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THE OLIGOCENE "SEPTARIENTON" OF LOWER SAXONY. BIOSTRATIGRAPHY OF AN EQUIVALENT OF THE BOOM FORMATION OF BELGIUM, WITH SPECIAL CONSIDERATIONS TO ITS UPPER AND LOWER BOUNDARIES

by

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ABSTRACT

Since the last century, the "Septarienton" (= Septaria clay Formation without its sandy base) of Northern Germany has been regarded to be an equivalent of the Boom Formation of the Rupelmonde Area of Belgium. Early comparisons were made through the molluscan fauna. The equivalence has been confirmed in the meantime by various groups of microfossils.

Spandel (1909) was the first to notice fluctuations within foraminiferal assemblage compositions of the Mainz basin Septaria clay Formation (here called "Rupelton"). He suggested a subdivision of the Septaria clay Formation of the Frankfurt area into "Unterer, Mittlerer and Oberer Rupelton".

This subdivision has been found to be useful for the "Septarienton" of Northern Germany as well and is retained with minor modifications as the R 1, R 2, R 3 and R 4 Assemblage Zones of Spiegler (1966). The R 1 unit is only gradually different from the R 2 by the predominance of agglutinating species. In Belgium, the Belsele-Waas, Terhagen and part of the Putte Members of the Boom Formation contain the R 2 assemblage. The remaining part of the Putte Member is probably equivalent to R 3, up to the septaria layer S 80, where the R 4 assemblage has been observed (Ritzkowski, 1980). The NSB 7a Zone of King (1981) with *Cassidulina carapitana* can be recognized within the R 1 and R 2 of Lower Saxony as well as in the Belsele-Waas and Terhagen Members of Belgium. In the Wursterheide and Gartow well sections, the basal member of the Septaria clay Formation contains *Bolivina microlancetiformis*, which is also present in the lowermost part of the Belsele-Waas Member of the St. Niklaas clay pit.

The equivalence of the lower part of the Boom Formation of Belgium with the lower part of the Septaria clay Formation has further been shown by the presence of the nannoplankton Zone NP 23 in both units. The only exception is the lowermost clay bed of the "Septarienton" with NP 22 in the Gartow borehole section.

Dinoflagellate zonation may serve as a further tool for correlations. Subzone D 14 na is present in the "Septarienton" of Lower Saxony, generally close to its base, together with R 2 assemblages. It has been found also in the Belsele-Waas Member of the Boom Formation in the St. Niklaas clay pit. The D 13 Zone is as yet known to be present in lowermost subunits of the Septaria clay Formation, in the Neuengammer Gassand Member of the Gartow well and the basal member with *Bolivina microlancetiformis* in the Wursterheide well.

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The Silberberg Formation of the Gartow well and at Lehrte are within the D 12 nc Subzone. This unit of the dinoflagellate biostratigraphy seems to be more or less congruent with the NP 21 nannoplankton Zone, at least at these localities.

KEY WORDS

Oligocene, Lower Saxony (Germany), stratigraphy, foraminifera.

1. INTRODUCTION

Since the last century, the "Septarienton" (= Septaria clay Formation sensu VINKEN, 1988, without its sandy base) of Northern Germany has been regarded to be an equivalent of the Boom Formation in the Rupelmonde area of Belgium and along the cuesta of the Rupel River. Due to a proposal by v. Koenen 1867, the name "Septarienton" was commonly replaced by the name Rupelton. The footnote of v. Koenen (1867) reads in the original orthography as follows: "Den Namen Septarien--Thon für Thone dieses Alters gebrauche ich nicht, um Irrthümer zu vermeiden, welche leicht entstehen können, da Septarien sich fast in allen Tertiär- und sonstigen Thonen finden. Bezeichnender ist jedenfalls der Ausdruck Rupel-Thon, die einfache Uebersetzung des alten belgischen Namens "Argiles Rupéliennes". Confusion ensued, as in Belgium, the Rupelian Stage was regarded to consist of two subunits, of which the Boom Formation should only be the equivalent of the upper one, whereas the "Septarienton" was commonly supposed to be the type formation of the German "Mittel-Oligozän", in the sense of Beyrich, who named it "Septarienthon der Mark" which refers to the Berlin area in 1854. The map on fig. 1 indicates only outcrops and wells within Lower Saxony and close to the River Elbe. The Lemke clay pit is to the west, outside the frame of the map.

Early correlations depended on the molluscan fauna (v. Koenen 1867: 131). As larger fossils are rather scarce within the "Septarienton", the microfauna was already used in the last century for identifications in borehole sections and isolated clay pits. The equivalence of the Septaria clay Formation, or more precisely, the clay unit thereof without its silty base, with the Boom Formation has been proved in the meantime by various groups of microfossils.

As the Septaria clay Formation as a whole is one of the most remarkable transgressive units in the stratigraphic column of Northwestern Germany, the biostratigraphy of its base must be of special interest.

2. BIOZONATIONS, CORRELATIONS

2.1 Benthic Foraminifera

A first and successful attempt to subdivide the Septaria clay Formation, the "Rupelton" of the Mainz basin, was made by Spandel (1909). He used shifts in foraminiferal assemblage compositions to define three units. This threefold subdivision into "Unterer, Mittlerer and Oberer Rupelton" is more or less identical to the R 1, R 2, R 3 and R 4 zonation of Spiegler (1966).

These zones are assemblage zones, caused by changes of environmental factors, rather than by evolution. The zones R 1 and R 2 are almost inseparable. Zone R 1 stands for the poor assemblages of the silty beds in the lowermost part of the formation which tend to be dominated by agglutinating genera. The R 3 Zone is again impoverished, probably due to basinwide stagnation. The R 4 Zone is characterized by the incoming of *Cibicides ungerianus* and an abundance of species with high numbers of individuals. It can be subdivided into an upper part with *Plectofrondicularia seminuda*, and a lower one without. For details see fig. 2. The range of the B 5 Zone of Gramann & v. Daniels (*in* Vinken, 1988) covers R 1 to R 4 Zones and comprises also the Early Oligocene, as *Cancris subconicus* is included with the later part of its range. The Spiegler zonation has been used in many reports and publications on the Paleogene of Lower Saxony (Niedersachsen). It has been applied only recently for the beds, penetrated by the mine-shaft Lohberg IV in the Lower Rhine-Embayment (Jung & Langer, 1990).

Batjes (1958) was the first to compare assemblages of foraminifera from the Boom Formation of Belgium and the Winterswijk area of The Netherlands with those from the R 4-Zone "Septarienton" of Hermsdorf, a suburb of Berlin and the locality Pietzpuhl near Magdeburg. His distribution chart (Table 3) documents the close resemblance, which would have been even better, if Batjes would have

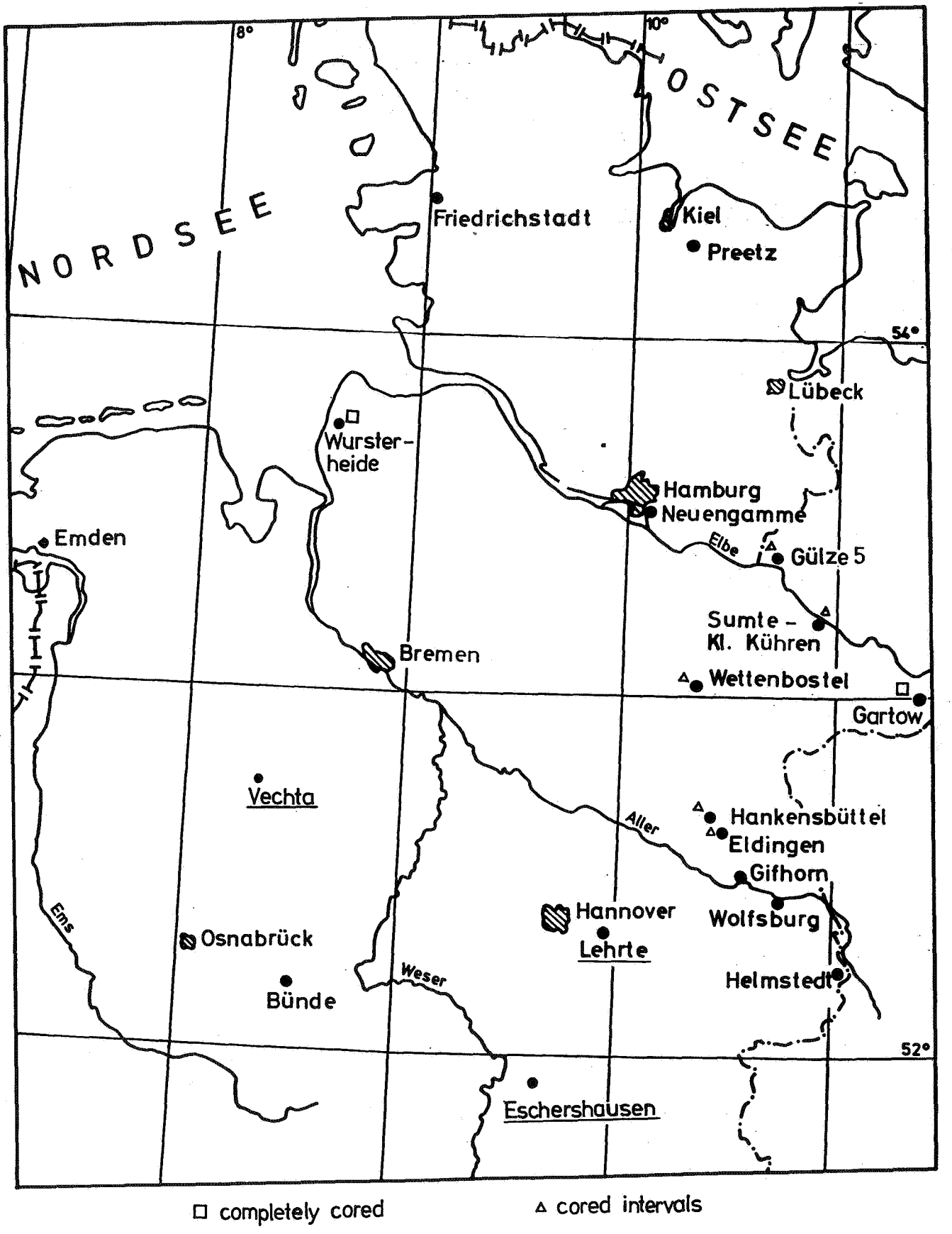

Figure 1. Lower Saxony and adjacent area. Location of outcrops and wells mentioned in text ; fully cored, partly cored. Locality name underlined - clay pit.

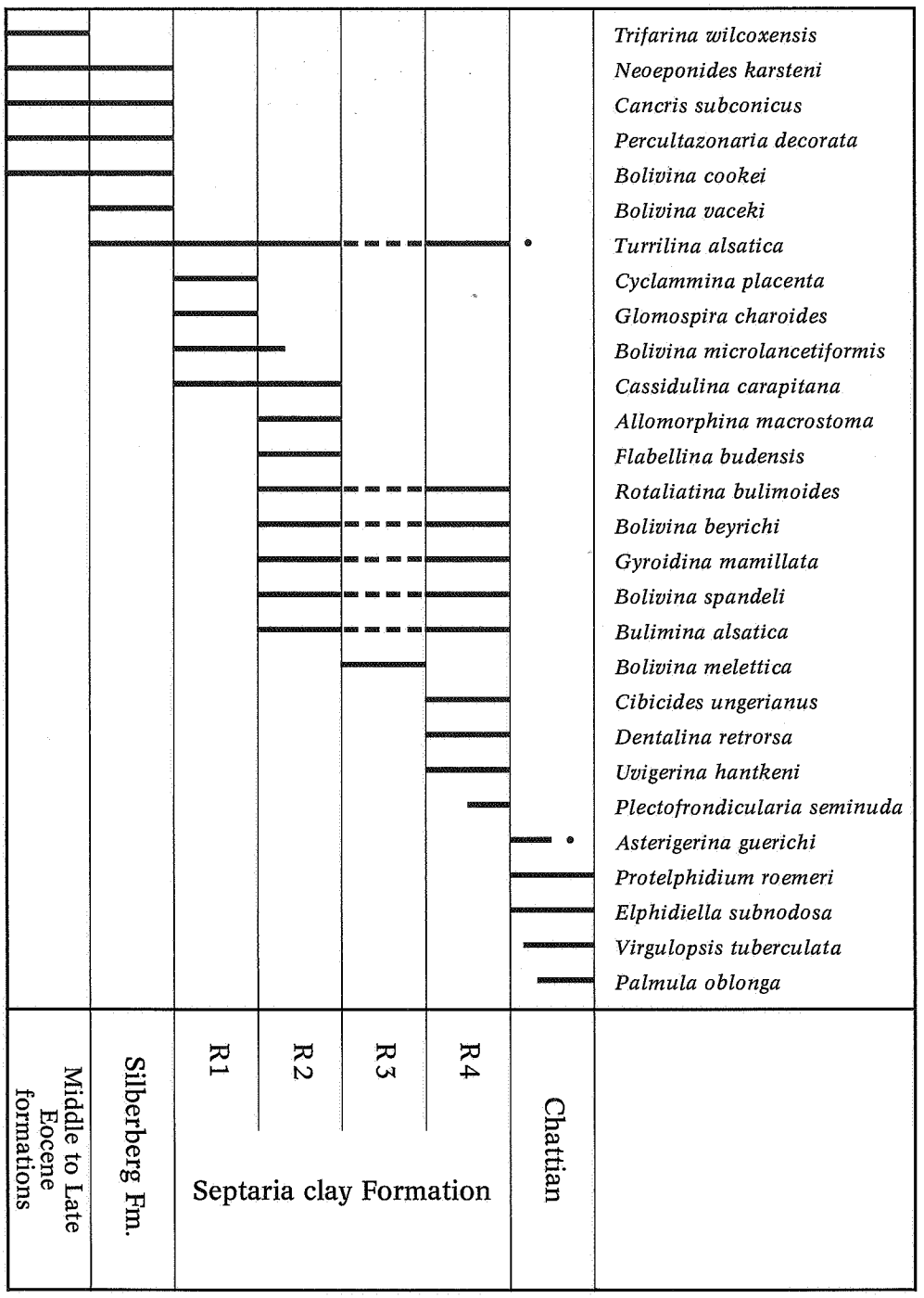

Figure 2. Distribution of selected foraminifers during Middle Eocene to late Oligocene in the northen part of Lower Saxony.

had R 2 assemblages from Germany at his disposal.

First attempts to subdivide the Boom Formation of the Rupelmonde and Waasland areas by their foraminiferal assemblages were made by Gramann (1960) and Ritzkowski (1980), in order to have an additional proof for the equivalence of both, the "Septarienton" and the Boom Formation. According to samples taken in 1990 and others, provided by the RCNPS "Working Group on the Rupelian" in 1991, the R 2 assemblage can be traced from the base of the Boom Formation, the Belsele-Waas Member, up into roughly the middle of the Putte Member, slightly above the septaria layer S 50 of Vandenberghe & van Echelpoel, (1987). The almost barren upper part of the Putte Member, accessible in the Kruibeke section, may represent the R 3 Zone, the "Mittlerer Rupelton" of Spandel (1909). Our set of samples from K 47 to K 73 of the Kruibeke section, provided in May 1991, was

practically barren to the top. The R 4 Zone assemblage with *Cibicides ungerianus* is however present in a sample, taken in the year 1979 by Ritzkowski from the septaria layer S 80.

The NSB 7 Zone of King (1981) for the North Sea Paleogene correlates with R 1 and R 2 Zones of Spiegler (1965). The subzone NSB 7a, marked by the presence of *Cassidulina carapitana*, is largely concordant with the combined R 1 and R 2 Zones as well. The species is present at least in the early part of the R 2 Zone of Lower Saxony and the samples from the Belsele-Waas Member of Belgium. The distribution of *Cassidulina carapitana* in the Piepenhagen Formation of Bünde, has been described by Ritzkowski (1991). Due to these observations, the species is also present in sediments with NP 22 nannoplankton Zone.

The upper part of the formation with the R 4-Zone foraminiferal assemblage may be the only marine unit in marginal areas of the basin. This independent overlap of the "Oberer Rupelton" of Spandel (1909) is seen in the Solling anticline, the Kassel and Leipzig areas and has been described for the Polish Lowlands by OdrzywolskaBienkowa *et al.* (1978).

2.2. Planktonic Foraminifera

Planktonic foraminifera in the Septarienton Formation show similar distribution patterns with fluctuating frequencies, as the benthics within R 1, R 2, R 3 and R 4 Zones. They are present in the R 2 and R 4 Zones and extremely rare in R 1 and R 3 Zones. Mass occurrence is known from R 4 Zone in northern parts of Lower Saxony.

Zonations have been defined by Spiegler (1986) and Spiegler *et al.* (*in* Vinken, 1988). There are two units, NPF 8b subzone for the lower part, and the NPF 9 Zone for the R 4 unit. The situation in Belgium has been described by Hooyberghs & Moorkens (*in* Vinken, 1988). The marker for the subzone NPF 8a, *Truncorotaloides danvillensis*, has not been found in the Septaria clay Formation of Lower Saxony or the Boom Formation of Belgium, but is present in the Latdorf Formation as well as in the Silberberg Formation, its equivalent in deeper parts of the basin. In Belgium, it has been determined in the Mol well by Hooyberghs (1983) in the NP 22 dated sand below the Boom Formation. The positions of the subunits of the Boom Formation relative to the zones of Foraminifera, calcareous nannoplankton and dinoflagellates, known from the Septaria clay Formation, are given in Fig. 2.

2.3. Calcareous Nannoplankton

The Septaria clay Formation usually yields calcareous nannoplankton of the NP 23 Zone in its lower part. An exception is found in the Gartow well, (Köthe, 1986 and Gramann, 1990). In this cored sequence, drilled in the area of Lower Saxony known for most complete and thick Paleogene, Zone NP 22 has been recorded in the lowermost clay layer of the "Septarienton". The NP 23/NP 24 boundary falls within the R 4 unit of the Gartow and Wursterheide cored sequences. In the outcrops of Belgium, the Boom Formation has only yielded NP 23 Zone assemblages or, higher up in the sequence, uninterpretable nannoplankton-associations according to Verbeek (*in* Vinken, 1988, 272). In Poland NP 24 Zone has been documented for the R 4 Zone dated sediment in the Szczecin I G 1 borehole by Martini *in* Odrzywolska *et al.* (1978) : 280-282.

2.4. Dinoflagellates

The dinoflagellate Zones and Subzones of the late Eocene to late Oligocene interval, as defined by Costa & Manum (*in* Vinken, 1988) and modified by Köthe (1990a), are distributed in Lower Saxony as follows : Subzone D 12 nc is determined in latest Eocene (or "Latdorfian" equivalents) as the Quetelet Beds of Lehrte and the Silberberg Formation of the Gartow well. Zone D 13 is present in a silty clay member below the "Septarienton" with R 1 fauna in the Wursterheide and Gartow boreholes. The sand with phosphorites below the base of the Belsele-Waas Member in the St. Niklaas clay pit however yielded D 14 na, the next younger subzone.
The D14 na is the subzone present in the bulk of the "Septarienton" rocks of Lower Saxony and the whole presently exposed Boom Formation in the type region. The upper part of the "Septarienton" with the R 4 Zone assemblage has shown to belong partly to the D 14 na and partly to the D 14 nb subzones. There seems to be no possibility to draw the Rupelian-Chattian boundary with dinoflagellates, as Subzone D 14 nb has also been found in the lower parts of the Chattian Sands Formation.

The remaining part of sediments of the Chattian Stage from the top of the "Asterigerina Horizon" upwards, has been found to belong to Zone D 15.

3. THE OUTCROP SITUATION

In Lower Saxony, outcrops with the Boom Formation equivalent, were formerly widespread, as it was one of the rather workable clays for brickyards. Operations of some stratigraphic importance, which have been closed down during the last decades are the following :

3.1. Eschershausen (Map sheet TK 25 Eschershausen No 4023 of the 1: 25000 scale, also avaible as geologic map)

South of Hannover, in a subroded area, the pit of a former brickyard exposed some 20 meters of Septaria clay Formation with a sandy base. It is overlain by some meters of fossiliferous Chattian Sands Formation. The contact has been observed to be complicated by animal burrows down the former seafloor. During earlier times, also a basal sand unit with *Pycnodonta queteleti* and other "Early Oligocene" molluscs has been sampled there (Grupe, 1901). The "Septarienton" yielded the R 2 Zone assemblage of benthic foraminifera. The Chattian Sands start with the "Asterigerina Horizon" (Gramann *in* Waldeck (1975) : 96-98).

3.2. Lehrte (Map sheet GK 25 Lehrte No. 3625 of the geologic map)

East of Hannover, the Lehrte clay pit was sunk into the topfill on the roof of a subroded salt diapir. Glauconitic sand at its deepest has yielded D 10 and D 11 Zone dinoflagellate assemblages of Middle Eocene time (Köthe, 1990a) and the crab *Coeloma balticum*. The next unit, a micaceous sandy marl, with *Pycnodonta queteleti* displays the Silberberg Formation foraminiferal asssemblage with *Truncorotaloides danvillensis*, nannoplankton of NP 21 Zone and dinoflagellates of Subzone D 12 nc. The Septaria clay Formation was introduced by a bioturbated sand unit, the "Sandflaserschichten", barren of nannofossils and microfauna, but yielding concretions with *Coeloma rupeliense* and the D 14 na Subzone dinocyst assemblage. The same D 14 na Subzone was found in the "Septarienton" which has shown to contain the R 2 microfauna and NP 23 nannoflora (Dietz, 1973, Gramann *et al.* 1975, Gramann & Mutterlose 1975, Martini 1971, Köthe 1986, 1990a).

At present, only two brickyards in Lower Saxony use the "Septarienton" clay beds as material :

3.2.1. Olfry-clay pit, south of Vechta (Map sheet TK 25 Vechta No. 3215)

The "Septarienton" clay beds of this outcrop show a characteristic change of lighter and darker layers. Two septaria-horizons are exposed and covered by a dark-green glauconite sand. Burrows filled with the greensand and penetrating to a depth of 80 cm into the clay indicate the former seafloor and a considerable hiatus, accentuated by an angular unconformity, which has been documented by Gripp (1941: 27) with a photograph. A late Chattian age for the greensand unit is probably due to the radiometric age of 23,4 ± 0.3 ma, determined by Kreuzer *et al.* (1980). Phosphatic pebbles with a shiny black surface from the lowermost part of the Greensand unit have yielded dinoflagellates of the D 14 nb Subzone, indicating either a late Rupelian or early Chattian age. The Septaria clay Formation has been drilled down to a sand unit of Ypresian age. Thus, the total thickness of the truncated Septaria clay Formation at this place does not exceed 15 meters. The clay contains the R 2 benthic assemblage, with *Cassidulina carapitana*, indicating the NSB 7a Zone of King in the first two meters above a silty base, which has been drilled and yielded a poor microfauna with *Bolivina* cf. *microlancetiformis*.
This sand unit contains the same D 14 na Subzone, as the subsequent R 2-clay. The next sample below yielded a foraminiferal assemblage of the B3 benthic foraminiferal Zone and planktonic foraminifera of the patagonica-Zone of Spiegler (1986). The same sand unit has been dated as Early Eocene D 7 b to D 8 nb by Köthe (1990b). Therefore, a hiatus of at least 15 ma. (Harland *et al.*, 1990) between the sandy base of the Septaria clay Formation and the Ypresian marine sand is confirmed and an unconformity very probable.

3.2.2. Lemke clay pit (Map sheet TK 25 Neuenhaus No. 3507) (Emsland, outside the western limit of the frame of fig. 1)

The situation of the Lemke clay pit in the Emsland area in the West of Lower Saxony is similar, as only the "Septarienton" with the R 2 assemblage of benthic foraminifera is exposed below a glauconitic sand unit. As this sand may belong to the Hemmoorian local stage of the Early Miocene, the hiatus at its top is even much more important than at Vechta. The base of the Septaria clay Formation is as yet unknown at this locality (Kuster *in* Hinze, 1991).

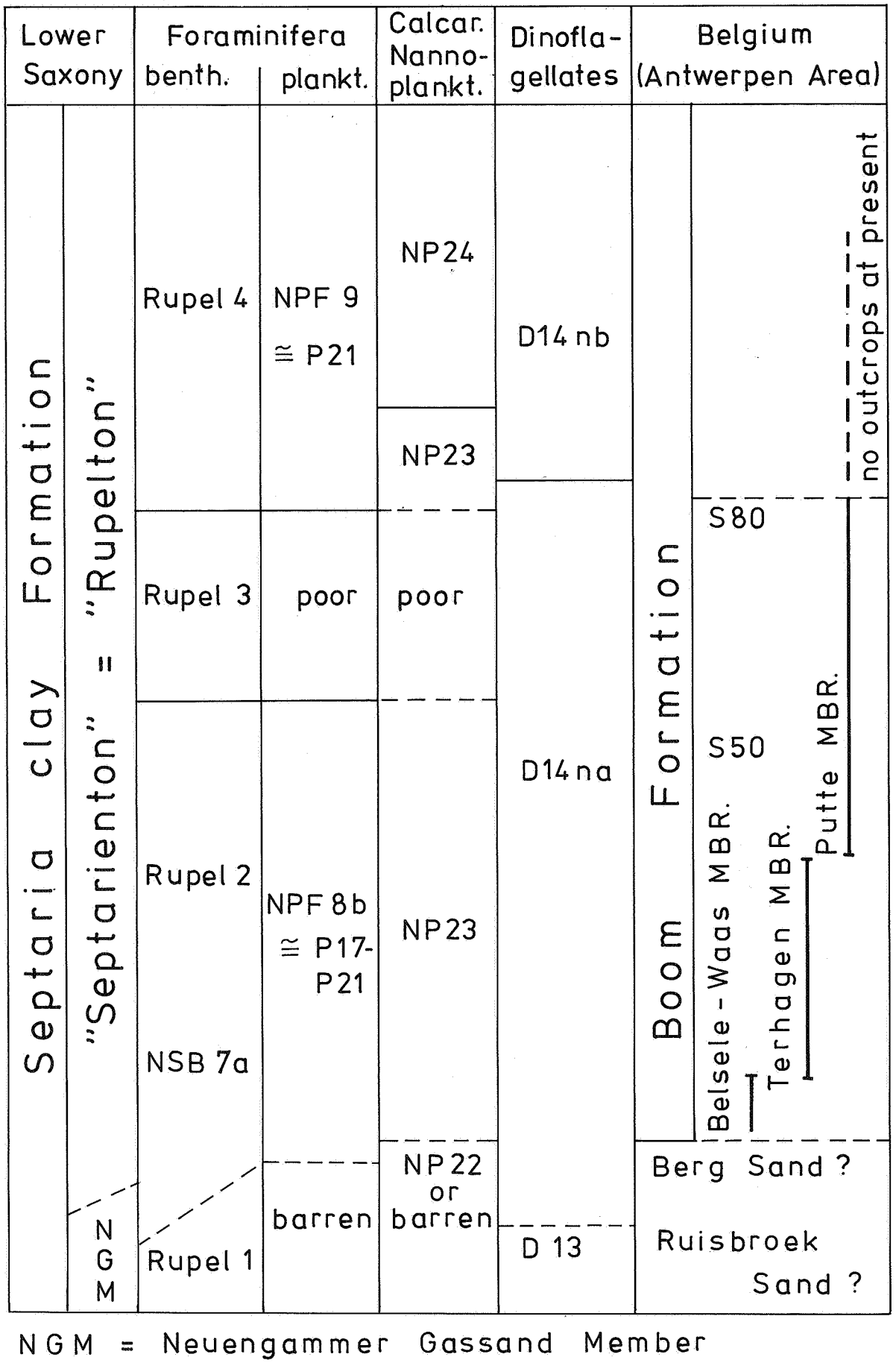

Figure 3. Biostratigraphic subdivisions of the Oligocene "Septarienton" and Boom Formation intervals of Lower Saxony and the Antwerpen area of Belgium.

4. SUBSURFACE DATA

In Lower Saxony, the thickness of the Septaria clay Formation visible in the outcrops is only a part of what has been observed by drilling, e.g. in the Hankensbüttel and Gartow wells with more than 150 m, or in adjacent Western Mecklenburg, where the total thickness of the Septaria clay Formation is in the same order of magnitude (Meinhold, 1953). In this area, thickness of the Paleogene sequence, including the Septaria clay Formation, depends largely on synsedimentary movements during rim sink formation of the then active salt diapirs or on subrosion on top of such structures. But also regional subsidence must be considered (Gramann & Kockel *in* Vinken, 1988 : 437). Wells with a considerable thickness of the Septaria clay Formation usually display the whole span of R 1 to R 4 foraminiferal Zones of Spiegler (1966).

The problems with the base of the "Septarienton" unit have been discussed in previous publications by Gramann (1990) and Köthe (1986, 1990a) in some detail. As the former data on the foraminiferal fauna had been incomplete, due to reduced diversity and low numbers of individuals on one side and widely spaced sample intervals on the other, additional research is presently done to improve the knowledge. The stratigraphic problem caused by poor microfaunas in marine units at the base of the Septaria clay Formation is partly overcome by the study of fossil dinoflagellates. This includes the long discussed problem of the Neuengammer Gassand Member, which was either regarded as the topmost unit of the "Unter-Oligozän (= Latdorfian)" or the basal sand unit of the "Mittel-Oligozän" (= Rupelian). During the last years, the Neuengammer Gassand Member was interpreted as the transgressive base of the Septaria clay Formation. In the Wursterheide cored well, the dinoflagellate Zone D 13 has been found in a silty clay unit below the R 2 Zone "Septarienton". The foraminiferal assemblages at the same depth are very poor, but can be regarded as R 1 Zone with *Bolivina microlancetiformis* and *Glomospira charoides*.

5. CONCLUSIONS

Accessible and former outcrops in Lower Saxony display truncated Septaria clay Formation sections. They are not qualified for the definition of boundary stratotypes. The situation in the subsurface of the north-eastern part of Lower Saxony, the Wendland area, and across the river Elbe, in the adjoining western Mecklenburg is better, as shown by the Gartow, Sumte-Klein Kühren, and possibly also the Gülze wells.

The equivalence of zones R 1 to R 3 of the Septaria clay Formation with the exposed part of the Boom Formation in the Rupelmonde and Waasland areas in Belgium can be confirmed.

The R 4 Zone, uppermost part of the "Septarienton" in Germany, also present in the Polish Lowlands and in the Peel-Horst of the Netherlands, seems to be confined to the S 80 septaria layer, which forms the top of the Boom Formation in the present outcrop sections of the type area in Belgium but it is probably represented in some well sections of northern Belgium.

The samples from Loksbergen, Kemzeke-Hol and Kontich in Batjes (1958) must belong to the same zone as *Cibicides ungerianus* is indicated as frequent.

The lower boundaries of the clay facies units "Septarienton" and Boom Formation are diachronous, when traced to more marginal or more distal parts of the North Sea Basin.

Our sample, taken in 1990 from the Ruisbroek Sand unit, at the base of the St. Niklaas claypit, was barren, regarding foraminifera and calcareous nannoplankton. Fossils from probably the same level, including foraminifera, have been recorded by Boekschoten (1967). They indicate an Oligocene age of Rupelian affinities.

To define a Rupelian/Chattian boundary by ranges of dinoflagellates or calcareous nannoplankton seems to be difficult. The hitherto available zonations straddle the boundary between the R 4 Zone of the Septaria clay Formation and the Asterigerina Horizon, the lowermost unit of the Chattian in its present definition.

Nevertheless in sections with the R 4 Zone present, there seems to occur a stratigraphic gap between the top of the Septaria clay Formation and the Asterigerina Horizon of Chattian age. Sections, which might be more complete, have been studied from Western Mecklenburg, where a shallow marine or even brackish unit, called the "Plate Member" (see fig. 27 *in* Vinken, 1988) is intervening.

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