or *Hedbergella*; sample 290906; length= 0.33 mm
   a. spiral view; b. lateral view; c. umbilical view
8. *Ticinella madecassiana* SIGAL; sample 290906; length= 0.385 mm
   a. umbilical view; b. lateral view; c. spiral view
9. *Ticinella primula* LUTERBACHER; sample 300908; length= 0.35 mm
   a. umbilical view; b. lateral view; c. spiral view
10. *Hedbergella* sp. sample 290906; length= 0.225 mm
    a. spiral view; b. lateral view; c. umbilical view
11. agglutinated undetermined; sample 29005; length=0.337 mm
12. *Trochammina* sp.; sample 290905; length= 0.4 mm
    a. spiral view; b. lateral view; c. umbilical view
13. *Asanospira* sp.; sample 290905; length= 0.35 mm
    a. umbilical view; b. lateral view
14. *Ammobaculites* sp. ; sample 290905; length= 0.6 mm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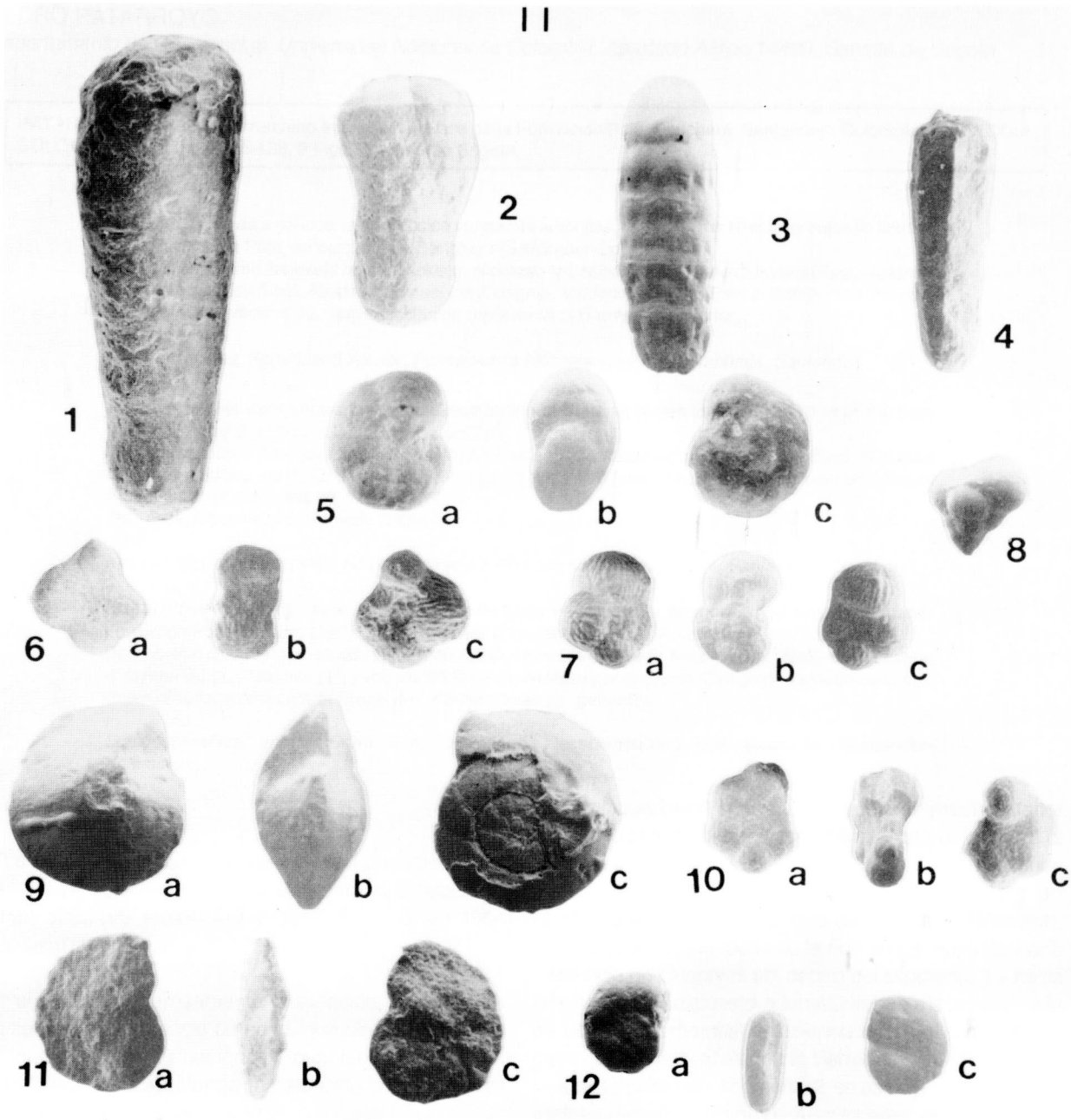
14

PLATE II
FORAMINIFERA FROM THE GIRARDOT-MELGAR SECTION

1. *Siphogenerinoides clarki* CUSHMAN & CAMPBELL; sample 091104; length=1.24 mm
2. *Siphogenerinoides whitei* CHURCH (inner cast); sample 091104; length=0.66 mm
3. *Siphogenerinoides bramlettei* CUSHMAN; sample 091104; length=0.676 mm
4. *Siphogenerinoides* sp.; sample 091106; length=0.784 mm
5. *"Gyroidina" cretacea* (CARSEY); sample 091107; length=0.369 mm
   a. ventral view; b. lateral view; c. dorsal view
6. *Rugoglobigerina ornata* GANDOLFI; sample 091104; length=0.307 mm
   a. spiral view; b. lateral view; c. umbilical view
7. *Rugoglobigerina macrocephala* BRÖNNIMANN; sample 091104; length=0.37 mm
   a. spiral view; b. lateral view; c. umbilical view
8. *Praebulimina carseyae* PLUMMER; sample 091107; length=0.246 mm
9. *Osangularia cordieriana* (D'ORBIGNY) sample 091106; length=0.523 mm
   a. ventral view; b. lateral view; c. dorsal view
10. *Hedbergella* sp. sample 091104; length=0.292 mm
    a. spiral view; b. lateral view; c. umbilical view
11. *Haplophragmoides calcula* CUSHMAN & WATERS; sample 091103; length=0.415 mm
    a. umbilical view; b. lateral view; c. umbilical view
12. *"Gyroidina"* cf. *depressa* (ALTH) CUSHMAN & CHURCH sample 091106; length=0.261 mm
    a. spiral view; b. lateral view; c. umbilical view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