RMS Home

Reproduced from Asociación Venezolana de Geología, Minería y Petróleo. *Boletín Informativo* 12-4, 1969.

AGES OF UPPER TERTIARY AND QUATERNARY FORMATIONS[1] IN VENEZUELA

(EDADES DE FORMACIONES DEL TERCIARIO SUPERIOR Y DEL CUATERNARIO DE VENEZUELA)

Por: R. M. Stainforth[2]

Summary

The studies of the **Mediterranean Neogene Committee (1959-67)** have achieved important revisions of regional stratigraphic correlations in Western Europe and a scheme of planktonic foraminiferal zonation tied in with type stages of the Miocene-Pliocene-Pleistocene interval. By means of the planktonic zones, the marine Tertiary formations of Venezuela can be dated directly in terms of the standard European time-scale. The result is a general upward revision of the ages currently accepted in Venezuela—as shown, for instance, on the widely used correlation chart prepared for the **First Venezuelan Petroleum Congress in 1962**. Specifically: (1) the *Globorotalia fohsi* Zone, represented by parts of the La Rosa, Carapita and Oficina formations and Agua Salada Group, is now assigned to the Middle, not Lower, Miocene; (2) overlying beds, correlated directly or indirectly with the *Globorotalia menardii* Zone, are Upper, not Middle, Miocene; 3) the Cubagua Formation, now treated as upper Middle to upper Upper Miocene, appears to be really Late Miocene to Middle or Upper Pliocene in age; and (4) the Playa Grande, Mare and Cumaná formations, now referred to the Pliocene, either Lower or Upper depending on the author concerned, appear to belong entirely in the Pleistocene.

Resumen

Los estudios del Comité del Neogeno Mediterráneo (1959 67) han logrado revisiones importantes en las correlaciones estratigráficas de escala regional en Europa occidental, y un esquema de zonación por medio de foraminíferos planctónicos que está enlazada con los pisos tipo del intervalo Mioceno Plioceno-P1eistoceno. Por intermedio de las zonas planctónicas, se puede estimar directamente las edades de las formaciones terciarias marinas en Venezuela, en términos de la geocronología “standard” de Europa. Resulta que las edades aceptadas actualmente en Venezuela, como se muestran por ejemplo en el muy conocido cuadro de correlación preparado para el Primer Congreso Venezolano de Petróleo en 1962, necesitan una revision general en el sentido de hacerlas más jóvenes. Específicamente: (1) la Zona de *Globorotalia fohsi* representada por partes de las formaciones La Rosa, Carapita y Oficina y el Grupo Agua Salada, ahora se coloca en el Mioceno Medio, no Inferior; (2) las capas suprayacentes correlacionadas directa o indirectamente con la Zona de *Globorotalia menardii*, pertenecen al Mioceno Superior, nó Medio; (3) la edad de la Formación Cubagua, ahora colocada en el intervalo Mioceno Media superior al fin del Mioceno, paece ser realmente la parte más alta del Mioceno Superior hasta un nivel alto en el Plioceno; y (4) las formaciones Playa Grande, Mare y Cumaná ahora referidas al Plioceno, parte inferior o superior según el autor, parecen pertenecer enteramente al Pleistoceno.

The *Stratigraphical Lexicon of Venezuela* was published in 1956, and represented a thorough compilation of all published and much unpublished information on the character, nomenclature, correlation and ages of all the stratigraphic units then recognized in the country,

The *Lexicon* includes summary articles on the distribution of sediments and the paleogeography in intervals then assigned to the Eocene (G.A. Young) Oligocene (H.H. Renz), Miocene (K. F. Dallmus), Pliocene (K. F. Dallmus) and Quaternary (J. Royo y Gómez). The articles on the Tertiary give no information on the criteria used to distinguish between the four epochs, nor on the basis for dividing them into lower, middle and upper portions, though these subdivisions are designated in many of the articles on individual formations. In these articles, some of the

characteristic fossils of each unit may be mentioned, but there is little discussion of their age diagnostic significance. The fossils listed belong mainly to the Mollusca and Foraminifera, in the latter case mainly the larger and smaller benthonic forms with only occasional mention of planktonic species.

It is apparent that the prime basis for the ages of Tertiary units, as given in the *Lexicon*, was the body of published studies by specialists on the mollusks (*e.g.* F. & H.K. **Hodson, 1926-31**; **Rutsch 1930**, **1934**; **Hoffmeister, 1938**; Dusenbury, in **Sutton, 1946**) and the foraminifera (*e.g.* **Nuttall, 1935**; **Hedberg, 1937**; **H.H. Renz, 1948**). Supplementary to these were compilations which had established a generally agreed chronologic framework for the Tertiary formations, such as those of **Liddle (1928, 1946**), **Hedberg & Sass (1937)**, **Renz (1942)**, **Hedberg & Pyre (1944)**, **Sutton (1946)**, **Hedberg (1950)**, **Mencher *et al.* (1951**, **1953**). Direct paleontologic age determinations only existed for the marine formations, but the brackish to non-marine deposits could be fitted into the scheme by tracing their levels relative to the more fossiliferous units.

In the adjacent island of Trinidad, age determinations within the Tertiary had, by 1956, become highly dependent on the sequence of appearances and extinctions of key species of planktonic foraminifera. The planktonic zonation had been demonstrated in a series, of publications by **Cushman & Stainforth (1945)**, **Cushman & Renz (1946-48)**, **Stainforth (1948)**, **Bronnimann (1950-52)**, **Bolli (1950-54)** and others. It is rather surprising that these papers are barely mentioned in the 1956 *Lexicon*, and that not one of the publications cited therein reveals any strong attempt to recognize and apply the Trinidad planktonic zonation in Venezuela. **H.H. Renz (1948)** includes rather casual mention of a couple of the planktonic index species in the Tertiary of Falcón (but this memoir was in press for over three years). Dr. Renz himself was instrumental in developing the basic zonation in Trinidad, and he was also an active member of the Executive Committee of the Lexicon, yet the latter contains hardly any mention of the utility of planktonic foraminifera in age determination. The article of the La Rosa Formation, by A.N. Dusenbury, is one of the few exceptions

In the period immediately following publication of the *Lexicon*, there began a worldwide phase of increasingly more detailed and more extensive application of planktonic foraminiferal zonation to stratigraphy. The famous U.S. National Museum Bulletin 215 appeared in 1957, containing numerous papers on this theme, among which Bolli's on the Upper Eocene to Miocene of Trinidad were of outstanding importance to Venezuelan stratigraphers. He introduced a much finer zonal scheme and provided names for several index-species, most of which have subsequently been found at the same levels in Venezuela. **Blow (1959)** re-studied the Agua Salada Group in Falcón and showed that by planktonic zonation it could be correlated accurately with Trinidad and other sectors, whereas the facies-control of the benthonic faunas mainly used to define the zones of **Renz (1948)** made these distinctly less reliable for regional correlation.

Independent compilations by **Bolli (1959)** and **Stainforth (1959**, **1960**) showed that the planktonic zones of Trinidad and the general Caribbean-South American region could be recognized in Western Europe, even though at that time the published data on Tertiary planktonic foraminifera in the European journals were sparse and scattered. This direct transatlantic correlation was potentially highly important, simply because Western Europe is the type region of the standard stages, hence of the standard time-scale of the Upper Tertiary (and many older intervals). Bolli and Stainforth were in quite good agreement on the key levels of correlation, namely:

base of Helvetian Stage (lower Middle Miocene) coincides with first appearance of *Globorotalia menardii*

Burdigalian Stage (upper Lower Miocene) corresponds rather closely with the *Globorotalia fohsi* Zone (s.l.)

the Oligocene/Miocene boundary is at the base of the *Globigerina* (*Catapsydrax*) *dissimilis* Zone (to some extent tentative)

the Eocene top is where traditionally placed in America (= *Globorotalia cerroazulensis* Zone of Bolli)

Application of this new transatlantic correlation called for appreciable revisions to the chronology of Venezuelan formations as published in the 1956 *Lexicon*. Only units previously dated as "Lower Oligocene" (*Globigerina ciperoensis* Zone s.l.) remained in the Oligocene, and those previously treated as "Middle to Upper Oligocene" now became Lower Miocene. The datum hitherto treated as the base of the Lower Miocene (advent of *G. menardii*) had now to be recognized as the base of the Middle Miocene.

These revisions, which were consolidated by additional data published on the Mediterranean region, gained general acceptance in Venezuela (though see published discussion between Stainforth and **Renz, 1961**). When it was proposed to compile a multi-author "Correlation Chart of Venezuela and Trinidad" for presentation at the **First Venezuelan Petroleum Congress in 1962**, agreement was quickly reached that the Oligocene to mid-Miocene chronology should be based on the planktonic foraminiferal zones The chart, first published in 1963, included an insert showing the ages assigned to the zones and in this respect it was an improvement over the 1956 *Lexicon*; be the age assignments right or wrong, the basis for postulating them was made clear.

I suspect that many of my colleagues think that this is the end of the story, and that the 1962 63 chart gives a correct chronology for the post Eocene formations in Venezuela. Unfortunately this is not true, mainly because of revisions in the classical Tertiary areas of Europe, as described below.

While the planktonic zonation was being developed and accepted in the New World, stratigraphers in the Old World were facing up to the problem of the innumerable local stages in use as standards of geochronology. As one instance of many, the lower Oligocene was habitually known as Sannoisian in France, Lattorfian in Germany, and Tongrian in Belgium. Differences of facies and climatic province, combined with large geographic gaps where no Tertiary sediments existed, made it difficult to match the faunas of the local stages. Yet such a correlation, followed by agreement on which of the stages to retain as standards, was obviously desirable in the interests of uniform international usage and understanding of regional stratigraphy.

A concerted effort to standardize the stage nomenclature and improve correlations across national frontiers was initiated at a "Colloque sur le Miocène" held in Paris in 1958. At that meeting a "Committee on Mediterranean Neogene Stratigraphy" was organized, and this body[3] has subsequently held well-attended meetings in 1959 (Vienna), 1961 (Madrid) 1964 (Berne) and 1967 (Bologna), with a fifth reunion scheduled in 1971 (Lyon). This committee has functioned effectively by setting up nine "working groups" in distinct fields of stratigraphy and paleontology. Each group established a long term, step by step program of attack on its particular problems, and has reported its progress at the successive meetings of the whole committee. The degree of international cooperation and suppression of national prejudices has been remarkable (as I can personally attest, having attended the Bologna meeting).

Much of the committee's work has admittedly only remote application in Venezuela, but certain themes do have a direct bearing here. One is the fitting of type European stages into the framework of planktonic foraminiferal zonation, which is improving geochronology in the two ways of 1) demonstrating directly the European stage equivalence, hence the age, of our marine formations, and 2) revealing errors (presumably rooted in reliance on facies controlled benthonic faunas) in long accepted correlations between the various European basins. A second important theme is the development of a planktonic zonation in the Late Tertiary Quaternary, an interval largely represented in Venezuela Trinidad by marginal to non marine deposits, hence only locally suited to planktonic studies.

Significant conclusions reached at the **Berne meeting (1964)** were:

a) the *G. ciperoensis* Zone (s.l.) represents the Oligocene,
b) the "*Globigerinoides* datum" is a good approximation to the base of the Miocene,
c) the "*Orbulina* datum", corresponding to the base of the *Globorotalia fohsi* Zone (s.l.), falls within the Middle Miocene, at a level equivalent to the bases of the French Sallomacian and Italian "Elveziano" stages, some distance above the base of the Swiss Helvetian Stage.

Points (a) and (b) accord with the transatlantic correlations postulated earlier by Bolli and Stainforth, but point (c) is an appreciable upward revision of their estimate of the stage-equivalence of the *fohsi* Zone. The underlying reason is that Bolli and Stainforth accepted longstanding but erroneous correlations in Europe of the type mentioned above. Specifically the Committee's studies had shown that the Langhian Stage of Italy is younger than the Burdigalian of France, and not a close equivalent as long supposed, and that the "Elveziano" of Italy is completely younger than its supposed equivalent, the true Helvetian Stage of Switzerland.

Before reviewing the Committee's work on the Late Tertiary-Quaternary interval, it is convenient to refer now to studies of this interval made in recent years here in Venezuela. There are two main bodies of such work, one being the megafaunal studies of **Weisbord (1957-68)**, the other the planktonic foraminiferal studies by Bolli and his

collaborators **(1964-66)**.

Weisbord made exhaustive studies of the rich fossil faunas in the Cabo Blanco Group exposed near the Maiquetía airport, paying special attention to the mollusks but also describing some fossils of other groups. He has based his age determinations of different levels within the group on the Lyellian method of percentage of still-living species among the fossil faunas. In his monographs he has published successively updated tables of the pertinent statistics, the latest being in **Weisbord, 1968 a**, p. 14-15. By this technique, the ages postulated for the Cabo Blanco Group are:

Abisinia Formation	- Lower Pleistocene
Mare Formation	- Lower Pliocene
Playa Grande Formation	- Lower Pliocene
Las Pailas Formation	- not dated (barren)

Bolli (1964) gave preliminary data on ranges of some planktonic foraminifera in the West and East Indian regions, above the mid-Miocene level at which his earlier zonations stopped. He foreshadowed the possibility of a planktonic zonation of the Late Tertiary, but pointed out difficulties caused by climatic (temperature) control over geographic distribution, and by presence of fewer short-ranging and distinctive species as compared with the older Tertiary. In **1965 Bolli and Bermúdez** provided additional data and formally proposed six new zones above the existing *G. menardii* Zone, in an interval to which they assigned mid-Miocene through Pliocene age. As concerns Venezuela, they dated the Cubagua Formation late Middle Miocene to late Upper Miocene and both the Playa Grande and Cumaná formations Upper Pliocene (and possibly younger). The evidence for these age determinations was discussed briefly (p. l6), and they were based “for convenience” on existing studies of macrofossils, even though it was recognized that some microfaunal evidence would point to younger ages. **Bolli (1966)** maintained the same zones (with slightly altered names) and the same age assignments in a proposed worldwide planktonic zonation of the whole Cretaceous-Tertiary interval.

To revert now to the Mediterranean Neogene Committee, considerable attention was paid at the **Bologna meeting (1967)** to the late Miocene-Pliocene interval. It was evident during the sessions that European specialists, despite certain local anomalies, were approaching accord on a standard planktonic foraminiferal zonation of this interval (see, for instance, **Bertolino *et al.*, 1968**). Consequently, a special meeting was convened after the formal sessions had closed and, by comparison of types and local range-charts, a master zonation was produced which showed four slightly different-schemes for different sectors of the Mediterranean region and tied them in with the Caribbean zones as published by **Bolli in 1966** (see **Cati *et al.*, 1968**). (Since Dr. Bolli was a prime mover in organizing the meeting in question, it is to be assumed that he accepts the age-revisions which have resulted.)

Eliminating details of interest only to foraminiferal specialists, the outcome of this latest attempt at transatlantic correlation can be summarized, as follows:

Zones of Bolli 1966	Ages assigned by Bolli, 1966	Actual ages according to Cati *et al.* 1968	Venezuelan formations
truncatulinoides	Upper Pliocene (to Recent)	Pleistocene	Cumaná and Playa Grande
altispira/ truncatulinoides	Lower Pliocene		hiatus
altispira	Upper	Pliocene	
margaritae	Miocene		Cubagua
dutertrei		indefinite	
acostaensis	late Middle Miocene	Upper Miocene	

The marked upward revisions of all Bolli’s age determinations are clearly evident. Furthermore, the type section of the *G. truncatulinoides* Zone is in the lower part of the Playa Grande Formation: according to Weisbord, the whole

Playa Grande Formation and the overlying Mare Formation are Lower Pliocene, whereas Cati *et al.* place this zone in the Pleistocene.

The new transatlantic correlations uses, as key factors, the limited range of *Globorotalia margaritae* (hitherto frequently called "*G. hirsuta*" in the Mediterranean literature) and the successive appearances of this species, *G. crassaformis*, *G. inflata* and *G. truncatulinoides*. Since the relative positions of these datum levels are the same in the Caribbean and Mediterranean regions, it appears that the proposed zonation is chronologically sound, and not significantly affected by climatic factors. If this is so, the age assignments expressed by Bolli and Bermúdez and by Weisbord must be erroneous, based on misinterpretation of the fossil evidence. This is a matter requiring scrutiny.

Regarding the Cubagua Formation, the only pertinent reference cited by Bolli and Bermúdez is **Kugler (1957)**. In this compressed summary of the sedimentary formations of Margarita and Cubagua islands, a short list of mollusks is included, identified by W.P. Woodring and determined by him as late Middle Miocene in age and equivalent to the Urumaco and Caujarao formations of Falcón. Foraminiferal studies of the Cubagua Formation by J.P. Beckmann are quoted, to the effect that the greater part of it is younger than the Lengua Formation of Trinidad. In point of fact it seems evident, from comparison with Bolli and Bermúdez data on the same subsurface section, that Beckmann confused *Globorotalia acostaensis* with the older *G. mayeri* and more correctly he could have asserted that the Cubagua is entirely younger than the Lengua Formation. Since the latter is no older than upper Middle to Upper Miocene, its base coinciding with the top of the *fohsi* Zone, it seems plausible that the wholly younger Cubagua Formation may be Mio-Pliocene in age.

Regarding the Playa Grande and overlying formations, the Lyellian method of age determination is an indirect one. In describing its application, **Weisbord (1968**, p. 10-11) specifies that it is based on "…the per cent of marine mollusks that are still living (*in the neighboring seas*)…" (my emphasis). There is a tacit assumption here that climate and general ecologic factors have not changed appreciably in the area since the fossil fauna was living there. I suggest that, in fact, there has been a significant change, and that this accounts for Weisbord's low percentage of surviving species, hence for his age determination of Lower Pliocene when more direct evidence indicates a Pleistocene age.

Bolli and Bermúdez (1965, p. 127, 128, 134) make several mentions of the fact that the foraminifera in the Playa Grande and Cumaná formations indicate cold water conditions, and even comment that "…the zonal markers point to a colder water influx that is unusual for these low latitudes, probably reflecting one or more of the periods of increased glaciation". (This remark in itself is surely suggestive of Pleistocene age, as the concept of significant glacial episodes in Mio-Pliocene time, though occasionally mooted, has gained little acceptance.) But, to continue the argument, if the Playa Grande molluscan fauna is a cool-water assemblage, it makes sense that it can be as young as Pleistocene and yet contain a rather low percentage of species living today in the tropical seas of this region.

Weisbord's faunal lists show an appreciable number of species of mollusks, corals and bryozoa which have previously been recorded only in Recent or Pleistocene Recent faunas, but which he would extend back to the Lower Pliocene because they occur in the Playa Grande Formation. He published a special note (1968b) on the supposed Lower Pliocene occurrence of *Reteporellina marsupiata*, a bryozoan hitherto known only as a Recent form. While admitting that recorded ranges of fossils are always subject to some extension, I find it simpler to explain these cases as due to mis determination of Pleistocene beds as Pliocene.

Looking at the whole problem in another light, until the young coastal Tertiaries of Venezuela came under study in quite recent years, the youngest firm datum was the almost synchronous extinction of *Globorotalia fohsi* and first appearance of *G. menardii*. This was a key level in correlating such widely separated lithostratigraphic units as the mid-Husito Member of Falcón, the Oficina/Freites contact and upper Carapita Formation of Eastern Venezuela, and the Cipero/Lengua contact in Trinidad. Until about 1959 this datum was accepted as the base of the Lower Miocene, and the substantial thickness of beds above it could be divided proportionately into the Lower, Middle and Upper Miocene, the Pliocene, and the Pleistocene. Molluscan evidence might help in the correlation, but to a limited extent because of the dominance of non-marine beds. In 1959-60, however, the datum was moved up to the base of the Middle Miocene (Bolli, Stainforth); in 1964 to somewhere high in the Middle Miocene (**Berne conference**); and in 1967-68 to approximately the base of the Upper Miocene (**Bologna conference**, **Cati *et al.***). In other words, in less than a decade a sequence of deposits which we placed in the entire Miocene-Pliocene Pleistocene sequence has

had to be compressed into only the Late Miocene through Pleistocene interval. It seems inevitable, therefore, that certain formations traditionally treated as Miocene must actually be Pliocene, and that younger beds treated as Pliocene are really Pleistocene. Thus the upward age revisions postulated by Cati *et al.*, though doubtless surprising to many Venezuelan stratigraphers, fit into a pattern which might have been anticipated from the earlier findings of the Mediterranean Neogene Committee.

The revised age determinations will lead to some revisions of paleogeographic concepts which can only be hinted at here. The Playa Grande and Mare formations exposed near Maiquetía have a combined thickness of 267 meters and the correlative Cumaná Formation is about 500 meters thick in its type area (**Bermúdez, 1966**), figures which imply a substantial net uplift of the central Venezuelan coast since Pleistocene time. Below the Playa Grande are 300-400 meters of the conglomeratic Las Pailas Formation. If it is correct to treat this as depositionally part of the Cabo Blanco Group, as has been customary, the uplift becomes even more striking.

However, these beds are markedly unconformable below the Playa Grande Formation, and they might be a remnant of an earlier cycle—as Bermúdez, in fact, suggests (1966, cuadro de correlación)—and should perhaps be removed from the Cabo Blanco Group. Currently some of the young formations of Falcón (San Gregorio, Tucupido, Punta Gavilán) are treated as correlatives of the Playa Grande and Cumaná formations, hence a critical review is warranted to see if a Pleistocene age is acceptable for them. In line with the age revisions, the possibility of Pliocene age must be considered, at least in part, for the oil producing formations of Eastern Venezuela and Trinidad (La Pica, Cruse Forest), even though they have been staunchly maintained as Miocene until now.

REFERENCES

ANONYMOUS, 1958. Comptes-rendus du Congrés des Sociétés savantes de Paris et des départements, tenu à Aix et à Marseilles en 1958, Section des Sciences, Sous-Section de Géologie, Colloque sur le Miocene. Gauthier-Villars, Paris.

BERMÚDEZ, P.J., 1966. Consideraciones sobre los sedimentos del Mioceno Medio al Reciente de las costas central y oriental de Venezuela. Bol. de Geol. (Venezuela), vol. 7, no. 14, pp. 333-411.

BERTOLINO, V. *et al.*, 1968. Proposal for a biostratigraphy of the Neogene in Italy based on planktonic foraminifera. Giorn. di Geol. Ann. Mus. Geol. di Bologna, ser 2, vol. 35, fasc. 2, p. 23 30.

BLOW, W.H., 1959. Age, correlation and biostratigraphy of the upper Tocuyo (San Lorenzo) and Pozón Formations, eastern Falcón, Venezuela. Bull. Amer. Paleont., vol. 39, no. 178, p. 59-251.

BOLLI, H.M., 1950. The direction of coiling in the evolution of some Globorotaliidae. Cushman Found. Foram. Res., Contr., vol. 1, pts. 3-4, p. 82-89.

—, 1951. Notes on the direction of coiling of rotalid foraminifera. *Idem*, vol. 2, pt. 4, p. 139 143.

—, 1954. Note on *Globigerina concinna* Reuss 1850. *Idem*, vol. 5, Pt. 1, p. 1 3.

—, 1957. Planktonic foraminifera from the Oligocene Miocene Cipero and Lengua Formations of Trinidad, B.W.I. U.S. Nat. Mus., Bull. 215, p. 97 124.

—, 1957. Planktonic foraminifera from the Eocene Navet and San Fernando Formations of Trinidad, B.W.I. *Idem*, p. 155 172.

—, 1959. Planktonic foraminifera as index fossils in Trinidad, West Indies, and their value for worldwide stratigraphic correlations. Eclog. Geol. Helv., vol. 52, no. 2, p. 627 637.

—, 1964. Observations on the stratigraphic distribution of some warm water planktonic foraminifera in the younger Miocene to Recent. *Idem*, vol. 57, no. 2, p. 541 552.

—, 1966. Zonation of Cretaceous to Pliocene marine sediments based on planktonic foraminifera. Asoc. Venez. Geol. Min, Petrol., Bol. Inform., vol. 9, no. 1, p. 3 32.

—, & BERMÚDEZ, P.J., 1965. Zonation based on planktonic foraminifera of Middle Miocene to Pliocene warm water sediments. *Idem*, vol. 8, no. 5, p. 121 149.

—, & KRAUSE, H.H., 1964. Microfossils from the younger Tertiary of La Sabana, Distrito Federal. *Idem*, vol. 7, no. 5, p, 131 133.

BRÖNNIMANN, P., l950. Occurrence and ontogeny of *Globigerinatella insueta* Cushman & Stainforth from the Oligocene of Trinidad, B.W.I, Cushman Found. Foram. Res., Contr., vol. 1, pts. 3 4.

—, 1951. The genus *Orbulina* d'Orbigny in the Oligo Miocene of Trinidad, B.W.I. *Idem*, vol. 2, pt. 4.

—, 1952. *Globigerinita* and *Globigerinatheka* new genera from the Tertiary of Trinidad, B.W.I. *Idem*, vol. 3, pt. 1.

CATI, F. *et al.*, 1968. Biostratigrafia del Neogene mediterraneo basata sui foraminiferi planctonici. Boll. Soc. Geol. Ital., vol. 87, p. 491 503.

(NOTE: for Spanish summary, see Rev. Española de Micropaleont., vol. 1, no. 1, p. 103 111. 1969).

(NOTA: para un resumen en castellano, véase Rev. Española de Micropaleont., vol. 1, no. 1. p. 103-111. 1969).

COMMITTEE ON MEDITERRANEAN NEOGENE (STRATIGRAPHY), 1960-1968. Verhandlungen des Comité du Nogene Mediterranéen, I. Tagung in Wien, 10-20 Juli 1959. Geol. Gesell. Wien, Mitteil., vol. 52, p. 225-243 (1960).

Memorias de la segunda Reunion del Comité del Neogeno Mediterráneo y Symposium de la Unión Paleontológica Internacional. Sabadell y Madrid, septiembre 1961. Inst. "Lucas Mallada" Invest. Geol., Cursillos y Conferencias, fasc. 9 (Madrid, 1964).

Proceedings of the Third Session in Berne, 8-13 June 1964. E.J. Brill, Leiden. (1966).

Proceedings of the Fourth Session in Bologna, 19-30 September 1967. Giorn. di Geol., Ann. Mus. Geol. di Bologna, ser 2, vol. 35, fasc. 1-4. (1968).

CUSHMAN, J.A. & RENZ, H.H., 1946. The foraminiferal fauna of the Lizard Springs formation of Trinidad, B.W.I. Cushman Lab. Foram. Res., Contr., Spec. Publ. 18.

—, & —, 1947. The foraminiferal fauna of the Oligocene Ste. Croix formation of Trinidad, B.W.I. *Idem*, Spec. Publ. 22.

—, & —, 1948. Eocene foraminifera of the Navet and San Fernando formations of Trinidad, B.W.I. *Idem*, Spec. Publ. 24.

—, & STAINFORTH, R.M., 1945. **The foraminifera of the Cipero Marl formation of Trinidad, B.W.I.** *Idem*, Spec. Publ. 14

FIRST VENEZUELAN PETROLEUM CONGRESS, 1962. (PRIMER CONGRESO VENEZOLANO DE PETROLEO, 1962). See: (véase) **Sociedad Venezolana de Ingenieros de Petróleo, 1963**.

HEDBERG, H.D., 1937. Foraminifera of the middle Tertiary Carapita formation of northeastern Venezuela. Jour. Paleont., vol. 11, no. 8, p. 661-697.

—, 1950. Geology of the Eastern Venezuela Basin (Anzoátegui Monagas Sucre eastern Guárico portion). Geol. Soc. Am., Bull., vol. 61, no. 11. p. 1173 1216.

—, & PYRE, A., 1944. Stratigraphy of northeastern Venezuela. Amer. Assoc. Petrol. Geol., Bull., vol. 28, no. 1. p. 1 28.

—, & SASS, L.C., 1937. Synopsis of the geologic formations of the western part of the Maracaibo Basin, Venezuela. Bol. Geol. y Min. (Venezuela), vol. 1, nos. 2 4, p. 73-112. (Engl. ed.).

HODSON, F., 1926. Venezuelan and Caribbean Turritellas, with a list of Venezuelan type stratigraphic localities. Bull. Amer. Paleont., vol. 11, no. 45, p. 173-220.

—, & HODSON, H.K., 1931. Some Venezuelan mollusks. *Idem*, vol. 16. no. 59 60, 132 p.

—, —, & HARRIS, G.D., 1927. Some Venezuelan and Caribbean mollusks. *Idem*, vol. 13, no. 49, p 1 160.

HOFFMEISTER, W.S, 1938. Aspect and zonation of the molluscan fauna in the La Rosa and Lagunillas formations, Bolivar Coastal Fields, Venezuela. Bol. Geol. y Min. (Venezuela), vol. 2, nos. 2-4, p. 103-121, (Engl. ed.).

KUGLER, H.G., 1957. Contributions to the geology of the islands Margarita and Cubagua, Venezuela. Geol. Soc. Am., Bull., vol. 68, p. 555-566.

LIDDLE, R.A., 1928; 1946. *The geology of Venezuela and Trinidad* (1st ed.) J.P. MacGowan, Fort Worth. (2nd ed.) Paleont. Res. Inst., Ithaca, N.Y.

MENCHER, E. *et al.*, 1951. Geological review. Min. Min. e Hidr. (Venezuela), Text of papers presented at the National Petroleum Convention, chap. 1, p. 1 75 (Engl. ed.).

—, 1953. Geology of Venezuela and its oilfields. Amer. Assoc. Petrol. Geol., Bull., vol. 37, no. 4, p. 690 777.

MINISTERIO DE MINAS E HIDROCARBUROS, 1956. *Stratigraphical Lexicon of Venezuela*. Bol. de Geol. (Venezuela), Spec. Publ. no. 1, (Engl. ed.).

NUTTALL, W.L.F., 1935. Upper Eocene foraminifera from Venezuela. Jour. Paleont. vol. 9, no. 2, p. 121-131.

RENZ, H.H., 1942. Stratigraphy of northern South America, Trinidad and Barbados. 8th. Amer. Sci. Congr., Proc., vol. 4, p. 513-571.

—,1948. Stratigraphy and fauna of the Agua Salada Group, State of Falcón, Venezuela. Geol. Soc. Am. Mem. 32.

—, l961. The Cretaceous/Tertiary and Oligocene/Miocene boundaries in Venezuela: a reply. Asoc. Venez. Geol. Min. Petrol., Bol. Inform., vol. 4, no. 8, p. 259-261.

RUTSCH, H. l930. Einige interessante Gastropoden aus dem Tertiar des Staaten Falcón und Lara (Venezuela). Eclog. Geol. Helv., vol. 23, no. 2, p. 602-614.

—, 1934. Die Gastropoden aus dem Neogen der Punta Gavilán in Nord Venezuela. Soc. Paléont. Suisse, Mém., vol. 54 55, 169 p.

SOCIEDAD VENEZOLANA DE INGENIEROS DE PETROLEO, 1963. Cuadro de correlación de las unidades estratigráficas en Venezuela y Trinidad. In *Aspectos de la industria petrolera en Venezuela* p. 188-189. (NOTE: This book is, in effect, the proceedings of the First Venezuelan Petroleum Congress, 1962. The correlation chart has been reproduced in English in VAMP Boletín Informativo, vol. 6, no. 11 and at a larger size in vol. 7, no. 5).

STAINFORTH, R.M., 1948. Description, correlation and paleoecology of Tertiary Cipero marl formation, Trinidad, B.W.I. Amer. Assoc. Petrol. Geol., Bull., vol. 32, no. 7, p. 1292-1330.

—, 1959. Estado actual de las correlaciones trasatlánticas del Oligo-Mioceno por medio de foraminíferos planctónicos. III Congr. Geol. Venez., Mem., vol. 1, p. 382 406.

—, 1960. **Current status of transatlantic Oligo-Miocene correlations by means of planktonic foraminifera** Rev. de Micropaléont., vol. 2, no. 4, p. 219-230.

—, 1961. The Cretaceous/Tertiary and Oligocene/ Miocene boundaries in Venezuela. Asoc. Venez. Geol. Min. Petrol., Bol. Inform., vol. 4, no. 8, p. 256 258.

SUTTON, F.A., 1946. Geology of Maracaibo Basin, Venezuela. Amer. Assoc. Petrol, Geol., Bull., vol. 30, no. 10, p. 1621-1741.

WEISBORD, N.E., 1957. Notes on the geology of the Cabo Blanco area, Venezuela. Bull. Amer. Paleont., vol. 38, no. 165, 25 p.

—, 1962. Late Cenozoic gastropods from northern Venezuela. *Idem*, vol. 42, no. 193, p. 672 p.

—, 1964. Late Cenozoic pelecypods from northern Venezuela. *Idem*, vol. 45, no. 204, 564 p.

—, 1964. Late Cenozoic scaphopods and serpulid polychaetes from northern Venezuela. *Idem*, vol. 47, no. 214, p. 111 203.

—, 1965 (1966). Some Late Cenozoic cirripeds from Venezuela and Florida. *Idem*, vol. 50, no. 225, 145 p.

—, 1967. Some Late Cenozoic bryozoa from Cabo Blanco, Venezuela. *Idem*, vol. 53, no. 237, 247 p.

—, 1968a. Some Late Cenozoic stony corals from northern Venezuela. *Idem*, vol. 55, no. 246, 288 p.

—, 1968b. The occurrence of the cheilostomatous bryozoan *Reteporellina marsupiata* (Smitt) in the Lower Pliocene of Venezuela. Jour. Paleont., vol. 42, no. 5, p. 1304 1307.

---

[1] Manuscrito recibido en Mayo de 1969.

[2] Geólogo, Creole Petroleum Corporation, Caracas.

[3] The Committee is now formally sponsored by the Commission on Stratigraphy of the International Union of Geological Sciences.