TULANE STUDIES IN GEOLOGY AND PALEONTOLOGY

Volume 16, Number 3 October 28, 1981

LATE QUATERNARY MICROPROBLEMATICA (*VOORTHUYSENIELLA*) FROM A MISSISSIPPI DELTA MUDLUMP

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ILLUSTRATIONS

I. ABSTRACT

The micro-fauna and flora of a Mississippi Delta mudlump sample dated as 15,500 years B.P. (C^{14}) is detailed. The age of the sample is discussed with reference to the chronostratigraphic and biostratigraphic problems of the Holocene-Pleistocene boundary. Four specimens of *Voorthuyseniella* Szczechura (1969) recovered permit some previously recorded forms of this taxon, originally left in open nomenclature, to be taxonomically stabilized into three new species: *Voorthuyseniella baileyi*, *V. greigi*, and *V. williamsae*.

II. INTRODUCTION

The capacity to classify an organism affords the neontologist or paleontologist a certain degree of satisfaction. Whether the classification utilized is natural (biologic) or artificial (morphologic) will depend upon the philosophy of the individual, which, in turn, is often determined by the state of knowledge concerning the organism. Conversely, the inability to classify an organism often leads to frustration but, as pointed out by Hantzchel (1975, p. W153) this inability need not detract from the stratigraphic value of the organism. Further, the paleoecological usefulness of such an organism need not be ignored.

Since the middle of the past decade a number of Tertiary forms of unknown affinities have appeared in print. These forms exhibit all types of morphologic characters ranging from specimens with subspherical to triangular tests, to irregular, and even horseshoe shaped forms. Body openings vary in number from one to four or more. In other words, these objects are highly variable. The described taxa include *Bicornifera* Lindenberg 1965, *emend.* Keij, 1969; *Bolboforma* von Daniels and Spieglar, 1974;

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Dicasignetella Keij, 1969; *"Guttulae"* Hiltermann and Schmitz, 1968; *"Parvangulae"* Hiltermann and Schmitz, 1968; *Spinophenia* Szczechura, 1969; *Triangulina* Quilty, 1970; *Urnulella* Szczechura, 1969; *Voorthuyseniella* Szczechura, 1969; and *Bifissurinella* Poignant and Ubaldo, 1973. Keij, 1977, ascribes two of these forms, *Bicornifera* and *Bifissurinella* to bryozoa.

Voorthuyseniella Szczechura, 1969, is an organism which, since its introduction to the scientific community in 1949 by J. H. van Voorthuysen as *Lagena-x*, has yet to be classified with any confidence. Keij (1970, p. 480) declared "no positive statement can be made about the systematic position of *Voorthuyseniella.*" As stated, the biologic affinities of the organism are not established, and, indeed, the nature of the form is unknown as to whether it is an entity in itself or whether it is part of a higher organism.

Attention given to this organism can be regarded chronologically, based on geographic areas of interest. The introduction of the taxon as *Lagena-x* and reported European and Far East occurrences represents the first phase of activity. This period lasted from 1949 to 1967, as evidenced by the following occurrences: Netherlands (Voorthuysen, 1949); Holland (Voorthuysen, 1956); Portugal (Ferriera and Rocha *in* Voorthuysen, 1956); Germany (Ellerman, 1960); Belgium and France (Bignot, 1962); Taiwan (Huang, 1962); W. Germany (Indans, 1962; Kummerle, 1963); South China Sea (Keij, 1964); W. Germany (Kummerle and Gunawardena, 1967).

The formalization of *Lagena-x* as *Voorthuyseniella* by Szczechura in 1969 represents the start of a second period of activity. In this phase can be placed the monographic work of Keij, (1970).

The most recent phase shows an increased interest in New World occurrences while continued interest in European occurrences is evidenced by the following reports: Belgium (Willems, 1972, 1975); France (Poignart and Ubaldo, 1973), and Germany (Spieglar, 1976).

The report by Keij (1970) provided the catalyst for interest in this form in North America. Gulf Coast records have been provided by the following: Alabama (Keij, 1970; Haman and Kohl, 1976a); Mississippi (Keij, 1970); Texas (Keij, 1970; Haman and Kohl, 1976b; Haman, 1977, 1978; and Louisiana (Haman, 1978, and this report).

The purpose of this article is to document the occurrence of *Voorthuyseniella* in late Quaternary sediments obtained from a structurally complex area in a unique geologic and geomorphologic province, namely a mudlump off the Mississippi Delta.

The recovery of these specimens of this taxon now allows previously described forms, left in open nomenclature, to be taxonomically stabilized by formal naming. This procedure will provide uniformity to the Gulf of Mexico occurrences.

III. DISCUSSION

The Mississippi Delta province is characterized by "mudlump" development. The mudlumps are generated by diapiric action due to differential sediment loading. Local distributary mouth bar sands are rapidly deposited over plastic pro-delta and marine clays. The more dense sands cause diapiric action by the underlying less dense clays, which are intruded into the overlying sands. Clay movements of 200 meters vertical displacement have been documented (Coleman, 1976). The classic model of a delta front advancing over the underlying sediments, as illustrated by Morgan (1961), is complicated by low angle thrust faults as detailed by Morgan *et al.* (1963). Mudlumps, due to their sedimentological character, are relatively short-lived phenoma. After development they are either incorporated into the advancing delta or are rapidly destroyed by wave action. Detailed discussions on mudlumps are to be found in Morgan (1961), Morgan *et al.* (1963), and Coleman (1976).

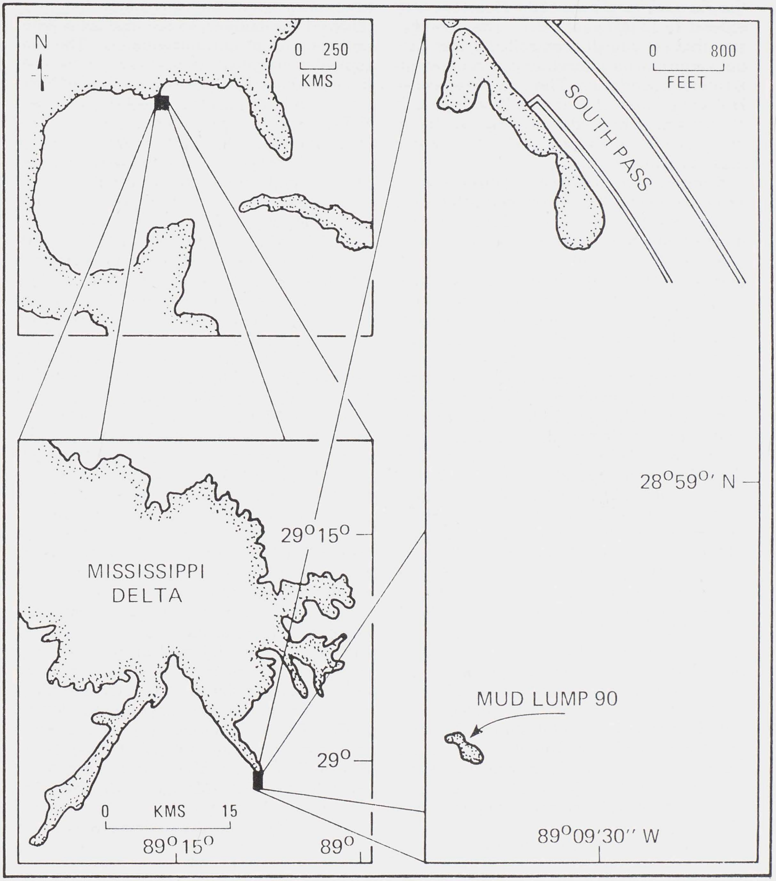
In December, 1976, a sample was collected from mudlump 90, south west of the mouth of South Pass in the Mississippi Delta (Text-Figure 1). The sample was essentially a shell hash with marl and proved to be extremely rich in microfauna, particularly foraminifera. A detailed analysis was made of the microfauna and microflora in an attempt to gain a better understanding of the depositional environment and age of the sample. During this examination the *Voorthuyseniella* specimens were obtained.

Sample Age with Reference to the Holocene-Pleistocene Boundary

The subject sample is coeval with the shell horizon of Coleman (1976) (J. P. Morgan, personal communication, 11/4/78).

This horizon is regarded as an excellent subsurface stratigraphic marker throughout the entire delta region (Coleman, 1976, p. 48). Numerous radio-carbon analyses have dated the shell layer at 13,400-16,600 years B.P. (Coleman, 1976), and the subject sample has been dated as 15,500 years B.P. (Morgan, personal communication). This date approximates to the C^{14} dates of this horizon in Borehole SP-1 "B" of 15, 175 + 575 and 15,575 + 500 years B.P. (Morgan *et al.*, 1963).

The dating of the Holocene-Pleistocene boundary in the Gulf of Mexico and elsewhere in the world is still open to question, and numerous differing dates and/or da-



Text Figure 1. Location of Mudlump 90 in relation to the Mississippi Delta in the Gulf Coast province.

tums exist in the literature. Poag and Sweet (1972) reviewed the INQUA subcommission recommendations and the European and U.S. viewpoints. Berggren and Van Couvering (unpubl.) note that the date of *ca.* 10,000 years is referred to by many geologists as the Holocene-Pleistocene boundary. Van Eysinga (1975) may be quoted as an example. The same authors mention that the climatological base of the Holocene may extend to 13,000 years B.P. They emphasize that climatically controlled cycles cannot serve as a basis for drawing chronostratigraphic boundaries. The late Pleistocene-Holocene interval in the Gulf of Mexico is characterized by evidence of rapidly changing climatic conditions and allied water mass oscillations.

Kennett and Huddlestun (1972) defined 18 zones in the late Pleistocene-Holocene section based on foraminiferal assemblages, most of which are related to paleoclimatic changes. These authors emphasize (footnote 3, p. 44) that these zones are biostratigraphic and not chronostratigraphic in nature. In defining the zones these authors note that although each zone is characterized by a distinct faunal assemblage, in most cases the boundaries between the zones are indistinct and arbitrarily placed at gradational faunal changes. In fact, they indicate that some of their subzone boundaries (*e.g.*, Y1-Y2, late Pleistocene) are more distinct than their zone boundaries (*e.g.* Y-Z, late Pleistocene-Holocene). The Y-Z boundary, by definition, is based on the first consistent occurrence of the *Globorotalia menardii* (d'Orbigny) plexus. In other words, the Z interval (Holocene) is recognized by the presence of warmer water planktics such as *Globorotalia menardii* (d'Orbigny), *Pulleniatina obliquiloculata* (Parker and Jones) to name just two, and a distinct decrease in abundance of the cooler water forms such as *Turborotalia inflata* (d'Orbigny). The reverse is the case in the Y (Wisconsin) interval. Kennett and Huddlestun (1972) state that the most distinct faunal change associated with the Holocene warming does not coincide with the Y-Z boundary as defined, but occurs slightly earlier during the latest Wisconsin.

While Kennett and Shackleton (1974) date the Y-Z paleontological boundary at 11,000 years B.P. they note (1975, p. 150) that this boundary may be slightly younger in the Gulf than in the Caribbean (11,000 ± 500 years B.P.) due to the delayed migration of tropical *Globorotalia menardii* (d'Orbigny) into the cooler Gulf near the end of the last glaciation.

Kennett and Shackleton (1974, 1975) documented evidence to record the effects of the Laurentide ice sheet meltwaters in late Pleistocene cores in the Gulf of Mexico. The meltwater effect resulted in oxygen isotope anomalies in core measurements and these allowed the authors to reconstruct a paleoclimatological chronosequence. The isotopically negative meltwaters were believed to have first affected the Gulf of Mexico possibly as early as 16,000-17,000 years B.P., or at least by 14,500 years B.P. The incursion peaked around 13,500 years or as late as 12,800 years B.P., followed by a decline in meltwater discharge with normal marine isotopic composition being restored by 11,500 years B.P.

If C^{14} dating could be regarded as infallible, then the date of the subject sample (15,500± years B.P.) would be of late Wisconsin age (subzone Y1). C^{14} dating has, however, been subject to criticism. Broecker and Bender (1972) questioned the accuracy of dates between 5,000 and 25,000 years B.P. and regarded dates $>$ 25,000 years B.P. as highly suspect. Stapor and Tanner (1973) stated that the 6,000 year B.P. datum based on the bristle-cone pine curve represents the limit of reliable C^{14} dating. Morgan (1963) and Poag and Sidner (1976) rejected some of their own C^{14} dates as unreliable due to carbon contamination.

Representatives of the *Globorotalia menardii* (d'Orbigny) plexus are evident in the subject sample. Although a single sample precludes evaluation of occurrence persistency (criterion of Zone Z recognition), the geologic relationship of the sample to the stratigraphic interval in question may assist in determining the reliability of the occurrence. As stated earlier, this sample is equivalent to the shell horizon of Coleman (1976). The shell horizon was encountered in a corehole (Borehole SP-1 "B") in the South Pass area of the delta region at −348.8′ to −349.8′ (Morgan *et al.*, 1963). Andersen (*in* Morgan *et al.*, 1963) recorded *Globorotalia menardii* (d'Orbigny) as persistent in occurrence in this borehole from a depth of −350′ to the top of the core. The taxon ranged in abundance (of total planktics) from 4-15% (−350′ to −230′±) and from 1-4% (−230′± to the core top). This interval, including the shell horizon, is by definition of Zone Z (Holocene) age. The presence of the calcareous nannofossil *Emiliania huxleyi* (Lohmann) in the present sample supports this age assignment. This sample also yielded specimens of *Globorotalia ungulata* Bermudez, *Globorotalia tumida* (Brady) and *Globorotalia truncatulinoides* (d'Orbigny) (with deep umbilical pit) which, while not definitive, tend to substantiate the Holocene age (see Stainforth *et al.*, 1975). Specimens of *Globigerinoides ruber* (d'Orbigny) are common in the sample. Of these specimens, 10-15% are colored red, pink, and pink-amber, the remainder being white. Parker, 1973, used pink *Globigerinoides ruber* (d'Orbigny) and pink *Globigerina rubescens* Hofker to recognize the Holocene in low latitude Atlantic localities. This pink coloration has apparently been utilized by some Gulf Coast laboratories for recognition of the Holocene. Bé and Tolderlund (1971) did not directly comment on the stratigraphic value of *Globigerinoides ruber* (d'Orbigny) but noted that pigmented forms appear to be restricted to the North and South Atlantic. They also made the observations that this form is predominantly associated with near land mass populations and is temperature (seasonally) controlled. Luz and Bernstein (1976) noted that the pink coloration of *G. ruber* (d'Orbigny) appeared to fade rapidly with depth in cores they examined from the eastern Mediterranean. They did, however, utilize the pink forms to identify Recent core tops. Kennett, 1976, reviewed the pigmentation (pheophytin) distribution in tests of both *Globigerinoides ruber* and *Globigerina rubescens* and stated that the distribution is related to seasonal changes. Consequently it can be stated that the stratigraphic value of the pigmented *Globigerinoides ruber* is still open to question, the form is seasonally controlled, and the pink coloration is more dominant with warmer temperatures.

The total planktic faunal composition (see appendix) would, following the techniques of Bé and Tolderlund (1971), suggest a subtropical to tropical regime, which would be consistent with a Holocene warming following the last glaciation. Conversely, by relating such a temperature increase to the curve of Emiliani (1971) it could be suggested that this paleoclimatological regime could have begun in the latest Wisconsin (subzone Y1). Poag and Sidner (1976) made the statement that the C^{14} dates for their *crassaformis* facies "would indicate that the post Wisconsin rise in sea level began earlier than generally has been reported." This is not inconceivable bearing in mind the statement by Kennett and Huddlestun (1972) concerning the Holocene warming.

Consequently the age of this sample is problematic. If the C^{14} age of 15,500± years B.P. is correct, the sample is of Wisconsin age. The fauna is a warm water fauna and may be equivalent to that portion of the section affected by the Laurentide ice sheet meltwater (17,000±-13,500± years B.P.). If this is correct, the use of the persistent *Globorotalia menardii* plexus as definitive for Zone Z (Holocene) recognition is suspect. On the contrary, if the *G. menardii* zonal criterion is accepted, then the sample is of Holocene age and the C^{14} date is suspect, as other workers have stated for radiometric dates of this magnitude.

Reference may be made to other studies concerned with the Gulf of Mexico late Quaternary with its allied chronostratigraphic and biostratigraphic problems as a means to determine the correct stratigraphic placement of the sample. In recent years the works of Poag and his colleagues have been instrumental in attempting to solve some of these problems (Poag, 1971, 1972, 1973a,b; Poag and Sweet, 1972; Poag and Carney, 1974; Poag and Sidner, 1976; Poag and Valentine, 1976).

Poag and Sidner (1976) recognized three biofacies in their zonation of the West Flower Garden Bank area, offshore Texas. The lowest sequence was termed the basal Inflata Facies related to the late Pleistocene cool water regime. The top sequence was termed the upper Cultrata Facies, characteristic of the Holocene outer shelf environment. Between these two facies occurred the Crassaformis Facies, which was stated to represent a deepening sea that had warming surface waters. A historical sequence of the facies was presented but a definitive Pleistocene or Holocene age for the Crassformis Facies was not given. It was simply stated to be a "transition between the cool Inflata Facies and the warmer overlying Cultrata Facies" (p. 23). It was noted that during the final deposition stages of the Crassaformis Facies sea level stood at approximately −53 m. If this depth is related to Figure 8-20 of Poag and Sweet (1972), it would equate to the 60 m stillstand of Holocene age. Poag and Valentine (1976) in their biostratrigraphic and ecostratigraphic zonation of the Pleistocene sediments of the Texas-Louisiana basin equate the *G. cultrata* facies referred to above to *G. menardii* (Fig. 13) and *G. ungulata* (Fig. 2). This zone is referred to as Holocene while the *G. crassaformis* zone is regarded as Pleistocene (Fig. 2). In the same publication on Figure 12, however, the *Globorotalia crassaformis* zone is shown to range from subzone Y2 (Wisconsin) to subzone Z2 (Holocene). The same authors state (p. 197) "we conclude that the *Gl. ungulata* Zone was deposited during the last 10-12 × 10^3 years and represents the Holocene." On their Figure 12, C^{14} dates for the lower part of this zone (basal Holocene) of 13,000, 13,150, and 15,000 years B.P. are included.

In summary, the Holocene-Pleistocene boundary in the Gulf of Mexico is not clear-cut. This is in part due to discrepancies between the cycles and zonations recognized in deep water sediments being applied to continental margins, and in part due to the difficulty of equating chronostratigraphic and biostratigraphic control. The subject sample is believed to be associated with a reefal type of environment situated on the outer shelf associated with the 60 m still-stand of Poag and Sweet (1972). The sample has *G. menardii* present and is probably of Holocene age, although the possibility of it being of latest Wisconsin age should not be overlooked.

Sample Fauna and Flora

The prolific nature of the foraminifera in mudlump samples is attested to by the publications of Andersen (1961) and Andersen *in* Morgan *et al.* (1963). In the 1961 publication Andersen described 213 species and 8 subspecies and in 1963 added another 21 species.

A 25 ml sample was selected for examination. Of this, approximately 20 ml remained on the +30 ($>600\,\mu$) mesh. This material was composed of mollusk debris, oyster fragments, gastropods, echinoid spines, echinoid plates, bryozoa, worm tubes, otoliths, crustacean debris, fish bones, plus large representatives of some of the foraminifera described later. The benthic foraminiferal component comprised 12 agglutinated species (9 genera), 121 calcareous benthic species (72 genera) and 11 planktic genera with 24 species were recorded.

In addition, one gram of washed residue was examined to determine the Foraminiferal Number. This is not in strict accordance with the Schott (1935) method but is believed acceptable following the philosophy of Boltovskoy and Wright (1976) who regarded FN simply as a crude index of foraminiferal abundance in an area as variables (ecologic and biologic) affect this measurement. The FN subdivisions as outlined in Boltovskoy and Wright (1976) are followed.

$FN_t = 5722$ $FN_{cb} = 2809$
$FN_b = 4567$ $FN_{hb} = 2119$
$FN_{ab} = 1758$ $FN_{pb} = 690$
$FN_p = 1155$

It is believed that the difference between this method and that of Schott (1935) would be that the above figures would be somewhat high.

Following the concept proposed by Uchio (1960) that if the number of species per genus decreases with depth, the benthic fauna would indicate a bathymetry of 110 meters (index = 1.64). The planktic-benthic ratio would suggest a bathymetry of around 85 meters (Grimsdale and Morkhoven, 1955). The Fisher α value (described in Murray, 1973) gives an approximate $\alpha > 20$ value which would suggest an open marine shelf sea. The Miliolina-Textulariina-Rotaliina triangular plot (Murray, 1973) again indicates a shelf sea environment. The presence of occasional warmer-water, carbonate-loving benthics in the sample corroborates well with the environment postulated earlier (reefal type of association in the outer portions of the continental shelf).

Corroboration of a shelf environment is provided by the ostracod fauna. Ostracod genera present are *Echinocythereis* Puri, *Hulingsina* Puri, *Henryhowella* Puri, *Krithe* Brady, Crosskey and Robertson, *Puriana* Coryell and Fields, *Cytheropteron* Sars, *Pterygocythereis* Blake, *Cytherura* Sars, *Buntonia* Howe, *Aurila* Pokorny, *Cytherella* Jones, *Argilloecia?* Sars, *Munsyella?* van den Bold, *Cativella* Coryell and Fields. This association is indicative of a middle to outer shelf environment (N. J. Tartamella, personal communication, 1977). Howe and van den Bold (1975) suggest a water depth of approximaely 100 feet for ostracod faunas they retrieved from similar mudlump samples.

The indication that the environment suggested by this assemblage has good marine connections is supported by the calcareous nannoflora composed of *Emiliania huxleyi* (Lohmann), *Gephyrocapsa oceanica* Kamptner, *Umbilicosphaera mirabilis* Lohmann, *Scapholithus fossilis* Deflandre, *Helicopontosphaera kamptneri* Hay and Mohler, *Rhabdosphaera clavigera* Murray and Blackman, *Syracosphaera histrica* Kamptner, *Cricolithus jonesi* Cohen, *Thoracosphaera saxea* Stradner, *Cyclococcolithus leptoporus* (Murray and Blackman), and *Umbellosphaera tenuis* Kamptner. The last taxon supports a warm water interpretation for this sample (W. E. Steinkraus and P. E. Koeppel, personal communication, 1977).

In summary, the microfauna and microflora suggest a warm water, open marine, probably outer shelf location for this sample, the assemblage also indicating a reefal or calcareous mound build up somewhat similar to the banks found at the present day in the northern Gulf of Mexico.

IV. ACKNOWLEDGMENTS

The author is indebted to W. H. Akers, W. S. Drugg, W. P. S. Ventress, and D. Mason for reading an early draft of this article and for offering constructive advice; to I. B. Murray and B. L. Hill for making the subject sample available; to J. P. Morgan for valuable communication concerning the stratigraphy and radio-carbon dating of the sample as well as providing pertinent literature, to P. Koeppel, B. Kohl, W. E. Steinkraus, N. J. Tartamella, and H. O. Woodbury for providing valuable information and/or participating in discussions during the preparation of the article, to J. R. Bailey for meticulous technical assistance, to D. Greig for expert assistance with the SEM, to Chevron U.S.A., Inc., for allowing access to the SEM, and to Chevron Oil Field Research Company for publication permission.

V. SYSTEMATIC DESCRIPTIONS

The retrieval of four additional specimens of *Voorthuyseniella* from the mudlump sample has made it advisable to place forms previously described with open nomenclature into a more stable taxonomic position. The value of these epithets is, of course, dependent upon the biologic nature of the organism. Since, at present, this is unknown, the nomenclature may, with additional knowledge, need to be changed at a future date. Until that time, however, the names proposed herein should provide a more uniform method of communication when compared to the problems inherent with open nomenclature.

Test orientation, morphologic terms and measurement teminology used in this report are adapted from Haman and Kohl (1976a,b) and Haman (1978).

VOORTHUYSENIELLA BAILEYI n. sp.
Plate 1, figs. 1-5

Voorthuyseniella sp. indet. HAMAN AND KOHL, 1976, Tulane Stud. Geol. Paleont., vol. 12, no. 3, p. 157, 158, pl. 1, figs. 1-7; pl. 2, figs. 1-4.

Description: Test free, calcareous, imperforate, unilocular, nearly spherical. Test widest at or just below the middle of the camera when viewed from either lateral aperture (pl. 1, figs. 1,3). Test shows symmetrical cameral inflation viewed from above (pl. 1, fig. 4). Tubus reasonably flat to becoming higher on one end (towards lateral aperture "A"). Tubus is widest at the middle, narrowing to either end (pl. 1, fig. 5). Porta is subcircular to ovate (0.09 mm × 0.06 mm) situated in a bevelled depression (0.12 mm × 0.09 mm) at the top of the camera. Tubus pore is subcircular to elliptical (0.06 mm × 0.03 mm), situated midway between the lateral apertures and in line with them. Test twisting or distortion is not evident. Lateral aperture "A" is circular to subcircular with cameral extension over the upper part (pl. 1, figs. 1,2). The thickness of wall rim surrounding the aperture varies from .018 mm-.010 mm. Lateral aper ture "B" is circular in shape surrounded by a fairly flat thick rim (pl. 1, fig. 3) varying in width from 0.031 mm-0.048 mm. No internal septa are present in the camera. Test surface under light microscope examination appears striate but with SEM examination this is shown to be the effect of differential solution. The solution effect does not appear to be restricted to any specific area of the test but is evident over the camera and tubus. The tubus region appears to be more severely affected by the solution effect than the camera.

Test Dimensions: Maximum length 0.35 mm, maximum width 0.31 mm, height 0.27 mm.

Locality: Outcrop sample, mudlump 90, South Pass Area of the Mississippi Delta.

Stratigraphic Level: Early Holocene.

Derivato nominis: The species is named in honor of Mr. J. R. Bailey, technical assistant (Paleontology), Chevron U.S.A., Inc., Eastern Region.

Remarks: The affinities of this species have already been discussed (Haman and Kohl, 1976b) and no purpose is served by repeating the analysis. Specific variation can be noted between the mudlump form and the previously described upper Pleistocene form (Haman and Kohl, 1976b) as follows. The test size has an overall range of length 0.31-0.35 mm, width 0.24-0.31 mm, and height 0.24-0.27 mm. The mudlump specimen is slightly larger but this can be attributed to growth. Porta and tubus shape is variable but essentially very similar and can be attributed in both cases to probable test dissolution. The stratigraphic range of the species is late Pleistocene to early Holocene.

VOORTHUYSENIELLA GREIGI n. sp.
Plate 1, figs. 6-10

Voorthuyseniella sp. 1, HAMAN, 1978, Revue de Micropaléontologie, vol. 20, no. 4, p. 189, pl. 1, figs. 1-7.

Description: Test free, calcareous, imperforate, unilocular, longer than high, as wide as high, asymmetric in side view, tapering from the portal region to both lateral apertures (pl. 1, fig. 7). Test is widest at or just below the middle of the camera when viewed from either lateral aperture (pl. 1, figs. 6, 8). Test exhibits slight asymmetric cameral inflation when viewed from the porta (pl. 1, fig. 9). Test twisting is not evident. Tubus reasonably flat, slightly higher at "A" lateral aperture end (pl. 1, fig. 7). Tubus widest at the middle tapering slightly to either end (*i.e.*, towards the lateral apertures) (pl. 1, fig. 10). Tubus pore is subcircular to elliptical (0.018 × 0.038 mm) situated midway between the lateral apertures and in line with them. Porta is subcircular to ovate in shape (0.045 × 0.030 mm) situated in a bevelled depression (0.10 × 0.08 mm) at the top of the camera. Lateral aperture "A" is subcircular to elliptical in shape with cameral extension over the upper part (pl. 1, figs. 6, 7). The wall rim around lateral aperture "A" varies in thickness from 0.020-0.005 mm. A small, thin, partially eroded, delicate flap is present above the cameral extension (pl. 1, fig. 9). Lateral aperture "B" is circular in shape surrounded by a fairly flat thick rim varying in width from 0.031-0.030 mm (pl. 1, fig. 8). No internal septa are present in the camera. Test surface under light microscope examination appears faintly striate but with SEM examination this is seen to be the result of differential solution. The solution effect is present on the camera and tubus, but is more severe on the tubus region.

Test dimensions: Maximum length 0.35 mm, maximum width 0.23 mm, height 0.24 mm.

Locality: Outcrop sample, mudlump 90, South Pass area of the Mississippi Delta.

Stratigraphic level: Early Holocene.

Derivato nominis: The species is named in honor of Mr. D. Greig, technical assistant (SEM operator), Chevron U.S.A., Inc., Eastern Region.

Remarks: The taxonomic affinities of this species and its paleobathymetric distribution have already been discussed (Haman, 1978). Specific variation can be noted between the mudlump form and the previously described late Pleistocene form as follows. The test size has an overall range of width 0.23-0.25 mm, height 0.23-0.24 mm, the length of both forms are identical. The thin delicate flap is better represented in the late Pleistocene form, compared to the Holocene form. This is believed to be simply the result of test erosion as vestigial traces of the flap are present in the mudlump form. The stratigraphic range of the species is late Pleistocene to early Holocene.

VOORTHUYSENIELLA WILLIAMSAE n. sp.
Plate 2, figs. 1-10
Plate 3, figs. 1-3

Voorthuyseniella sp. 2. HAMAN, 1978, Revue de Micropaléontologie, vol. 20, no. 4, p. 191, pl. 2, figs. 1-6.

Description: Test free, calcareous, imperforate, unilocular, as high as long, only slight asymmetry exhibited in side view (pl. 2, figs. 2,7). Camera inflated, globular to subglobular when viewed from either lateral aperture (pl. 2, figs. 1,3,6,8). Camera may be slightly compressed when viewed from the porta (pl. 2, fig. 9) so that a

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PLATE 1
(Bar = 100 microns)

Figures 1-5.	*VOORTHUYSENIELLA BAILEYI* n.sp. (Holotype) .... 87 (1) view to lateral aperture "A", (2) side view, (3) view to lateral aperture "B", (4) portal view, (5) view to tubus and tubus pore.
Figures 6-10.	*VOORTHUYSENIELLA GREIGI* n.sp. (Holotype) .... 88 (6) view to lateral aperture "A", (7) side view, (8) view to lateral aperture "B", (9) portal view, (10) view to tubus and tubus pore.

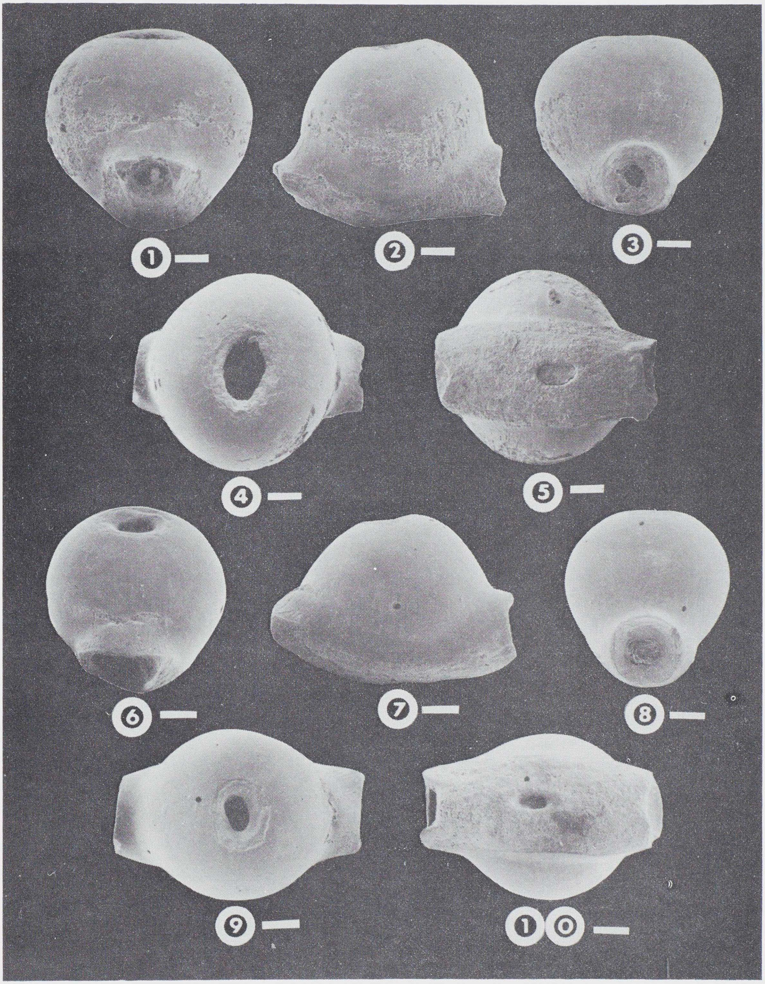

PLATE 1

slightly ovate camera is situated transverse to tubus. This cameral compression is variable and may be minimal (pl. 2, fig. 4). Test is widest at, or just below, the middle of the camera when viewed from either lateral aperture (pl. 2, figs. 1,3,6,8). No test twisting is evident. Tubus is slightly curved in side view, higher at lateral aperture extremities than at the center (pl. 2, figs. 2,7). Tubus surface flat, wider at the end adjacent to lateral aperture "B" tapering to lateral aperture "A" (pl. 2, figs. 5,10). Degree of tapering is variable. Tubus pore ovate to elliptical, situated midway between the lateral apertures and in line with them. Tubus pore may be set in a slight depression. Porta, ovate to elliptical in shape, situated in a bevelled depression at the top of the camera, and orientated transverse to the tubus (pl. 2 figs. 4,9). Lateral "A" is subcircular in shape with an extension of the camera over the upper portion (pl. 2, fig. 1,6). A thin delicate flap is present above this cameral extension (pl. 2, figs. 6,9) although it may be eroded (pl. 2, figs. 1,4). Lateral aperture "B" is subcircular in shape surrounded by a thick rim (pl. 2, fig. 3). No cameral septa are evident. Test surface appears to be delicately striate under light microscope examination but SEM analysis shows this to be the result of solution effects. The solution effects are present over both the camera and tubus, but are most noticeable over the tubus.

Test dimensions: Maximum length 0.32 mm, maximum width 0.30 mm, height 0.30 mm.

Locality: Outcrop sample, mudlump 90, South Pass area of the Mississippi Delta.

Stratigraphic Level: Early Holocene.

Derivato nominis: The species is named in honor of Ms. C. F. Williams, Paleontologist, Chevron U.S.A., Inc., Eastern Region.

Remarks: These two specimens, along with the one previously described, illustrate a number of variable morphologic features, all of which are believed to represent acceptable specific variation. This variation is discussed below. The degree of asymmetry exhibited by the test in side view is minimal (pl. 2, fig. 2) to more pronounced (Haman, 1978, pl. 2, fig. 2). The amount of cameral compression varies from minimal (pl. 2, fig. 4) to noticeable (Haman, 1978, pl. 2, fig. 6). The rapidity of tubus tapering from adjacent to lateral aperture "B" to lateral aperture "A" varies between specimens, from gentle (Haman, 1978, pl. 2, fig. 5) to severe (pl. 2, fig. 10). The tubus pore shape is variable, ranging from subcircular (pl. 2, fig. 10) to elongate (Haman, 1978, pl. 2, fig. 5). Variable measurements of various features between the specimens as noted in Table 1.

This variation is believed related to the growth process of the organism and with the case of certain features to solution effects.

Close examination of the specimen illustrated on plate 2, figures 6, 9, shows a rectangular feature on the test adjacent to the porta. An enlargement of this specimen

Table 1

	Specimen 1 (pl. 2, figs. 1-5)	Specimen 2 (pl. 2, figs. 6-10)	Specimen 3 (1978, pl. 2, figs. 1-6)
Max. length	0.32 mm	0.28 mm	0.37 mm
Max. width	0.30 mm	0.26 mm	0.28 mm
Max. height	0.30 mm	0.28 mm	0.31 mm
Porta	0.060 × 0.091 mm	0.030 × 0.070 mm	0.040 × 0.085 mm
Tubus pore	0.035 × 0.065 mm	0.031 × 0.045 mm	0.040 × 0.140 mm

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PLATE 2

(Bar = 100 microns)

VOORTHUYSENIELLA WILLIAMSAE n. sp.

Figures 1-5. Holotype 88
(1) view to lateral aperture "A", (2) side view, (3) view to lateral aperture "B", (4) portal view, (5) view to tubus and tubus pore.

Figures 6-10. Paratype
(6) view to lateral aperture "A", (7) side view, (8) view to lateral aperture "B", (9) portal view (note crystal scar indicated by arrow), (10) view to tubus and tubus pore.

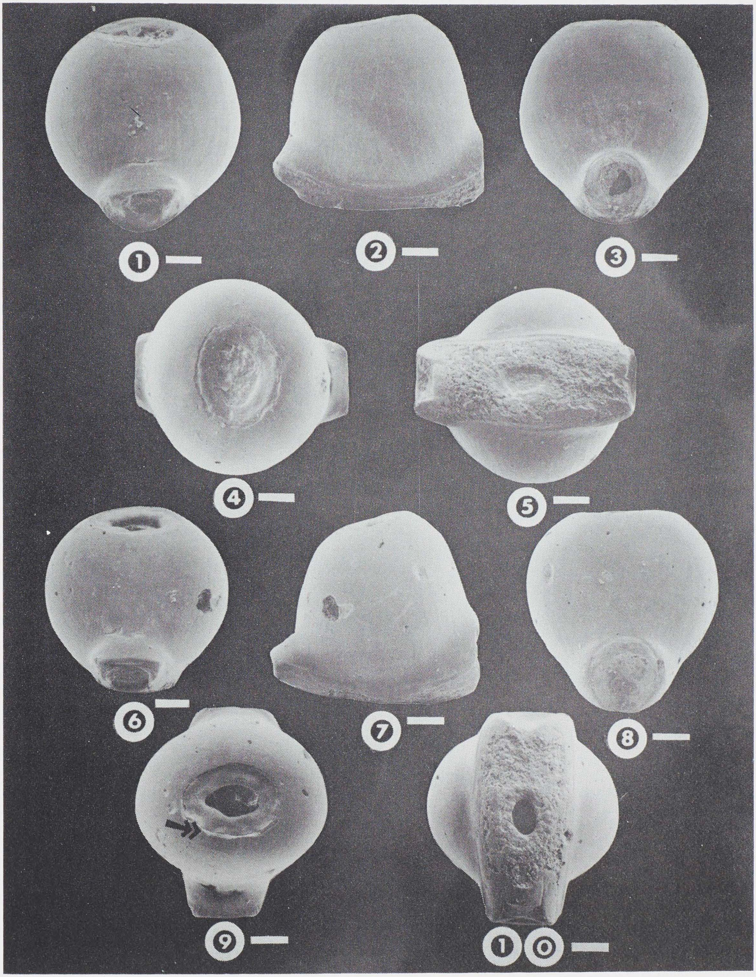

PLATE 2

(pl. 3, fig. 1) and of the relevant area (pl. 3, figs. 2,3) demonstrates that the feature is real. The "scar" is believed to have resulted from crystal overgrowth on the test. Later crystal removal leaves the scar. Crystal overgrowths are not unknown on foraminifera and there does not appear to be any reason why they could not occur on problematic organisms. Akers, 1979, illustrated *Globigerina* sp. (pl 19, fig. 2) from the Neogene of Mexico that has distinct pyrite crystals developed in the apertural region. Towe *et al.* (1977, pl. 1, fig. 1) document secondary calcite rhombs on tests of *Patellina corrugata* Williamson. These laboratory-created rhombs could occur in the natural state and would, if removed from the test, leave scars identical to the one displayed on the specimen of *V. williamsae*. The stratigraphic range of the species is late Pleistocene to early Holocene.

VI. APPENDIX.

List of species from sample

Due to the rapidly changing nomenclature of the foraminifera on a supraspecific level, the taxa obtained from the mudlumps sample are listed below by group, and alphabetically by species. As the systematic evaluation of the generic assignments was not the purpose of this article, the majority of the generic names remain as those familiar to Gulf Coast paleontologists.

AGGLUTINATED BENTHIC SPECIES

aequa, cf., *Gaudryina* Cushman
affinis, *Siphotextularia* (Fornasini)
barrettii, *Textulariella* (Jones and Parker)
calva, *Textularia* Lalicker
irregularis, *Bigenerina* Phleger and Parker
mayori, *Textularia* Cushman
mexicana, *Clavulina* Cushman
mexicana, *Textularia* Cushman
parkerae, *Cribrobigenerina* Andersen
parva, *Psammosphaera* Flint
sica, *Textularia* Lalicker and Bermudez
soldanii, *Liebusella* (Jones and Parker)

CALCAREOUS BENTHIC SPECIES

advena, *Rectobolivina* (Cushman)
albatrossi, *Bolivina* Cushman
albatrossi, *Nodosaria* Cushman
ampla, *Saracenaria* Cushman and Todd
antillarum, *Neoeponides* (d'Orbigny)
antillarum, *Spiroloculina* d'Orbigny
atlantica, *Nodobaculariella* Cushman and Hanzawa
atlanticus, *Florilus* (Cushman)
atlanticus, *Tretomphalus* Cushman
barbata, *Brizalina* (Phleger and Parker)
barleeanus, *Melonis* (Williamson)
basiloba, *Nonionella* Cushman and McCulloch
beccarii, *Ammonia* (Linne)
bella, *Trifarina* (Phleger and Parker)
bellula, *Uvigerina* Bandy
bertheloti, *Discopulvinulinella* (d'Orbigny)
bicostata, *Quinqueloculina* d'Orbigny
bowdenensis, *Lenticulina* (Cushman)
bulloides, *Sphaeroidina* d'Orbigny
calcar, *Lenticulina* (Linne)
camachoi, *Amphicoryna* Andersen
candeina, *Rosalina* (d'Orbigny)
carinata, *Pyrgo* (d'Orbigny)
cassis, *Nodobaculariella* (d'Orbigny)
caudigera, *Oolina* (Wiesner)
communis, *Dentalina* d'Orbigny
compta, *Quinqueloculina* Cushman
concentrica, *Hanzawaia* (Cushman)
concentrica, *Stomatorbina* (Parker and Jones)
dentata, *Spiroloculina* Cushman and Todd
discoidale, *Elphidium* (d'Orbigny)
elegans, *Hoeglundina* (d'Orbigny)
falcifer, *Lenticulina* (Stache)
faveolata, *Planulina* (Brady)
filiformis, *Dentalina* (d'Orbigny)
fimbriatulum, *Elphidium* (Cushman)
flintii, *Sigmoilopsis* (Cushman)
floridanus, *Cibicides* (Cushman)

PLATE 3

VOORTHUYSENIELLA WILLIAMSAE n.sp.

Figures 1-3. Paratype 88

(1.) Portal view with crystal scar indicated by arrow No. 1 (×270).

(2.) Enlargement of portion of Figure 1 to show scar margin (indicated by white lines). Area of enlargement illustrated on figure 1 by arrow No. 2 (×2600).

(3.) Enlargement of portion of Figure 2 to show scar margin (indicated by white lines). Area of enlargement illustrated on Figure 2 by arrow (×13,000).

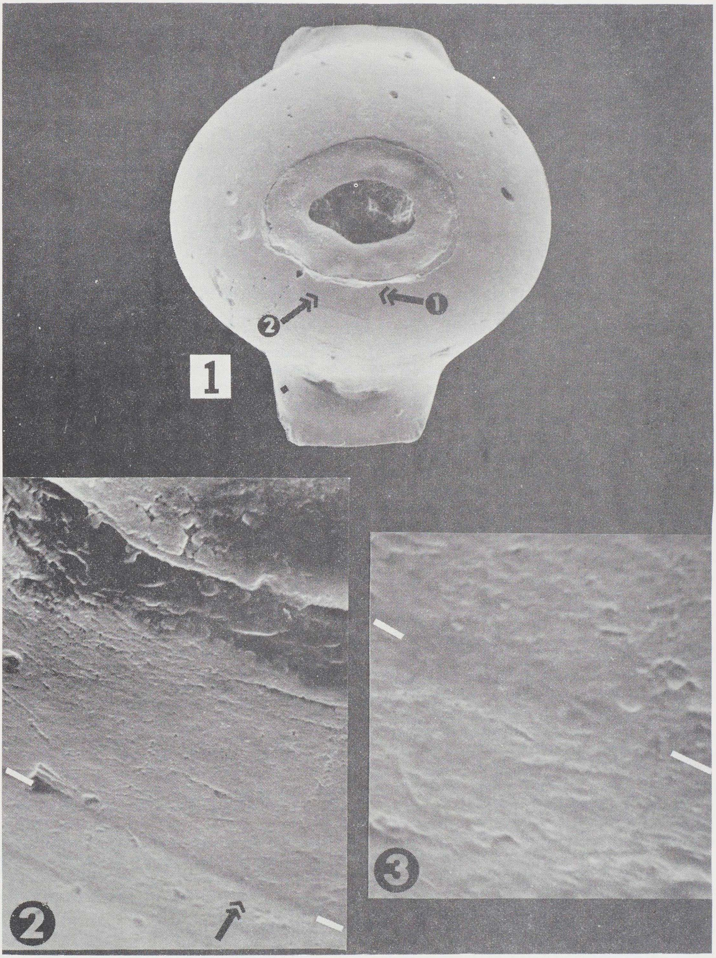

PLATE 3

floridensis, *Rosalina* (Cushman)
fragilis, *Brizalina* (Phleger and Parker)
fusta, *Nodosaria* Cushman and Todd
garettii, *Quinqueloculina* Andersen
gelbi, *Loxostomum* Andersen
gibbosa, *Amphistegina* d'Orbigny
globulifera, *Ramulina* Brady
globulus, *Sphaerogypsina* (Reuss)
grateloupi, *Florilus* (d'Orbigny)
gunteri, *Elphidium* Cole
hannai, *Buccella* (Phleger and Parker)
hexagona, *Oolina* (Williamson)
hispidula, *Lagena* Cushman
incertum, *Elphidium* (Williamson)
insignis, *Triloculina* (Brady)
inusitata, *Lagena* Andersen
io, *Cibicidoides* (Cushman)
iotus, *Lenticulina* (Cushman)
labiosa, *Miliolinella* (d'Orbigny)
laevigata, *Glandulina* (d'Orbigny)
laevis, *Lagena* (Montagu)
lateralis, *Poroeponides* (Terquem)
latiformis jamaicensis, *Saracenaria* Cushman and Todd
lessonii, *Amphistegina* d'Orbigny
marginata, *Bulimina* d'Orbigny
marginata, *Fissurina* Seguenza
mayori, *Articulina* Cushman
mediterranensis, *Planorbulina* d'Orbigny
melo, *Oolina* d'Orbigny
mera, *Planulina* Cushman
mexicana, *Cassidulinoides* (Cushman)
mexicana, *Valvulineria* Parker
miocenica, *Pavonina* Cushman
miocenica, *Reussella* Cushman
nasuta, *Pyrgo* Cushman
nucleatus, *Anomalinoides* (Seguenza)
occidentalis, *Trifarina* (Cushman)
orbitolitoides, *Broeckina* (Hofker)
parkinsoniana, *Ammonia*, (d'Orbigny)
parvula, *Eouvigerina* Cushman
pauciloculata, *Ammonia* (Phleger and Parker)
perprocera, *Marginulina* (Schwager)
planata, *Vaginulinopsis* (Phleger and Parker)
pontoni, *Fursenkoina* (Cushman)
popei, *Chrysalidinella* Andersen
proteus, *Peneroplis* d'Orbigny
pulchra, *Siphonina* Cushman
punctata, *Fursenkoina* (d'Orbigny)
pyrula, *Nodosaria* d'Orbigny
roederi, *Amphicoryna* Andersen
sabulosa, *Quinqueloculina* Cushman
saggitula, *Frondicularia* van den Broeck
sagra, *Cancris* (d'Orbigny)
schlumbergeri, *Sigmoilina* Silvestri
selseyense, *Uvigerina* Heron-Allen and Earland
sp. *Cushmanella*
sp. B., *Fissurina* (of Akers and Dorman, 1964)
sp. formae fistulosae, *Globulina*
spicaeformis, *Guttulina* (Roemer)
spicata, *Lagena* Cushman and McCulloch
spinata, *Brizalina* (Cushman)
spirata, *Lagena* Bandy
spp. *Elphidium*
spp. *Lenticulina*
spp. *Vaginulinopsis*
strattoni, *Hanzawaia* (Applin)
striatula, *Marginulina* Cushman
subcarinata, *Pullenia* (d'Orbigny)
subglobosa, *Cassidulina* Brady
substriata, *Lagena* Williamson
suezensis, *Rosalina* (Said)
tenuis, *Bulimina* Phleger and Parker
tepida, *Ammonia* (Cushman)
terquemi, *Neoconorbina* (Rzehak)
toddae, *Biloculinella* Andersen
tricarinata, *Triloculina* d'Orbigny
trigonula, *Triloculina* (Lamarck)
tumidulus, *Neoeponides* (Brady)
vespertilio, *Pyrgo* (Schlumberger)
vivipara, *Spirillina* Ehrenberg
westi, *Oridorsalis* Andersen

PLANKTIC SPECIES

aequilateralis, *Hastigerina* (Brady)
bulloides, *Globigerina* d'Orbigny
conglobatus, *Globigerinoides* (Brady)
dehiscens, *Sphaeroidinella* (Parker and Jones)
dutertrei, *Neogloboquadrina* (d'Orbigny)
eggeri, *Neogloboquadrina* (Rhumbler)
falconensis, *Globigerina* Blow
fimbriata, *Globorotalia* (Brady)
finalis, *Pulleniatina* Banner and Blow
glutinata, *Globigerinita* (Egger)
helicina, *Globigerinoides* (d'Orbigny)
hirsuta, *Globorotalia* (d'Orbigny)
inflata, *Turborotalia* (d'Orbigny)
menardii, *Globorotalia* (d'Orbigny)
nitida, *Candeina* (d'Orbigny)
pyramidilis, *Globigerinoides* van den Broeck
ruber, *Globigerinoides* (d'Orbigny)
sacculifer, *Globigerinoides* (Brady)
siphonifera, *Hastigerina* (d'Orbigny)
trilobus, *Globigerinoides* (Ruess)
truncatulinoides, *Globorotalia* (d'Orbigny)
tumida, *Globorotalia* (Brady)
ungulata, *Globorotalia* Bermudez
universa, *Orbulina* (d'Orbigny)

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