

The stratigraphy of a late Lower Hauterivian horizon in the Speeton Clay formation (Lower Cretaceous) of East Yorkshire

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DOYLE, J. C. 1989. The stratigraphy of a late Lower Hauterivian horizon in the Speeton Clay formation (Lower Cretaceous) East Yorkshire. *Proc. Geol. Ass.*, **100**(2), 175–82. A detailed lithological description is given of beds C8.A and C7.H in the Speeton Clay formation of East Yorkshire. Across these divisions profound changes in the Lower Hauterivian ammonite fauna take place. Several ammonites new to Great Britain, of Boreal and Tethyan affinities, are recorded.

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1. INTRODUCTION

In spite of over one hundred years of intensive collecting from the Speeton Clay by many workers, this formation still yields ammonites new to Great Britain. Some of the recent discoveries may provide the basis for more accurate inter-regional correlation, especially with the standard Hauterivian succession of South-East France.

The magnificent pioneer work on the lithostratigraphy by Lamplugh (1889), modified and refined by Fletcher (1969), provided the basis for the present investigation at Middle Cliff, Speeton (Fig. 1). However, because of the highly condensed nature of the beds, a revision of the lithostratigraphic sequence across the C7/C8 boundary has proved necessary.

To obtain an accurate profile, 70.0 mm diameter core samples have been taken. Dried, sanded and varnished these showed up the intensely bioturbated nature of many horizons and also revealed many small scale distortions and fractures, no doubt related to the larger scale structures seen in the cliff sections.

The state of preservation of the ammonites is highly variable and only rarely are solid pyritised or phosphatised examples found. Almost all the ammonites are crushed and flattened but it is from such unpromising material, best obtained by digging into the clays, that many previously unrecorded taxa have come. Fortunately the shell is usually preserved and the original sculpture of even the most compressed specimens is usually well defined allowing certainty in identification.

Great care has been taken to record the precise horizon from which each ammonite has come. Confusion seems to have occurred in the past over the provenance of ammonites collected near the C7/C8 boundary. This has applied in particular to the genera *Endemoceras* and *Simbirskites* both of which are important zonal indices. Danford (1906) recorded *Simbirskites* down to C8. and *Endemoceras* up to C7., thus suggesting an overlap. Rawson (1971) indicated that *Endemoceras* ranged to the top of C8., to be replaced immediately above in C7.H., by *Simbirskites*

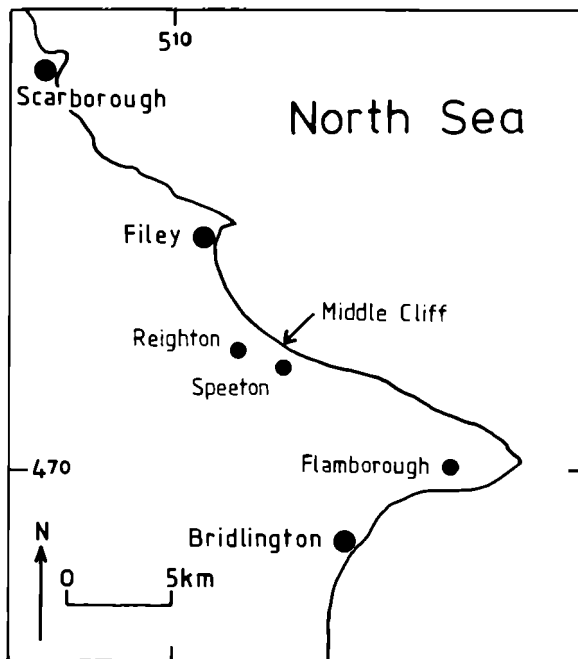


Fig. 1. The location referred to in the text: Middle Cliff, Speeton.

(*Speetonicerias*) thus suggesting an abrupt faunal change and no overlap. The confusion seem to have resulted from problems encountered in recognising the presence at the top of C8., of two close but quite distinct hiatus concretion (phosphatic nodule) horizons, each with its own characteristic ammonite suite. These concretions are described below.

The accurate identification of ammonite bearing horizons is further complicated by tight folding affecting much of the Middle Cliff section, the rapid weathering of exposed surfaces, and the tendency of fallen material to adhere to the clays giving the impression of being *in situ*. The occasional shore

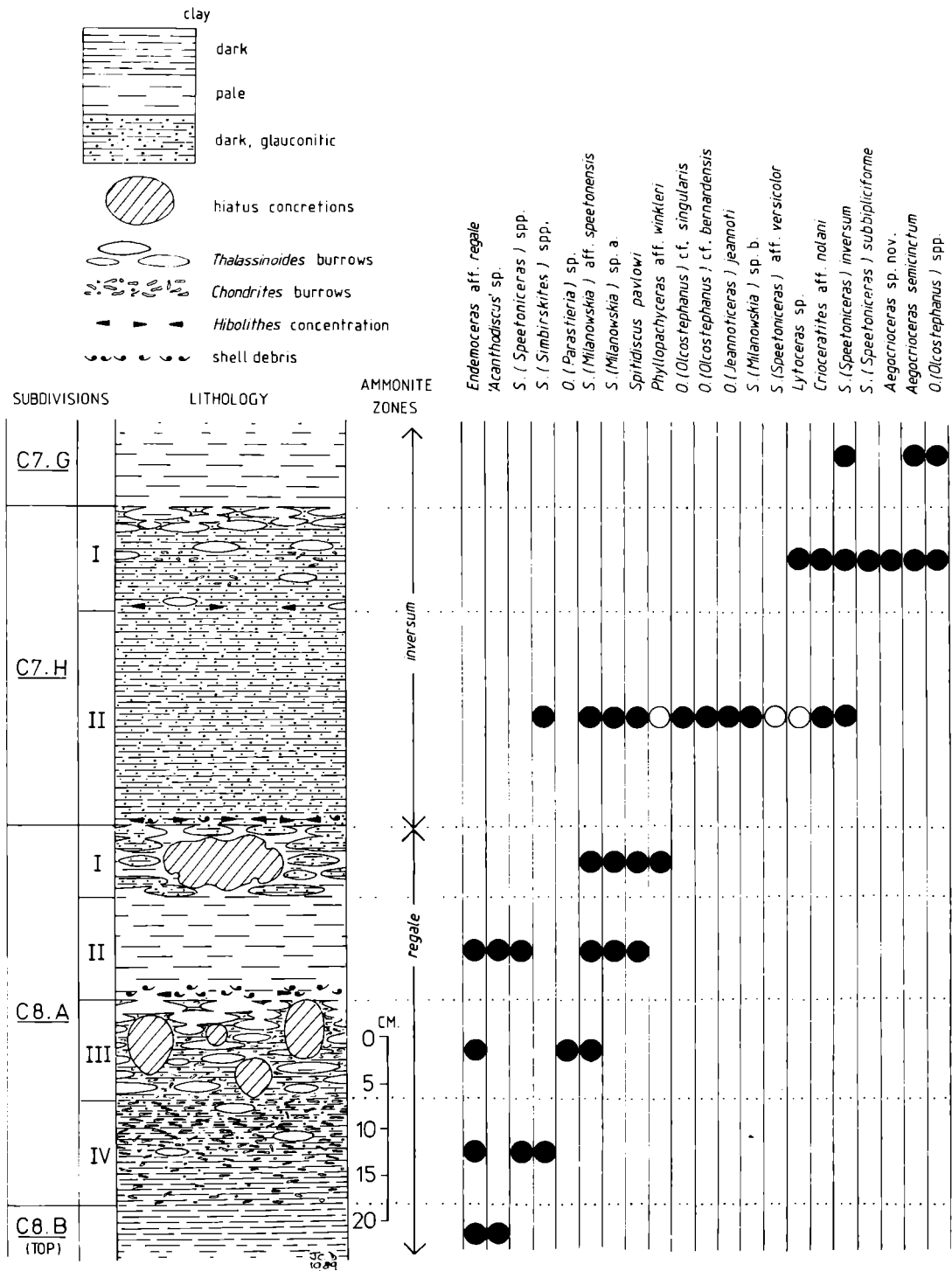


Fig. 2. Lithological log and range/zone chart for beds C7.H. and C8.A, Speeton. Adjacent beds included for continuity. (Open circles indicate uncertainty of precise horizon within subdivision.)

exposures offer by far the best sections but as these are infrequent the Middle Cliff exposures have been used for most of the present study (Fig. 2).

2. LITHOSTRATIGRAPHY

(a) Bed C8.A

Contrasting strongly with the dark clays at the base of C7., and most of C8., in both Middle Cliff and shore exposures it is the thin pale bed at the top of C8., designated C8.A., by Rawson (1971). This horizon shows clear evidence of slow, punctuated sedimentation. Strong bioturbation is revealed in the form of burrows of both small *Chondrites* and large *Thalassinoides* types, these being especially prominent towards the top and base. Hiatus concretions are a feature of this bed and two prominent horizons of them can be recognised; one close to the upper boundary of C8.A., and the other towards the base. These two beds of concretions are quite distinct.

The lower concretions, located in unit C8.A.III. are:

1. Small, up to 50 mm, in diameter
2. Usually elongated perpendicular to the bedding.
3. Smooth externally, and well rounded, ovoid, or spherical in shape.
4. Non-composite.
5. Rarely coated with adherent glauconite grains.
6. With prominent external circumferential ridges marking the intersection of bedding planes.
7. Generally more thickly scattered and never interconnected.
8. In close proximity to the base of C8.A.

In contrast, the upper concretions located in unit C8.A.I. are:

1. Large, up to 120 mm, in diameter.
2. Roughly tabular.
3. Deeply grooved externally.
4. Composite, the dark cores being scoured and grooved, and partially or completely surrounded by smooth envelopes of fresh, light coloured phosphatic material.
5. Often coated with scattered grain of adherent glauconite
6. Without prominent external traces of bedding.
7. Generally thinly scattered, but sometimes interconnected to form 'nests'.
8. In close proximity to the top of C8.A.

C8.A.IV

Below the lower horizon of C8.A. concretions *Chondrites* burrows are especially prominent as the enclosing clay darkens down to C8.B. This horizon, designated C8.A.IV herein, is very obvious in the field and therefore a useful field reference. The top of C8.B is placed at the highest level free of such burrows.

C8.A.III

The lower concretions are scattered throughout a vertical range of approximately 100 mm, and are enclosed in a pale clay with wisps of darker material in which pale *Chondrites* burrows are visible. This bed is herein designated C8.A.III. Prepared samples show that the texture results from the presence of *Thalassinoides* burrows, infilled with pale material brought down from above, penetrating down into the darker clay with *Chondrites* burrows. This is however not obvious in the field.

C8.A.II

The clay between the two concretion horizons, herein designated C8.A.II., is the palest within C8.A. Appearing structureless in the field, it shows traces of bioturbation in prepared examples. At the base there is a concentration of shell debris but the amount varies across the exposures. Flattened specimens of *Thracia phillipsi* Romer are abundant at this level. At several locations the shell debris is especially concentrated and the enclosing clay, darker than usual, contains some glauconite. Occurring infrequently amongst the debris are small, (<40 mm) polished concretions displaying prominent syneresis cracks. Bivalves are the dominant element in the shell deposit, but also frequent are gastropods, *Hibolithes* guards, ammonites, and fossil wood. Of the ammonites, large incomplete phosphatic moulds of *Endemoceras sp.* are especially frequent.

C8.A.I

The upper concretions are located in the streaky top few centimetres of C8.A. herein designated C8.A.I. The streaks are formed by sub-horizontal burrows of a *Thalassinoides* type infilled with dark material. Many of the burrows have glauconite rich cores, probably representing material brought down from the base of C7.H. This streaky horizon is usually quite distinct in the field, but at certain locations along Middle Cliff the matrix of the burrows is rather dark giving problems in distinguishing between the base of C7.H. and the top of C8.A. This can often be resolved by the laboratory examination of prepared samples. In the field, a useful guide is the presence of abundant *Hibolithes* guards at the base of C7.H.

Lens-shaped, sideritic concretions exhibiting well preserved burrows occur infrequently. Crushed specimens of *Thracia phillipsi* are abundant and solid phosphatic moulds occasional at the top of the bed. One epizoan, an adherent bryozoan, has been found attached to the core of one of the nodules.

Slight variations in the thickness of the unit along Middle Cliff are probably the result of current scour prior to the deposition of bed C7.H.

(b) Bed C7.H.

This very dark clay, almost black when wet, is rich in glauconite. Appearing rather structureless in the field,

prepared samples show traces of bioturbation throughout.

As the lithology is so uniform, reference has to be made to the upper and lower contacts with the paler C7.G., and C8.A., respectively, when establishing the precise level of fossil material in the field. This is essential as important changes in the ammonite fauna take place at the base of the upper third of the bed.

Occasional phosphatised fragments of ammonites occur in the upper part. Unfortunately these are usually corroded or friable and therefore of little value.

C7.H.II.

The base of C7.H. is usually marked by a concentration of *Hibolites* guards, often broken, in association with other shell debris including ammonites and fossil wood. Where glauconite is especially concentrated, a sharp contact with the underlying bed C8.A.I., can often be seen. At one point along Middle Cliff, there is almost a glauconite-sand at the base of C7.H., and clear evidence of scouring down into bed C8.A.I., can be seen. Here, composite concretions, derived from bed C8.A.I., are polished and stripped of their outer envelopes.

One such concretion has been recorded with its upper surface projecting into basal C7.H., this

portion being scoured and polished down to the core, whilst the lower half, still embedded in C8.A.I., retained a fresh envelope. At a second point nearby, part polished concretions are overlain by an indurated, well laminated, sideritic lens at the base of C7.H.

C7.H.I.

The upper limit of C7.H., is taken at the level at which the last wisps of dark glauconite clay can be distinguished in the zone of *Thalassinoides* bioturbation at the junction of C7.H. and C7.G. Scattered *Thalassinoides* burrows infilled with paler material derived from the overlying C7.G., occur throughout the unit and these provide a useful characteristic. Guards of *Hibolites* sp. are frequent at the base of the unit and their association with infrequent corroded concretions would suggest an hiatus at this level.

3. BIOSTRATIGRAPHY

Figs. 2 & 3 show the biostratigraphy at Middle Cliff, Speeton.

(a) C8.A.IV

The earliest simbirskitid ammonites so far recorded from the Speeton Clay come from this horizon, two small

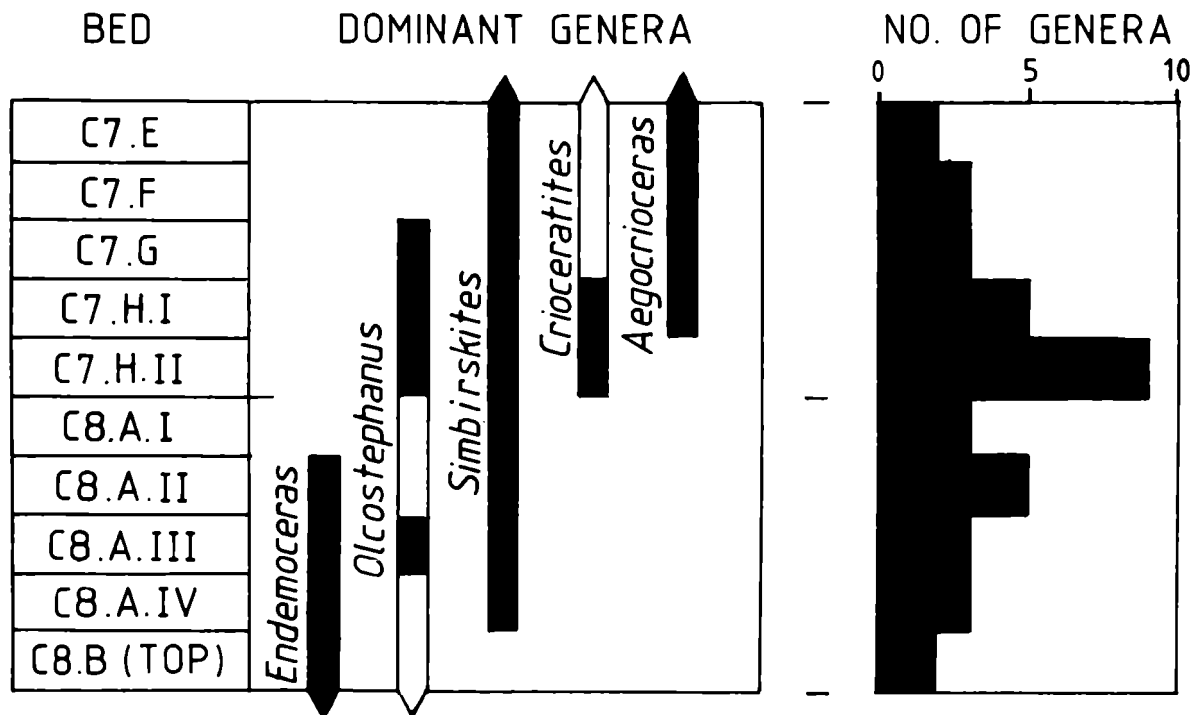


Fig. 3. Range of dominant ammonite genera and numbers of all recorded ammonite genera across the C7/C8 boundary.

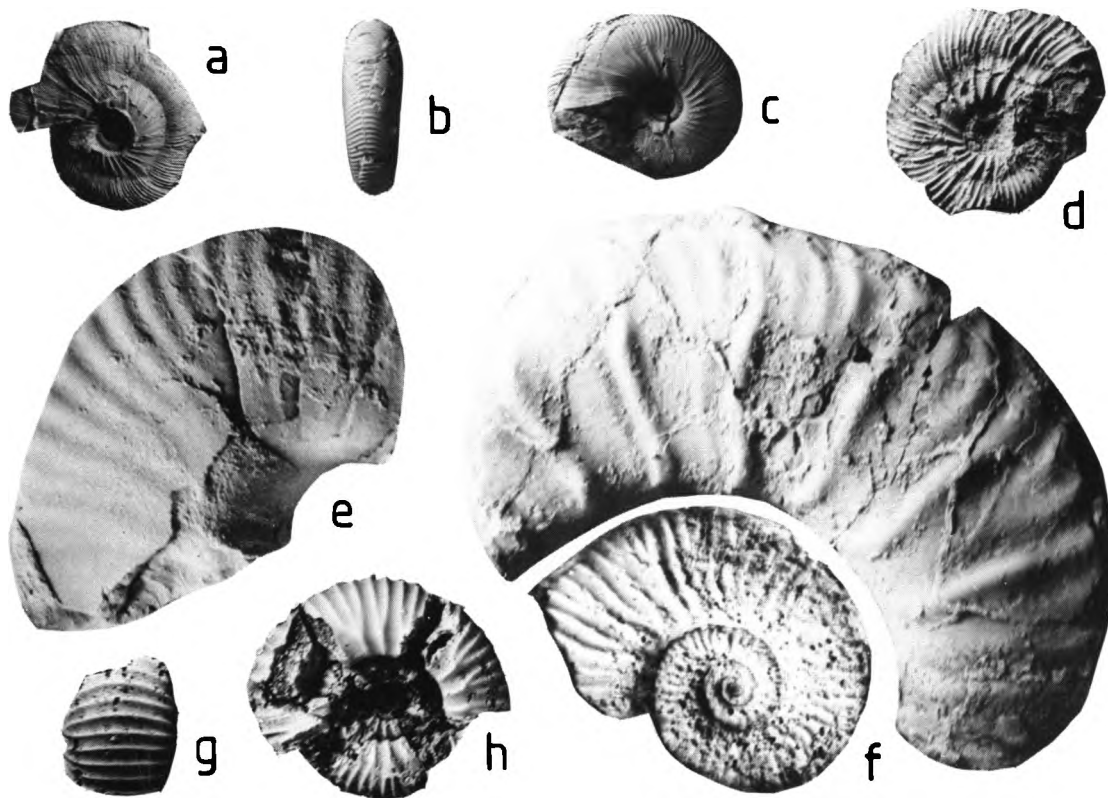


Fig. 4. Ammonites from the top of the *regale* Zone, Speeton. Specimens deposited with the British Geological Survey, Keyworth, Nottingham, NG12 5GG. (a) *S. (Milanowskia)* sp. a. Latex cast from an external mould; bed C8.A.II, (BGS Zt 8744). (b, c) *S. (Milanowskia)* sp. a.; bed C8.A.I, (BGS Zt 8746). (d) *S. (Milanowskia)* aff. *speetonensis* (Young and Bird). Latex cast from an external mould; bed C8.A.II, (BGS Zt 8749). (e) *Phyllopachyceras* aff. *winkleri* (Uhlig); bed C8.A.I, (BGS Zt 8751). (f) *Endemoceras* aff. *regale* (Pavlow). Inner whorls are a latex cast from an external mould; bed C8.A.III, (BGS Zt 8753-4). (g, h) *S. (Simbirskites)* sp.; bed C8.A.IV, (BGS Zt 8755). All figures xl.

examples having been found. One displays straight, radial, primary ribs terminating in prominent tubercles from each of which arise two secondary ribs and is clearly a species of *S. (Speetonicerus)* but as the specimen is both juvenile and crushed, there is no way of determining its specific identity.

The other example (Fig. 4g, h) is a pyrite mould displaying the general features of *S. (Simbirskites)*. The whorl section is coronate and the short primary ribs terminate at prominent lateral tubercles from which secondary ribs spring in threes or occasionally twos.

Small crushed examples of *Endemoceras* aff. *regale* are frequent.

(b) C8.A.III

Phosphatised body-chambers of a large and distinctive *Endemoceras* of the *regale* group, together with

fragments of small, finely ribbed simbirskitids are occasionally found. A fragment in a concretion, of the olcostephanid microconch *O. (Parastieria)* sp., is the highest record from the Speeton Clay of the genus.

(c) C8.A.II.

Ammonites are frequent at the base of this unit, a layer of shell debris yielding several forms, including the last of the endemoceratids in the Speeton Clay succession. *Endemoceras* aff. *regale* (Pavlow) identical to that in unit C.8.A.III, is frequent, being represented by phosphatic moulds of body chambers, often large, and more rarely septate portions. Small juvenile examples are absent suggesting reproduction failure. The septate portions of this form display ornamentation typical of the *regale* group, however the body chamber is quite distinct being characterised by prominent periodic primary ribs bearing bullae at

the umbilical and ventral shoulders as well as low tubercles at a point just beyond mid-flank. (Fig. 4f).

The only other endemoceratid is '*Acanthodiscus*' sp., a tuberculate form of uncertain affinity found throughout C8, C9, C10 and C11.A. Together with the last endemoceratids are the first examples of *Spitidiscus pavlowi* (Karakasch) usually crushed.

Also found at this level and invariably crushed are very rare *S.(Speetonicerias)* sp., occasional *S.(Milanowskia)* aff. *speetonensis* (Young and Bird), and frequent, a finely ribbed *S.(Milanowskia)* sp.a. This last and very distinctive form is characterised by its small size (<30 mm), and long, straight, strongly prorsiradiate primary ribs which split into bundles of two, three or four flexuous secondaries. (Figs. 4a; 4b,c; 5i). There is some variation between individuals in the coarseness of ribbing and the author would assign to this group, forms from the Myrtle Formation of Oregon, USA, figured as *Simbirskites* sp. juv. by Imlay (1960, pl. 33., figs. 4-7).

The specimens of *S.(Milanowskia)* aff. *speetonensis* referred to above have straighter, more strongly prorsiradiate primary ribs than the typical forms from Bed C6 and may be related to the accompanying finely ribbed *S.(Milanowskia)* sp.a.

(d) C8.A.I.

Large phosphatised and well preserved body chambers of *Spitidiscus pavlowi* are found in the upper part of this unit, almost at the junction with C7.H. Crushed specimens of *S.(Milanowskia)* aff. *speetonensis* (Young & Bird) (Fig. 4d) are frequent, but the finely ribbed *S.(Milanowskia)* sp.a., found in the unit below, is less so, however, one small concretion yielded two well preserved examples.

Phyllopachyceras aff. *winkleri* (Uhlig) is recorded from one of the concretions (Fig. 4e).

(e) C7.H.II

There is an immediate diversification of the ammonite fauna at the base of C7.H., and an increase in the number of genera of Tethyan affinity. (See Fig. 2). *Olcostephanids* are frequent but usually poorly preserved. Examples referable to *O.(Olcostephanus)* cf. *singularis* (Baumberger), (Fig. 5c), and *O.(Olcostephanus)* cf. *bernardensis* (Lory MS), (Fig. 5a), are identified.

The occurrence of *Olcostephanus (Jeannoticerias) jeannoti* (d'Orbigny) is of special interest as this sub-genus has not previously been recorded from N.W. Europe. The sub-genus, erected by Thieuloy (1964, p. 212) is very distinctive, being characterised by a loss of umbilical tubercles in the adult, fine secondary ribs which usually spring in pairs from the primaries, and a rather compressed whorl section. Both sexual dimorphs have been found, three macroconchs and one microconch, examples of which

are figured herein (Figs. 5d & e). All are from C7.H. and two definitely from the lower division C7.H.I. It is almost certain that the other two examples are from this division.

S.(Milanowskia) sp.a., of C8.A., and *Spitidiscus pavlowi* are frequent at the base of this unit, both occurring for the last time in the succession. There is the possibility that these forms constitute a derived fauna resulting from the reworking of the top of bed C8.A.I.

S.(Simbirskites) reappears being represented by two distinct varieties, both rare. The first, (Fig. 5b) is coarsely ribbed, displaying mainly tri-costate secondary bundles. The second (Fig. 5l, m) is a densely ribbed species with quadri-costate secondary bundles. A Specimen in the authors collection of *S.(Speetonicerias)* aff. *versicolor* (Trautschold) from C7.H., is believed to come from this lower division.

A fourth group of simbirskitids found is characterised by the possession of a compressed whorl section, short sinuous primary ribs and dichotomous secondaries: *S.(Milanowskia)* sp.b. (Figs. 5f, g & h). There appears to be no previous record of this group from Great Britain.

One, poorly preserved example of *Phyllopachyceras* aff. *winkleri* (Uhlig) has been found. A fragment of *Lytoceras* sp. from C7.H. is thought to be from this lower division. *Crioceratites* aff. *nolani* (Kilian) is frequent but as yet no well preserved examples have been found.

(f) C7.H.I.

Compared with C7.H.II. the ammonite fauna is much less diverse, there being a significant reduction in the number of Tethyan species *S.(Speetonicerias) inversum* (M. Pavlow) is frequent, whilst *S.(Speetonicerias) subpliciforme* (Spath) is occasional. The inner whorls of both species are frequently pyritised.

One phosphatised but much corroded whorl fragment, referable to *O.(Olcostephanus)* sp., has been found, this being of a highly coronate coarsely ribbed variety.

Aegocrioceras makes a first appearance and is frequent. At least two groups of the genus are represented, these possessing in the adult form an almost circular whorl section. In one group comparable with *A. semicinctum* (Roemer) found above in beds C7.G., and C7.F., the ribs which pass uninterruptedly across the ventral region are in the adult form rectiradiate to rursiradiate and the coiling is generally tight.

A second group recorded infrequently from the base of this unit is the 'Crioceratid Indeterminate' of Rawson (1971) which is characterised by variable, often lax coiling, and markedly prorsiradiate ribs which weaken across the ventral region (Fig. 5j, k). The author would suggest that this is an early form of

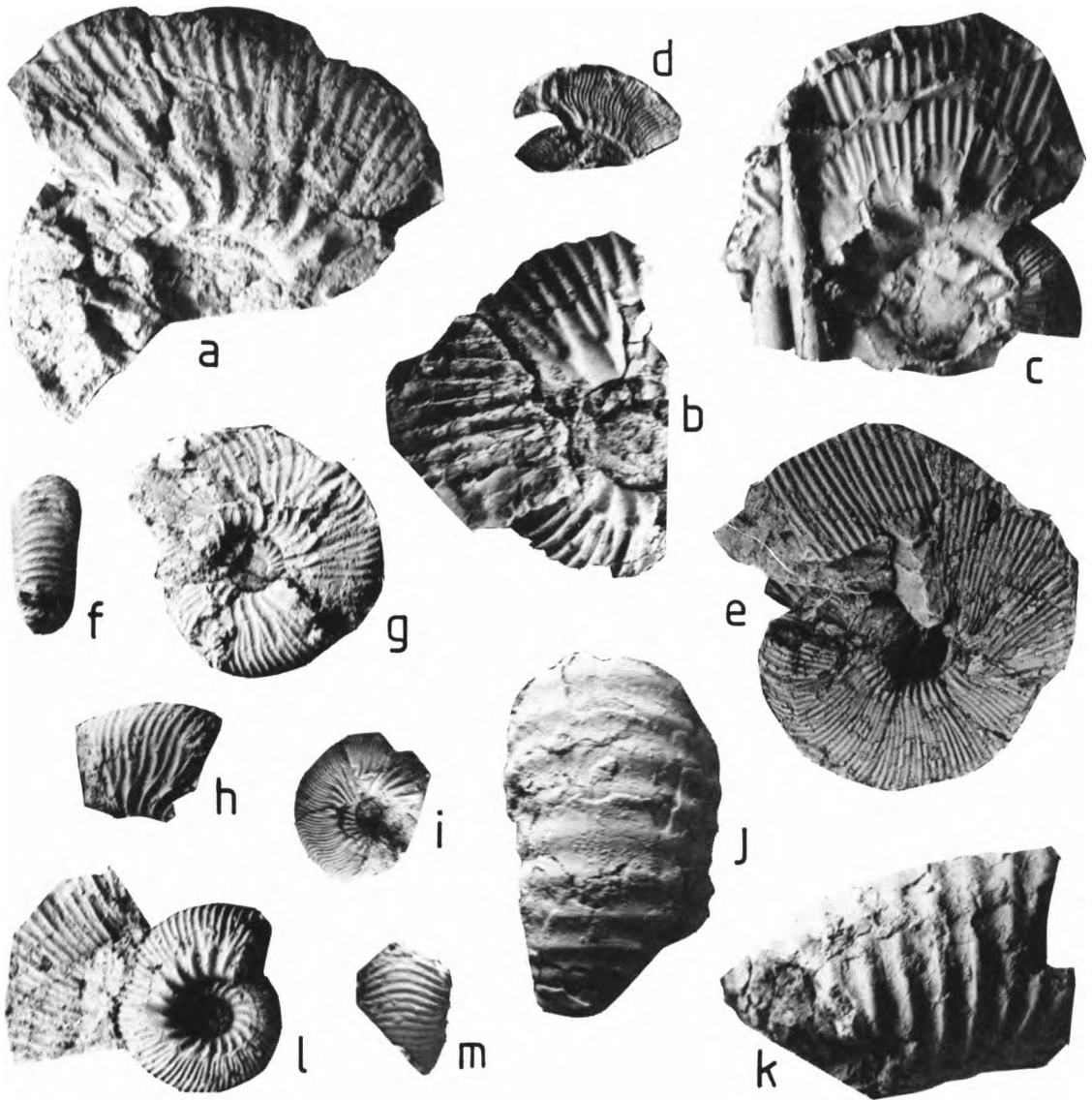


Fig. 5. Ammonites from the base of the *inversum* Zone, Speeton. Specimens deposited with the British Geological Survey, Keyworth, Nottingham, NG12 5GG, and the British Museum (Natural History), London, SW7 5BD. (a) *O. (Olcostephanus) cf. bernardensis* (Kilian MS); bed C7.H.II, (BGS Zt 8756). (b) *S. (Simbirskites)* sp.; bed C7.H.II, (BGS Zt 8757). (c) *O. (Olcostephanus) cf. singularis* (Baumberger). Latex cast from an external mould; bed C7.H.II, (BGS Zt 8758). (d) *O. (Jeannoticerias) jeannoti* (d'Orbigny), microconch. Latex cast from an external mould; bed C7.H. (undifferentiated), (BGS Zt 8762). (e) *O. (Jeannoticerias) jeannoti* (d'Orbigny), macroconch; bed C7.H.II, (BM C. 91194). (f, g) *S. (Milanowskia)* sp. b.; bed C7.H.II, (BGS ZT 8763). (h) *S. (Milanowskia)* sp. b.; bed C7.H, (BGS Zt 8764). (i) *S. (Milanowskia)* sp. a.; bed C7.H.II, (BGS Zt 8765). (j, k) *Aegocrioceras* sp.; bed C7.H.I, (BGS Zt 8767). (l, m) *S. (Simbirskites)* sp.; bed C7.H.II, (BGS Zt 8768). All figures x 1.

Aegocrioceras, possibly transitional from *Crioceratites*.

Rare *Crioceratites* aff. *nolani* (Kilian) and *Lytoceras* sp. are recorded from the base of the unit.

4. DISCUSSION

The study suggests that the ammonite sequence within beds C8.A. and C7.H. is more complete and diverse than hitherto recorded. Bed C7.H.II., with its rich suite of both Tethyan and Boreal forms, may prove a valuable guide for long distance correlation. The bed seems to have been laid down at a cross roads of ammonite migration routes, during a short period of optimal conditions.

The Tethyan ammonites, and in particular the olcostephanids, suggest the correlation of Bed C7.H.II with the highest part of the *loryi* zone, or lowest part of the *nodosoplicatum* zone of south-east France. This would agree with the placement by Kemper, Rawson & Thieuloy (1981), of bed C7.A., at the base of the Upper Hauterivian.

O. (Jeannoticeras), *S. (Speetoniceras)* and *S. (Simbirskites)* are recorded from the Myrtle Formation of the Shasta Series, Oregon, USA by Imlay (1960). Imlay considered *O. (Jeannoticeras)* indicative of a late Valanginian horizon but this seems highly improbable. The occurrence at Speeton of simbirskitids of North America affinity further suggests a migration route between North West Europe and the Pacific Coast States during Lower Hauterivian times. Possible routes include an 'Arctic Ocean' and also a seaway

through the Gulf of Mexico associated with the opening Atlantic.

It is interesting to note that the enigmatic genus *Shastrioceras* described from Bed DI., at Speeton (Doyle, 1963) has recently been recorded from a corresponding lower Hauterivian horizon in Columbia, according to Dr. F. Etayo-Serna (pers. comm.).

The initial opening of a seaway in late Lower Hauterivian Times, between the Russian province and Great Britain, is suggested by an influx of simbirskitids, first recorded in bed C8.A.IV at Speeton. More information on the Russian sequence of early simbirskitids is desirable before an accurate correlation can be established.

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