AMMONITES FROM THE TRANSGRESSIVE CRETACEOUS ON THE RHENISH MASSIF, GERMANY

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ABSTRACT. Ammonites from the transgressive Cretaceous at Mülheim-Broich near Essen in Germany are from the Zone of *Hypoturrilites carcitanensis*, at the base of the Cenomanian.

IN western Germany, on the southern flank of the Münster basin, the Upper Cretaceous is transgressive southwards on the Sauerland region of the Rhenish massif (for a general account, including an extensive summary in English, see Thiermann and Arnold 1964). Kahrs (1927), in a study of the palaeogeography of the Upper Cretaceous of Westphalia at its southern limits, described in detail exposures at Kassenberg in Mülheim-Broich, some 13 km west-south-west of Essen. In Rauen quarry, cut in the east slope of the hill, there were pockets of Cretaceous resting in hollows about half a metre deep in the upper surface of Upper Carboniferous sandstone; Kahrs called these sediments in pockets 'klippenfacies' to distinguish them from the flat-lying more extensive Cretaceous where it rests on Upper Carboniferous shales on the other side of the hill in Becker quarry, some 500 m to the west (Kahrs 1927, figs. 1 and 2). The lower klippenfacies ('Rotkalk mit Brauneisen-schwarte') is a conglomeratic sandy limestone with a very rich Cenomanian fauna.

Kahrs listed two species of porifera, ten species of scleractinid corals, nine species of echinoids, 16 species of brachiopods, 65 species of bivalves, 77 species of gastropods, two species of ammonites, four species of serpulids, and one crab; many of these fossils were collected by J. Böhm. The ammonites listed by Kahrs were *Schloenbachia varians* Sow. and *Hyphoplites laurenti* Joh. Böhm. Until recently nearly every *Schloenbachia* has been called *S. varians*. *H. laurenti*, according to Wright and Wright (1949), is a synonym of *Hyphoplites curvatus* (Mantell); this strongly suggests a Lower Cenomanian age.

LENTICLE OF KLIPPENFACIES IN THE RAUEN QUARRY

For over 12 years one of us (H. K.) has kept observations on the Rauen quarry, east of Holzstrasse and just west of the railway beside the Ruhr in Mülheim-Broich. In the north-eastern quarter of the quarry the basal conglomerate has been found to occur as an infilling of a shallow trough, rather than in pockets. The trough was aligned roughly north–south, with a maximum width of 100 m and a length of possibly 150–180 m, cut into Carboniferous shales. Kahrs's horizontal section (his fig. 1) may have been drawn through the southern margin. Even in the centre the lenticle of sediment does not exceed 1·5 m in thickness, and is the same facies as Kahrs's older klippenfacies which can still be found in pockets elsewhere in the quarry: a pink to rusty-brown micritic limestone with pebbles and boulders of Carboniferous sandstone, granules of limonite, and grains of quartz. Limonitic crusts have formed in the top 0·25 metre on the south-east flank

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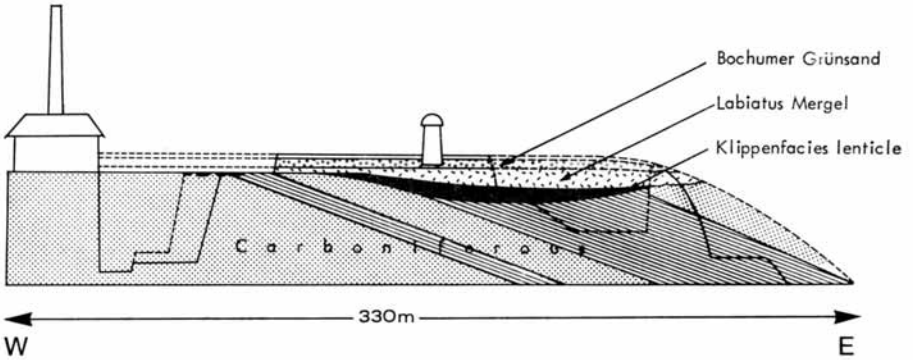

TEXT-FIG. 1. Section at the Rauen quarry, Mülheim-Broich. The small patches of klippenfacies west of the lenticle are the pockets in which Kahrs recorded Plenus Zone sediments above the Lower Cenomanian Rotkalk mit Brauneisen-schwarte and below the Labiatus Mergel.

EXPLANATION OF PLATE 81 (*pars*)

(See opposite p. 440)

All figures are of natural size except 2*c*; all specimens are coated with ammonium chloride.

Figs. 2*a–c*. *Hyphoplites* aff. *campichei* Spath transitional to *falcatus aurora* Wright and Wright. H. Klaumann coll. 14. Fig. 2*c* is a side view ×2 to show the feather structure preserved on the body chamber and the last few chambers of the phragmocone. Feather structure has previously been described in Cretaceous placenticeratids (Meek 1876; Hyatt 1903, p. 222, pl. 47, figs. 3–5; Haas 1961) and desmoceratids (Wright in Arkell *et al.* 1957, p. L92), Jurassic oppeliids (Waagen 1869, pl. 18, fig. 5; Petitclerc 1918) and haploceratids (Arkell in Arkell *et al.* 1957, p. L92; Hölder 1955). This specimen compares best with the example figured by Haas, but all examples are on the outer whorls of ammonites with markedly compressed whorl sections. Feather structure has previously been regarded as a structure of the inner nacreous shell layer, but on this *Hyphoplites* it is preserved on an internal mould.

Figs. 3*a–b*. *Schloenbachia varians* juv. ?var. *subvarians* auct. H. Klaumann coll. 11. Conch preserved, probably as a calcite replacement.

Figs. 4*a–c*. *Schloenbachia varians* var. *subplana* (Mantell). H. Klaumann coll. 10.

Figs. 5*a–c*. *Schloenbachia varians* (J. Sowerby) forma typica. H. Klaumann coll. 3. Note the complete absence of umbilical tuberculation.

Figs. 6*a–c*. *Schloenbachia varians* var. *subplana* (Mantell) H. Klaumann coll. 7. A nearly complete adult with more than half a whorl of body chamber much of which has conch preserved.

Figs. 7*a–c*. *Schloenbachia varians* aff. var. *subtuberculata* (Sharpe) H. Klaumann coll. 15. Appreciably more compressed than the lectotype.

Figs. 8*a–c*. *Sciponoceras roto* Cieśliński. Side, ventral, and dorsal views of H. Klaumann coll. 13. A wholly septate internal mould. The circular cross-section and constrictions spaced at one in a length equivalent to about three diameters, distinguish this species from the later *S. baculoide* (Mantell) which has a markedly compressed whorl section and more closely spaced constrictions (Kennedy 1971), as does *S. glaessneri* Wright.

Figs. 9*a–b*. *Anisoceras* aff. *picteti* Spath. H. Klaumann coll. 12. Side and ventral views. The body chamber begins at the first long rib. Whorl breadth 86 per cent of whorl height. Kennedy (1971) discussed this form. There are around four ribs in a length equal to the whorl height. This internal mould shows a flattening on the top of each shoulder tubercle, indicating that there was a septum across the base of each spine on the conch. This animal was injured in the last formed part of the phragmocone: a pit on each flank may be bite-marks, and there is also a tubercle missing on one shoulder.

of the lenticle. The lithology of the matrix is remarkably similar to the Shenley Limestone of the English Lower Albian, and in many places has a similar-looking brachiopod fauna and the bivalves *Septifer lineatus* and *Chlamys robinaldina*. Like the Shenley Limestone also is the fact that the fauna varies from place to place.

The lenticle contains a fauna similar to that recorded by Kahrs from the pocket occurrences of Rotkalk mit Brauneisen-schwarte klippenfacies, with the addition in places of a rich bryozoan fauna. Moreover, the lenticle has yielded many more cephalopods. We have: *Eutrephoceras sublaevigatum* (d'Orbigny) (2): *Anisoceras* aff. *picteti* Spath (1): *Sciponoceras roto* Cieśliński (1): *Hyphoplites* aff. *campichei* Spath transitional to *H. falcatus aurora* Wright and Wright (1): *Schloenbachia varians* (J. Sowerby) forma typica (1): *Schloenbachia varians* aff. var. *subtuberculata* (Sharpe) (2): *Schloenbachia varians* juv. ?var. *subvarians* auct. (1): *Schloenbachia varians* transitional between var. *subvarians* auct. and *subplana* (Mantell) (2): *Schloenbachia varians* var. *subplana* (Mantell) (5). Most of the specimens are preserved as internal moulds, but some of the ammonites retain some of the conch, probably as a calcite replacement of the original aragonite. The *Hyphoplites*, *Sciponoceras*, and *Anisoceras* were all collected in the range 70–108 cm above the base of the conglomerate, whilst most of the *Schloenbachia* came from 45–60 cm above the base.

By comparison with the English succession the whole faunule belongs to the Zone of *Hypoturrilites carcitanensis*, although this ammonite itself has not yet been found at Mülheim-Broich. This Zone is the lowest of three that have been recognized in the Lower Cenomanian in England (Kennedy 1969, 1971; Kennedy and Hancock 1971), and equates with the lower part of the Zone of *Hypoturrilites schneegansi* in Algeria-Tunisia (Dubourdieu 1956). The assignment of the faunule to the Carcitanensis Zone is supported by the occurrence of *Inoceramus anglicus elongatus*? Pergament.

REGIONAL SETTING

Since the basal klippenfacies at Mülheim-Broich belongs to the Carcitanensis Zone, some of the Rhenish massif in this area must have been submerged very early in the Cenomanian. Some 50 km to the north-east towards Münster, on the hidden extension of the Rhenish massif, the Carboniferous was submerged even earlier, some time in the Albian (Arnold 1964). The subsequent sedimentological history on the massif is complicated, and is now difficult to work out because most of the region is built over, but it is certain that there is a variety of breaks in the succession.

In the Rauen quarry itself the lenticle of klippenfacies conglomerate is overlain by 0·15 to 3 m of chalky marl (Labiatuston or Labiatus Mergel) from which we have obtained inoceramids that Dr. E. G. Kauffman has kindly identified as *Mytiloides labiatus labiatus* (Schlotheim) and *M. labiatus* transitional to *M. latus* (Mantell), which together indicate low Turonian. But on the western side of the quarry, in the pockets, a glauconitic marl with pebbles and phosphatic nodules (younger klippenfacies) intervenes between the Rotkalk mit Brauneisen-schwarte and the Labiatuston, and was assigned by Kahrs to the Plenus Zone.

In the Becker quarry, now built over, there was no klippenfacies but beneath the glauconitic marl there was 'Glauconitische Schwammergel'. This is a dark green rock of glauconite in a clay matrix which has often been called the Essen Greensand. But it

is by no means certain that 'Essen Greensand' has been used only for this formation. Bärtling and Breddin (1931), for example, seem to have used the name for any basal greensand. On the west side of Rauen quarry, and probably at other localities, one can get Turonian greensand (Bochumer Grünsand) resting directly on the Carboniferous. Yet a further complication is that some authors (e.g. Schlüter) have distinguished another formation, the Tourtia, above the Essen Greensand, whilst others have treated these two names as synonyms. In view of all this confusion we feel it is not possible to give an exact date for this oft-quoted formation. We would only mention that most of the 14 ammonites from Essen Greensand and Essen Tourtia figured by Schlüter (1871–1876) are Lower Cenomanian, and all of them could be. On the other hand, the whole of the Cenomanian in the Essen area is shown as 'greensand' on the facies map by Arnold (1964). The two statements are not necessarily contradictory because (i) the ammonites may not have occurred through the whole thickness of the Essen Greensand, and/or (ii) much of the Middle and Upper Cenomanian may be missing in most of the region, as is now known to be the case in the Rauen quarry.

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