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A NEW PLANKTONIC FORAMINIFER (FAMILY HEDBERGELLIDAE LOEBLICH AND TAPPAN, 1961) FROM THE LOWER CAMPANIAN SEDIMENTS OF THE FALKLAND PLATEAU, SOUTH ATLANTIC OCEAN (DSDP SITE 511)

Marius D. Georgescu

Department of Geoscience, University of Calgary, 2500 University Drive N. W., Calgary, Alberta T2N 1N4, Canada
e-mail: dgeorge@ucalgary.ca

ABSTRACT

***Liuella falklandica* nov. gen., nov. sp. is a planktonic foraminifer of the Late Cretaceous (lower Campanian) that is characterized by the following combination of features: imperforate peripheral band throughout the final whorl, smooth chamber surface and finely perforate to macroperforate test wall with crater-like perforations on the earlier chambers of the test. It is included in the Subfamily Hedbergellinae due to its strong resemblance in gross test architecture to *Hedbergella planispira* (Tappan) of the late Albian-Santonian, presumably its ancestor. The genus is monospecific.**

INTRODUCTION

Four genera are included within the Subfamily Hedbergellinae Loeblich and Tappan, 1961: *Hedbergella* Brönnimann and Brown, 1958, *Asterohedbergella* Hamaoui, 1964, *Costellagerina* Petters, El-Nakhal and Cifelli, 1983 and *Whiteinella* Pessagno, 1967 (Loeblich and Tappan, 1987, p. 461–462). All are characterized by a simple test periphery and by lack of such peripheral structures as imperforate bands and keels. The only genus with a general hedbergellid appearance in the early stage and with an imperforate peripheral band on the earlier chambers of the final whorl is *Clavihedbergella* Banner and Blow, 1959. This genus also exhibits two to three elongate last-formed chambers. Its stratigraphic range is Aptian-Coniacian according to Loeblich and Tappan (1987, p. 466), but was narrowed to the Albian-Coniacian by BouDagher and others (1997).

A new planktonic foraminifer with a hedbergellid appearance (globular to subglobular chambers throughout ontogeny) and with a smooth test surface, a finely perforate to macroperforate test wall, crater-like pores on the earlier chambers and an imperforate peripheral band on all the chambers of the final whorl is herein reported from lower Campanian sediments of the DSDP Site 511 of the Falkland Plateau, South Atlantic Ocean (Fig. 1). *Liuella falklandica* nov. gen., nov. sp. appears to have evolved from *Hedbergella planispira* as suggested by the similarities in the general test architecture. It is the first hedbergellid taxon with an imperforate peripheral band developed on all the chambers of the final whorl.

TAXONOMY

The suprageneric classification follows that of Loeblich and Tappan (1987), and the species concept follows Georgescu and Huber (2007).

Order FORAMINIFERIDA Eichwald, 1830
Suborder GLOBIGERININA Delage and Hérouard, 1896
Superfamily ROTALIPORACEA Sigal, 1958
Family HEDBERGELLIDAE Loeblich and Tappan, 1961
Subfamily HEDBERGELLINAE Loeblich and Tappan, 1961

Genus ***Liuella*** nov. gen.
(Type species: *Liuella falklandica* nov. sp.)

Diagnosis. Smooth, very low trochospiral test, finely perforate to macroperforate test wall, crater-like pores on the earlier chambers and imperforate peripheral band throughout the final whorl.

Description. Test low to very low trochospiral with globular to subglobular chambers, separated by straight, incised and radial sutures. Test biconvex, nearly symmetrical in edge view. Periphery broadly rounded with a wide imperforate band throughout the final whorl. Main aperture is in the shape of a low to medium high arch, peripheral-umbilical in position and bordered by an imperforate lip. Test wall calcitic, hyaline, perforate, with perforation diameters ranging between 1.7 and 3.1 μm. Test surface smooth.

Remarks. Liuella nov. gen. differs from any other hedbergellid genus by presenting an imperforate peripheral band throughout the final whorl. It also differs from *Clavihedbergella* Banner and Blow of the upper Albian by its finely perforate to macroperforate test wall and lack of radially elongate chambers. Seemingly, there is a gap that separates the stratigraphic ranges of the two genera and that spans the Cenomanian-early Santonian interval. Herein, *Liuella* is included within the Subfamily Hedbergellinae—despite the presence of the imperforate peripheral band—due to the strong general resemblances with the hedbergellid group rather than with the ticinellids of the Subfamily Ticinellinae, such as *Biticinella*, *Clavihedbergella*, *Claviticinella* and *Ticinella* (Loeblich and Tappan, 1987, p. 466). Pore-size terminology is that used by the Mesozoic Planktonic Foraminifera Working Group (2006, coordinator B. T. Huber): 1.0 to 2.5 μm is considered finely perforate, and over 2.5 μm is considered macroperforate.

Species included. Liuella falklandica nov. sp.

Etymology. The genus is named in honor of Dr. Chengjie Liu (ExxonMobil Exploration and Production) in appreciation for his studies on the Paleogene planktonic foraminifera.

Phylogenetic relationships. The low to very low trochospire, the shape and position of the aperture, which touches the periphery, and the size of the umbilical area, which is approximately one third of the maximum test diameter, suggest that this genus evolved from *Hedbergella planispira* or related species of the Santonian, such as *H. atlantica* Petters, 1977. Another species with close morphological features to *Liuella falklandica* n. sp. is *Hedbergella punctata* Michael, 1973, which was originally described from the upper Albian sediments of the southern United States (Texas) by Michael (1973) and subsequently reported from the Great Artesian

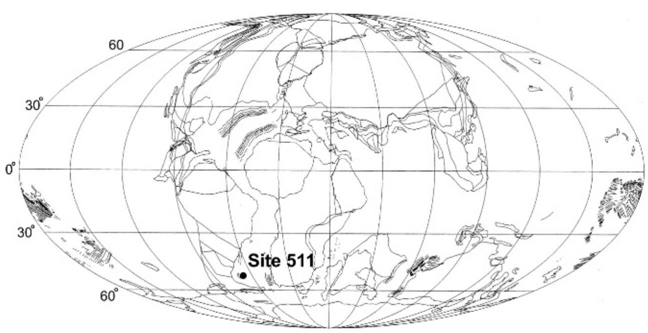

FIGURE 1. Location of Site 511, the type locality of *Liuella falklandica* nov.gen., nov.sp. Paleogeographic reconstruction after Hay and others (1999).

Basin of northern Australia (Playford and others, 1975). This is a small-sized species (D_{max}=0.150 mm), with relatively large-sized pores and low trochospire. The presence of an imperforate peripheral band throughout the final whorl, the large-sized pores situated in the center of crater-like structures and lower trochospire differentiate *L. falklandica* from *H. punctata*. However, there is a significant stratigraphical interval that separates the two species without a record of similar tests and spanning the Cenomanian and Santonian. The genera of the Family Hedbergellidae that have an imperforate peripheral band and that have traditionally been included within the Subfamily Rotundininae Bellier and Salaj, 1977 of the Albian-Coniacian comprise two genera: *Falsotruncana* Caron, 1983 and *Praeglobotruncana* Bermúdez, 1952 (Loeblich and Tappan, 1987, p. 462–463). Both of these have a truncated and keeled periphery and apparently evolved from globular-chambered hedbergellids (Caron and Spezzaferri, 2003). Accordingly, a phylogenetic relationship between either *Falsotruncana* or *Praeglobotruncana* and *Liuella* nov. gen., which does not show keels, is not plausible (Fig. 2).

Stratigraphic range. Lower Campanian (upper part of the *Marginotruncana marginata* Biozone and lower part of the *Archaeoglobigerina cretacea* Biozone). Biostratigraphic zonation (Table 1) after Huber (1992) and Huber and others (1995).

Geographic distribution. South Atlantic Ocean, Falkland Plateau.

Liuella falklandica nov. sp.
Pl. 1, figs. 1–10

Hedbergella loetterlei (Nauss) – Krasheninnikov and Basov, 1983, p. 805, pl. 6, figs. 1–4 (Santonian-Campanian, DSDP Site 511, Falkland Plateau).

Holotype. Specimen deposited in the Willi K. Braun Micropaleontological Collection of the University of Calgary, WKB 01001.

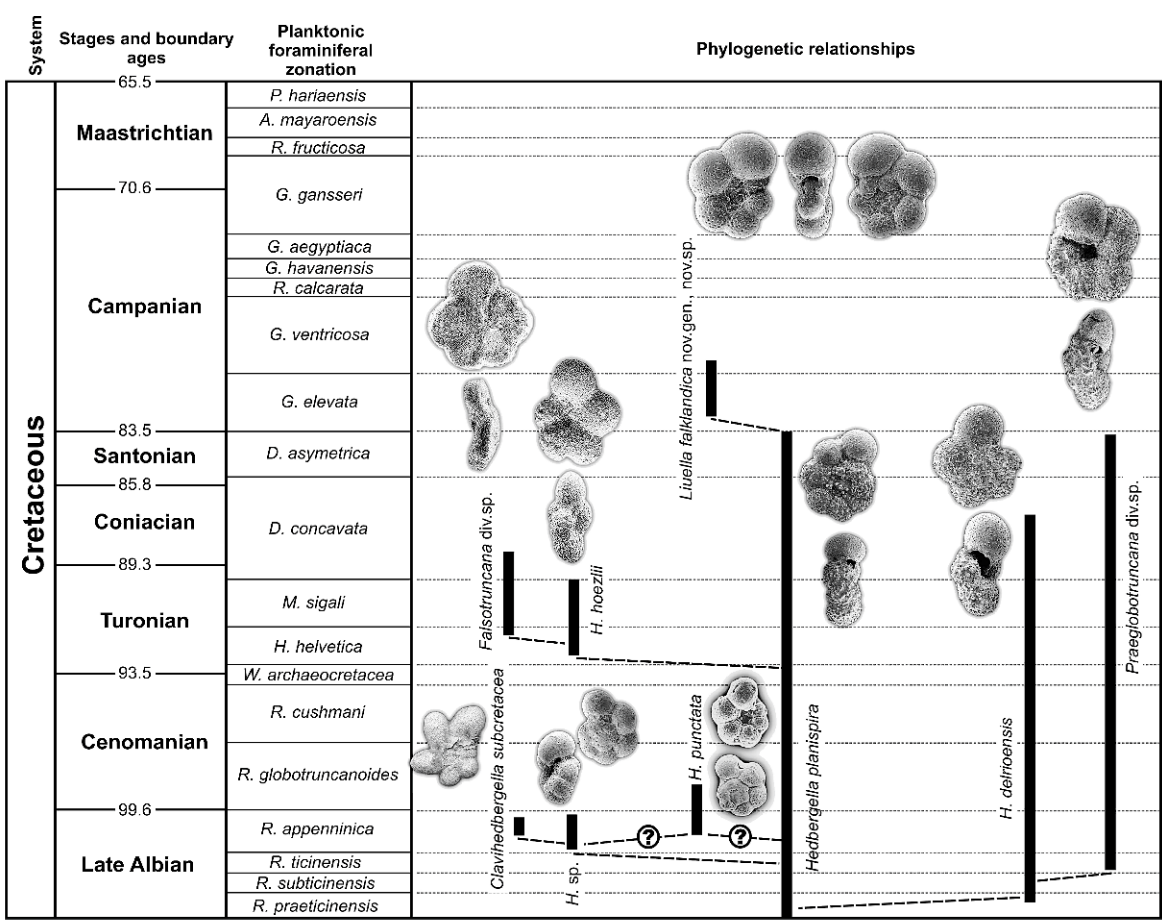

FIGURE 2. Phylogenetic relationship diagram showing the iterative pattern of the development of imperforate peripheral band (bordered or not by keels) in the genera that evolved from *Hedbergella*. *Hedbergella punctata* figures are from Michael (1973). Ages after Gradstein and others (2004). Standard planktonic foraminiferal zonation after Robaszynski and Caron (1995). No scale is implied.

TABLE 1. Stratigraphic distribution of *Liuella falklandica* nov. gen., nov. sp. and other planktonic foraminiferal species in the Upper Cretaceous of Site 511, Falkland Plateau, South Atlantic Ocean. Marker species are shown with light gray background. Correlation between the Southern Hemisphere and Tethyan planktonic foraminiferal frameworks for the Late Cretaceous after Huber (1992).

Samples (DSDP Site 511-Falkland Plateau)	Planktonic foraminiferal species																																Planktonic foraminiferal biozonation after Huber (1992) and Huber and others (1995)	Cretaceous stages
	Heterohelix globulosa	*H. planata*	*H. papula*	*H. rumseyensis*	*H.* sp. 1	*Laeviheterohelix pulchra*	*L. reniformis*	*Pseudoguembelina costulata*	*Globigerinelloides asperus*	*G. impensus*	*G. alvarezi*	*G. bollii*	*Schackoina tritubercula*	*Hedbergella atlantica*	*H. delrioensis*	*H. holmdelensis*	*H. planispira*	*H. cf. planispira*	*H. cf. sliteri*	*Whiteinella baltica*	*W. brittonensis*	*W. paradubia*	*Liuella falklandica* nov. gen., nov. sp.	*Marginotruncana marginata*	*M. pseudolinneiana*	*Globotruncana linneiana*	*G. bulloides*	*Globotruncanella havanensis*	*Archaeoglobigerina australis*	*A. blowi*	*A. bosqensis*	*A. cretacea*		
23-1 4-6 cm	C	C									R								R									R	F				***G. havanensis***	upper Campanian
22-4 22-25 cm	F	F		F	F					C									R										C				***G. impensus***	
24-5 21-24 cm	F	F		C	R			R		C									R										R					
24-7 20-23 cm	F	A		R						R	R								R										R					
26-cc	R									R									R											R				
28-2 21-25 cm																																	***A. cretacea***	lower Campanian
28-6 18-22 cm	F	C							C				R					C												R		R		
29-1 12-15 cm	R	C									C																			C		R		
30-1 23-27 cm	F	F							C		R							R														R		
30-5 12-16 cm	C	C				R			F							C		R												R		R		
31-5 8-11 cm		R		R		A			C		C	R						C					R							R		R		
32-1 19-22 cm	R	C				A			R		C	C											F											
32-4 23-27 cm	R	F		R		A	R		C		F	F											R							R		C		
33-1 20-24 cm	F	A		R		A			F		F	F		C						R	R		C			R				R		R		
33-4 76-80 cm									R							R				R										R				
34-2 20-24 cm	R	F				F			R		F	R		R						R	R		C				R					F		
34-6 22-24 cm	F	R				A					F					R							C							F				
35-1 20-24 cm		R		R		F					R	R																		R				
36-1 24-28 cm	R	R				F	R									R							R	R	R					R		R	***M. marginata*** (partly)	
36-5 27-33 cm	C	C				A			F														F	C	R					F		R		
36-7 23-27 cm	C	F		R		A			F		F			R									C							A		F		
37-1 23-27 cm	R																													R		R		
38-1 24-28 cm	C	R				R			R														R							R		R		
38-4 24-28 cm	R	R				F																	R							C		R		
39-2 13-17 cm	F	C				A			F																					R		R		
40-1 38-40 cm	C	R							F		F			R																F				
40-4 26-29 cm	C	F				F					C	C		F																F				
40-6 20-23 cm	A	F	R								C																			R				
41-2 21-23 cm	R																																	
41-3 55-57 cm											R			R																				
42-1 25-30 cm																																		upper Santonian
42-3 21-23 cm	R																																	
42-4 21-23 cm	A	A	F							A	F									A	A	R								R				
42-5 16-20 cm	C	R	F								F			R		R				F	C	R												
43-4 23-29 cm	R																			F														
44-1 24-26 cm		C															F			A	A													
44-3 16-20 cm	C										C									R				R							R			

Dimensions of the holotype. Maximum test diameter: D_{max}=0.229 mm, minimum test diameter: D_{min}=0.189 mm, D_{min}/D_{max}=0.825, thickness: T=0.108 mm, T/D_{max}=0.472.

Type location. DSDP Site 511, Falkland Plateau. Geographic coordinates: 51°00′ S, 47°58′ W.

Type level. Lower Campanian (*Archaeoglobigerina cretacea* Biozone), Sample 511-32-1, 19–22 cm.

Paratypes. Five specimens deposited in the Willi K. Braun Micropaleontological Collection of the University of Calgary, WKB 01002.

Dimensions of the paratypes. D_{max}=0.170–0.255 mm, D_{min}=0.135–0.205 mm, D_{min}/D_{max}=0.794–0.831, T=0.073–0.114 mm, T/D_{max}=0.373–0.486.

Material. Over seventy specimens.

Etymology. The species is named after the Falkland Plateau, where the type locality is situated.

Description. Test with very low trochospire, nearly planispiral, consisting of 12 to 17 globular to subglobular chambers, which gradually and slowly increase in size as added. There are 5 ½ to 6 chambers in the final whorl. Sutures are distinct, straight, radial and depressed. Test slightly asymmetrically biconvex in edge view. Periphery broadly rounded with an imperforate peripheral band, which is developed on all the chambers of the final whorl. Main aperture is in the shape of a low to medium high arch, interiomarginal, umbilical-peripheral in position and bordered by an imperforate lip. Umbilicus

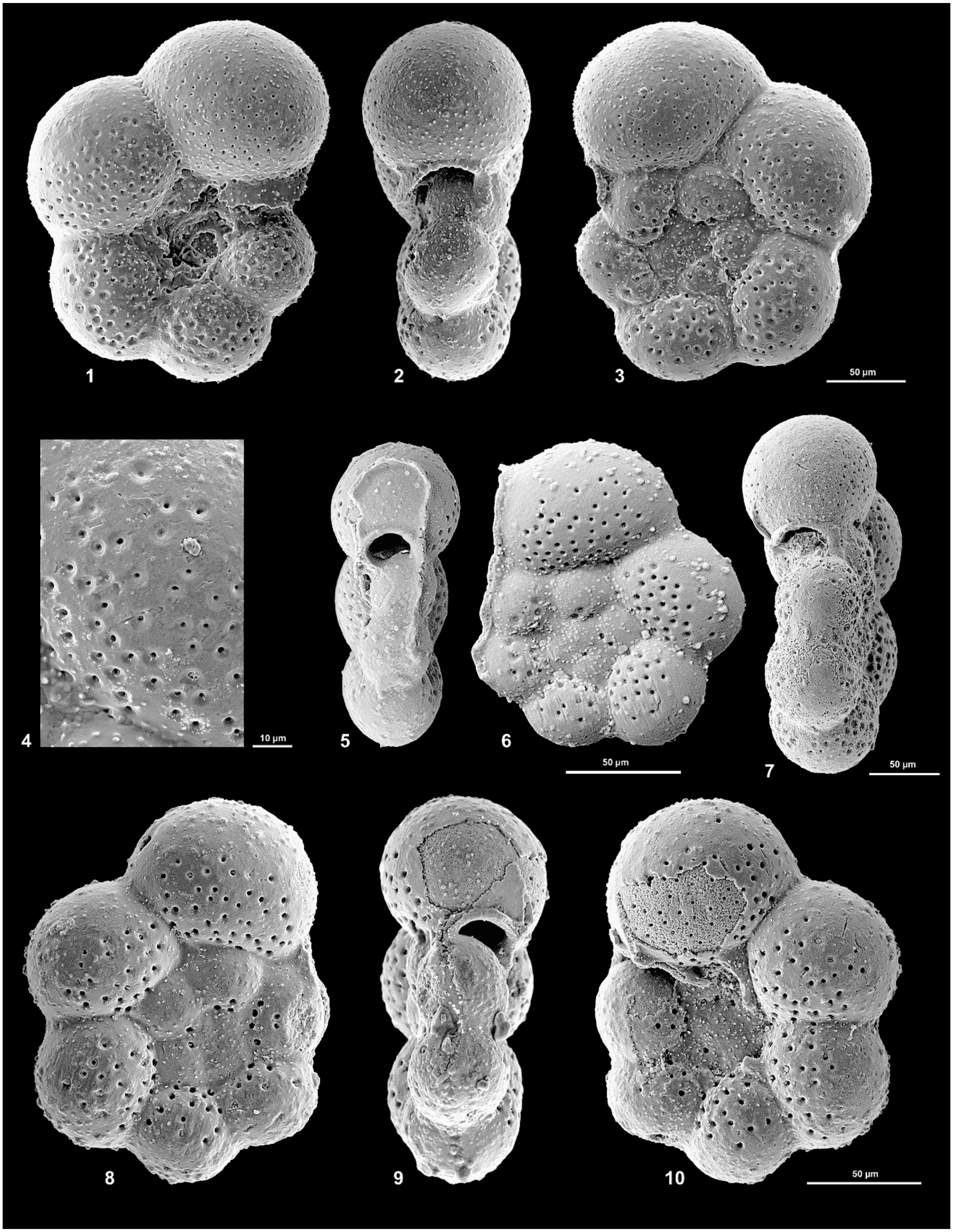

PLATE 1

Type specimens of *Liuella falklandica* nov.gen., nov. sp. from the lower Campanian of the Falkland Plateau (South Atlantic Ocean), DSDP Site 511. **1–4** Holotype, Sample 511-32-1, 19–22 cm: **1** umbilical view, **2** edge view, **3** spiral view, **4** the detail photograph showing the crater-like pores on the penultimate chamber on the spiral side. **5–6** Paratype, Sample 511-32-1, 19–22 cm: **5** notice the perfectly developed imperforate peripheral band in the edge view and **6** the secondary calcite on the spiral side. **7** Topotype, Sample 511-33-1, 20–24 cm; notice the imperfect development of the imperforate peripheral band, which shows pores along the sutures in the peripheral region. **8–10** Paratype, Sample 511-32-1, 19–22 cm: **8** Spiral view; **9** notice the secondary calcite deposition on the chamber infill in edge view; **10** umbilical view.

is of medium size, its diameter reaching approximately one third of the maximum test diameter. Relict apertures and periapertural structures are present in the umbilical area. Test wall calcitic, hyaline, perforate; perforation diameter varies between 1.7 and 3.1 μm; crater-like pores are developed on the earlier chambers of the test. Perforations can be occasionally present in the imperforate band area along the sutures. Test surface smooth.

Remarks. The presence of the imperforate peripheral band developed on the last whorl and crater-like pores on the earlier chambers of the test differentiate *Liuella falklandica* nov. sp. from any hedbergellid taxon. It differs from *Hedbergella planispira* (Tappan) in having (i) a smooth test surface rather than pustulose, (ii) larger pores rather than being finely perforate and (iii) presenting an imperforate peripheral band rather than lacking peripheral structures. *Whiteinella loetterlei* (Nauss) is a species with a hispid test surface as shown in the scanning electron microscope images by McNeil and Caldwell (1981, pl. 21, fig. 1).

Stratigraphic range. Lower Campanian (upper part of the *Marginotruncana marginata* Biozone and lower part of the *Archaeoglobigerina cretacea* Biozone).

Geographic distribution. DSDP Site 511, South Atlantic Ocean (Falkland Plateau).

CONCLUSIONS

A new planktonic foraminiferal genus is reported from the Late Cretaceous (lower Campanian) of the DSDP Site 511, Falkland Plateau (South Atlantic Ocean). *Liuella* nov. gen. has a general hedbergellid appearance and is characterized by its smooth test surface, wide perforations (1.7 to 3.1 μm perforation diameter), and, above all, an imperforate peripheral band visible on all the chambers of the final whorl. The latter feature seems to have developed at least four times in genera that evolved from *Hedbergella*, in the following lineages: *Hedbergella-Clavihedbergella* (upper Albian), *Hedbergella-Praeglobotruncana* (upper Albian), *Hedbergella-Falsotruncana* (Turonian) and *Hedbergella-Liuella*, which is the only one of the Late Cretaceous (lower Campanian). *Liuella falklandica* nov. sp. is the type species of the new genus. Notably, the perforations are crater-like on the earlier chambers of the test. *Liuella* is included within the Subfamily Hedbergellinae despite the presence of the imperforate peripheral band and based on the general resemblances with *Hedbergella planispira* (Tappan).

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