beek. Hoewel in visserij kringen wel iets over paaitrek van *L. cephalus* bekend is, lijkt mij het beschreven verschijnsel voor deze soort tenminste ongewoon.

6. *Nemacheilus barbatulus,* het bermpje, komt voornamelijk in beken voor, verder ook wel in onze grote rivieren. Van dit visje zijn wat meer vindplaatsen bekend. Volgens de R u y t e r (1924) en de catalogus „Nederlandse vindplaatsen" van het Zoöl. Mus. te Amsterdam in verschillende beekjes op de Veluwe en in Limburg. Verder door mij in Drente in de Amer (L e e n t v a a r en S c h i m m e l, 1955) en met een „hybi"-kamp der N.J.N. in verschillende beken bij Winterswijk gevangen (Augustus 1954, coll. Zoöl. Mus., Amsterdam). Het bermpje wordt wel samen met de elrits een begeleider van de forel genoemd, komt echter niet zover stroomopwaarts voor als laatstgenoemde (I l l i e s, 1952).
8. *Cottus gobio,* de rivierdonderpad, komt in beken als Geul en Gulp hier en daar bij tientallen op enkele m² voor. Volgens R e d e k e (1948) „in onze binnenwateren verre van zeldzaam; in Friesland komt het o.a. talrijk in de zgn. „oude slootjes" voor." Niettemin schijnt *Cottus gobio* het enige visje te zijn dat de forel tot in de bovenloop der bergbeken begeleidt (I l l i e s 1952, D i t t m a r 1955).
9. *Gaterosteus* spec.*) Een in de Vierlinkbeekse Molenbeek gevangen exemplaar behoort volgens de heer H o e d e m a n waarschijnlijk tot een van de gewone vorm *G. aculeatus* afwijkende. Deze zou zijn gehele leven in het zoete water doorbrengen. Het gevangen exemplaar vertoonde meer de habitus van een echt baarsje dan van een driedoornige stekelbaars, was meer zijdelings afgeplat en bezat donkere dwarsbanden.

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*)Professor K u e n e n te Leiden maakte mij er ep attent dat het hier waarschijnlijk om de door Huets onderzochte vorm *trachurus* gaat. (Huets, M. J. 1947: The phenotypical variability of *Gasterosteus aculeatus* (L.) populations in Belgium. — Verh. Kon. Vlaamse Acad. v. Wetensch. Lett. en Schone Kunsten v. België. Kl. Wetensch. 9, 25 : 1 - 63).

FORAMINIFERA FROM THE CRETACEOUS OF SOUTH LIMBURG, NETHERLANDS. XXXX.

THE AGE OF THE Cr 4, CRAIE TUFFOIDE

by J. HOFKER

In the vicinity of Maestricht, the Cr 3 c at its top shows a distinct hard banc, comparable with a hard ground; that banc has been stated also in the drill-hole of Glons, and also could be traced in a drill hole near Maestricht, No. 3496 of the Geologic Survey, at a depth of 67-68 m. In that hole, from 82-68 m we find *Bolivinoides australis* E d g e l l with number of pustules running from average 5 up to average 6; above that hard ground we find the average 7; this is quite the difference between the Craie grise and the Craie tuffoide in the drill-hole at Glons (See Natuurhist. Maandbl. vol. 47, 1958, p. 151, fig. 3); moreover, the structure changes from *australis* to *gigantea* (long ridges running over the test, see l.c., p. 149, fig. 1). The same hard banc can be found just at the top of the Cr 3 c (tiger chalk) at the bridge at Petit Lanaye, Belgium, where it separates the Cr 3 c from the Cr 4.

On the other hand, at many localities the top of the Cr 4 can be found (Canal Albert, Petit Lanaye, Saint Pietersberg, Savelsbos, Wylre, Boschhuysen). In most of these localities that top is covered by the regression-transgression-zone called here Ma. Over that Ma lies the Mb, characteristic enough by its fauna as well as its lithology. So, the Cr 4 is known very well stratigraphically.

When we analyse the fauna of the Cr 4, which already has been done in two publications (H o f k e r, Ann. Soc. géol. Belgique, vol. 80, 1956, pp. B 191-233; idem, vol 81, 1958, pp. B 467-493), we come to the conclusion that it shows a large identity with the fauna, described by the author from the so-called *Pseudotextularia*-zone of the drill-hole Maasbühl I and the outcrops in Denmark (Kjölby-Gaard, Stevns Klint); the latter zone as well is well-established stratigraphically: below that zone is found Upper Maestrichtian not differing in its fauna with our Cr 3 c, tiger chalk, and known already from the top of the quarries Basbeck and Hemmoor in Germany, and fully described by the author (Geol. Jahrb., Beih. 27, 1957). At the top of that zone we find something which in its lithology is identical with the Ma, viz. a

distinct, thin regression-transgression zone, in Denmark called the „Fiskeler".

The only difference in the whole fauna of the upper-Cr 4 with that of the *Pseudotextularia*-zone is the occurrence in the latter of two groups of typical species; the one is *Bolivinoides dorreeni* F i n l a y, the last form of the *Bolivinoides miliaris-draco-dorreeni* gens (but since that gens does not occur, but for some scattered specimens of *B. draco* at the boundary between Cr 3 b and Cr 3 c (Cr 3 gamma) in Holland and Belgium, this last form is missing in the Cr 4 also) and the occurrence of many more planctonic forms, such as several species of *Gümbelina* and of *Pseudotextularia varians* R z e h a k. But that difference merely is due to the fact that the *Pseudotextularia*-zone in Maasbühl and in Denmark shows a much more open-sea facies than the Cr 4 in Holland and Belgium.

In the South of Belgium, in the Basin of Mons, we find a formation, comparable in its fauna with the base of Cr 4, though it lithologically is different, the Craie phosphatée de Ciply. Here, however, it is lying on the Craie de Spiennes in some localities, the latter being lowest Maestrichtian, as I will prove in another paper, but which has been already mentioned in the analysis of *Bolivinoides* of the quarry Pourbaix (1958, l.c., Maandbl., pp. 157—159). So there is a large gap in sedimentation here. But at the top of the Craie phosphatée, we may in some localities find once again a regression-transgression layer, forming the base of the Tuffeau de Saint Symphorien, the latter being identical with lower Maestrichtian Chalk Tuff.

Since the only possible method to prove the identity in geologic time is the discovery of comparable orthogeneses (see Hofker, N. Jahrb. Geol. Pal., 1957, pp. 338—342), we will now analyse those identities here. In another paper (Natuurhist. Maandbl., vol. 45, 1956, pp. 99—110, range-chart), I have proved that the pore-orthogeneses of several species of Gavelinellidae, occuring in the *Pseudo-textularia*-zone, as well as in the Cr 4 of Holland and Belgium and the top of the Craie phosphatée in the Basin of Mons, show the same stages of development. Also I found, that at the base of the Tuffeau de Saint Symphorien which is exposed in the quarry André at Ciply, we find the indices of the Ma, as well as those of the uppermost *Pseudotextularia*-zone, in Denmark. These orthogeneses thus point directly to the identity in chronology of the Craie phosphatée, at least at its very top.

In my paper on the *Pseudotextularia*-zone (Paläont. Zeitschr., vol. 30, 1956, pp. 59—79). I showed, that in that fauna which always is considered to form the very top of the Cretaceous, we find together *Bolivinoides gigantea* H i l t e r m a n n and K o c h and *Neoflabellina postreticulata* H o f k e r, both in their most advanced stage of development (Pl. 7, fig. 49; Pl. 6, fig. 13). Quite the same forms we met with in the Craie phosphatée de Ciply, the Craie tuffoide in Northern Belgium (see the cited papers), and in the Cr 4 of the vicinity of the Pietersberg. We will now analyse those two groups in the different localities (See fig. 1 and 2).

I. Kjölby Gaard, *Pseudotextularia*-zone; samples procured by the author from J. T r o e l s e n.
Bolivinoides gigantea:
pustules number from 7—9; average 8,0; breadth of last formed chamber from 3,2 to 5,5 in cm × 80; average 4,3.
Neoflabellina postreticulata; ornamentation shows its highest regular development.

II. Base of Tuffeau de Saint Symphorien, sample H o f k e r, No. 537, quarry André, Ciply, where it rests on Craie phosphatée and where it forms a typical conglomerate, indicating a regression-transgression zone.
Bolivinoides gigantea:
pustules number from 7 to 9; average 8,2; breadth of last formed chamber from 3,5 tot 5 in cm × 80; average 4,2.
Neoflabellina postreticulata: not found.

III. Ma, regression-transgression zone at the base of the Maestrichtian Chalk tuff; sample H o f k e r 678, in the bicycle-shed at the ENCI-quarry, type-locality of the Ma.
Bolivinoides gigantea:
pustules number from 7 to 9; average 8,0; breadth of last formed chamber from 3,5 to 5,5 in cm × 80; average 4,3.
Neoflabellina postreticulata: not found.

IV. Craie phosphatée de Ciply, sample H o f k e r 607, top of the formation in the quarry

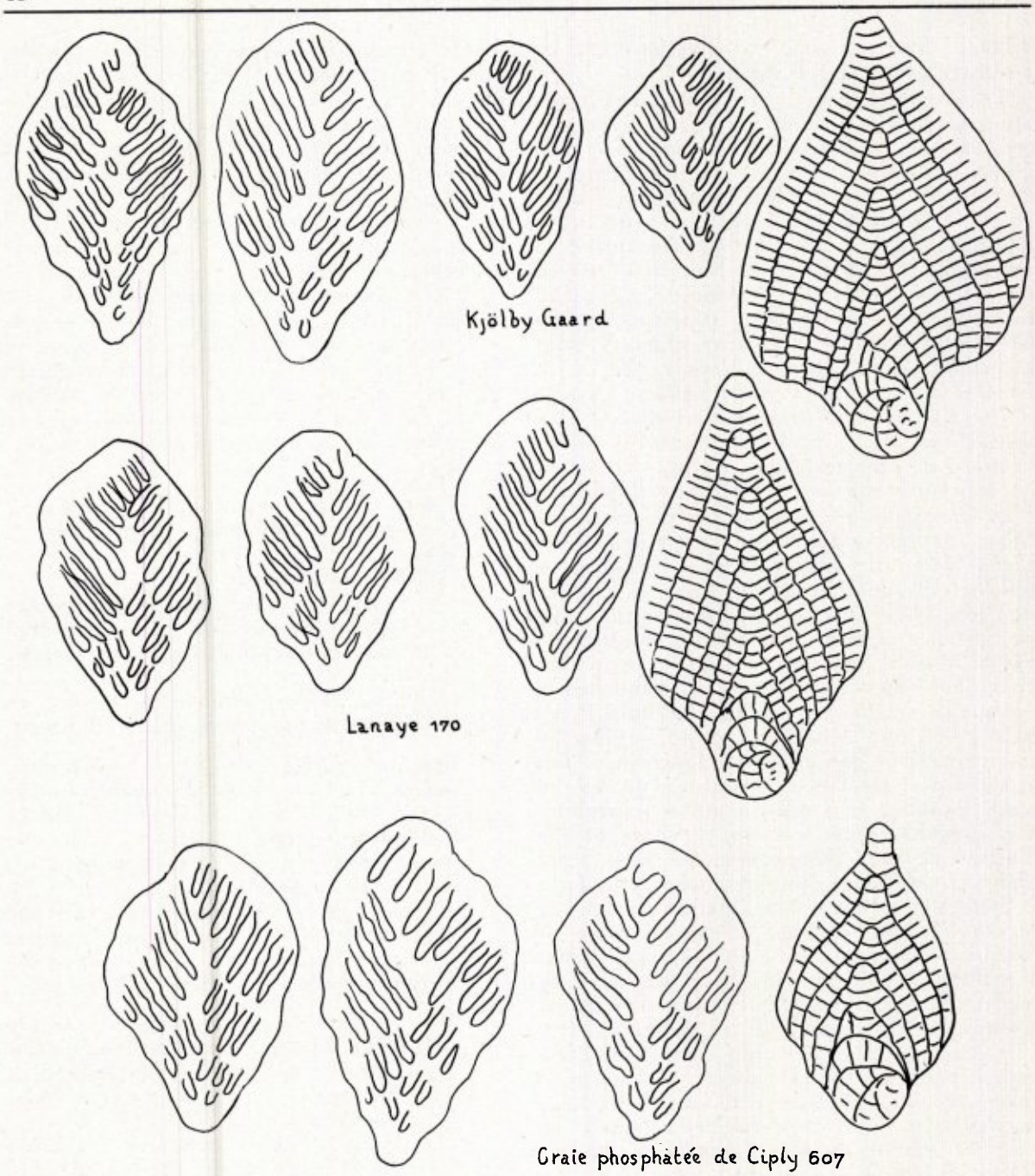

Fig. 1. Upper row. *Bolivinoides gigantea* and *Neoflabellina postreticulata* from Kjölby Gaard, Denmark, *Pseudotextularia*-zone sample Troelsen. All × 80.
Middle row. Idem, from Petit Lanaye, Belgium, Southern part of the Saint Pietersberg, sample Hofker 170, just at the bridge, above the hard banc dividing the Cr 4 from the tiger chalk. All × 80.
Lower row. Idem, from the Craie phosphatée de Ciply, sample Hofker 607, just below the Poudingue de la Malogne, quarry Liénard, Ciply. All × 48.

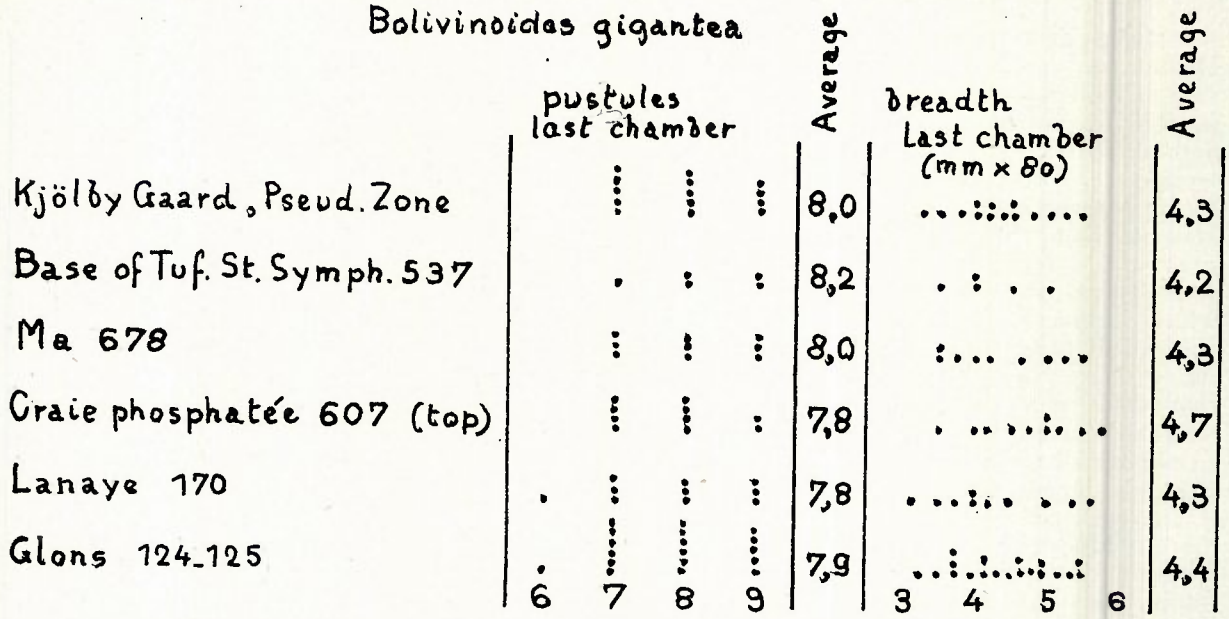

Fig. 2. Statistic analysis of the *Bolivinoides gigantea* assemblages from the different formations in question. All show the same number of pustules and breadth of the last formed chamber. Comparison with the results obtained at Glons, Belgium (Natuurhist. Maandblad, vol. 47, pp. 151—152, figs 3 and 4), proves that all assemblages must be placed in the same geologic level or time, viz. equal to the upper 20 m of the chalk of Glons.

Liénard, just below the Poudingue de la Malogne, and typical locality for this formation, at Ciply.

Bolivinoides gigantea:

pustules number from 7 to 9; average 7,8; breadth of last formed chamber from 3,5 to 5,7 in cm × 80; average 4,7.

Neoflabellna postreticulata: several typical specimens not differing from those found in the drill-hole Glons at its top.

V. Petit Lanaye, in Northern Belgium, Southern part of the Saint Pietersberg; base of the Cr 4, sample H o f k e r 170, just above the hard banc separating the Cr 4 from the tiger chalk.

Bolivinoides gigantea:

pustules number from 6 to 9; average 7,8; breadth of last formed chamber from 3,1 to 5,6 in cm × 80; average 4,3.

Neoflabellina postreticulata: typical ornamentation of the last development.

VI. Glons, in the quarry at 124—125 m + N.P. sample taken by L. C a l e m b e r t.

Bolivinoides gigantea:

pustules number from 6 to 9; average 7,9; breadth of last formed chamber from 3,2 to 5,5 in cm × 80; average 4,4.

Neoflabellina postreticulata: see Natuurhist. Maandbl., 1958, p. 150, figured specimens from 5 and 11 m of the drill-hole.

When we consider these results, and also the typical orthogeneses of both species mentioned here, we can come to only one conclusion:

the upper Craie phosphatée de Ciply, the Craie tuffoide of Northern Belgium, the Cr 4 of Holland and the Pseudotextularia-zone of Maashühl and Denmark, must have been formed during the same geologic time.

When we consider, moreover, the fact, that at Stevns Klint the *Pseudotextularia*-zone forms

the highest level of the Cretaceous under the Danian, we also have to come to the conclusion that in Holland the Cr 4 (as well as the comparable formations elsewhere) must form the highest possible Cretaceous. This is the more stringent, since as well in the Lower Danian as in the Maestrichtian Chalk Tuff and the Tuffeau de Saint Symphorien, all overlying the zone with a regression-transgression zone, the orthogeneses of those species of *Gavelinellidae* which continue in those formations, only show a very small jump, as is seen on the mentoined range chart from 1956. That jump indicates that there is no possibility that the Maestrichtian Chalk Tuff and the Tuffeau de Saint Symphorien have been formed during the small gap of sedimentation indicated by the Fiskeler in Denmark. So, the only real conclusion can be, that the Maestrichtian Chalk Tuff and the Tuffeau de Saint Symphorien were sedimented during the same geologic period in which at least the lower part of the Danian (Danskekalk) was formed. The foraminiferal faunae agree in many points with this conclusion.

LIST OF FAUNAE

(I—VI see formations above mentioned)

	I	II	III	IV	V	VI
Atamophragxium globosum (Marie)	×	×	×	×	×	×
Orbignyna rimosa (Marsson)	×	×	×	×	×	×
Orbignyna ovata Hagenow	×					
Gaudryina supracretacea Hofker...	×	×	×	×	×	×
Heterostomella gracilis Hofker ...	×		×	×	×	×
Marssonella oxycona (Reuss)	×	×	×		×	×
Spiroplectammina laevis (Roemer)	×	×	×		×	×
Robulus pseudovortex (Marie) ...	×		×		×	
Lenticulina harpa (Reuss)	×					
Robulus rotulatus (Lamarck)	×	×	×		×	×
Palmula robusta Brotzen	×					
Neoflabellina postreculata Hofker	×			×	×	×
Neoflabellina numismalis-efferata H. et K.	×					
Lagena spp.	×	×	×		×	
Frondicularia biformis Marsson ...	×	×	×	×	×	×
Frondicularia incrassata Marie ...	×		×	×		
Frondicularia sepiolaris Marie	×				×	
Enantiovaginulina recta (d'Orbigny)	×					
Marginulina bullata Reuss	×					
Dentalina monile Hagenow	×	×	×		×	×
Marginulina trilobata d'Orbigny ...	×	×	×		×	×
Dentalina basiplanata Cushman ...	×		×	×	×	×
Chrysalogonium consobrinum (d'Orbigny)	×	×	×	×	×	×
Dentalina angusticostata Cushman	×	×	×		×	
Dentalina marcki Reuss	×	×	×	×	×	
Globulina gibba d'Orbigny	×	×	×		×	
Pyrulinoides accuminata d'Orbigny	×	×	×		×	×
Guttulina hantkeni Cushman et Ozawa	×	×	×	×	×	×
Guttulina problema d'Orbigny ...	×	×	×	×	×	×
Bolivina selmensis Cushman	×	×				
Bolivina basbeckensis Hofker ...	×	×		×	×	×
Bolivina hiltermanni Hofker	×	×	×	×	×	×
Bolivina tenuis Marsson	×					
Bolivina decurrens (Ehrenberg)...	×					
Loxostoma selmaensis Cushman ...	×	×				
Stilostomella spinosa (Hofker) ...	×		×		×	×
Bolivinoides peterssoni Brotzen ...	×	×		×		
Bolivinoides gigantea Hilt. et Koch	×	×	×	×	×	×
Bolivinoides dorreeni Finlay	×					
Bolivinoides paleocenica (Brotzen)	×			×		
Bolivinoides compressa Reiss	×					
Bolivinoides ödumi (Brotzen)	×					
Reussella cimbrica (Troelsen)	×	×	×	×	×	×
Praebulimina laevis (Beissel)	×		×	×	×	×
Allomorphina halli Jennings	×	×	×	×	×	×
Praebulimina carseyae (Plummer)..	×	×	×		×	×
Bulimina arkadelphiana Cushman et Parker	×					
Pleurostomella nodosa d'Orbigny...	×					
Eponides toulmini Brotzen	×	×	×	×	×	
Pullenia americana Cushman	×		×		×	×
Osangularia lens Brotzen	×		×		×	×
Gavelinella danica (Brotzen)	×	×	×		×	×
Gavelinella pertusa maestr. Hofker	×		×	×	×	×
Gavelinonion nobilis (Brotzen) ...	×					
Gavelinella umbilicatiformis Hofker	×	×	×		×	×
Gavelinella lorneiana (d'Orbigny)	×		×	×	×	×
Gavelinopsis bartensteini Hofker...	×		×		×	×
Gavelinopsis bembix (Marsson) ...	×	×	×	×	×	×
Gavelinopsis pseudacuta (Nakady)	×		×		×	
Gavelinopsis involutiformis Hofker	×		×	×		
Stensiöina esnehensis Nakady	×		×		×	
Cibicides bosqueti (Reuss)	×	×	×		×	×
Marginotruncana intermedia (Bolli)	×				×	
Marginotruncana arca esnehensis Nakady	×	×			×	
Marginotruncana citae Bolli	×					
Marginotruncana contusa (Cushman)	×				×	×
Globigerina esnehensis Nakady ...	×	×		×	×	
Globigerina compressa Plummer...	×					
Globigerina biforaminata Hofker..	×	×	×		×	×
Gümbelina ultimatumida White ...	×	×	×	×	×	×
Gümbelina decurrens Chapman ...	×					
Gümbelina pulchra Brotzen	×					
Pseudotextularia elegans Rzehak...	×					
Verneuilina limbata Cushman	×	×		×		
Dorothia bulletta (Carsey)	×	×	×		×	×
Dentalina obliqua (Toulmin)		×			×	×
Pseudopolymorphina rudis (Reuss)		×			×	
Bolivina firma Hofker		×	×		×	×
Gyroidinoides octocamerata Cushm. et Hanna	×	×	×	×	×	×
Neoconorbina sp.	×	×	×		×	×
Globigerina supracretacea Hofker		×			×	
Gavelinopsis involuta (Reuss)	×	×	×		×	×
Globigerina cf. *triloculinoides* Plummer		×			×	×
Cibicides burlingtonensis Jennings		×			×	
Sigmomorphina soluta Brotzen ...	×	×	×		×	×
Orbignyna frankei (Brotzen)			×		×	×
Heterostomella foveolata (Marsson)				×		
Eouvigerina cretae (Ehrenberg) ...	×			×		
Eponides frankei Brotzen			×	×	×	×
Pseudoparrella alata (Marsson) ...	×			×	×	×
Cibicides beaumontianus (d'Orbigny)				×		
Globigerina rugosa Plummer	×			×	×	×
Nonionella troostae (Visser)			×	×	×	×