

**LATE OLIGOCENE FOSSILIFEROUS CONCRETIONS OF LOCAL ORIGIN FROM
QUATERNARY RHINE-DEPOSITS AT KAMP-LINTFORT, LOWER RHINE
DISTRICT, F.R.G.**

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**WITH A DESCRIPTION OF *SCHIZASTER* (*SCHIZASTER*) SP.
(ECHINODERMATA, SPATANGOIDA)**

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Late Oligocene concretions, occurring as reworked components of local origin in Quaternary fluvial (river Rhine) deposits at Kamp-Lintfort, Lower Rhine District, F.R.G., are described and their fossil contents are analyzed. The fauna comprises 46 mollusc species, indicating a Chattian B age for most of the concretions, and several non-Mollusca, among which an internal and external mould of the echinoid *Schizaster* (*Schizaster*) sp., of which a detailed description is given.

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INTRODUCTION (AWJ)

In 1985 Mr J. van der Essen, non-professional palaeontologist at Venlo, The Netherlands, sent a concretion with a fragmentary fish skeleton, collected in the Lower Rhine area, F.R.G., for identification to the educational department of the Rijksmuseum van Geologie en Mineralogie (RGM) in Leiden. As this specimen also contained some molluscan fossils the head of the department, Mrs E. van der Wilk, invited me to give my opinion. The molluscs indicate a Late Oligocene age and I realized that such concretions from Quaternary deposits in that area had never come to my knowledge, although very similar ones from Late Oligocene sediments *in situ* were known to me, both from the literature and *in natura*.

This find therefore seemed to be of some importance and I contacted Mr van der Essen, asking for further details on the occurrence. Subsequently I was informed on all locality data and it appeared that several other, very similar objects from the same locality were present in his collection. This additional material was donated later to the RGM collections. Identical material from the same locality was equally present in the J.W.M. Jagt collection, among which one piece containing a mould of an irregular sea-urchin. This material (except the echinoid) was also donated to the RGM.

In this paper the concretions are described and their fossil content is analyzed. Mr Jagt added a description of the sea-urchin, which will remain in his private collection.

LOCALITY (AWJ) (Fig. 1)

All concretions studied in this paper originate from one and the same locality, viz. the Riedel gravel-pit, situated on the NE side of Kamp-Lintfort (F.R.G., federal state of Nordrhein-Westfalen), in the Lower Rhine district, topographical map 1 : 50.000, sheet L 4504 Moers. The coordinates of this pit are:

R ²⁵39.700 H ⁵⁷07.900 Z = approx. 25 m + NN.

Exploitation of this gravel-pit ceased several years ago and the site is now being used as a swimming-pool.

Other localities mentioned in this paper are indicated in Fig. 2.

STRATIGRAPHICAL ORIGIN OF THE CONCRETIONS (AWJ)

The sediments from which the fossiliferous concretions were collected are of Quaternary age. They belong to the Weichselian so-called 'Rhein-Niederterrasse' (= lower terrace of the river Rhine). The

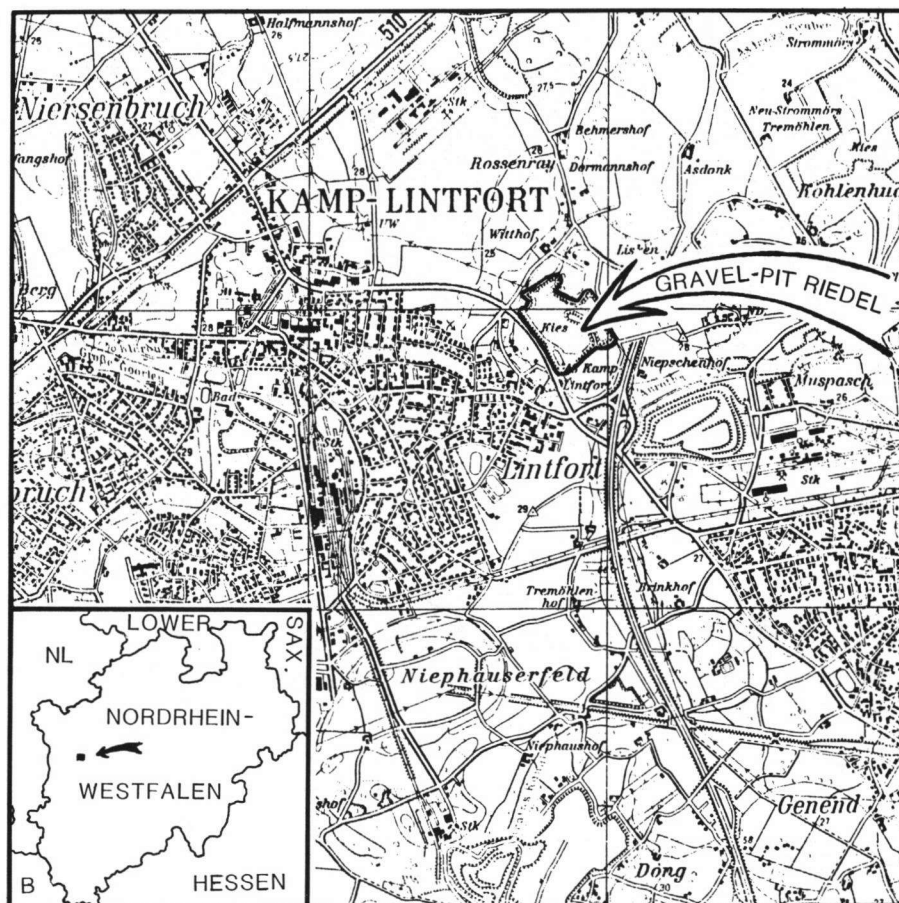


Fig. 1. Location of the Riedel gravel-pit at Kamp-Lintfort, Nordrhein-Westfalen, F.R.G., based on the topographical map 1 : 50,000, sheet L 4504 Moers, 1952.

geographical distribution of this deposit is given in Brunnacker (1978, pl. 1). According to Dr J. Klostermann (Geologisches Landesamt Nordrhein-Westfalen, Krefeld; pers. comm. 1987) it is possible that in the basal parts of the Riedel gravel-pit also Elsterian deposits of the 'Mittlere Mittelerrasse', so-called 'Rinnenschotter' were excavated as well. It is not known, however, from which part of the section exactly the concretions originate, as the specimens were exclusively collected from already excavated material. Supply by the river Rhine is also evident, for instance, by the presence of *Hydrobia*-limestones (Jagt collection), the source area of which is found far to the South, in the Mayence Basin (Koenderink, 1959, 1960; Sinnema-Bloemen, 1977).

Teichmüller (1958, pl. 1) published a map with the distribution of the Tertiary deposits outcropping below the Quaternary cover, from which it is obvious that Late Oligocene (Chattian) sediments are widely distributed SE of Kamp-Lintfort (compare Fig. 2). It may safely be presumed that the origin of the concretions lies somewhere in this area. Thus, the distance over which they were transported seems to be quite short and we may consider these rocks as local boulders. This agrees also with the only slightly rounded appearance of the stones (Plate 1).

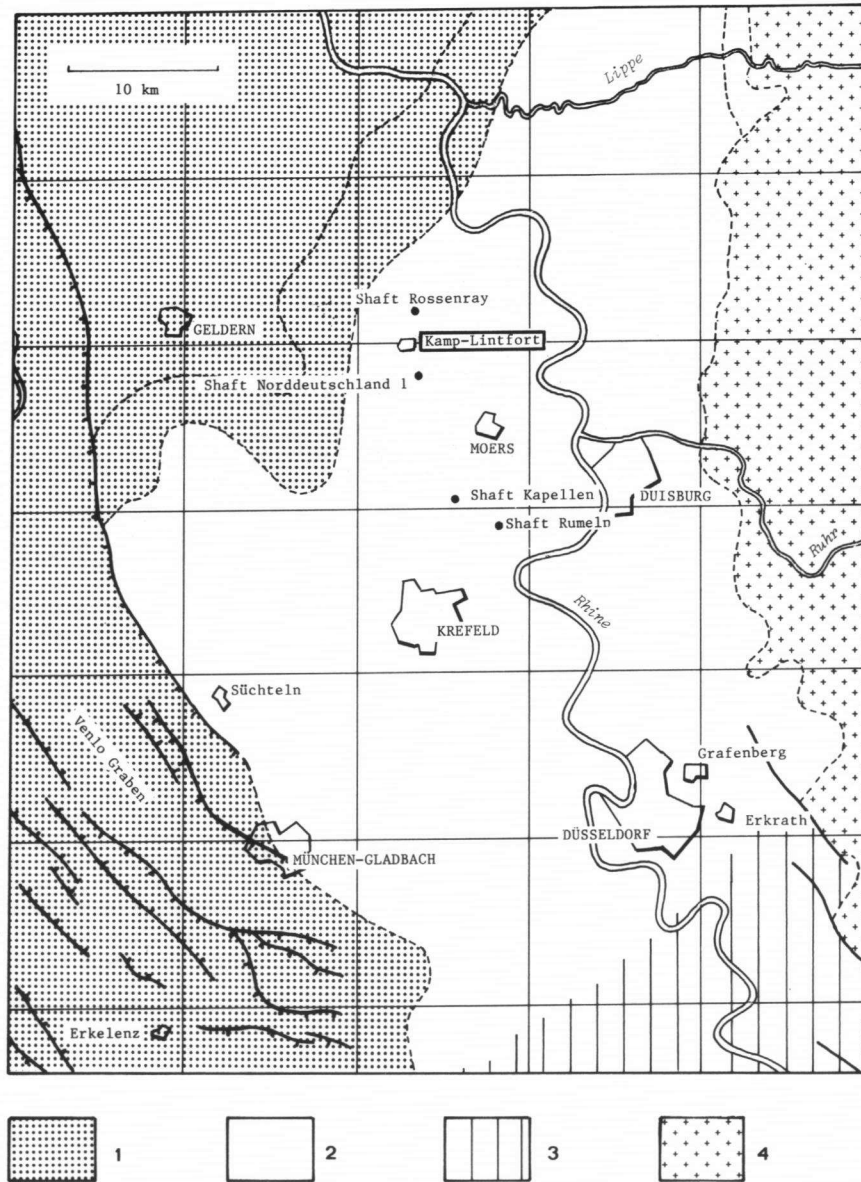


Fig. 2. Situation of localities mentioned in this paper and distribution of (1) Miocene, (2) marine, (mainly Late) Oligocene, (3) transition to terrestrial Oligocene, and (4) pre-Tertiary rocks, outcropping below the Quaternary cover in the Lower Rhine area. Based on Teichmüller (1958, pl. 1).

Similar concretionary sediments of Chattian age are well-known from autochthonous deposits in the Lower Rhine area (e.g. at Süchteln, see Rothausen, 1958; Schürmann, 1958). Quite recently abundant Chattian concretions, with similar appearance as the Kamp-Lintfort specimens, were observed and collected during the construction of the new shaft nr. 8 of the Steinkohlenbergwerk Sophia-Jacoba at Erkelenz, Lower Rhine area (van den Bosch & Janssen, 1986) (RGM collections). Near Düsseldorf (Grafenberg, Erkrath) autochthonous Chattian sediments crop out at the surface,

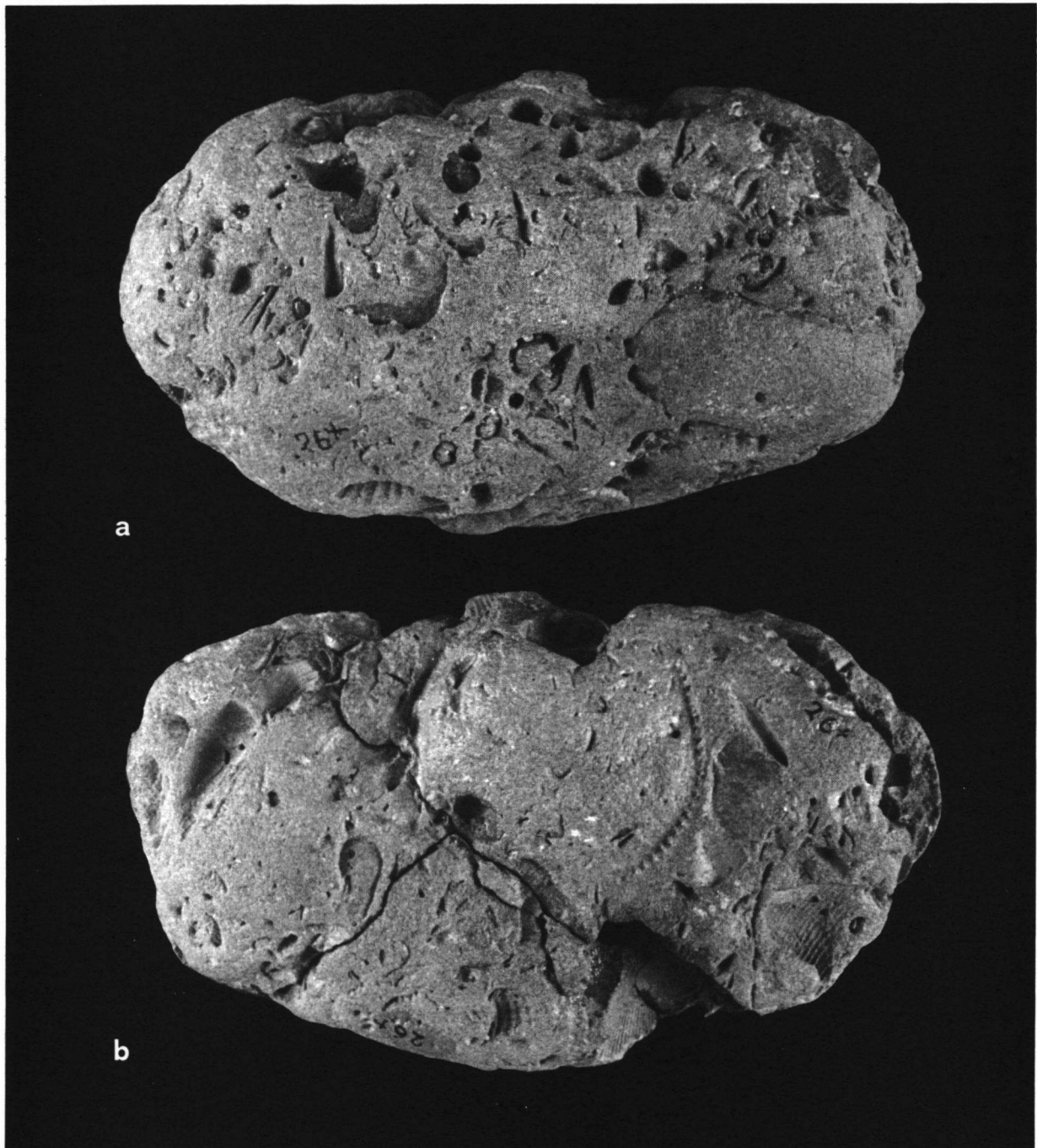


Plate 1. External views of concretion nr 1, collected in the Riedel gravel-pit at Kamp-Lintfort, F.R.G. Note that the specimen is only slightly rounded and that all visible fossils are completely decalcified. Natural size. Coll. J. van der Essen, Venlo.

commonly with levels of concretionary consolidated sediments, usually decalcified and rusty brown in colour by oxidation above the groundwater level.

Isolated molluscan fossils of Chattian age, reworked in Quaternary deposits, were mentioned in literature from this area by Steeger (1913), but concretions as described here seem to have never been mentioned, although their presence is by no means astonishing, considering the distribution of Chattian *in situ* sediments.

All marine Late Oligocene deposits of the Lower Rhine District are indicated with the lithostratigraphical name Grafenberg Sands, which therefore also must be the source rock of the concretions described here. The type locality of the Grafenberg Sands lies very close to the Riedel gravel-pit, within the municipality of Kamp-Lintfort, viz. the level from 24.5 to 147 m below surface in the mine-shaft Norddeutschland 1 (Hinsch, 1958, p. 16). The Grafenberg Sands consist mainly of fine-grained sands with a varying clay content, and concretionary consolidated parts at irregular intervals.

DESCRIPTION OF THE MATERIAL (AWJ)

For this paper ten concretions could be studied, together with some fragments. This material is specified here. The numbers refer to the column numbers in table 1.

1. Complete concretion, split into four pieces, of which two more or less according to the stratification of the sediment. The intact specimen had the following measurements (compare Plate 1): length 129 mm, width 76 mm, thickness 55 mm. Externally the stone is yellowish-grey and demonstrates slight signs of transport. All fossils visible on the outside are completely decalcified. Internally (Plate 2) the stone contains a large fragmentary bony fish skull skeleton and an isolated tooth of a bony fish. Furthermore a large number of molluscs, some of them with remnants of aragonitic shell-material, are present, some 40 of which could be identified. Dr P.A.M. Gaemers (Leiden) had a look at the fish remains. He recognized the large bone as part of an elongate teleostiid skull, which could not be identified. The tooth does not belong to this skull and may be indicated as 'Sparidae gen. et spec. indet.'. This specimen, collected by Mr J. van der Essen, is housed in the van der Essen collection, Venlo.

2-7. Six smaller concretions or fragments of concretions, some of which may originally have belonged to one and the same specimen. All material was collected by Mr. J. van der Essen (Venlo) and subsequently donated to the RGM collection (registration nrs RGM 229 316-321). The specimens have identical external appearances as concretion nr 1, but two of them (nrs 5 and 6) have a more reddish-brown colour, apparently as a result of oxidation.

8. Small concretion, not rounded. The calcitic shell-material of some pectinids is preserved, but aragonitic shells are preserved as casts. Collected by J.W.M. Jagt (Venlo), housed in the RGM collection (registration nr RGM 229 322).

9. Large concretion (maximum dimension some 20 cm) in ten fragments, with similar appearance as concretion nr 1. In this specimen many molluscan fossils are present, 125 of which could be identified. Furthermore this specimen contains a cast of *Schizaster* (*Schizaster*) sp., with parts of both the internal and external moulds preserved (see Plate 3). A detailed description of this echinoid is given below. The concretion was collected by J.W.M. Jagt and donated to the RGM (registration nrs RGM 229 323-332). The *Schizaster* specimen is housed in the Jagt collection (registration nr 3587).

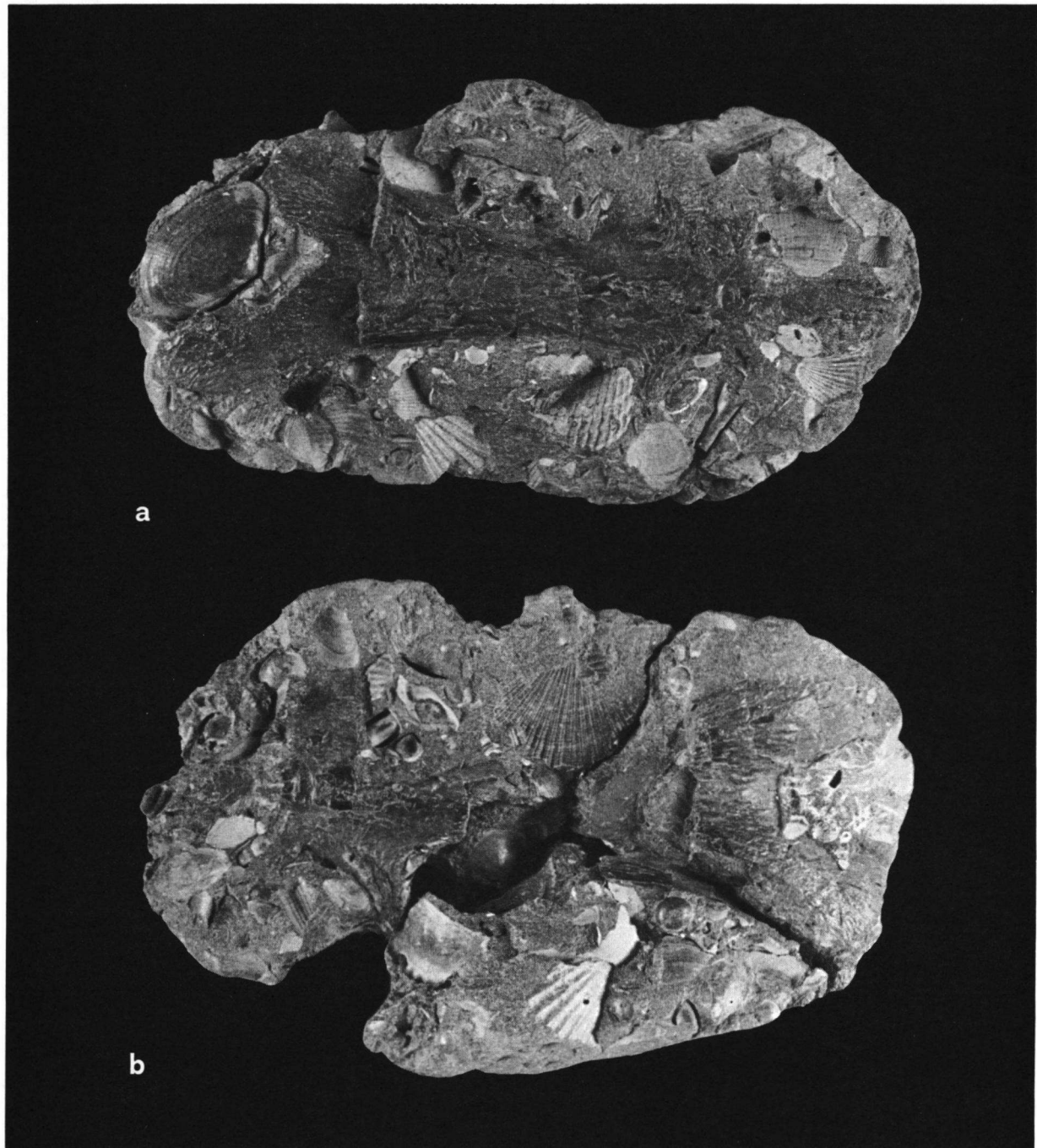


Plate 2. Internal views of concretion nr 1, containing a fragmentary fish skull and several molluscan specimens. On the left side of Pl. 2a an internal mould of *Angulus (Peronidia) posterus* (Beyrich, 1868) is visible. In the upper middle part of Pl. 2b an external mould of *Hilberia bifida ? bifida* von Münster, 1835 is present. In both figures fragmentary specimens of *Laevicardium (Habecardium) tenuisulcatum* (Nyst, 1836) can be recognized.

10. Concretion fragment in three pieces, external appearance similar as nr 1. Collected by J.W.M. Jagt, housed in the RGM collection (registration nr RGM 229 333).

11. Eight fragments of concretions, probably belonging to nrs 9 and/or 10. Collected by J.W.M. Jagt, RGM collection nrs 229 334-341. Some further material belonging to this lot was used for the preparation of a thin-section (Fig. 3, RGM 229 366) and for the petrological study, details of which are given below.

PETROLOGICAL CHARACTERISTICS (AWJ)

Some fragments, presumably originating from concretions nrs 9 and/or 10, were investigated by Mr A.W. Burger (Rijks Geologische Dienst, Haarlem). According to him the sediment can be described petrologically as "authigenic, concretionary, calcareous sandstone". The concretions disintegrate slowly in cold hydrochloric acid. In a thin-section (Fig. 3) it is clear, that the sediment consists of well-sorted, but poorly rounded quartz grains in a dense matrix, and some fossils.

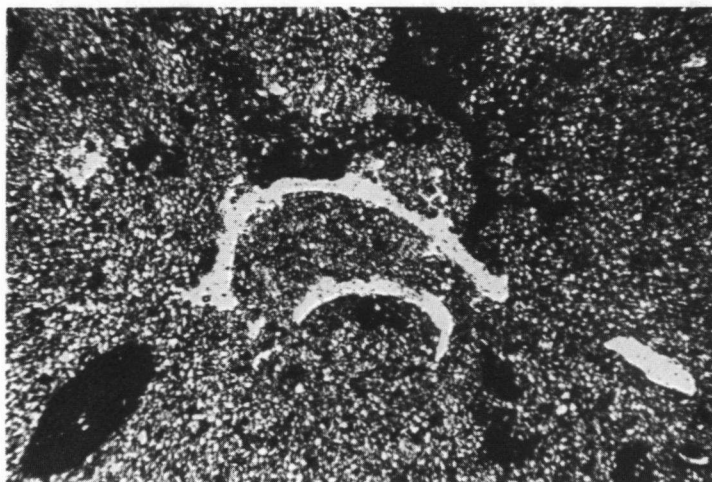


Fig. 3. Thin-section of a fragmentary concretion from sample nr. 11, showing well-sorted but poorly rounded quartz grains in a dense matrix, and some fossils. Magnification x 10. Coll. RGM 229 366.

The transparent heavy-mineral content (s.g. over 2.87) is dominated by the so-called fine-stable group (zircon, rutile, anatase) which makes up for 52% of the heavy fraction. Of importance are the unstable minerals garnet (15%), epidote (11%) and hornblende (14%) which presumably cannot be derived from a river system flowing at that time into the Lower Rhine Embayment. For instance the outcropping Grafenberger Sands in pit Lieth at Ratingen-Hornberg, situated in a near-coastal position, yielded no unstable minerals at all.

In sediments that are found more basin-inwards, however, the same type of rather hornblende-rich assemblages are encountered in part of the Late Oligocene succession. Examples that can be mentioned are ROvD well nr 21 at Swalmen (The Netherlands, province of Limburg), published by Muller in 1943, and the Geldern T1 borehole (F.R.G., Nordrhein-Westfalen), published recently

by van Rooyen et al. (1984). Quite possibly this association represents the influence of material originating from the Scandinavian Shield.

A similar fragment was studied by Dr P.S. Balson (British Geological Survey, Keyworth, U.K.), using XRD-analysis, microprobe and visual inspection. The X-Röntgen Diffraction analysis on a whole rock sample shows a mixture of quartz and carbonate apatite and very little else. Minerals with abundances less than a few percent will not be detected using XRD. A microprobe analysis of the cement matrix shows a P₂O₅ content of approximately 27% consistent with a carbonate apatite composition. No siderite was detected, either by XRD, microprobe or visual inspection.

Summarizing Dr Balson concluded that the sample is a carbonate apatite cemented, well sorted, very fine sand in which the matrix forms roughly 25% of the sediment. If the matrix was originally mud before anthigenic concretion growth then the sediment was a muddy sand. The sediment is slightly micaceous (c. 1% micas) and sparsely glauconitic (c. 0.5% of sediment). Feldspars are abundant (10%), with numerous K feldspar grains, including microcline, and some albite.

THE MOLLUSC FAUNA AND THE AGE OF THE SEDIMENT (AWJ)

The mollusc fauna was analyzed, as far as the state of preservation of most specimens as internal and external casts allowed this. The results are given in table 1, where the fossil contents of samples 1 to 11 are specified, together with some non-molluscs. The larger stones were, during the collectors' search, strongly fragmented. Therefore quite a number of molluscs could be identified, but it cannot be excluded that some specimens were counted twice.

Generally speaking the mollusc association found in the present collection is undoubtedly of Late Oligocene (Chattian) age and agrees largely with the fauna known from the Grafenberg Sands in the Lower Rhine area (R. Janssen, 1978; 1979a-b), although the number of species is rather restricted. Altogether 46 mollusc species could be identified, whereas some 200 species at least are known from the Grafenberg Sands.

Among the molluscs some species give more detailed information on the stratigraphical origin of the fauna. The bivalve *Palliolium hausmanni hausmanni* is restricted to the Chattian B interval. This species is present in concretions nrs 3, 7, 8, 9 and 10. A Chattian B age is supported by the bivalve species *Astarte (Astarte) gracilis praecursor*, which was found in concretions nrs 10 and 11, and by the gastropod *Hinia (Tritonella) schlotheimi*, present in nrs 9, 10 and 11. The nominal subspecies of *Hilberia bifida*, on the other hand, seems to be restricted to Chattian A associations (R. Janssen, 1979b, p. 162, fig. 1), which might indicate that concretions 1 and 4 are slightly older. The identification of the subspecies, however, is not certain, and there are no other indications for a Chattian A age. The concretions nrs 2, 5 and 6 yielded only a restricted mollusc fauna without useful index species.

DESCRIPTION OF *SCHIZASTER (SCHIZASTER) SP.* (JWMJ)

Ordo	Spatangoida Claus, 1876
Subordo	Hemiasterina Fischer in Moore, 1966
Familia	Schizasteridae Lambert in Doncieux, 1905
Genus	<i>Schizaster</i> Agassiz, 1836
Subgenus	<i>Schizaster</i> s.s.
Type species	<i>Schizaster studeri</i> Agassiz, 1836 (subsequent designation, ICZN opinion 209, 1948)

Table 1. Distribution of fossils in the various concretions. See the text for explanation of columns nrs 1-11.
For the Bivalvia the number of valves is mentioned. Because of the strongly fragmented condition of the concretions it cannot be excluded that some individuals were counted twice.

number of concretion	*1	2	3	4	5	6	7	8	9	10	11
<i>Nucula (Lamellinucula) comta</i> Goldfuss, 1837			1								1
<i>Nuculana (Saccella) westendorpi</i> (Nyst, 1839)	1										
<i>Yoldia (Yoldia) glaberrima</i> von Münster, 1837										2	
<i>Scapharoa (Scapharoa) speyeri</i> (Semper, 1861)									1		
<i>Limopsis (Pectunculina) retifera</i> Semper, 1861									2		
<i>Modiolula pygmaea</i> (Philippi, 1843)				1							
<i>Palliolula (s. lat.) hausmanni hausmanni</i> (Goldfuss, 1835)			3				2	4	23	6	
<i>Hilberia bifida ? bifida</i> von Münster, 1835	1			1							
<i>Gonimyrtea droueti schloenbachi</i> (von Koenen, 1868)	4								1		
<i>Lucinoma borealis</i> (Linné, 1767)									3		1
<i>Thyasira (Thyasira) flexuosa</i> (Montagu, 1803)										1	
<i>Cyclocardia (Cyclocardia) tuberculata</i> (von Münster, 1837) (non Sowerby, 1816)	6										
<i>Astarte (Astarte) gracilis praecursor</i> Glibert, 1957										1	1
<i>Astarte (Astarte) pygmaea</i> von Münster, 1837								1			
<i>Parvicardium kochi</i> (Semper, 1861)				3				1	3		2
<i>Laevicardium (Habecardium) tenuisulcatum</i> (Nyst, 1836)	7			2					1	1	3
<i>Laevicardium (Habecardium) subturgidum</i> (d'Orbigny, 1852)		1					3		4		
<i>Ensis hausmanni</i> (Goldfuss, 1841)		2	2				1		7		2
<i>Angulus (Peronidia) posterus</i> (Beyrich, 1868)	2										
<i>Abra (Abra) bosqueti</i> (Semper, 1861)	2						1		2	2	2
<i>Arctica islandica rotundata</i> (Agassiz, 1845)									2		
<i>Glossus (Glossus) subtransversus</i> (d'Orbigny, 1852)					1	1	2				
<i>Pelecypora (Cordiopsis) polytropoa suborbicularis</i> (Goldfuss, 1841)									1		
<i>Corbula (Varicorbula) gibba</i> (Olivieri, 1842)						2	2		4	1	
<i>Panopea (Panopea) angusta</i> (Nyst, 1836)	2								4		
<i>Thracia (Thracia) cf. speyeri</i> von Koenen, 1884	2	1					1				
<i>Dentalium (Dentalium) sp.</i>	4		4				3	2	39	3	10
<i>Calliostoma (Ampullotrochus) serratocostatum</i> (Speyer, 1869)									1		
<i>Haustator (Haustator) goettentrupensis</i> (Cossmann, 1899)									7	1	
<i>Calyptrea (Calyptrea) chinensis</i> (Linné, 1758)									2		1
<i>Drepanocheilus (Arrhoges) speciosus</i> (von Schlottheim, 1820)	5	1							3		
Naticidae sp.	1								2	1	
<i>Phalium (Echinophoria) rondeleti</i> (de Basterot, 1825)	1										
<i>Charonia (Sassia) flandrica</i> (de Koninck, 1837)									2		
<i>Boreotrophon (s. lat.) capito</i> (Philippi, 1843)	1										
<i>Lyrotypis (Eotyphis) sp.</i>											1
<i>Scalaspira elegantula elegantula</i> (Philippi, 1843)	1										
<i>Scalaspira kochi</i> Tembrock, 1968							1				1
<i>Keepingia bolli</i> (Beyrich, 1854)									1		
<i>Hinia (Tritonella) schlotheimi</i> (Beyrich, 1854)									4	1	5
<i>Streptochetus (Streptodictyon) cheruscus</i> (Philippi, 1843)		1					1		1		
<i>Babylonella pusilla</i> (Philippi, 1843)									1		
<i>Fusiturris duchastelii</i> (Nyst, 1836)	1								3		
<i>Microdrillia bicingulata</i> (Sandberger, 1860)								1			
<i>Crenilabium terebelloides</i> (Philippi, 1843)									1		
<i>Philine (Philine) kochi</i> von Koenen, 1882											1
Foraminifera											
Coelenterata - Anthozoa: <i>Ceratocyathus</i> sp.			1						1	1	
Crustacea - Decapoda									1		
- Cirripedia: <i>Balanidae</i> sp.								1	11		5
Echinodermata - <i>Schizaster (Schizaster)</i> sp.									**1		
Bryozoa	1								3		1
Pisces - Teleostei - indet.	1										
- Sparidae indet.	1										

note: all material is housed in the RGM collection (RGM registration numbers 229 316 - 341), except concretion nr *1 (coll. J. van der Essen, Venlo) and the *Schizaster* specimen (**) (coll. J.W.M. Jagt, Venlo, registration nr 3587).

Schizaster (Schizaster) sp.

Plate 3

Material — The specimen available is an incomplete, slightly deformed internal mould with the corresponding impression of the aboral test surface. The adoral surface is not preserved: the test was apparently broken somewhat above the ambitus before diagenesis. Collection J.W.M. Jagt, Venlo, nr 3587.

Description — Test round-edged, longer than broad (length c. 23 mm, width c. 17 mm, both dimensions approximate), moderately inflated and comparatively short. Apical system situated posterior of centre, genital pores not preserved. Probably only two pores were present. Anterior notch of ambulacrum III relatively narrow, but deep. It gradually decreases in width towards the ambitus. Unfortunately the anterior part of the test is missing: nothing can therefore be stated about the structure of A III across the ambitus. Pore pairs transversely arranged in two regular rows (angle c. 15° with test axis, also adapically). Pores of each pair are comma-shaped to round, with only minor differences in size between the pores of the inner and outer rows. Pores separated by a rather small and inconspicuous elongate granule. Edges of bordering interambulacra 2 and 3 are very sharp and provided with small, rectangular indentations. Interporiferous area seems to be coated with very small “pustules” only, except for some tubercles (one tubercle per pore pair) situated adjacent to the pore pairs. Pores become very small towards the ambitus and are virtually invisible even before reaching the point where peripetalous fasciole crosses ambulacrum III.

Anterior paired petals strongly petaloid, broad and moderately deeply sunken (length c. 7 mm). Pore rows more closely positioned towards the point where the peripetalous fasciole bounds the petals. About 20-22 pore pairs are countable in these petals. Pores of the anterior row are somewhat larger and more elongate than those of the posterior row, which are oval to comma-shaped. The clearly conjugate pores are relatively far apart. Interporiferous area and zone between the pore pairs seem to be ornamented with small “pustules” only.

Posterior paired petals very short in comparison with the anterior ones; length c. 2.5 mm. These are also strongly petaloid and display about 10 pore pairs of comparable structure as those of the anterior petals. Interporiferous area relatively less wide. Edges of interambulacra 1, 4 and 5 well-rounded and never as sharp as those of IA 2 and 3.

Tubercles relatively small and unevenly spaced, with concentrations of larger tubercles on the adapical parts of the interambulacra, near the suture in IA 5 and towards the ambitus. Tubercles are undoubtedly all crenulate and perforate, but this cannot be ascertained in the present specimen. Tubercles on ambulacra I and V less closely spaced, but towards ambitus more tubercles appear.

Peripetalous fasciole complete and very broad where it bounds the IAs, especially in the anterior part of the test, otherwise narrower. Lateral fasciole, which splits off from the peripetalous one in the centre of the test, is equally complete but conspicuously narrower. It appears to become slightly wider towards the anal area. Anal area and adoral surface not preserved, so that description of the structure of the labrum, the plastron and the periplastron plates cannot be given.

Discussion — On the basis of the structure of the petals and the peripetalous and lateral fascioles the echinoid fragment before me can undoubtedly be assigned to the genus *Schizaster*, as interpreted by Fischer (in Moore, 1966). It fits the emended diagnosis of the subgenus *Schizaster*, as given by McNamara & Philip (1980, p. 52) rather well. A specific identification is considered premature for

the time being (if possible at all, since the aboral surface is missing). Probably, this specimen is conspecific with "*Spatangus*" *acuminatus* of Goldfuss (1829, p. 141, pl. 49, fig. 2a-c), who recorded this species for the Oligocene of Kassel and of Grafenberg near Düsseldorf (both F.R.G.). Of this species there are also records from the Belgian and northern and central German Oligocene (Cotteau, 1880 and Ebert, 1889, respectively). The specimen here described and illustrated differs in some respects from a test from the Silberberg Schichten (Latdorfian) of Helmstedt (F.R.G.), figured by Lienau (1984, pl. 10, fig. 15a-c) sub nomine *Schizaster (Aplospatangus) acuminatus* (Goldfuss).

Summarizing, an identification of the present specimen in open nomenclature seems preferable at the moment, since the echinoid fauna of the NW European Oligocene is in need of a modern revision. In such a revision also material from the Late Oligocene (Grafenberg Sands and equivalent strata) of the Lower Rhine district should be critically reviewed.

ACKNOWLEDGEMENTS (AWJ)

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Dr H. Hager and Dr J. Klostermann (both Geologisches Landesamt Nordrhein-Westfalen, Krefeld, F.R.G.) supplied me with information on topographical and stratigraphical subjects, and with some literature data.

Mr A.W. Burger, Mr J.G. Zandstra (both Rijks Geologische Dienst, Haarlem) and Dr P.S. Balson (British Geological Survey, Keyworth, U.K.) were kind enough to give their opinion on petrological and mineralogical aspects of the concretions and allowed me to publish these. Dr P.A.M. Gaemers (RGM) had a look at the bony fish skeleton material and Mr J.W.M. Jagt made a detailed description of the echinoid. Mr B.C. Sliggers (Rijks Geologische Dienst, Haarlem) supplied literature not present in the RGM library.

The photographic illustrations were skilfully made by Messrs W.A.M. Devilé and R.I.W. Dijkman (both RGM). The thin-section was prepared by Mr F.F. Jordens (RGM). The author is grateful to all these colleagues for their cooperation.

Plate 3. *Schizaster (Schizaster)* sp.

Riedel gravel-pit, Kamp-Lintfort (F.R.G.). Jagt collection nr 3587 (part of concretion nr 9).

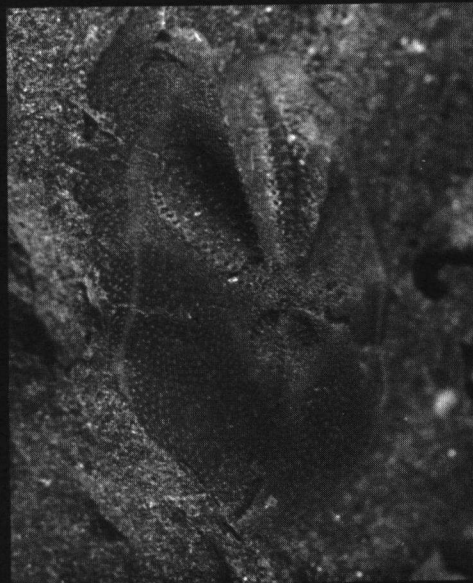
Figs a-b. Two views of the impression of the aboral test surface, showing the posterior part of the peripetalous fasciole and the relatively narrower lateral fasciole; x 3.

Fig. c. The corresponding internal mould; x 2.

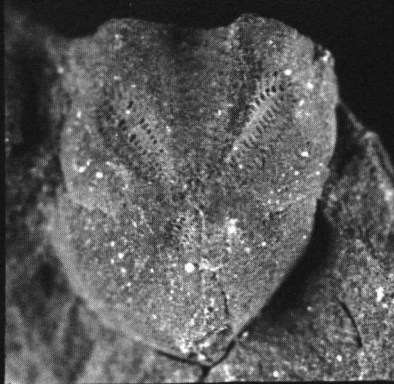
Figs d-e. Two views of an artificial cast of the impression illustrated in Figs a-b, showing petals and tuberculation of the aboral test surface; x 3.



a



b



c



d



e

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