ASPECTS OF THE STRATIGRAPHY, AND AMMONITE FAUNAS OF THE, AALENIAN - BAJOCIAN STAGES IN GREAT BRITAIN

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The following has been redacted from this digital copy of the original thesis at the request of the awarding university:

7 publications/journal articles at the end of Volume 2 (after page 565)

3. SYSTEMATIC DESCRIPTIONS OF MEMBERS OF THE BAJOCIAN AMMONITE SUPERFAMILY STEPHANOCERATACEA

The original intention of this thesis was to have been a systematic revision of the Bajocian members of the ammonite Superfamily Stephanoceratacea. This has proved to be beyond the scope of the present work, since it has been impossible to collect sufficient material. Hence the relative quantity of systematic descriptions has been reduced. I am restricting myself here, firstly to the description of two,new,microconch Otoitid species, which are of considerable phylogenetic and stratigraphic significance ; and secondly to a full systematic revision of the ammonite subfamily Sphaeroceratinae. The latter was chosen because it is a relatively small, well defined group, which many previous authors have mis-interpreted. Up to now, it is also the only one to have large enough *in situ* collections, to give a more reliable indication of the degree of intra- and interspecific variation.

3A. TWO NEW BAJOCIAN MICROCONCH OTOITID AMMONITES AND THEIR SIGNIFICANCE

by

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ABSTRACT

Two new Bajocian (Middle Jurassic), microconch species belonging to the ammonite family Otoitidae : *Trilobiticeras* (*Trilobiticeras*) *cricki* nov. and *Emileia* (*Otoites*) *douvillei* nov. : are described, and are paired with their probable macroconch partners; *T.* (*Emileites*) *malenotatus* (Buckman) and *E.* (*E.*) *subcadiconica* Buckman, respectively. The stratigraphic distribution of the main members of the subfamily Otoitinae in southern England which is given, shows that the two new species fill an important gap in our knowledge of this subfamily. In particular *T.* (*T.*) *cricki* is of fundamental importance, as it is the undoubted ancestor to both *Emileia* and *Frogdenites* and possibly also *Pseudotoites*. With their restricted stratigraphic range and wide geographic distribution, these new species are valuable stratigraphic indices for delimiting the base of the *ovalis* subzone of the *laeviuscula* Zone. The most important exposures of the *ovalis* subzone are discussed, and the famous fauna described from the south of France by Douvillé is revised.

INTRODUCTION

During the course of a recent stratigraphic study of the Bajocian rocks (Middle Jurassic), of southern England (Parsons 1974, pp.164-171), large ammonite collections have been made from some long neglected horizons. In particular the ovalis or so called 'Lower Iron-shot' bed of Dundry Hill, near Bristol, England (Buckman and Wilson 1896), has yielded an interesting assemblage, which may be correlated with the ovalis subzone of the laeviuscula Zone (Parsons 1974, p.169) - see Table I for the zonal scheme used here. The majority of ammonites collected from this horizon (+56%), belong to the Witchellia/Pelekodites dimorphic group. However, intensive collecting revealed that a small proportion of the total fauna consists of two, as yet undescribed species belonging to the microconch subgenera Otoites and Trilobiticeras. A study of both the literature and existing museum collections showed that these stratigraphically important species had been collected and recognised as distinct for some considerable time; it has merely taken a hundred years for them to be formally described. The small physical size of these two new microconch species, as well as their relative rarity in comparison with the abundant Witchellia goes some way towards explaining their absence in previous works on the Bajocian Otoitidae (Westermann 1954).

As already noted, these two new species form only a minor part of the total ammonite fauna of this age in England. However, at comparable horizons in southern Europe the Sonninid ammonites are less dominant, whilst the Stephanoceratids are more relatively abundant. It is thus not surprising that this area of Europe has

	ZONES	SUBZONES
LOWER BAJOCIAN	*Stephanoceras humphriesianum*	
	Emileia (*Otoites*) *sauzei*	
	Witchellia (*Witchellia*) *laeviuscula*	*W.* (*W.*) *laeviuscula*
		Sonninia ovalis
	Hyperlioceras discites	

Table 1.

Zones and relevant subzones of the Lower Bajocian substage (= Middle Bajocian *sensu* Arkell, 1956), after Parsons (1974).

produced the majority of previous records of these two new species, particularly the south of France, Portugal and Sicily. With their wide geographic distribution and relatively restricted stratigraphic range, these ammonites are of great value for correlation purposes, particularly for between Sonninid dominated north-west Europe and the Tethyan region. These taxa are also of considerable phylogenetic importance, as they form a critical link between the early Stephanoceratids of the *concavum/discites* Zones and the more abundant forms of the upper *laeviuscula/sauzei* Zones. As *Emileia* (*Otoites*) *douvillei* nov. and *Trilobiticeras* (*Trilobiticeras*) *cricki* nov. are characteristic of the *ovalis* subzone of the *laeviuscula* Zone, the stratigraphy of this horizon in southern England and elsewhere in Europe will be discussed.

Note: Numbers preceded by these abbreviations refer to specimens in the following collections:-

BMNH.	-	The British Museum (N.H.) London.
Cb.	-	Bristol City museum.
IGS.	-	The Institute of Geological Sciences, London.
M.	-	The École des Mines collection, Université de Paris-Sud, Paris.
OUM	-	The Oxford University museum.
SM.	-	The Sedgwick museum, Cambridge.
CP.	-	The author's collection.

SYSTEMATIC DESCRIPTIONS

Class <u>CEPHALOPODA</u>

Subclass AMMONOIDEA

Superfamily STEPHANOCERATACEA Neumayr, 1875

Family OTOITIDAE Mascke, 1907

The classification of the Otoitidae follows Westermann (1964), who divided this family between two subfamilies; the Otoitinae and Sphaeroceratinae.

Subfamily OTOITINAE Mascke, 1907

The generic classification within this subfamily follows Westermann (1964, pp.51-4), except for the inclusion of <u>Frogdenites</u>, which on both morphological and stratigraphic criteria has been transferred from the Sphaeroceratinae.

Genus <u>Emileia</u> Buckman, 1898

<u>Type species</u> - <u>Emileia</u> (<u>Emileia</u>) <u>brocchii</u> (J. Sowerby 1818), M.

<u>Diagnosis</u> - The nominate subgenus consists of a group of medium to large sized, macroconch ammonites, which vary from involute sphaerocones, via cadicones to evolute platycones. The flared mouth border is always preceded by a constriction of the internal cast, and the primary ribs are 'club' shaped, being terminated by blunt nodes, rather than by tubercles.

Subgenus <u>Otoites</u> Mascke, 1907

<u>Type species</u> - <u>Emileia</u> (<u>Otoites</u>) <u>sauzei</u> (d'Orb. 1846), (m.)

<u>Diagnosis</u> - A group of moderately small sized, lappeted microconch ammonites, which are characteristically involute

sphaerocones, with a pronounced contraction of the body chamber. The ribbing style on the inner whorls is identical to its macroconch, *Emileia s. str.*, that is 'club' shaped primary ribs, dividing into 3 to 4 finer secondaries. On its outer whorls, *Otoites* tends to develop sharp tubercles or spines at this point of division, whilst on the body chamber, the secondary ribs tend to become inflated and coarsened, often with an alternation of strength on the last half whorl, with every 2nd., 3rd. or 4th. rib being more inflated than its neighbour.

Emileia (*Otoites*) *douvillei* sp. nov.

Plate 1, figs. 6, 7 & 9, Text figure 1.

1885 *Sphaeroceras sauzei* d'Orb.; Douvillé, p.41, Pl. III, figs. 9a-b.

? 1921 *Otoites sauzei*; Riche & Roman , p.138, Pl. 6, fig.8.

1925 *Sphaeroceras* (*Otoites*) *sauzei* d'Orbigny; Renz, p.32, Pl. II, figs. 8 & 8a.

? 1929 *Emileia sauzei* d'Orb.; Lanquine , p.293, Pl. ix, fig. 6.

1960 *Otoites* sp. (*O. sauzei* Roman *non* d'Orb.); Lelièvre, p.17.

1960 *Otoites* sp.; Dubar, p.52, Pl. vii, figs. 25-26 & ?24.

1961 *Otoites* cf. *sauzei* (d'Orb.) (Douvillé, 1885, pl.3, fig.9); Ruget-Perrot, p.54.

? 1967 *Otoites* sp.; Gabilly & Rioult, p.3.

? 1974 *Emileia* (*Otoites*) sp. nov.; Parsons, p.168.

? 1975 *Emileia* (*Otoites*) sp. nov.; Morton, pp.84-5, Pl.16, figs. 5-6.

non 1954 *Otoites fortis* n. sp.; Westermann, pp.103-6, Pl. 3, figs. 2-4, text figs. 10 & 21.

Diagnosis

Small, sphaeroconic ammonite, with strongly contracted body-chamber, terminated by lappets. Strongly ribbed, with short, bullate primary ribs dividing into three to four rounded secondaries. Its small size separates it from all described species of Otoites, whilst the otherwise very similar T.(E.) cricki nov. has a different ribbing style, with sharp tubercles.

Material

Two specimens -0.30m. from the top of bed 2, Barns Batch Spinney (National Grid Reference ST557659), Dundry Hill, Bristol (Buckman & Wilson 1896, p.689), BMNH. C79428, C79429; five Dundry specimens from old museum collections, BMNH.C75242, IGS.25189, Cb4744, Cb4957-8, and one specimen +0.30m. from the base of bed 4, Bruton Railway quarry (ST682345), Bruton, Somerset (Richardson 1916, p.495), BMNH.C79432; a total of eight specimens.

Dimensions

Holotype, Cb4744, from Dundry Hill, and by matrix from the ovalis bed. It is complete, with the base of lappets and just over ¾ whorl of body chamber at a diameter of 2.67cm.

Diameter (D.)	Umbilical diameter (Ud.)	Number of primary ribs (Pn.)	Whorl height (Wh.)	Whorl breadth (Wb.)	Wb/Wh
2.50	0.83 (33%)	c.20	1.04 (42%)	1.36(54%)	1.31
2.16	0.64 (30)	-	1.01 (47)	1.50(69)	1.49
1st Paratype, BMNH.C79429, with ¼ whorl of body chamber.					
1.96	0.57 (29%)	19	0.89 (45)	1.25(64)	1.4
1.7	0.46 (27)	17	0.84 (49)	1.13(67)	1.35
2nd. Paratype, BMNH.C79428,					
1.7	0.59 (35)	-	0.8 (47)	1.15(68)	1.44
1.31	0.39 (30)	-	0.6 (46)	0.92(70)	1.53

Description

A small (c.2.3 - 2.7cm. diameter), sphaeroconic ammonite, with a strongly contracted body chamber, which extends for three quarters to one whorl. The prorsiradiate primary ribs are short, blunt and

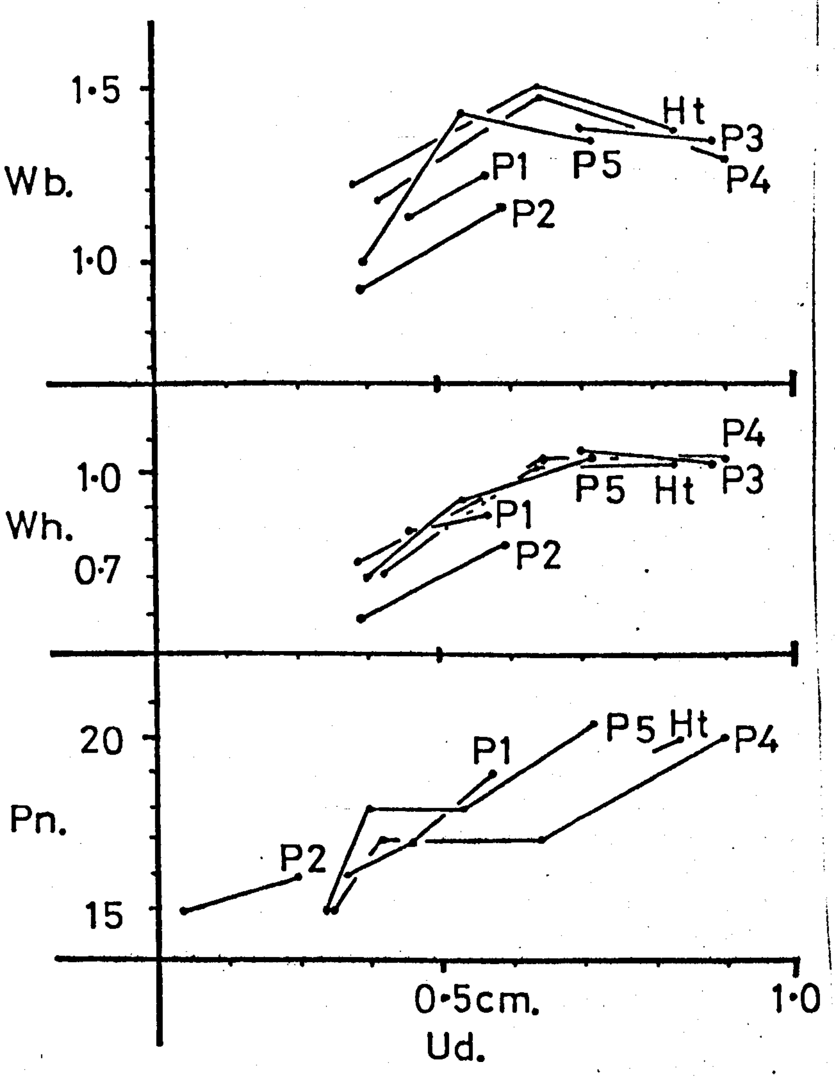


Figure 1.

A plot of whorl breadth (Wb), whorl height (Wh) and number of primary ribs (Pn), against umbilical diameter (Ud), for Emileia (Otoites) douvillei sp. nov. Ht. = Holotype, P.= paratype.

expand into 'club' shaped nodes at the point of division into three to four secondary ribs. These secondaries are relatively coarse, rounded rather than sharp, and bend forward only slightly over the rounded venter. The primary ribs weaken on the body chamber, whilst the secondaries, particularly on the last quarter whorl, are reduced to two per primary, and become inflated and coarsened, often with a tendency to become irregularly swollen. Thus on the last half whorl of the third paratype (IGS.25189), every second or third rib is more expanded than its neighbour. The relative primary rib density increases rapidly (see Text figure 1), from 15 to 16 per whorl on the inner whorls, to 20 to 21 on the body chamber. There is very little relative change in whorl cross-section, which stays more or less rounded, but depressed throughout ontogeny. The exception to this is found on the last quarter whorl of the body chamber, where associated with the rapid uncoiling of the umbilical seam, there is a marked decline in whorl breadth relative to whorl height - see Text fig.1. This rapid uncoiling of the body chamber changes the shell shape from a slightly sphaeroconic, to a more evolute form, although it is never as evolute as <u>Trilobiticeras</u> <u>cricki</u> nov. The mouth border is characterised by a pair of spatulate lappets, which extend from the mid-whorl position (see Plate 1, fig.6a).

<u>Type Series</u>

The holotype (Plate 1, figs.6a-b), the best preserved British specimen, comes from an old collection in the Bristol City Museum (Cb.4744). The matrix of this specimen is identical to that of bed 2, Barns Batch Spinney, Dundry (Buckman & Wilson 1896, p.689); that is the <u>ovalis</u> bed, which is unique to the west side of Dundry Hill. The 1st. paratype (BMNH.C79429), has only a quarter whorl of body chamber, but it is clearly very similar to the holotype in both proportions and ornament (see Plate 1, figs.9a-b), and like the 2nd. paratype (BMNH.C79428), it was collected _in situ_ from bed 2 Barns Batch Spinney, Dundry, thus confirming the type horizon of the holotype. The 3rd paratype (IGS.25189), has the best preserved lappets, whilst the 4th. is a well preserved specimen (Cb.4957), which is recorded on its label as coming from the 'Sherborne district' of north Dorset. However the matrix of this specimen is totally atypical of the Sherborne area, and this would suggest a true provenance from the _ovalis_ bed of Dundry. Lastly the 5th paratype (BMNH.C75242), is another well preserved specimen, with a matrix characteristic of the _ovalis_ bed, (Plate 1, figs.7a-b).

Sexual Dimorphism

Sexual dimorphism is well marked in this group. _Emileia_ (_Otoites_) _douvillei_ nov., like other members of its subgenus, shows typical microconch features. The mature shell is of relatively small size, and exhibits well developed lappets. The corresponding macroconch is less well represented in the _ovalis_ bed. A typical specimen from Dundry, _ex_ Etheridge collection, BMNH.C75279, is an involute, slightly cadiconic form, with bullate primary ribs and a quarter of a whorl of body chamber at a diameter of 4.1cm. (see Plate 1, fig.8). The matrix of this specimen suggests the _ovalis_ bed as its source. This is confirmed by the occurrence of a complete specimen, with a plain mouth band, 9.0cm. in diameter, from the _ovalis_ bed of West Dundry (Bristol University, Department of Geology, No.67). These macroconchs are best referred to _Emileia_ (_Emileia_) _subcadiconica_ S.Buckman (1927, in 1909-30, Plate 711).

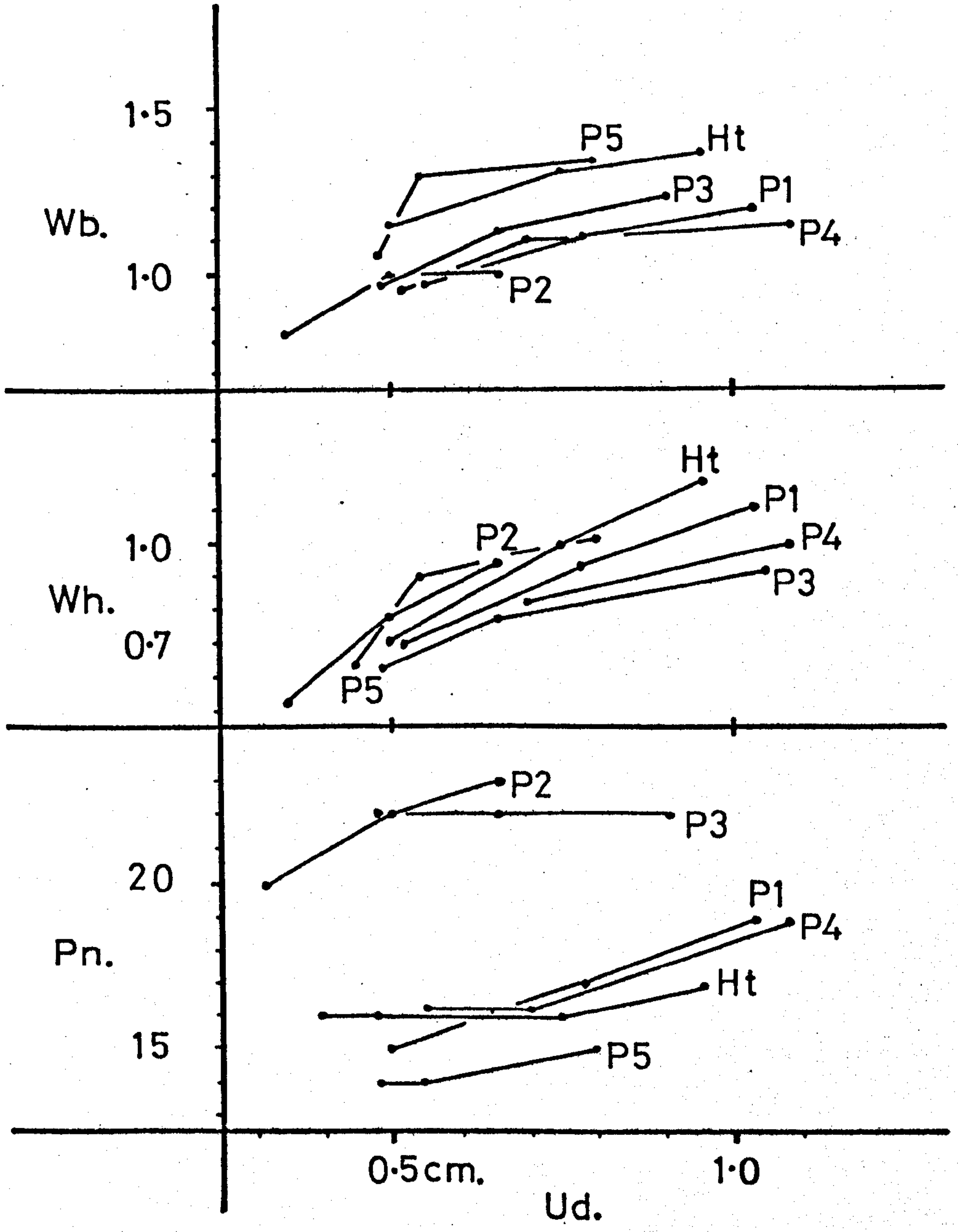


Figure 2.

A plot of whorl breadth (Wb), whorl height (Wh) and number of primary ribs (Pn), against umbilical diameter (Ud), for <u>Trilobiticeras</u> (<u>Trilobiticeras</u>) <u>cricki</u> sp. nov.

Ht. = Holotype P. = paratype.

The type specimen of the latter (IGS.49304), although fragmentary and wholly septate, exhibits, as noticed by Buckman (loc.cit.), a typical ovalis bed matrix.

Stratigraphic Range

E. (O.) douvillei appears to be characteristic of the ovalis subzone of the laeviuscula Zone. However this taxon probably ranges up into the base of the laeviuscula subzone, although the specimens referred to it from the basal part of the 'Sandford Lane fossil bed', near Sherborne, Dorset (ST628179), are possibly not conspecific. The latter are slightly larger, with a different primary rib density (= Otoites sp. nov.; Parsons 1974, p.168). By way of comparison, a single specimen from this locality and horizon, in the Reed collection of the Yorkshire Museum is figured here (Plate 1, fig.4).

Geographic Range

Apart from Dundry Hill, and more doubtfully Sandford Lane, the only other British localities to yield this species are, Bruton Railway quarry, Bruton, near Castle Cary, Somerset, (Richardson 1916, p.495, bed 4), which has yielded one specimen, BMNH.C79432, and possibly Bearreraig Burn, Isle of Skye, Scotland (= Otoites sp. nov.; Morton 1975, Plate 16, figs.5 & 6). It is impossible to be certain of the latter, as the specimen is not well preserved and is badly localised. Elsewhere this species has been recorded from the south of France (Douvillé 1885; Lanquine 1929), Sicily (Renz 1925), Portugal (Ruget-Perrot 1961) and Morocco (Dubar 1960).

Discussion

As may be seen from the synonymy list, the presence of this species has been noticed by numerous authors, most of whom commented on its distinctive nature. This species has been named in honour of H. Douvillé, who was the first to figure it (Douvillé 1885). Dubar (1960, p.52) has given the most detailed previous description of this taxon, and he also pointed out the differences between his specimens, and the other species of Otoites, which had been figured up to that time. The criteria separating E. (O.) douvillei from E. (O.) fortis (Westermann), with which it has been equated (Westermann 1954, p.103), were given by Dubar (1960)as; a/ its small size, half to one third of that of other Otoitids, b/ the very strong contraction of its body chamber and c/ the modification of its ornament near the mouth border, particularly the loss of tubercles or nodes on the last two ribs. These characters appear perfectly valid, although there is some variation in the amount of contraction of the body chamber, since not all specimens show this to the same degree; notably those figured by Douvillé (1885, Plate III, fig.9) and Lanquine (1929, Plate ix, fig.6). It is also interesting to note Dubar's comment (op. cit., p.52) ..... 'The exact age of this small form is still to be established ...... perhaps this Otoites will be the most ancient' ....; as it can now be shown that this species is indeed the oldest yet recorded belonging to the subgenus Otoites.

There are really no other species of Otoites closely related to E. (O.) douvillei, since they are all of much larger size and occur at higher stratigraphic horizons. In fact the most closely related forms are the more inflated variants of Trilobiticeras (Trilobiticeras) cricki nov., which are found together at the same horizon. These two groups are very much alike in size and relative proportions, the main difference being in the style of ribbing. It is thus reasonable to suggest that Emileia (E.)/(E.) Otoites evolved from the Trilobiticeras (T.)/T. (Emileites) group at the base of the laeviuscula Zone, especially since no specimens of either Otoites or Emileia have been found below this horizon.

Genus Trilobiticeras Buckman, 1919

Type species - Trilobiticeras (Trilobiticeras) trilobitoides Buckman, 1919, (m.)

Subgenus Trilobiticeras Buckman, 1919

Diagnosis - A group of very small sized, microconch ammonites, with coronate inner whorls. It has sharp primary ribs, which are terminated by sharp tubercles or spines at the point of division into the fine secondary ribs. The secondaries, of which there are three to five per primary, sweep forward over an arched venter. The body chamber shows an uncoiling of the umbilical seam, a coarsening of the tubercles and secondary ribs, a fading of the primary ribs, and it is terminated by a well differentiated mouth border, with two spatulate lappets. The stratigraphic range of the subgenus is the same as that of Emileites, its macroconch counterpart, that is upper concavum Zone to middle laeviuscula Zone.

Trilobiticeras (Trilobiticeras) cricki sp. nov.
Plate 1, figs.1-3 & 5, Text figure 2

1885 Sphaeroceras sauzei (variete ?); Douvillé, p.41, Plate III, fig.10.

1894 Sphaeroceras sp. nov.; Crick, p.436.

1972 Trilobiticeras trilobitoides Buckman; Galacz, pp.43-4, Text fig. 2a-d.

1974 Trilobiticeras sp. nov.; Parsons, p.169.

Material

Three specimens from the top 10cm. of bed 2, Barns Batch Spinney, Dundry Hill, Bristol, BMNH.C79426, C79427 & C79425; one specimen from bed 4b, Seavington St. Mary (ST398144), Somerset (Parsons & Torrens in Torrens 1969, p.A27), BMNH.C79433; one specimen from bed 6, Bruton Railway quarry, Bruton, Somerset, BMNH. C79431; one specimen from the base of the 'fossil-bed', Sandford Lane, Sherborne, Dorset (Buckman, 1893, p.492, bed 6), BMNH.C79430; one specimen from Cape Mondego, Portugal (Ruget-Perrot 1961, p.27, bed 5), BMNH.C79435; one specimen from Bradford Abbas, near Sherborne, Dorset, SM.J24550 and three Dundry specimens from old museum collections, BMNH.C75270, C75287 and OUM.J1163. A total of eleven specimens, plus numerous (+100) other less well localised specimens in various old museum collections.

Dimensions

Holotype, BMNH.C79426, a complete specimen, with lappets and $\frac{3}{4}$ of a whorl of body chamber.

D.	Ud.	Pn.	Wh.	Wb.	Wb./Wh.
2.82	0.96 (34%)	17	1.19 (42)	1.36 (48)	1.14
2.23	0.75 (34)	16	1.0 (45)	1.32 (59)	1.32

1st. paratype, BMNH.C79427, a complete specimen, with lappets and $\frac{3}{4}$ of a whorl of body chamber.

D.	Ud.	Pn.	Wh.	Wb.	Wb./Wh.
2.85	1.03 (36)	19	1.11 (39)	1.2 (42)	1.08
2.2	0.78 (36)	17	0.94 (43)	1.11 (51)	1.18

2nd. paratype, BMNH.C79425, a complete specimen, with lappets

Diagnosis

Small, relatively evolute ammonite, with sphaeroconic/corona inner whorls, and a strongly contracted body-chamber terminated by lappets. The primary ribs are sharp, and subdivide at a sharp tubercle into three to five secondaries. It is more evolute and less inflated than any other species of *Trilobiticeras*, whilst the presence of tubercles separates it from *E.*(?) *douvillei* nov.

and $\frac{3}{4}$ of a whorl of body chamber.

2.14	0.66 (31)	23	0.95 (44)	1.0 (47)	1.05
1.16	0.50 (30)	22	0.78 (47)	1.0 (61)	1.28

Description

A small microconch ammonite (maximum diameter, modal value from 95 specimens = 2.65cm.), with cadicone inner whorls and a rapid contraction of the body chamber, which extends for three-quarters of a whorl. The primary ribs are sharp, prorsiradiate and approximately one third of the length of the secondaries. The secondary ribs are extremely fine on the inner whorls, where there are three to five per primary, whilst on the outer whorls, where there are only two to three per primary, they are coarser and more widely spaced. The fine, sharp tubercles at the point of division of the secondary ribs, become stronger on the body chamber, whilst the primary ribs weaken and in some cases become virtually obsolescent. The primary rib density is fairly constant on the inner whorls, but shows a marked increase on the penultimate and last whorls - see Text figure 2. This rib density varies from individual to individual, between 14 and 25 ribs per whorl, the majority of specimens having in the region of 17 to 18 on the last whorl. The contraction of the body chamber results in a relative reduction in whorl breadth, as is clearly shown in Text fig.2. Since the whorl height continues to increase, although at a reduced rate, right up to the mouth border, there is a pronounced change in the whorl cross-section; the cadicone inner whorls, with an arched venter $\left\{\frac{Wb.}{Wh.} = 1.32\right\}$, take on a more rounded cross-section $\left\{\frac{Wb.}{Wh.} = 1.14\right\}$. The mouth border is characterised by fine spatulate lappets, which develop in the mid-whorl position - see Plate 1, fig.1a, and which are usually preceded by a more coarse and prominent secondary rib. Although the inner whorls are cadicone, the contraction of the body chamber gives a more planulate appearance to the mature shell, which is one of the more evolute Otoitid microconchs $\left(\frac{Ud.}{D.} \times 100 = 30\text{-}40\%\right)$. The suture line is difficult to make out on most specimens, but it appears similar to that of the Hungarian specimen (Galacz, 1972, fig.2).

Type Series

The holotype (BMNH.C79426), is one of the dominant morphotypes, (Plate 1, figs.1a-b), whilst the first paratype (BMNH.C79427) is a slightly less inflated and more finely ribbed variant (Plate 1, figs.2a-b). The second paratype (BMNH.C79425), is a small, even more finely ribbed form (Plate 1, fig.5). All three of the above specimens were collected in situ from bed 2 (top 10cm.), Barns Batch Spinney, Dundry Hill. The third paratype from Dundry (BMNH.C75287, ex. Charlesworth coll.), is a large fine ribbed specimen (Plate 1, figs.3a-b), whilst the fourth (BMNH.C75270, ex. Pratt coll.) is one of the more evolute forms. Finally the fifth paratype (OUM.J1163, ex. Goddard coll.), also from Dundry, is the most coarsely ribbed form I have seen; at a diameter of 2.4cm., with $\pm\frac{2}{3}$ of a whorl of body chamber, it has 15 primary ribs, at an umbilical diameter of 0.8cm. (33%).

Sexual Dimorphism

Sexual dimorphism is well marked in this group and Trilobiticeras (T.) cricki nov. exhibits typical microconch features; small size, with well developed lappets. The corresponding macroconch, although not quite as abundant as its partner, is well respresented in the *ovalis* bed at Dundry. These specimens are identical in shell form, style of ribbing and general ornament, to all but the last whorl of *T.* (*T.*) *cricki* nov., but differ by still being wholly septate at a diameter in excess of that attained by mature specimens of the latter. A typical *ovalis* bed macroconch specimen from Dundry (BMNH.C73979) is figured here (Plate 1, fig.10). This has one whorl of body chamber at a diameter of 5.05cm. There are two specific names available for this group. The type specimen of *T.* (*Emileites*) *malenotatus* (Buckman 1927, in 1909-30, Plate 702, - IGS.49293), although rather fragmentary and poorly localised, is undoubtedly very similar to many of these macroconchs. As noted by Buckman (*loc. cit.*), the matrix of this specimen is typical of the *ovalis* bed of Dundry. The type specimens of *T.* (*E.*) *liebi* (Maubeuge 1955, Plate 9, figs. 1a-d and 2) are even closer in gross morphology to the Dundry forms, and it is likely that this species is a subjective junior synonym of *T.* (*E.*) *malenotatus*.

Stratigraphic Range

The majority of members of this species have come from the *ovalis* bed of Dundry, which is *ovalis* subzone, *laeviuscula* Zone in age (Parsons 1974, p.169). The lowest occurrence of this species would appear to be the *discites* Zone. A single specimen from Bradford Abbas, near Sherborne, Dorset (SM.J24550), has the 'iron-shot', black stained matrix typical of the top part of the Bradford Abbas 'fossil-bed', which is of this age (*op. cit.*, p.170). A few specimens have been found as high as the *laeviuscula* subzone of the laeviuscula Zone at Sandford Lane quarry, Sherborne (BMNH.C79430; Buckman 1893, p.492, bed 6c.) and at the South Main-road quarry (ST567655), Dundry (CP.2403; Buckman & Wilson 1896, p.691, bed 5).

Geographic Range

Outside of the localities in southern England mentioned above, this species has been figured from Hungary (Galacz 1972, fig.2) and south-east France (Douvillé 1885, Plate III, fig.10; - M121), whilst I have collected it from Cape Mondego, Portugal (BMNH.C79435; Ruget-Perrot 1961, p.27, bed 5).

Discussion

This species is named in honour of G.C. Crick, who first noticed its presence in the Inferior Oolite of Dundry Hill (Crick 1894, p.436). T. (T.) cricki nov. is closest in gross morphology to specimens from the upper concavum/lower discites Zones of southern England, which have been included in T. (T.) punctum (Vaček); (Westermann 1964, Plate 6, figs.5 and 6). It is in fact difficult to establish if the small, fragmentary type specimen of this latter species (op. cit., Plate 6, figs.7a-b) is in fact conspecific with the larger specimens figured by Westermann (loc. cit.), from Seavington-St.-Mary, Somerset. If it is, then this group is consistently more inflated, with a more depressed and coronate whorl section than T. (T.) cricki. These two also have distinct stratigraphic distributions at Seavington-St.-Mary. The more inflated forms, T. (T.) punctum, are relatively common in bed 3, (Parsons & Torrens, in Torrens 1969, p.A27), which is upper concavum Zone in age, whilst the specimen of T. (T.) cricki (BMNH.C79433), came from a higher horizon, bed 4b, which is ovalis subzone in age.

However, ~~the possibility must remain that~~ the lectotype of *T.* (*T.*) *punctum* is nothing but poorly preserved inner whorls and ~~specimen of *T.* (*T.*) *cricki*, rather than of the other congeneric, but stratigraphically lower group. Unfortunately there is no definite solution to this problem, as the lectotype of *T.* (*T.*)~~ is virtually uninterpretable.

The only other species of *Trilobiticeras*, *T.* (*T.*) *trilobitoides* Buckman and *T.* (*T.*) *platygaster* Buckman, both have considerably more coronate inner whorls, a stronger contraction of the body chamber and more prominent spines and tubercles. The primary rib density of these two species is also consistently lower at 14 to 18 per whorl (average 15). As noticed by Crick (1894, p.436), there is a considerable resemblance between some specimens of *T.* (*T.*) *cricki* and members of the *Pseudotoites* group; particularly *P.* (*Latotoites*) *evolutum* (Tornquist), (Westermann 1964, Plate 9, fig.5). Whilst this resemblance could be nothing but another example of convergent evolution and homoeomorphy, taking their relative stratigraphic positions into account, it is possible that these antipodean forms evolved from the *Trilobiticeras*/*Emileites* group at the base of the *laeviuscula* Zone.

PHYLOGENETIC SIGNIFICANCE OF NEW TAXA

One of the main requirements for establishing a phylogenetic relationship is a detailed stratigraphic knowledge of the groups concerned. There have been considerable problems in the past in the interpretation of the early history and evolution of the ammonite family Otoitidae. This has largely been due to the inadequate and often erroneous stratigraphic information available to fill the apparent gap between the first well documented faunas of the discites Zone and the diverse and abundant forms of the sauzei Zone. One obvious source of confusion has been the error introduced by Mascke (1907) and perpetuated by Westermann (1954); that is the artificial stratigraphic separation of the microconch Otoites above its macroconch counterpart Emileia. The other major stratigraphic error which has compounded the difficulties inherent in interpreting the early history of the Otoitids, has centred on the correlation of the horizons now included within the laeviuscula Zone. Buckman (1909-30), when describing several new Otoitid species from these horizons, referred them to more than six different hemerae (approx. = to subzone in present use). When these hemerae were subsequently replaced by Oppel's re-instated sowerbyi Zone (Spath 1936), there was little or no evidence available on the correct stratigraphic age of Buckman's taxa. This is particularly true of the faunas ascribed to the 'so-called' trigonalis subzone, which were an artificial combination of species from at least two separate horizons (see Parsons 1974, pp.162-4, 171, for further details). Because of this confusion it has in the past proved impossible to subdivide the highly diverse Otoitid faunas found below the sauzei Zone (Arkell 1956, p.33). This unfortunately led Westermann (1964, Text fig.14) to use dominantly morphological rather than stratigraphic criteria to establish his Otoitid phylogeny.

Recent work has revealed that there are numerous inconsistencies present in Westermann's phylogenetic scheme. Groups such as Labyrinthoceras and Frogdenites, which were linked as macroconch and microconch are now known to occupy different stratigraphic horizons in the sauzei and laeviuscula Zones respectively, whilst other groups, such as Emileia crater, E. catamorpha, E. brocchii and E. (Otoites) delicata, which were separated by Westermann, are now known to occur together in the lower part of the 'fossil-bed', Sandford Lane, near Sherborne, Dorset (Parsons 1974, p.168). It has now proved possible to determine the correct stratigraphic position of most members of the Otoitinae, an essential step prior to establishing any phylogenetic relationships. The successive Otoitid faunas from southern England (after Parsons 1974, pp.164-171, with additions) are as follows:-

(i) concavum Zone, rare specimens of Trilobiticeras (T.) 'punctum', and its undescribed macroconch, T. (Emileites) sp. nov., both of which are morphologically very similar to the Abbasites group from the subjacent horizons.

(ii) discites Zone, rare specimens of T. (T.) trilobitoides, T. (T.) platygaster and two undescribed macroconchs, T. (Emileites) spp. nov., along with extremely rare specimens of T. (T.) cricki nov.

(iii) ovalis subzone, relatively common specimens of T. (T.) cricki nov., T. (E.) malenotatus, Emileia (E.) subcadiconica and E. (Otoites) douvillei nov.

(iv) laeviuscula subzone (lower part), a diverse fauna of E. (E.) brocchii, E. (E.) catamorpha Buckman, E. (E.) contrahens Buckman, E. (E.) crater Buckman, E. (E.) polyschides (Waagen), E. (Otoites) delicata (Buckman), E. (O.) douvillei nov., E. (O.) sauzei (d'Orb.) group, T. (T.) cricki nov. and T. (Emileites) sp.

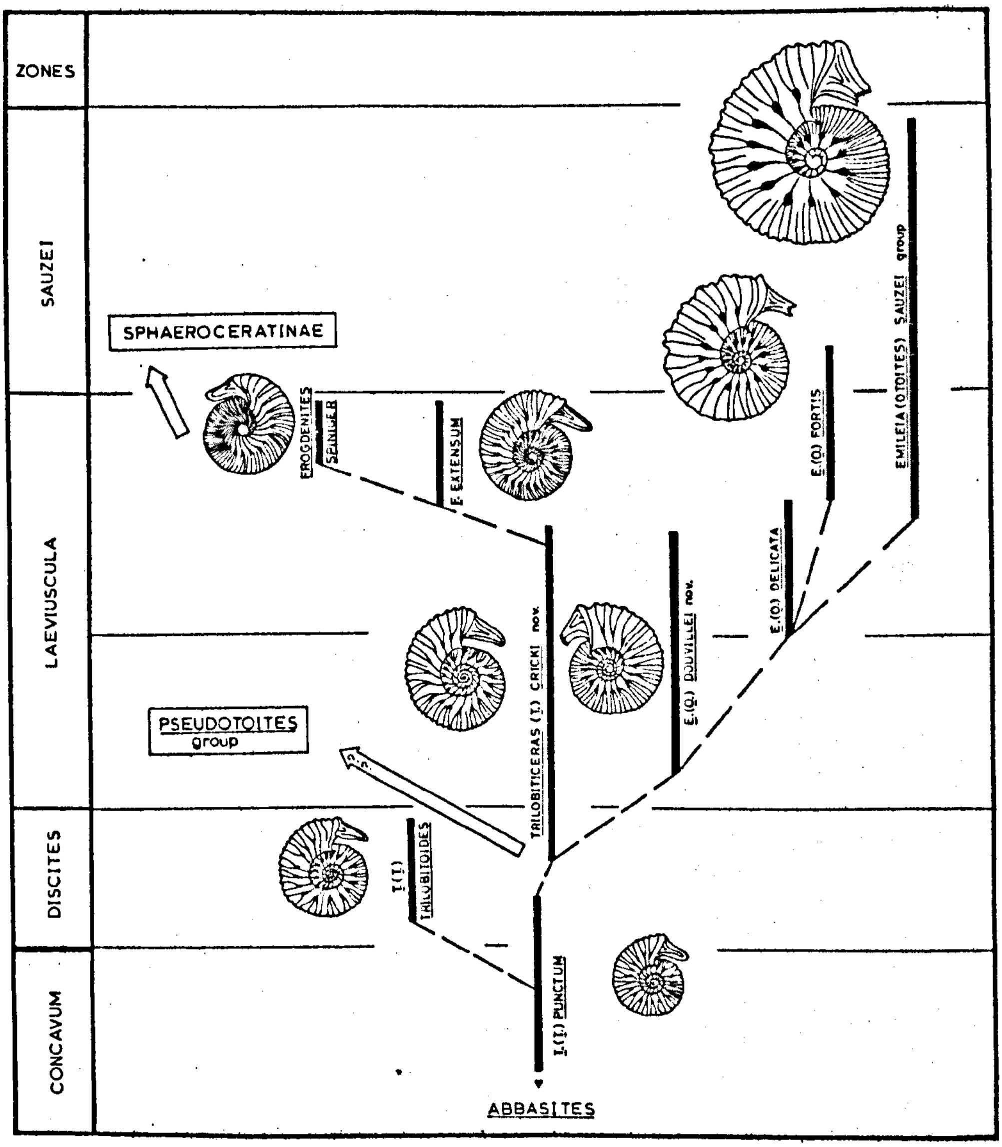


Figure 3.

The stratigraphic distribution and probable phylogenetic relationship of the main microconch members of the ammonite subfamily Otoitinae in southern England.

(v) laeviuscula subzone (upper part), E. (E.) brocchii, E. (E.) bulligera (Buckman), E. (E.) polyschides, E. (Otoites) fortis (Westermann), E. (O.) sauzei group, Frogdenites extensum (Buckman), F. gibberulum (Buckman) and F. spiniger Buckman.

(vi) sauzei Zone, E. (E.) bulligera, E. (E.) greppini Maubeuge, E. (E.) multifida Buckman, E. (E.) polyschides, E. (E.) pseudocontrahens Maubeuge, E. (Otoites) sauzei group and E. (O.) contracta (Buckman non Sow.).

In most of the above faunas, mainly due to lack of material, it is still difficult to specifically link micro- and macroconchs. Thus, except in the case of Frogdenites where the dimorphism is manifestly intraspecific in character, in the bulk of the Otoitinae, following Callomon (1963), dimorphism is best expressed at the sub-generic level. Since morphological diversity is lower in the micro-conch groups, it is easier to establish a phylogenetic link between their successive populations. A summary of the stratigraphic distribution and probable phylogeny of the main microconch members of the Otoitinae is thus shown in Text figure 3.

It is clear from this figure that the two new species are of critical phylogenetic importance. E. (O.) douvillei is the earliest member of its subgenus and its close relationship with T. (T.) cricki finally establishes the Emileia/Otoites group as an offshoot of Trilobiticeras. T. (T.) cricki is of fundamental importance, as it proves to be the root-stock for several important Otoitid groups, as well as a long ranging taxon useful for demonstrating the continuity between the faunas of the discites and laeviuscula Zones.

The genus Frogdenites closely resembles T. (T.) cricki, whilst its early members, such as F. extensum, also have an overlapping stratigraphic range : both F. extensum and T. (T.) cricki occur abundantly together in the middle laeviuscula Zone of Cape Mondego, Portugal (pers. obs.; Ruget-Perrot 1961, p.27, bed 5). Specimens of F. extensum from north Dorset ('green-grained marl', Oborne Wood, Parsons 1974, p.167), exhibit relatively coronate inner whorls, with a rapid uncoiling of the umbilical seam, in a similar fashion to T. (T.) cricki, to give a more planulate overall shell form. Only the relatively late forms, such as F. spiniger, have developed the more inflated, involute, sphaeroconic form, which is transitional to the Sphaeroceratinae. T. (T.) cricki thus shows both a similar shell form, with coronate inner whorls and fine sharp tubercles, and a similar style of dimorphism, with a low size ratio between dimorphs, to that exhibited by Frogdenites. Since T. (T.) cricki is the only group to show these characters, which has a contiguous stratigraphic range with Frogdenites, it thus forms a highly probable ancestor for the latter genus.

The connection between the Pseudotoites group and T. (T.) cricki is the most tenuous of the three phylogenetic relationships suggested. Pseudotoites, particularly in W. Australia, is cryptogenic, as it appears suddenly in a geographically and stratigraphically isolated horizon; the Newmarracarra Limestone (Arkell & Playford 1954). The only way to determine the origins of such a group is to attempt to establish its relative stratigraphic position, and its similarities and affinities, if any, with possible related groups. The genus Fontannesia is abundant in W. Australia, where it forms a mono-specific swarm at the base of the Newmarracarra Limestone (op. cit., text fig.2). Fontannesia is found dominantly in the _discites_ Zone in Europe, although it possibly ranges up into the base of the _laeviuscula_ Zone (Pavia & Sturani 1968, p.311). It is significant that this genus has been found in New Guinea associated with '_Docidoceras_' _longalvum_ (Vacek), another _discites_ Zone form, (Westermann & Getty 1970). This would suggest that the succeeding _Pseudotoites_ fauna (Arkell & Playford 1954, text fig.2), is just post-_discites_ Zone in age. Since both _Fontannesia_ and _Docidoceras_ are predominantly Tethyan in origin (Arkell 1956, pp.177 and 209; Westermann & Getty 1970, p.291), it is logical to seek the ancestors of the _Pseudotoites_ group in the Otoitids of the Tethyan _discites_ Zone.

The _Pseudotoites_ group shows a high degree of morphological diversity. The Australian macroconchs (_Pseudotoites_ _s. str._), are medium sized, relatively inflated forms, with inner whorls exhibiting numerous, fine prorsiradiate secondary ribs (Arkell & Playford 1954, pl.32, fig.3), very similar to the _T._ (_E._) _malenotatus_ figured here (Plate1 , fig.10). The outer whorls show a modified ornament, with the development of short, inflated, nodate primary ribs. This is a similar trend to that shown by some undescribed specimens of _Emileia_ from the lowest _laeviuscula_ subzone at Dundry. The corresponding microconchs (_Pseudotoites_ (_Latotoites_) spp.), included by Arkell in _Otoites_ are similar to the latter genus in ribbing style, but differ by being much more evolute. They are thus similar in many characters, except size, to _T._ (_T._) _cricki_ nov. There are rare specimens in the Australian faunas which show a close similarity with members of the _T._ (_T._) _trilobitoides_ Buckman group: _P._ (_Latotoites_) _depressus_ (Whitehouse), (Arkell & Playford 1954, pl.30, fig.7). Arkell was hesitant about including the latter taxon in Trilobiticeras, because of its greater size (c.4.0cm.), compared to the much smaller european Trilobiticeras known at that time. The description of T. (T.) cricki, with a maximum diameter in excess of 3.1cm. has thus removed one serious objection to any comparisons between these groups.

On both general morphological and stratigraphic grounds, there is thus no really plausible existing alternative to accepting the Trilobiticeras/T.(Emileites) group as the root stock of Pseudotoites. If Pseudotoites did not evolve directly from the T. (T.) cricki group, then they both must have had a common ancestor in the discites Zone. An interesting problem is presented by the relationship of the above groups to the genus Docidoceras. As pointed out by Arkell (Arkell & Playford 1954, p.572), the type species of this genus, D. cylindroides S. Buckman, bears a close morphological relationship to some members of the Pseudotoites group. The former species is in fact atypical of the rest of the forms included in Docidoceras by Buckman (1909-30), (Arkell & Playford 1954, p.572). There is thus a possibility that this species may have had a common origin, with Trilobiticeras/Emileites, in the concavum Zone Abbasites; a suggestion already made by Westermann (1969, pp.129 and 137). The bulk of the other 'species' of 'Docidoceras', with their more typically stephanoceratid ribbing style, are undoubtedly closely related to some as yet undescribed species, akin to 'D.' longalvum (Vacek), from the middle murchisonae Zone of south Dorset (Senior, Parsons & Torrens 1970 - Docidoceras sp., Horn Park quarry, bed 5a). The genus Docidoceras, as at present defined, could thus be polyphyletic. One thing which can be certain is that Docidoceras, taking into account its stratigraphic range and gross morphology, makes a

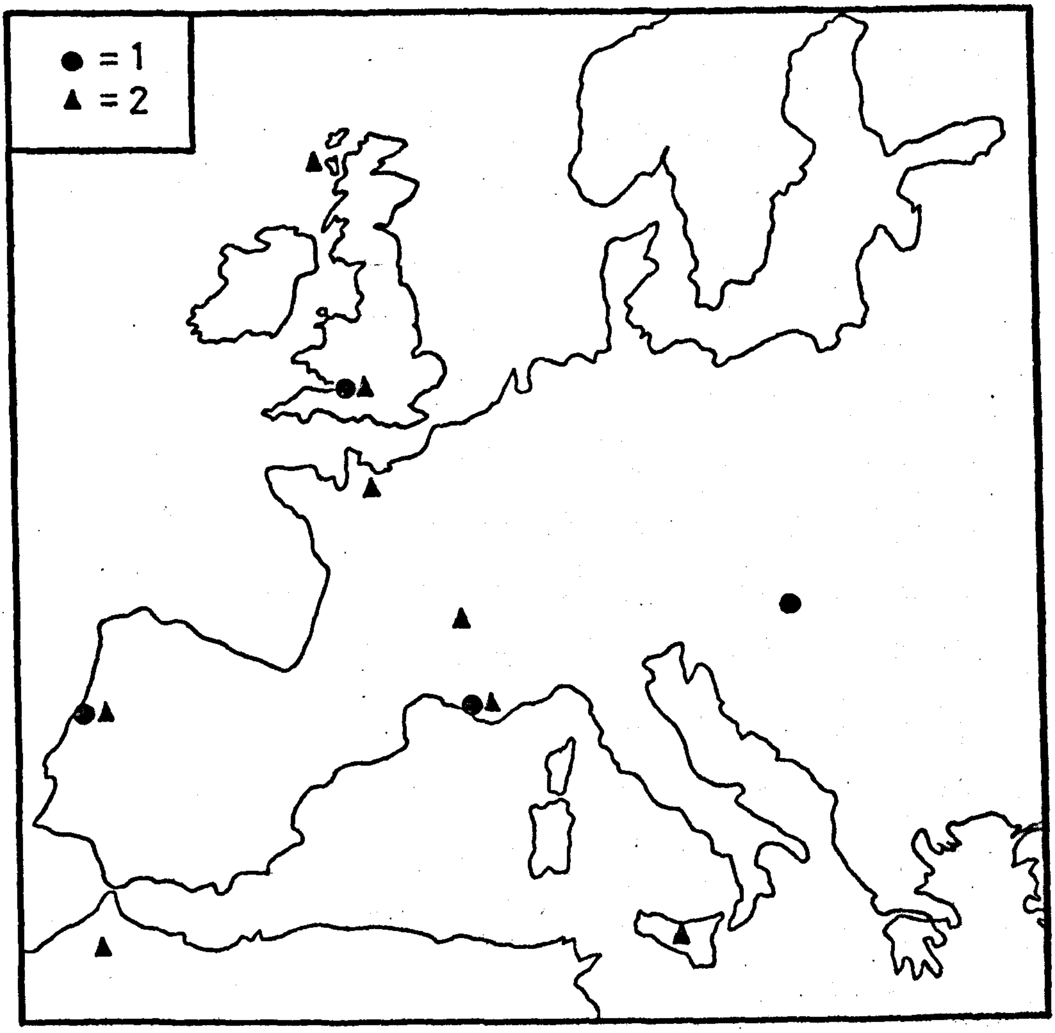


Figure 4.

The geographic distribution of 1/ Trilobiticeras (Trilobiticeras) cricki sp. nov. and 2/ Emileia (Otoites) douvillei nov.

poor dimorphic partner for Trilobiticeras; on these grounds Emileites is far more satisfactory.

STRATIGRAPHIC SIGNIFICANCE

The two species described here jointly have a restricted stratigraphic range (Text figure 3) and a wide geographic distribution (Text figure 4), they thus form an important part of an ammonite fauna, which over most of Europe is characteristic of the basal ovalis subzone of the laeviuscula Zone (Parsons 1974). Whilst the constituent members of this fauna remain much the same, their relative proportions vary according to geographic position. In southern England, a fairly typical locality, Barns Batch Spinney, Dundry, has yielded a fauna (N = 84), with the following proportions:

Witchellia	46 specimens
Sonninia	10 specimens
Trilobiticeras	17 specimens
Emileia	2 specimens
Docidoceras	1 specimen
Bradfordia	6 specimens
Strigoceras	2 specimens

To the north in Skye (Inner Hebrides, Scotland), the Sonninidae are almost totally dominant, as apart from an isolated specimen of E. (O.) cf. douvillei nov., only specimens of Sonninia s. lat. and Witchellia have been recorded (pers. obs.; Morton 1975). South towards Tethys the Sonninidae become progressively less abundant, as there is an increase in diversity, linked with a levelling out of the relative proportions of the different ammonite groups present.

On the whole in Tethyan and adjoining regions, the Stephanoceratacea and Haploceratacea are the more important. Of these, the genus *Bradfordia* is particularly characteristic of the Lower Bajocian in Bulgaria (Sapunov 1971), Sicily (Renz 1925) and Portugal (pers. obs.). The major exception to this trend appears to be south Germany, where probably due to palaeo-geographic isolation, the faunas are largely restricted to *Sonninia s. str.* The most important areas of preservation of *ovalis* subzone faunas in Europe are to be found in England, France and Germany.

Southern England

The best exposures of rocks assigned to this subzone in England are to be found on Dundry Hill, near Bristol. Here sections at Castle Farm (Buckman & Wilson 1896, p.676), Barns Batch Spinney (*op. cit.*, p.689), South Main-road (*op. cit.*, p.691) and Rackledown (*op. cit.*, p.692), have all yielded abundant *ovalis* subzone faunas. The most extensive collection from this horizon, the 'Lower white Iron-shot', has been made at Barns Batch Spinney (*op. cit.*, p.689, bed 2), and this includes:

Witchellia (*Witchellia*) *albida* (S. Buckman)
W. (*W.*) *romanoides* (Douvillé)
W. (*W.*) cf. *connata* (S. Buckman)
W. (*W.*) cf. *sutneri* (Branco)
W. (*Pelekodites*) *pelekus* (S. Buckman)
W. (*P.*) cf. *macra* (S. Buckman)
Sonninia ovalis (S. Buckman, *ex.* Quenstedt)
Euhoploceras sp.
Bradfordia cf. *inclusa* S. Buckman

Strigoceras compressum (S. Buckman)

Toxamblyites sp.

Docidoceras cf. *cylindroides* S. Buckman

Trilobiticeras (*Trilobiticeras*) *cricki* nov.

T. (*Emileites*) *malenotatus* (S. Buckman) -

T. (*E.*) *liebi* (Maubeuge) group

Emileia (*Otoites*) *douvillei* nov.

Other areas in England which have produced similar faunas include the Cotswold Hills (Buckman 1895, p.397, beds 4-5); the Cole 'syncline', Bruton, Somerset (Richardson 1916, p.495, bed 6); the Sherborne district, Dorset (Buckman 1893, p.493, bed 8) and Seavington-St.-Mary, Somerset (Parsons & Torrens, in Torrens 1969, p.A27, bed 4b).

France

The so called '*Witchellia*-beds' of Normandy have produced a fauna of at least the *ovalis* subzone (Haug 1893; Bigot 1900; Gabilly & Rioult 1974). The most famous exposures of rocks of this age are however to be found to the south near Toulon (Douvillé 1885). Here a thin, condensed limestone has produced one of the most diverse faunas from this subzone, which has been described in detail (*op. cit.*). Whilst the stratigraphy and distribution of this bed is well known (*op. cit.*; Lanquine 1929), the interpretation of its fauna has been difficult, as only a few specimens have been figured by modern methods (Lanquine 1929, pls.IX and X). For the rest only the rather stylized drawings provided by Douvillé (1885, pls.I-III) have been available. However Douvillé's specimens are still preserved in the École des Mines collections, now held at the Université de

Paris-Sud. The latter has kindly provided me with photographs of this material, which have enabled a more accurate interpretation of Douvillé's figures to be made:

Plate I, Figure	1	= *Euhoploceras* sp.
	2	= ?*E.* sp.
	3 & 3a	= *E.* sp.
	4	= *E.* cf. *palmata* S. Buckman
	5	= *Witchellia* (*Pelekodites*) cf. *zurcheri* (Douvillé)
	6	= *W.* (*P.*) *zurcheri*, lectotype, designated by Buckman (1909-30, pl.399)
	7	= *W.* (*P.*) *zurcheri*
	8	= *Zurcheria ubaldi* Douvillé
Plate II, Figure	1	= *Witchellia* (*Witchellia*) *sayni* Haug, lectotype designated by Gillet (1937, p.59)
	2-5	= *W.* (*W.*) spp.
Plate III, Figure	1-2	= *W.* (*W.*) sp.
	3 & 3a	= *W.* (*W.*) *romanoides* (Douvillé)
	4	= *W.* (*W.*) *romanoides*
	5	= *W.* (*W.*) *romanoides*
	6 & 6a	= *Bradfordia praeradiata* (Douvillé), lectotype designated by Sapunov (1971, p.79)
	7	= *Bradfordia* cf. *praeradiata*
	8	= *Emileia* (*Emileia*) aff. *subcadiconica* S. Buckman
	9	= *E.* (*Otoites*) *douvillei* nov.
	10	= *Trilobiticeras* (*Trilobiticeras*) *cricki* nov.

The two other specimens, which have been figured from this horizon by Lanquine (1929), are *Emileia* (*Otoites*) cf. *douvillei* nov. (*op. cit.*, pl.IX, fig.6) and *Trilobiticeras* (*Emileites*) sp. (*op. cit.*, pl.X, fig.2). This fauna, apart from its slightly higher apparent diversity, is identical to that recorded from Dundry Hill, England; the close similarity of the *Witchellia* groups is particularly striking.

Germany and Switzerland

The Schwabian Albe of south-west Germany and the adjoining Swiss Jura both possess fossiliferous representatives of the *ovalis* subzone. The 'Unterer Wedel-sandstein' of Schwabia (Parsons 1974, p.173) is the source of the type specimen of *Sonninia ovalis* (Buckman *ex.* Quenst.), and this species is far and away the most abundant in these beds. Other less common forms include rare specimens of *Witchellia* spp. and a solitary specimen of *Trilobiticeras* (*Emileites*) *liebi* (Maubeuge), (Bayer 1968; Parsons 1974, p.175). The equivalent beds in the Swiss Jura have apparently yielded the type specimens of *T.* (*E.*) *liebi* (Maubeuge 1955, pl.9, figs.1a-d and 2), but this needs to be confirmed by the collection of *in situ* topotypes.

Acknowledgements

I should like to thank the curators of the following museums for access to material in their care: The British Museum (N.H.) and Institute of Geological Sciences, London; the museum of the department of Geology, Bristol University; Bristol City museum; Oxford University museum; the Sedgwick museum, Cambridge and the Yorkshire museum, York. I should also like to thank the Université de Paris-Sud, Centre d'Orsay, for providing photographs of material in the Douvillé collection.

EXPLANATION OF PLATE 1.

(All specimens are coated with ammonium chloride)

Figures 1a–b, Trilobiticeras (Trilobiticeras) cricki nov. (m.), holotype, BMNH. C79426, in situ bed 2, Barns Batch Spinney (Buckman & Wilson, 1896), Dundry Hill, Bristol, England; x 1.5.

Figs. 2a–b, T. (T.) cricki nov., 1st. paratype, BMNH. C79427, in situ bed 2, Barns Batch Spinney; x 1.5.

Figs. 3a–b, T. (T.) cricki nov., 3rd. paratype, BMNH.C75287, Dundry; x 1.5.

Fig. 4, Emileia (Otoites) sp. cf. E. (O.) douvillei nov. (m.), Reed collection, Yorkshire Museum, YM989, the 'fossil-bed', Sandford Lane, Sherborne, Dorset, England; x 1.0.

Fig. 5, T. (T.) cricki nov. (m.), 2nd. paratype, BMNH.C79425, in situ bed 2, Barns Batch, Spinney, Dundry; x 1.5.

Figs. 6a–b, E. (O.) douvillei nov. (m.), holotype, Cb4744, Dundry; x 1.5.

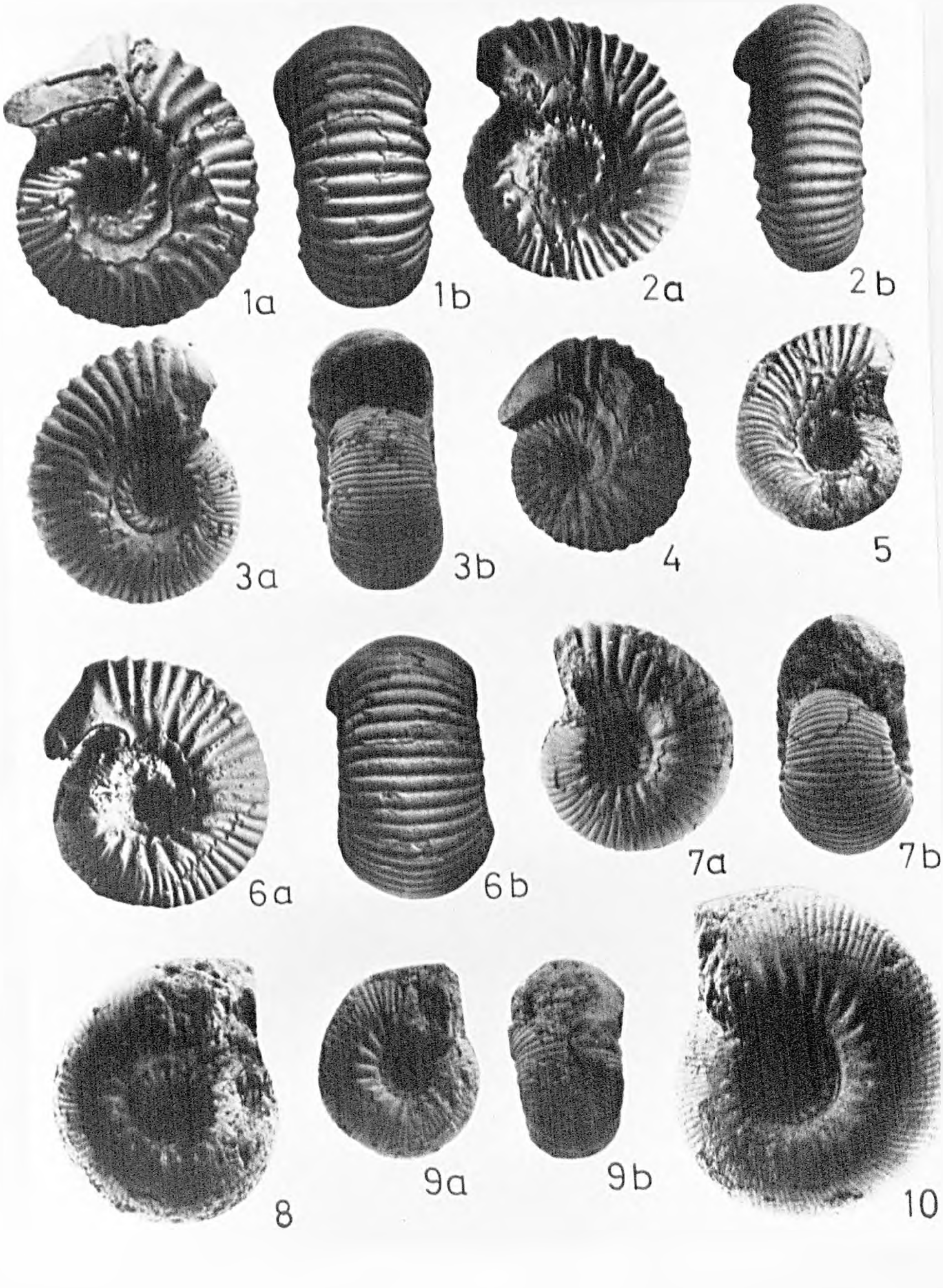
Figs. 7a–b, E. (O.) douvillei nov. (m.), 5th. paratype, BMNH. C75242; x 1.5.

Fig. 8, E. (Emileia) subcadiconica S. Buckman (m.), BMNH. C75279, Dundry; x 1.0.

Figs. 9a–b, E. (O.) douvillei nov. (m.), 1st. paratype, BMNH. C79429, in situ bed 2, Barns Batch Spinney, Dundry; x 1.5.

Fig. 10, T. (Emileites) malenotatus (S. Buckman), (m.), BMNH. C73979, Dundry; x 1.0.

PLATE 1.



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3B. A SYSTEMATIC REVISION OF THE BAJOCIAN AMMONITE SUBFAMILY SPHAEROCERATINAE

by

C.F. Parsons

Abstract: The classification of this Bajocian (Middle Jurassic) ammonite group is discussed, and it is here defined as a subfamily within the ammonite family Otoitidae; with three constituent genera (*Chondroceras*, *Labyrinthoceras* and *Sphaeroceras*) and five subgenera (*Sphaeroceras* (*S.*), *S.* (*Megasphaeroceras*), *Chondroceras* (*C.*), *C.* (*Defonticeras*), and *C.* (*Praetulites*)). Six species and subspecies of *Sphaeroceras* (*S.*); eight of *Chondroceras* (*C.*), including one new (*C. obornensis* nov.), and two subspecies of *Labyrinthoceras* are described. The evolution of the subfamily is discussed and its interesting exhibition of evolutionary size decrease described. The problems of sexual dimorphism in the Sphaeroceratinae are summarised and the stratigraphic distribution and significance of its members detailed.

CONTENTS

I. INTRODUCTION TO THE SPHAEROCERATINAE

The Sphaeroceratidae was erected as a family name for a diverse group of unrelated ammonite genera: *Sphaeroceras*, *Emileia*, *Otoites*, *Chondroceras*, *Docidoceras*, *Labyrinthoceras*, *Trilobiticeras*, *Morrisiceras* and *Macrocephalites* (Buckman, 1920 in 1909-30, p.22). This taxon was later restricted by Buckman (1921 in 1909-30), who removed *Morrisiceras* and *Macrocephalites* to the Tulitidae and Macrocephalitidae respectively. Roman (1938, p.197), further restricted his use of the Sphaeroceratidae to the genera, *Sphaeroceras* (including *Labyrinthoceras* & *Chondroceras*), *Platystomaceras*, *Emileia*, *Otoites* (including *Trilobiticeras*) and *Defonticeras*; whilst Arkell (1951-9; 1957), assigned most of these genera to other families, and restricted the Sphaeroceratidae to *Sphaeroceras*, *Chondroceras*, *Labyrinthoceras* and *Oecoptychoceras* only. With the placing of this latter genus in the Morphoceratidae (Westermann, 1956a), the Sphaeroceratidae came to be represented solely by three genera, as are accepted here. The ammonite subfamily Sphaeroceratinae, so defined, consists of a well differentiated, Bajocian group, of small to medium sized, sphaeroconic ammonites, with fine sharp ribs and a low degree of morphological differentiation between sexual dimorphs.

There are several Bathonian/Callovian genera, such as *Bomburites*, *Bullatimorphites* and *Kheraiceras* (Arkell, 1951-9, pp.86-90), which bear a strong, if perhaps only superficial resemblance to these Bajocian taxa. Many of these younger genera were originally placed in *Sphaeroceras*, and thus were included in the Sphaeroceratidae (cf. Roman, 1938). The greatest similarity, as noticed at an early date by Waagen (1867, p.604), is between certain species of *Chondroceras*, particularly *C. evolvescens* (Waagen), and members of the *Bullatimorphites* group (e.g. *B. suevicum* (Roemer), Quenstedt, 1845-9, Plate 15, fig. 5; Westermann & Getty, 1970, Plates 53-5). This has suggested a direct phylogenetic link between these two groups (Arkell, 1951-9, p.82). Whilst the latter must remain a possibility, there are several factors which suggest that this close similarity could be nothing more than another example of convergent evolution and homoeomorphy. Notably there are considerable differences between these groups in the structure and organisation of their septal sutures. In particular the Bajocian taxa, such as *Chondroceras* possess a 'heterochronous, internal lateral lobe' (U_n), rather than the 'normal' U_1 in *Bullatimorphites*, which is characteristic of the Tulitidae (i.e. the latter is 'eubullate', see Westermann, 1964a, p.996; 1967, pp.259-60; Westermann & Getty, 1970, pp.253, 263). Another important factor is the considerable stratigraphic break between the last Bajocian members of the Sphaeroceratinae in the upper Garantiana Zone (= lower-most Parkinsoni Zone of some authors), and the appearance of the Bathonian forms in the upper Zigzag Zone. In fact this stratigraphic gap is even larger, since the species of *Chondroceras*, which are commonly compared with *Bullatimorphites*, are restricted to the lower Humphriesianum Zone. The younger Bajocian Sphaeroceratinids are far less comparable, since they are more involute, and much smaller. It has been suggested that members of the subgenus *Chondroceras* (*Praetulites*), particularly "*C.* (*P.*)" *dalpiazi* Sturani 1964 (pp.24-5), might at least in part fill this gap, (*loc. cit*). However, it has subsequently been shown that this latter taxon is a mis-placed Callovian form (Sturani, 1968, pp.43-49), and in fact there is little or no information available on the

	ZONE	SUBZONE
UPPER BAJOCIAN	*Parkinsonia parkinsoni*	*Parkinsonia bomfordi* *Strigoceras truellei*
	Strenoceras (Garantiana) garantiana	*Parkinsonia acris* *Strenoceras (Pseudogarantiana) dichotoma*
	Strenoceras (S.) subfurcatum	*S. (Garantiana) baculata* *Caumontisphinctes (C.) polygyralis* *Teloceras banksi*
LOWER BAJOCIAN	*Stephanoceras (S.) humphriesianum*	*Teloceras blagdeni* *Stephanoceras (S.) humphriesianum* *Dorsetensia romani*
	Emileia (Otoites) sauzei	
	Witchellia (W.) laeviuscula	*Witchellia (W.) laeviuscula* *Sonninia ovalis*
	Hyperlioceras (H.) discites	

Table 1.

Zones and Subzones of the Bajocian Stage (excl. Aalenian), modified after Parsons, (1974 & 1976).

correct stratigraphic position of Praetulites, which might well originate from an horizon as low as the Sauzei Zone (Westermann, 1956, p.46).

Thus, whilst it is possible that the Bathonian Bullatimorphites may have originated from a long ranging, but as yet unknown Bajocian Sphaerocerati~~i~~nid, other origins, such as within the Morphoceratidae, cannot be ruled out. In these circumstances it would seem best to restrict membership of the Sphaeroceratinae to those Bajocian taxa, which can be shown to be naturally related; that is the three genera discussed above.

Sphaerocerat~~i~~inid ammonites are most commonly found within the Humphriesianum and Subfurcatum Zones of the Bajocian, although they are more rarely encountered at horizons above and below these Zones. The absolute range of this subfamily depends on the definition of its contents, but as defined here, it would appear to be from the upper Laeviuscula Zone to the base of the Parkinsoni Zone; see Table I for the zonal scheme used here. Whilst these ammonites have a relatively wide stratigraphic range, they would seem to have a restricted geographic distribution. The sphaeroconic shell shape appears to be linked with some form of 'facies control' of these ammonites, as with the Bathonian Tulitidae (Torrens, 1967, p.84: Hahn, 1971, pp.62-4). Thus the genus Sphaeroceras is particularly abundant in limestone deposits, which were laid down on shallow, current swept areas of the sea floor (Sturani, 1971, p.44). Some degree of palaeo-geographic isolation undoubtedly increased their provinciality: thus some species of Chondroceras, including C. schmidti (Westermann) & C. schindewolfi (Westermann), are more relatively abundant in Germany and the Swiss Jura, where similarly restricted faunas of Staufenia are to be found in the Aalenian. This provinciality of the Sphaeroceratinae strongly contrasts with the occurrence of the Stephanoceratidae at the same horizons, most of which are truly cosmopolitan. In this work I am thus restricting myself to those members of this subfamily, which are known to occur in the British Isles.

In the recent past attempts have been made to undertake a systematic revision of this subfamily, (Westermann, 1956 and 1964). Both of these works suffered from a lack of knowledge of the strati-graphic distribution of the various species and 'morpho-types', which resulted in dubious and often illogical conclusions. A more recent paper by Sturani (1971) has described large and well localised collections of Sphaeroceratids from the Venetian Alps of Italy. However the nature of these faunas, with their small physical size in this 'Coquina facies' makes comparisons with other areas difficult. It is also sad to note some glaring omissions in this otherwise fine work; notably the lack of any measurements or collection numbers for many specimens, including the holotypes of some new species, such as *Sphaeroceras tenuicostatum* Sturani.

Material

The following account is mainly based on over four hundred Sphaeroceratid ammonites, which I have collected *in situ* from various localities in the British Isles: south Dorset, Somerset, the Isle of Skye, but mostly from the Sherborne area of north Dorset. Use of museum specimens has, as far as possible been restricted to well localised and documented specimens. The latter overwhelmingly originate from Milborne Wick, Somerset, where the one thin bed which has yielded most of the Sphaeroceratid ammonites, has a highly distinctive matrix. Other, less well documented museum material has only been used either for comparative purposes, or to give a better knowledge of the range of variation in species, such as *C. grandiforme* Buckman, where only small *in situ* samples are available. Because of the very close affinity between the Normandy (France) and Dorset ammonite populations, and also because many of the type specimens of distinctive Sphaeroceratid species originate from Normandy, a few specimens from this region, in both my own and museum collections, are included here.

II. HIGHER LEVEL CLASSIFICATION OF THE SPHAEROCERATINAE

In deciding the limits of taxa above the species level, consideration must be given to the phylogeny of the groups concerned, as well as to their degree of morphological diversity and divergence. Various attempts at revising the classification of the Sphaeroceratinae have come to grief, either by ignoring or over stressing one or more of these criteria. Thus Westermann (1956) overstressed minute morphological differences, and produced a highly restricted family group, with an excessive number of genera and species. Westermann's more recent attempt to rationalise his previous over zealous 'splitting' by, reducing the Sphaeroceratinae to a subfamily, eliminating a number of species and reducing a number of genera to subgenera, (Westermann, 1964), whilst on the right lines, has failed to produce a more natural classification. This has been due to a lack of evidence on another important criteria; relative stratigraphic distribution. Hence, whilst it might seem logical, on the basis of previously published statements and following Buckman's work (Buckman, 1893 & 1909-30), to link together the genera <u>Frogdenites</u> and <u>Labyrinthoceras</u> as micro- and macroconch respectively; this would be untenable if these two genera were shown to be stratigraphically isolated; as is in fact the case (Parsons 1974, p.175). Before any attempt was made to revise the classification of the Sphaeroceratinae, a great deal more knowledge of the degree of variation and the stratigraphic distribution of this group was needed. The first aim of this work is thus to try to fulfil some of these needs.

Since its inception the Sphaeroceratinae has been considered as; 1/ a full family (Buckman, 1909-30); 2/ a subfamily within the Stephanoceratidae (Morton 1971); 3/ a subfamily within the Otoitidae, (Westermann, 1964). Whilst a full family rank for this taxon could be considered, there is perhaps insufficient divergence from the Otoitidae root stock to warrant this status. There are good reasons for rejecting any close taxonomic link between the Otoitidae/ Sphaeroceratinae and the Stephanoceratidae, since these groups possibly evolved independently; the Stephanoceratidae from _Erycites_ _sensu stricto_ in the Scissum-Murchisonae Zones (Aalenian Stage) and the Otoitidae from _Abbasites_ in the basal Concavum Zone. The latter of these three groupings would thus appear the most suitable.

The morphological divergence which separates the Sphaeroceratinae from the Otoitinae is slight. _Frogdenites spiniger_ S.Buckman and _Chondroceras obornensis nov._ are in many respects extremely alike (they have a similar size range, style of dimorphism and shell form and coiling) but they differ in one important feature, _C. obornensis_ has lost all trace of any spines or tubercles. The Otoitinae are here characterised as a subfamily, by two important criteria; by their well developed sexual dimorphism, with the presence of relatively small, well lappeted microconchs, and by their different ornament with the occurrence of sharp spines and/or tubercles, on the microconchs. The differentiation of the Sphaeroceratinae is thus immediately apparent when the loss of spines in the earlier species is reinforced in later groups by the loss of lappets in the microconchs and a lower relative size ratio between dimorphs.

At the generic level there seems little need for the recognition of more than three genera and six subgenera within the Sphaeroceratinae, which are as follows:-

1. The genus Sphaeroceras Bayle, 1878.

A series of small, globular ammonites, with a closed umbilicus. This generic name was preoccupied, but its use has been validated under the plenary powers of the International Commission of Zoological Nomenclature (Opinion 300, 1954).

i. The subgenus Sphaeroceras (Sphaeroceras).

As typified by its type species, S. brongniarti (J. Sow.), this group consists of a series of very small, globular ammonites, with wiry, sharp ribs, an occluded umbilicus and a very sharp contraction of the body-chamber.

ii. The subgenus Sphaeroceras (Megasphaeroceras) Imlay, 1961.

This taxa is closely related to the nominate subgenus. The type species, S. (M.) rotundum (Imlay), differs only in its greater maximum size, from some typical members of Sphaeroceras s. str. However, since members of this subgenus appear to be restricted to North and South America, this apparent similarity to Sphaeroceras, could be nothing more than another example of convergent evolution. Until it is possible to show that Megasphaeroceras did not evolve independently from the 'Old World' stocks, it is best kept separate.

2. The genus Chondroceras Mascke, 1907.

This genus comprises a group of relatively small, involute ammonites, with a deep, narrow, but open umbilicus.

i. The subgenus Chondroceras (Chondroceras) syn. Schmidtoceras, Westermann 1956.

A group of small, relatively involute ammonites, with an open umbilicus and fairly fine ribs, with a high primary rib density per whorl. The type species, C. (C.) gervillei (J. Sow.), is closer in gross morphology to the type species of Schmidtoceras, S. schmidti

Westermann, than many species which have been assigned to *Chondroceras s. str.*, such as *C.* (*C.*) *evolvescens* (Waagen). There is thus no alternative but to consider *Schmidtoceras* as a junior subjective synonym of *Chondroceras* (*Chondroceras*).

ii. The subgenus *Chondroceras* (*Defonticeras*) McLearn, 1927, syn. *Saxitoniceras*, McLearn.

There are no stratigraphic or morphological characters which would support the separation of *Defonticeras* and *Saxitoniceras* (Arkell, 1951-9, p.78; Westermann, 1964). The type species of this subgenus, *C.* (*D.*) *defontii* (McLearn), is extremely like certain members of *Chondroceras s. str.*, such as *C. evolvescens*; although it, and its close relations, differ from most European Chondroceratids, by possessing, stronger, coarser and straighter primary ribs. However, like *Megasphaeroceras*, these taxa have only been found in America, and until such time as it can be proved to be directly connected with its European counterparts, and not merely another example of convergent evolution, it is best kept separate.

iii. The subgenus *Chondroceras* (*Praetulites*) Westermann, 1956.

This taxon is based on the isolated and unlocalised occurrence of its type species, *C.* (*P.*) *kruizingai* Westermann, in the Mollucoas, of the East Indies. This very dubious group is retained here solely because one or two ammonites have been described, such as *C.* (*C.*) *boehmi* Westermann, which in general morphology may link it with the *C.* (*C.*) *grandiforme* Buckman group.

3. The genus *Labyrinthoceras* Buckman, 1921.

This genus consists of a group of medium to small sized, involute ammonites, with an open, narrow and very deep umbilicus, and with very fine prorsiradiate ribs. The type species, *L.*

perexpansum (Buckman), is based on an inadequate, septate nucleus (Buckman, 1909-30, Plate 134A). Buckman's interpretation of the complete ammonite (_op. cit._, Pl.134C), would suggest that this species should be considered as a junior subjective synonym of Waagen's _L. meniscum_ (= '_Ammonites_' _gervillii_ d'Orb. _non_ Sow., d'Orbigny, 1842-51, Pl.140, figs. 1 & 2). This group is the only subgenus within the Sphaeroceratinae, which exclusively possesses lappeted microconchs.

III. THE STRATIGRAPHIC DISTRIBUTION OF THE SPHAEROCERATINAE

The Sphaeroceratinae range in Great Britain from the upper Laeviuscula Zone to the base of the Parkinsoni Zone - see Table 1 for the zonal scheme used here. However, they are at their most abundant in the Humphriesianum/Subfurcatum Zones of the Sherborne district of north Dorset. The detailed stratigraphy of this area has recently been revised (Parsons, 1976), and for further details of these ammonite faunas, the latter work should be consulted. The earliest members of this subfamily are found to intergrade with the genus _Frogdenites_ (= Otoitinae _s. str._), in the 'green-grained marl' bed of Oborne, north Dorset (= bed 3, Oborne Wood; ST648188; Parsons, 1976, p.132). From this earliest member of the genus _Chondroceras_ (_C. obornensis_ nov.), all subsequent Sphaeroceratids seem to have evolved. The successive faunas, within which various lineages may be separated are as follows:-

1/ Laeviuscula Zone and subzone

C. obornensis nov., which shows some transitional features to _Frogdenites_, is occasionally found at this horizon, at Oborne Wood (bed 3) and on Dundry Hill, Avon (= bed 5, South Main-road quarry; Buckman & Wilson, 1896, p.691).

2/ Sauzei Zone

A more varied fauna has been found at this horizon, although Sphaeroceratinids are still exceedingly rare. _Labyrinthoceras meniscum_ and _Sphaeroceras manseli_ (J. Buckman) have been found in the top of the Sandford Lane 'fossil-bed' (Parsons, 1974, p.166), at Sandford Lane, near Sherborne (ST628179), and in its equivalents in the Clatcombe area (Clatcombe Farm; ST636184; Parsons, 1976, p.124, bed 4), whilst at Dundry specimens of Labyrinthoceras have been found in the topmost part of the 'Brown iron-shot' (= bed 4, South Main-road).

3/ Humphriesianum Zone, Romani subzone

This horizon is characterised by the most abundant and varied occurrence of the Sphaeroceratinae; particularly C. evolvescens, with less common specimens of C. gervillei (J. Sow.), C. grandiforme S. Buckman, C. polypleurum (Westermann), C. polypleurum crassicostatum (Westermann) and Sphaeroceras brongniarti (J. Sow.). These species have been found in the basal part of the 'Oborne Road-stone' (beds 4a/b, Oborne Wood; Parsons, 1976, pp.131-2), at Milborne Wick lane section (ST663205; Parsons, 1976, p.134, bed 5), in the 'Irony bed' to the west of Sherborne (Parsons, 1976, p.122), at Louse Hill (ST608152), and in the 'Red conglomerate' (loc. cit.), at Upton Manor farm (SY512936), Loders Cross (SY506929), Stony Head cutting (SY496927), Bonscombe Hill (SY488919) and Burton Bradstock (SY487891), south Dorset. C. evolvescens is also not uncommon in the middle of the Rigg Sandstones of the Isle of Skye (Morton, 1971).

4/ Humphriesianum Zone and subzone

This horizon has yielded only rare specimens of C. evolvescens, C. polypleurum, C. polypleurum crassicostatum and S. brongniarti in the Oborne area of north Dorset (= bed 4c, Oborne Wood).

5/ Subfurcatum Zone, Banksi subzone

Only very rare specimens of C. sp. nov. aff. C. tenue (Westermann) have come from this horizon at Frogden quarry (ST642185; Parsons, 1976, p.127, bed 5b).

6/ Subfurcatum Zone, Polygyralis and Baculata subzones

Specimens of *Sphaeroceras auritum* (Parona) and *Chondroceras canovense* (de Gregorio) are moderately common throughout the '*cadomensis* beds' of the Oborne area, which are of this age (Oborne Wood & Frogden quarry; Parsons, 1976, beds 6b-d). This is also the claimed type horizon of *S. globus* S. Buckman, although it has been impossible to confirm this by the location of *in situ* topotypes.

7/ Garantiana Zone, Dichotoma and Acris subzones

The basal part of the Sherborne Building-stone, which is to be correlated with the Dichotoma subzone of the Garantiana Zone, has yielded one specimen of *S.* aff. *globus* , at Castle View, Sherborne (ST646173). The '*Astarte* bed' of south Dorset (Parsons, 1975, p.9), which is of Acris subzone age, has yielded *Chondroceras canovense*, *Sphaeroceras tenuicostatum* Sturani and *S. auritum tutthum* (S. Buckman), from Horn Park quarry (ST458022), Upton Manor farm, Loders Cross, Stony Head and Bonscombe. This latter horizon has been placed at the base of the Parkinsoni Zone by some authors (Pavia & Sturani 1968), but by original definition (Buckman, 1893), it must be considered an integral part of the Garantiana Zone (Parsons, 1976a, p.48).

IV. SEXUAL DIMORPHISM IN THE SPHAEROCERATINAE

During the resurgence of interest in the problems of sexual dimorphism in Jurassic ammonites, the Sphaeroceratinae were one of the first groups to receive attention, (Makowski, 1963). Whilst most members of the Stephanoceratacea possess marked morphological differences between micro- and macroconchs, which has resulted in some being placed in different families (eg. Stephanoceras in the Stephanoceratidae and Normannites in the Otoitidae), the Sphaeroceratinae are characterised by a low level of differentiation between dimorphs. In most species of Chondroceras and Sphaeroceras the dimorphism may be considered in taxonomic terms as being of intraspecific rank, rather than subgeneric (q.v. Callomon, 1963, p.50), since the only difference between the two dimorphs is often one of size. Even this difference may not be all that marked, as ratios in size of less than 1:2 between micro- and macroconchs are not uncommon (e.g. C. evolvescens). Thus large samples of any one species may be needed in order to demonstrate the bi-modal size distribution of its population (see Text fig. 1). On the other hand, where the sample size is very small, as with C. gervillei, it may be impossible to establish the presence of both dimorphs, one of which may either still be separate as a different species (or subspecies), or may still remain to be discovered.

The microconchs of the earliest members of the Sphaeroceratinae retain, although much reduced, the lappets of their Otoitid progenitors. Thus C. obornensis nov. and Labyrinthoceras meniscum have lappeted microconchs, whilst Sphaeroceras manseli has evolved a microconch, which has retained only a slight prolongation of the

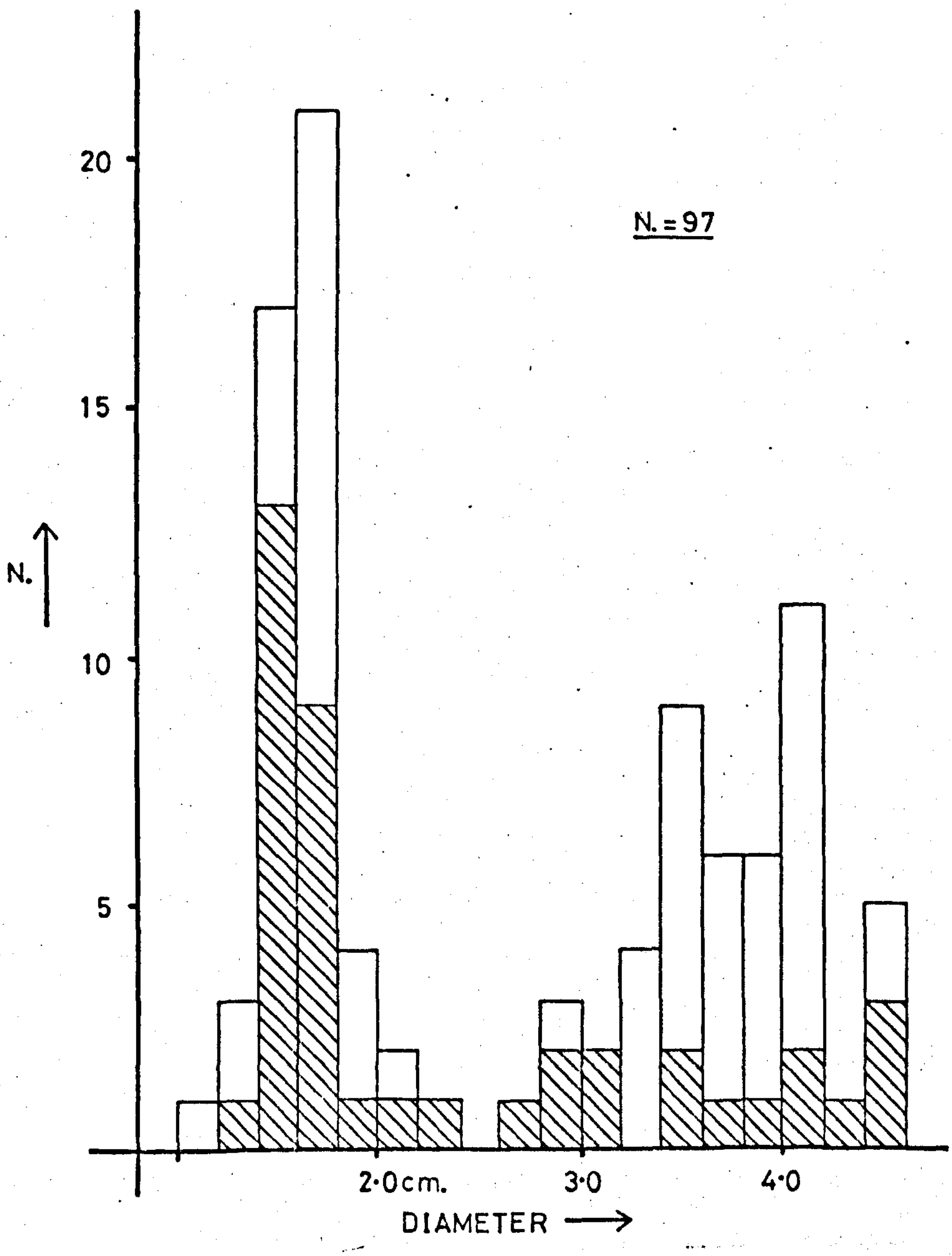


Figure 1.

A histogram of the distribution of maximum, mature diameter in Chondroceras (C.) evolvescens (Waag.) The shaded section is based on in situ material, the rest on museum specimens. All came from Milborne Wick.

mouth-border (see Plate 1 , fig. 10c). Many subsequent species, such as Sphaeroceras brongniarti, have microconchs, which show no modifications to the mouth-border, and have only plain lips (see Plate 1 , fig. 8). Some later Sphaeroceratids, such as S. auritum show the development of other secondary, sexual modifications. These include, terminal constrictions, flared collars and hoods, bilobate or 'two pronged' flared collars and lateral, lappet like projections from the side of the mouth-border, rather than forward, as with true lappets. All of these modifications are well illustrated by Sturani (1971, text fig. 42) and Westermann (1956, text figs. 13-17) and need no further description here. The evolution and development of dimorphism in the Sphaeroceratinae thus follows a straightforward course; the microconchs first loose their lappets and attain a plain mouth-band, subsequent species then develop a series of different apertural modifications.

The ontogenetic development of dimorphism follows the normal pattern. Studies of the inner whorls of numerous specimens belonging to the Sphaeroceratinae shows that, up to the maximum diameter represented by the penultimate whorl of the microconch, both micro- and macroconchs are identical, in shell form, ornament and dimensions; differentiation only occurs in the last whorl. This is clearly shown in the graph, (Text fig. 2), which shows a logarithmic plot of diameter against whorl breadth for specimens of Chondroceras evolvescens. The measurements of whorl breadth and diameter were made from cross-sections of the ammonites, which were measured under a microscope, using a vernier mechanical stage. This allowed a high degree of accuracy to be obtained in measuring the smallest whorls and protoconchs. The style of ontogenetic development shown in this graph

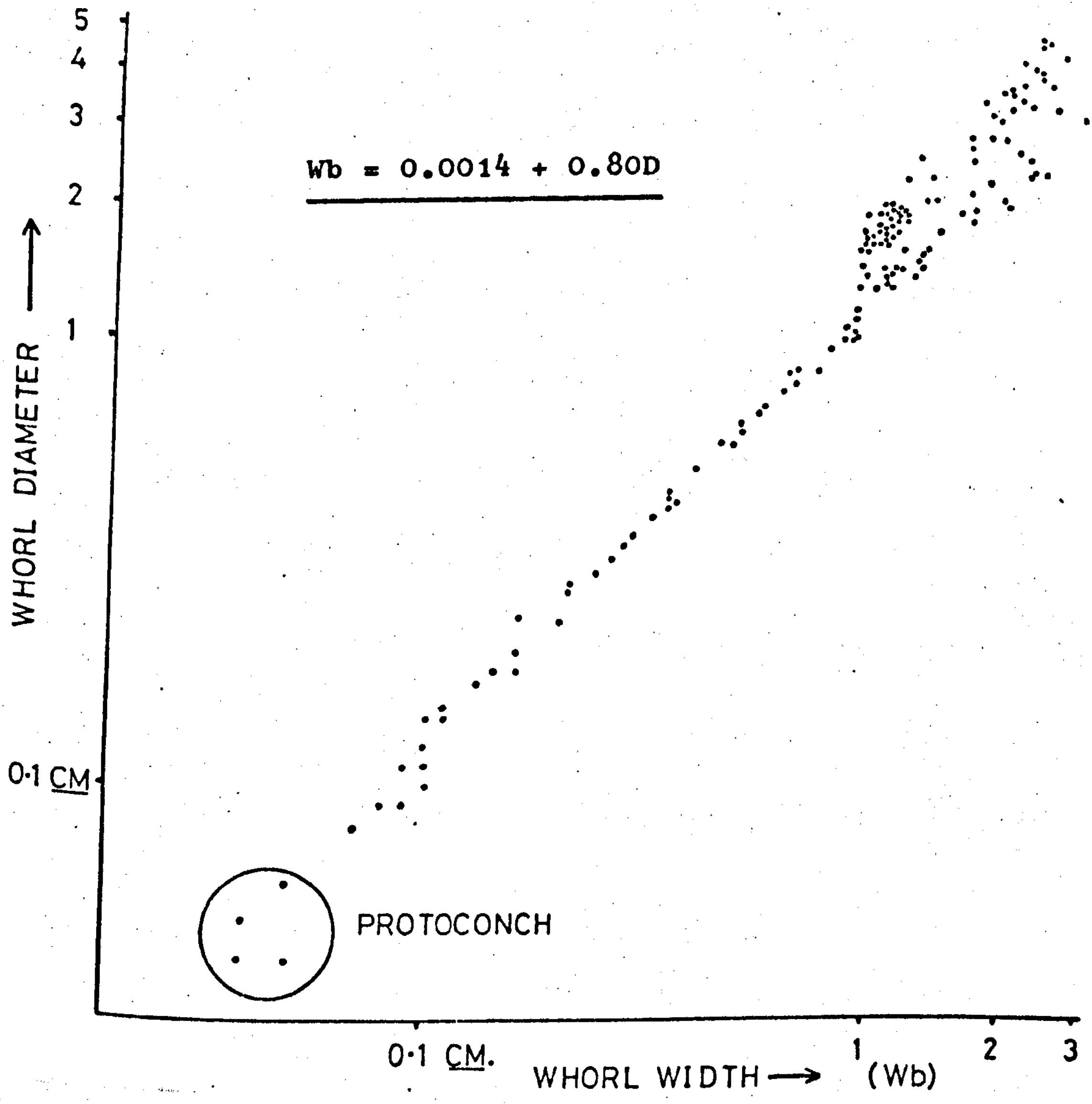


Figure 2.

A logarithmic plot of whorl diameter (D.), against whorl width (Wb.), for specimens of <u>Chondroceras evolvescens</u>, from Milborne Wick and Oborne Wood.

is the same as that displayed in other groups, such as *Taramelliceras/ Creniceras*, (Palframan, 1966). In its essentials this graph consists of a growth curve, constructed from the measurements taken from the inner whorls, surmounted by two clusters of points which represent measurements taken from the body-chambers, of more than 80 mature micro- and macroconchs. The divergence of these two clusters from the growth curve is due to the uncoiling and contraction of the body-chamber, as seen in both mature dimorphs. The separation of these two clusters along the diameter ordinate is a reflection of the bi-modal size distribution, which is more clearly seen in the histogram representing the size distribution in *C. evolvescens*, from Milborne Wick, (Parsons, 1976, bed 5), (Text fig. 1). Whilst the development of *C. evolvescens* is illustrated here, other groups, such as *C. canovense* (d'Greg.), have a similar size distribution (Text fig. 20), and growth curves.

One other feature which serves to separate the two dimorphs in the Sphaeroceratinae; apart from size and certain apertural modifications; is the tendency for some microconchs to be slightly more coarsely ribbed than the corresponding macroconchs. This is particularly true of *C. canovense* and *S. auritum*.

V. SYSTEMATIC DESCRIPTIONS

Phylum	Mollusca
Class	CEPHALOPODA
Order	AMMONITIDA
Superfamily	STEPHANOCERATACEA Neumayr 1875
Family	OTOITIDAE Mascke 1907
Subfamily	SPHAEROCERATINAE Buckman 1920

Genus Sphaeroceras Bayle 1878

Type species, by subsequent designation 'A'. brongniarti J. Sow. - Douvillé 1879.

Subgenus Sphaeroceras Bayle 1878

Diagnosis

A group of very small, globular ammonites, with fine, wiry, often superficial ribs. The inner whorls are tightly coiled, leading to the development of an occluded umbilicus. The rapid contraction of the body-chamber, leads to a sharp uncoiling of the umbilical seam. In some species, such as S. brongniarti, this uncoiling is so pronounced, as to have produced a straight umbilical seam on the last half whorl, which in turn has produced a 'scaphitoid' shell form. The sutures are complex; finely divided and interdigitating; and this together with the small size of the ammonites, makes their interpretation difficult. The micro- and macroconchs fall into a size ratio of approximately 1:2, with the former being slightly more coarsely ribbed. The modification of the mouth-border varies, with plain lips, residual lappets and flared hoods all having their adherents. This subgenus ranges from the Sauzei Zone to the base of the Parkinsoni Zone.

Subgenus group

Whilst numerous species have been described under the generic name Sphaeroceras, only the following are accepted here as members of the restricted subgenus.

1/ Sphaeroceras brongniarti (J. Sowerby, 1817)

syn S. brongniarti sub sp. terpartitum Westermann, 1956.

2/ _S_. _manseli_ J. Buckman, 1881.

3/ S. _auritum auritum_ Parona 1896.

syn. _S_. _disputabile_ Parona 1896.

_S_. _pilula_ Parona 1896.

4/ _S_. _auritum_ sub sp. _tutthum_ S. Buckman, 1921.

syn. _S_. _renzi_ (Christ 1960)

5/ _S_. _globus_ S. Buckman, 1927.

6/ _S_. _tenuicostatum_ Sturani 1971.

syn. _S_. _tenuicostatum_ sub. sp. _glabrum_ Sturani 1971.

7/ _S_. _pusillum_ Sturani, 1971.

8/ ?_S_. _talkeetnanum_ Imlay 1962.

Of these species, _S_. _pusillum_ has yet to be recorded from Great Britain, whilst _S_. _talkeetnanum_ is a very large American form. _S_. _tenuicostatum_ perhaps has a doubtful status since the only feature serving to separate it from the _S_. _auritum/tutthum_ group is the presence of a continuous rather than a bilobate, 'two pronged' flared hood. There is strong evidence to suggest that the remaining five species and subspecies form part of a continuous evolutionary lineage or chronocline, which stretches from the Sauzei Zone to the upper Garantiana Zone, - see below for further details.

Location of Material

Numbers prefixed by these abbreviations, refer to ammonites in the following collections:-

BCM.	Bristol City Museum.
BMNH.	British Museum (Nat. Hist.), London.
BUGM.	Bristol University, Geology Museum.
CP.	The author's collection.
IGS.	The Institute of Geological Sciences, London.
MM.	Manchester City Museum.
OUM.	Oxford University Museum.
SM.	Sedgwick Museum, Cambridge.
TC.	Taunton Castle Museum, Taunton.
YM.	Yorkshire Museum, York.

Note on synonymy lists

The synonymy lists, which are given here, are in most cases not intended to be complete, as detailed lists for the bulk of the Sphaeroceratinae are to be found elsewhere (Westermann, 1956). The references which are mainly given, are either to works which make a significant contribution to our knowledge of the relevant species, or to works which cite particular specimens, which are described here.

1. Sphaeroceras (Sphaeroceras) brongniarti (J. Sowerby)

Plate 1 , figs.1-6 & 8 ; Text figs. 3 & 4.

1817 Ammonites brongniarti nov. ; J. Sowerby (in J. & J. de C. Sowerby, 1812-46), p.190, Plate 184, A, fig.2.

1846 Ammonites gervillii ; d'Orbigny (1842-51), pp.409-10, Plate 140, figs. 3-8 non 1 & 2.

non 1846 Ammonites brongniarti ; d'Orbigny (1842-51), pp.403-5, Plate 137.

1847 Ammonites brongniarti ; Quenstedt (1845-9), p.186, Plate 15, fig. 9.

1856 Ammonites brongniarti; Oppel, p.375.

1867 Ammonites brongniarti; Sowerby; Waagen, p.602.

1877 Stephanoceras brongniarti; Hyatt, p.394.

1878 Sphaeroceras brongniarti Sowerby; Bayle, Plate 53, figs. 3-5.

1879 Sphaeroceras (Am. brongniarti, Sow.); Douvillé p.91.

non 1881 Ammonites brongniarti Sow.; J. Buckman, p.64, fig.5.

1881 Sphaeroceras brongniarti (Sow.); S.S. Buckman, p.597, (Partim).

1886 Ammonites brongniarti; Quenstedt (1886-7), p.509, Plate 64, figs. 1 & 2.

1907 Sphaeroceras (Ammonites brongniarti, Sow.); Mascke, p.19.

1952 Sphaeroceras brongniarti (J. Sow.); Arkell (1951-9), p.77, text fig. 20, 2a & b, (holotype), non 1a & b.

1956 Sphaeroceras brongniarti (Sow.); Westermann, pp.28-35, Plate 14, figs.1-7, text figs. 3-8, including sub. sp. S. brongniarti terpartitum Westermann, cum syn. exclud. S. globus & S. tutthum Buckman.

1957 Sphaeroceras (Am. brongniarti J. Sowerby); Arkell (in Arkell, Kummel & Wright 1957), p.L292, fig.347, 1a & b, (holotype).

non 1963 Sphaeroceras brongniarti (Sow.); Makowski, pp.46-48 + 81, text fig.XI, 1 & 2.

1964 Sphaeroceras brongniarti (Sowerby); Westermann, p.55.

non 1968 Sphaeroceras brongniarti (J. Sowerby); Senior, p.45.

1971 Sphaeroceras brongniarti (Sowerby); Sturani, pp.137-141, text figs. 42/8-9, 43 & 44/3, Plate 10, figs. 2, 6-10 & ?12.

1975 Sphaeroceras brongniarti (J. Sow.); Parsons, p.11.

Material

The following specimens have all been collected in situ by the author: one topotype from the Bayeux Conglomerate, St. Honorine-des-Pertes Normandy, France, BMNH. C80317; two specimens from bed 4a Oborne Wood, BMNH. C80318-9; six specimens from bed 4b Oborne Wood BMNH. C80320-5; one specimen from bed 4c Oborne Wood, BMNH. C80326; two specimens from the 'Irony bed' of Louse Hill near Sherborne, BMNH. C80327-8 and three specimens from the 'Red Conglomerate' of Upton Manor Farm near Bridport, BMNH. C80329-80331; a total of fifteen ammonites.

Dimensions

Holotype (BMNH.C36734), (m.),

Diameter	Umbilical diameter	Number of Primary ribs	Whorl height	Whorl breadth
D.	Ud.	Pn.	Wh.	Wb.
1.92	0.34 (18%)	28	0.87 (45%)	c.1.25 (65%)
1.60	0.08 (5)	-	1.06 (66)	1.44 (90)

Diameter	Umbilical diameter	Number of Primary ribs	Whorl height	Whorl breadth
D	Ud.	Pn.	Wh.	Wb.
BMNH. C80317, (M.),				
2.32	0.49 (21%)	-	1.18 (51%)	1.46 (63%)
BMNH. C80318, (m.),				
1.87	0.32 (17)	30	0.88 (47)	1.27 (68)
1.59	0.13 (8)	-	0.9 (57)	1.31 (82)
BMNH. C.80319, (m.),				
1.54	0.13 (8)	-	0.9 (58)	1.05 (68)
BMNH. C.80320, (M.),				
2.5	0.45 (18)	25	1.13 (45)	1.5 (60)
2.0	0.1 (5)	-	1.34 (67)	c1.6 (80)
BMNH. C.80321, (M.),				
2.44	0.5 (21)	26	1.12 (46)	1.4 (57)
1.95	0.16 (8)	-	1.2 (62)	1.62 (83)
BMNH. C.80322, (m.),				
1.84	0.3 (16)	27	0.9 (49)	1.1 (60)
1.46	0.16 (11)	-	0.9 (62)	1.18 (81)
BMNH. C.80323, (m.),				
1.7	0.43 (25)	c24	0.8 (47)	1.03 (61)
1.35	0.11 (8)	-	0.89 (66)	1.17 (87)
BMNH. C.80324, (m.),				
1.94	0.38 (20)	28	0.88 (45)	1.19 (61)
1.57	0.1 (6)	-	0.98 (62)	1.27 (81)
BMNH. C.80325, (m.),				
1.76	0.31 (18)	34	0.84 (48)	1.1 (63)
1.39	0.09 (7)	-	0.94 (68)	1.15 (83)

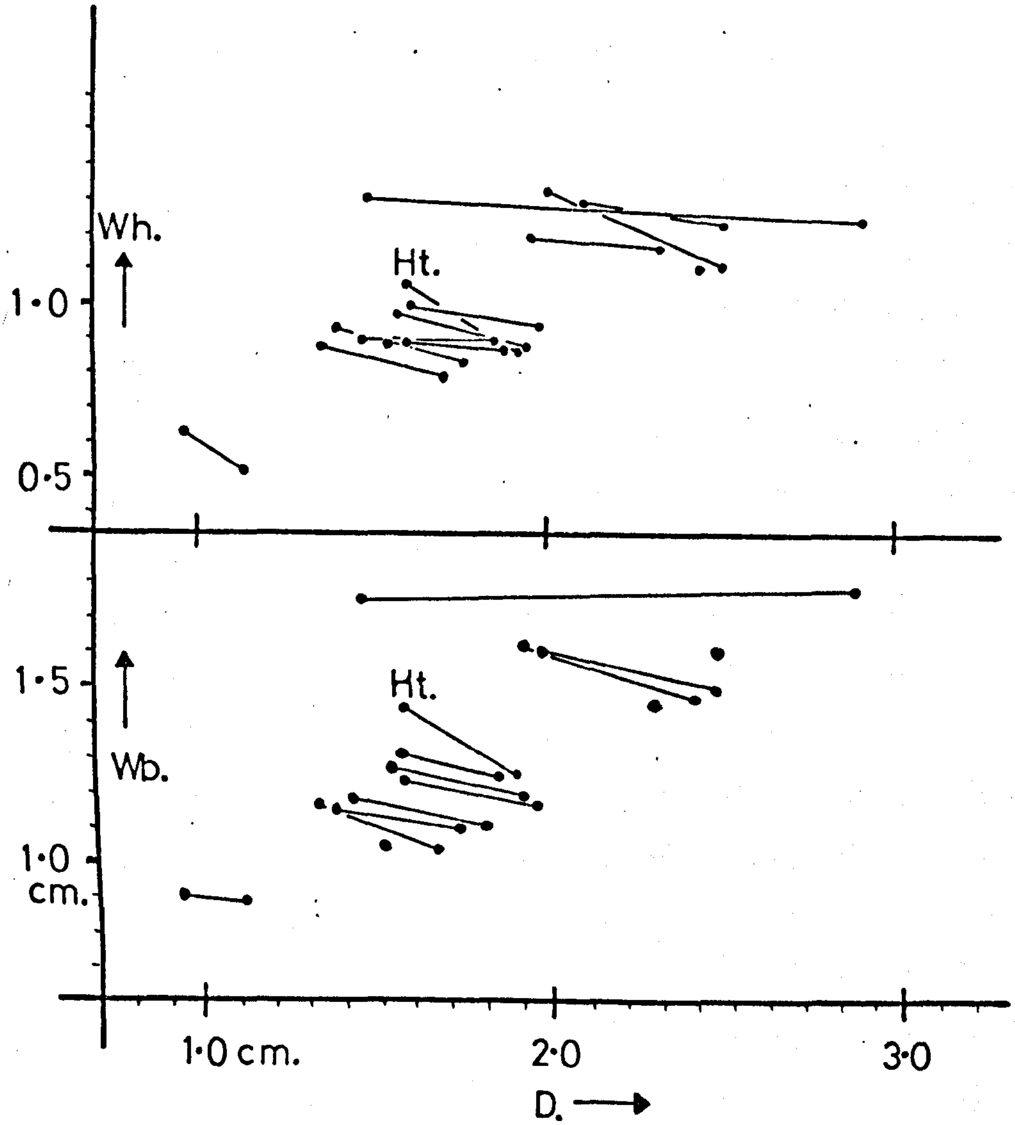


Figure 3.

A plot of whorl height (Wh.) and whorl breadth (Wb.) against maximum diameter (D.) in S.(S.) brongniarti (J.Sow.). Ht. = holotype.

Diameter	Umbilical diameter	Number of Primary ribs	Whorl height	Whorl breadth
D	Ud.	Pn.	Wh.	Wb.
BMNH. C80329, (M.),				
2.9	0.62 (21)	29	c1.27 (44)	1.79 (62)
1.48	0.47 (32)	26	1.32 (89)	1.76 (119)
BMNH. C80330, (M.),				
2.5	0.42 (17)	28	1.25 (50)	1.6 (64)
2.1	0.12 (6)	-	1.3 (62)	-
BMNH. C80331, (m.),				
1.13	0.25 (22)	c24	0.51 (45)	0.88 (78)
0.96	0.09 (9)	-	0.63 (66)	0.89 (93)
BMNH. C80327, (m.),				
1.98	0.32 (16)	-	0.95 (48)	1.16 (59)
1.6	0.19 (12)	-	1.0 (63)	1.24 (78)

Description

A small, (average macroconch size = 2.5 cm.), globose or sphaeroconic ammonite, with tightly coiled inner whorls and a rapid retraction of the umbilical seam over the last half whorl. The inner whorls are relatively depressed, with a whorl height/width ratio in the order of 0.87:1, whilst the last half whorl has a more rounded cross-section; - see Text fig. 3 . This change in cross-section is linked to the sudden contraction of the body-chamber, which spans almost exactly one whorl. The umbilical seam on the last half whorl is almost straight, whilst prior to this the umbilicus is totally occluded. The primary ribs are sharp, slightly curved, prosiradiate and are fairly dense; the primary rib density for the final whorl varies between 24 and 34 per whorl. The secondary ribs are about the

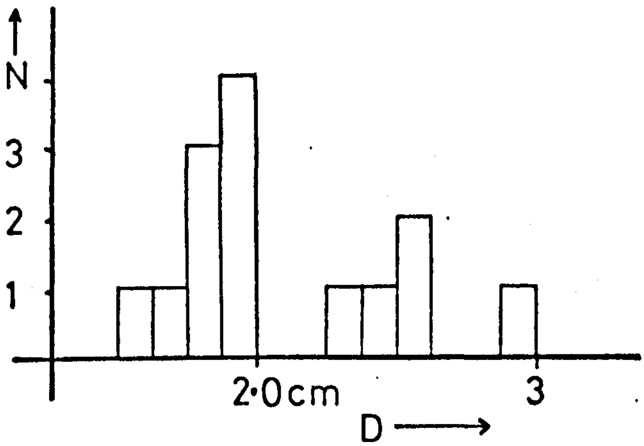


Figure 4.

A histogram showing the distribution in maximum, mature diameter, in the Dorset specimens of *S.(S.) brongniarti* (J.Sow.).

same length as the primaries, and they sweep forward gently over the rounded venter. These secondaries are very fine, sharp and often superficial, since they leave no impression on the internal cast. Although the secondaries are fine, with 3-4 per primary on the inner whorls, towards the mouth-border they become coarser, with only 2-3 per primary. The modification of the mouth-border is simple, with a prosiradiate, narrow flare, followed by a constriction and then a smooth lip or mouth band - see Plate 1 , fig. 8.

Sexual dimorphism

The small sample size creates some difficulties in determining the style of sexual dimorphism in *S. brongniarti*, which previous authors (Westermann, 1964, p.55; Sturani, 1971, pp.138-9) have regarded as intraspecific. Sturani (*op. cit.*), when dealing with a large sample (although very depleted in macroconchs), considered that there were little or no differences between dimorphs, except that of size: the macroconchs having a diameter greater than 2.0 cm., the microconchs a maximum diameter less than 1.5 cm. The size distribution of the Dorset specimens (see Text fig. 4), tends towards a similar bimodality, although more material is needed to give a more convincing distribution. If this style of dimorphism is accepted, then there is indeed little morphological differentiation between dimorphs, apart from size: macroconch average maximum diameter = 2.5 cm., microconch average diameter = 1.7 cm., a size ratio of 1 : 1.47.

Discussion

Sphaeroceras brongniarti differs from *S. manseli*, by its slightly smaller size, sparser primary ribs, stronger contraction of the body-chamber and by its more rounded cross-section on the last whorl. S. auritum is the closest in gross morphology, but this differs by its smaller size, and by its more differentiated mouth border, which is characterised by its bilobate, two pronged flared hood. These three species, together with S. globus, S. tutthum and S. tenuicostatum form a chronocline, or continuously evolving lineage, within which it would be difficult to distinguish any single species, if stratigraphic breaks had not dislocated the sequence. As noted by Sturani (1971, p.140) there is no basis for the separation of the subspecies S. brongniarti terpartitum Westermann, as there is a wide variation in the number of ribs in S. brongniarti s. str. The holotype of this species (Plate 1 , fig. 5), shows the presence of a weak, narrow, flared hood, followed by a constriction and then a narrow, smooth lip. This form of mouth-border is typical of all the specimens of this species collected from the Romani Subzone in England and in the Venetian Alps of Italy, (Sturani, 1971, p.138). Some specimens collected from the upper Subfurcatum Zone of the Oborne district, showing signs of a ventral interruption in the flared hood, (Plate 1, fig. 11) have been included in S. auritum, in spite of an otherwise close similarity to some smaller specimens of S. brongniarti, (Sturani, 1971, p.143). S. globus Buckman, considered by Sturani (1971, p.138) as a subspecies of S. brongniarti is here kept as a distinct species, since it is the possible macroconch dimorph of the S. auritum (m.) group.

Stratigraphic distribution

The holotype of S. brongniarti came from the 'Bayeux Conglomerate' of the Bayeux district of Normandy (France). The ammonite assemblage from this horizon includes:- Chondroceras gervillei, C. evolvescens, Phaulostephanus paululum Buckman, Dorsetensia eduardiana (d'Orb.) etc.: which indicates a Romani Subzone, Humphriesianum Zone, age for this bed. A topotype, collected in situ from the 'Bayeux Conglomerate' of St. Honorine-des-Pertes, Normandy, BMNH. C80317, confirms this as the type horizon. All the specimens of this species from southern England described here have come either from beds 4a-c of Oborne Wood, which are mainly Romani Subzone in age, or from highly condensed equivalents of this horizon; the 'Irony bed' and 'Red Conglomerate' (Parsons, 1975). There is no evidence for a higher stratigraphic occurrence of this species in England, than this fauna from the lower/middle Humphriesianum Zone, (Contra, Westermann, 1964, p.55).

2. Sphaeroceras (Sphaeroceras) manseli (J. Buckman)

Plate 1 , figs. 7 & 9- 10 ; Text figs. 5 & 6.

1881, Ammonites manselii Buckman, n.sp.; J. Buckman, p.64.

1881, Sphaeroceras manselii (J. Buckman); S. Buckman, p.597.

1882, Sphaeroceras manselii J. Buckman; S. Buckman, p.141, Pl.II, figs. 3a & 3b.

1939, Sphaeroceras manselii J. Buckman; Roché p.226.

1974, Sphaeroceras manselii (J. Buckman); Parsons, p.166.

Material

Three specimens from the top half of the Sandford Lane 'Fossil-bed', Sandford Lane, (bed 6b); near Sherborne, Dorset, from the author's collection and now BMNH. C80332-4. One specimen from the 'Sherborne area', SM. J24529; and one specimen from Yorkshire Museum, ex W. Reed Collection, 216, also from the 'Sherborne area'.

Dimensions

Buckman's figured specimen (S. Buckman, 1881, p.597), (M.),

D.	Ud.	Pn.	Wh.	Wb.
4.45 cm.	0.83 (19%)	c.34	2.23 (50%)	3.05 (69%)
BMNH. C80333, (M.),				
2.9	0.65 (22)	37	1.33 (46)	1.84 (63)
2.18	0.35 (11)	-	1.32 (61)	1.74 (80)
BMNH. C80332, (M.),				
2.73	0.54 (20)	38	1.4 (51)	1.76 (66)
2.05	0.26 (13)	-	1.35 (66)	1.64 (80)
BMNH. C80334 (m.),				
1.91	0.36 (19)	39	0.92 (48)	1.2 (63)
1.49	0.25 (17)	-	0.81 (54)	1.06 (71)

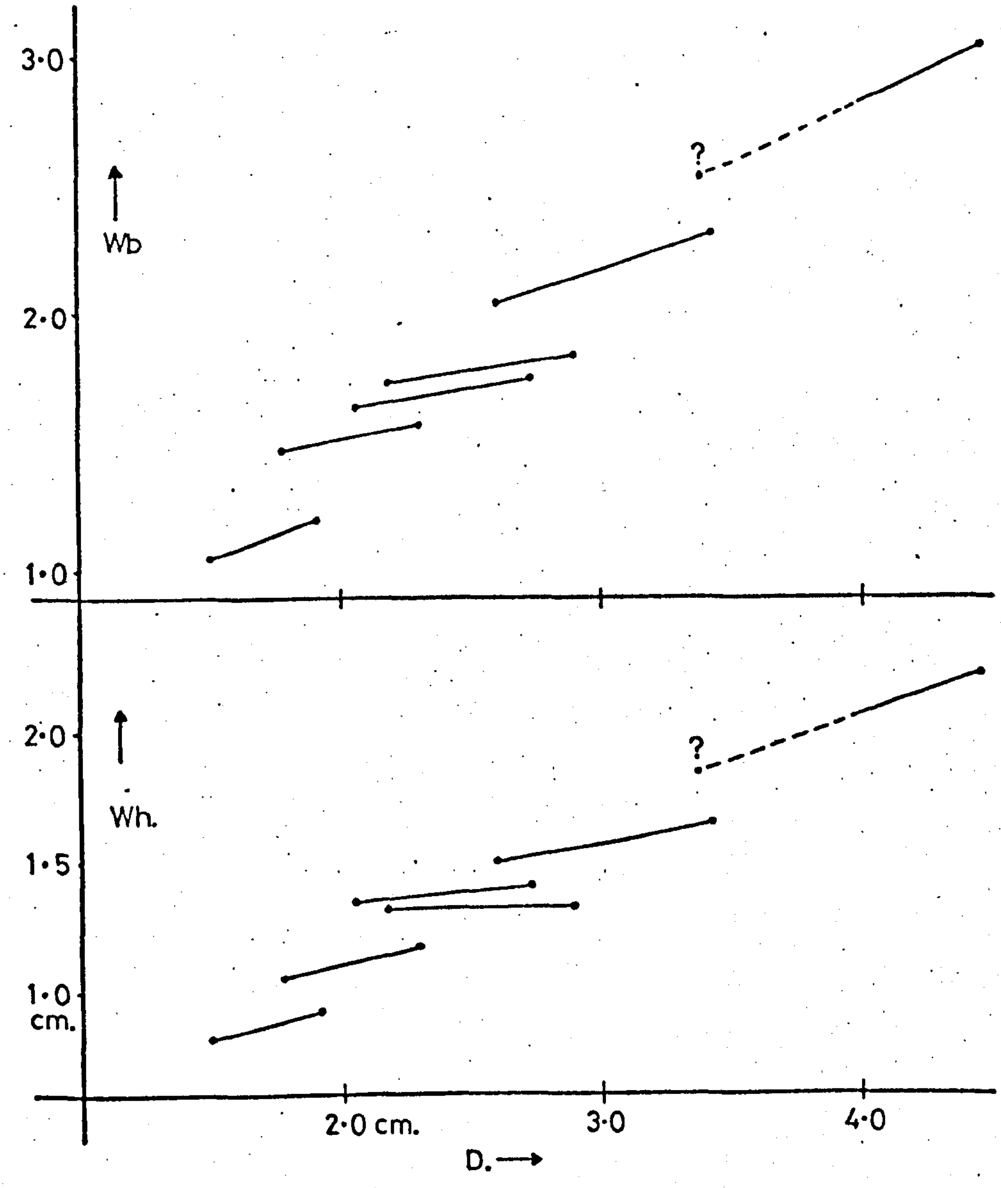


Figure 5.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum whorl diameter (D.), for specimens of S.(S.) manseli (J.Buck.). The line with the question mark (?), is an extrapolation from the dimensions given by S.S.Buckman (1881).

D.	Ud.	Pn.	Wh.	Wb.
J24529, (M.),				
3.42	0.75 (22)	38	1.65 (48)	2.32 (68)
2.6	0.43 (17)	-	1.5 (58)	2.05 (79)
YM. Reed.col. 216, (?M.),				
2.3	0.50 (22)	40	1.18 (51)	1.57 (68)
1.77	0.24 (14)	-	1.06 (60)	1.47 (83)

Description

A small (average size of macroconch = 3.4 cm.), involute, sphaeroconic ammonite, with three quarters of a whorl of body-chamber. The inner whorls are tightly coiled, producing a deep, very narrow umbilicus, whilst the gradual uncoiling of the umbilical seam on the last third to half whorl, gives a more open umbilicus. There is a progressive change in the whorl cross-section, with the rounded inner whorls, giving way to a more square cross-section on the last half whorl - see Plate 1 , fig. 9c. This is mainly due to the decline in the whorl height, relative to whorl width, as may be seen in Text fig. 5 . Although there is a fairly strong contraction of the body-chamber, the whorl height and whorl width, immediately prior to the mouth-border, are still greater than on any part of the preceding whorls. This is a direct contrast to several other members of the Sphaeroceratinae, where the greatest values for these dimensions are to be found approximately half a whorl prior to the mouth-border, (e.g. S. brongniarti - Text fig. 3). The primary ribs are relatively short, sharp, slightly curved, prosiradiate and dense; there are 34-40 on the last whorl. The secondary ribs are fairly coarse for the Sphaeroceratinae, and they branch from the

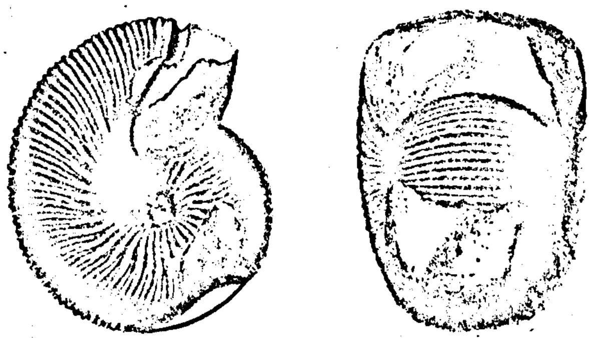


Figure 6.

S.(S.) manseli (J.Buckman), a copy of S.S. Buckman's original figure (S.Buckman,1882,pl.2,fig.3).

umbilical edge, with 2-3 per primary on the inner whorls, and 2 per primary on the outer whorl. The mouth-border is characterised by a deep terminal constriction, followed by a smooth expanded lip, which on the microconch shows a residual lappet like projection along the line of the umbilical edge, - see Plate 1 , fig. 10c.

Sexual dimorphism

Buckman's figure (here reproduced as Text fig. 6), shows a mature ammonite, with a mouth-border consisting of a deep constriction, followed by a smooth lip. The relatively large size of this specimen, (as with J24529, BMNH. C80333) compared to the specimen figured here showing residual lappets, (Plate 1 , fig.10 ; BMNH. C80334), would suggest that the former is a macroconch; the smaller specimen, with the 'lappets', being the corresponding microconch. If this is so, then the size ratio between the dimorphs is in the region of 1 : 1.6.

Discussion

James Buckman's original description of this species is rather nebulous .... 'related to the Ammonites brocchii group; but the fineness of its ribs and the absence of tubercles is a sufficient distinction. (The mouth-border has) .. the usual deep depression before the terminal semicircular depression. We possess several examples of this shell from Bradford (Abbas), Chalcombe (sic) and other places.' ... (J. Buckman, 1881, p.64). On its own this abbreviated diagnosis would be insufficient to determine the true identity of this species. Fortunately J. Buckman's son, S.S. Buckman, gave a more detailed and restricted description of S. manseli

(S. Buckman, 1881, p.597; 1882, p.141, Plate II, figs 3a-b). However S. Buckman (1881, p.597) listed only two specimens as belonging to this species; both from the Clatcombe area of Sherborne and from the T.C. Maggs collection. It is thus certain that S. Buckman was using this specific name in a much more restricted sense than originally intended by his father. This was due to S. Buckman's subsequent introduction of a new species '<u>Sphaeroceras</u>' (<u>Labyrinthoceras</u>) <u>perexpansum</u>, in which he included specimens previously considered by his father to belong to <u>S. manseli</u>, (S. Buckman, 1882, Plate II, fig.3). No type specimen of <u>S. manseli</u> has been designated, thus the two specimens cited by S. Buckman (1881, p.597; 1882, p.141), must be considered the only recognizable syntype members of the more extensive type series cited by J. Buckman (1881). If the use of this specific name is to be continued, for what is in fact a highly distinctive and stratigraphically useful ammonite species, then S. Buckman's interpretation of the species must be accepted. The dimensions taken from S. Buckman's figure of this species (S. Buckman, 1882 - reproduced here as Text fig. 6), appear very similar, if not identical, to those which Buckman had previously cited (S. Buckman, 1881, p.598). There thus can be little doubt, that both of these records were based on the same specimen. A search for the two known syntypes from the T.C. Maggs collection, revealed the presence of one specimen in the British Museum, in the Buckman collection. Unfortunately this specimen (S.S.B. collection number 478), looks very different to Buckman's figure, and also has very different relative proportions. It is in fact a large specimen of <u>S. brongniarti</u>. This ammonite obviously should not be selected as leotoptype, as it would make <u>S. manseli</u> a junior subjective synonym of the latter species. In the present absence of Buckman's figured specimen, it seems inadvisable to make any decision concerning the selection of a lectotype. This need not however effect the interpretation of this taxon, since in this connection, the dimensions given by S. Buckman, taken together with his figure, make identification of this species relatively easy.

The species which are closest in gross morphology are significantly those which are in close stratigraphic proximity. With its relatively large size and inflated shell shape, S. manseli is closely related to Chondroceras obornensis nov., whilst its strongly contracted body-chamber, and poorly differentiated dimorphs show some similarity with S. brongniarti. Taking into account its stratigraphic position, S. manseli makes a good evolutionary link between these two latter species. The intermediate nature of S. manseli, with its 'mosaic' of morphological features characteristic of Chondroceras, Sphaeroceras and Labyrinthoceras, makes it difficult to place in any one genus. The less well developed sexual dimorphism, with the presence of only residual lappets, would however point to the inclusion of this taxon in Sphaeroceras.

Stratigraphic distribution

The two specimens cited by S. Buckman (1881), came from the 'iron-shot' limestones of the Clatcombe area of Sherborne, which are either Humphriesianum or Sauzei Zone in age, according to their exact horizon. The three specimens which I have found in situ, came from the top half of the Sandford Lane 'fossil-bed', Sandford Lane quarry, near Sherborne (-0.20m. below the top). This horizon is the stratigraphic equivalent to bed 4 at Clatcombe Farm (Parsons, 1974, p.164, fig.2), which is the probable type horizon for Buckman's figured specimen. Both of these beds are Sauzei Zone in age. The other two specimens described here, from the York and Sedgwick museums, both show the characteristic matrix of the upper Sandford Lane 'fossil-bed', thus all the existing specimens of this species probably originate from Sauzei Zone beds.

3. *Sphaeroceras* (*Sphaeroceras*) *auritum* cf. Sub. sp. *auritum* Parona Plate 1 , figs.11a-b ; Plate 2,figs.1-3;Text fig. 7.

1894 *Sphaeroceras brongniarti*; Parona , p.377.

?1896 *Sphaeroceras pilula nov.*; Parona, p.16, Plate I, figs. 14 & 15.

1896 *Sphaeroceras auritum nov.*; Parons, p.16, Plate I, fig.16.

1896 *Sphaeroceras disputabile nov.*; Parona, p.17, Plate I, fig. 17.

1897 *Sphaeroceras auritum* Parona; Glangeaud, p.104, Plate III, figs. 4 & 5, (holotype).

1971 *Sphaeroceras auritum* Parona; Sturani, pp.141-3; text figs. 42/1 and 43; Plate 10, figs. 17, 19, 21 & 23; *cum. syn.* exclud. *S. tutthum* Buckman and ?*S. renzi* (Christ).

Material

The following specimens have been collected *in situ*, from the 'Cadomensis bed' of the Oborne district, near Sherborne, Dorset: three specimens from bed 6d Frogden Quarry, BMNH. C80374-6; three specimens from bed 6d Oborne Wood, BMNH. C80339, C80341 and C80342, and one specimen from bed 6c Oborne Wood, BMNH, C80340.

Dimensions

Lectotype, (m.),

D	Ud	Pn	Wh	Wb
1.3	0.29 (22)	-	0.59 (45)	0.72 (55)

D	Ud	Pn	Wh	Wb
BMNH. C80340, (m.),				
1.42	0.29 (21)	c28	0.69 (49)	0.86 (61)
1.15	0.1 (9)	-	0.7 (61)	0.98 (85)
BMNH. C80341, (m.),				
1.46	0.3 (21)	29	0.69 (41)	0.97 (67)
1.17	0.14 (12)	-	0.78 (67)	1.05 (90)
BMNH. C80339, (m.),				
1.38	0.23 (17)	30	0.69 (50)	0.88 (64)
1.12	0.08 (7)	-	0.73 (65)	0.97 (87)
BMNH. C80374, max. D over flare; 1.23, (m.),				
1.15	0.28 (24)	26	0.58 (51)	0.87 (76)
0.97	0.06 (6)	-	0.61 (63)	0.91 (94)
BMNH. C80375, (m.),				
0.99	0.3 (30)	24	0.45 (46)	0.7 (71)
0.85	0.08 (10)	-	0.55 (65)	0.78 (92)
BMNH. C80376, (m.),				
1.02	0.23 (23)	-	0.55 (54)	0.74 (73)
0.87	-	-	0.58 (67)	0.77 (89)

Description

A small (average size = 1.26 cm.), globose ammonite, with tightly coiled inner whorls and a rapid contraction of both the body-chamber and the umbilical over the last half whorl. The whorl cross-section is rounded but depressed, the whorl breadth (Wb) being consistently greater than the whorl height (Wh), $(\frac{Wh}{Wb} = .73)$. The whorl section does not change much over the last whorl, since both the whorl height and breadth decrease at a similar rate, (see Text

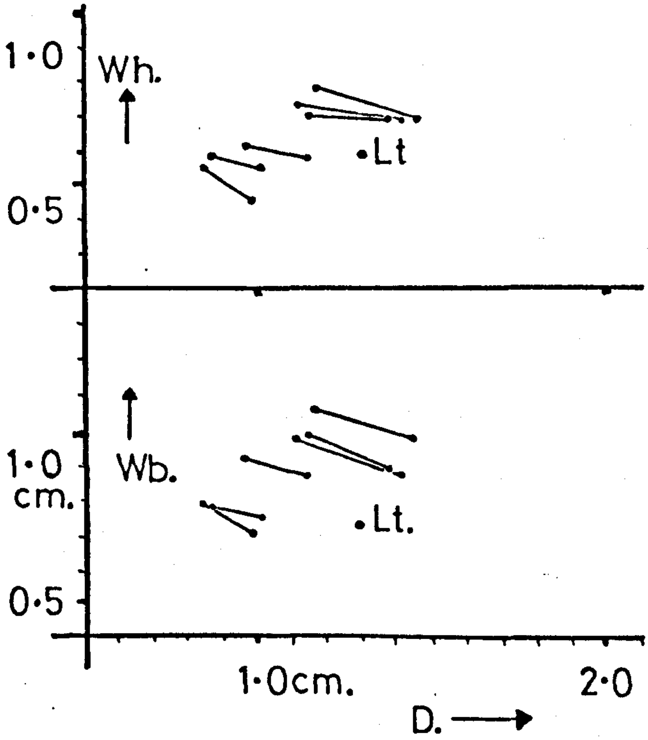


Figure 7.

A plot of whorl height (Wh.) and whorl breadth (Wb.) against maximum diameter (D.) for specimens of S.(S.) auritum auritum (Parona), from the cadomensis beds of the Oborne area. Lt. = lectotype.

fig. 7). Over the last half whorl the umbilical seam is so retracted as to be almost straight, (see Plate 1 , fig. 11b), as is also true of S. brongniarti. The primary ribs are fine, dense (27 per whorl), sharp, prosiradiate and mainly divide into fine, sharp secondaries, often with one extra secondary interdigitating. These secondary ribs swing forward over the venter, although there may be a slight backward flexure along the mid ventral line of the last quarter whorl, - see Plate 1 , fig. 11a . All the ribs have a tendency to be superficial, leaving a smooth internal cast. The mouth-border is well differentiated, and shows a complex structure, of which the thin, high, flared hood is the most evident. This hood is not bilobate, but shows signs of a slight ventral interruption - Plate 1 , fig.11a . Forward of this hood there is a deep constriction, followed by a wide, triangular shaped, expanded lip, with a large, blunt node in the mid, ventral position: well preserved specimens also show the presence of two lateral, lappet like extensions of the lip, (Plate 2 , fig. 3b), as is so well seen in the lectotype of the S. auritum s. str., (Sturani, 1971, p.142, Text fig. 42/1).

Sexual dimorphism

The specimens described here, taking into account their small size and highly differentiated mouth-border, are probably microconchs. I suspect that the corresponding macroconch partner may be S. globus, since this is the only macroconch sphaeroceratid ammonite so far recorded from this horizon in southern England.

Discussion

The lectotype of S. auritum auritum Parona, (selected Sturani, 1971, p.142), from Monte Meletta (Venetian Alps, N. Italy) is upper Subfurcatum Zone in age (Schroederi Subzone _sensu_ Sturani, 1971 = upper Baculata Subzone herein). It differs from the specimens described here by having a better developed, 'two pronged' flared hood, (Sturani 1971, Text fig. 42/1 and Plate 10, fig. 19). This hood is the major feature which serves to separate this species from the older _S. brongniarti_. Those specimens found in the '_cadomensis_ beds' of the Oborne district, have a much more prominent hood than _S. brongniarti_, with some signs of the beginning of a ventral interruption. They are thus similar to the 'primitive morphotypes' of _S. auritum_ described by Sturani (1971, p.143), and are hence included within this taxon, under 'open nomenclature'.

Stratigraphic distribution

All bar one of the specimens described here have come from bed 6d of Oborne Wood and Frogden, which is lower Baculata Subzone in age. A single specimen has come from bed 6c at Oborne Wood, which is upper Polygyralis Subzone, Subfurcatum Zone in age. The range of this species in England, is thus similar to that in its type area, (Polygyralis - Schroederi Subzones, Sturani, 1971).

4. Sphaeroceras (Sphaeroceras) auritum sub. sp. tutthum (S. Buckman) Plate 2 , figs. 4 - 6 ; Text figs. 8 & 9.

1881 Sphaeroceras brongniarti (Sow.); S. Buckman, p.597, (partim).

1921 Sphaeroceras tutthum nov.; S. Buckman, (1909-30), Pl. 259.

1937 Sphaeroceras tutthum Buck.; Wetzel, p.78, ?Pl.10, fig.1.

1939 Sphaeroceras tutthum Buck.; Roché, p.225.

1956 Sphaeroceras brongniarti (Sow.); Westermann, pp.28-30,(partim).

1960 Oecoptychius renzi nov.; Christ, pp.91-2, Pl.5, fig. 8ab.

1963 Sphaeroceras tutthum Buckman; Rioult, p.245.

1964 Sphaeroceras brongniarti (Sowerby); Westermann, p.55, (partim)

1965 Sphaeroceras brongniarti tutthum, Buckman; Wendt, p.301.

1970 Sphaeroceras tutthum S. Buckman; Senior, Parsons & Torrens, pp.116-8.

1971 Sphaeroceras auritum Parona; Sturani, pp.141-3, (partim)

1975 Sphaeroceras tutthum S. Buckman; Parsons, p.9.

Material

Four specimens from the 'Astarte bed' equivalent at Horn Park quarry, near Beaminster (Dorset), (Senior, Parsons & Torrens, 1970, p.118, bed 8), BMNH. C80362-5; one specimen from the 'Astarte bed' of Stony Head cutting, near Bridport, Dorset (Parsons, 1975, bed 13), BMNH. C80356; one specimen from the 'Astarte bed' of Bonscombe Hill, near Bridport, (Senior et al., 1970, p.116, bed 30), BMNH. C80361;

and five specimens from the 'Oolithe Ferrugineuse de Bayeux', Port en Bessin, Normandy, France, BMNH. C80366-80370; a total of eleven specimens, all collected *in situ* by the author.

Dimensions

Holotype, *ex.* Buckman collection (S.B.3502) IGS 32060. Maximum diameter over flare = 1.0 cm., (m.),

D.	Ud.	Pn.	Wh.	Wb.
0.89	0.11 (12)	-	0.5 (56)	0.69 (78)
0.73	?0.0	-	0.51 (70)	0.71 (97)
BMNH. C80362, (m.),				
0.79	0.21 (27)	-	0.39 (49)	0.56 (71)
0.64	0.01 (2)	-	0.41 (64)	0.6 (94)
BMNH. C80363, (m.),				
0.89	0.18	-	0.44 (50)	0.63 (71)
0.73	0.06 (8)	-	0.46 (63)	0.64 (88)
BMNH. C80364, (m.),				
0.83	0.2 (24)	28	0.4 (48)	0.58 (70)
0.7	0.05 (7)	-	0.44 (63)	0.6 (86)
BMNH. C80365, (m.),				
0.74	0.2 (27)	0	0.33 (45)	0.53 (72)
0.63	0.03 (5)	-	0.34 (54)	0.54 (86)
BMNH. C80356, (m.),				
1.16	0.34 (29)	28	0.5 (43)	0.76 (66)
0.91	0.11 (12)	-	0.61 (67)	0.83 (91)
BMNH. C80361, incomplete, (m.),				
0.67	-	-	0.52 (78)	0.62 (93)
0.58	-	-	0.41 (71)	0.59 (102)

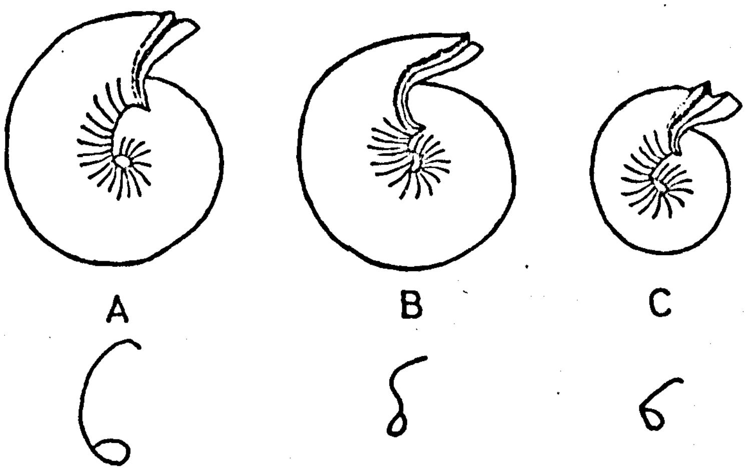


Figure 8.

Outline sketches of; A/S.(S.) brongniarti , B/ S.(S.) tenuicostatum and C/ S.(S.) auritum tutthum , with enlarged skeletal outlines of their umbilical seams.

D.	Ud.	Pn.	Wh.	Wb.
BMNH. C80366, (m.),				
0.94	0.3 (32)	27	0.46 (49)	0.66 (70)
0.76	0.03 (4)	-	0.51 (67)	0.73 (96)
BMNH. C80367, incomplete, (m.),				
0.88	0.08 (9)	-	0.59 (67)	0.81 (92)
0.7	-	-	0.5 (72)	0.78 (112)
BMNH. C80368, nucleus, (m.),				
0.72	-	-	0.52 (72)	0.71 (99)
0.6	-	-	0.48 (80)	0.56 (93)
BMNH. C80369, (m.),				
0.95	0.21 (22)	21	0.47 (50)	0.66 (70)
0.78	0.04 (5)	-	0.5 (64)	0.73 (94)
BMNH. C80370, (m.),				
0.81	0.2 (25)	-	0.42 (61)	0.58 (72)
0.73	0.15 (21)	-	0.49 (67)	0.6 (82)

Description

A very small (average size = 0.87 cm.) globose ammonite, with tightly coiled inner whorls and a strongly contracted body-chamber. The whorl section is rounded, but depressed (average Wh:Wb. = .72), and although both of these dimensions decrease rapidly over the last half whorl, they keep approximately to the same relative proportion, (see Text fig. 9). The primary ribs are very faint, strongly prosiradiate, dense (average 26 per whorl) and branch into two-three very faint secondary ribs which gently swing forward over the venter, often with a slight backward deflection along the mid ventral line. All the ribs, except innermost parts of some of the later primaries,

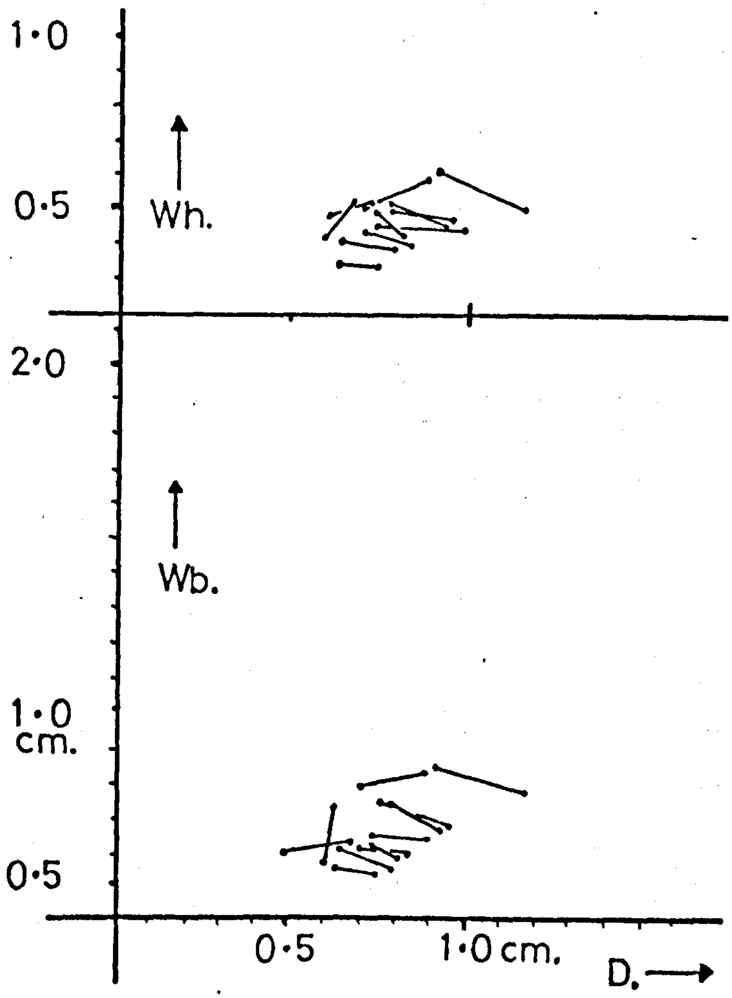


Figure 9.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum diameter for S.(S.) *auritum tutthum* (S.Buck.).

are superficial giving a totally smooth internal cast, particularly on the inner whorls, where all ribs are absent. The umbilical seam is strongly retracted and flexed, rather than straight as in _S. brongniarti_ and _S. auritum auritum_ (see Plate 2 , fig. 5b , and Text fig. 8). The mouth-border, as in _S. auritum s. str._, is well differentiated, with the presence of a prominent bilobate, 'two pronged', flared hood, (see Plate 2 , fig. 5a), followed by a deep constriction and a triangular shaped expanded lip with lateral, lappet like, extensions.

Sexual dimorphism

The small size and highly differentiated mouth-border of this species, point to it being a microconch ammonite. Unfortunately there is at present very little evidence of the nature of its macroconch partner. At first sight _S. tenuicostatum_ would make a good choice for the latter, but it is excluded by the presence of its own, obvious microconch counterpart, with a continuous, rather than bilobate flared hood, (e.g. BMNH. C80359).

Discussion

The type specimen of _S. tutthum_ Buckman, (1909-30, Pl. 258), (IGS 32060) was not collected by S. Buckman, but came from his father's collection, with no more information than a provenance from the 'Sherborne district'. The citing of a _niortensis_ hemera age (= Baculata Subzone, Subfurcatum Zone herein) for this specimen, by S. Buckman was thus nothing more than a guess, based on its 'iron-shot' matrix. Recent detailed collecting, by several workers, of the '_cadomensis_ beds' of the Sherborne district, has revealed no trace of this subspecies. On the other hand it does appear to be relatively common at a higher horizon; the '<u>Astarte</u> bed' of north and south Dorset, (upper Garantiana Zone). Whilst the specimens of this subspecies, described here come from the '<u>Astarte</u> bed' of south Dorset and its equivalents in Normandy, ('Oolithe Ferrugineuse de Bayeux'), it has been recorded from the '<u>Astarte</u> bed' equivalent of north Dorset; Halfway House, near Sherborne, (Whicher, 1969, p.327). There is thus no reason to doubt the Sherborne district as the type area for this taxon. However considerable doubts must be expressed over the supposed Subfurcatum Zone age of the holotype, since all available evidence, including its matrix, would point to a higher, Garantiana Zone, type horizon.

<u>S. tutthum</u> was considered as a junior subjective synonym of <u>S. auritum</u> by Sturani, (1971, p.143), since he wrongly considered it was also of upper Subfurcatum Zone age. Whilst it is true that <u>some</u> members of the <u>S. auritum s. str.</u> group do have superficial ribs, with a smooth internal cast, this is not the predominant morphotype. Thus the consistently smooth nature of <u>S. tutthum</u>, taken together with its finer ribs, higher stratigraphic position and different shaped umbilical seam, all serve to separate it from <u>S. auritum s. str.</u>, (<u>contra</u> Sturani, 1971, p.143). However, taking into account the features it has in common with <u>S. auritum</u>, such as the form of the mouth-border, <u>S. tutthum</u> is best considered as a chronological subspecies of the former, both of these taxa being microconchs.

<u>Stratigraphic distribution</u>

There is no evidence of <u>S. auritum tutthum</u> in the Subfurcatum Zone. The specimens described here come from the '<u>Astarte</u> bed' of south Dorset and from the 'Oolithe ferrugineuse de Bayeux' of St. Honorine-des-Pertes, Normandy, both of which are upper Garantiana Zone, Acris Subzone in age. Similar specimens have been collected from the '<u>Astarte</u> bed' equivalent of north Dorset, which is of a similar age, (Whicher, 1969, p.327).

5. Sphaeroceras (Sphaeroceras) aff. globus S. Buckman

Plate 2 , figs. 7a-b ; Text fig. 10.

1927 Sphaeroceras globus nov.; S. Buckman (1909-30), Pl.725.

?1932 Sphaeroceras sp. nov., Richardson, p.76.

1939 Sphaeroceras globus Buckman; Roché, p.225.

1956 Sphaeroceras brongniarti (Sow.); Westermann, pp.28-9, (partim).

1964 Sphaeroceras brongniarti (Sowerby); Westermann, p.55, (partim).

1971 Sphaeroceras brongniarti sub. sp. globus (S. Buckman); Sturani, pp.137-141, non Pl.10, fig. 12.

Material

One specimen from the 'Rubbly beds' of the Sherborne Building stone series, Castle View, Sherborne, Dorset (ST646173), BMNH. C80371.

Dimensions

Holotype, IGS.49315, (ex. S.S.B. 4762), (M.)

D	Ud.	Pn.	Wh.	Wb.
4.0 cm.	?0.24 (6%)	-	2.30 (58)	3.1 (78)
3.62	?0	-	2.23 (62)	3.10 (86)
BMNH. C80371, (M.),				
2.7	0.55 (20)	-	1.24 (46)	2.02 (75)
2.33	0.18 (8)	-	1.44 (62)	2.03 (87)

Description

A small ammonite, with just over three-quarters of a whorl of

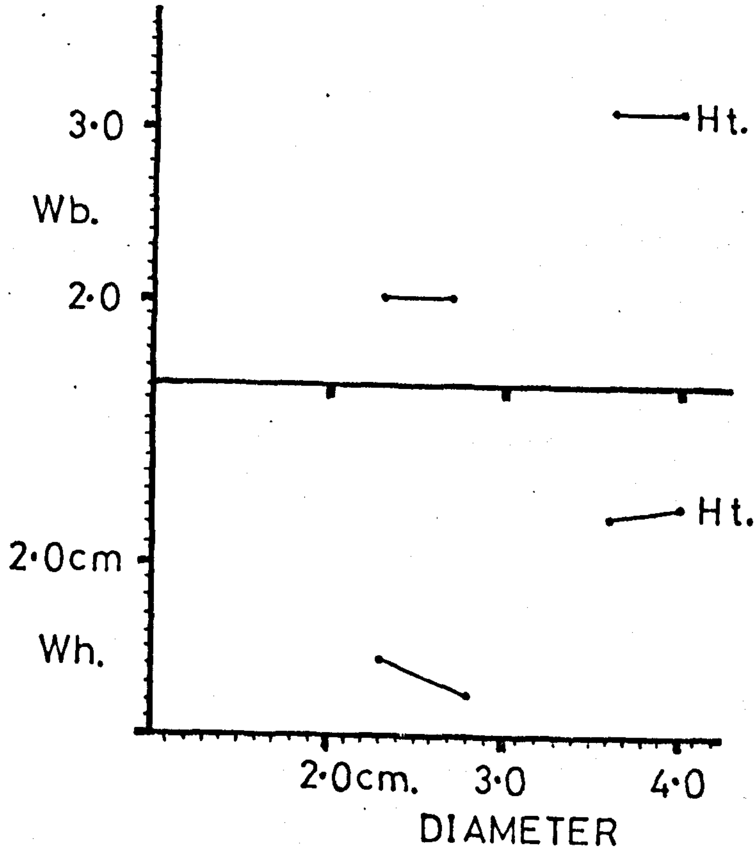


Figure 10.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum diameter for S.(S.) aff. globus S.Buckman. Ht. = holotype.

body-chamber. The inner whorls are tightly coiled to give an occluded umbilicus, whilst the rapid but uneven uncoiling of the body-chamber produces a flexed 'S' shaped umbilical seam (see Plate 2 fig. 7b). The inner whorls are relatively depressed (Wh:Wb = 0.71) and this becomes more accentuated on the last half whorl, where the relative height decreases at a greater rate than the breadth. The primary ribs are prosiradiate and very weak, whilst the secondary ribs are totally superficial on the internal cast. The mouth-border shows the development of a prosiradiate, weak flare, followed by a constriction and the beginning of a narrow, smooth lip.

Sexual dimorphism

As it is a relatively large, smooth ammonite, with a poorly differentiated mouth-border, S. globus is probably a macroconch. The corresponding microconch, may well be S. auritum cf. sub. sp. auritum, although this would have to be confirmed by more extensive material.

Discussion

The holotype of S. globus is purported to have come from the middle part of the 'cadomensis beds' of Frogden Quarry, Oborne (S. Buckman, 1909-30, Plate 725), which is equivalent to bed 6c at Oborne Wood. However, it has been impossible to confirm this by the location of in situ topotypes. The specimen described here comes from a higher stratigraphic position and shows various differences in gross morphology. It is smaller than the holotype, ~~still within the range of a 10% standard deviation~~ and shows coarser ribbing and a stronger retraction of the umbilical seam.

The holotype does have the same inflated shell shape and until more is known of this species, the described specimen is included under open nomenclature.

Stratigraphic distribution

The holotype, if its cited horizon is correct, is Subfurcatum Zone, Polygyralis Subzone in age, whilst the specimen described here from the 'Rubbly Beds' of the Sherborne Building Stone series, is Garantiana Zone in age.

6. Sphaeroceras (Sphaeroceras) tenuicostatum Sturani

Plate 2 figs. 8 - 10 ; Text figs. 8 & 10.

?1935 Sphaeroceras brongniarti (Sowerby); Roman , p.28, Plate III, fig. 10.

1952 Sphaeroceras brongniarti (J. Sow.); Arkell (1951-9), text fig. 20/ 1a-b only.

1970 Sphaeroceras brongniarti (J. Sow.); Senior, Parsons & Torrens, p.117.

1971 Sphaeroceras tenuicostatum nov.; Sturani, pp.143-4, Plate 10, fig.24 and Text fig. 42/4.

1971 Sphaeroceras tenuicostatum sub sp. glabrum nov.; Sturani p.144, Plate 10, figs.20, 22 and Text figs. 42/2 & 5.

1975 Sphaeroceras tenuicostatum Sturani; Parsons, p.9.

Material

One specimen from the 'Astarte Bed' of Upton Manor Farm, near Bridport, Dorset (Senior et al. 1970, p.117, bed 7a), BMNH. C80359, two specimens from the 'Astarte Bed' of Stony Head Cutting, near Bridport, Dorset, (Parsons, 1975, p.9, bed 13), BMNH. C80357-8, and one specimen from the Sherborne Building Stone Series, Clatcombe (S. Buckman, 1893, p.496, Section 12), near Sherborne, BMNH. C78591.

Dimensions

BMNH. C80359, Max. diameter on flare 1.16 cm., (m.),

D	Ud.	Pn.	Wh.	Wb.
1.1	0.14 (12)	c.29	0.6 (55)	0.79 (72)
0.94	0.05 (5)	-	0.62 (66)	0.8 (85)

D	Ud.	Pn.	Wh.	Wb.
BMNH. C80357, (M.),				
2.53	0.44 (17)	38	1.24 (49)	2.02 (80)
2.0	0.07 (4)	-	1.44 (72)	2.03 (102)
BMNH. C80358, (M.),				
2.3	-	-	1.15 (50)	1.68 (73)
1.96	c.0.1 (5)	-	1.27 (65)	-
BMNH. C78591, maximum diameter on flare - 3.14 cm. (M.),				
2.88	0.46 (16)	-	1.53 (53)	2.08 (72)

Description

A small (average macroconch diameter = 2.7 cm.), highly globose ammonite, with tightly coiled inner whorls, a rapid uncoiling of the umbilical seam but with a less marked contraction of the body-chamber over the last half whorl. The whorl section is well rounded, but the whorl width is consistently greater than the whorl height (Wh/Wb = 0.72). The whorl height decreases relative to the width over the last quarter whorl (see Text fig. 11), which leads to the development of a very wide but depressed aperture (see Plate 2 , fig. 10c). The umbilical seam retracts at an uneven rate, which leads to the production of the highly characteristic, sinuous, 'S' shape (Text fig. 8 , B). The primary ribs are extremely fine, sharp, wiry, prorsiradiate, very dense (28-38/whorl) and divide on the outer part of the whorl flank into two and often on the inner whorls, three secondary ribs. These secondaries are also very fine, sharp, and swing forward smoothly over the venter, with the hint of a slight backward deflection along the mid ventral line. All the ribs are partly superficial but leave a slight impression on the internal cast.

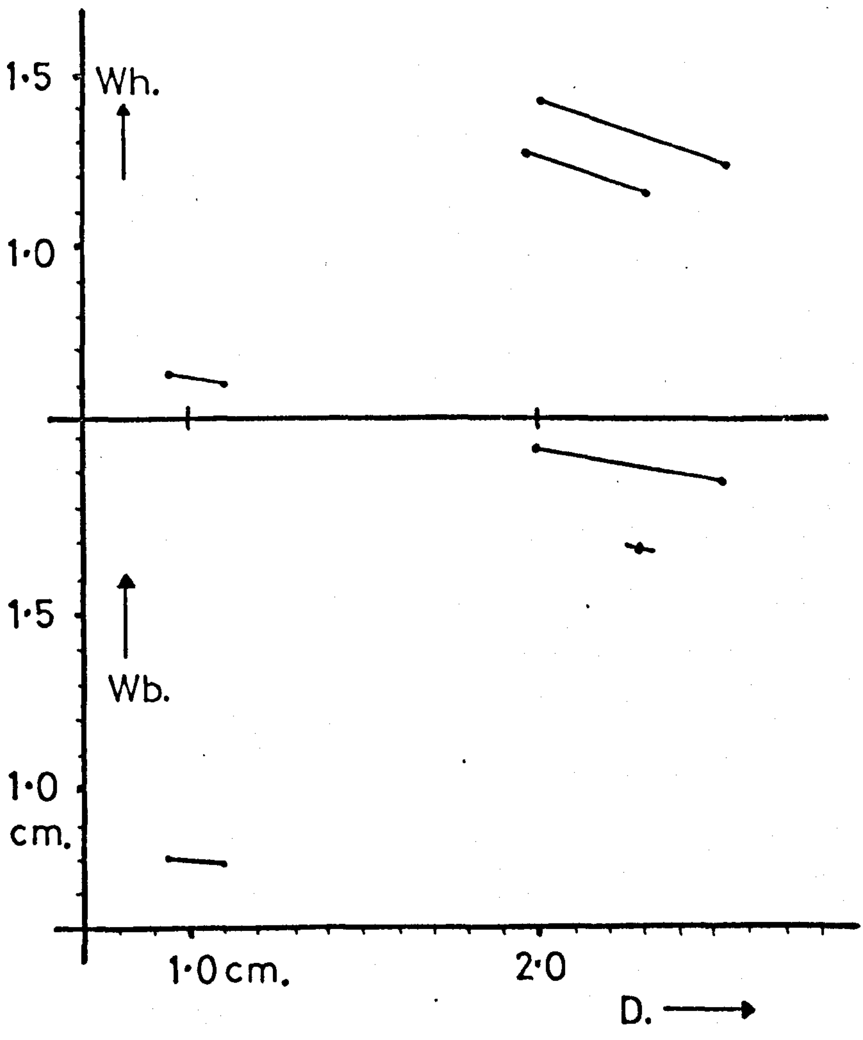


Figure 11.

A plot of whorl height (Wh.) and whorl breadth (Wb.) against maximum diameter (D.), for specimens of S.(S.) tenuicostatum Sturani from the Astarte bed of south Dorset.

The mouth-border is well differentiated, with a very thin, but high flared hood, which is strongly prorsiradiate (see Plate 2 , fig. 10a). The hood is followed by a narrow, deep constriction and then a narrow, smooth lip, which has a mid-ventral node. The flare is unusual, in that it shows the presence of numerous secondary ribs on its adapical surface (Plate 2 , fig. 9).

Sexual dimorphism

The three larger specimens (average diameter = 2.7 cm.) are very similar to Sturani's (1971, p.144) material in relative proportions, ribbing style, mouth-border and shape of umbilical seam; but differ by being much larger. They are probably thus macroconchs. The specimen from Upton Farm (BMNH. C80359), is much smaller (1.16 cm.) and is of the same order of magnitude as the larger end members of the Italian fauna (loc. cit., 10-11 mm.); they are thus the ideal microconch partners for the larger English specimens. Although based on a very small sample, the size ratio between dimorphs is in the order of 1:2.3.

Discussion

The holotype of this species (Sturani, 1971, Plate 10, fig.24) comes from the Garantiana Zone of the Venetian Alps. The specimens described here conform to those figured by Sturani in most characters, both groups having similar mouth-borders, very fine ribs and sinuous umbilical seams; however, exact comparisons are made difficult by Sturani's unfortunate omission of any measurements for the holotype and paratypes. This species is easily separated from S. brongniarti by its thinner, sharper hood and by its more occluded umbilicus (see

Text fig. 8), whilst its continuous rather than bilobate hood distinguishes S. tenuicostatum from the S. auritum/tutthum group, which otherwise has very similar relative proportions.

Stratigraphic distribution

The holotype of this species is Garantiana Zone in age, whilst the specimens described here come from the Astarte bed of south Dorset, which is to be correlated with the Acris subzone of the Garantiana Zone, and from the Sherborne Building Stone Series, which is probably, at least in part, of the same age.

Genus Chondroceras Mascke 1907

Type species, by original designation - C. gervillei (J. Sowerby 1817)

Subgenus Chondroceras Mascke 1907

Syn. Schmidtoceras Westermann, 1956.

Diagnosis

A group of small, sphaeroconic ammonites, with relatively fine, sharp ribs. The inner whorls are closely coiled leading to the development of a deep, narrow, but open umbilicus. There is a moderate uncoiling of the umbilical seam associated with the contraction of the body-chamber; this contraction however, is never as marked as in Sphaeroceras. The sutures are complex and interdigitating. Macro- and microconchs have a size ratio of approximately 2:1, both showing modifications to the mouth-border, usually a constriction, followed by a smooth lip. This subgenus ranges from the upper Laeviuscula Zone to the base of the Parkinsoni Zone.

Subgenus group

Numerous species have been described under the generic name Chondroceras, but only the following are accepted here as members of the restricted subgenus.

1/ C. gervillei (J. Sowerby, 1817)

syn. C. orbignyanum (Wright, 1860 non Geinitz)

2/ C. evolvescens (Waagen 1867)

syn. C. wrightii (Buckman, 1881),

C. wrightii sub. sp. minor, Westermann, 1956,

C. (Schmidtoceras) schindewolfi sub. sp. hispanicum Westermann, 1956,

?*C.* (*S.*) *ibericum* Westermann, 1956,

C. (*Defonticeras*) *parvumbilicum* Westermann, 1956,

??*C.* *densicostatum* Westermann, 1956.

3/ *C.* *canovense* (de Gregorio, 1886)

4/ *C.* *grandiforme* S. Buckman, 1922

syn. *C.* *delphinus* S. Buckman, 1923

?*C.* *polytomum* Westermann, 1956.

5/ *C.* *polypleurum* (Westermann, 1956)

syn. *C.* *gracile* (Westermann, 1956).

6/ *C.* *polypleurum* sub. sp. *crassicostatum* (Westermann, 1956),

7/ *C.* *obornensis* nov.

8/ *C.* sp. nov. aff. *C.* *tenue*

9/ *C.* *schmidti* (Westermann, 1956), group including syn./ sub. sp.

C. *schmidti multicostatum* (Westermann, 1956).

?*C.* *arkelli* (Westermann, 1956).

?*C.* *arkelli gerzense* (Westermann, 1956)

??*C.* *crassum* (Westermann, 1956)

C. *evolutum* (Westermann, 1956)

10/ *C.* *antiquum* (Westermann, 1956)

11/ *C.* *tenue* (Westermann, 1956)

12/ *C.* *boehmi* Westermann, 1956

13/ *C.* *flexuosum* Sturani, 1971

syn./sub. sp. *C.* *fasciculatum* Sturani, 1971.

14/ *C.* *callomoni* Sturani, 1971.

Of these species, *C.* *boehmi* has only been recorded from New Guinea, whilst *C.* *callomoni* and *C.* *flexuousum* have not yet been recognised outside of northern Italy. The most problematic group consists of those 'species' here included in C. schmidti, which are members of Westermann's subgenus Schmidtoceras. There is little or no stratigraphic basis for most of the species erected by Westermann in this subgenus. Only two (C. antiquum & C. tenue) were recorded from any horizon other than the lower Humphriesianum Zone. It is solely because of their distinct stratigraphic ranges in the Sauzei and upper Humphriesianum Zones respectively, that these latter two species are retained here.

Since there is at present insufficient stratigraphic and morphological criteria to separate them, any future attempts at a revision of the members of the C. schmidti group must be based on a greater appreciation of both their relative stratigraphic distribution and intra-specific variation. The C. schmidti group is largely restricted to the German/Swiss Jura area, and a study of large collections from Lüphen, Schwabian Albe, south Germany (U. Bayer collection, Stuttgart), would suggest that most of the so called 'species' of Schmidtoceras are merely morphotypic variants, within a single highly variable bio-species, centred on C. schmidti.

1. Chondroceras (Chondroceras) gervillei (J. Sowerby)

Plate 2, figs. 11-13; Plate 3 , fig. 1. ; Text figs. 12 & 25

1817 Ammonites gervillii nov.; J. Sowerby (in J. & J. de C. Sowerby, 1812-46), p.189, Plate 184A, fig. 3.

non 1846 Ammonites gervillii Sow.; d'Orbigny (1842-51), pp.409-410, Plate 140, figs.1-8.

non 1849 Ammonites gervillii; Quenstedt (1845-9), p.187, Plate 15, fig.11.

1856 Ammonites gervillii Sow.; Oppel, p.375.

non 1867 Ammonites gervilli Sowerby; Waagen, p.605.

1877 Stephanoceras gervilii ; Hyatt, pp.393-4.

non 1878 Sphaeroceras gervillii Sowerby; Bayle, Plate 53, figs. 6 & 7.

non 1881 Ammonites gervillii Sow.; J. Buckman, p.63, fig.4.

non 1881 Sphaeroceras gervillii (Sow.); S. Buckman, p.597.

non 1886 Ammonites gervillii; Quenstedt (1886-7), p.510, Plate 64, figs.3, 14 & 15.

?1893 Sphaeroceras gervillii (Sow.); S. Buckman, p.501.

1907 Chondroceras gervillei Sow.; Mascke, p.33.

non 1927 Chondroceras gervillii (J. Sowerby); S. Buckman (1909-30), Plate 724.

non 1951 Sphaeroceras gervillei (Quenstedt); Maubeuge, 1951, p.81, Plate 12, fig.5.

1952 Chondroceras gervillii (J. Sowerby); Arkell (1951-9), p.78, Text fig. 20/a & b. (holotype).

1956 Chondroceras gervillii (J. Sowerby); Westermann, pp.50-3, Text figs. 25 & 31, Plate 1, figs.1 (holotype), 3 & 4, non 2.

? 1956 Chondroceras russelli Crickmay; Westermann, pp.53-5, Plate 1, figs. 5 & 6.

1956 Chondroceras (Schmidtoceras) orbignyanum orbignyanum (Wright); Westermann, pp.74-7, Text figs. 39 & 45, Plate 5, fig.6 non 7; & non Plate 6, figs. 1 & 2.

1957 Chondroceras gervillii (Sow.), Arkell (in Arkell, Kummel & Wright 1957), p.L292, Figure 347/3a-b. (holotype).

1961 Chondroceras gervillii Sowerby; Maubeuge, p.146 (with figure).

1964 Chondroceras gervillii (J. de C. Sowerby); Westermann, p.54.

1971 Sphaeroceras (Chondroceras) gervillii (Sow.); Sturani, p.146.

1971 Chondroceras gervillii (Sowerby); Morton, p.287.

1971 Chondroceras gervillii (J. Sowerby); Whicher & Palmer, p.117.

Material

Four specimens from Oborne Wood; two collected in situ from bed 4b, BMNH. C80380-1, and two probably from this horizon, BMNH. C80382-3 and one specimen from the 'Irony bed' of Louse Hill quarry, near Sherborne, Dorset (ST 608163), BMNH. C80379.

Dimensions

Holotype, BMNH. C36735, maximum diameter on flare - 2.85 cm.

D	Ud.	Pn.	Wh.	Wb.
2.60	0.60 (23%)	38	1.30 (50)	1.90 (73)
c.2.35	0.5 (21)	37	1.14 (49)	1.74 (74)

D	Ud.	Pn.	Wh.	Wb.
BMNH. C80380, diameter on flare - 2.9 cm.				
2.83	0.7 (25)	26	1.39 (49)	1.93 (68)
2.36	0.51 (22)	25	1.23 (52)	1.78 (75)
BMNH. C80382,				
2.6	0.62 (24)	26	1.23 (47)	1.84 (71)
2.05	0.43 (21)	-	1.22 (59)	1.84 (90)
BMNH. C80383,				
2.57	0.77 (30)	28	1.2 (47)	1.8 (70)
2.12	-	-	1.18 (56)	1.67 (79)
BMNH. C80381,				
2.94	0.72 (24)	39	1.41 (48)	1.94 (66)
2.44	0.58 (24)	-	1.23 (50)	1.88 (77)
BMNH. C80379, (incomplete),				
1.78	0.40 (22)	23	0.92 (52)	1.44 (81)
1.51	0.32 (21)	-	0.82 (54)	1.23 (81)

Description

A small (average size = 2.8 cm.), globose species, with a narrow, deep, but open umbilicus, and with a rounded but relatively depressed whorl section $\left(\frac{Wh}{Wb} = 0.69\right)$. There is a very slight uncoiling of the umbilical seam over the last quarter whorl, but this produces little or no change in the relative whorl height and breadth of the body-chamber, compared to the earlier whorls - see Text fig. 12 . The ribbing is sharp and well marked. The primary ribs are curved, prorsiradiate, dense (26-39 on the outer whorl) and divide just above the whorl shoulder into two secondaries, with the occasional third interdigitated. The secondary ribs sweep forward

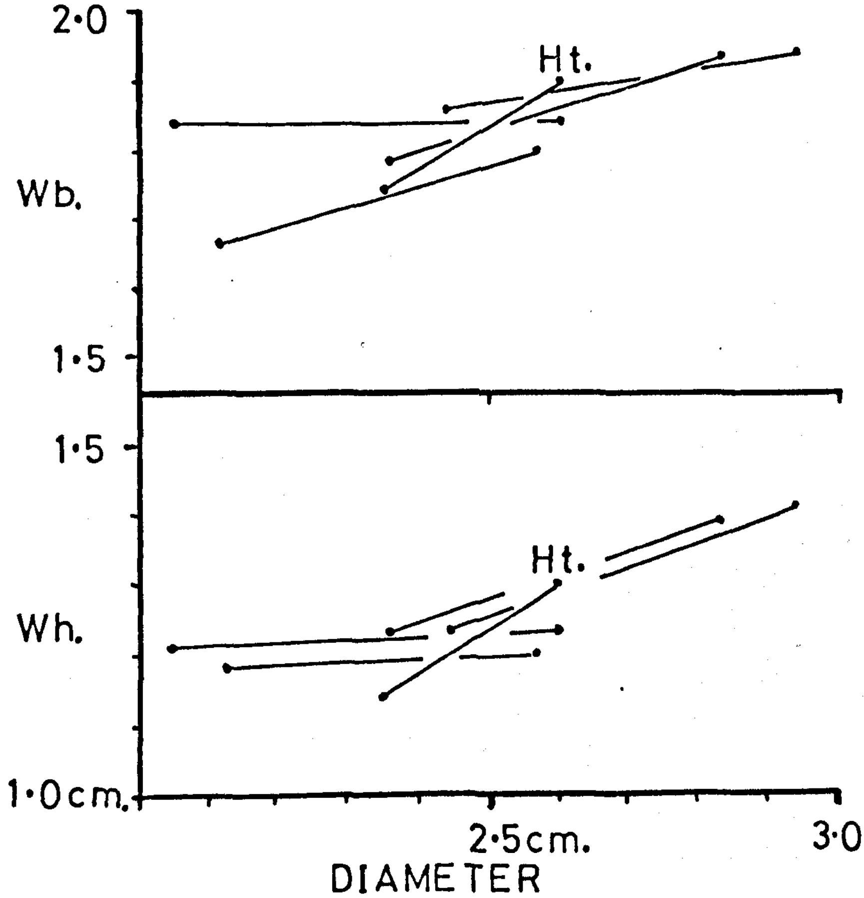


Figure 12.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum diameter for C.(C.) gervillei (J.Sow.). Ht. = holotype.

gently over the relatively flat venter, and tend to become slightly coarser just before the aperture. The body-chamber stretches for four-fifths of a whorl and it is terminated by a well developed mouth-border. This consists of a slight flare, followed by a deep constriction and a smooth expanded lip - see Plate 2 , fig. 11.

Sexual dimorphism

There is a problem in determining the identity of the dimorphic partner of C. gervillei. In relative proportions, ribbing style and shape of mouth-border, this species is very close to C. grandiforme. This might suggest C. gervillei as the microconch counterpart of this much larger species. The only factor against this is the higher proportion of secondary to primary ribs on the inner whorls of C. grandiforme; as a ratio closer to 3:1, rather than the 2:1 of C. gervillei is evident. Another possibility is that C. gervillei is the macroconch of a smaller, and as yet un-recognised group. It is however certain that C. wrighti minor (= C. evolvescens, (m.).), cannot be considered as the microconch of this species (contra Sturani, 1971, p.146), since its relative proportions and the shape of its mouth-border are very different, (see the later discussion of C. evolvescens). The last possibility is that C. gervillei is the microconch of an as yet undescribed macroconch, which would have the appearance of a more inflated form of C. polypleurum (Westermann), M., but with a more depressed whorl cross-section. The only solution to this problem rests in the collection of larger in situ samples.

Discussion

As can be seen from the synonymy list, this species has been the subject of much past confusion, which at least in part has originated from d'Orbigny's interpretation of this taxon (d'Orbigny, 1842-51, Plate 140). This confusion was augmented by Quenstedt's erroneous and broad interpretation of this species, which he used as the basis for several invalid trinomens (Quenstedt, 1886, Plate 64). Other authors who have mis-identified this group include Buckman, whose figured specimen (Buckman, 1909-30, Plate 724; IGS. 49314), is too compressed and umbilicate for this species, and Westermann (1956), at least one of whose specimens is a member of the C. evolvescens group (op. cit., Plate 1, figs. 2a-b), since it shows the presence of a smooth mouth-band and a highly contracted body-chamber. In connection with the latter work, it is possible that the specimens figured by Westermann as C. russelli Crickmay, (op. cit., Plate 1, figs. 5a-b & 6a-b), are coarser ribbed morphotypes of C. gervillei, since there is a wide range of variation in primary rib density in the latter species. In any event these specimens cannot be referred to C. russelli, as this species is based on an inadequate nucleus of relatively large size, which from the associated ammonite fauna is Sauzei Zone in age (Crickmay, 1933, p.913, Plate 27, figs. 6-8). Similarly Westermann's 'lectotype' of C. orbignyanum (Wright) is undoubtedly synonymous with C. gervillei. They both come from the same horizon, the 'Bayeux Conglomerate', Normandy, show a similar gross morphology, depressed whorl cross-section and rib style, particularly the prevalence of biplicate secondary ribs. In any case 'Ammonites' orbignianus (Wright, 1860) is a junior objective homonym of 'A.' orbignyanus Geinitz (1850), (Waagen, 1867, p.605), inspite of the one letter difference, (Int. Code Zoo. Nomen., Article 58(2)).

The specimens which are here referred to this species are both rare compared to other Romani subzone sphaeroceratids and relatively variable. The specimen closest to the holotype (Plate 2 , figs. 11a-b) is BMNH. C80380 (Plate 2 , figs. 12a-b), which has very similar relative proportions and whorl shape, but which is coarser ribbed. However the range of rib density and relative proportions exhibited by this, and the other specimens, is well within that shown by larger samples of other more clearly defined species, such as _C. evolvescens_ (see below). This species may be easily confused with _C. polypleurum crassicostatum_ which is very similar in many respects. However, they may be separated by their very different whorl proportions, as is clearly brought out in Text fig. 24.

Stratigraphic distribution

The type horizon of this taxon, the 'Bayeux Conglomerate', is Romani subzone, Humphriesianum Zone in age, as are all the English specimens, which have been collected _in situ_.

2. Chondroceras (Chondroceras) evolvescens (Waagen)

Plate 3 , figs. 2 - 9 ; Text. figs. 1,2,13-9.

non 1849 Ammonites gervillii Sow.; Quenstedt (1845-9), p.187, Plate 15, fig.11.

1867 Ammonites evolvescens n.sp.; Waagen, pp.604-5.

non 1881 Ammonites gervillii Sow.; J. Buckman, pp.63-4, fig.4.

1881 Sphaeroceras wrightii n.sp.; S.S. Buckman, p.599.

non 1886 Ammonites gervillii Sow.; Quenstedt (1886-7), p.510, Plate 64, fig.3.

1893 Sphaeroceras wrighti ; S. Buckman, p.501.

1923 Chondroceras wrighti S. Buckman; S. Buckman (1909-30), Plate 415.

1939 Chondroceras wrighti Buck.; Roché, p.225.

1939 Sphaeroceras evolvescens Waagen; Roché, p.226.

1943 Sphaeroceras evolvescens Waagen; Roché, pp.20-2, Plate 1, figs. 5, 6, (leotype) & 7.

?1951 Sphaeroceras gervillei (Quenstedt); Maubeuge, p.81, Plate 12, figs. 5a-c.

1952 Sphaeroceras wrighti S. Buckman; Jackson, p.139.

1956 Chondroceras (Chondroceras) evolvescens (Waag.); Westermann, pp.55-8, (pars), Plate 1, figs. 7a-b, non 8, non Plate 2, figs. 1a-b.

1956 Chondroceras (Chondroceras) wrighti wrighti Buckm.; Westermann, pp.58-61, Plate 2, figs. 3 & 4, Plate 3, fig. 1.

1956 Chondroceras (Chondroceras) wrighti minor n. subsp.; Westermann, p.61, Plate 3, figs. 2 & 3.

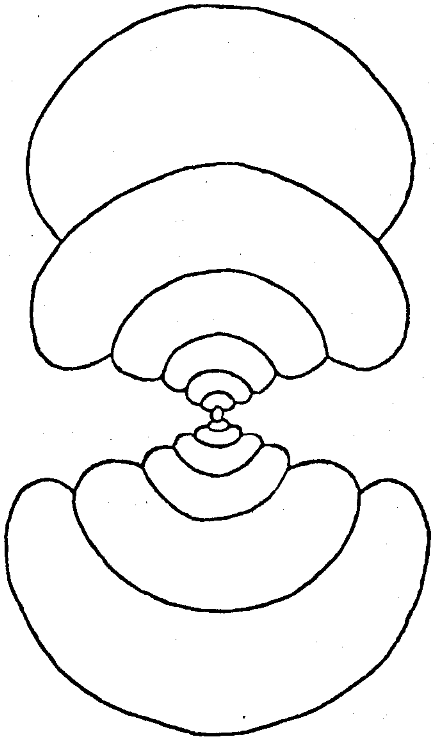


Figure 13.

A median cross-section of a specimen of Chondroceras (C.) evolvescens (Waag.), from bed 4b, Oborne Wood, Dorset ; x2.5.

1956 Chondroceras (Chondroceras) gervillii (Sow.); Westermann, Plate 1, fig. 2a-b, non 1, 3-4.

1956 Chondroceras (Schmidtoceras) schindewolfi hispanicum n. subsp.; Westermann, pp.82-4, Plate 8, figs. 1a-b, non 2 & 3.

1956 Chondroceras (Defonticeras?) parvumbilicum n. sp.; Westermann, pp.104-6, Plate 12, figs. 1 & 2.

?1963 Chondroceras wrighti wrighti Buckm.; Makowski, pp.50 & 81, Text fig. XII, 1 & 2.

1964 Chondroceras evolvescens (Waagen); Westermann, p.54.

1964 Chondroceras parvumbilicum (Westermann); Westermann, p.54.

1971 Sphaeroceras (Chondroceras) wrighti (Buckm.) minor (Westermann); Sturani, pp.145-6, Plate 11, figs. 1-3, 5 & 6.

1971 Chondroceras wrighti S. Buckman; Whicher & Palmer, p.117.

1971 Chondroceras evolvescens (Waagen); Morton, pp.286-7, Plate 51, figs. 4-7.

Material

The following have been collected in situ: 41 from bed 5, Milborne Wick, BMNH. C80400-2, CP2178-2190, CP2192-2200, CP2202-2213, CP2280-3; 39 from bed 4b, Oborne Wood, BMNH. C80384-8, CP2226-8, CP2230-6, CP2238-2248, CP2250-2, CP2254-2261, CP2726-7; 2 from bed 5b, Clatcombe Farm, BMNH. C80372-3 and two from the Rigg Sandstone, Rigg, Isle of Skye (NG521567), CP2262-3. In addition 20 specimens from the Manchester Museum (ex. Earwaker coll.), from Milborne Wick, LL4252A-I & N-X; and 38 from Milborne Wick, OUM.J10800, J10812-9, J10821-4, J10826-42 and 8 on a collective number J10847, have been

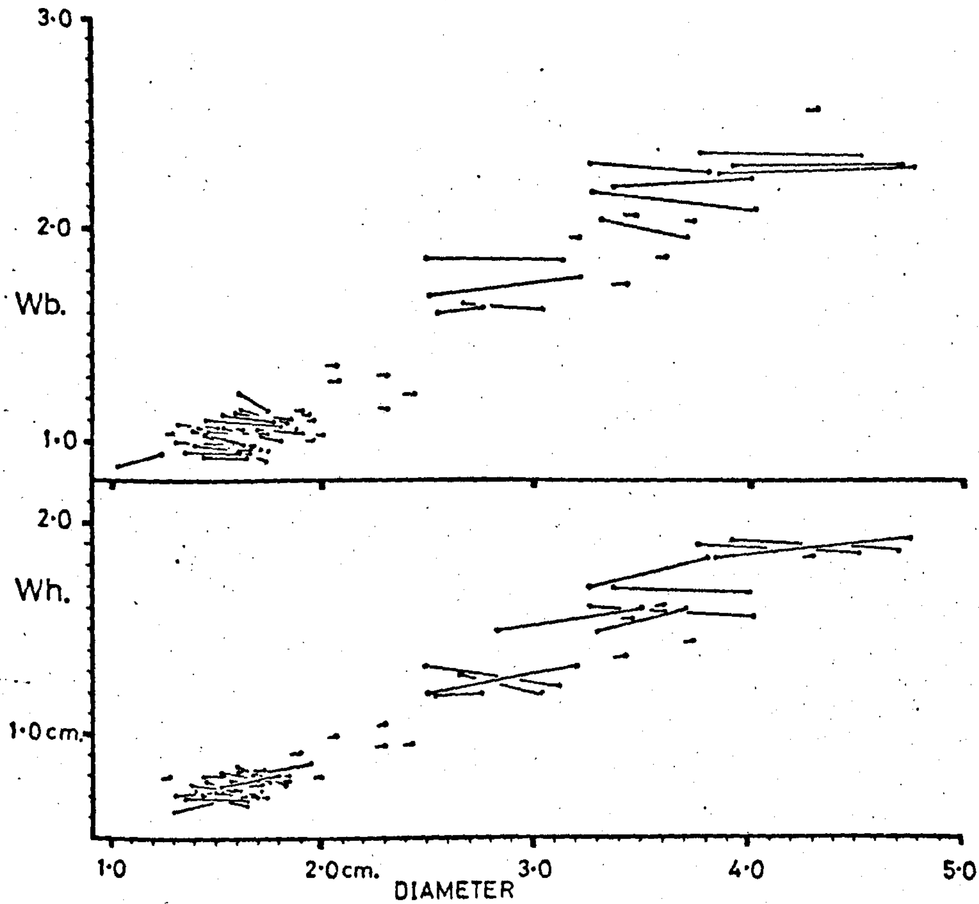


Figure 14.

Plots of whorl breadth (Wb.) and whorl height (Wh.) against maximum diameter, for mature specimens of C.(C.) evolvescens (Waag.), from Milborne Wick lane section.

utilised, since they have a highly characteristic matrix, and thus can be well localised. The following topotype material of C. evolvescens, from Le Mesnil-Louvigny, Normandy, France has also been included; OUM.Jz1465 & BMNH. C78324-5. A total of 145 specimens.

Dimensions

Jz1465, (M.),

D.	Ud.	Pn.	Wh.	Wb.
4.0 cm.	1.25 (31.3%)	26	1.76 (44)	2.25 (56.3)
3.2	-	-	1.7 (53.1)	2.23 (69.7)
BMNH. C78324, maximum diameter 3.74 cm., (M.),				
3.53	0.96 (27)	-	1.6 (45)	2.03 (58)
3.05	0.70 (23)	-	1.54 (51)	2.11 (69)
BMNH. C78325, maximum diameter 4.13 cm., (M.),				
3.83	1.05 (27)	-	1.62 (42)	2.28 (60)
3.34	0.85 (26)	-	1.7 (51)	2.37 (71)
BMNH. C80372, maximum diameter, 4.24 cm., (M.),				
4.16	1.2 (29)	37	1.85 (45)	2.35 (57)
3.32	0.64 (19)	-	1.67 (50)	2.44 (74)
BMNH. C80400, maximum diameter, 4.8 cm. (M.),				
4.72	1.5 (32)	26	1.93 (41)	2.28 (48)
3.84	0.75 (20)	24	1.84 (48)	2.25 (59)
BMNH. C80401, maximum diameter, 1.74 cm., (m.),				
1.64	0.44 (27)	27	0.70 (43)	0.94 (57)
1.43	0.30 (21)	-	0.71 (50)	0.94 (66)
BMNH. C80384, maximum diameter, 4.0 cm., (M.),				
3.76	0.95 (25)	29	1.54 (41)	2.2 (59)
3.2	0.58 (18)	28	1.65 (52)	2.25 (70)

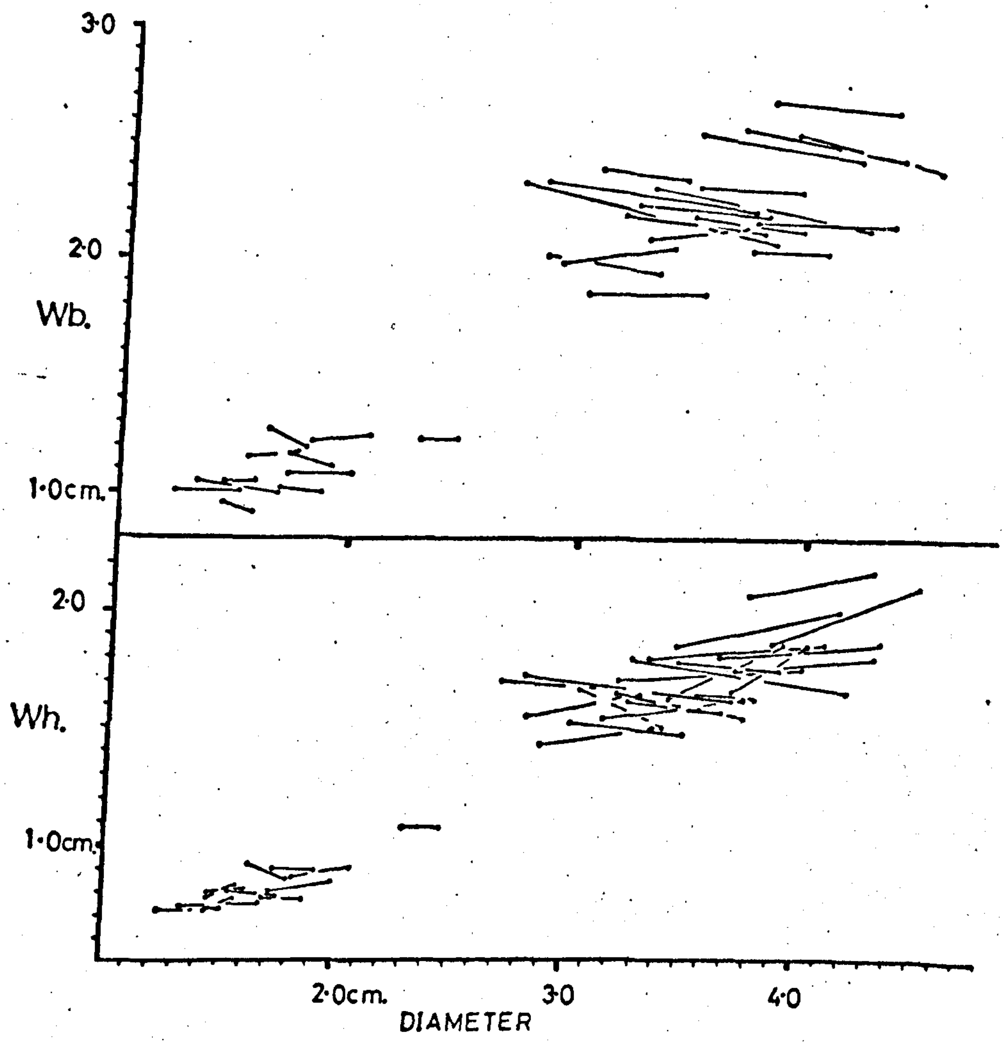


Figure 15.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum whorl diameter for specimens of C.(C.) *evolvescens* (Waag.), from bed 4b , Oborne Wood, Dorset.

D	Ud.	Pn.	Wh.	Wb.
BMNH. C80385, maximum diameter, 1.76 cm., (m.),				
1.68	0.40 (24)	29	0.76 (45)	1.00 (60)
1.33	0.3 (23)	-	0.74 (56)	1.05 (65)

Dimensions of only a small representative sample of the total material are given above, and the majority are recorded in an appendix.

Description

A small (average size, Oborne Wood microconch = 1.90 cm., macroconch = 4.01; Milborne Wick microconch = 1.87, macroconch = 3.98), globose, involute ammonite, with a deep and very narrow umbilicus (see Text fig. 13). There is a marked uncoiling of the umbilical seam (hence Waagen's name), associated with the contraction of the body-chamber, which stretches for between three-quarters and one whorl. This contraction is caused by the reduction in whorl breadth relative to whorl height (see Text figs. 14 & 15), which results in the highly depressed inner whorls becoming more rounded towards the aperture (see Text fig. 13). The ribbing is well marked and strong, although with a tendency to be slightly superficial on the inner whorls. The primary ribs are almost straight, slightly prorsiradiate, dense (modal values = 26-7 per last whorl) and divide well up the whorl flank into two to three secondaries. The latter are coarser on the last half whorl and sweep forward very gently over the arched venter. The mouth-border is characterised by a constriction, followed by a faint flare and a broad smooth lip. The sutures of some specimens from Milborne Wick (CP2224, 2280, 2289 & 2291), are more easily visible, than is the case with many other

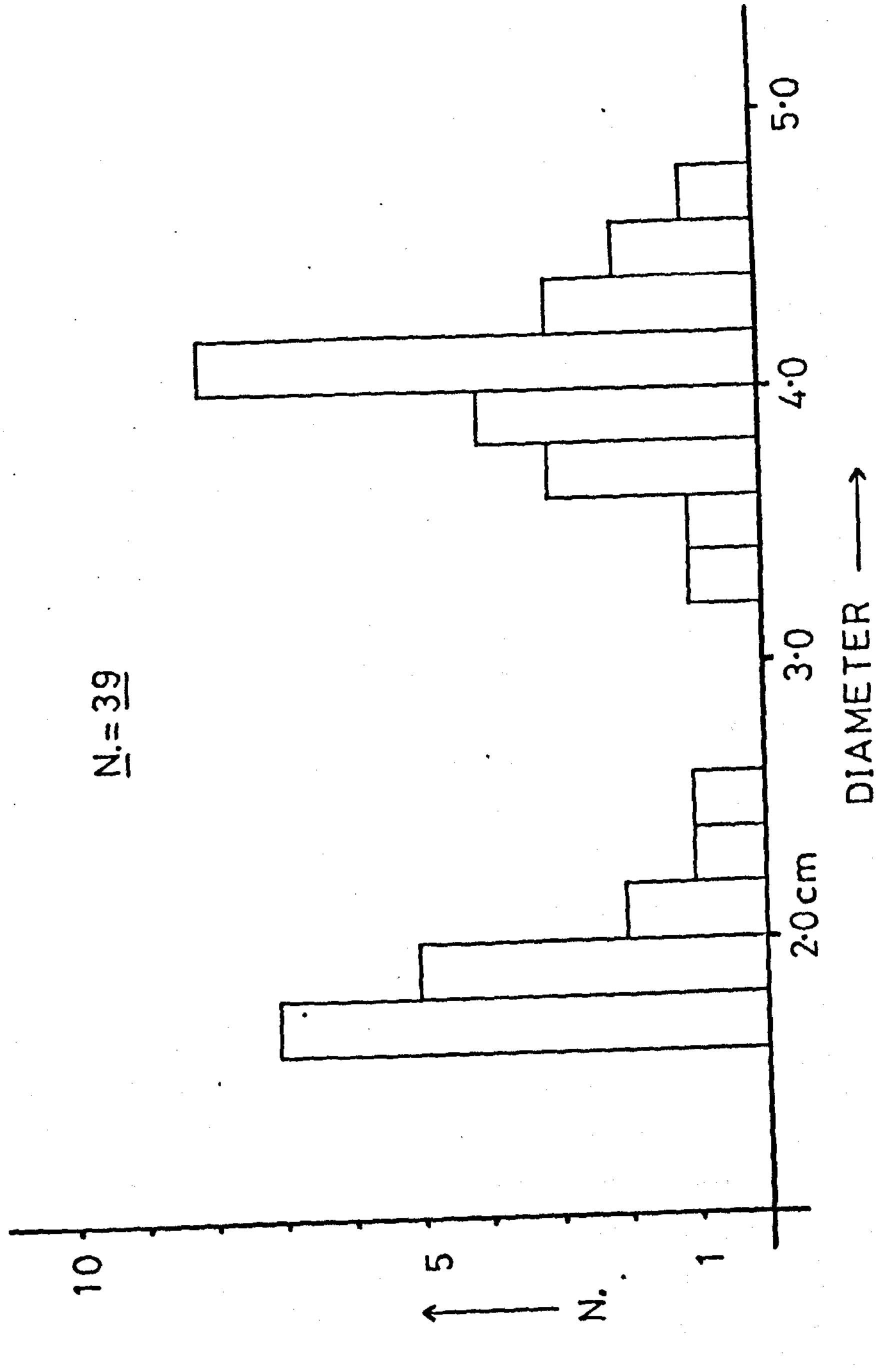


Figure 16.

A histogram of the distribution of maximum mature diameter in specimens of C.(C.) evolvescens (Waag.), from Oborne Wood, Dorset.

British Sphaeroceratids. Although they are still complex and difficult to delineate, the larger size of these sutures has enabled a detailed comparison to be made with previous figured specimens. Whilst there is a considerable degree of individual variation, these sutures agree in general terms with that figured by Westermann (1956, Text fig. 33), of Chondroceras wrighti. The only clear difference from this figure, would appear to be a tendency for the second umbilical lobe (U_{II}) to be narrower and more divided on the Milborne Wick specimens, compared to Westermann's.

Sexual dimorphism

Both of the larger samples from Oborne Wood and Milborne Wick, clearly show bi-modal size distributions (Text figs. 1 & 16). It is evident from the examination of both the inner whorls of numerous complete specimens, as well as more fragmentary material, that the micro- and macroconchs are identical in relative proportions and ribbing style, up to a diameter of approximately 1.25 cm. It is only with the appearance of the mature body-chamber, that sexual differentiation becomes apparent. The size ratio between dimorphs is fairly constant, as both the Milborne Wick and Oborne Wood samples, yielded ratios of average microconch diameter to average macroconch diameter of 1:2.1. The microconchs, apart from their smaller size, tend to be slightly coarser ribbed and to have a more modified mouth-border, than their macroconch counterparts. Whilst the majority of the microconchs have a slightly sinuous edge to their apertures, a few show additional modifications, including mild flares preceding the constriction, mid-ventral nodes on the lip, and the presence of residual lappets,(e.g. BMNH. C80402). The latter are extremely

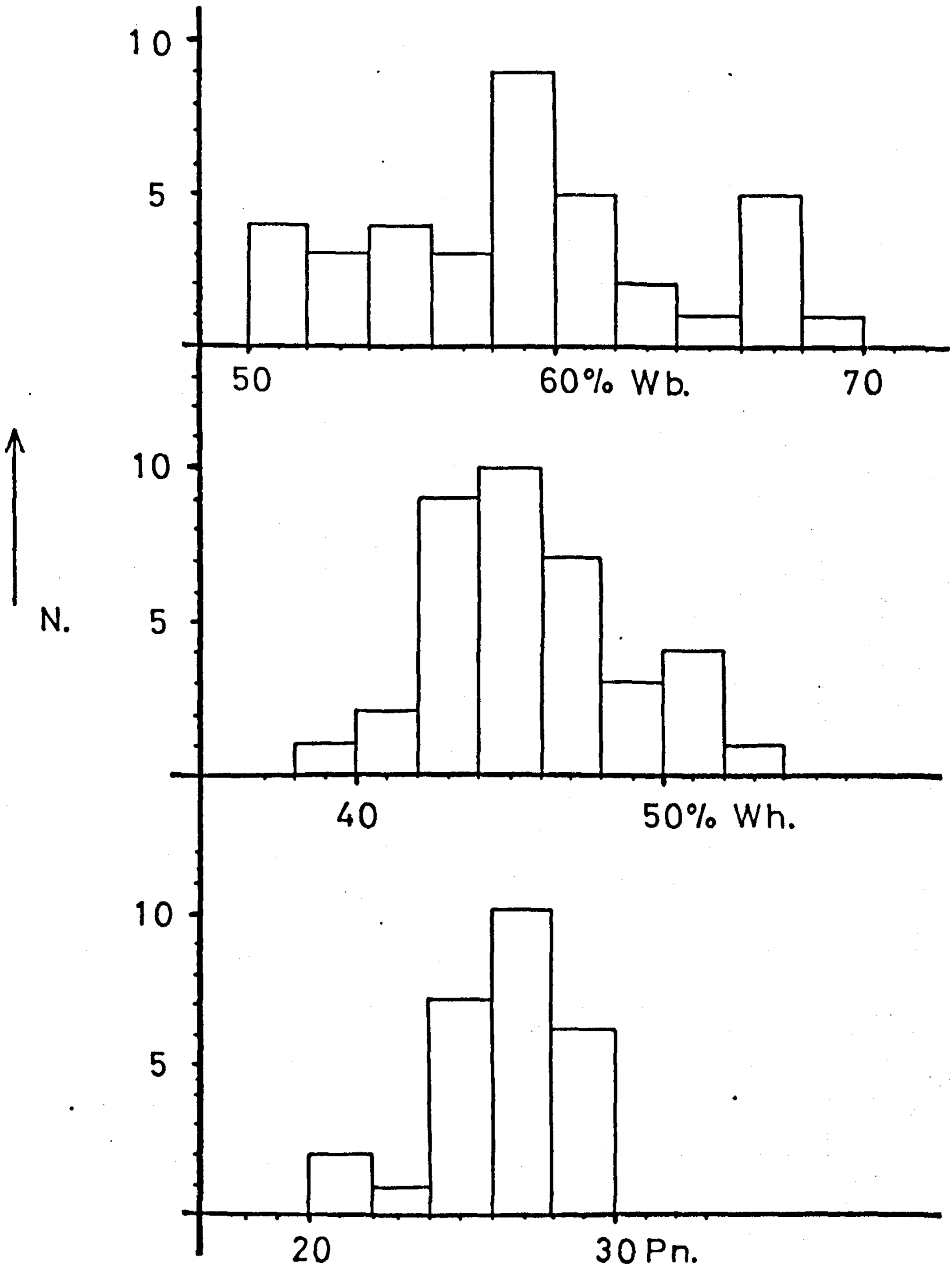


Figure 17.

Histograms showing the distribution in relative values of whorl breadth (Wb.), whorl height (Wh.) and primary rib density (Pn.), for specimens of <u>C</u>. (<u>C</u>.) <u>evolvescens</u> from Oborne Wood, Dorset.

similar to those exhibited by _Sphaeroceras mansellі_ and _Labyrinthoceras meniscum_ (see Plate 1 , fig. 10c; Plate 3 , fig. 4). However these additional modifications of the mouth-border are both relatively rare and highly variable in their development.

Morphological variation

There is a considerable range of morphological variation inherent in this group (see Table II). The sample from Oborne Wood has the most even distribution between the two dimorphs, and hence this was used for a study of the variation in relative proportions. This showed that the variation of both whorl height and of the number of primary ribs per whorl, follows an approximately gaussian distribution (see Text fig. 17), whilst whorl breadth has a more widely spread, non-gaussian distribution. The variation in relative dimensions of the Milborne Wick sample show similar trends, with a wide spread in the whorl breadth distribution, and well developed gaussian distributions in the rest, particularly the primary rib density (see Text fig. 18). Although they have similar relative whorl proportions, the Milborne Wick and Oborne Wood samples do not show identical ranges of variation. An examination of the plots of relative whorl height and breadth (Text figs. 14 & 15), shows that the macroconchs from Milborne Wick are consistently less inflated, with a lower whorl height, than the Oborne Wood macroconchs at identical diameters. This variation is not however discontinuous, as there is a considerable overlap of these two groupings, (see Text fig. 19). A similar style of variation appears to be inherent in the small sample from the Clatcombe Farm section, Sherborne

	At aperture	Half whorl before aperture
Relative whorl height (%)	39-52%	45-63%
" " breadth (%)	48-69%	53-87%
Number of primary ribs per whorl	20-37	-
Relative umbilical width	20-34%	15-26%

Table II

Variation in relative proportions for *C. evolvescens* (Waagen), based on *in situ* material from Oborne Wood and Milborne Wick, Dorset.

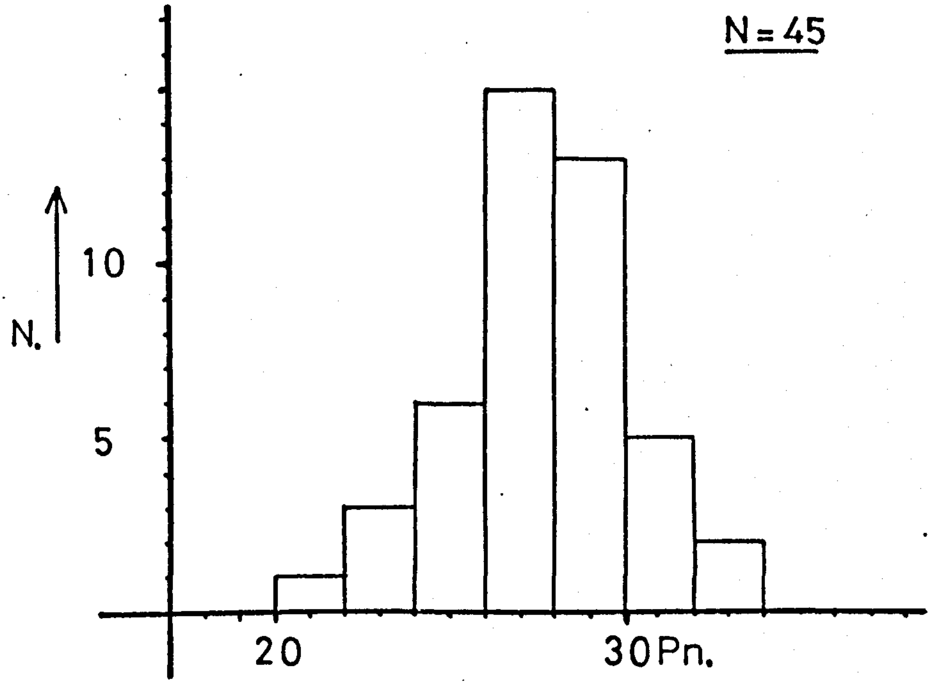


Figure 18.

A histogram showing the distribution in values of primary rib density (Pn.) in C.(C.) evolvescens, from Milborne Wick, bed 5.

(ST628179). These specimens have a much higher primary rib density than most members of the other collections (30-37 per whorl). However, this again overlaps with the range of variation of the larger samples.

Discussion

The type series of C. evolvescens (Waagen), contains specimens from at least two localities; Le Mesnil-Louvigny and Les Moutiers, Normandy (Waagen, 1867, p.605); hence the figuring of only one of these specimens as 'holotype' (Roché, 1943, Plate 1, figs. 6a-b), may be considered as a lectotype designation. This specimen, together with the three topotypes from Le Mesnil, fall in the centre of the range of morphological variation of the Dorset populations, particularly that from Milborne Wick (bed 5). Thus C. evolvescens is undoubtedly the oldest available specific name for this latter population of ammonites.

The synonymy of this species is fairly involved, but its interpretation has been simplified by the large size of the available samples. C. wrightii (S. Buckman) is the senior, junior subjective synonym. Buckman (1881, p.599), included in his type series of this species a figure by Quenstedt (1845-49, Pl.15, fig. 6) and an unknown number of specimens from the Oborne and Sherborne districts of north Dorset (Buckman, 1881, p.599). It is important to note at this juncture, the presence of a mis-print in Buckman's description. It is evident from a correction made in Buckman's own copy of his 1881 paper, that the Quenstedt figure which he intended to cite was fig.5, rather than fig.6 (Quenstedt, 1845-9, Pl.15). Figure 5, a Callovian form, is, as noticed by Waagen (1867, p.604), very like the Bajocian taxon. Since both of these Quenstedt figures have subsequently

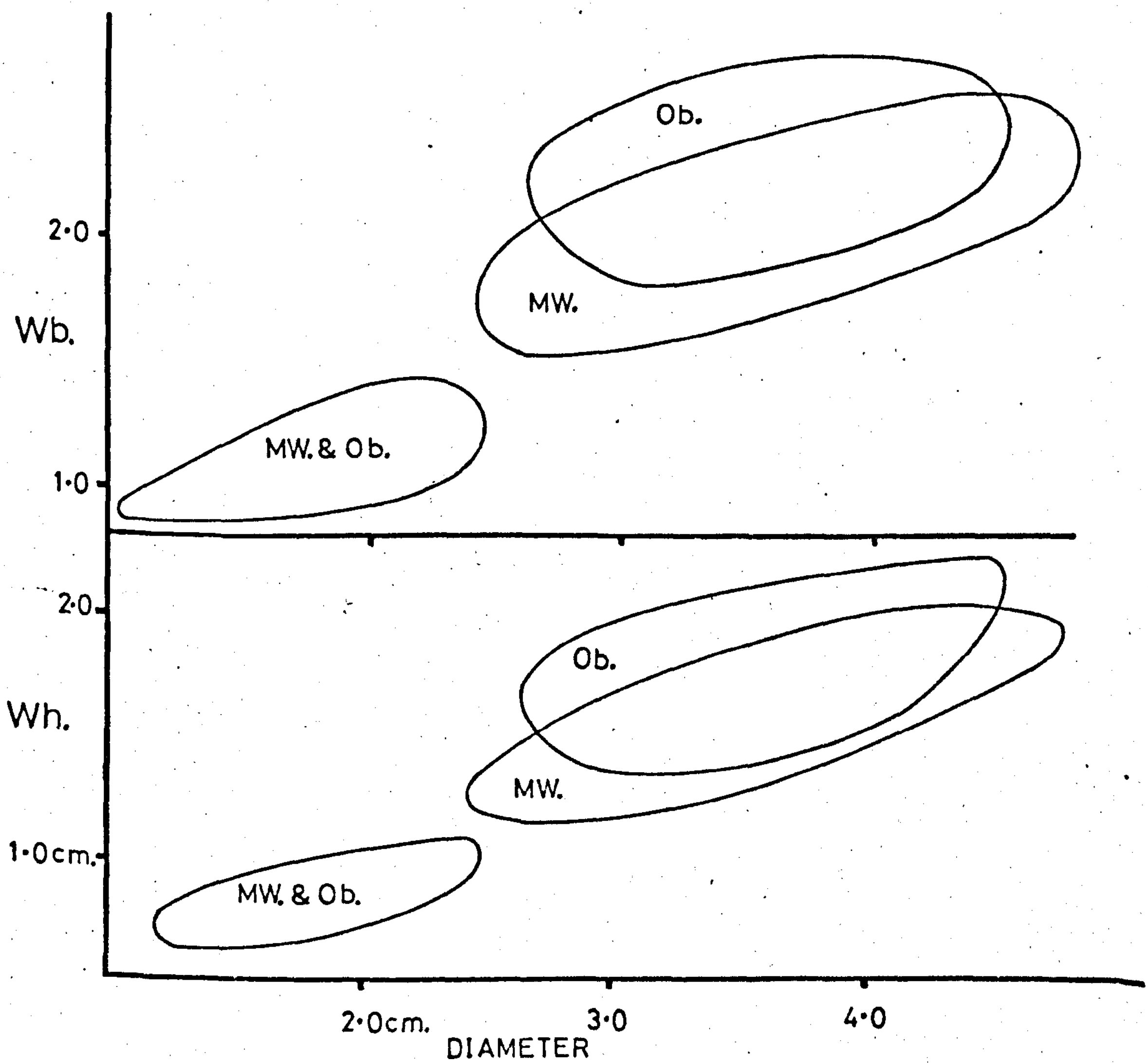


Figure 19.

The range of variation in whorl breadth (Wb.) and whorl height (Wh.), plotted against overall diameter in <u>C</u>.(<u>C</u>.) <u>evolvescens</u> (Waag.). Ob = Oborne Wood macroconchs ; MW = Milborne Wick macroconchs.

become types of new species (fig.5, Ammonites microstoma = 'Sphaeroceras' suevicum Roemer, 1911, p.43 : fig. 6, A. microstoma impressae = A. chapuisi Oppel, 1856-8, p.605), the selection of a lectotype for 'Sphaeroceras' wrightii should be restricted to the Dorset specimens. As Buckman designated no holotype in his original description, the later figuration of one of the syntypes as the 'holotype' of C. wrightii Buckman (1909-30, Pl.415), can be considered as a lectotype designation of 'Sphaeroceras' wrightii Buckman, 1881; particularly since this syntype is undoubtedly the same specimen as that which provided the dimensions cited in 1881 (Jackson, 1952, p.139).

This confused taxonomic situation has been made chaotic by Westermann (1956). He claimed that the Quenstedt figure cited by Buckman was the holotype of 'Sphaeroceras' wrightii, and this led him to consider Buckman's species as a Callovian Bullatimorphites. Whilst this action is understandable, although incorrect, Westermann's subsequent recognition of a second homonymic Buckman species based on the figure in 'Type Ammonites' (Buckman, 1909-30, Pl.415), is totally unforgivable. It is evident both from the text of this plate, and from the catalogue of type material in the Manchester museum (Jackson, 1952), that the specimen figured in 'Type Ammonites' is the same one as that cited by Buckman in 1881. This same specimen cannot be divided into two homonymic species; Bullatimorphites wrightii Buckman 1881 and Chondroceras wrightii Buckman 1923; as suggested by Westermann (1956, p.58). Fortunately this situation is easily rectified by the re-interpretation of Buckman's 1923 selection of a type specimen, as a lectotype designation for 'Sphaeroceras' wrightii, as discussed above.

This lectotype, which came from Frogden quarry, Oborne, is now preserved in the Manchester museum (L11420), and it proves to be identical in dimensions and ornament to numerous topotypes of this species from bed 4b, Oborne Wood. There is thus no reason for separating this species from _C. evolvescens_, which is morphologically identical. Of the other taxa included in the synonymy, _C. wrightii_ sub. sp. _minor_ Westermann (1956, Pl.3, fig.2), is identical in size, ornament and relative dimensions, to the smaller specimens in both the Oborne and Milborne Wick samples, and is clearly the microconch counterpart of _C. evolvescens s. str._ Since there is very little morphological differentiation between the two dimorphs, there would appear to be no reason for keeping them as two distinct taxa. The holotype of _C._ (_Defonticeras_) _parvumbilicum_ Westermann, (1956, Plate 12, fig.1), originates from Dorset. The only morphological feature which Westermann utilised, in first recognising this group as a distinct species, and second in placing it in the subgenus _Defonticeras_, would appear to be its rather coarse primary ribbing (22-3 per whorl). As a high degree of variation is now recognised in this character (Text figs. 17 & 18), _C. parvumbilicum_ need be nothing more than a coarsely ribbed variant of _C. evolvescens_, since it falls well within the range of variation of this latter species. Similarly the holotype of _C._ (_Schmidtoceras_) _schindewolfi hispanicum_ Westermann (1956, Plate 8, fig.1), seems nothing more than an evolute variant of _C. evolvescens_, as has been confirmed by the study of topotypes of this taxon from the Burgos district of north Spain(R. Sykes personal collection). _C. evolvescens_ is clearly separated from, _C. gervillei_ and _C. polypleurum_ by its narrower umbilicus, from _C. grandiforme_, by its smaller size and greater contraction of the body-chamber, and from *C. obornensis* nov., by its coarser ribs and narrower whorl cross-section.

Some mention must be made of the interesting degree of morphological variation shown by the Dorset collections of *C. evolvescens*; in particular the anomalous, non-gaussian distribution of the whorl breadth measurements, in comparison with the other dimensions. This latter feature is similar to that shown by *Poecilomorphus cycloides* (d'Orb.).and *C. canovense* (de Gregorio), (Sturani, 1971, pp.102-3 & 148 respectively). In future descriptions of new taxa, some account must be taken of the possible presence of this style of variation, if any attempt is to be made at establishing true bio-species. Similarly the degree of variation evident in the form of the mouth-border would tend to preclude the use of this character as the sole arbiter in the establishment of new Sphaeroceratid species (*contra* Sturani, 1971, p.137). This character is merely one amongst many other morphological features useful in taxonomic description.

Stratigraphic distribution

The most abundant members of this species were found in bed 4b. at Oborne Wood, which is Humphriesianum Zone, Romani subzone in age, as is the type horizon in Normandy; the 'Bayeux Conglomerate'. Rare specimens of this taxon have however been found in the base of bed 4c. Oborne Wood, which is Humphriesianum subzone in age. The specimens recorded from the Rigg Sandstone of the Isle of Skye, Scotland, both here, and by Morton (1971, p.286), are also from their associated fauna Romani subzone in age.

3. Chondroceras (Chondroceras) canovense (de Gregorio)

Plate 3, figs. 10 - 17 ; Text figs. 20A-B.

1886 Stephanoceras (Sphaeroceras) brongniarti Sow. mut. canovensis; de Gregorio, p.11, Plate 1, figs. 3c-e, non 3a-b, & f.

1971 Sphaeroceras (Chondroceras) canovense (de Gregorio); Sturani, pp.146-9, Plate 10, figs. 14-17, Pl.11, fig.10, Text figs. 42/3 & 6, 44 & 45.

1975 Chondroceras canovense (de Gregorio); Parsons, p.9.

Material

Fifty-three specimens from bed 6d, Oborne Wood; BMNH. C80392-3, C80397-9, CP2323, CP2366, CP2368-2371, CP2373-2396, CP2813-2831; four from bed 6b, Oborne Wood, BMNH. C80394-6 & CP2339; four from bed 6d, Frogden quarry, CP2331, 2342-3 & 2832; three from bed 6b, Frogden quarry, BMNH. C80377, CP2341 & 2344; three from the 'Astarte bed' of south Dorset, from Bonscombe Hill, BMNH. C80360, Loders Cross (SY506929), BMNH.C80354, and Stony Head Cutting, BMNH. C80355; and finally three specimens from the Reed collection, in the Yorkshire Museum, from the 'Loders district' (2) and Burton Bradstock (1) : a total of seventy specimens.

Dimensions

D.	Ud.	Pn.	Wh.	Wb.
BMNH. C80392, maximum diameter - 1.65 cm., (M.),				
1.52	0.26 (17)	37	0.78 (51)	1.1 (72)
1.33	0.20 (15)	-	0.79 (59)	1.1 (83)
BMNH. C80393, maximum diameter - 1.4 cm., (M.),				
1.38	0.33 (24)	-	0.72 (52)	0.97 (70)
1.12	-	-	0.67 (60)	0.93 (83)

D.	Ud.	Pn.	Wh.	Wb.
BMNH. C80397, maximum diameter - 1.24 cm., (M.),				
1.17	0.25 (21)	-	0.54 (46)	0.82 (70)
1.00	0.16 (16)	-	0.57 (57)	0.81 (81)
BMNH. C80398, maximum diameter - 1.16 cm., (M.),				
1.10	0.23 (21)	-	0.63 (57)	0.73 (66)
0.94	0.13 (14)	-	0.51 (54)	0.70 (74)
BMNH. C80399, maximum diameter - 0.64 cm., (m.),				
0.61	0.14 (23)	-	0.35 (57)	0.44 (72)
0.52	0.10 (19)	-	0.31 (60)	0.42 (81)
BMNH. C80377, maximum diameter - 1.51 cm., (M.),				
1.47	0.33 (22)	-	0.8 (54)	0.92 (63)
1.20	0.18 (15)	-	0.75 (63)	0.91 (76)
BMNH. C80354, maximum diameter - 2.01 cm., (M.),				
1.96	0.38 (19)	c.34	0.95 (49)	1.36 (69)
1.46	0.18 (12)	-	0.96 (66)	1.39 (95)
BMNH. C80360, maximum diameter - 0.77 cm., (m.),				
0.73	0.17 (23)	c.21-2	0.36 (49)	0.46 (63)
0.60	0.09 (15)	-	0.36 (60)	0.48 (80)
YM. maximum diameter - 2.18 cm., (M.),				
2.00	0.41 (21)	41	0.91 (46)	1.40 (70)
1.80	0.30 (17)	-	1.17 (65)	1.61 (89)

Dimensions of only a small proportion of the material are given here, as the rest are to be found in an appendix.

Description

A very small (Oborne Wood, bed 6d, average macroconch diameter = 1.20 cm., microconch diameter = 0.67 cm.), globose, involute ammonite,

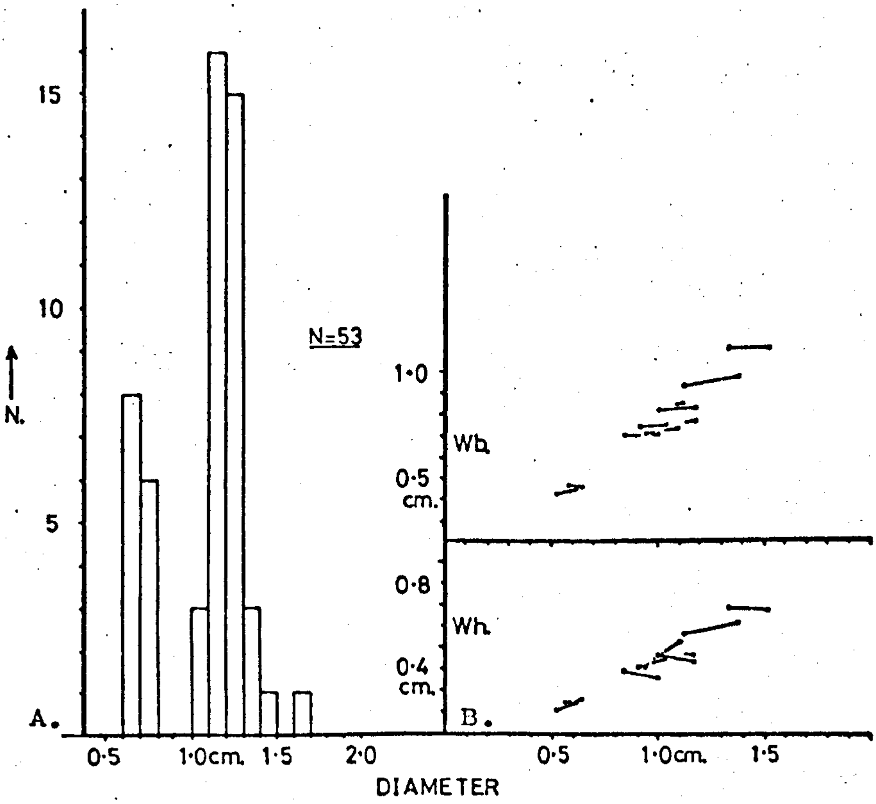


Figure 20.

A. a histogram of the distribution of maximum diameter in C.(C.) canovense (de Greg.), from bed 6d, Oborne Wood, Dorset.

B. a plot of whorl height (Wh.) and whorl breadth (Wb.) against whorl diameter, for some of the above specimens.

with a deep, very narrow, but open umbilicus. The whorl breadth increases at a greater relative rate than the whorl height on the inner whorls, leading to the development of a very depressed whorl cross-section - see Text fig.20B . There is a minor uncoiling of the umbilical seam associated with the slight retraction of the body-chamber, the latter stretching for just under one whorl. This contraction is not uniform to all specimens, as some show a marked relative decrease in whorl height, as well as breadth, (see Text fig. 20B). The ribbing is extremely fine, dense, and superficial. The primary ribs are long, highly curved and prorsiradiate. The primary ribs divide well up the whorl flank into two secondary ribs, which sweep forward over an arched venter, and become coarser towards the aperture.

Sexual dimorphism

All of the samples collected show a marked division into micro- and macroconchs, but only the collection from Oborne Wood, bed 6d, is large enough to show the bimodal size distribution (see Text fig.20A). The microconchs, apart from their smaller size, also show coarser ribbing and a greater modification of the mouth-border; including a thin flare behind the constriction, and lateral, lappet like extensions from the lip; than the macroconchs, which are finer ribbed, with a simpler mouth-border. The latter consists of nothing more than a faint constriction, followed by a lip with a sinuous edge.

Morphological variation

As noticed by Sturani (1971, p.148), there is a high degree of morphological variation inherent in this species. The large sample from Oborne Wood, bed 6d, came from the top-most 0.03 m. of this horizon. The specimens in this sample are consistently of a smaller size, with finer ribbing, than the other samples from beds 6b & d, at Oborne Wood and Frogden. The specimens from the '<u>Astarte</u>'bed' of south Dorset are on the whole slightly larger than the Subfurcatum Zone forms. These Garantiana Zone forms also show a greater modification of the mouth-border, particularly in the development of flares preceding the constriction on the macroconch specimens. However both the smaller macroconchs and the microconch from this horizon, are identical in size and morphology to their Subfurcatum Zone equivalents.

<u>Discussion</u>

This species is here interpreted in a very broad sense. With the sole exception of the sample from the top of bed 6d, Oborne Wood, insufficient specimens have been collected to enable an accurate picture of the phenotypic variation of this group to be established. It is thus likely that more than one species is represented in this highly variable material. This is particularly true when the extended stratigraphic range of this group is taken into account. The specimens from bed 6b Oborne Wood and beds 6b-d, Frogden quarry, are the closest in size and morphology to the topotypes figured by Sturani (1971, Pl.10, figs. 14-16 & 18). The south Dorset microconch specimen from Bonscombe Hill (BMNH.C80360) and the 2 smaller macroconchs from Loders Cross (BMNH. C80354; and York. mus., Reed Col.475) which are upper Garantiana Zone in age, are also very similar to Sturani's material. However, the other material from the '<u>Astarte</u>

bed' is of much larger size, with a more prominent flared mouth-border, than is exhibited by the topotypes. On the other hand the specimens from bed 6d, Oborne Wood are all finer ribbed and smaller than the topotype material. The microconchs from this Oborne sample are without doubt the smallest mature ammonites yet recorded from the British Jurassic. This Oborne population possibly intergrades with the larger and more typical forms found in the "*cadomensis* beds", since there is little difference in size or morphology between the end members of the former group, such as BMNH. C80393, and the latter, larger specimens, such as BMNH. C80377. Further material is thus needed before a definite decision can be made on the taxonomic position of either the Garantiana Zone, or Oborne Wood, bed 6d material.

It is certain that groups closely related to *C. canovense*, are represented by the specimens described here as *C.* sp. nov. aff. *C. tenue* and by Sturani's species *C. flexuosum*. Both these groups are undoubted members of the genus *Chondroceras* since they possess an open umbilicus. Whilst *C. canovense* has an umbilicus which often varies in width, it is never occluded or completely closed, there thus seems little difficulty in also accepting this species as a member of the same sub-genus (*contra*, Sturani, 1971, p.149). All the Subfurcatum Zone members of *Sphaeroceras s. str.* fortunately have an highly occluded umbilicus, which precludes generic confusion. In any event, the variation in relative proportions of the umbilicus in *C. canovense* is little different to that exhibited by *C. evolvescens*, a typical member of the subgenus *Chondroceras*.

Stratigraphic distribution

The type horizon of *C. canovense* is either Banksi or Polygyralis subzone, Subfurcatum Zone in age (Sturani, 1971, p.146). The material described here comes from the Polygyralis and Baculata subzones of the Subfurcatum Zone, and from the Acris subzone of the Garantiana Zone.

4. <u>Chondroceras</u> (<u>Chondroceras</u>) <u>grandiforme</u> S. Buckman

Plate 4 , figs. 1-3 & 4 ; Text figs. 21-3.

? 1849 <u>Ammonites gervilli</u> Sowerby; Quenstedt (1845-9), p.187, Plate 15, fig.11.

1878 <u>Sphaeroceras gervillii</u> Sow.; Bayle, Plate 53, fig. 7 <u>non</u> 6.

1881 <u>Ammonites gervilli</u> Sow.; J. Buckman, p.63 (excluding synonomy), fig.4.

1881 <u>Sphaeroceras gervillii</u> (Sow.); S. Buckman, p.597, (<u>pars</u>).

? 1886 <u>Ammonites gervillii</u> Sow.; Quenstedt (1886-7), p.510, Plate 64, fig. 3 <u>non</u> 14 & 15.

1922 <u>Chondroceras grandiforme</u> nov.; S. Buckman (1909-30), Plate 357.

1923 <u>Chondroceras delphinus</u> nov.; S. Buckman (1909-30), Plate 431.

1952 <u>Chondroceras</u> sp.; Jackson, p.85.

1952 <u>Chondroceras grandiforme</u> S. Buckman; Arkell (1951-9), Text fig. 20/5a-b.

1956 <u>Chondroceras evolvescens</u> (Waagen); Westermann, pp.55-8 (<u>pars</u>), Plate 1, fig. 8 <u>non</u> 7, Pl.2, fig.1 <u>non</u> 2.

? 1956 <u>Chondroceras polytomum</u> n. sp.; Westermann, pp.62-3, Plate 3, fig. 4, Text figs. 34 & 35.

? 1961 <u>Chondroceras</u> sp. cf. <u>C. delphinus</u> Buckman; Maubeuge, pp.144-5.

1964 <u>Chondroceras grandiforme</u> Buckman; Westermann, p.54.

Material

One specimen from bed 4a., BMNH. C80343, and three from bed 4b., BMNH. C80344-6, Oborne Wood; four specimens from Milborne Wick, IGS.37293 (holotype of C. delphinus), TC.1731, IGS.25286 and OUM. J10787; one from the 'Red Conglomerate' of Burton Bradstock, Dorset, BMNH. C2768; and one from the Bayeux Conglomerate, of Bayeux, Normandy, BMNH. 37264. In addition the following less well localised specimens from the 'Sherborne district': IGS.47157 (holotype), SM.J57746; MM.L11160; BMNH. C3223, C80286-9, C80290-8. A total of 27 specimens.

Dimensions

IGS.47157, holotype C. grandiforme, maximum diameter over flare - 7.7 cm., (M.),

D	Ud.	Pn.	Wh.	Wb.
7.32	1.93 (26)	-	3.43 (47)	4.66 (64)
6.04	1.2 (20)	c.29	2.83 (47)	4.72 (78)

IGS.37293, holotype of C. delphinus, maximum diameter over flare - 4.7 cm., (M.),

4.14	0.87 (21)	26	2.0 (48)	2.78 (67)
3.68	0.6 (16)	-	1.9 (52)	2.6 (71)

BMNH. C80345, diameter 5.1 cm. on flare, (M.),

4.45	1.1 (25)	27	2.32 (52)	3.1 (70)
3.87	0.7 (18)	-	2.12 (55)	2.95 (76)

BMNH. C80343, diameter 3.96 cm. on flare, (?M.),

3.71	1.0 (27)	31	1.83 (49)	2.43 (66)
3.13	0.65 (21)	-	1.65 (53)	2.34 (75)

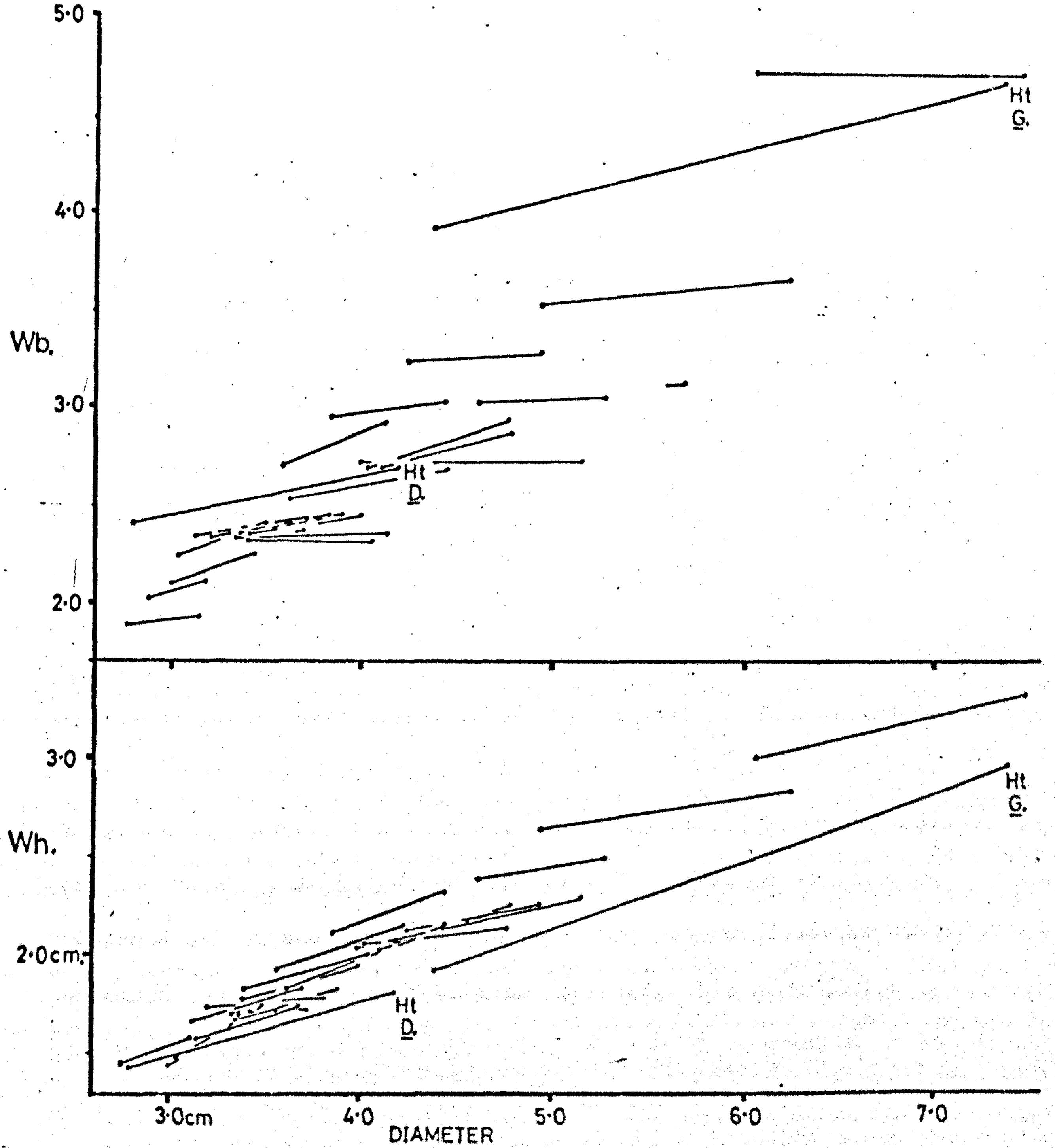


Figure 21.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum whorl diameter, for specimens of C. (C.) grandiforme S. Buckman, from the Sherborne area. Ht. G. = holotype C. grandiforme Ht. D. = holotype of C. delphinus S. Buckman.

D.	Ud.	Pn.	Wh.	Wb.
BMNH. C80344, incomplete, (M.),				
4.24	1.0 (24)	30	2.15 (51)	2.91 (69)
3.59	0.75 (21)	-	1.93 (54)	2.70 (75)
IGS.25286, diameter 7.76 cm. on flare, (M.),				
7.50	1.97 (26)	24	3.33 (44)	4.69 (63)
6.08	0.79 (13)	25	3.0 (49)	4.7 (77)
OUM. J10787, (M.),				
5.5	1.48 (27)	26	2.45 (45)	3.25 (59)
4.3	0.84 (20)	-	2.17 (51)	3.1 (72)

Description

A relatively large (average size = 5.0 cm., range 3.52-7.76 cm.), globose ammonite, with a narrow, deep, but open umbilicus. There is a marked uncoiling of the umbilical seam over the last third of a whorl, usually associated with a relative reduction of whorl breadth compared to whorl height - see Text fig. 21 . This produces a more rounded whorl cross-section at the aperture, compared to the highly depressed form of the inner whorls. However, this contraction is purely relative, as the maximum value for the whorl breadth is to be found directly behind the aperture. The ribbing is sharp and well marked. The primary ribs are strong, curved, prorsiradiate and relatively coarse, with 24-35 per outer whorl. The primaries, which become much coarser and straighter on the last half whorl, divide just above the whorl shoulder into predominantly three secondaries, although there are more rarely two, often with an additional free secondary intercalated. These secondaries, which become much coarser and more rounded just before the aperture, sweep forward

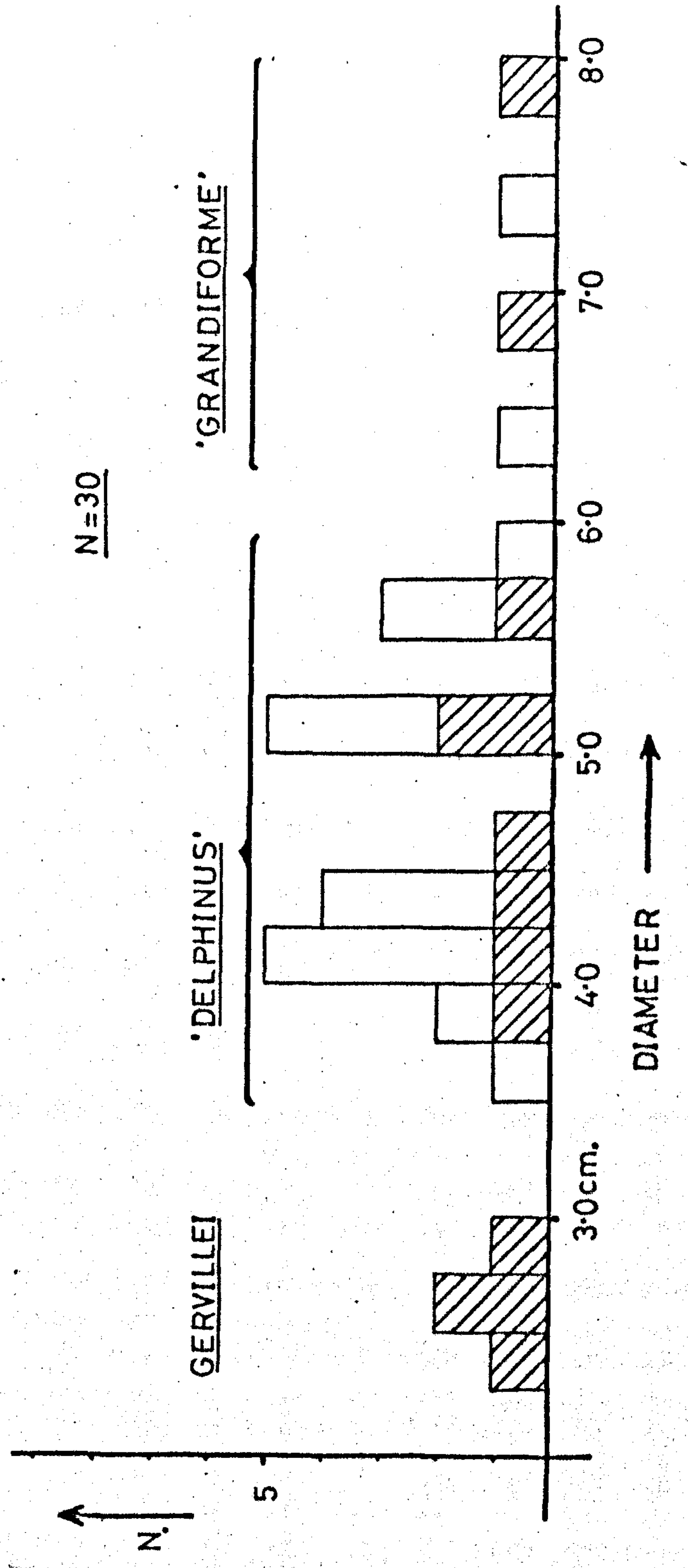


Figure 22.

A histogram of the distribution of maximum mature diameter in C.(C.) grandiforme Buckman, compared to C.(C.) gervillei (J.Sow.). The shaded portions are based on in situ material .

very gently over a flatly arched venter. The mouth-border is highly distinctive. It consists of a faint flare, followed by a deep constriction, then a very strong, 'delphinulate' flare (J. Buckman, 1881, fig.4), then another deep constriction, followed by a smooth, expanded lip.

Sexual dimorphism

There are considerable difficulties in determining this group's dimorphic partner. The size frequency distribution shown in Text fig. 22 , illustrates this problem. If only the well localised specimens (shaded on this figure) are taken into account there is no evidence of bimodality. The addition of sixteen specimens from Buckman's collection, of which nothing is known but a provenance from the 'Sherborne district', produces a hint of bimodality. This might suggest the presence of a microconch group centred on the size range 4.0-4.2 cm., with a macroconch group between 5.0-8.0 cm., (cf. Westermann, 1964, p.54). If this is correct, it would suggest a ratio between dimorphs in the order of 1:1.43, which is rather low. On the other hand the strong similarity in morphology between this group and *C. gervillei* suggests the latter as a possible microconch partner. In this light a broader regrouping of the size grades in the size frequency distribution, produces a highly skewed, but unimodal distribution, which could represent a single macroconch group. Unfortunately it is impossible on the present evidence to eliminate either of these possibilities, and again more *in situ* material is needed.

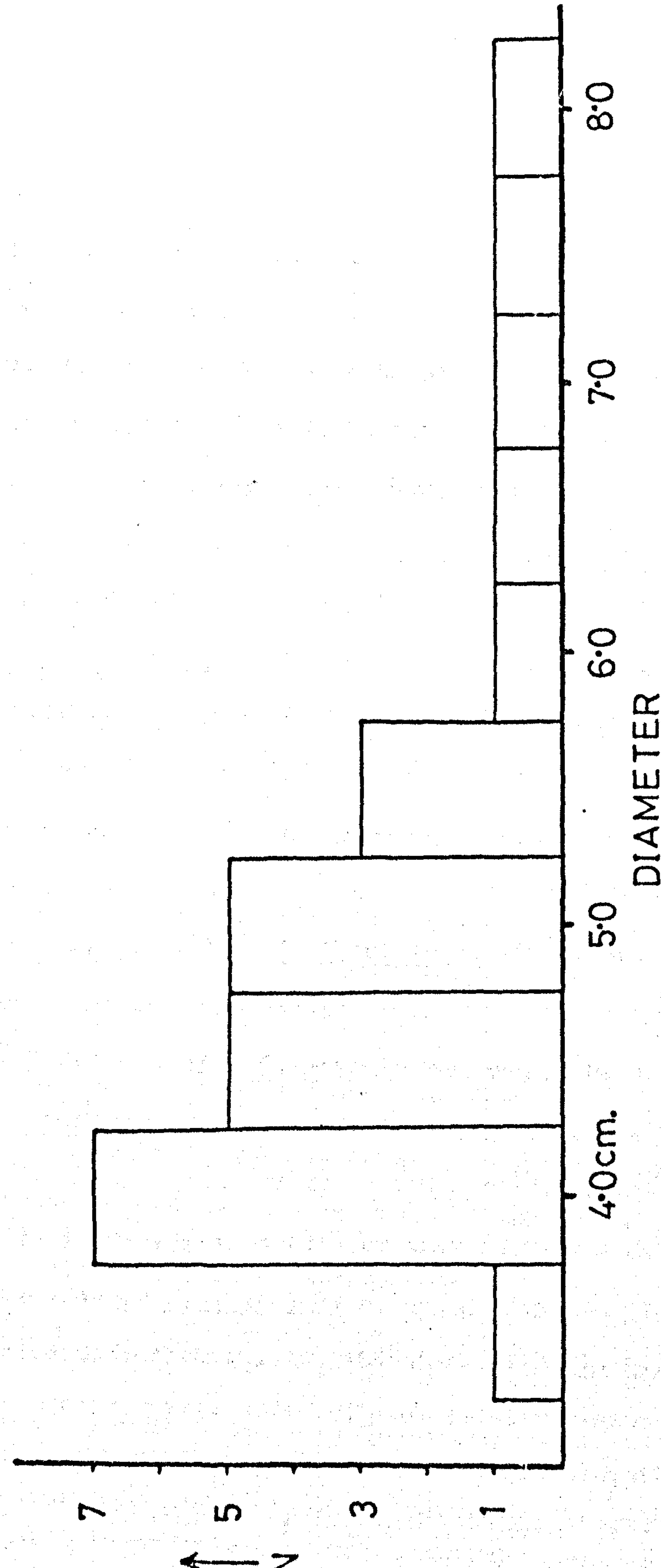


Figure 23.

A histogram of the distribution of maximum mature diameter in C.(C.) grandiforme ,using larger size groupings than in figure 22.

Discussion

This is a highly distinctive group, which is characterised by its large size and its superbly developed 'delphinulate' mouth-border. One of the specimens which is figured here, is the same as that exhibited to the Geological Society of London by J. Buckman, (1881, fig.4). This specimen shows that S. Buckman's restoration of the flare on the holotype of C. grandiforme (Buckman, 1909-30, Pl. 357) is not as excessive, as has been suggested by Westermann (1956, p.57). C. delphinus is identical to C. grandiforme in its relative whorl proportions, and in its style of mouth-border and ribbing; they differ only in size. As can be seen in Text fig. 22 , the present sample shows a highly discontinuous size frequency distribution, which makes separation of these two 'species' solely on this basis highly unlikely. C. grandiforme having priority by one year, is hence here used as the specific name for the whole group. What can be certain is that C. grandiforme cannot be considered synonymous with C. evolvescens (contra Westermann, 1956, pp.56-7). Apart from the obvious difference of the mouth-border, C. grandiforme is consistently larger, with coarse primary ribs on a more inflated body-chamber, than C. evolvescens, which has a plain mouth band and a more contracted body-chamber. On the other hand, C. polytomum Westermann (1956, pp.62-3, Plate 3, figs.4a-c) is very similar, as the fragmentary holotype is of a similar size and gross proportions to the holotype of C. grandiforme. It differs by having very slightly coarser ribs (23 per whorl). This however is well within the possible range of variation of C. grandiforme and it is thus here considered conspecific with this latter species. Apart from Westermann's species, there are no other European, Humphriesianum Zone sphaeroceratids with which this taxon could be confused; they are all of much smaller size.

Stratigraphic distribution

The specimens which I have collected *in situ* originate from the Romani subzone beds of Oborne Wood. The specimens from Milborne Wick, including the holotype of *C. delphinus*, show a matrix, which is typical of beds 4-5, which again are Romani subzone, Humphriesianum Zone in age. The material from the 'Sherborne district', have a grey matrix, with brown, shiny ooliths, which is characteristic of bed 4b., Oborne Wood. Thus all available evidence would suggest that this taxon is dominantly or totally restricted to the Romani subzone.

5. *Chondroceras* (*Chondroceras*) *polypleurum* (Westermann)

Plate 4 , figs. 4-5 & 7 ; Text figs. 24-5.

1846 *Ammonites brongniarti* Sow.; d'Orbigny (1842-51), Plate 137, fig. 5.

1878 *Sphaeroceras brocchii* Sow.; Bayle, Plate 52, fig.2.

1927 *Chondroceras gervillii* (Sow.); Buckman (1909-30), Plate 724.

1956 *Chondroceras* (*Schmidtoceras*) *orbignyanum polypleurum* n. subsp.; Westermann, pp. 19 & 77-8, Plate 6, figs. 6a-d.

1956 *Chondroceras* (*Schmidtoceras?*) *gracile* n.sp.; Westermann, pp.96-7, Plate 10, figs.8a-c.

1964 *Chondroceras* (*Schmidtoceras*) *evolutum* Westermann; Westermann, p.55 (*pars*).

1968 *Sphaeroceras brongniarti* (Sow.); Senior, p.45.

1971 *Sphaeroceras* (*Chondroceras*) *gracile* (Westermann); Sturani, p.150.

Material

One specimen, BMNH. C80347 from bed 4b, and one, BMNH. C80348, from bed 4c Oborne Wood; two, BMNH. C80349, 80350, from bed 4 Oborne Wood, one from the 'Red Conglomerate', of Loders Cross (SY506929), near Bridport, Dorset, BMNH. C80353, (*ex*. J. Senior collection), one from the 'Sherborne district', of Dorset, SM. J24525, (*ex*. Monk coll.), and one from the 'Oborne district' of Dorset, YM, (*ex*.Reed coll. 216).

Dimensions

BMNH. C80348, (m.),

D.	Ud.	Pn.	Wh.	Wb.
2.26	0.64 (28)	31	1.0 (44)	1.27 (56)
1.73	0.44 (25)	-	0.84 (49)	1.2 (69)
BMNH. C80349, (m.),				
2.05	0.44 (21)	34	0.98 (48)	1.18 (58)
1.48	0.35 (24)	-	0.76 (51)	1.04 (70)
BMNH. C80350, (m.),				
2.35	0.61 (26)	31	1.0 (43)	1.35 (57)
1.84	0.44 (24)	30	0.85 (46)	1.23 (67)
BMNH. C80348, slightly incomplete, (m.),				
2.13	0.54 (25)	35	1.0 (47)	1.30 (61)
1.60	0.39 (24)	-	0.78 (49)	1.17 (73)
SM.J24525, maximum diameter over flare - 4.19 cm., (M.),				
4.0	1.2 (30)	34	1.73 (43)	2.20 (55)
3.27	0.95 (29)	-	1.5 (46)	2.1 (64)
BMNH. C80353, incomplete, (M.),				
c.4.0	1.11 (28)	-	1.59 (40)	2.26 (57)

Description

A small (average microconch size = 2.2 cm.), relatively evolute ammonite, with a deep umbilicus. It shows a marked change in the relative whorl height compared to the whorl breadth (see Text fig.24), which leads to the slightly depressed inner whorls becoming more rounded on the last quarter whorl. There is a slight uncoiling of the umbilical seam on the last fifth of a whorl, but little or no contraction of the body-chamber, as the maximum values

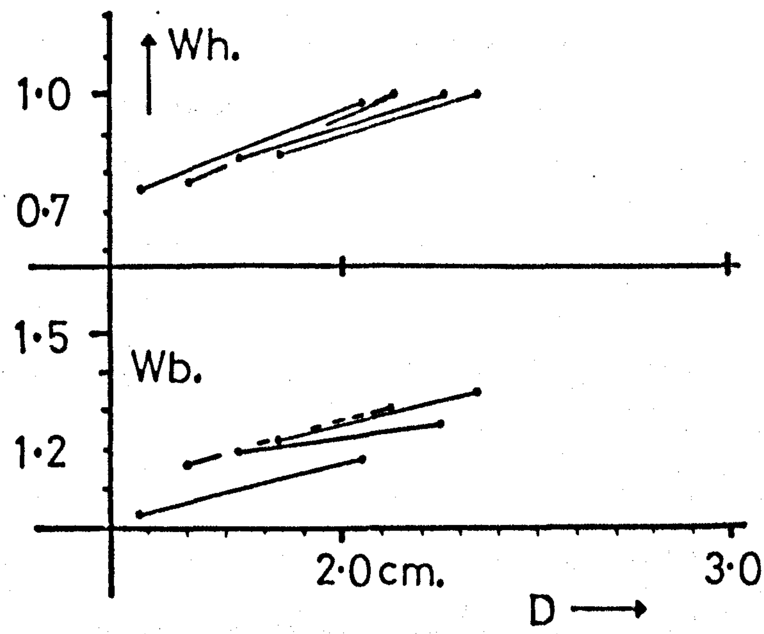


Figure 24.

A plot of whorl height (Wh.) and whorl breadth (Wb.) against maximum diameter (D.), for microconch specimens of C.(C.) polypleurum polypleurum (West.).

of both whorl height and breadth are found at the very end of the body-chamber, which stretches for four-fifths of a whorl. Both primary and secondary ribs are fine and sharp on the inner whorls, but become gradually coarser on the last half whorl. The primary ribs are curved, prorsiradiate, very dense (31-35 per outer whorl), and divide well up the relatively flat whorl flank, into two-three secondary ribs. These secondaries sweep forward gently over the arched venter. The mouth-border is marked by a slight flare produced by an expanded secondary rib, followed by a deep constriction and a smooth, narrow, flared lip.

Sexual dimorphism

The style of dimorphism and the ratio between micro- and macroconchs are similar to those of the subspecies C. polypleurum crassicostatum. The probable macroconch of the nominate subspecies, from the 'Red conglomerate' of Loder Cross, south Dorset, (BMNH. C80353), although fragmentary, is virtually identical to a more complete specimen from the 'Sherborne district' in the Sedgwick Museum (SM.J24525). These two are identical in all but size to C. polypleurum s. str., and would suggest a ratio of approximately 1:1.86 between dimorphs; although this would have to be confirmed by larger collections.

Discussion

As already mentioned in the discussion of C. gervillei, C. orbignyanum is an invalid homonym, and must be replaced by the oldest valid name among the included co-ordinate taxa (I.C.Z.N., article 23,e,iii). Since C. orbignyanum polypleurum (Westermann, 1956, pp.19 & 77-8, Pl.6, figs.6a-d), has clear page priority, it thus becomes the nominate subspecies (I.C.Z.N., article 47b). The only real difference between the holotype of C. polypleurum (loc. cit.), and C. gracile (Westermann, 1956, Pl.10, figs.8a-c), would appear to be relative primary rib density, since in style of ribbing, relative whorl proportions and in the form of the mouth-border, they are identical. Considering the wide range of variation in primary rib density which is found in the Sphaeroceratids (cf. C. evolvescens), this would appear to be an inadequate basis for separating these taxa. Hence C. gracile is here considered conspecific with C. polypleurum, which in turn has page priority.

C. polypleurum, a relatively rare form, is distinguished from the other Humphriesianum Zone Sphaeroceratids, by its higher primary rib density, its more open umbilicus, and by its characteristic change in relative whorl proportions over the last half whorl. Of the other Romani subzone groups, with which C. polypleurum might be confused, its subspecies C. polypleurum crassicostatum has slightly rounder, less compressed whorls and is coarser ribbed, whilst C. gervillei has a far more inflated whorl cross-section (see Text fig.25). The only other comparable forms are the microconch members of C. evolvescens, which are clearly distinguished by their strongly contracted body-chambers.

Stratigraphic distribution

There is no evidence as to the exact horizon of the type material of C. polypleurum, within the Humphriesianum Zone. The specimens described here originate from beds 4b/c, Oborne Wood, which span the Romani and Humphriesianum subzones of the Humphriesianum Zone.

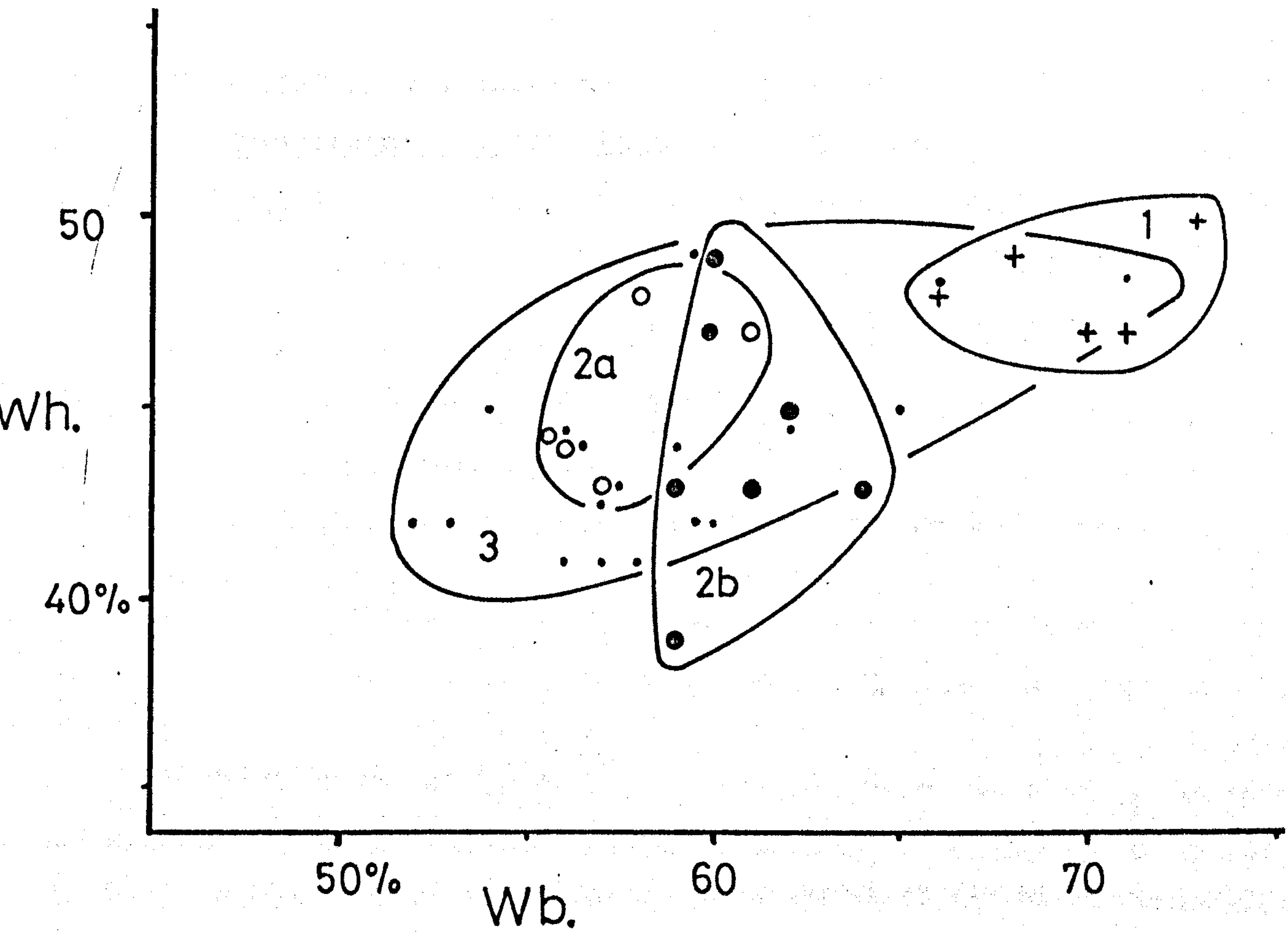


Figure 25.

A plot of whorl height (Wh.) against whorl breadth (Wb.) for specimens of C.(C.) gervillei (1), C.(C.) polypleurum polypleurum (2a), C.(C.) polypleurum crassicostatum (2b) and microconch and macroconch specimens of C.(C.) evolvescens (3).

6. <u>Chondroceras</u> (<u>Chondroceras</u>) <u>polypleurum</u>. sub. sp. <u>crassicostatum</u> (Westermann)

Plate 4, fig. 8 ; Plate 5 , figs. 1 - 2 ; Text figs. 25-6.

1878 <u>Sphaeroceras gervillii</u> Sow.; Bayle, Pl.53, fig.6.

1907 <u>Chondroceras crassicostatum</u> n.f.; Mascke, p.33.

1956 <u>Chondroceras</u> (<u>Schmidtoceras</u>) <u>orbignyanum orbignyanum</u> (Wright); Westermann, Plate 5, figs. 7a-c, <u>non</u> 6a-c.

1956 <u>Chondroceras</u> (<u>Schmidtoceras</u>) <u>orbignyanum crassicostatum</u> n. sub.sp.; Westermann, pp.79-80, Plate 5, figs. 8a-d, <u>non</u> Pl.6. figs. 3 & 4.

1964 <u>Chondroceras orbignyanum</u> (Wright); Westermann, p.54. (<u>pars</u>).

<u>Material</u>

One specimen from bed 4c, BMNH. C80389, and one from bed 4b, BMNH.C80390, Oborne Wood; and one from the 'Irony bed' of Louse Hill quarry, near Sherborne, BMNH.C80378, all the above specimens having been collected <u>in situ</u> by the author. In addition four specimens from Milborne Wick (ST663205), (<u>ex</u>. Earwaker collection), in the Manchester City Museum, LL4252J-M, and one from the 'Bayeux Conglomerate', Bayeux, Normandy, <u>ex</u>. Tesson collection, BMNH. 37263.

<u>Dimensions</u>

BMNH. C80378, maximum diameter on flare - 2.35 cm. (m.),

D.	Ud.	Pn.	Wh.	Wb.
2.22	0.63 (28%)	27	0.96 (43)	1.36 (61)
1.89	0.50 (26)	-	0.92 (49)	1.31 (69)

D.	Ud.	Pn.	Wh.	Wb.
BMNH. C80389, diameter over flare - 2.47, (m.),				
2.44	0.70 (29)	c.28	0.95 (39)	1.43 (59)
2.00	0.46 (23)	-	0.90 (45)	-
BMNH. C80390, diameter over flare - 2.53, (m.),				
2.33	0.68 (29)	c.27	1.0 (43)	1.50 (64)
2.00	0.50 (25)	-	1.01 (51)	1.49 (75)
LL4252J, (m.),				
2.5	0.65 (26)	32	1.22 (49)	1.5 (60)
LL4252K, (m.),				
2.57	0.67 (26)	28	1.2 (47)	1.53 (60)
LL4252L, (m.),				
2.6	0.65 (25)	30	1.18 (45)	1.6 (62)
LL4252M, (m.),				
2.6	0.7 (27)	28	1.12 (43)	1.53 (59)
BMNH. 37263, diameter over flare - 4.28 cm., (M.),				
3.86	1.0 (26)	29	1.82 (47)	2.28 (59)
3.20	0.78 (24)	28	1.55 (48)	2.12 (66)

Description

A small (average microconch size = 2.52 cm.), involute ammonite, with a deep, narrow, but open umbilicous, and with a rounded whorl cross-section. There is a slight uncoiling of the umbilical seam associated with the retraction of the body-chamber, which reaches its maximum breadth a quarter of a whorl before the aperture. There is little relative change between the whorl height and breadth (see Text fig. 26), and thus there is no change in whorl cross-section, over the last whorl. The ribbing is coarse and well marked. The

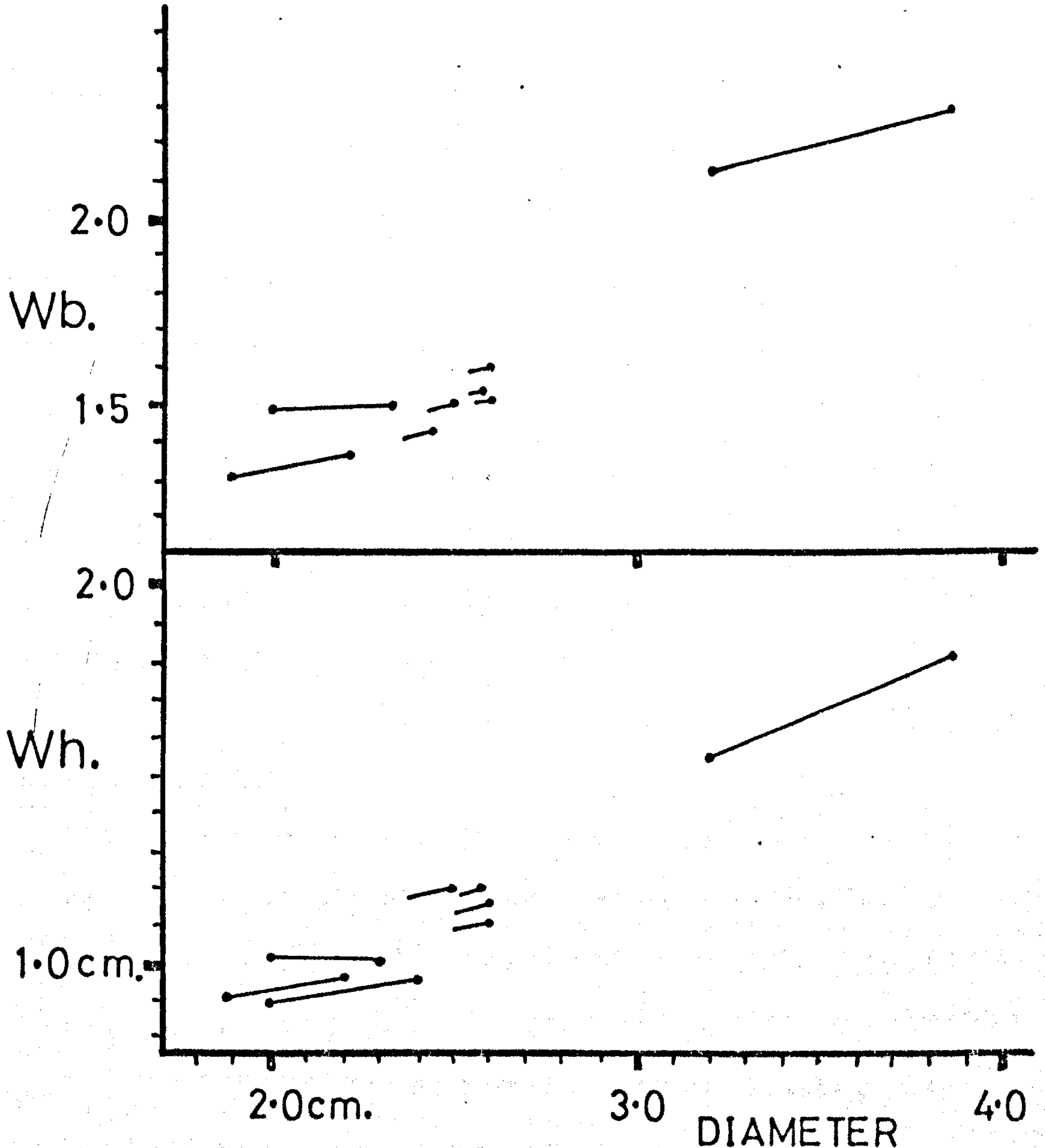


Figure 26.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum diameter for <u>C</u>.(<u>C</u>.) <u>polypleurum crassicostatum</u> (West.).

primary ribs are slightly curved, prorsiradiate, relatively dense (32-27/whorl on the body-chamber), and branch just above the whorl flank into two secondary ribs. These secondaries, of which there are rarely more than two per primary, become coarser just before the aperture, and sweep forward very gently over the flatly arched venter. The body-chamber, which stretches for one whorl, is terminated by a well developed mouth-border. This consists of a faint flare, followed by a deep constriction, then a smooth, expanded lip, which shows signs of the development of lateral projections, out from the mid-whorl position.

Sexual dimorphism

This species is probably a microconch, since a possible macroconch counterpart has been figured by Bayle (1878, Pl.53, fig.6). A specimen similar to the latter, and also from the 'Bayeux Conglomerate' of Normandy, is now preserved in the Tesson collection (BMNH.37263). This has an identical style of ribbing and relative proportions to C. polypleurum crassicostatum, but is of much larger size (4.28 cm.). If this specimen is in fact the authentic macroconch, a size ratio of approximately 1:1.7 between dimorphs is indicated. It is possible that this macroconch is conspecific with C. schindewolfi (Westermann, 1956), but this suggestion (Westermann, 1964, p.54) needs to be confirmed by the collection of further material.

Discussion

Chondroceras crassicostatum Mascke (1907, p.33) is a nomen nudum, it thus takes the date and authorship of the first person to satisfy

I.C.Z.N. Articles 11-14, which in this case is Westermann (1956, p.79). Westermann established this taxon as a subspecies of *C. orbignyanum*, it is thus here transferred to *C. polypleurum*. Amongst the specimens figured by Westermann (1956), under the name *C. (Schmidtoceras) orbignyanum orbignyanum*, there is one which is less inflated and with a more rounded whorl cross-section than that of the 'neo-lectotype' (*sic*). This specimen (*op. cit.* Pl.5, figs.7a-c), is virtually identical in all features except size, to the holotype of *C. polypleurum crassicostatum* (*op. cit.*, Pl.5, figs.8a-d). On the other hand the paratypes of the latter taxon, figured by Westermann (1956, Pl.6, figs.3-5), are rather more evolute, and look closer to *C. crassum* (*op. cit.*, Pl.9 , figs. 4a-c).

The relationship of this subspecies to other Romani subzone sphaeroceratids is clear. In style of ribbing, size and shape of mouth-border, this taxon is very similar to *C. gervillei*, which however, has a different whorl cross-section (see Text fig. 25). The specimens here included in *C. polypleurum* s.str. are also very similar, but they differ by having finer, more prorsiradiate ribs, and by being slightly less inflated, with flatter whorl flanks and a more arched venter. However, all three of these taxa are undoubtedly closely related, and must have arisen from a common ancestor. There are in fact insufficient morphological differences to warrant separating this taxon from *C. polypleurum*, and Westermann's subspecific rank is probably the most satisfactory. Although more material is needed there is a suggestion that these are chronological subspecies, with the finer ribbed, nominate subspecies being more common at the higher horizon: the Humphriesianum subzone.

Stratigraphic distribution

There is no evidence of the exact horizon of the German and Swiss type material, but the specimens described here originate from the Romani and Humphriesianum subzones of the Humphriesianum Zone.

7. Chondroceras (Chondroceras) obornensis n.sp.

Plate 5, figs. 4-8 & 11; Text fig. 27.

1971 Chondroceras sp.; Whicher & Palmer, p.117.

1974 Chondroceras sp. nov.; Parsons, p.167.

Material

Four specimens *in situ* from bed 3, Oborne Wood, Dorset, BMNH. C80313-6; one specimen from "Miller's quarry", Sherborne, Dorset (*ex.* Monk collection), SM.J20154; one from the Sherborne district, SM.J24526, and one from Dundry Hill, near Bristol, BUGM.3325; a total of seven specimens.

Dimensions

Holotype, BMNH. C80313, with over three-quarters of a whorl of body-chamber, (M.),

D.	Ud.	Pn.	Wh.	Wb.
4.04 cm.	1.25 (31%)	56	1.93 (48)	2.73 (68)
3.32	0.71 (21)	50	1.76 (53)	2.64 (80)
1st. Paratype, BMNH. C80314, with over 1 whorl of body-chamber, (M.),				
c.4.1	1.25 (31)	43	-	-
3.36	0.59 (18)	39	1.88 (56)	c.2.40 (71)
2nd. Paratype, BMNH. C80316, with ¾ of a whorl of body-chamber, (m.),				
2.3	0.49 (21)	36	1.03 (45)	1.58 (69)
1.75	0.23 (13)	28	c.1.0 (57)	1.49 (85)
3rd. Paratype, BMNH. C80315, with just over 1 whorl of body-chamber, (M.),				
3.8	1.13 (30)	47	-	-
3.1	0.8 (26)	45	1.6 (52)	2.39 (77)
2.6	0.58 (22)	42	1.56 (60)	2.33 (90)

__Diagnosis__

A small, globose ammonite, with a deep umbilicus and slight contraction of the body-chamber. The smaller microconch has a lappeted mouth-border, whilst both dimorphs are extremely finely ornamented, with fine bifurcating ribs. The only similar species of __Chondroceras__ , __C. evolvescens__, is both more coarsely ribbed and less inflated, whilst __Labyrinthoceras__ and __Sphaeroceras__ are more involute, with a more strongly contracted body-chamber.

D.	Ud.	Pn.	Wh.	Wb.
4th. Paratype, SM.J24526, with the edge of the mouth-border preserved, and approximately 1 whorl of body-chamber, (M.),				
4.14	1.4 (34)	63	1.8 (44)	2.58 (62)
3.25	0.8 (25)	62	1.72 (53)	2.52 (78)
SM.J20154, with $1\frac{1}{4}$ whorls of body-chamber, (M.),				
c.4.05	1.23 (30)	c.53	-	-
3.24	0.74 (23)	c.55	1.71 (53)	2.58 (80)
BUGM.3325, with 1 whorl of body-chamber, original diameter = 4.0 cm.+, (M.),				
3.34	1.03 (31)	51	1.48 (44)	2.18 (65)
2.9	0.73 (25)	52	1.54 (53)	2.23 (77)

Description

A small (average macroconch size = 4.1 cm.), globose ammonite, with a deep, narrow umbilicus. There is a marked uncoiling of the umbilical seam associated with the slight contraction of the body-chamber, which stretches for just over one whorl. The inner whorls are relatively depressed, and this shell form is only slightly modified by a minor decrease in whorl breadth relative to whorl height over the last half whorl, (see Text fig. 27). The ribbing is extremely fine and dense (63-43 primary ribs/outer whorl). The primary ribs are short, curved, prorsiradiate and often show a slight backward deflection on the whorl shoulder, above which point they divide into two secondaries. A small proportion of the ribs are simple, and pass straight over the venter. The sharp secondary ribs, which become coarser and blunter towards the mouth-border, sweep forward very gently over a broad, flatly arched venter. One

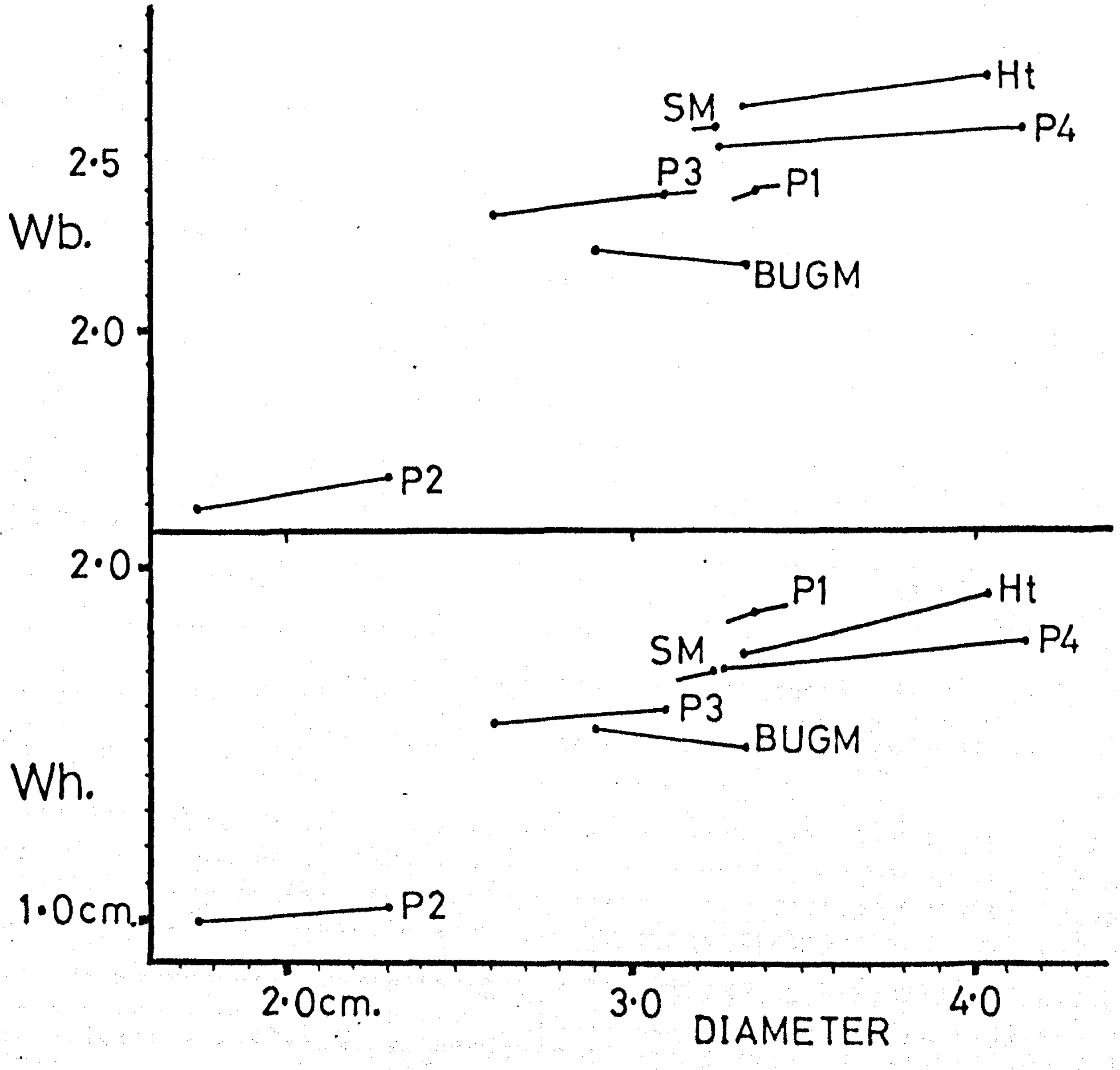


Figure 27.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum diameter for C.(C.) obornensis sp.nov. P = paratype ,Ht. = holotype.

specimen (BMNH. C80315), shows the presence of slight node like swellings of the primary ribs at the point of division into the secondaries. None of the macroconch specimens are wholly complete and only one (SM.J24526) shows a fragment of the mouth-border, consisting of the base of a constriction, followed by a lip. One complete microconch has been found (BMNH.C80316), which shows the presence of a relatively deep constriction, followed by a lip. The base of a lappet was preserved on this latter specimen, but unfortunately it disintegrated during extraction.

Sexual dimorphism

The small specimen, with the lappets is an undoubted microconch. The larger specimens, although little is known of the shape of their mouth-border, are likely to be its macroconch partners. Taking into account the very small sample, a size ratio between dimorphs in the region of 1:1.8 is suggested.

The type series (5 specimens)

The holotype, (BMNH. C80313) is an almost complete macroconch specimen, collected in situ from bed 3, Oborne Wood, Dorset.

The 1st paratype, BMNH. C80314, is a more evolute, coarsely ribbed macroconch variant, from bed 3, Oborne Wood.

The 2nd. paratype, BMNH. C80316, is a complete microconch specimen from bed 3 Oborne Wood.

The 3rd. paratype, BMNH. C80315, is an incomplete, macroconch specimen from bed 3 Oborne Wood, showing the presence of faint tubercles or node like swellings at the top of the primary ribs.

The 4th. paratype, SM.J24526, is the most complete macroconch specimen, showing part of the mouth-border, and comes from the

Sherborne district of Dorset.

Discussion

Although only very rarely found in the 'green-grained marl bed' of the Oborne district of north Dorset (= bed 3 Oborne Wood), where it forms less than 2% of the total ammonite fauna, this taxon is interesting, as it is the oldest recorded sphaeroceratid and as it shows features which are transitional to the Otoitid genus _Frogdenites_. Thus _F. spiniger_ S. Buckman, is very similar to this species in its size range, style of dimorphism and general whorl proportions and coiling, but it differs by having sharp spines or tubercles situated on the relatively acute ventrolateral angle of the whorl. It is clear from some specimens that these tubercles have a tendency both to migrate ventrally and to become less pronounced. This results in the umbilical angle becoming more obtuse, which thus produces a more rounded whorl cross-section. This trend is illustrated by two microconch specimens of _Frogdenites_ (Plate 5 , figs.9-10), where one (BMNH. C75252) has its spines situated directly on the sharp ventrolateral angle, whilst the second (BMNH. C80391) has its tubercles situated ventrally of a more rounded umbilical shoulder. The location of one specimen of _C. obornensis_ retaining some relict tubercles well up the whorl flank, (C80315), confirms the origin of this species as nothing but the straightforward result of the continuation of the above trend. Thus the total loss of tubercles has produced a smoothly rounded whorl cross-section.

It is difficult to determine the precise generic position of this species, since its phylogenetic position as progenitor of all the succeeding Sphaeroceratid ammonites is reflected in the hybrid nature of its morphological features. In particular it combines the very fine, sharp ribbing of Labyrinthoceras, with the smaller size and open, evenly coiled umbilicus of Chondroceras. Comparison of this taxon with closely related Sphaeroceratids reveals the greatest similarity with members of the C. evolvescens group and in particular the finely ribbed variants of this species from Clatcombe Farm, near Sherborne, Dorset (BMNH. C80372). The latter differ only in being slightly coarser ribbed and less inflated. Taking this similarity into account C. obornensis is best included in the genus Chondroceras. The existing species of Labyrinthoceras are on the whole of much larger size and exhibit a more contracted body-chamber. However the existence of smaller specimens of Labyrinthoceras, such as L. "intricatum" S. Buckman (1909-30, Plate 135A), which are transitional in size and general morphology between C. obornensis and L. meniscum s.str., confirms the close relationship which exists between these two groups. The only other stratigraphically similar species, Sphaeroceras manselli also shows transitional features; in this case between C. obornensis and Sphaeroceras s. str. (such as S. brongniarti). This Sauzei Zone species differs from C. obornensis by having a more occluded umbilicus and a squarer whorl cross-section. There thus can be little doubt that this close morphological similarity between all the early Sphaeroceratids confirms C. obornensis in its position as the earliest, root stock of this subfamily. In these circumstances strong doubts must be expressed concerning the supposed critical phylogenetic position of C. antiquum (Westermann, 1956, p.94). Westermann (1956, p.95, text fig.23), considered that this species was the oldest european representative of the genus, and thus was a probable root stock for the bulk of the post-Sauzei Zone Sphaeroceratids. In fact this 'species' is probably nothing more than an extreme morphotype of the C. schmidti group.

Stratigraphic distribution

The specimens which have been collected in situ have come from bed 3, Oborne Wood, which is to be correlated with topmost part of the Laeviuscula subzone of the Laeviscula Zone. Of the museum material, the specimens from the Sherborne district of Dorset, also appear from their matrix to have come from this same bed, whilst the one specimen from Dundry Hill, near Bristol has the matrix of the 'White Iron-shot bed', (= bed 4a, South Main-road Quarry), and is presumably also Laeviuscula subzone in age.

8. <u>Chondroceras</u> (<u>Chondroceras</u>) sp. nov. aff. <u>C</u>. <u>tenue</u> (Westermann), Plate 5, figs. 3a-b ; Text fig. 28.

? 1956 <u>Chondroceras</u> (<u>Schmidtoceras</u>) <u>tenue</u> n. sp.; Westermann, pp.91-3, Text figs. 11-12, 22, 51, 55, Plate 10, figs. 1-4.

? 1964 <u>Chondroceras</u> (<u>Schmidtoceras</u>) <u>tenue</u> Westermann; Westermann, p.55.

1971 <u>Sphaeroceras</u> (<u>Chondroceras</u>) <u>flexuosum</u> n. sp.; Sturani, pp.149-150, Plate 11, fig.18, <u>non</u> Plate 16, figs.17-18, 20-21.

<u>Material</u>

Two specimens from bed 5b, Frogden quarry, Oborne, Dorset, BMNH. C80351-2.

<u>Dimensions</u>

BMNH. C80351, incomplete, with $\frac{1}{4}$ whorl of body-chamber,

D.	Ud.	Pn.	Wh.	Wb.
0.96 cm.	0.26 (27)	-	0.44 (46)	0.61 (64)
0.82	0.21 (26)	-	0.36 (44)	0.55 (67)

BMNH. C80352, with $\frac{3}{4}$ whorl body-chamber, maximum size 1.86 cm.,

1.74	0.53 (31)	45+	0.71 (41)	0.91 (52)
1.48	0.40 (27)	-	0.69 (47)	0.84 (57)

4th. Paratype, <u>C</u>. <u>flexuosum</u>, Ponte sul Ghelpach, N. Italy, Pisa museum,

0.81	0.21 (26)	-	0.36 (44.6)	0.47 (58)

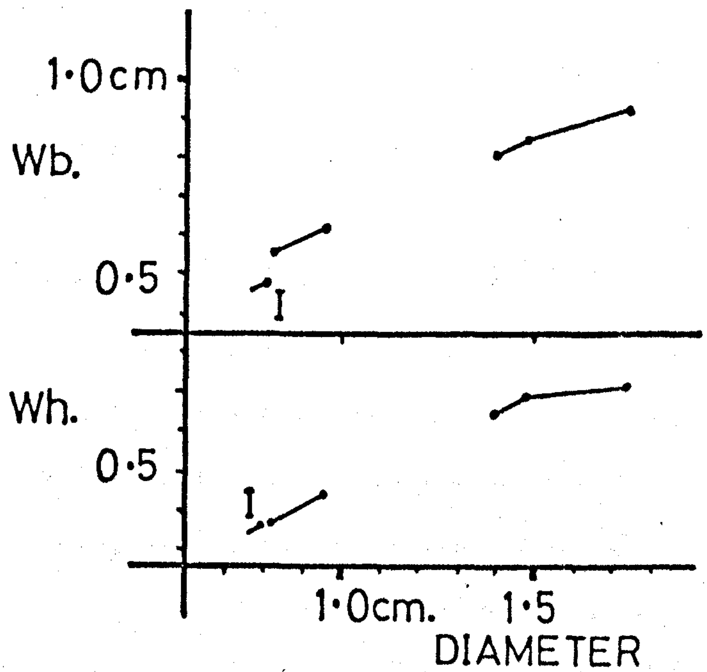


Figure 28.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum diameter for specimens of C.(C.) sp. nov. A. aff. C.(C.) tenue (Westermann). I = Italian specimen of C.(C.) flexuosum (Sturani).

Description

A small, relatively evolute (Ud. = 24-31%) ammonite, with a rounded-ovate whorl cross-section, and with a relatively sharp angle between the whorl flank and the umbilical wall. There is a slight uncoiling of the umbilical seam associated with the retraction of the body-chamber, which stretches for three-quarters of a whorl. As can be seen in Text fig. 28 , there is little relative change in the whorl breadth over the last whorl, but a sharp decline in the relative whorl height. The ribbing is extremely fine, with a tendency to be superficial on the inner whorls, and in the case of the primary ribs, on the last half whorl. The rib density is high, but it is difficult to exactly determine, as the larger specimen is slightly damaged; it must however be in excess of 44 primary ribs per whorl. The primary ribs are strongly prorsiradiate and bend forward sharply from the umbilical shoulder, from just above which point they divide into two, or more commonly three secondary ribs. These secondaries, which become coarser just before the aperture, sweep forward gently over a tightly arched venter.

Sexual dimorphism

Only the edge of the mouth-border is preserved on the larger specimen, and this together with the small number of specimens, precludes any discussion of the style of dimorphism.

Discussion

These two specimens represent members of a very rare species; no equivalent material was found in the much larger collections from the Banksi subzone beds at Oborne Wood. The larger specimen is one of the most evolute and almost platycone sphaeroceratids found in the British Bajocian. The most closely comparable groups consist of C. polypleurum from the Humphriesianum subzone of Oborne Wood, which is larger and coarser ribbed, and C. canovense from the upper Subfurcatum Zone, which is smaller, with a more occluded umbilicus. C. tenue (Westermann, 1956, Plate 10, figs.1a-d), from the upper Humphriesianum Zone, Gerzen, N.W. Germany (Westermann, 1954, p.25), is of a similar size and has a similar style of coiling. However, this species differs from the specimens described here, by having a more rounded whorl cross-section and less well marked, straighter and sparser ribbing. The most strictly comparable specimen, described in the previous literature, is undoubtedly the fourth paratype of C. flexuosum (Sturani, 1971, Plate 11, fig. 18). This specimen is the only one of the type series to have come from the Banksi rather than the Polygyralis subzone of the Subfurcatum Zone. It differs from the other paratypes and the holotype, by being more evolute and less inflated. As can be seen from the dimensions given above, it has very similar relative proportions to the specimens recorded here, as well as showing an identical style of very fine, prorsiradiate ribbing. It is likely that the specimens from Frogden quarry represent a new species, but further material is needed before an adequate description of this taxon can be made.

Stratigraphic distribution

These specimens were found in bed 5b, Frogden quarry, which is Banksi subzone, Subfurcatum Zone in age.

The genus *Labyrinthoceras* S.S. Buckman, 1919

Type species, by original designation - *L. perexpansum* (S. Buckman, 1882), = subjective syn. *L. meniscum* (Waagen, 1867)

Diagnosis

A group of relatively large Sphaeroceratinid ammonites, with round whorls, a contracted body-chamber, and a narrow, deep umbilicus. The ribbing is very fine and dense, the dimorphism well marked, and there are no spines or tubercles present (*contra*, Westermann, 1956, p.13). The microconch is relatively small in comparison to other members of the subfamily, and bears lappets, whilst the macroconch has a mouth-border made up of a deep constriction, followed by an expanded, smooth lip.

Stratigraphic distribution

All the described species are apparently restricted to the Sauzei Zone.

Genus group

Only the following is here recognised as a member of the restricted genus:-

1. *L. meniscum* (Waagen, 1867)
   syn. *L. perexpansum* (Buckman, 1882)
   L. intricatum S. Buckman, (1919)
2. *L. meniscum* sub. sp. *amphilaphes* (S. Buckman, 1922).

The other two 'species', which Buckman assigned to this genus; '*L.*' *extensum*, Buckman, 1921, & '*L.*' *gibberulum* Buckman, 1922; show the presence of an acutely angled umbilical shoulder, surmounted by sharp tubercles or spines, they are thus better included in the genus _Frogdenites_.

1. Labyrinthoceras meniscum (Waagen)

Plate 5, figs. 12-14; Plate 6, figs. 1 - 6; Text fig. 29.

1845 Ammonites gervillii Sow.; d'Orbigny (1842-51), Plate 140, figs. 1 & 2, non 3-8.

? 1856 Ammonites brongniarti Sow.; Oppel (1856-8), p.375.

1867 Ammonites meniscus n. sp.; Waagen, pp.602-3.

1881 Sphaeroceras meniscus (Waagen); S. Buckman, p.597.

1882 Sphaeroceras perexpansum nobis; S. Buckman, p.142, Plate II, figs. 4a-b.

1891 Sphaeroceras meniscus Waag.; Haug. p.68.

1900 Sphaeroceras meniscus (Waagen); Bigot, p.47.

1919 Labyrinthoceras perexpansum (S. Buckman); S. Buckman (1909-30), Plates 134A-D.

1919 Labyrinthoceras intricatum nov.; S. Buckman (1909-30), Plate 135.

1927 Labyrinthoceras intricatum Buckman; S. Buckman (1909-30), Plate 135A.

1938 Sphaeroceras perexpansum Buck.; Roman, pp.197-8.

1939 Sphaeroceras meniscus Waagen; Roché, p.226.

? 1952 Sphaeroceras (Labyrinthoceras) intricatum; Kumm, p.383.

1957 Labyrinthoceras perexpansum (Buckman); Arkell (in Arkell, Kummel & Wright, 1957), p.292, fig. 347/4a-b.

1964 Labyrinthoceras (Labyrinthoceras) meniscum (Waagen); Westermann, p.54.

1968 Labyrynthoceras perexpansum Buckm.; Pavia & Sturani, p.311.

1974 Labyrinthoceras meniscum (Waag.); Parsons, pp.159 & 166.

Material

Three specimens in situ, from the top 0.20 m. of the Sandford Lane 'fossil-bed', BMNH. C80335-7, and one from the top 0.06 m. of the Dundry, 'Brown Iron-shot' bed, BMNH. C80338, from the 'South-Main-road' quarry, Dundry Hill. Five specimens from Dundry Hill, nr. Bristol; BMNH. C78582-5, BCM.Cb4969; one specimen from Rackle-down quarry, Dundry (ST572654), BUGM.3324/1; two specimens from 'South-Main-road' quarry, Dundry, (ST567655), BUGM.3289 & 3324/2: seven specimens from the 'Sherborne district', north Dorset, BMNH. C80300 (ex. S.S.B. 475), C80304 (ex. S.S.B. 1248), C80301 (ex S.S.B. 2968), C78581, IGS.32001, 32041 & 49296; one specimen from the 'Yeovil district', south Somerset/north Dorset, BMNH. C75263; three specimens from 'Clatcombe', near Sherborne, Dorset, BMNH. C80803 (ex. S.S.B. 2969), C3282, IGS.3649; two specimens from Sandford Lane, near Sherborne, Dorset, BMNH. C78580, C80302 (ex. S.S.B. 1245); one specimen from Chideock Quarry hill (SY434931), south Dorset, BMNH. C80299 (ex. S.S.B. coll.) and three specimens from Normandy, north-west France, St. Vigor, BMNH.37268 (ex. Tesson), Bayeux, BMNH.37269 (ex. Tesson) & BMNH.74307 : a total of 29 specimens.

Dimensions

BMNH. C80300 (ex. S.S.B. 475), paralectotype of L. perexpansum (S. Buckman 1882), septate phragmacone, (M.)

D.	Ud.	Pn.	Wh.	Wb.
4.36 cm.	0.75 (17%)	-	2.5 (57)	3.68 (84)
3.27	0.62 (19)	-	1.8 (55)	2.6 (80)

IGS.32041 (ex. S.S.B. 1249), metatype of L. perexpansum (Buckman, 1909-30, Pl. 134C-D), (M.), mD. = 13.55

12.6	4.04 (32)	-	5.35 (43)	6.95 (55)
10.36	2.8 (27)	-	5.07 (49)	6.90 (67)

D.	Ud.	Pn.	Wh.	Wb.
IGS.32001 (ex. S.S.B. 476), holotype of *L. intricatum* Buckman (1909-30, Pl. 135), incomplete specimen, with start of body-chamber, (?M.)				
4.2	0.88 (21)	-	2.16 (51)	c.3.8 (91)
3.52	0.72 (21)	-	1.96 (56)	-
IGS.49296 (ex. S.S.B. 1264), paratype of *L. intricatum* Buckman (1909-30, Pl. 135A), (M.), mD. = 7.25				
6.8	2.18 (32)	67	2.75 (40)	-
5.83	1.61 (28)	63	2.68 (46)	-
BMNH. C80302 (ex S.S.B. 1245), complete with mouth-border, (M.), mD. = 10.85.				
10.3	3.05 (30)	c.46	4.44 (43)	6.1 (59)
8.65	2.07 (24)	-	3.42 (40)	6.1 (71)
BMNH. C78582 (ex S.S.B. coll.), complete with flared mouth-border and one whorl of body-chamber, (M.)				
3.57	1.14 (32)	67	1.4 (39)	1.8 (50)
2.78	0.71 (26)	-	1.33 (48)	1.78 (64)
BMNH. C78581 (ex. Darell-Stephens, via S.S.B. coll.), complete with flared mouth-border and one whorl of body-chamber, (M.), mD. = 4.34.				
4.03	1.3 (32)	61	1.68 (42)	2.12 (53)
3.40	0.87 (26)	54	1.66 (49)	2.26 (67)
BUGM.3289, fragmentary, but with edge of mouth-border and one whorl of body-chamber, (M.)				
9.08	2.6 (29)	-	3.8 (42)	-
-	1.75	45	-	5.08
6.8	1.32 (19)	41	3.49 (51)	5.06 (74)
BMNH.37268 (ex. Tesson coll.), topotype of *L. meniscum* (Waagen), complete with flared mouth-border and one whorl of body-chamber, (M.), mD. = 6.98.				
5.66	1.4 (25)	54	2.7 (48)	3.61 (64)
4.95	0.97 (20)	50	2.66 (54)	3.58 (72)

D.	Ud.	Pn.	Wh.	Wb.
BMNH. C78585 (ex. S.S.B. coll.), complete with three-quarters of a whorl of body-chamber and small lappets, (m.)				
2.4	0.53 (22)	-	1.13 (47)	1.46 (61)
1.98	0.31 (16)	-	1.12 (57)	1.45 (73)
BUGM.3324/1 (ex. Underhill coll.), complete with three-quarters of a whorl of body-chamber and the base of lappets, (m.)				
2.41	0.60 (25)	31	1.2 (50)	1.4 (58)
2.0	0.28 (14)	27-28	1.08 (54)	1.37 (69)

Dimensions of further material are to be found in an appendix.

Description

A relatively large (average macroconch diameter, from 14 specimens = 6.74 cm., range 3.3 - 13.55; average microconch diameter from five specimens = 2.45), globose ammonite species, with a deep and very narrow umbilicus. There is a pronounced contraction of the body-chamber, particularly in the macroconchs, associated with the decrease in whorl breadth relative to whorl height (see Text fig.29). Thus the highly depressed inner whorls become more rounded on the body-chamber, which spans one whorl of the macroconchs and three-quarters of a whorl in the microconchs. The contraction of the body-chamber on the last half whorl is also marked by a rapid retraction of the umbilical seam. Although there is a reduction of the rate of increase of both whorl height and breadth over the last three-quarters of a whorl, the maximum values for these dimensions are still found just before the mouth-border. The ribbing is extremely fine and sharp, with a tendency to be superficial. The primary ribs are curved, prorsiradiate, extremely dense (44-76/outer whorl of macro-

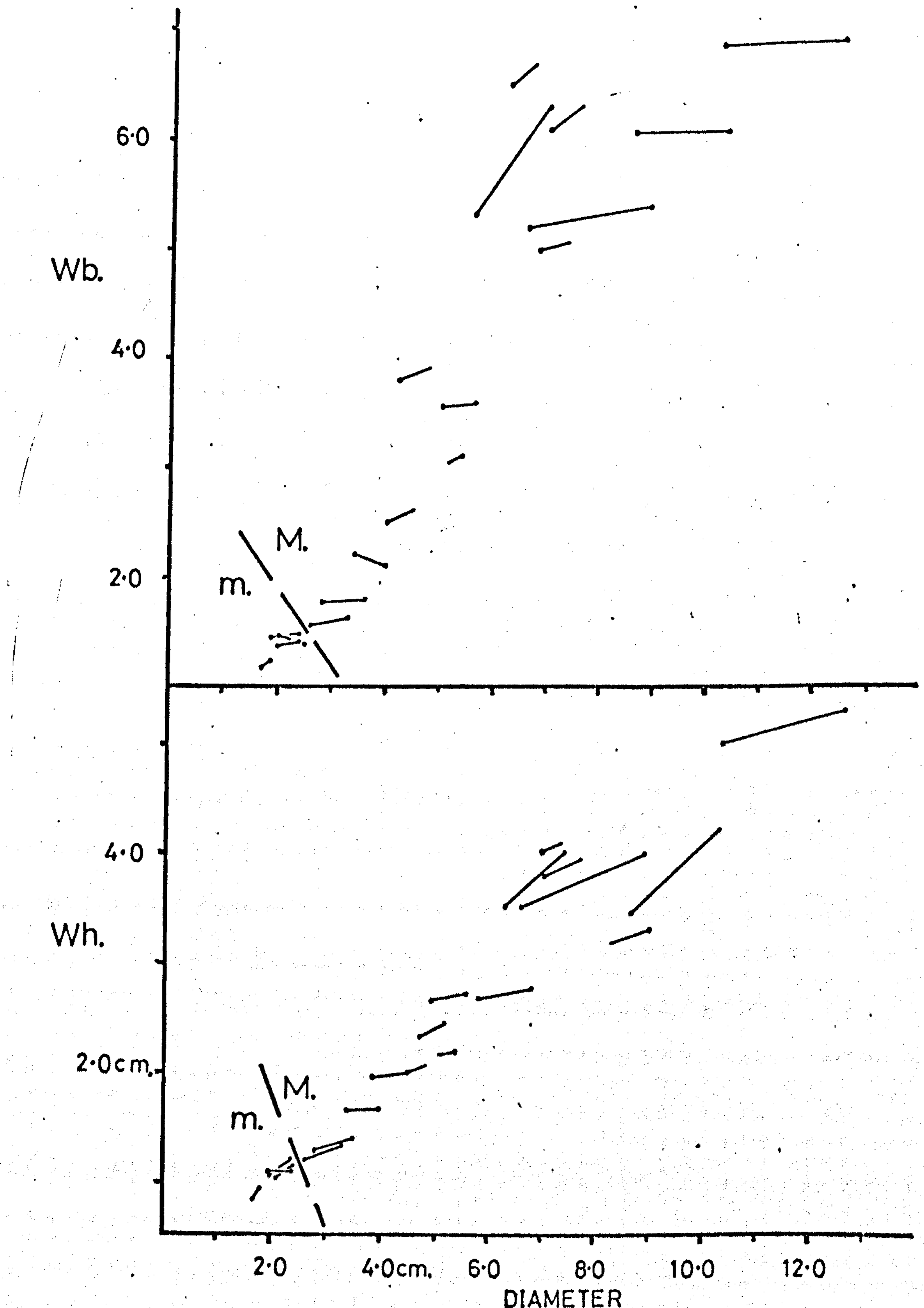


Figure 29.

A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum diameter, for specimens of <u>Labyrinthoceras</u> <u>meniscum</u> (Waag.)

conchs; 27-38 outer whorl of microconchs), and divide well up past the whorl shoulder into two or more rarely three secondary ribs. These secondaries are also fine and sharp, and sweep forward gently over the arched venter, often with a slight backward deflection along the mid-ventral line. Although almost superficial on the inner whorls, the secondaries tend to become coarser and blunter just before the mouth-border. The latter is characterised by a very strong constriction (particularly on the internal cast), followed by a slight flare and a smooth lip, which on the microconchs shows the presence of a pair of wide, forward projecting lappets (see Plate 5, figs. 13b+14b).

Sexual dimorphism

It is evident that the majority of the specimens of _L. meniscum_; with their relatively large size and mouth-borders, with smooth lips; are macroconchs (cf. Westermann, 1964, p.54). Westermann (_loc. cit._), suggested the genus _Frogdenites_ as the corresponding microconch. However, it is now certain that this latter taxon is Laeviuscula rather than Sauzei Zone in age (Parsons, 1974, p.175), and in any case has a very different morphology, with the presence of spines and/or tubercles (Parsons, 1977). This apparent problem is solved by the presence in the Sauzei Zone beds of obvious microconchs, which are identical to _L. meniscum_ in relative proportions and ornament, but are much smaller, and bear lappeted mouth-borders (e.g. BMNH. C78585). The size ratio between these two dimorphic groups is in the order of 1:2.75. This is perhaps a trifle low, as it has been biassed by the relatively large number of complete small macroconchs in the sample: many of the larger macroconchs are incomplete, and thus could not be taken into account.

Discussion

The type series of '*Ammonites*' *meniscus* Waagen 1867 is made up of an unknown number of specimens, including those discussed by d'Orbigny (1846 in 1842-51, Pl.140, figs. 1 & 2, *non* 3-8) and Oppel (1856 in 1856-8, p.375 *pars*), as well as the specimens collected by Waagen himself (1867, p.603), from the top of the Malière (La Couche verte) at Sully, near Bayeux, Normandy. No holotype as such was designated, hence a lectotype must be chosen. The mere casual citing of d'Orbigny's 1846 figure (Pl.140, figs. 1 & 2 only), as the 'holotype' or 'type' (e.g. Westermann, 1964, p.63) on its own does not fulfil this need. Whilst it is admissible to designate a figure as lectotype, it must be treated as a designation of the specimen represented by the figure, (I.C.Z.N., Art. 74b). In d'Orbigny's case so many of his figures are blatant synthetographs (cf. d'Orbigny, 1842-51, Pls. 133, 136 etc.), that it is impossible to be certain in many cases that any one figure was based on a single specimen. Thus, any such lectotype designation can only be considered valid, if a single specimen can be found in the d'Orbigny collection, which closely matches the relevant figure. Unfortunately the specimen in question of *L. meniscum*, has yet to be found in the d'Orbigny collection. However, this need not affect the interpretation of this taxon, since d'Orbigny's figure is more than adequate, especially since it is supported by abundant topotype material, including specimens in the Tesson collection (BMNH.37268-9), which are themselves of considerable historic importance. Specimens extremely close, both to d'Orbigny's figure, and to the topotypes have been found fairly commonly in the

Sauzei Zone beds at Sandford Lane and Clatcombe, north Dorset, and at Dundry Hill, near Bristol. These specimens are undoubtedly conspecific with Waagen's taxon.

Sphaeroceras perexpansum S. Buckman 1882 was based on "a few", but unknown number of specimens from the 'Sherborne district', collected by J. Buckman (S. Buckman, 1882, p.142). No holotype was designated in the original description (loc. cit.), hence Buckman's later re-description (S. Buckman, 1909-30, Pl.134A-B), of the figured syntype (S. Buckman, 1882, Pl.2, figs.4a-b), as 'holotype', may be taken as a lectotype designation. Unfortunately this specimen (S. Buckman collection number: 474), appears to have been lost, since it is not with the rest of the material figured in 'Type Ammonites' (Buckman,1909-30), and now in the Institute of Geological Sciences. Neither does it seem to be in any of the other Buckman collections in, the British Museum (the bulk of his collection is here), Oxford University Museum, Manchester City Museum or Liverpool University geology department collections. However, several paralectotypes still exist, including S.S.B. 476 (= the subsequently designated holotype of L. intricatum S. Buckman, now IGS.32001) and S.S.B. 475, now in the Buckman collection at the British Museum (N.H.); C80300. This latter specimen is very similar to the lectotype, which was well figured by Buckman (loc. cit.). Although this 'species' thus appears relatively well defined, its interpretation is made difficult by the fact that all the original type material appears to have been based on fragmentary specimens which are mainly only septate inner whorls. This makes any comparison with larger, complete specimens rather difficult. Most, if not all, the type series seem to have had an 'iron-shot' matrix. In the Sherborne area this virtually restricts their type horizon to either the Sauzei or Humphriesianum Zones (see the previous discussion of Sphaeroceras manseli). The original diameter of the lectotype, when complete, must have been in excess of 10 cm., and luckily there are very few comparable ammonite groups in the rocks of these ages, which reach this size. In the Humphriesianum Zone, only Chondroceras grandiforme is large enough, and this species has a very different whorl cross-section and ornament. In the Sauzei Zone there are several species of Emileia, which are the correct size, but have a different ornament, with 'club' shaped primary ribs. Only Emileia multifida S. Buckman has a comparable ribbing style and this differs by being far more evolute. There thus can be little doubt that the specimen later figured by Buckman (1909-30, Pl.134C-D), does represent the only group which could have provided the inner whorls, that are the lectotype of L. perexpansum. If this is the case, then this latter taxon must be considered as a junior subjective synonym of L. meniscum, since Buckman's complete specimen (IGS.32041), is virtually identical to d'Orbigny's figure. This is confirmed by the fact that the more extensive collections of Buckman's 'species' now available, show a complete morphological intergradation with the topotypes of Waagen's species from the 'Couche verte', of Normandy.

The taxonomic status of Labyrinthoceras intricatum S. Buckman, is almost identical to that of L. perexpansum. It is based on a similarly incomplete type specimen, which is also a paralectotype of L. perexpansum (Buckman, 1909-30, Pl.135 - IGS.32001). However, this specimen has a small part of its body-chamber preserved, its original diameter, when complete, was thus considerably less than L. perexpansum. Buckman's interpretation of the complete L. intricatum

(Buckman, 1909-30, Pl.135A), is probably correct. However, this specimen (IGS.49296) is almost identical to the figured metatype of L. perexpansum in almost every character, except size. The available specimens of L. meniscum show a wide size range (3.3 - 13.5 cm.). Although this collection is anything but a statistically homogenous sample (it is made up of mainly poorly localised material, from a variety of localities and horizons), its size range is not incompatible with a standard deviation for the diameter of about 15% (see Callomon, 1963, pp.26-8, for a fuller discussion). Taking into consideration that the paratype of L. intricatum is slightly larger than the average of this 'sample', size alone would appear to be an inadequate basis for separating this taxon from L. perexpansum, and thus L. meniscum.

However, the detailed stratigraphy of this group is still rather poorly known. If at some future time it could thus be shown that the younger populations of L. meniscum are of a larger average size, than the older specimens, which in turn are transitional to C. obornensis nov.; then a case could be made for resurrecting L. intricatum as a chronological subspecies of L. meniscum.

'Labyrinthoceras' gibberulum Buckman has been considered conspecific with L. meniscum (Westermann, 1964, p.54). However, this taxon is characterised by having faint tubercles/spines, it is hence best transferred to the genus Frogdenites: under no circumstances should it be included in L. meniscum.

Stratigraphic distribution

The type horizon of L. meniscum is 'La Couche verte' of Normandy, which is Sauzei Zone in age (Parsons, 1974). The well localised English material has come either from the top half of the Sandford Lane 'fossil-bed' (Parsons, 1974, p.166), or the topmost part of the 'Brown iron-shot' bed on Dundry Hill, both of which are also Sauzei Zone in age (op. cit.). The other English material includes a specimen from the 'Red beds' of Chideock Quarry Hill (BMNH. C80299), which are at least in part of Sauzei Zone age; and several from the 'iron-shot' beds at Clatcombe, which are also of this age (Parsons, 1974, p.165, bed 6). All available evidence would thus suggest that L. meniscum is restricted to the Sauzei Zone.

2. Labyrinthoceras meniscum sub. sp. amphilaphes (S. Buckman), Text fig. 30.

1922 Labyrinthoceras amphilaphes nov.; Buckman (1909-30), Plate 279.

1964 Labyrinthoceras meniscum (Waagen); Westermann, pp.54 & 63, pars.

Material

Two specimens from Dundry Hill, near Bristol; IGS.47114 (the holotype, ex S.S.B. 3315) & BCM.Cb4970; and ?, one specimen from Oborne Wood, a derived specimen, found in the base of bed 4a, CP1208.

Dimensions

IGS.47114, (holotype), septate nucleus. (M.),

D.	Ud.	Pn.	Wh.	Wb.
4.7 cm.	0.65 (14%)	-	2.80 (60)	c.4.9 (104)
BCM.CB.4970, septate nucleus, with a diameter of 7.0 cm. (M.),				
6.22	0.92 (15)	-	3.84 (62)	6.2 (100)
CP1208, septate nucleus, (M.),				
3.0	0.61 (20)	42	1.62 (54)	+2.91 (97)
2.63	0.52 (20)	-	1.4 (53)	+2.6 (99)

Description

This taxon is very like L. meniscum s. str. It is a relatively large, involute ammonite group, with a deep, narrow umbilicus. The ribbing is fine, sharp, dense, and with a tendency to be superficial. The whorl section is extremely depressed, with very high values for

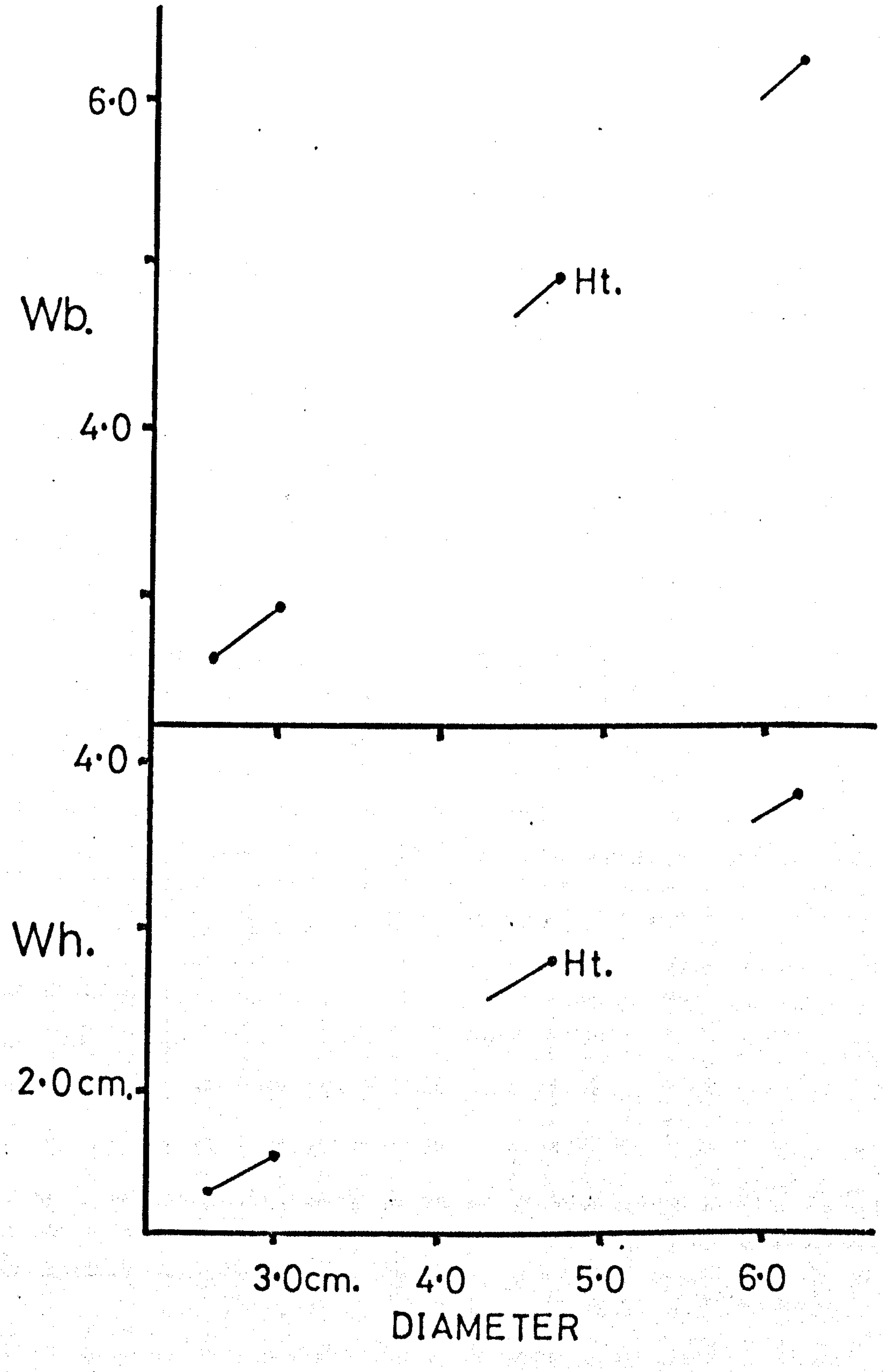


Figure 30. A plot of whorl breadth (Wb.) and whorl height (Wh.) against maximum diameter for Labyrinthoceras meniscum sub.sp. amphilaphes (S.Buck.).

the whorl breadth (Wb. = 98-105%). Little more can be added to this description, particularly concerning the nature of the body-chamber and aperture, as all the material described here consists of septate inner whorls.

Sexual dimorphism

The specimens described here, taking into account their relatively large size, are probably macroconchs. The corresponding microconchs are still unknown.

Discussion

All the available material, including the holotype, is totally septate, which prevents any really detailed comparisons with related taxa. However, the specimens described here are extremely similar to the inner whorls of L. meniscum, in almost every detail, except whorl breadth. L. amphilaphes seems to be consistently more inflated than the latter, with a more depressed whorl cross-section. Taking into account both the small size of the sample and the wide range of variation in whorl breadth, which has been observed in some ammonite populations (e.g. Chondroceras evolvescens), it would seem inadvisable to retain L. amphilaphes as a distinct species. In these circumstances, the best solution would appear to be relegating it to a subspecies of L. meniscum.

Stratigraphic distribution

Both the Dundry specimens have a highly 'iron-shot' matrix, which would suggest that they are Sauzei Zone in age. The Oborne specimen came from a derived pebble at the base of the Humphriesianum

Zone beds. Its matrix is a soft, grey, 'iron-shot' limestone, which militates against an origin from the subjacent 'green-grained marl' (Parsons, 1974, p.165, bed 9). A more likely source would be a thin, lower Sauzei Zone age bed, which has been broken up by pre-Humphriesianum Zone erosion. This would be an equivalent horizon to bed 4 at Lower Clatcombe (loc. cit.).

VI. EVOLUTION OF THE SPHAEROCERATINAE

Some interesting features in the evolution of the ammonite subfamily Sphaeroceratinae have come to light during the course of this work. Early attempts at elucidating the phylogeny of this group were severely hampered by a lack of information relating to the stratigraphic distribution of its constituent taxa. Thus Westermann (1956, Text fig.23; 1964, Text fig.14), suggested that *Sphaeroceras* was an offshoot of *Chondroceras*, which appeared at the base of the Subfurcatum Zone. However, it has since been shown (here & Sturani, 1971), that the type species of *Sphaeroceras*, (*S. brongniarti*), is Humphriesianum Zone in age, and indeed is at its most abundant in the basal third of this Zone. The origins of *Sphaeroceras* should thus be sought at an even lower horizon. The Sauzei Zone, *S. manseli*, which is discussed above, is the earliest taxon, which can be reliably assigned to *Sphaeroceras*, and it shows morphological features which are transitional between *Sphaeroceras s. str.* (i.e. *S. brongniarti*), and the earliest known Sphaeroceratid, *C. obornensis* nov., of the upper Laeviuscula Zone. It would thus seem that *Sphaeroceras* is indeed an offshoot of *Chondroceras*, but that it split off at a much earlier date than was previously thought; that is at the base of the Sauzei Zone. The genus *Labyrinthoceras* appears to have a similar relationship to *Chondroceras*, since, like *S. manseli*, it is very similar to *C. obornensis* nov. in most features, except size. There is thus little reason to doubt that *Labyrinthoceras* also evolved from *C. obornensis* at the base of the Sauzei Zone. With its close relationship to both *Sphaeroceras* and

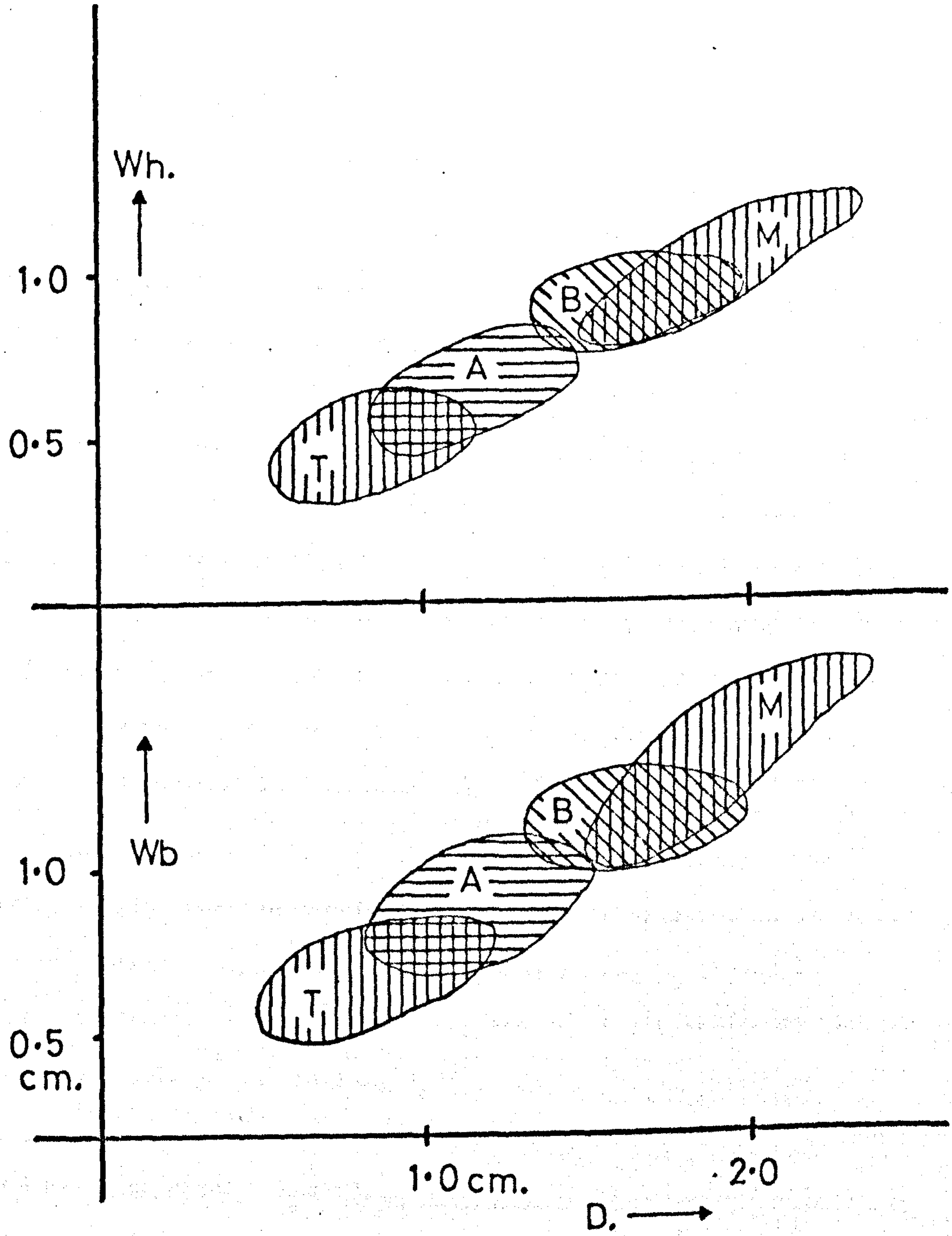


Figure 31.

A plot of whorl height (Wh.) and whorl breadth (Wb.), against diameter (D.), for mature specimens of S.(S.) auritum auritum (A), S.(S.) auritum tutthum (T), S.(S.) brongniarti (B) and S.(S.) manseli (M), showing the overlap in relative proportions with time : i.e. a chronocline.

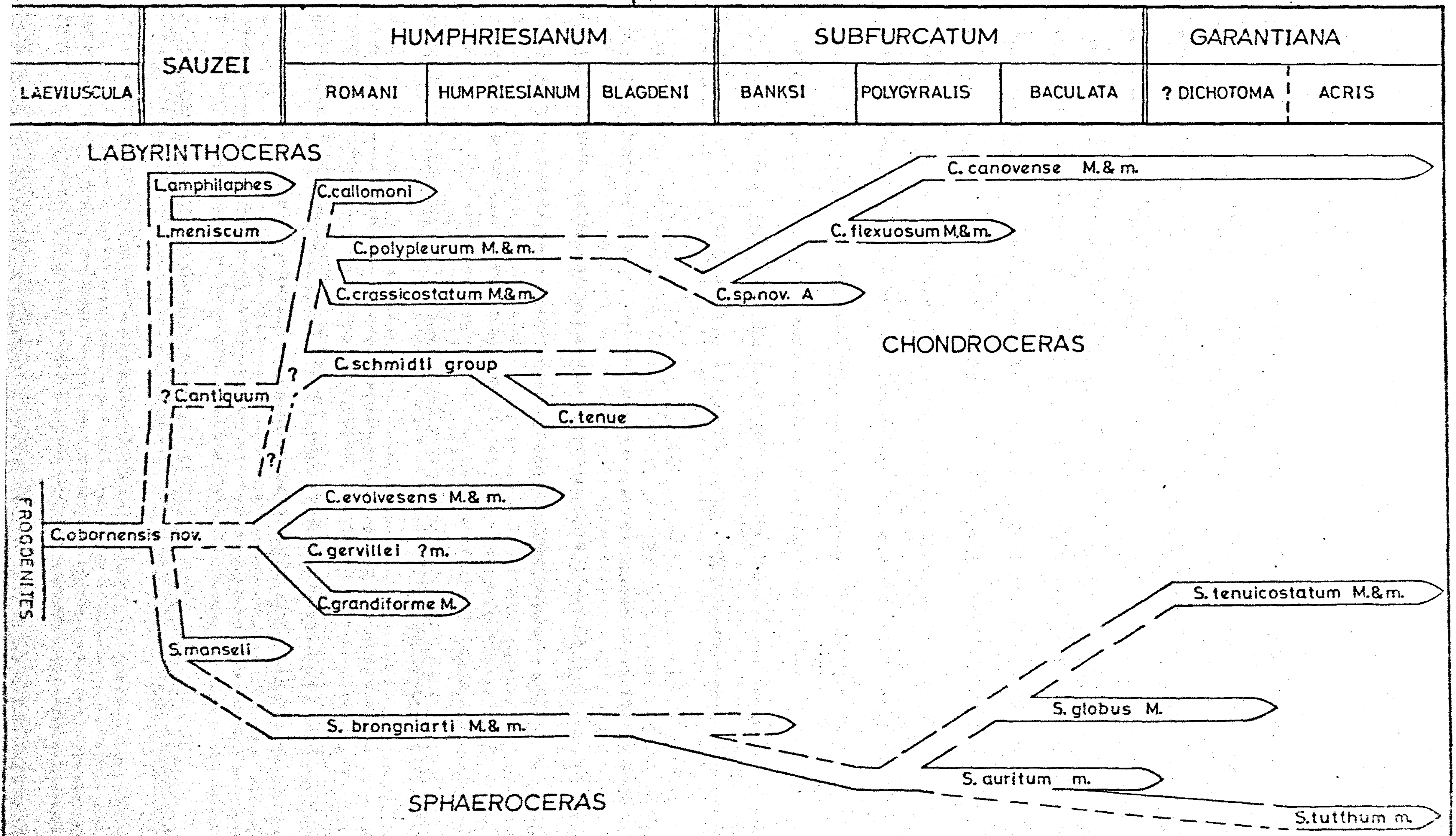
Labyrinthoceras, *Chondroceras obornensis* thus seems to be the root stem for all the Bajocian Sphaeroceratinae.

The stratigraphic distribution and probable phylogenetic relationships of the main european members of the Sphaeroceratinae are shown in Figure 32. It is evident from this figure, that there were several evolutionary bursts in this Subfamily. The primary radiation appears to have been in the Sauzei Zone, when although still relatively rare, all the european constituent subgenera make their appearance. There is a strong secondary radiation in the lower Humphriesianum Zone, which coincides with the greatest relative abundance of members of the Subfamily. Finally there is a late radiation in the Subfurcatum Zone, where again several new species appear, at the same time as there is an increase in their relative abundance.

At lower taxonomic levels, the Sphaeroceratinae exhibit some interesting phylogenetic trends, particularly in relation to evolutionary size changes. A relatively common phenomenon, in lineages of Jurassic molluscs, is a slow, but progressive size increase within successive populations, (Hallam, 1975). In the Sphaeroceratinae, *Labyrinthoceras* and the early members of the genus *Chondroceras* show marked size increases. Thus *C. grandiforme* is x1.5-2.0 and *Labyrinthoceras* up to x3.0 times the size of their direct ancestor; *C. obornensis*. However, this trend is atypical of the subfamily, which as a whole exhibits a very unusual, progressive evolutionary size decrease. Thus within the *Chondroceras* lineage *C. polypleurum*/*C.* sp. nov. cf. *C. tenue*/*C. flexuosum*/*C. canovense*, the microconchs (and macroconchs, although there is less material), show a decrease from an average maximum diameter

Explanation of Figure 32 (overleaf)

The stratigraphic distribution and probable phylogenetic relationships of the main european members of the Sphaeroceratinae. The un-broken lines represent known stratigraphic ranges, whilst the broken show probable extensions of stratigraphic ranges and/or suggested phylogenetic relationship.


HUMPHRIESIANUM
SUBFURCATUM
GARANTIANA
LAEVIUSCULA
SAUZEI
ROMANI
HUMPRIESIANUM
BLAGDENI
BANKSI
POLYGYRALIS
BACULATA
? DICHOTOMA
ACRIS
LABYRINTHOCERAS
L.amphilaphes
L.meniscum
C.callomoni
C.polypleurum M.& m.
C.crassicostatum M.& m.
C. canovense M.& m.
C. flexuosum M.& m.
C.sp.nov. A
CHONDROCERAS
C.schmidti group
C. tenue
? C.antiquum
?
?
C.evolvesens M.& m.
C.obornensis nov.
C.gervillei ?m.
C.grandiforme M.
FROGDENITES
S.manseli
S. brongniarti M.& m.
S. tenuicostatum M.& m.
S. globus M.
S. auritum m.
S.tutthum m.
SPHAEROCERAS

in the Romani subzone of 2.2 cm. to 0.67 cm. at the top of the Subfurcatum Zone. The genus Sphaeroceras shows an even better documented pattern of size decrease. Here the lineage S. manseli/S. brongniarti/S. auritum/S. auritum tutthum, shows an overlap in general morphology between individual populations (see Text fig.31), linked with progressive changes in the form of the aperture (the appearance of bilobate hoods) and flexing of the umbilical seam (see Text fig.8). Within this phyletic lineage, with its morphological intergradation (i.e. a chronocline), it would be impossible to separate distinct species, if stratigraphic discontinuities had not broken up the sequence. Perhaps the most striking feature of this chronocline, concerns the associated size changes. Again taking the more abundant microconch material, this group shows a decrease from an average maximum diameter of 1.7 cm. in S. brongniarti, to 0.87 cm. in S. auritum tutthum. The most likely mechanism to account for this unusual case of evolutionary size decrease, would be a strong overall selection pressure in successive sphaeroceratid populations in favour of the smaller forms. This could take the form of either positive selection in favour of the smaller forms, or negative pressure, with increased predation of the larger size grades. Taking into account the sphaeroceratid's preferred environment, with their predeliction for algal horizons (Sturani, 1971), the former, positive selection would seem the most likely. Thus this particular case of evolutionary size decrease could be a positive adaption to life in a micro-environment, associated with 'algal-meadows' (Sturani, 1971, p.46).

Apart from size, there are several other gradual changes in morphology within the Sphaeroceratinae, which taken together aid our understanding of this group's phylogeny, (see Text fig.32). In particular there are gradual evolutionary changes relating to the shape of the mouth-border and umbilical region. In the early members of *Sphaeroceras* and *Chondroceras*, there is a gradual loss of the microconch's lappets, which at an earlier date were characteristic of their Otoitid progenitors. Consequently the Romani subzone members of these genera have plain and simple mouth-bands, with no prolongations of the mouth-border. Subsequently the genus *Sphaeroceras* acquired a series of increasingly complex modifications to the mouth-border. These include prominent, thin, flared hoods, which in the *S. auritum/tutthum* group, acquire mid-ventral interruptions, leading to the development of the characteristic 'two prongs' of *S. auritum tutthum*. Both *Sphaeroceras* and *Chondroceras* show progressive modifications of the umbilicus. In the *C. polypleurum/canovense* lineage, this results in a gradual decrease in relative umbilical diameter, until later members have an almost, but not quite occluded umbilicus. In *Sphaeroceras* the umbilicus is all but occluded from the beginning, and the evolutionary changes relate to the retraction of the umbilical seam, which is only slightly curved in *S. brongniarti*, but which becomes increasingly retracted and flexed in the younger populations (see Text fig.8).

Taken together, all the gradual evolutionary changes detailed above, on the one hand facilitate fine divisions of the various phyletic lineages, which are thus of considerable stratigraphic significance; and on the other hand they demonstrate the close inter-relationship of all the Bajocian Sphaeroceratinae, which in consequence can thus be safely described as a 'natural grouping'.

Note

The above work was completed prior to Westermann's latest discussion of the phylogeny of the sphaeroceratids (Westermann, G.E.G. & Riccardi, A.C. 1979; Middle Jurassic Ammonoid fauna and biochronology of the Argentine-Chilean Andes. II Bajocian Stephanoceratacea. Palaeontographica (A), 164 : 85-188). However, it introduces no new data to significantly change the above conclusions.

EXPLANATION FOR PLATE 1

All specimens on this and the following Plates, unless otherwise stated, are coated with Ammonium chloride.

Figure 1. Sphaeroceras (Sphaeroceras) brongniarti (J.Sow.),(M.),BMNH.C80330, 'Red conglomerate' (=bed 6, Senior et al., 1970, p.117), Upton Manor farm, near Bridport, Dorset; side view, x1.0.

Fig.2a-c. S.(S.) brongniarti (m.),BMNH.C80325, bed 4b, Oborne Wood (Parsons, 1976, p.131), near Sherborne, Dorset ;2a side view, x2.0; 2b ventral view, x2.0 ; 2c side view, x1.5.

Fig.3a-b. S.(S.) brongniarti (M.),BMNH.C803201, bed 4b, Oborne Wood, near Sherborne, Dorset ;3a ventral view, x1.5 ; 3b side view, x1.5.

Fig.4a-b. S.(S.) brongniarti (M.),BMNH.C80329, 'Red conglomerate' , Upton Manor farm, near Bridport, Dorset; 4a side view, x1.0 ; 4b ventral view, x1.0.

Fig.5a-b. S.(S.) brongniarti (m.),BMNH.C36734, holotype, Bayeux, Normandy, France; 5a side view, x1.0 ; ventral view of mouth-border, x1.0.

Fig.6a-b. S.(S.) brongniarti (m.),BMNH.C80327, the 'Irony bed', Louse Hill, near Sherborne, Dorset (not coated); 6a ventral view, x1.0 ; 6b side view, x1.0.

Fig.7a-b. S.(S.) manseli (J.Buckman),(M.),BMNH.C80332, 0.20m. from the top of the 'fossil-bed' , Sandford Lane, near Sherborne, Dorset ; 7a ventral view, x1.5 ; 7b side view, x1.5.

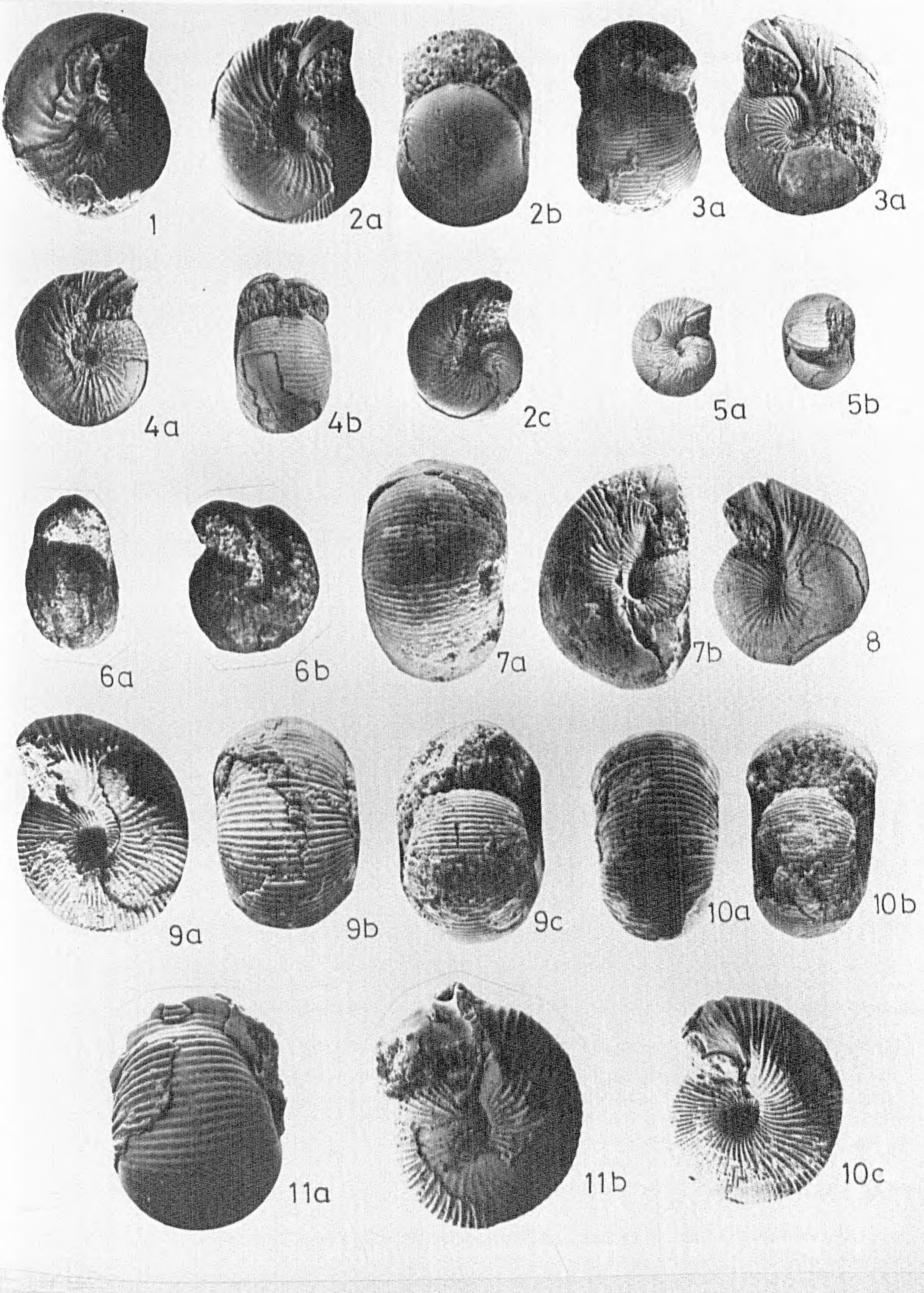
Fig.8. S.(S.) brongniarti (m.), bed 4a, Oborne Wood, near Sherborne, Dorset, x2.0.

Fig.9a-c. S.(S.) manseli (M.),BMNH.C80333, top half of the 'fossil-bed' , Sandford Lane, near Sherborne, Dorset; 9a side view, 1.5 ; 9b ventral view, x1.5 ; 9c apertural view, x1.5.

Fig.10a-c. *S.(S.) manseli* (m.),BMNH.C80334, 0.20m. from the top of the 'fossil-bed' ,Sandford Lane, near Sherborne, Dorset ; 10a ventral view, x2.0 ; 10b apertural view, x2.0; 10c side view,showing small residual lappet, x2.0.

Fig.11a-b. *S.(S.) auritum auritum* (Parona),(m.),BMNH.C80341, bed 6d, Oborne Wood,near Sherborne,Dorset ; 11a ventral view,showing the mid-ventral interruption to the flare, x3.0; 11b side view, x3.0.

PLATE 1



EXPLANATION FOR PLATE 2

Figure 1a-b. Sphaeroceras (Sphaeroceras) auritum auritum (Parona),(m.),BMNH.C80340, bed 6c,(Parsons,1976),Oborne Wood, near Sherborne,Dorset; 1a side view, x2.0 ; 1b apertural view, x2.0.

Fig. 2a-b. S.(S.) auritum auritum (m.),BMNH.C80375,bed 6d, (Parsons,1976,p.126),Frogden quarry, near Sherborne; 2a side view, x2.0 ; 2b apertural view, x2.0.

Fig. 3a-b. S.(S.) auritum auritum (m.),CP2344,bed 6b,Frogden quarry, near Sherborne,Dorset ; 3a side view,x2.0 ; 3b apertural view, showing lateral extensions, x3.0.

Fig. 4. S.(S.) auritum tutthum (S.Buckman),(m.), BMNH.C80356, the 'Astarte bed' ,Stony Head cutting, near Bridport,Dorset; side view, x2.0.

Fig. 5a-b. S.(S.) auritum tutthum (m.),BMNH.C80369, 'Oolithe ferrugineuse de Bayeux' ,Les Hachettes, Port-en-Bessin, Normandy,France; 5a view of 'two pronged' aperture, x2.0; 5b side view, x2.5.

Fig. 6a-c. S.(S.) auritum tutthum (m.),BMNH.C80363, bed 8 , (Senior et al,1970,p.118),Horn Park quarry,near Beaminster, Dorset ; 6a side view, x3.0 ; 6b view of aperture, x2.3 ; 6c side view, x2.0

Fig. 7a-b. S.(S.) cf. globus S.Buckman, (M.),BMNH.C80371, the Sherborne Building-stone 'series' ,Castle View,Sherborne, Dorset ; 7a apertural view, x1.5 ; 7b side view, x1.5.

Fig.8a-b. S.(S.) tenuicostatum Sturani,(m.),BMNH.C80359, the 'Astarte bed' (Senior et al.,1970,p.117,bed 7a),Upton Manor farm, near Bridport,Dorset; 8a apertural view ,x2.0 ; 8b side view, x2.0.

Fig.9. S.(S.) tenuicostatum (M.),BMNH.C80358, 'Astarte bed', Stony Head cutting, near Bridport,Dorset; ventral view, x1.5, showing at the top the ribs on the adapical surface of the flare.

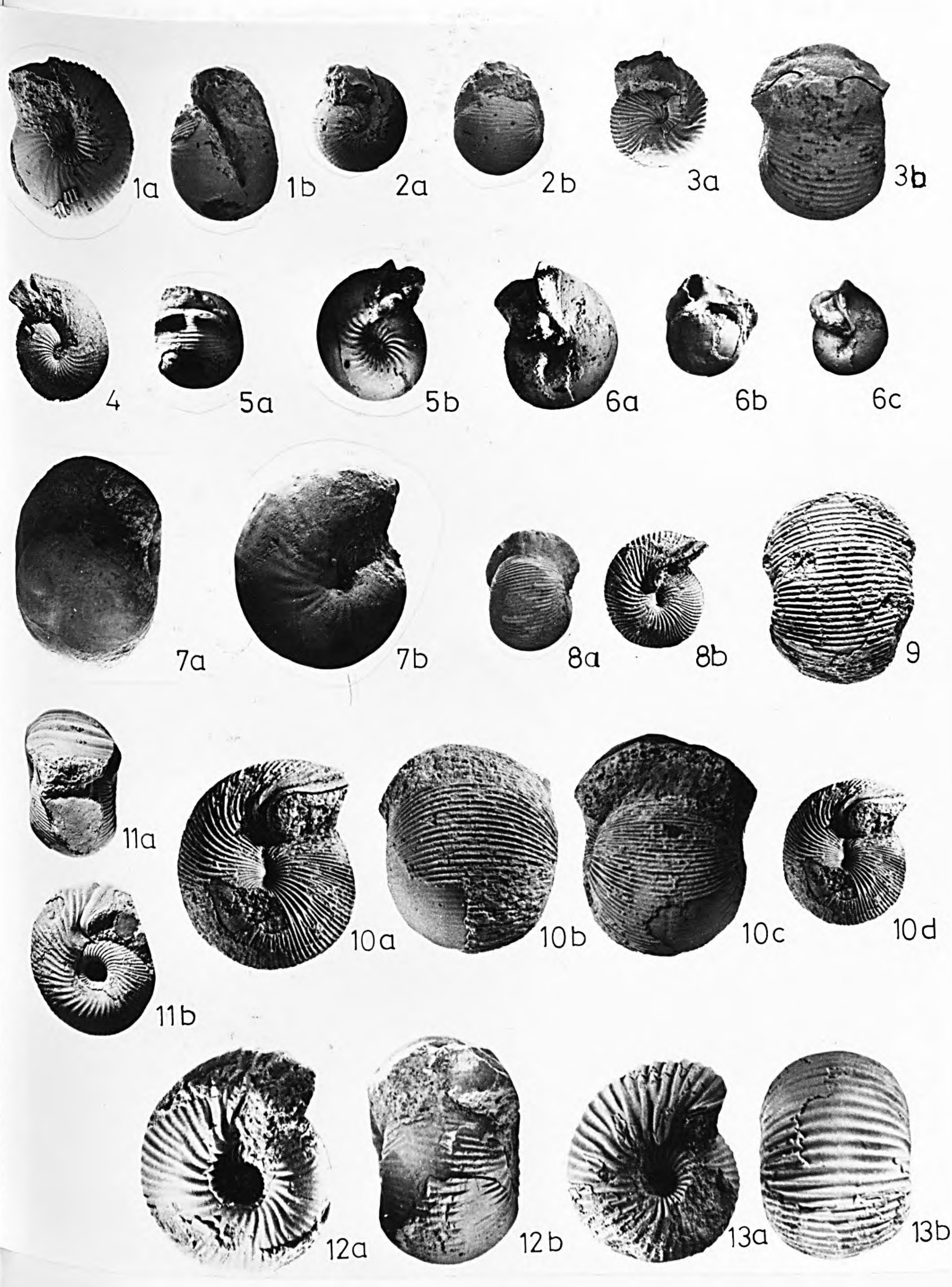
Fig.10a-d. S.(S.) tenuicostatum (M.),BMNH.C80357, 'Astarte bed' , Stony Head cutting, near Bridport,Dorset ; 10a side view, x1.5 ;10b ventral view, x1.5 ; 10c apertural view , x1.5 ; 10d side view , x1.0.

Fig.11a-b. Chondroceras (Chondroceras) gervillei (J.Sow.), (?m.), BMNH.C36735,holotype, Bayeux district,Normandy,France; 11a apertural view,x1.0 ; 11b side view, x1.0.

Fig. 12a-b. C.(C.) gervillei ,(m.?),BMNH.C80380, bed 4b, Oborne Wood, near Sherborne,Dorset; 12a side view, x1.5 ; 12b apertural view, x1.5.

Fig. 13a-b. C.(C.) gervillei (?m.),BMNH.C80382, a coarse ribbed variant from bed 4,Oborne Wood, near Sherborne, Dorset ; 13a side view, x1.5 ; 13b ventral view, x1.5.

PLATE 2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EXPLANATION FOR PLATE 3

Figure 1. Chondroceras (Chondroceras) gervillei (?m.),CP2271, a fine ribbed,typical form, bed 4, Oborne Wood,near Sherborne, Dorset ; side view, x1.5.

Fig.2a-b. C.(C.) evolvescens (Waagen),(M.),BMNH.C80386,bed 4b, Oborne Wood,near Sherborne,Dorset; 2a side view,x1.0 ; 2b apertural view, x1.0.

Fig. 3a-b. C.(C.) evolvescens (m.),BMNH.C80388, bed 4b,Oborne Wood, near Sherborne,Dorset; 3a side view,x1.5;3b apertural view, x1.5.

Fig.4. C.(C.) evolvescens (m.),BMNH.C80402, bed 5 (Parsons, 1976,p.134),Milborne Wick Lane section,Somerset;ventral view showing lappet like extensions of the mouth-border, x1.5.

Fig.5. C.(C.) evolvescens (m.),CP2205,bed 5,Milborne Wick lane section,Somerset; ventral view, showing the mouth-border, with a smooth, wide ,expanded lip, x1.5.

Fig.6a-b. C.(C.) evolvescens ,(m.),BMNH.C80401, bed 5,Milborne Wick lane section,Somerset; 6a side view,x1.5;6b apertural view, x1.5.

Fig.7a-c. C.(C.) evolvescens ,(m.),BMNH.C80387, bed 4b,Oborne Wood, near Sherborne,Dorset ;7a side view,x1.0 ; 7b side view, x1.5 ; 7c apertural view, x1.5.

Fig.8a-b. C.(C.) evolvescens ,(M.),BMNH.C80372, bed 5b,(Parsons, 1976,p.124), Clatcombe farm section,near Sherborne,Dorset ; 8a side view, x1.2 ; 8b apertural view, x1.2.

Fig.9a-b. C.(C.) evolvescens,(M.),BMNH.C80400, bed 5,Milborne Wick lane section,Somerset; 9a side view,x1.0; 9b apertural view, x1.0.

Fig. 10. Chondroceras (Chondroceras) canovense (de Gregorio), (m.),BMNH.C80395, bed 6b, Oborne Wood, near Sherborne,Dorset; side view, x2.5.

Fig.11. C.(C.) canovense,(m.),CP2342,bed 6d,Frogden quarry, Sherborne,Dorset ; side view, x2.0.

Fig.12. C.(C.) canovense,(M.), BMNH.C80394, bed 6b,Oborne Wood, near Sherborne,Dorset ; side view, x1.5.

Fig.13a-b. C.(C.) canovense,(m.),BMNH.C80396,bed 6b,Oborne Wood,near Sherborne,Dorset; 13a side view,x2.5; 13b ventral view of aperture, showing lateral extensions and mid-ventral node, x2.0.

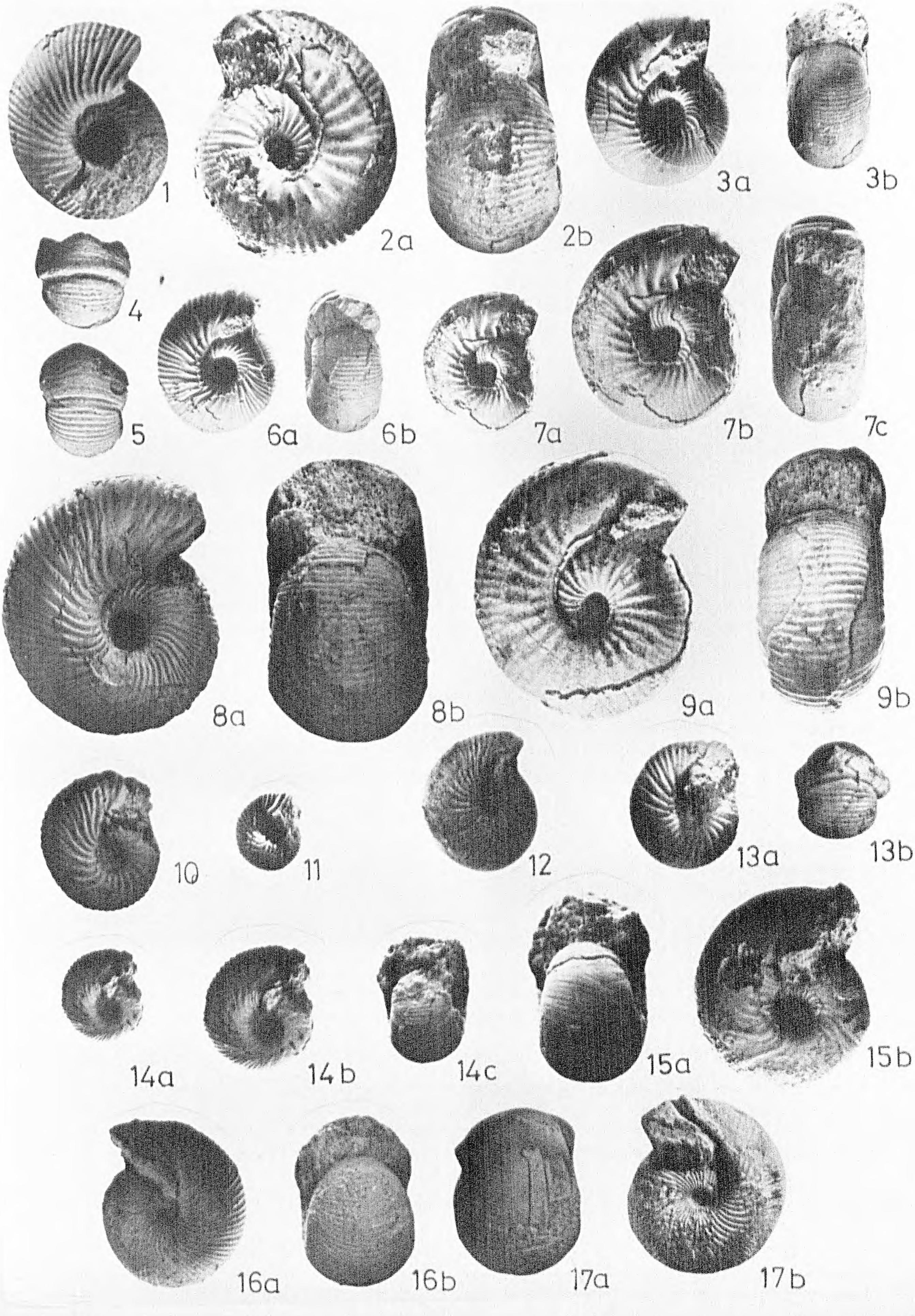
Fig.14a-c. C.(C.) canovense,(m.),BMNH.C80399, bed 6d,Oborne Wood,near Sherborne,Dorset ;14a side view, x2.5 ; 14b side view, showing the sinuous outline to the mouth-border ,x4.0; 14c apertural view, x4.0.

Fig.15a-b. C.(C.) canovense,(M.),BMNH.C80398, bed 6d,Oborne Wood,near Sherborne,Dorset ; 15a apertural view, x3.0 ; 15b side view, x3.0.

Fig. 16a-b. C.(C.) canovense ,(M.),BMNH.C80392, bed 6d,Oborne Wood,near Sherborne,Dorset ; 16a side view,x2.0; 16b apertural view, x2.0.

Fig. 17a-b. C.(C.) canovense,(M.), Yorkshire Museum,ex. Reed collection, 'Loders' , i.e. Loders Cross, near Bridport, Dorset, with a matrix of the 'Astarte bed' ; 17a ventral view, x1.5 ; 17b side view, x1.5.

PLATE 3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EXPLANATION FOR PLATE 4

Figure 1a-c. Chondroceras (Chondroceras) grandiforme S.Buckman, (M.),IGS.25286, Milborne Wick,Somerset ; 1a apertural view, x1.0 ; 1b side view, x1.0 ; 1c ventral view, x1.0.

Fig.2a-b. C.(C.) grandiforme ,(M.),MM.LL11160, the 'Sherborne district' ,Dorset, cited by J.Buckman (1881),not coated ; 2a apertural view, x1.0 ; 2b side view, x1.0.

Fig.3a-b. C.(C.) grandiforme ,(M.),BMNH.C80345, bed 4b,Oborne Wood,near Sherborne,Dorset ;3a side view,x1.0 ;3b apertural view , x1.0.

Fig.4a-b. C.(C.) polypleurum polypleurum (Westermann),(M.), SM.J24525, 'Oborne' , near Sherborne,Dorset ; 4a apertural view, x1.0 ; 4b side view, x1.0.

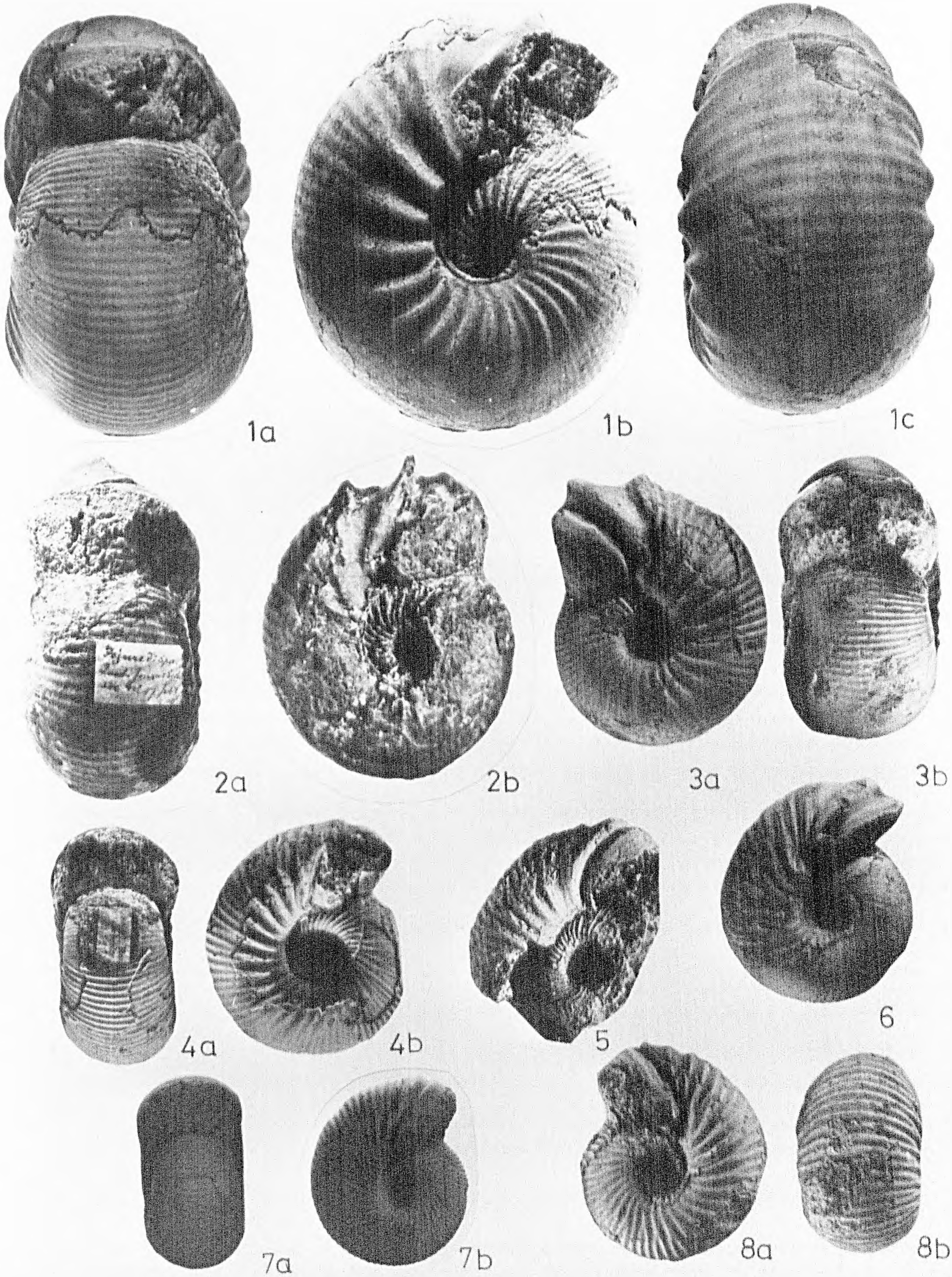
Fig. 5. C.(C.) polypleurum polypleurum ,(M.),BMNH.C80353, the 'Red Conglomerate' ,Bomford's exposure, Loders Cross, near Bridport,Dorset ; side view, x1.0.

Fig. 6. C.(C.) grandiforme (?M. or ?m.),BMNH.C80343 , bed 4a, Oborne Wood, near Sherborne,Dorset ; side view, x1.0.

Fig. 7a-b. C.(C.) polypleurum polypleurum (m.),BMNH.C80348, bed 4c, Oborne Wood, near Sherborne, Dorset ; 7a apertural view, x1.5 ; 7b side view, x1.5.

Fig. 8a-b. C.(C.) polypleurum crassicostatum (Westermann),(m.), BMNH.C80390, bed 4b,Oborne Wood, near Sherborne,Dorset ; 8a side view, x1.5 ; 8b ventral view, x1.5.

PLATE 4



EXPLANATION FOR PLATE 5

Figure 1a-b. Chondroceras (Chondroceras) polypleurum crassicostatum (Westermann),(m.), MM.LL42521 , Milborne Wick,Somerset; 1a side view, x1.5 ; 1b apertural view , x1.5.

Fig.2. C.(C.) polypleurum crassicostatum ,(m.),BMNH.C80378, the 'Irony bed' , Louse Hill quarry, near Sherborne,Dorset, not coated ; side view, x1.0.

Fig.3a-b. C.(C.) sp. nov.A . aff C.(C.) tenue (Westermann), (?M.),BMNH.C80351, bed 5b, Frogden quarry, near Sherborne, Dorset ; 3a side view, x2.0 ; 3b apertural view, x2.0.

Fig. 4a-c. C.(C.) obornensis sp.nov.,(M.),BMNH.C80313,holotype, bed 3, Oborne Wood,near Sherborne,Dorset ; 4a apertural view, x1.0 ; 4b side view, x1.0 ; 4c ventral view , x1.0.

Fig. 5. C.(C.) obornensis sp. nov.,(M.),BMNH.C80314 , 1st. paratype,bed 3,Oborne Wood, near Sherborne,Dorset ; side view , x1.4.

Fig.6 C.(C.) obornensis sp.nov.,(M.), BUGM.3325, Dundry Hill,near Bristol,Avon ; side view, x1.0.

Fig.7a-b. C.(C.) obornensis sp. nov.,(M.),SM.J24526, 4th. paratype, the 'Sherborne district' ,Dorset ; 7a side view, x1.0 ; 7b side view (opposite to 7a), showing the base of the mouth-border , x1.0.

Fig.8a-b. C.(C.) obornensis sp.nov.,(M.),BMNH.C80315, 3rd. paratype, bed 3, Oborne Wood, near Sherborne,Dorset ; 8a ventral view, x1.0 ; 8b side view, showing faint,relict tubercles, x1.0.

Fig.9. Frogdenites sp. (m.),BMNH.C75252, 'green grained marl' matrix, 'Sherborne district' , Dorset; side view, x1.0.

Fig. 10. Frogdenites spiniger S.Buckman ,(m.),BMNH.C80391, derived from bed 3 , at base of bed 4a,Oborne Wood,near Sherborne,Dorset ; side view, x1.5.

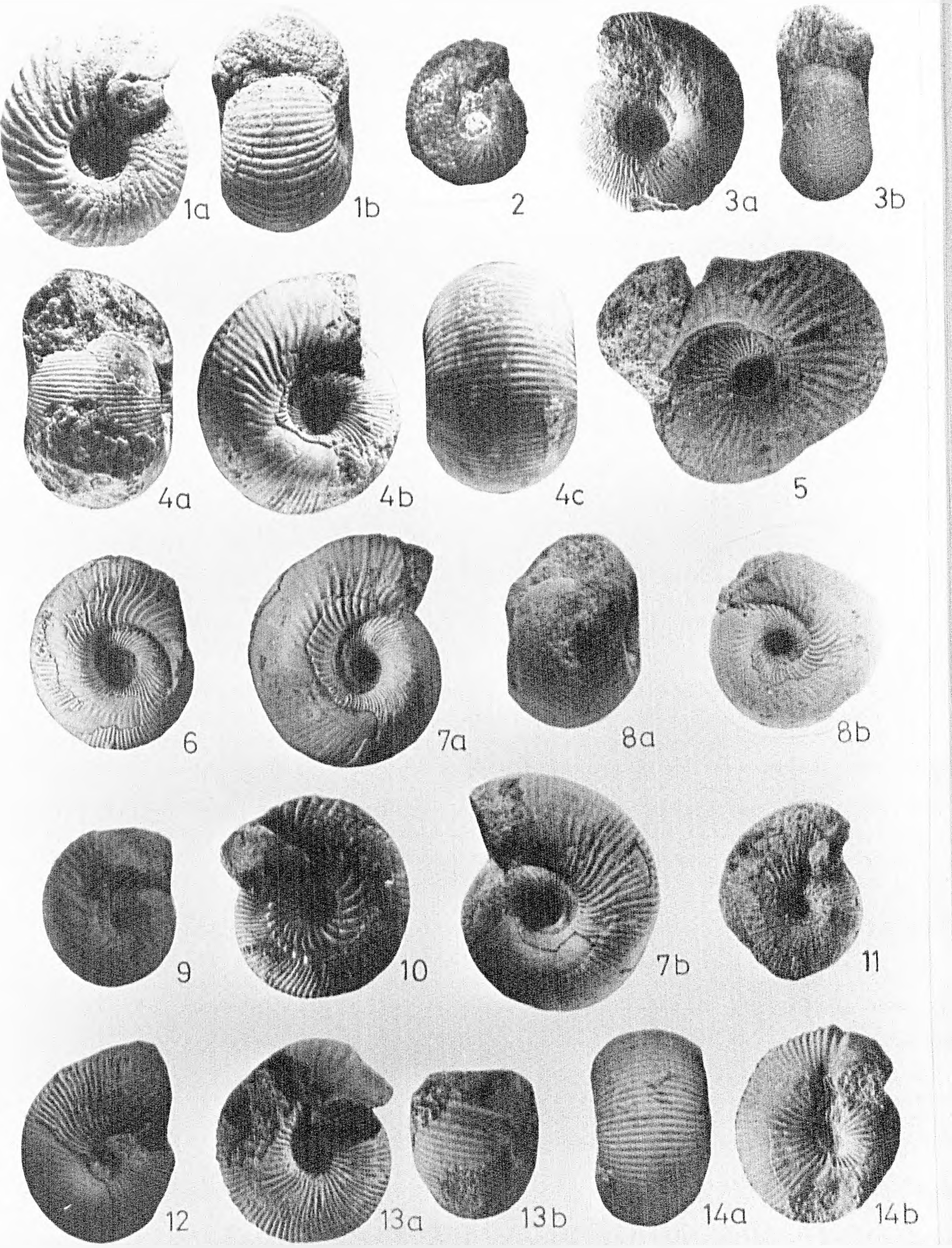
Fig. 11. C.(C.) obornensis sp.nov.,(m.), BMNH.C80316, bed 3, Oborne Wood, near Sherborne,Dorset ; side view, x1.5.

Fig. 12. Labyrinthoceras mensicum (Waagen),(m.), BUGM.3324/2, South Main-road quarry,Dundry Hill, near Bristol,Avon ; side view, x1.5.

Fig. 13a-b. L. meniscum (m.), BMNH.C78584 (ex.S.S.B. col.), Dundry Hill, near Bristol,Avon ; 13a side view, x1.5 ; 13b oblique view of lappet , x1.5.

Fig. 14a-b. L. meniscum (m.), BUGM.3324/1 ,Rackledown quarry , Dundry Hill,near Bristol, Avon ; 14a ventral view, x1.5 ; 14b side view, x1.5.

PLATE 5



EXPLANATION FOR PLATE 6

Figure 1a-b. Labyrinthoceras meniscum (Waagen),(M.),BMNH. 37268, topotype (ex.Tesson col.), St.Vigor,near Bayeux, Normandy,France ; 1a side view , x1.0 ; 1b apertural view,x1.0.

Fig. 2. L. meniscum ,(M.),BMNH.C80336 , 0.20 m. from the top of the 'fossil-bed' ,Sandford Lane quarry, near Sherborne, Dorset ; view of mouth-border , x1.0.

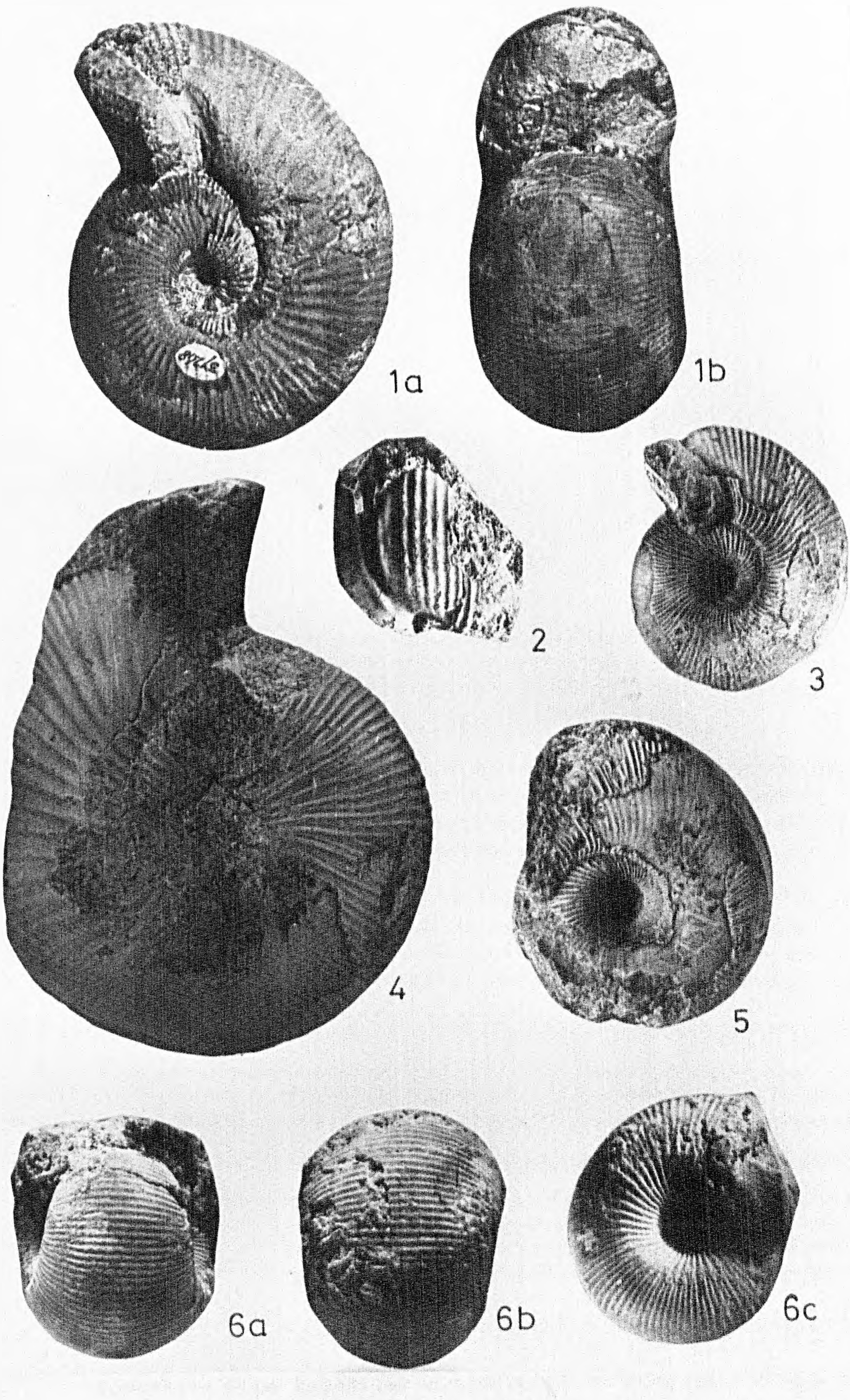
Fig. 3. L. meniscum,(M.), BMNH.C78581, (Ex.S.S.B.), 'Sherborne district' (matrix of Sandford Lane 'fossil-bed') ,Dorset ; side view , x1.0.

Fig. 4. L. meniscum ,(M.), BUGM.3289, South Main-road quarry, Dundry Hill, near Bristol,Avon ; side view , x1.0.

Fig.5. L. meniscum ,(M.), BMNH.C78580 , (ex.S.S.B.),Sandford Lane, near Sherborne,Dorset ; side view , x1.0.

Fig. 6a-c. L.meniscum ,(?M.), BMNH.C80335, top 0.20m. of the 'fossil-bed' , Sandford Lane quarry, near Sherborne, Dorset, septate inner whorls ; 6a apertural view, x1.5 ; 6b ventral view, x1.5 ; 6c side view , x1.5.

PLATE 6



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APPENDIX

Dimensions of additional Sphaeroceratid ammonites, not given in the main body of the text, but used in the construction of Wb/D and Wh/D graphs and histograms of maximum diameter.

Chondroceras evolvescens (Waagen) bed 4a/b, Oborne Wood.

max.D.	D.	Ud.	Pn.	Wh.	Wb.
CP2225					
4.55	4.34	1.37 (32)	23	1.86 (43)	2.45 (56)
	3.64	0.76 (21)	23	1.8 (49)	2.58 (71)
CP2226					
4.0	3.75	1.12 (30)	27	1.62 (43)	2.13 (57)
	3.14	0.75 (24)	26	1.54 (49)	2.2 (70)
2227					
4.17	3.9	1.04 (27)	29	1.75 (45)	2.31 (59)
	3.46	0.81 (23)	-	1.78 (51)	2.33 (67)
2228					
3.72	3.66	1.0 (27)	-	1.57 (43)	2.12 (58)
	3.25	0.72 (22)	-	1.61 (50)	2.1 (65)
2229					
4.0	3.76	0.95 (25)	29	1.54 (41)	2.2 (59)
	3.2	0.58 (18)	28	1.65 (52)	2.25 (70)
2230					
3.51	3.3	0.77 (23)	25	1.62 (49)	1.95 (59)
	2.81	0.44 (16)	24	1.55 (55)	2.02 (72)
2231					
3.8	3.7	0.97 (26)	21	1.61 (44)	2.22 (60)
	2.8	0.42 (15)	-	1.72 (61)	2.35 (84)
2232					
3.96	3.88	1.15 (30)	-	1.76 (45)	2.03 (52)
2233					
4.29	4.15	0.82 (20)	27	2.0 (48)	2.45 (59)
	3.45	0.6 (17)	-	1.85 (54)	2.56 (74)

max.D.	D.	Ud.	Pn.	Wh.	Wb.
2234					
3.38	3.32	0.95 (29)	-	1.57 (47)	1.94 (58)
2235					
4.05	3.81	1.17 (31)	21	1.64 (43)	2.2 (58)
2236					
3.84	3.5	0.98 (28)	26	1.48 (42)	1.86 (53)
	3.0	0.61 (20)	24	1.52 (51)	1.86 (62)
2237					
2.55	2.46	0.73 (30)	28	1.07 (44)	1.23 (50)
	2.3	0.54 (23)	27	1.07 (47)	1.22 (53)
2238					
4.18	4.1	-	-	1.85 (44)	2.3 (56)
	3.54			1.8 (54)	-
2239					
4.6	4.5	1.3 (29)	-	2.1 (47)	2.4 (53)
	3.87	1.0 (26)	—	1.85 (48)	2.56 (66)
2240					
4.05	4.02	1.14 (28)	24	1.84 (46)	2.04 (51)
	3.7	0.86 (23)	24	1.65 (45)	2.05 (55)
2241					
4.42	4.3	1.15 (27)	27	2.17 (51)	2.66 (62)
	3.76	0.7 (19)	27	2.07 (55)	2.7 (72)
2242					
4.34	4.31	1.14 (26)	25	1.8 (42)	2.17 (50)
	3.71	0.91 (25)	22	1.76 (47)	2.18 (59)
2243					
3.8	3.8	0.92 (24)	-	1.62 (43)	2.08 (55)
	2.7	0.64 (24)	-	1.7 (63)	2.34 (87)

max.D.	D.	Ud.	Pn.	Wh.	Wb.
<u>2244</u>					
4.0	3.23	0.84 (26)	24	1.68 (52)	2.15 (67)
<u>2245</u>					
3.74	3.36	0.94 (28)	26	1.5 (45)	2.06 (61)
	2.88	0.58 (20)	24	1.43 (50)	2.0 (69)
<u>2246</u>					
4.21	4.2	1.12 (27)	-	1.65 (39)	2.14 (51)
	3.26	0.66 (20)	-	1.8 (55)	2.32 (71)
<u>2247</u>					
3.6	3.4	0.9 (26)	c.25	1.5 (44)	2.36 (69)
	3.03	0.68 (22)	-	1.65 (55)	2.4 (79)
<u>2248</u>					
2.0	1.92	0.52 (27)	27	0.89 (46)	1.11 (58)
	1.73	0.43 (25)	-	0.9 (52)	1.17 (68)
<u>2249</u>					
2.13	2.0	0.64 (32)	29	0.84 (42)	1.08 (54)
	1.72	0.4 (23)	28	0.8 (47)	1.08 (63)
<u>2250</u>					
2.21	2.08	0.6 (29)	-	0.9 (43)	1.24 (60)
	1.82	0.43 (24)	32	0.86 (47)	1.21 (66)
<u>2251</u>					
1.95	1.8	0.46 (26)	27	0.85 (47)	1.20 (67)
	1.63	0.42 (26)	-	0.92 (56)	1.27 (78)
<u>2252</u>					
1.78					
<u>2253</u>					
1.76	1.68	0.4 (24)	29	0.76 (45)	1.0 (60)
	1.33	0.3 (23)	-	0.74 (56)	1.05 (65)

max.D.	D.	Ud.	Pn.	Wh.	Wb.
2254					
1.92	1.62	0.4 (25)	28	0.76 (47)	1.05 (65)
2255					
1.71	1.57	0.38 (24)	-	0.78 (50)	0.92 (59)
	1.44	0.33 (23)	-	0.73 (51)	0.96 (67)
2256					
1.65	1.51	0.43 (28)	27	0.74 (49)	1.01 (67)
	1.24	0.22 (18)	-	0.73 (59)	1.01 (81)
2257					
1.77	1.57	0.51 (32)	-	0.73 (47)	0.94 (60)
2258					
1.86	1.76	0.46 (26)	24	0.78 (44)	1.18 (67)
	1.54	0.35 (23)	-	0.8 (52)	1.16 (75)
2259					
1.96	1.87	0.52 (28)	27	0.77 (41)	1.0 (54)
	1.67	0.43 (26)	-	0.79 (47)	1.0 (60)
2260					
1.8	1.58	0.36 (23)	27	0.83 (53)	1.05 (66)
	1.45	0.28 (19)	-	0.78 (54)	1.04 (72)
2261					
1.71	1.61	0.36 (22)	-	1.81 (50)	1.0 (62)
	1.45	0.26 (18)	-	1.79 (55)	1.0 (69)
2726					
4.12	3.91	0.91 (23)	26	1.85 (47)	2.14 (55)
	3.42	0.76 (22)	25	1.63 (48)	2.2 (64)
2727					
1.7					

C. evolvescens Oborne Wood, bed 4a/b.

Average size of macroconchs = 4.01 cm.

" " " microconchs = 1.90

Ratio between dimorphs = 1:2.1

C. evolvescens from Rigg, Isle of Skye

CP2262

mD.	D.	Ud.	Pn.	Wh.	Wb.
3.7	3.2	0.57 (18)	21	1.61 (50)	1.96 (61)
	2.89	0.46 (16)	-	1.6 (55)	1.9 (66)

<u>Chondroceras</u> <u>evolvescens</u> (Waagen), <u>in</u> <u>situ</u>, Milborne Wick, bed 5.

mD.	D.	Ud.	Pn.	Wh.	Wb.
<u>CP2177</u>					
4.76	4.76	1.5 (32%)	26	1.93 (41)	2.28 (48)
	3.84	0.75 (20)	24	1.84 (48)	2.25 (59)
<u>2178</u>					
3.66	3.5	0.9 (26)	33	1.60 (46)	1.98 (57)
	2.82	0.32 (18)	31	1.5 (53)	1.8 (64)
<u>2179</u>					
4.64	4.51	1.18 (26)	24	1.86 (41)	2.33 (52)
	3.76	0.73 (19)	21	1.9 (51)	2.35 (63)
<u>2180</u>					
4.2	4.02	1.23 (31)	25	1.56 (39)	2.08 (52)
	3.26	0.74 (23)	22	1.61 (49)	2.16 (66)
<u>2181</u>					
4.7	4.7	1.3 (28)	23	1.87 (40)	2.28 (49)
	3.91	0.8 (21)	20	1.92 (49)	2.29 (59)
<u>2182</u>					
3.96	3.8	0.9 (24)	26	1.85 (49)	2.26 (60)
	3.25	0.6 (19)	25	1.7 (52)	2.3 (71)
<u>2183</u>					
4.08	4.0	1.08 (27)	22	1.68 (42)	2.23 (56)
	3.36	0.68 (20)	22	1.7 (51)	2.19 (65)
<u>2184</u>					
3.2	3.2	0.84 (26)	25	1.33 (42)	1.76 (56)
	2.5	0.4 (16)	25	1.2 (48)	1.68 (67)
<u>2185</u>					
2.87	2.75	0.81 (30)	29	1.2 (44)	1.62 (59)
	2.54	0.61 (24)	-	1.2 (47)	1.6 (63)

mD.	D.	Ud.	Pn.	Wh.	Wb.
2186					
	3.12	0.67 (21)	26	1.24 (40)	1.84 (59)
	2.49	0.45 (18)	24	1.33 (53)	1.86 (75)
2187					
3.3	3.2	0.68 (21)	30	1.56 (49)	1.95 (61)
2188					
3.18	3.03	0.8 (26)	25	1.2 (40)	1.61 (53)
	2.65	0.54 (20)	25	1.3 (49)	1.64 (62)
CP2189 (incomplete)					
	4.2				
2190 (incomplete)					
	2.8	0.63 (23)	30	1.45 (52)	1.9 (68)
	2.28	-	-	-	1.76 (77)
2191					
1.74	1.64	0.44 (27)	27	0.7 (43)	0.94 (57)
	1.43	0.3 (21)	-	0.71 (50)	0.94 (66)
2192					
2.05	1.85	0.48 (26)	25	0.76 (42)	1.09 (60)
	1.6	0.24 (15)	-	0.85 (53)	1.13 (71)
2193 (pathological)					
1.7	1.7	0.5 (29)	-	0.7 (41)	0.95 (56)
	1.38	0.22 (16)	-	0.75 (54)	1.05 (76)
2194					
1.8	1.8	0.5 (28)	30	0.8 (44)	1.0 (56)
	1.52	0.31 (20)	29	0.75 (49)	1.06 (70)
2195					
1.76	1.72	0.45 (26)	28	0.73 (42)	0.9 (52)
	1.44	0.28 (19)	-	0.74 (51)	1.04 (72)

mD.	D.	Ud.	Pn.	Wh.	Wb.
2196 (broken)					
	1.84	0.45 (24)	26	0.9 (49)	1.1 (60)
2197					
1.75	1.72	0.43 (25)	27	0.76 (44)	0.96 (56)
	1.45	0.3 (21)	25	0.71 (49)	0.98 (68)
2198					
1.93	1.73	0.5 (30)	27	0.83 (48)	1.14 (66)
	1.6	0.26 (16)	-	0.82 (51)	1.22 (76)
2199 (slightly incomplete)					
c.1.65	1.62	0.5 (31)	26	0.73 (45)	1.05 (65)
	1.31	0.26 (20)	-	0.71 (54)	1.08 (82)
2200					
2.57	2.43	0.87 (34)	-	0.96 (40)	1.21 (50)
2201					
1.7	1.5	0.38 (25)	29	0.72 (48)	1.06 (71)
	1.4	0.30 (21)	-	0.75 (54)	1.06 (76)
2202					
1.85	1.76	0.44 (25)	29	0.79 (45)	1.13 (62)
	1.52	0.3 (20)	-	0.82 (54)	1.12 (74)
2203					
1.9	1.9	0.54 (28)	26	0.85 (45)	1.03 (54)
	1.68	0.42 (25)	-	0.81 (48)	1.04 (62)
2204					
1.8	1.8	0.48 (27)	27	0.8 (44)	1.07 (59)
	1.44	0.23 (16)	-	0.8 (56)	1.1 (76)
2205					
1.67	1.67			-	0.97 (58)
	1.41			0.76 (54)	0.98 (70)

mD.	D.	Ud.	Pn.	Wh.	Wb.
<u>2206</u>					
1.65	1.65	0.52 (32)	29	0.68 (41)	0.94 (57)
	1.35	0.29 (22)	-	0.7 (52)	0.95 (70)
<u>2207</u>					
1.65	1.65	0.51 (31)	28	0.67 (41)	0.95 (58)
	1.38	0.33 (24)	-	0.7 (51)	0.98 (71)
<u>2208</u>					
1.93	1.93	-	-	-	1.13 (59)
<u>2209</u> (broken)					
1.5	1.23	-	-	-	0.95 (77)
	1.02	-	-	-	0.89 (87)
<u>2210</u>					
1.6	1.6	-	-	-	0.95 (59)
<u>2211</u>					
1.93	1.85	0.57 (31)	29	0.78 (42)	1.1 (60)
	1.58	0.33 (21)	-	0.78 (49)	1.13 (72)
<u>2212</u>					
1.62	1.62	0.45 (28)	29	0.7 (43)	0.92 (57)
	1.3	0.24 (19)	-	0.63 (49)	1.0 (77)
<u>2213</u>					
1.82	1.77	0.58 (33)	26	0.74 (42)	0.94 (53)
<u>2280</u> (broken)					
c.3.7		c.1.07	-	1.6	1.95
	3.3	0.83 (25)	-	1.5 (46)	2.03 (62)
<u>2281</u> (broken)					
c.2.3		c.0.84	-	0.95	1.14

mD.	D.	Ud.	Pn.	Wh.	Wb.
2282 (broken)					
c.1.74		0.58	-	0.7	1.03
	1.45	0.27 (19)	-	0.79 (55)	1.05 (72)
2283 (broken)					
1.7	1.7	-	-	-	1.05 (62)

Milborne Wick *C. evolvescens*

Average size of macroconchs = 3.90 cm.

" " " microconchs = 1.85

ratio between dimorphs = **1:2.1**

C. *evolvescens* from Milborne Wick.

Manchester Museum, *ex.* Earwaker col. LL4252

	D.	Ud.	Pn.	Wh.	Wb.
A	4.3	1.2 (28)	25	1.85 (43)	2.56 (60)
B	3.6	1.18 (33)	22	1.6 (44)	1.85 (51)
C	2.06	-	-	-	1.35 (66)
D	2.07	-	-	1.0 (48)	1.23 (62)
E	3.42	1.0 (29)	31	1.38 (40)	1.73 (51)
F	3.46	1.05 (30)	27	1.54 (45)	2.05 (59)
G	3.74	1.23 (33)	20	1.45 (39)	2.03 (54)
H	2.30	0.66 (29)	33	1.05 (46)	1.3 (57)
I	1.95	0.53 (27)	29	0.85 (44)	1.1 (56)
N	1.85	0.5 (27)	27	0.8 (43)	1.1 (59)
O	1.85	0.56 (30)	26	0.79 (43)	1.1 (59)
P (incomplete)	1.45	0.32 (22)	-	0.75 (52)	0.92 (63)

D.	Ud.	Pn.	Wh.	Wb.
Q				
1.65	0.45 (27)	28	0.7 (42)	1.0 (61)
R				
1.87	0.62 (33)	27	0.8 (43)	1.05 (56)
S				
1.28	0.6 (34)	31	0.8 (45)	1.04 (58)
T				
1.90	0.56 (29)	29	0.91 (48)	1.03 (54)
U				
1.95	0.55 (28)	28	0.86 (44)	1.0 (51)
V				
1.90	-	-	-	1.14 (60)
W				
1.9 dia.				
X				
2.00	0.55 (28)	29	0.80 (40)	1.02 (51)

Oxford University Museum, from Milborne Wick.

Collective number, J10847,

x3 specimens of C. gervillei 2.7, 2.6 & 2.5 dia.

x8 micro- C. evolvescens, 1.9, 1.7, 1.75, 1.9, 1.8, 1.5, 1.6, & 1.8

J10840 Dia. 4.0; 10842 3.8; 10839 3.8; 10838 3.15; 10846 2.2 (nearer to C. polypleurum); 10842 4.0; 10837 4.3; 10832 3.8; 10833 4.0; 10834 4.3; 10829 4.2; 10830 4.6; 10831 3.8; 10835 4.1; 10826 4.25; 10836 4.35; 10827 4.3; 10828 4.4; 10818 4.3; 10819 4.3; 10821 3.5; 10824 3.7; 10815 3.5; 10816 3.7; 10823 3.7; 10814 4.2; 10822 3.8; 10813 3.7; 10812 3.7; 10817 4.1; 10800 4.7; 10787 5.5 (C. delphinus)

Measurements taken from polished cross-sections, for the production of the diameter/whorl width graph.

Chondroceras evolvescens CP.2243, Oborne Wood, bed 4 (b).

Wh. Dia.	Wh. wid.
2.34	2.2 (94%)
1.83	1.63 (89)
1.39	1.20 (86)
1.04	0.87
0.77	0.62
0.57	0. ?
0.4	0.32
0.3	0.24
0.24	0.16
0.17	0.13
0.11	0.1
0.09	0.09
0.06	0.05 (Protoconch)

C. evolvescens CP.2246, Oborne Wood, bed 4b.

1.94	1.5 (77)
1.46	1.24 (85)
1.08	0.86 (80)
0.80	0.63
0.59	0.48
0.44	0.35
0.32	0.26
0.23	0.20
0.18	0.14

Wh. Dia.	Wh. wid.
0.14	0.10
0.09	0.08
0.04	0.05 (Protoconch)

C. evolvescens CP.2284 Oborne Wood, bed 4b.

1.17	0.89 (76)
0.85	0.64 (75)
0.62	0.5 (81)
0.45	0.35
0.33	0.35?

Chondroceras evolvescens CP.2286, Milborne Wick, bed 5.

3.14	2.85 (91)
2.53	2.17 (86)
1.97	1.63 (83)
1.5	1.22
1.12	0.9
0.85	0.67
0.64	0.50
0.43	0.36
0.34	0.28
0.27	0.21
0.18	0.16
0.15	0.11
0.12	0.10

C. evolvescens CP.2265, Milborne Wick, bed 5.

Wh. Dia.	Wh. wid.
1.32	1.05 (80)
0.95	0.8 (84)
0.69	0.55 (80)
0.51	0.4
0.37	0.29
0.28	0.21
0.2	0.16
0.14	0.11
0.11	0.09
0.08	0.07
0.05	0.04 (Protoconch)
0.04	0.04 (Protoconch)

C. evolvescens CP.2268, Milborne Wick, bed 5.

0.45	0.35 (78)
0.36	0.29 (81)

Chondroceras cf. canovense, Oborne Wood, top 0.15m., bed 6d.

CP2321 Macroconch, mth. bdr., max. D. = 1.65 cm.

D.	Ud.	Pn.	Wh.	Wb.
1.52	0.26 (17)	c.37	0.78 (51)	1.1 (72)
1.33	0.20 (15)	-	0.79 (59)	1.1 (83)
2323				
1.3	0.23 (18)	-		
2324 max. D. 1.4,				
1.38	0.33 (24)	-	0.72 (52)	0.97 (70)
1.12	-	-	0.67 (60)	0.93 (83)
2364, max. D. 1.24,				
1.17	0.25 (21)	-	0.54 (46)	0.82 (70)
1.0	0.16 (16)	-	0.57 (57)	0.81 (81)
2365 max. D. 1.16,				
1.10	0.23 (21)	-	0.63 (57)	0.73 (66)
0.94	0.13 (14)	-	0.51 (54)	0.70 (74)
2366 max. D. 1.08,				
1.0	0.2 (20)	-	0.47 (47)	0.71 (71)
0.84	0.14 (17)	-	0.5 (60)	0.70 (83)
2367, max. D. 0.64,				
0.61	0.14 (23)	-	0.35 (57)	0.44 (72)
0.52	0.10 (19)	-	0.31 (60)	0.42 (81)
2368 max. D. 1.24				
1.12				0.84 (75)
2369 max. D. 1.15,				
1.04	0.23 (22)	-	0.56 (54)	0.74 (71)
0.91	-	-	0.51 (56)	0.73 (80)

D.	Ud.	Pn.	Wh.	Wb.
2370	max. D. 1.14,			
2371	max. D. 1.3			
2373,	max. D. 1.14			
2374	max. D. 1.23			
1.17	0.23 (20)		0.57 (49)	0.76 (65)
2375	max. D. 1.25			
2376	max. D. 1.15			
2377	mD. 1.16			
2378	mD. 1.34			
2379	mD. 1.22			
2380	mD. 1.18			
2381	mD. 1.19			
2382	mD. c.1.25			
2383	mD. 1.21			
2384	mD. 1.21			
2385	mD. 1.2			
2386	mD. 1.24			
2387	mD. 1.14			
2388	mD. 1.14			
2389	mD. 1.1			
2390	mD. 1.21			
2391	mD. 1.1			
2392	mD. 1.16			
2393	mD. 1.28			
2394	mD. 1.23			
2395	mD. 1.15			
2396	mD. 1.04			

D.	Ud.	Pn.	Wh.	Wb.
2813	mD. 0.68			
2815	mD. c.1.1			
2816	mD. 1.2			
2817	mD. 1.15			
2818	mD. 1.05			
2819	mD. 0.71			
0.64	0.13 (20)		0.36 (56)	0.45 (70)
0.58	0.10 (17)		0.35 (60)	0.46 (79)
2820	mD. 0.72			
2821	mD. 0.62			
2822	mD. 0.72			
2823	mD. 0.66			
2824	mD. 0.63			
2825	mD. 0.7			
2826	mD. 0.67			
2827	mD. 0.73			
2828	mD. 0.73			
2829	mD. 1.2			
2830	mD. 0.6			
2831	mD. 0.63			

Chondroceras cf. canovense Oborne Wood, bed 6d.

Average size of macroconch = 1.2 cm.

" " " microconch = 0.67

Ratio between dimorphs = 1:1.8

Chondroceras grandiforme / C. delphinus group, British Museum, mainly from the 'Sherborne district'.

BMNH.C2768, Burton Bradstock, 'Red Conglomerate' matrix. Md. = 4.38

D.	Ud.	Pn.	Wh.	Wb.
4.14	-	-	-	2.35 (57%)
3.34	1.07 (32)	-	1.7 (51)	2.34 (70)
C3223, 'Sherborne' ex. S.S.B.				
6.25	1.35 (22)	28	2.84 (45)	3.63 (58)
4.96	0.88 (18)	28	2.64 (53)	3.51 (71)
C80286, 'Sherborne' ex. S.S.B. Md. = 5.87				
5.29	1.14 (22)	-	2.50 (47)	3.03 (57)
4.63	-	-	2.39 (52)	3.01 (65)
C80289, 'Sherborne' ex. S.S.B. Md. = 4.04				
3.7	1.0 (27)	-	1.74 (47)	2.37 (64)
3.15	0.74 (24)	-	1.57 (50)	-
C80288, 'Sherborne' ex. S.S.B. Md. = 4.08				
3.83	1.04 (27)	27	1.78 (47)	2.44 (64)
3.21	-	-	1.73 (54)	2.34 (73)
C80287, 'Sherborne' ex. S.S.B. Md. = 4.2				
3.9	1.0 (26)	-	1.83 (47)	2.45 (63)
3.36	0.82 (24)	-	1.67 (50)	2.36 (70)
C80297, 'Sherborne' ex. S.S.B. Md. = 5.0				
4.46	1.04 (23)	28	2.16 (48)	2.68 (60)
3.63	0.78 (21)	-	1.82 (50)	2.53 (70)
C80296, 'Sherborne' ex. S.S.B. Md. = 5.0				
4.78	1.2 (25)	30	2.14 (45)	2.92 (61)
4.04	0.87 (22)	-	2.05 (51)	2.68 (66)

D.	Ud.	Pn.	Wh.	Wb.
C80292, 'Sherborne' ex. S.S.B. Md. = 3.94				
3.5	0.82 (23)	-	1.74 (50)	2.4 (69)
3.04	0.65 (21)	-	1.47 (48)	2.24 (74)
C80293, 'Sherborne' ex. S.S.B. Md. = 4.42				
4.06	0.82 (20)	-	2.0 (49)	2.31 (57)
3.4	0.62 (18)	-	1.82 (54)	2.32 (68)
C80294, 'Sherborne' ex. S.S.B. Md. = 3.52				
3.14	0.76 (24)	-	1.57 (50)	1.93 (62)
2.76	0.56 (20)	-	1.44 (52)	1.9 (69)
C80295, 'Sherborne' ex. S.S.B. Md. = 4.25				
3.74	1.0 (27)	-	1.72 (46)	-
3.36	0.78 (23)	-	1.68 (50)	-
C80298, 'Sherborne' ex. S.S.B. Md. = 5.54				
4.95	1.31 (27)	31	2.26 (46)	3.27 (66)
4.26	0.84 (20)	31	2.13 (50)	3.22 (76)
C80290, 'Oborne' ex. S.S.B. Md. = 5.0				
4.8	1.05 (22)	29	2.25 (47)	2.85 (59)
4.11	0.83 (20)	30	2.03 (49)	2.68 (65)
C80291, 'Sherborne' ex. S.S.B. Md. = 4.0				
3.44	0.79 (23)	35	1.72 (50)	2.85 (59)
3.0	0.64 (21)	-	1.42 (47)	2.1 (70)
37264, Bayeux, Normandy, ex. Tesson, Md. = 4.32				
4.0	1.0 (25)	-	1.95 (49)	2.44 (61)
3.4	0.65 (19)	-	1.77 (52)	2.35 (69)

Labyrinthoceras meniscum

Microconch specimens:

BUGM.3324/2, South Main-road quarry, Dundry, 'Brown iron-shot' matrix, ex. Underhill collection. With the base of lappets and three-quarters of a whorl of body-chamber.

D.	Ud.	Pn.	Wh.	Wb.
2.41	0.6 (25%)	31	1.2 (50)	1.4 (58)
2.0	0.28 (14)	27-8	1.08 (54)	1.37 (69)

BMNH.C78584, (ex. S.S.B. coll.), Dundry with 'Brown iron-shot' matrix, complete with excellent lappets.

2.46	0.61 (25)	35	1.13 (46)	1.39 (57)
2.07	0.30 (15)	-	1.07 (52)	1.45 (70)

BMNH.C80338, (ex CP.2402), -6cm. below top of 'Brown iron-shot', South Main-road quarry.

1.84	0.48 (26)	28	0.91 (49)	1.23 (67)
1.75	0.45 (26)	-	0.82 (47)	1.15 (66)

Macroconch specimens:

BMNH.37269, Topotype, Couche Verte matrix, Bayeux, Normandy (ex. Tesson coll.), fraction under one whorl of body-chamber, with base of mouth-border.

3.3	1.0 (30)	-	1.37 (42)	1.63 (49)
2.61	0.54 (21)	-	1.22 (47)	1.56 (60)

BMNH.74307, (ex. Trenchman coll.) Couche Verte, Bayeux. mD = 5.1.

BMNH.C75263 (ex. Etheridge coll.), 'Yeovil', with light grey matrix, with cream ooliths. 7/8ths. whorl of body-chamber and base of mouth-border.

8.9	2.85 (32)	47	3.95 (44)	5.4 (61)
6.6	1.32 (20)	49	3.5 (53)	5.2 (79)

BMNH.C3282, Clatcombe, with iron-shot matrix. One whorl of body-chamber, and start of mouth-border.

D.	Ud.	Pn.	Wh.	Wb.
5.4	1.7 (31)	51	2.23 (41)	3.1 (57)
-	0.84	-	1.93	2.9

BMNH.C80299, (ex. S.S.B.), Chideock, crinoidal, upper 'Red beds' matrix. mD = 6.0, three-quarters of a whorl of body-chamber, and start of mouth-border.

5.26	1.37 (26)	44	2.46 (47)	-
4.7	0.99 (21)	-	2.32 (49)	-

BMNH.C80301, (ex. S.S.B.2968), 'Sherborne district', half whorl of body-chamber.

9.0	2.25 (25)	c.51	-	-
7.05	0.96 (14)	-	4.02 (57)	6.14 (87)

BMNH.C80303 (ex. S.S.B.2969), 'Clatcombe', mD = 7.9, with start of body-chamber.

7.43	1.5 (20)	-	4.1 (55)	-
6.33	1.18 (19)	-	3.5 (55)	c.6.5 (102)

BMNH.C80304, (ex. S.S.B.1248), 'Sherborne district', totally septate.

6.94	1.2 (17)	-	3.8 (55)	6.25 (90)
5.56	0.87 (16)	-	3.07 (55)	5.34 (96)

BMNH.C80335, (ex. CP.1323), Sandford Lane, -8" from top of 'fossil-bed', totally septate.

2.57	0.48 (19)	c.40	1.42 (55)	2.15 (84)
2.26	0.45 (20)	-	1.21 (54)	1.92 (85)

BMNH.C78580 (ex. S.S.B.), Sandford Lane, matrix of top 'fossil-bed', almost complete, with one whorl of body-chamber, mD = c.5.0.

4.85	1.47 (30)	c.76		-
4.5	1.05 (23)	c.63	2.08 (46)	
3.96	0.94 (24)	-	1.93 (50)	2.5 (63)

IGS.3649, ?Clatcombe, one whorl of body-chamber.

D.	Ud.	Pn.	Wh.	Wb.
5.0	1.55 (31)	-	-	-

BCM.Cb4969, Dundry, possible microconch, D = 2.76.

4. A STANDARD ZONAL SCHEME FOR THE BAJOCIAN STAGE

The following paper essentially gives a summary of the stratigraphic sections of the earlier part of the thesis. It adds a few details to the above accounts, as well as giving some discussion of points, which have been raised relating to sections 1A-B herein.

A STANDARD ZONAL SCHEME FOR THE BAJOCIAN STAGE

Abstract: The lower boundary of the Bajocian Stage is is discussed, and the Aalenian accepted as a separate Stage. The Zones and Subzones of the Bajocian are briefly defined, and their general synonymies given. The status of certain index species is discussed and type sections for the *garantiana* and *subfurcatum* Zones and the *romani* and *banksi* Subzones designated. The difficulties in applying this zonal scheme in the circum-Pacific area are briefly discussed and some indications of the stratigraphic importance of several rare, european Stephanoceratid species for World correlation given.

The diverse and abundant ammonites of the Bajocian Stage (Middle Jurassic), which hold a critical position in the phylogeny and development of the Mesozoic faunas (Arkell, 1957, fig.150; Teichert, 1967, fig.20), have over the past hundred and fifty years attracted the attention of numerous workers. Perhaps the most significant of these contributors was S.S. Buckman, who between 1893-1910 laid the foundations of modern biostratigraphic methods, with his detailed study of the Inferior Oolite Group of Southern England. Following on from Buckman's (1909-30) subsequent introduction of an increasingly large number of inadequately defined hemerae (theoretical stratigraphic units approx. = 'chronozone' sensu Hedberg 1976, p.67), there came a reaction against his highly subdivided polyhemeral schemes, and a return to Oppel's (1856-8) more broadly based zones (cf. Spath, 1936; Arkell, 1956). After well over half a century of neglect, there has recently been a revival of interest in the biostratigraphic problems presented by the English Bajocian rocks (Parsons, 1974, 1976a-b, 1977a & 1979), which has in part been encouraged by the need to provide a standard zonal scheme for the forthcoming Geological Society of London's Jurassic correlation charts (Cope et al., 1980). The following attempts to summarise both this, and other work, in order to establish the current 'state of play' in Bajocian stratigraphy. The zonal scheme for north-west Europe (see Table 1), provides the standard of reference for the rest of the world, and some of the difficulties in its application are discussed, particularly relating to the endemism prevalent in many faunas. In connection with the latter, several wide ranging taxa within the Stephanoceratacea, which supply significant evidence towards a correlation between the North-west European, Tethyean and Pacific provinces, will be briefly discussed.

	ZONE	SUBZONE
UPPER BAJOCIAN	Parkinsonia parkinsoni	P. bomfordi
		Strigoceras truellei
	Strenoceras (Garantiana) garantiana	P.acris
		S.(G.) tetragona
		S.(G.) subgaranti
		S.(Pseudogarantiana) dichotoma
	S.(Strenoceras) subfurcatum	S.(G.) baculata
		Caumontisphinctes (C.) polygyralis
		Teloceras banksi
LOWER BAJOCIAN	Stephanoceras (S.) humphriesianum	T.blagdeni
		S.(S.) humphriesianum
		Dorsetensia romani
	Emileia (Otoites) sauzei	
	Witchellia (W.) laeviuscula	W.(W.) laeviuscula
		Sonninia ovalis
	Hyperlioceras (H.) discites	

Table 1.

Zones and subzones of the Bajocian Stage (excl. Aalenian).

I. STATUS AND VERTICAL LIMITS OF THE BAJOCIAN STAGE

(a) The status of the Aalenian and Bajocian Stages

The Bajocian is one of the original members of d'Orbigny's scheme of stages (d'Orbigny, 1850 & 1842-51). Arkell (1956, pp.7-8), was inclined towards accepting this basic, un-augmented scheme as the basis for world correlation, and rejected virtually all subsequently erected stages, including the Aalenian (Mayer-Eymar, 1864). Since the last war there has been a polarization of opinion between those Jurassic workers (mainly British), who have followed Arkell in rejecting the Aalenian, and those who have accepted its use. This latter viewpoint has been accepted by majority decisions at two successive International Jurassic Colloquia (Luxembourg, 1962, 1967). However, the British have at least 'officially' continued to hold their minority viewpoint, (George et al., 1969, p.161; Ager, 1964; Morton (Editor), 1974).

It is unfortunate that d'Orbigny probably could not have chosen a more unsuitable type area for his stage, than the Bayeux district of Normandy. Most of the Upper Bajocian in this area is represented by thick limestones, with relatively few ammonites; 'Le Calcaire à Spongiaires'; whilst much of the rest of the sequence is represented by very thin (c.50cm.), highly condensed, 'iron-shot' limestones, containing numerous disconformities. The best existing exposure is at Les Hachettes, on the coast between Port-en-Bessin and Saint Honorine-des-Pertes (see Appendix). If, following d'Orbigny's cataclysmic viewpoint, the base of the Bajocian is taken at the most pronounced faunal and lithological break, then the base of the 'Conglomérat de Bayeux' is an obvious choice. This would define the start of the Bajocian below the base of the humphriesianum Zone (cf. Rioult, 1964, p.250). This is a solution, which has been seriously suggested (op. cit.), but has not gained general acceptance! In reality the so-called 'stratotype' of the Bajocian at Bayeux, has such a condensed and incomplete succession, that the base of the Bajocian and its overall vertical limits, must be interpreted in terms of more complete successions preserved elsewhere. It is this problem of interpretation, which has been the starting point for disagreement.

The various different national interpretations of this stage, have obviously been strongly influenced by the local development of the Bajocian rocks. The British, if only sub-consciously, have been influenced by the relatively thin development of the Bajocian in the Inferior Oolite of southern England. Here it is possible to go in one quarry, such as Horn Park, near Beaminster, Dorset, and within 2.0m. collect ammonites representing most of the Aalenian/Bajocian zones. The highly condensed nature of these beds masks many important changes in the ammonite faunas, which are more evident in thicker, expanded sequences. Whilst there has long been an implicit understanding of the condensed nature of much of the Inferior Oolite, its exact extent has not been appreciated. This has been evident from an early date, when many eminent palaeontologists criticised S. Buckman's work, since they did not understand how a relatively thin deposit, such as the Inferior Oolite, could either yield so many new species and genera of ammonites, or be so finely divided into numerous stratigraphic horizons (Blake in Buckman, 1893, p.522; Sollas & Walford in Buckman, 1910, p.109). Essentially then, southern England is not one of the best places for discussing the relative merits of even fairly broad stratigraphic divisions, although historical accident has made it one of the key places for the study of this period.

Since the present concept of Jurassic stages originates from Arkell's interpretation of d'Orbigny's work, his following comments are probably relevant ..... "a stage can be followed all over the world by a series of overlapping correlations and by the general grade of evolution of its critical fauna" ...... (Arkell, 1956, p.7). The latter factor is important, since on this basis Arkell's interpretation of the Bajocian is too broad, as it disguises and hides one of the most important changes in evolutionary grade to be found in Jurassic ammonites. The ammonite faunas of Arkell's 'Lower Bajocian' (Aalenian) are very similar to those of the preceding Toarcian; in particular the Graphoceratidae are very closely related to the other Toarcian members of the Hildoceratacea. The 'Lower Bajocian' (Aalenian), in terms of its ammonite faunas, thus bears a closer relationship to the Toarcian, than to the rest of the Bajocian. With the extinction of the Graphoceratidae at the discites/laeviuscula zonal boundary, the Stephanoceratacea make their appearance as the dominant ammonite group, a position they and their offshoots the Perisphinctacea, hold for most of the rest of the Jurassic. Thus the replacement of the Graphoceratidae by the Sonninidae, and the appearance of the Stephanoceratacea and Haploceratacea, together make up one of the most important ammonite faunal renewals in the Mesozoic. If a precision in world correlation, based on the evolutionary grade of its constituent faunas is a pre-requisite for the definition of a stage, then logic demands that the Bajocian be restricted by the acceptance of a separate Aalenian stage. This requires no new redefinitions or changes, merely an acceptance of what is already standard European practice; thus the Aalenian is here accepted as an independent stage.

(b) The vertical limits of the Bajocian Stage

The upper boundary of the Bajocian Stage is defined by the lower limits of the stage above (the Bathonian) which is drawn at the base of the convergens Subzone of the zigzag Zone (Sturani, 1967, p.10; Torrens, 1974, p.583). Thus the 'Planisphinctes fauna' (Sturani, 1967, p.9; Pavia, 1973, p.89) is included in the top of the Bajocian bomfordi subzones.

The base of the Bajocian is less well defined. Successive Jurassic colloquia (Luxembourg, 1962, 1967;: see Ager, 1963; Maubeuge, 1964, etc.), have drawn this boundary at the junction of the discites Subzone/Zone and concavum Zone. This horizon has yet to be objectively defined. The first appearance of the Sonninid ammonites has been suggested as a lower limit by Contini (1970), who for this reason included the 'formosum subzone/horizon' in the base of the discites subzone. However, if this criteria were to be accepted, then all of the concavum Zone, and the top of the murchisonae Zone, where the early Sonninids intergrade with spinose Hammatoceratids, would have to be included in the base of the Bajocian. Despite this problem, a similar definition of the base of the Bajocian has been implicitly accepted by many authors (e.g. Westermann & Riccardi, 1979, Table 2). Since such a solution is untenable, a more 'conventional' definition of the Bajocian is needed. The first appearance of Hyperlioceras s. lat. cannot be accepted, as this genus certainly appears well down in the concavum Zone (Senior, Parsons & Torrens, 1970, p.119). Thus the base is probably best defined by the first appearance of the truly 'deltoidal' Hyperlioceras of the H. subsectum (Buckman) group (see below). This definition, which is the closest to that suggested by the Jurassic Colloquia, is that accepted here.

II. STANDARD ZONES OF THE BAJOCIAN

(a) discites Zone Buckman 1893

Index species. Hyperlioceras (H.) discites (Waagen, 1867, pl.28, fig.2), lectotype refigured by Buckman (1887-1907, sup. fig.88). The latter specimen appears to be lost and a new type needs to be selected. An obvious candidate is the type specimen of the invalid species H. (H.) desori (Moesch 1867, non Pictet), refigured by Bayer (1969, pl.1, fig.2), which is an original member of Waagen's type series. This specimen, which does not seem to be conspecific with the others assigned to this species by Bayer (1969, pl.1, fig.1; text fig.9a), is very close to both Bayer's (op. cit., pl.2, figs.2-3) specimens of H. (H.) discites and the H. (H.) deflexum Buckman - H. (H.) subsectum (Buckman) group. These are probably all members of a single, relatively variable 'bio-species'. However, any designation of a new lectotype must await a full taxonomic revision of the group.

Nomenclature The discites hemera (Buckman, 1893), or zone (Buckman, 1913 in 1909-30), was introduced by Buckman for an horizon previously included by him in the top half of the concavum beds (Buckman, 1888 in 1887-1907) or zone (Buckman, 1892 in 1887-1907, pl.46). This unit must be largely synonymous with much of the now rejected (Parsons, 1974) '*sowerbyi* zone' as originally defined (Oppel, 1862, in 1862-3), since most of the specimens of '*Ammonites sowerbyi*' cited as evidence for the zone (e.g. Waagen, 1867, pp.590-1) are misidentified specimens of *S.* (*Euhoploceras*) allied to *S.* (*E.*) *adicra* (Waagen): a characteristic *discites* zone species. Other synonyms include: 'Zone de *Hyperlioceras walkeri*' (Brasil, 1895a, p.1), 'Discites schichten' (Mascke, 1907, p.9), *Docidoceras*, *Trilobiticeras*, *rudidiscites*, *Depaoceras*, *Reynesella* and *Platygraphoceras* hemerae (Buckman, 1909-30; see Parsons, 1974, tab.1) and *discites* subzone (Spath, 1936, p.16).

Stratigraphy Since most of the ammonite taxa found in *discites* Zone rocks have extended ranges, either down into the *concavum* Zone, or up into the *laeviuscula* Zone, it must be considered as an 'assemblage biozone' (Holland *et al.* 1978, p.13). The dominant elements of this fauna are various species of *Hyperlioceras* and large costate *S.* (*Euhoploceras*) of the *S.* (*E.*) *marginata* - *acanthodes* Buckman group, associated with less common *Darellia*, *Reynesella*, *Docidoceras* and *Trilobiticeras* (Parsons, 1974, pp.170, 176). Although diverse and abundant ammonite faunas are known from the type area of the zone, at Bradford Abbas (*loc. cit.* & see Appendix), very little is known of the precise, relative distributions of its various faunal elements. It is thus difficult to establish an objective definition of its lower limits,based on a first appearance. There is strong evidence supporting the evolution of *Hyperlioceras* from *Graphoceras s. lat.*, with the development of a more deltoidal whorl cross-section (cf. Bayer, 1969, fig.6). The *H.* '*desori*' -

deflexum - *subsectum* - *staeschei* - *discites* group, with their deltoidal shell form, are all very similar, but for minor differences in the degree of over-hang of the umbilical edge and flattening of the whorl flanks. They are probably all members of a single relatively variable biospecies, the first appearance of which could probably provide a good basis for the definition of the base of the *discites* Zone. A thicker, more 'expanded' sequence than those found at Bradford Abbas is needed to establish this boundary and just such a situation is found in the Corton Denham beds (Parsons, 1980a), further east at Milborne Wick (Richardson, 1916, p.517) and Corton Down (*op. cit.*, p.512). Further, more detailed work in this area may well provide a suitable type section for the zone.

(b) *laeviuscula* Zone Haug 1894

Index species *Witchellia* (*W.*) *laeviuscula* (J. de C. Sow. 1824, in J. & J. de C. Sowerby, 1812-46, pl.451, fig.1), lectotype refigured by Buckman (1908, pl.6, fig.1) and more recently by Westermann (1969, text - fig.35). I cannot accept the very broad interpretation of this species, suggested by the latter author (*op. cit.*, pp.112-3). There are at least four separate, successive *Witchellia* faunas of different stratigraphic ages (Parsons, 1974). Further work is thus needed before it will be possible to ascertain their range of intraspecific variation, and thus establish a reliable synonymy for the various *Witchellia* species.

Nomenclature Haug (1894) introduced the *laeviuscula* Zone as a replacement for the *sowerbyi* Zone (Oppel, 1862 in 1862-3), following on from Buckman's (1889 in 1887-1907, p.63) recognition of the confusion and ambiguity surrounding the identification of "*Ammonites sowerbyi*".

Although Buckman (1904, p.52), positively confirmed the sauzei Zone as the type horizon for Sonninia sowerbyi, subsequent authors returned to its use as a zonal index (Spath, 1936; Arkell, 1956), and it is only recently that Buckman's views have been vindicated, and its use abandoned (Parsons, 1974, pp.160-1). Synonyms include : the sowerbyi zone (sensu Buckman 1887-1907, p.63; 1891). Witchellia hemera (Buckman, 1893), "assise à Witchellia sp." (Munier-Chalmas, 1893), "couches à Witchellia" (Brasil, 1895b) and the Sowerbyi Schichten (Mascke, 1907).

Stratigraphy The vertical range of the laeviuscula Zone, as recently revised (Parsons, 1974), is largely defined by the distribution of Witchellia s. lat., although this genus does range up into the sauzei Zone. This Zone is also characterised by the greatest abundance of the large Sonninids; S. (Fissilobisceras) at the base, and Shirbuirnia towards the top; whilst the base is also defined by the first appearance of Emileia/Otoites. Southern England (Dundry, Parsons, 1979; Sherborne area, Parsons, 1974) has produced the most diverse and abundant european laeviuscula Zone ammonite faunas. Correlation elsewhere is often only with more depleted faunas, dominated by the large Sonninids (e.g. S. Germany, Parsons, 1974). Although no type section has been designated, the Basse Alpes of S.E. France has been suggested as a possible future candidate (Parsons, 1974, p.162).

(b) i. ovalis Subzone Oechsle 1958

Index species Sonninia (Fissilobisceras) ovalis Buckman, lectotype (Quenstedt, 1886-7, pl.62, fig.1) selected by Oechsle (1958, p.94). This species is based on an invalid Quenstedt (1886-7) trinomen :

'<u>Ammonites</u> <u>sowerbyi</u> <u>ovalis</u>': and following Hölder's (1958) suggestions it must take its authorship from the first person to employ it as a valid binomen, which in this case is Buckman (1892 in 1887-1907, p.315).

<u>Nomenclature</u> Although the origins of this unit go back to Buckman's use of the '<u>fissilobatum</u>/<u>ovalis</u> horizon' (Buckman & Wilson, 1896) or <u>ovalis</u> hemera (Buckman, 1909-30), it was not until relatively recently that it was formally recognised as a subzone (Oechsle, 1958; Gabilly <u>et al</u>., 1971). Inspite of the apparent similarity in stratigraphic position of the <u>trigonalis</u> subzone (Spath, 1936), the two are not synonyms. The exact stratigraphic position of the <u>Shirbuirnia</u> fauna characteristic of the latter was confused in Buckman's (1910) later work, since it occupies a higher situation, being largely synonymous with the <u>laeviuscula</u> subzone (Parsons, 1974, p.171). Synonyms include : the <u>sowerbyi</u> zone (<u>sensu</u> Zurcher & Douvillé, 1885; Maubeuge & Lieb, 1951), <u>Sonniniae</u> or <u>fissilobata</u> hemerae (Buckman, 1895, pp.420-2), Sonninia zone (Mascke, 1907), ?"zone à <u>Sonninia</u> <u>nuda</u>" (Bigot, 1914), <u>hebes</u>, <u>ovalis</u> and <u>Bradfordia</u> hemerae (Buckman, 1909-30), Sowerbyi subzone (Kumm, 1952) and Jugifera and Ovalis horizons (Gabilly et al.,1971).

<u>Stratigraphy</u> This horizon is characterised by the first appearance of the <u>Witchellia</u>/<u>Pelekodites</u> and <u>Emileia</u>/<u>Otoites</u> dimorphic groups, by the abundance of the <u>Trilobiticeras</u>/<u>Emileites</u> group, and by the occurrence of certain species of <u>S</u>. (<u>Fissilobisceras</u>): <u>S</u>. (<u>F</u>.) <u>fissilobata</u> (Waagen), <u>S</u>. (<u>F</u>.) <u>ovalis</u> and <u>S</u>. (<u>F</u>.) <u>rudis</u> (Qu. emend. Dorn). This fauna, which is particularly abundant on Dundry Hill (Parsons, 1979), was originally recognised by Buckman (1895, p.421) as the '<u>fissilobata</u>/<u>ovalis</u> horizon', but was later confused with that from the lower half of the Sandford Lane 'fossil-bed'

of the Sherborne district, where Shirbuirnia are abundant (Parsons, 1974). The fauna from its type horizon in the Schwabian Albe (the 'Unterer Wedelsandstein') is dominated by the large Sonninids, and the smaller ammonite species characteristic of the more 'condensed' British deposits are very rare or absent (Parsons, 1974, p.173). A similar picture holds true in the Lincolnshire Limestone of eastern England, where numerous specimens of S. (Fissilobisceras) have recently come to light (Ashton & Parsons, 1980), but again Witchellia and Trilobiticeras are noticeably absent. This suggests that there may be a palaeogeographic and/or facies control of the distributions of the various faunal elements at this horizon. This factor would have to be taken into account in any future choice of type locality for this subzone. A possible candidate for the latter would be an exposure in the ovalis bed on Dundry Hill, Bristol (such as at Barns Batch Spinney; Parsons, 1979, p.144, bed 8), where an abundant ovalis Subzone is found in conformable contact with the discites Zone.

(b) ii. laeviuscula Subzone Haug 1894, restricted Parsons, 1974

Index species Witchellia (W.) laeviuscula

Nomenclature The laeviuscula and trigonalis subzones (Spath, 1936), were based on Buckman's (1910) use of Witchellia and Shirbuirniae hemerae. Since it has proved impossible to separate the faunal elements of these two units in their type horizon : the lower half of the Sandford Lane 'fossil-bed' (Parsons, 1974, p.164) : only the senior of the two, the laeviuscula Subzone has been retained (op. cit., p.171). Synonyms include : the Witchellia hemera (sensu Buckman, 1895), Shirbuirniae hemera (Buckman, 1910), ruber, brocchii and mollis hemerae (Buckman, 1909-30; see Parsons, 1974, tab.1), _Witchellia_ and _Shirbuirnia_ zones (Arkell, 1933), _pinguis_ zone (Dorn, 1935), _laeviuscula_ and _trigonalis_ subzones (Spath, 1936), _laeviuscula_ zone (Maubeuge & Lieb, 1951), ?_pars_ Grandis zone (Kumm, 1952), _Witchellia laeviuscula_ - _Emileia polyschides_ subzone (Westermann, 1967) and the Adicra and Laeviuscula horizons (Gabilly _et al._, 1971).

Stratigraphy Our present knowledge of the stratigraphic distribution of the _laeviuscula_ subzone ammonite faunas rests largely on a series of isolated exposures in the Sherborne area of north Dorset (Parsons, 1974, pp.166-8, fig.2). The range of the subzone largely coincides with that of _Shirbuirnia_, particularly _S. stephani_ (Buckman), and the _Witchellia_ (_W._) _rubra_ - _W._ (_W._) _laeviuscula_ group, whilst its base is defined by the first appearance of the _Emileia_ (_E._) _contrahens_ Buckman group and '_Mollistephanus_' _mollis_ Buckman. There is some evidence to suggest that two distinct stratigraphic horizons may be represented in the present Subzone (Parsons, 1974, pp.167-8) : an upper part with _Shirbuirnia superba_ Buckman - _S. platymorpha_ Buckman and _Frogdenites spiniger_ Buckman and _F. profectus_ Buckman (= bed 3, Parsons, 1976b, p.132, see Appendix), and a lower part with _Shirbuirnia trigonalis_ Buckman, _S. fastigata_ (Buckman), _Emileia_ (_E._) _crater_ Buckman, _M. mollis_ and _S._ (_Euhoploceras_) _acanthera_ (Buckman) (Sandford Lane, bed 6b, Parsons, 1974, p.168, =? _S. adicra_ horizon, Gabilly _et al._, 1971). Unfortunately these faunas have come from isolated sections, and only the South Main-road quarry, Dundry (Parsons, 1979, pp.138-42), provides a continuous section through these beds (Parsons, 1974, fig.4). Even in the case of the latter section, the lower horizon is poorly fossiliferous. Further evidence from more widely dispersed sites is needed before any formal designation of these possibly separate horizons can be made, since the above faunal differences may only reflect variations in ammonite biofacies, rather than a different stratigraphic age. Although the southern England localities have yielded diverse and abundant ammonite faunas, a thicker, more expanded sequence is needed for a formal type section, such as that suggested for the Zone itself, in the Basse Alpes.

(c) sauzei Zone Oppel 1856

Index species Emileia (Otoites) sauzei (d'Orbigny, 1842-51, pl.139)
A considerable area of uncertainty surrounds the interpretation and possible synonymy of this important species. The absence of a lectotype, and the invalidity of the subsequently designated neotype (Westermann, 1954), have already been discussed (Parsons, 1974, pp.159-60). It is perhaps fortunate that the latter specimen appears to have been lost (Westermann & Riccardi, 1979, p.121), since we are now in a position to be able to finally stabilize the interpretation of this species. Roman's (1938, p.201) designation of the whole of d'Orbigny's (1842-51, pl.139) plate as 'type' can have no real validity as a lectotype designation. First, it is evident from his usage elsewhere (op. cit. p.264), that Roman was utilizing this term in a manner common in France at that time (e.g. Gillet, 1937, p.29), that is in the sense of 'type series' (= all specimens figured and/or described by the original author). Secondly, the whole of d'Orbigny's plate was cited, including the suture. Since so many of d'Orbigny's figures (e.g., 1842-51, pls.121, 133, 136) are blatant 'synthetographs', it is fairly unlikely that all the details

of these figures came from a single specimen. Thus a lectotype for this species still needs to be selected. The specimen recently figured as the 'best existing paralectotype' (Westermann & Riccardi, 1979, p.128, text-fig.12), which is incomplete, is certainly not the only candidate. For some reason Westermann continues to ignore the specimens in the Tesson collection, now in the British Museum, which were mentioned by d'Orbigny, and are thus valid syntypes. The best of these (BMNH.37323), a well preserved, complete specimen, with lappets, is thus here designated lectotype (see Plate 1, fig. 1).

Another problem relates to the suggested (Westermann & Riccardi, 1979, p.122) synonymy of this species with '*E.* (*O.*)' *contracta* (J. de C. Sow.). The latter is a dubious species, since owing to the absence of the original figured specimen, there are now considerable doubts as to its interpretation. Westermann's (1954, pl.1, fig.4) neotype is certainly very similar to *E.* (*O.*) *sauzei*, but it is invalid, as it is not a topotype, coming as it does from a different locality and geological horizon, to that of Sowerby's type. This neotype could thus never satisfy qualifying condition 5 of ICZN. article 75. The designation of this neotype was totally inexcusable since there are numerous well localized specimens of *Otoites* from the type horizon : the Dundry, Brown Iron-shot bed (Parsons, 1979, p.136). However, this is largely irrelevant, as there is little evidence to suggest that Sowerby's original specimen was a microconch of the *Otoites* group. This latter interpretation, which largely follows from Quenstedt (1886-7, pl.65, fig.1), is in fact at variance with some internal evidence from the 'Mineral Conchology' (J. & J. de C. Sowerby, 1812-46). First, in the systematic index '*A.*' *contractus* is included in '*A.*' *brocchi* (*op. cit.*, J. de C. Sow., 1835, p.249), whilst in the alphabetical index, these two species are bracketed together (op. cit., 1840, p.1). Secondly the figured paralectotype of 'A.' braikenridgii (op. cit., 1817, pl.184, lower figure), now in the British Museum (BMNH.43903), is a fragment of the body-chamber of a specimen of Otoites (cf. E. (O.) sauzei as defined here), complete with a lappet. This leads to the conclusion that 'A.' contractus was closely allied to 'A.' brocchi (i.e. it was an Emileia s. str.), an opinion held by Morris (1854), Oppel (1856-8) and Waagen (1867), and that it was very different to the E. (O.) sauzei group, a specimen of which had been included in a different species. These overall conclusions are substantiated by a specimen of 'A.' contractus in the Sowerby Collection (BMNH.43907). This ammonite is so close to Sowerby's figure (J. & J. de C. Sowerby, 1812-46, pl.500, fig.2), that, were it not for the fact that it was added to the collection, subsequent to the publication of the relevant volume, it could be taken as the type. Most significantly, this specimen proves to be, as suspected, the septate, inner whorls of an evolute Emileia! There is no need to designate a new neotype for this 'species'. Sowerby's figure, together with the well documented metatype, clearly show that the 'species' was founded on an uninterpretable nucleus, and is best forgotten. The specimens close to E. (O.) contracta (Buckman, 1909-30 non Sow. = Westermann's neotype), can be transferred to E. (O.) sauzei.

Nomenclature This, a member of Oppel's (1856-8) original zonal scheme, has remained the least modified of all of his Bajocian zones. The only serious contenders as a replacement have rested on the synonymy of E. (O.) sauzei with 'A.' contractus, a possibility that has now been eliminated. Subsequent synonyms include : "zone à *Sphaeroceras sauzei* et *S. polyschides*" (Nickles, 1887), "zone à *A. contractus*" (Haug, 1889), *sauzei* hemera (Buckman, 1893), *propinquins* hemera (Buckman, 1895), subzone of *Emileia polyschides* (Lissajous, 1905), Otoites zone (Mascke, 1907), *alsatica* and *Labyrinthoceras* hemerae (Buckman, 1909-30), *sauzei* and *alsatica/sulcata* horizons (Mouterde, 1953), *Emileia* and *Otoites* Schichten (Westermann, 1954, "horizon à *Sonninia felix*" (Gabilly, 1965), Sauzei and Polyschides horizons (Gabilly *et al.*, 1971) and the *hebridica* subzone (Morton, 1975).

Stratigraphy The *sauzei* Zone, on the basis of ammonite faunas from Schwabia, Normandy and southern England, has recently been redefined as an assemblage biozone (Parsons, 1974, pp.157-9). Although the exact stratigraphic ranges of the various faunal elements have yet to be established in an expanded sequence, the base of the Zone may be drawn at the first appearance of various species, including *S.* (*Kumatostephanus*) *kumaterus* (Buckman), *Labyrinthoceras meniscum* (Waagen) and *Sphaeroceras mansellii* (Buckman). The recently erected *hebridica* subzone (Morton, 1975) appears to be largely redundant. The absence of much of the typical Stephanoceratid fauna in the type area of this subzone (Skye, N.W. Scotland), makes it very difficult to objectively define the limits of the *sauzei* Zone. However, it is certain that most of the Sonninid ammonites recorded from the type horizon of this subzone (the Rigg sandstones), including '*Dorsetensia*' *hebridica* Morton itself (Morton, 1972 & 1975), are also found in the *sauzei* Zone *s. str.* at Sandford Lane, Dorset (Parsons, 1974, p.166) and Dundry Hill, (Parsons, 1979, p.138). This, taken together with the specimens of *Emileia* (*E.*) cf. *multifida*

Buckman and E. (Otoites) sp., which I have found in the lower part of the Rigg sandstones at Bearreraig Bay, Skye, suggest that the hebridica subzone is wholly synonymous with the sauzei Zone s. str. Although for historical reasons, the Schwabian 'Blaukalke' has been designated the type horizon of the sauzei Zone, it is not very fossiliferous, and there are few good exposures. Hence a more suitable area may have to be chosen for a type section. In this connection, Haug's (1891, p.67) suggestion of the 'couche verte' of the Bayeux district of Normandy, as type horizon, has some merit. Here there are extensive, highly fossiliferous, permanent, coastal exposures between Port-en-Bessin and St. Honorine des Pertes (see Appendix).

(d) humphriesianum Zone Oppel 1856

Index species Stephanoceras (S.) humphriesianum (J. de C. Sow. in J. & J. de C. Sowerby, 1812-46, pl.500; restricted to middle figure, op. cit., 1835, p.249), lectotype refigured by Buckman (1908, pl.7, fig.1) and Arkell (1956, pl.35, fig.3).

Nomenclature The humphriesianum Zone, like the sauzei Zone, is another member of Oppel's (1856-8) original zonal scheme, which has remained in relatively continuous use to this day. However, there have been doubts concerning both the precise identification of this species (it has often been confused with S. (Skirroceras) spp.), and its stratigraphic range, which have resulted in the introduction of various alternative index species (e.g. Dorsetensia romani, Haug, 1891; Teloceras blagdeni, Six, 1879). These alternatives are unnecessary as S. (S.) humphriesianum undoubtedly occurs in its zone, and an extended range beyond this horizon would not preclude its use as a zonal index (Parsons, 1976b, p.117). Synonyms include : blagdeni zone (Six, 1879; Arkell, 1933), romani zone (sensu Haug, 1891), humphriesiani hemera (Buckman, 1893), blagdeni hemera (Buckman, 1898), "assise à Sonninia deltafalcata (Qu.)" (Munier-Chalmas, 1893), "niveau de Dorsetensia Eduardiana" (Brasil, 1895b), "zone à Coeloceras blagdeni" (Bigot, 1900), and "zone à W. romani at S. humphriesianum" (Mouterde, 1953).

Stratigraphy This zone as recently redefined (Parsons, 1976b), coincides with the acme of the genus Stephanoceras, although some species range down into the sauzei and laeviuscula Zones. Similarly the acme of the genus Teloceras is found towards the top of the zone, although rare species range down into the romani Subzone. The first appearance of Teloceras, together with Poecilomorphus and Stegoxyites, can be taken as defining the base of this Zone. The relative, abundant ranges of Dorsetensia and Teloceras broadly subdivide the Zone (= romani & blagdeni subzones, Spath, 1936), although a three-fold subdivision, based on the distribution of individual species, is possible. The type area of the Zone is the Schwabian Albe, but a specific type section has yet to be designated (Parsons, 1976b, p.139).

(d) i. romani Subzone Haug 1891, restricted Muller 1941

Index species Dorsetensia romani (Oppel, 1856-8, p.370), type re-figured by Huf (1968, pl.13, fig.6). I cannot totally agree with the suggested synonymy of this species (op. cit.). The type of D. romani has a much squarer whorl cross-section and a more strongly bitabulate venter than D. complanata Buckman. The latter is at least a geographic subspecies, if not a separate species.

Nomenclature Although the relative stratigraphic range of Dorsetensia has long been understood (Haug, 1891, 1893), it was not until some time after, that a species of this genus was used as a subzonal index of the humphriesianum Zone (Spath, 1936). Other, prior use of members of this genus has been as replacement indices for the humphriesianum Zone itself (Haug, 1891; Munier-Chalmas, 1893; Brasil, 1895b). With the current, more detailed subdivisions of the humphriesianum Zone (Pavia & Sturani, 1968; Sturani, 1971), there is a need for additional subzonal indices, for which D. romani must have priority (Parsons, 1976b, p.120). Synonyms include: Stephanoceras & Stemmatoceras zones (Mascke, 1907), Stemmatoceras hemera (Buckman, 1910) or zone (Buckman, 1909-30), Epalaxites, parcicarinatus and Masckeites hemerae (op. cit.), Dorsetensien-schichten (Stahlecker, 1935), "zone à D. complanata" (Maubeuge, 1952), Umbilicum & Coronatum zones (Kumm, 1952), Epalaxites horizon (Mouterde, 1953), romani/complanata-schichten (Westermann, 1954), frechi & umbilicum subzones (Westermann, 1967), romani zone (Huf, 1968), 'Poecilomorphus' subzone (Pavia & Sturani, 1968), cycloides subzone (Sturani, 1971), Humphriesianum, Furticarinata and Gervillii horizons (Gabilly et al., 1971) and Dorsetensia tessoniana and Chondroceras gervillii subzones (Rioult, 1974).

Stratigraphy This horizon coincides with the acme of Dorsetensia, although individual members range above and below. The base can be defined by the first appearance of D. eduardiana (d'Orb.), D. regrediens (Haug) and the D. romani - D. complanata group. In certain clay formations, such as in Yorkshire (Parsons, 1977b) and S. Germany (Stahlecker, 1935), Dorsetensia predominates with no, or only rare members of other ammonite genera. Similarly, other faunas are dominated by Stephanoceratids, Haploceratids and Sphaeroceratids, to the virtual exclusion of *Dorsetensia* (=*cycloides* subzone, Sturani, 1971). Fortunately sections do exist (e.g. Frogden quarry, see Appendix and Parsons, 1976b, pp.131-4), where in spite of this strong 'facies control', there is overlap of the *Dorsetensia* and Stephanoceratid faunas. It can thus be demonstrated that these two are exact stratigraphic equivalents, and hence *D. romani* has priority as Subzonal index. In the absence of *Dorsetensia*, the *romani* Subzone is best thought of as an assemblage biozone, characterised by *Chondroceras evolvescens*, *Sphaeroceras brongniarti* (J. Sow.), *Teloceras blagdeniformi* (Roche), *Poecilomorphus cycloides* (d'Orb.) and *Stegoxyites* spp.

The holotype of '*S.*' *frechi* (Renz = Quenstedt, 1886-7, pl.66, fig.11), the type species of the genus '*Stemmatoceras*', has the trapezoidal whorl cross-section and primary rib density distribution of the genus *Teloceras*, and particularly the early *T. blagdeniformi* group. This would suggest that the *frechi* subzone (Westermann, 1967) is synonymous with the *romani* Subzone. The fauna of the *umbilicum* zone (Kumm, 1952) or subzone (Westermann, 1967), suggests that it is the 'Sonninid facies' equivalent of the *frechi* subzone (Kumm, 1952, p.388). In any event the index species is uninterpretable, as it is based on a fragmentary and highly incomplete type specimen (recently re-figured, Westermann & Riccardi, 1979, p.158, fig.24), which is best forgotten.

The type horizon and locality of the subzone is the "Couche à ammonites ferrugineuses de Beaumont" (Haug, 1891, p.70), near Digne, S.E. France (Pavia & Sturani, 1968).

(d) ii. humphriesianum Subzone Oppel 1856, restricted Muller 1941

Index species Stephanoceras (S.) humphriesianum

Nomenclature This Subzone, which coincides with the greatest abundance of Stephanoceras s. str., is probably the closest to Oppel's (1856-8) original concept of the Zone as a whole. It is the end result of the restriction of the 'humphriesianum fauna' following from the recognition of the romani and blagdeni Subzone faunas (e.g. Muller, 1941; Kumm, 1952; Huf, 1968). Synonyms include: Stepheoceras zone (Mascke, 1907), Humphriesianum zone (Kumm, 1952; Huf, 1968) and Umbilicum and Subblagdeni horizons (Gabilly et al., 1971).

Stratigraphy This horizon, with its relatively abundant Stephanoceras s. str. may in some cases be difficult to recognise, since it is often characterised more by the absence of the dominant members of the romani and blagdeni Subzones, rather than by the presence of any elements of its own. Its base is defined by the first appearance of certain species of Stephanoceras, including S. crassicostatum (Renz ex. Qu.), S. gibbosum (Buckman) and S. triptolemus (Buckman). Because the base of the blagdeni subzone has been defined by the first appearance of T. blagdeni s. str., the Subblagdeni horizon (Gabilly et al., 1971); with Teloceras acuticostatum Weisert, T. lotharingicum Maubeuge and S. crassicostatum; must be included in the humphriesianum Subzone. This horizon has been recorded from both Yorkshire (Parsons, 1977b, pp.213-4) and Dorset (Parsons, 1976b, p.131, top of bed 4c). A type section for the Subzone has yet to be designated, although an exposure in either Schwabia or the Basse Alpes would probably be the most suitable.

(d) iii. blagdeni Subzone Six 1879, restricted Spath 1936.

Index species Teloceras blagdeni (J. Sow., in J. & J. de C. Sowerby, 1812-46, pl.201), holotype refigured by Buckman (1908, pls. 2 & 3, fig.1) and Arkell (1956, pl.35, fig.4).

Nomenclature Waagen (1867) was probably the first to recognise the restricted stratigraphic distribution of Teloceras blagdeni, although the first use of this species was as a replacement index for the humphriesianum Zone (Six, 1879; Buckman, 1898). It has subsequently gained general acceptance as the upper Subzonal index for the humphriesianum Zone (Spath, 1936; Muller, 1941).

Stratigraphy This Subzone coincides with the acme of T. blagdeni, the first appearance of which defines its base. This definition thus excludes the Subblagdeni horizon (Gabilly et al., 1971; see above). The first Perisphinctids certainly make their appearance in the blagdeni Subzone of north Dorset (pers. obs.), and possibly at a slightly lower horizon in Poitou (Gabilly et al., 1971, p.87). Thus the first appearance of this group cannot be taken as defining the base of the subfurcatum Zone. A type locality has still to be designated for this Subzone, and no one area as yet suggests itself.

(e) subfurcatum Zone Terquem & Jourdy 1869, restricted Buckman 1893

Index species Strenoceras (S.) subfurcatum (Zieten, 1830, pl.7, fig.6), lectotype selected and figured by Arkell (1956, pl.35, fig.6).

Nomenclature Although Oppel (1856-8) separated subfurcatum beds from the base of his parkinsoni Zone, Terquem & Jourdy (1869), were the first to give them zonal status. It was restricted to its present range by the introduction of the garantiana hemera/Zone (Buckman, 1893). The main source of conflict has related to the choice of index species for this horizon. There have been several alternative indices; S. niortensis (d'Orb.) perhaps being the most popular (Buckman, 1893); but S. subfurcatum must have priority. Synonyms include: cadomensis zone (Buckman, 1891), bifurcaten-schichten (Quenstedt, 1858), niortensis hemera (Buckman, 1893), Subfurkaten-schichten (Althoff, 1928), niortensis Zone (Arkell, 1933) and niortensis subzone (Spath, 1936).

Stratigraphy Although characterised by the acme of Caumontisphinctes, Leptosphinctes and Strenoceras the first appearance of none of these exactly defines the base of this Zone. The single most stratigraphically significant species is Caumontisphinctes (C.) diniensis (Pavia), and its first appearance can be taken as defining the base of the subfurcatum Zone (cf. Pavia, 1973, tab.1-3; Parsons, 1976b, fig.3; Dietl & Hugger, 1979, fig.2). Although the 'Marne à Longwy' is the type horizon of the Zone (Parsons, 1976b), a more suitable area, with more exposure and better known ammonite faunas is needed for a type section. The exposures described by Pavia (1973) in the Basse Alpes of S.E. France seem to satisfy these criteria. The section at the "Ravin de la Coueste", Chaudon, is thus designated as type section, with the base falling at bed 281 (Pavia, 1973, tab.2; see also Pavia, 1969, fig.2).

(e) i. banksi Subzone Buckman 1910, restricted Sturani 1971

Index species Teloceras (T.) banksi (J. Sow. in J. & J. de C. Sowerby, 1812-46, pl.200), holotype refigured by Buckman (1908, pl.1 & 3, fig.2).

Nomenclature   Although Buckman (1910) introduced the banksi hemera for a thin bed at Frogden quarry (see Appendix, section iii, bed 5b), it was not until the recent resurgence of interest in the problems of Upper Bajocian stratigraphy, that its significance was noted (Parsons, in Sturani, 1971, p.49). It was then resurrected (*loc. cit.*) as the senior synonym of the aplous subzone (Pavia & Sturani, 1968). Synonyms include: banksi hemera (Buckman, 1910) or zone (Buckman, 1909-30), 'Praebigotites-Knollen' (Wetzel, 1936) and aplous subzone (Pavia & Sturani, 1968).

Stratigraphy   This horizon is characterised by the first abundant occurrence of *Caumontisphinctes* (see above) and *Leptosphinctes*. These typically Upper Bajocian forms occur with Stephanoceratids more characteristic of lower horizons, such as *Teloceras* (including *T. banksi*, *T.* cf. *blagdeni* etc), and *Stephanoceras s. lat.* Although the type horizon of the subzone is the 'Banksi bed' of Oborne (see Appendix), which has yielded abundant faunas (Parsons, 1976b, pp.127 & 130), a more expanded sequence is required for a type locality. The obvious choice, to correspond with that of the Zone, is at Chaudon, Basse Alpes (see above).

(e) ii. polygyralis Subzone Sturani, 1971

Index species   *Caumontisphinctes (C.) polygyralis* Buckman (1909-30, pl.163).

Nomenclature   Pavia and Sturani (1968) introduced the phaulus/polygyralis subzone, for the upper part of Westermann's (1967) phaulus subzone. Sturani (1971) subsequently selected *C. (C.) polygyralis* as the sole index. Other synonyms include: *Leptosphinctes* hemera (Buckman, 1909-30) and Leptosphinkten-schichten (Althoff, 1928).

Stratigraphy I consider the base of this Subzone to be defined by the first appearance of Strenoceras and/or Orthogarantiana and Torrensia (Parsons, 1976b, fig.3). This conflicts with Pavia (1973, fig.2 etc.), who chose the appearance of the Subzonal index and C. (Infraparkinsonia) phaulus Buckman. However, there are doubts as to the precise identification and synonymy of many species within the Caumontisphinctes group (e.g. Dietl & Hugger, 1979, p.7), which creates problems with such a definition. Certainly if the first appearance of Strenoceras is accepted, then the records of T. banksi and other Stephanoceratids made by the latter authors (loc. cit.), would then fall in the banksi rather than the polygyralis Subzones. Until this discrepancy is cleared up, no type section can be designated, although again the Basse Alpes are likely to provide the most suitable candidate.

(e) iii. baculata Subzone Kumm 1952, restricted Gabilly et al. 1971.

Index species Strenoceras (Garantiana) baculata (Quenstedt, 1858, pl.72, fig.1).

There must be doubts as to whether Quenstedt's (1886-7, pl.70, fig.7, 9-11) later figured specimens of this species, were in fact members of his original type series. This puts into question the validity of the designation of one of these specimens as lectotype (loc. cit., fig.7, Bircher, 1935, p.156). This is a problem to be clarified by a detailed taxonomic revision of the group. If any question then remains as to the interpretation of this species, then S. (G.) schroederi (Bentz), would make a good alternative index species.

Nomenclature The baculata zone, as originally defined (Kumm, 1952), contained some elements of the polygyralis Subzone, whilst the present Subzonal usage equates with the bulk of Kumm's (1952) Baculata and Schroederi Zones. This interpretation follows the French usage (Gabilly *et al*., 1971), since I consider there is little evidence for the recognition of separate *schroederi* and *baculatum* subzones (*contra* Pavia & Sturani, 1968; Pavia, 1973). Synonyms include: *niortensis* hemera (*sensu* Buckman, 1909-30), *subfurcatum* zone (Althoff, 1928), Baculata and Schroederi zones (Kumm, 1952), *subfurcatum* and *schroederi* subzones (Westermann, 1967) and *schroederi* and *baculatum* subzones (Pavia & Sturani, 1968; (note, their index is *Spiroceras baculatum*, not *S.* (*G.*) *baculata*).

Stratigraphy This subzone is characterised by an abundant and diverse ammonite fauna, dominated by *Leptosphinctes*, *Strenoceras*/*Garantiana* and by the first appearance of the heteromorph, *Spiroceras*. Indeed the two most characteristic species of the '*baculatum*' subzone, were given by (Pavia & Sturani, 1968, p.314) as '*Garantiani*' *baculata* and '*Apsorroceras baculatum*' (= *Spiroceras sauzeanum*). This did not stop Pavia (1973, tab.1), from, in some cases, defining the base of this Subzone by the first appearance of *Orthogarantiana densicostata* (Qu.). This is unsatisfactory, as species closely allied to the latter certainly occur in the *polygyralis* Subzone. The best solution is to define the base by the first appearance of *S.* (*G.*) *baculata* and/or *Spiroceras sauzeanum*. The ranges of these two seem to coincide in Dorset (Parsons, 1976b, fig.3) and Schwabia (Dietl & Hugger, 1979, fig.2), but apparently not in the Basse Alpes (Pavia, 1973, tab.1-3). These discrepancies need to be cleared up before a type section is selected, probably from either Schwabia or the Basse Alpes.

(f) garantiana Zone Buckman 1893

Index species Strenoceras (Garantiana) garantiana (d'Orbigny, 1842-51, pl.123), lectotype designated and figured by Arkell (1956, pl.35, fig.2).

Nomenclature The present usage almost exactly follows Buckman's (1893) hemera of the same name. It thus includes the acris Subzone fauna, which many continental authors (e.g. Pavia & Sturani, 1968; Gabilly et. al., 1971) have included in the parkinsoni Zone. The german use of Garantianen-schichten (e.g. Kumm, 1952), is particularly anomalous, as it is based on the absolute range of Garantiana, and thus includes much of the subfurcatum as well as the garantiana Zones. Synonyms include: garantiana hemera (Buckman, 1893), garantiana subzone (Spath, 1936) and upper and middle Garantianen-schichten (Kumm, 1952).

Stratigraphy Although coinciding with the acme of Garantiana, this Zone is largely defined by the absolute range of S. (Pseudogarantiana. In spite of the highly abundant and diverse Pseudogarantiana/Garantiana and Perisphinctid faunas, upon which the Subzones are based; the total fauna of this Zone has a depleted generic diversity, as compared to the subfurcatum Zone below. There are relatively thick and ammonite rich sections in the type area of the Zone (Sherborne district, Dorset), and the most complete of these, Sandford Lane quarry (ST628178) has been designated as its type section (Parsons, 1980b). Whilst this gives a good overall picture of the faunal character of the Zone, its base must be defined by that of its lowest subzone: the dichotoma. a different type locality for the latter unit is advisable, as this horizon is poorly fossiliferous in Dorset.

(f) i. dichotoma Subzone Kumm 1952, restricted Westermann 1967.

Index species Strenoceras (Pseudogarantiana) dichotoma (Bentz, 1928, pl.19, fig.2)

Nomenclature Kumm (1952) introduced the Dichotoma Zone for the Pseudogarantien -schichten (Althoff, 1928), and it was subsequently restricted by the introduction of the garantiana (Westermann, 1967) or subgaranti subzones (Pavia & Sturani, 1968).

Stratigraphy The faunas of this Subzone, the base of which is defined by the first appearance of its subzonal index, are still rather poorly known. It appears, that virtually all the elements of its ammonite fauna, are also found in one or more of the adjoining Subzones (Pavia, 1973, tab.1-3; pers. obs.). Further research is needed on this horizon, before a type section can be designated, preferably in a more fossiliferous area than that provided by the Basse Alpes.

(f) ii. subgaranti Subzone, Pavia and Sturani 1968.

Index species Strenoceras (Garantiana) subgaranti (Wetzel, 1911, pl.12, figs.3-4)

Nomenclature Introduced by Pavia and Sturani (1968) as a replacement for the garantiana subzone (Westermann, 1967), the subgaranti Subzone has recently undergone an unnecessary change of index species. Pavia (1973) has suggested the use of S. (G.) trauthi (Bentz), since he considered his original specimens of S. (G.) subgaranti from the Basse Alpes had been misidentified. However, S. (G.) subgaranti undoubtedly occurs at this horizon in both north Germany (Althoff, 1928, p.8; Kumm, 1952, p.390), and north Dorset (pers. obs.), thus no such change is needed.

Stratigraphy The definition of this Subzone rests on the first appearance of 'Subgarantiana' or 'Hlawiceras', that is members of the S. (G.) subgaranti - S. (G.) platyrryma (Buckman) - S. (G.) trauthi group (Pavia, 1973, tab.1-3). There is a suggestion that members of this group range down into the dichotoma Subzone (Hinkelbien, 1975, fig.12). If this should be confirmed in other sections, it would totally destroy the basis for the separation of these two Subzones. Further work is thus needed before any type section can be designated.

(f) iii. tetragona Subzone, Kumm 1952, restricted Westermann 1967.

Index species Strenoceras (Garantiana) tetragona (Wetzel, 1911, pl.11, figs.8-10).

Nomenclature The Tetragona zone introduced by Kumm (1952) for the Perisphinctes-schichten (Althoff, 1920), was later restricted by the introduction of the garantiana (Westermann, 1967) or subgaranti subzones (Pavia & Sturani, 1968). Other synonyms include: the Bigotiten-schichten (Wetzel, 1954), (Tetragona)/'Bigotites' subzone (Pavia & Sturani, 1968) and the Bigotites subzone (Gabilly et al., 1971).

Stratigraphy This Subzone is characterised by the first appearance of several large Perisphinctids (Prorsisphinctes & Bigotites), and of its index species. The latter sometimes, as in north Dorset, makes a delayed entry towards the top of the Subzone. Again the detailed distribution of the ammonites within this Subzone is still very poorly known and more work is needed.

(f) iv. acris Subzone Kumm 1952, restricted Westermann 1967.

Index species Parkinsonia (P.) acris Wetzel (1911, pl.15, fig.3)

Nomenclature This, the most well documented and reliable subdivision of the garantiana Zone is almost exactly equivalent to the 'garantiana zone', as used by all British workers subsequent to Buckman (1893). Most continental authors (e.g. Westermann, 1967; Gabilly et al., 1971), have included this horizon as the lowermost subzone of the parkinsoni Zone. However, this approach must be rejected, as it is entirely contrary to Buckman's (1893) interpretation, since the Zone, so restricted, would be almost unrepresented in its type area, north Dorset (Parsons, 1976a, p.48). The Acris zone (Kumm, 1952), or subzone (Westermann, 1967), was based on the 'untere Parkinsonien-schichten' (Althoff, 1928). As restricted (Westermann, 1967; Pavia & Sturani, 1968), it is also synonymous with the subarietis and orbignyana horizon (Mouterde, 1953; Gabilly et al., 1971) and the Subarietis subzone (Gabilly et al., 1971).

Stratigraphy This horizon is defined by the first appearance of Parkinsonia s. str., which in most cases is P. (P.) rarecostata Buckman. Apart from other species of Parkinsonia (P. acris, P. subarietis Wetzel etc.), and Bigotites, the only other major members of the ammonite fauna are S. (Garantiana) and S. (Pseudogarantiana) spp., which range up from the Subzone below. The latter die out before the base of the parkinsoni Zone, where the fauna is largely restricted to Parkinsonia (= 'orbignyana horizon' Gabilly et al., 1971). A type section has yet to be chosen, and it should, if possible, be more fossiliferous than those described by Pavia (1973) in the Basse Alpes.

(g) parkinsoni Zone Oppel 1856 (1856-8), restricted Arkell 1951

Index species Parkinsonia (P.) parkinsoni (J. Sow. in J. & J. de C. Sowerby, 1812-46, pl.307), lectotype refigured by Buckman (1908, pl.5, fig.2) and Arkell (1956, pl.35, fig.1). It should be noted that the lectotype is wholly septate, and thus represents the inner whorls of a large macroconch (Parsons, 1976a). This militates against Buckman's interpretation of this species, since he figured a much smaller, complete specimen (Buckman, 1909-30, pl.781).

Nomenclature This Zone has been much restricted, subsequent to its introduction (Oppel, 1856-8), by the erection of the zigzag and garantiana Zones, and its use here coincides with Arkell's (1951-9, p.9) definition. As discussed above, this is a more restricted definition than the general european interpretation, since the acris Subzone has been included in the garantiana Zone. Synonyms include: the truellei Zone, (Buckman, 1891) and hemera (Buckman, 1893), Parkinsonia Zone (Mascke, 1907) and the 'Oberer Parkinsonien-schichten' (Althoff, 1928).

Stratigraphy The base of this Zone is defined by the first appearance of the P. (P.) parkinsoni - P. (P.) dorsetensis Wright group. The overall ammonite fauna of the Zone, which is dominated by Parkinsonia and large Perisphinctids (Lobosphinctes & Bigotites), is still very poorly known. As a consequence, its Subzones are probably some of the most inadequate members of the Bajocian scheme. Further more detailed work is required, particularly on the richly fossiliferous south Dorset sections, before any improvement can be made. As a consequence, possible type sections cannot be discussed.

(g) i. *truellei* Subzone, Buckman 1891, restricted Buckman 1910.

Index species *Strigoceras* (*S.*) *truellei* (d'Orbigny, 1842-51, pl.117).

Nomenclature The *truellei* Zone (Buckman, 1891) or hemera (Buckman, 1893), was originally introduced as a replacement for the *parkinsoni* Zone, but became restricted with the introduction of further hemerae. It is the equivalent of the restricted *parkinsonia* subzone of some authors (Westermann, 1967), which has been renamed as the *densicostata* subzone (Pavia & Sturani, 1968). The fauna cited by the latter authors, as well as subsequent additions (Gabilly *et al.*, 1971), show that the *densicostata* subzone is the direct equivalent of the *truellei*. The fact that *S.* (*S.*) *truellei* has an extended range well beyond its nominate Subzone in no way rules out its use as a subzonal index, and it must have priority.

Stratigraphy This Subzone is characterised by the abundance of *P.* (*P.*) *parkinsoni*, *P.* (*P.*) *dorsetensis* and *P.* (*P.*) *densicostata* (Qu.), the first appearance of which define its base. Other faunal elements, including the subzonal index, various species of *Cadomites*, *Polyplectites* and *Lissoceras* are locally common. The type horizon of this unit is the Halfway House 'fossil-bed' of north Dorset, but a more suitable area, with an 'expanded' sequence needs to be found for the designation of a type locality.

(g) ii. *bomfordi* Subzone, Buckman (1908 as *schloenbachi* hemera), renamed Arkell (1951-9).

Index species *Parkinsonia* (*P.*) *bomfordi* Arkell (1951-9, text fig.55/3).

Nomenclature Buckman erected the *schloenbachi* hemera (Buckman in

Richardson & Paris, 1908) for the 'pre-zigzag/post-truellei' hemera (Buckman, 1907). However, Arkell (1951-9) considered that Buckman had misidentified his specimens, and as a consequence renamed P. schloenbachi (Buckman non Schlippe) as P. bomfordi. The present use of the bomfordi Subzone (Sturani, 1967) follows directly from this change of name.

Stratigraphy This Subzone is characterised by inflated Parkinsonia of the P. (P.) bomfordi and P. (P.) eimensis (Buckman non Wetzel)groups and by large Perisphinctids (Bigotites and Lobosphinctes). The base is not clearly delimited, and it is possible that a further subzone (the parkinsoni subzone s. str., cf. Gabilly, 1965), characterised by P. (Okribites) parkinsoni (Buckman non Sow.), may be recognized. The top of the Subzone/Zone, which is well defined (Sturani, 1967), includes the 'Planisphinctes fauna' (op. cit., tab.1), which is possibly the equivalent of the 'Oecotraustes nodifer' fauna of north Dorset (Arkell, 1951-9, p.10).

CORRELATION WITH THE STANDARD ZONAL SCHEME

The Bajocian standard zonal scheme (Table 1), although it is based almost entirely on sections in north-west Europe, has a wide application in Europe generally, in much of north Africa and as far east as the Caucasus. With minor exceptions, the ammonite faunas appear to be relatively independent of facies, and similar sequences and relative distributions are found in thick, 'expanded limestone/marl'deposits (e.g. Basse Alpes, Pavia & Sturani, 1968; E. Spain, Hinkelbien, 1975; central Portugal, pers. obs.), as are found in the highly condensed 'ammonitico rosso' facies of Hungary (Galacz, 1976). However, although endemism is less well marked than in the Bathonian, the Bajocian faunas are by no means cosmopolitan. In particular the important 'circum-Pacific faunas' show a variation from almost total endemism in areas such as Western Australia (Arkell & Playford, 1954), to a fairly close comparison with Europe in areas such as Eastern Oregon (Imlay, 1973). Whilst many european genera, if not species, appear to be represented in these faunas, they often show subtle differences in morphology and very different overall stratigraphic ranges, as compared to their european counterparts. These trends are well illustrated by the genera _Asthenoceras_, _Docidoceras_ and _Witchellia_ in Eastern Oregon (_op. cit._). It is also unfortunately true, that many of the commoner cosmopolitan forms, such as some Sonninids, tend to have extended stratigraphic ranges, which reduces their value for detailed correlation. Taking these difficulties into account, it comes as no surprise to find that independent, local zonal schemes are being developed for the circum-Pacific area (e.g. Westermann & Riccardi, 1979, tab.3). Whilst the ranges of various local forms, such as _Megasphaeroceras_, _Parabigotites_ and _Erycitoides_, allow a degree of inter-correlation between different circum-Pacific faunas, it is often difficult to tie in these local schemes with the european standard. In this light, my work on the British faunas has revealed certain, mainly rare, Stephanoceratids, which provide further evidence towards a more detailed correlation between these areas.

(1) As already noted (Parsons, 1977a), there is a striking resemblance between the european, _ovalis_ Subzone members of the _T._ (_Emileites_) group (_T._ (_E._) _liebi_ (Maubeuge) - _malenotatus_ (Buckman)) and the South

American Pseudotoites. This is further underlined by the recently figured specimens of P. sphaeroceroides (Tornquist), (Westermann & Riccardi, 1979, pl.13, figs.1-6).

(2) Chondroceras recticostata (op. cit., pl.20, figs.3-10), apart from being slightly coarser ribbed, is very close to the rare sauzei Zone Sphaeroceras manseli (Buckman). Westermann and Riccardi's (1979) comments on the evolution of Chondroceras are perhaps significant in this context. They postulate the evolution of Chondroceras from Emileia via their new taxon Chondroemileia. It is certainly true that most of the circum-Pacific Chondroceras ('Defonticeras' &'Saxitoniceras'), have coarse, well spaced, rather blunt ribs, very like Chondoemileia. On the other hand, there is very strong evidence that the generally finer ribbed european Chondroceras evolved from Frogdenites, by loss of spines. Hence there is a possibility that 'Chondroceras' is a polyphyletic group, containing two convergent homeomorphs: the european, fine ribbed forms, with a weaker constriction of the body-chamber, which originated from Frogdenites (possibly excluding the C. evolvescens - C. grandiforme Buckman group); and a circum-Pacific group of large, coarse ribbed forms, with a stronger contraction of the body-chamber (possibly including the C. evolvescens group), which evolved independently from Chondroemileia. This possibility must be borne in mind, when attempting to base any wide ranging correlation on Chondroceratids.

(3) There are several species of Stephanoceras s. lat. from Eastern Oregon, which have closely related european equivalents. Docidoceras lupheri Imlay (1973, pl.38, figs.15-6) is very close to an

EXPLANATION OF PLATE 1

Figure 1a-b *Emileia* (*Otoites*) *sauzei* (d'Orbigny), BMNH. 37323, ex.Tesson Collection, St.Vigor, Normandy, Lectotype here designated. 1.0x, coated with Ammonium chloride.

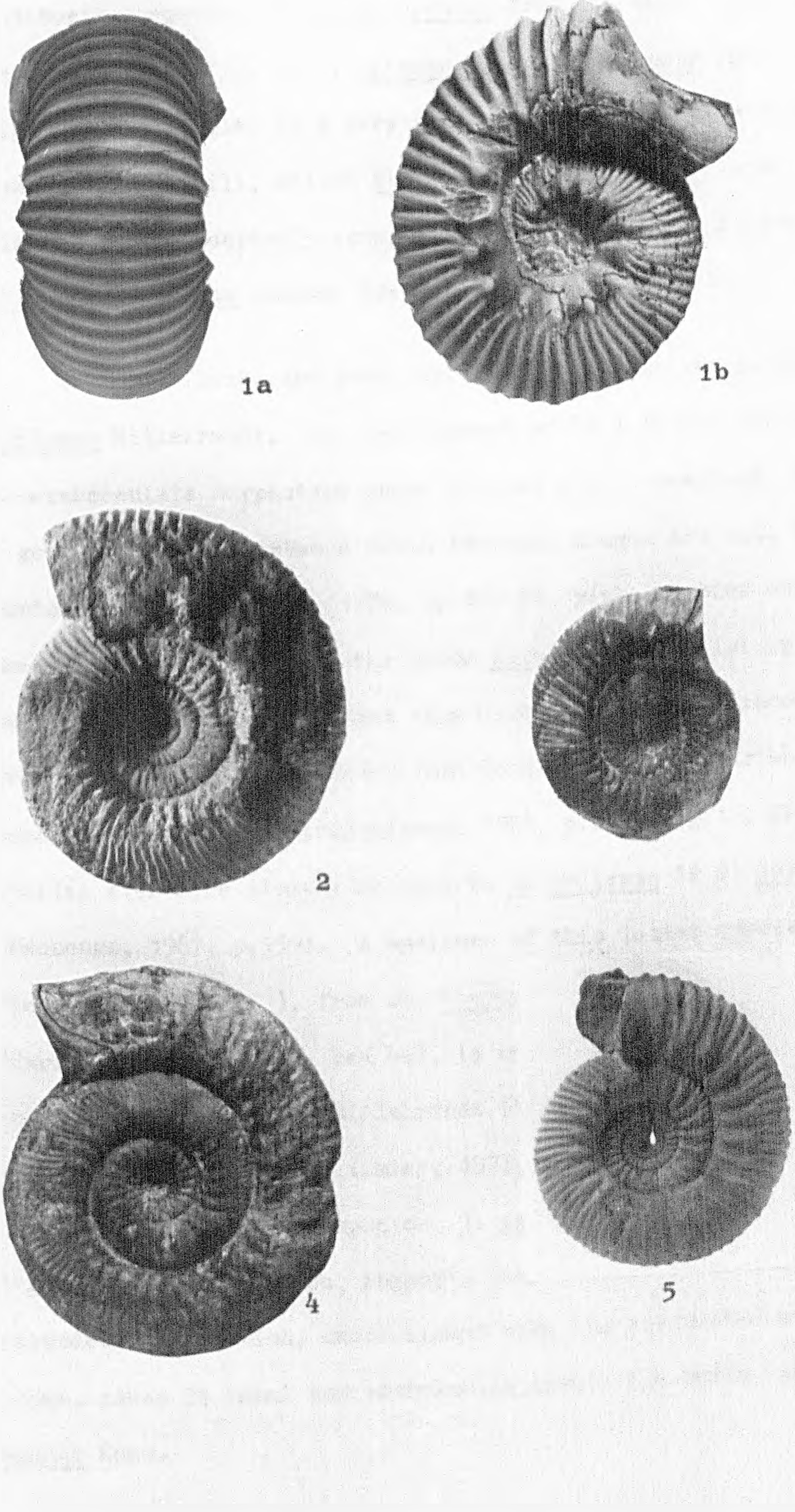
Fig.2 '*Alfeldites*' *trichalus* (Westermann), CP2038, 'Red Conglomerate', Burton Bradstock, Dorset, x $\frac{2}{3}$.

Fig.3 '*Phaulostephanus*' *paululum* Buckman, IGS.69991, ex. S.S.Buckman collection, Sherborne, Dorset, *romani* Subzone , x1.

Fig.4 *Stephanoceras* (*S.*) *helveticus* (Maubeuge), CP2713, Bed 4c, Oborne Wood , Dorset (Parsons, 1976b), x$\frac{1}{2}$.

Fig.5 ?*Mollistephanus* sp. nov. , CP1529, Milborne Wick Lane section, bed 3 (Parsons, 1976b), x1, coated with Ammonium chloride.

PLATE 1



undescribed species of Mollistephanus from the upper laeviuscula Subzone (see Plate 1, fig. 5). Stephanoceras oregonense Imlay (1973, pl.45, figs.1-2) is similar to a very rare, small ?Skirroceras from the sauzei Zone of Dundry Hill, whilst Stephanoceras mowichense Imlay (1973, pl.45, figs.5-7) is undoubtedly conspecific with the romani Subzone (Phaulostephanus paululus Buckman (see Plate 1, fig. 3).

(4) The final, and most important group centres on Stephanoceras chilense Hillebrandt. The development of this finely ribbed, almost non-tuberculate morphotype seems to have been widespread, and provides a good correlation between South America, Oregon and N.W. Europe. Westermann and Riccardi (1979, pp.161-2), rightly point out the close points of similarity with the genus Alfeldites. Whilst up to now the latter has only been recorded from Germany, I can now record a specimen from the humphriesianum Zone, 'Red Conglomerate' of Burton Bradstock, Dorset = A. trichalus (Westermann, 1954, pl.31, fig.1), CP2038. Another species even more closely related to S. chilense is S. helveticus (Maubeuge, 1967, p.139). A specimen of this latter species, CP2713 (see Plate 1, fig. 4), from the humphriesianum Subzone of Oborne Wood (Parsons, 1976b, p.131, bed 4c), is undoubtedly conspecific with the holotype of S. chilense Hillebrandt (1977, pl.3, fig.1), and probably with Stephanoceras A & B (Imlay, 1973, pl.45, figs.9-10) from Oregon. The record of a related species, S. densicostatum Atrops (1974, pl.2, fig.2) from north Africa, suggests that this somewhat rare group has an extended distribution, which linked with its restricted stratigraphic range, makes it ideal for correlation within the world, middle humphriesianum Zone.

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APPENDIX: Internationally significant reference sections

(i) Les Hachettes, Normandy, France.

This cliff-section visible between St. Honorine-des-Pertes and Port-en-Bessin, was measured in March 1969 from a series of coastal exposures, mainly tidal reefs and several up-faulted blocks, (Rioult, 1964, p.242). These exposures have been intensely studied and collected for more than a hundred and fifty years by such notable workers as d'Orbigny (1842-51), Eudes-Deslongchamps (1864), Oppel (1856-8) and Munier-Chalmas (1893). The more important previous descriptions of this section are those of Bigot (1900), Wetzel (1924 & 1937), Rioult (1964 & 1974) and Fürsich (1971). Apart from a general discussion by Arkell (1930), this is the first detailed description of this important section in the English language.

Bathonian - Bajocian, parkinsoni Zone, bomfordi subzone

5. 'Le Calcaire à Spongiaires' (= 'Oolithe Blanche'). A series of white, marly, bioclastic limestones interbedded with marl layers containing sponges. The basal 20-30 cm. contains rare limonite ooliths. These beds are largely inaccessible in the cliffs; only the basal part may be easily examined in situ.

Parkinsonia (Okribites) parkinsoni (Buckman 1928 non Sow.)

10 - 12m

Planed surface

'L'Oolithe Ferrugineuse de Bayeux' (4a-b)

truellei subzone

4b. A thin, light grey limestone with sporadic limonite ooliths.

These ooliths are concentrated in clusters on the surface of the rock, but when seen in section, they are seen to fill a burrow system. Fossils are fairly common, although not as abundant as in the bed below.

Cadomites (Cadomites) sp.

C. (Polyplectites) gracilis (Westermann)

Orthogarantiana sp.

Parkinsonia sp.

Lissoceras (L.) psilodiscum (Schloenbach)

Sphaeroidothyris sphaeroidalis

0.15 - 0.20m

Planed surface

garantiana Zone, acris subzone

4a. A thin, light yellow-grey limestone, with numerous large brown limonite ooliths. Where it is thickest, this bed may be divided into three layers: a middle portion which is the most highly fossiliferous, a lower portion which is less fossiliferous and contains numerous flattened laminated limonite concretions ('Snuff-boxes' - Gatrall, Jenkyns and Parsons, 1972, p.95), and a top layer which is relatively unfossiliferous. Most of the fauna, particularly the gastropod/bivalve portion, (see Fürsich, 1971, pp.318-320) comes from the middle layer. Only the ammonites have been listed here:

Strenoceras (Garantiana) garantiana (d'Orb.)

S. (Pseudogarantiana) minima (Wetzel)

S. (P.) aff. dichotoma (Bentz)

Orthogarantiana sp. nov.

Bigotites nicolescoi de Grossouvre

B. thevenini (Nicolesco)

?B. haugi (Nicolesco)

Prosisphinctes sp.

Parkinsonia (P.) cf. eimensis (Buckman non Wetzel)

P. (P.) rarecostata Buckman

Sphaeroceras tutthum Buckman

S. cf. tenuicostatum Sturani

Spiroceras waltoni (Morris)

Lissoceras (L.) oolithicum (d'Orb.)

L. (L.) psilodiscum

Oppelia (Oppelia) pleurifer (Buckman)

O. (Oecotraustes) genicularis (Waagen)

0.08 - 0.15m

Planed surface

?subfurcatum Zone

3b. A persistent stromatolite layer of LLH-C type, (Logan Rezak & Ginsburg, 1964) of variable thickness, (see Fürsich, 1971, fig.4).

0.01 - 0.07 m

subfurcatum - humphriesianum Zones

3a. 'Le Conglomérat de Bayeux. A highly distinctive bed, consisting of derived lithoclasts and fossils from bed 2, as well as remanié fossils, all of which are thickly coated with laminated limonite, and set in a richly 'iron-shot' limestone, (see Fürsich, 1971, fig.1; Gatrall et al., 1972, fig.9). Fossils from this bed are of at least three distinct stratigraphic ages:-

1/ Derived fossils from bed 2, (sauzei Zone)

Emileia (Emileia) sp.

E. (Otoites) sp.

Sonninia (S.) propinquans (Bayle)

Witchellia (Pelekodites) sulcata (Buckman)

Lissoceras (L.) semicostulatum Buckman

Strigoceras sp.

2/ Remanié fossils (humphriesianum Zone)

Poecilomorphus cycloides (d'Orb.)

Sphaeroceras brongniarti (J.Sow.)

Stephanoceras (Stephanoceras) sp.

S. (Normannites) sp.

3/ Indigenous fossils, (subfurcatum Zone)

Strigoceras (Cadomoceras) sulleyense (Brasil)

Strenoceras (Garantiana) sp.

Oppelia sp.

0.0 - 0.20m

Unconformity

sauzei Zone

2. 'La Couche Verte'. A soft, grey, marly, highly glauconitic limestone. This bed has a tendency to be conglomeratic, and has been channelled down into the top of the 'Malière', probably via pre-existing Thalassinoides burrows, (see Fürsich, 1971, p.323). Although fossils are extremely common, they are often badly preserved: broken, phosphatised, eroded or subsolved, and with their shells often replaced with glauconite,

Emileia (*Emileia*) *polyschides* (Waagen)

E. (*E.*) *pseudocontrahens* Maubeuge

E. (*E.*) cf. *polymera* (Waagen)

Stephanoceras (*Kumatostephanus*) *turgidulum* (Welsch ex. Qu.)

S. (*K.*) cf. *perjucundus* Buckman

S. (*K.*) sp.

Mollistephanus (*Mollistephanus*) sp. nov.

M. (subgen. nov.) sp. nov.

Sonninia (*S.*) *felix* (Buckman)

S. (*S.*) cf. *propinquans* (Bayle)

0.0 - 0.15m

- - - - - - - - - - - - -Irregular surface - - - - - - - - - - - - - - - - -

1. 'La Malière'. An off-white, or light grey, gritty, bioclastic limestone, with numerous black chert bands. The top is highly corroded and channelled, with the 'Couche Verte' penetrating down the channels and old burrow systems. Although relatively unfossiliferous, the following specimens were found towards the top:

Emileia (*Emileia*) *greppini* Maubeuge

S. (*Kumatostephanus*) cf. *triplicatum* (Renz)

seen to 2.5m

(ii) Bradford Abbas railway-cutting, Dorset.

This section (ST594145), which has been in existence for over one hundred years, has been virtually ignored. Although briefly described by Woodward (1894, p.78), and the Geological Survey, who listed an unlocalised fauna (Wilson *et al.*, 1959, p.94), this cutting has never been the subject of a detailed study. This is surprising since it is now the only section available which shows exposures in the World famous Bradford Abbas "fossil-bed". The following section was measured in May 1972 from the northern face, and it proves to be very similar to that recorded by Buckman (1893, p.485) from the nearby East Hill quarry:

zigzag Zone & *parkinsoni* Zone, *bomfordi* subzone

10. The Crackment Limestone. A series of, poorly bedded, rubbly, white, poorly oolitic limestones, which are deeply weathered and relatively unfossiliferous, it is thus difficult to determine the base of the *zigzag* Zone.

From basal 0.10m *Parkinsonia* (*Okribites*) *parkinsoni* (Buckman, 1909-30, Pl.781 *non* Sow.)

seen to 2.0m

Planed surface

truellei subzone

9. The Halfway House Bed. A soft, cream limestone with yellow-brown limonite ooliths. There are many shells present, particularly *Neocrassina* ('*Astarte*'), which have been replaced by limonite, whilst towards the base there are numerous small 'Snuff-boxes'.

Parkinsonia (*O.*) cf. *pseudoparkinsoni* Wetzel

0.35 - 0.65m

Planed surface

garantiana Zone

8. The Astarte Bed. A thin, limonite rich, 'iron-shot' limestone, which in much of the cutting is reduced to a limonitic clay parting.

This bed, where preserved, is highly fossiliferous, and contains numerous, fairly large 'Snuff-boxes'.

Neocrassina modiolaris (Lamarck)

Goniothyris phillipsi (Morris)

0.0 - 0.20m

Planed surface

subfurcatum - sauzei + ?laeviuscula Zones

7. 'The Irony Bed'. A hard, dark blue, crystalline limestone, with numerous large limonite pisoliths. This bed is very limonite rich and conglomeratic, as well as being highly lenticular; like the bed above it is often preserved solely as a limonite clay parting. There are numerous small and medium sized 'Snuff-boxes' present, some of which have ammonite fragments, derived from the bed below, as nuclei.

Emileia (Otoites) sp.

Darellia sp. (as nucleus to 'Snuff-box')

Neocrassina modiolaris

Aulacothyris sp.

Goniothyris sp.

0.0 - 0.15m

Very flat planed surface

The Bradford Abbas Bed (6a-c), a highly fossiliferous, 'iron-shot' limestone, divided into two or three courses by one to two discontinuous and irregular partings.

discites Zone

6c. A densely 'iron-shot' oobiomicrite, with fine, brown limonite ooliths set in a light blue-grey matrix. The common fossils and the joint faces of the bed are characteristically stained black. This horizon, unlike the two below, is fairly consistent in thickness, and is separable over the full length of the cutting, due to the presence of a persistent basal marl parting.

'*Braunsina*' *aspera* Buckman

Graphoceras (*G.*) cf. *apertum* (Buckman)

?*G.* *hamatum* (Buckman)

Darellia cf. *coela* (Buckman)

D. cf. *laxa* (Buckman)

?*Ludwigella* *carbatinum* (Buckman)

?*L.* *recticostata* (Buckman)

Hyperlioceras (*H.*) *walkeri* (Buckman)

H. (*H.*) cf. *subsectum* (Buckman)

H. (*H.*) spp.

Reynesella *piodes* Buckman

'*Nannoceras*' *nannomorphum* Buckman

Nannolytoceras cf. *liocyclum* (Brasil)

Sonninia (*Euhoploceras*) *acanthodes* (Buckman)

S. (*E.*) *submarginata* (Buckman)

Trilobiticeras (*Trilobiticeras*) *trilobitoides* (Buckman)

Trilobiticeras (*Emileites*) sp. nov.

0.18 - 0.20m

- - - - - - - - - - - - Marl parting - - - - - - - - - - - - - - - - - -

concavum Zone

6b. A densely 'iron-shot' oobiomicrite, with yellower ooliths, and a browner matrix than the bed above. The base of this bed is marked by an impersistent marl parting, and where this is absent it is impossible to separate this bed from the subjacent.

Graphoceras (G.) apertum (Buckman)

G. (G.) scriptitatum Buckman

G. (Ludwigella) compactum (Buckman)

G. (L.) limitatum Buckman

G. (L.) subrudis Buckman

Bradfordia liomphala Buckman

Eudmetoceras amplectans Buckman

S. (Euhoploceras) acanthodes (Buckman)

S. (E.) simplex (Buckman)

Haplopleuroceras subspinatum (Buckman)

Trilobiticeras (Trilobiticeras) cf. punctum (Vacek)

T. (Emileites) sp. nov.

0.0 - 0.25m

- - - - - - - - - Impersistent marl parting - - - - - - - - - - - - - - -

6a. An 'iron-shot' limestone, exactly similar to the bed above. This bed is at its thickest when the middle course of the 'fossil-bed' is incorporated with it; as is seen at the middle of the cutting.

Graphoceras (G.) concavum (Sow.)

G. (G.) magna (Buckman)

G. (G.) sublineata (Buckman)

G. (Ludwigella) attenuata Buckman

G. (L.) cornu (Buckman)

G. (L.) flexilis Buckman

G. (L.) micra Buckman

G. (L.) rotabilis (Buckman)

G. (L.) stigmosum Buckman

Bradfordia liomphala Buckman

S. (Euhoploceras) cf. crassiformis (Buckman)

0.20 - 0.35m

Total for bed 6 = 0.50 - 0.70m

murchisonae Zone,

bradfordensis subzone (fide Buckman, 1893)

5. A prominent, relatively thick, brown marl layer.

0.0 - 0.04m

murchisonae subzone

The Paving Bed (4)

4b. A hard, rubbly oolitic limestone, with small yellow ooliths set in a light blue-grey fine spar matrix. The relatively rare fossils and the joint faces of the bed, are covered in a dark red-purple iron stain. This staining, which also covers the bed below, makes it difficult to separate these two beds where there is no intervening parting.

Ludwigia (L.) brasili (Buckman) - 0.12m below top of bed.

haugi subzone

0.25 - 0.38 m

- - - - - - impersistent limonite stained parting - - - - - - - - - - -

4a. A hard, rubbly oolitic limestone, superficially very similar to the bed above, due to the red-purple iron staining. An examination of fresh surfaces shows that this bed has a sandier, more yellow-grey matrix than the bed above, although both are quite shelly.

Ancolioceras substriatum Buckman

Ludwigia (L.) murchisonae (Buckman, 1887-1907, Pl.III, figs.1+2, non Sow.)

0.30 - 0.70m

A prominent, undulating 'hard-ground'

levesquei Zone, moorei subzone (fide Buckman, 1893)

3. 'The Dew Bed'. An extremely hard, coarsely, shelly biosparite, which is blue 'hearted'. The highly undulating upper surface of the bed is heavily bored by 'lithophaga' and, in places, thickly smeared with limonite. Although fairly shelly, it is very difficult to extract any fossils. In certain parts of the cutting it appears that bed 4a has penetrated right through the 'Dew bed', and upto 0.40m has been deposited directly on top of the sands.

0.0 - 0.28 m

Impersistent limonite layer

'The Yeovil Sands' (2-1)

2. A hard, nodular, very shelly sandstone, which weathers yellow, but which is blue 'hearted'. This bed, which forms an indurated top to the softer sands, is sometimes clearly separated from the 'Dew bed', whilst elsewhere in the cutting there is only a gradual transition.

0.35 - 0.40m

1. Soft yellow sands with occasional sandstone doggers.

seen to 0.60m

(To the West of the road bridge a)
(greater thickness of sands)
(is visible, due to the)
(displacement of a small)
(fault.)

(iii) Frogden quarry, Oborne

This important section (ST642185) which has been described by Buckman (1893) and more recently by Parsons (1976b), has for many years been obscured below bed 6. Thanks to the recent work of the Nature Conservancy Council (Sept. 1979), an extensive section has been cleared, revealing additional details, not even seen by Buckman. The bed numbers are those used for the nearby Oborne wood section (Parsons, 1976b, p.128).

Sherborne Limestone (*pars*) (7-9)

Building Stone Beds (*pars*)

9. Massive, micritic limestone, very broken up by weathering.

+ 1.20m

Acanthothiris Beds (7-8)

8. Five regular, 20cm. thick, micritic limestone courses, interbedded with thick marl bands, and with common specimens of *Acanthothiris*, in the second course from the bottom.

1.30m

7. A sandy, limonite stained, marly limestone with a conglomerate of limonite-stained, re-worked ammonites at its base.

0.25 - 0.30m

planed surface

'Oborne Road-stone' (6-5), - '*cadomensis* beds' (6)

subfurcatum Zone, *baculata* Subzone

6d. A highly fossiliferous, hard oolitic limestone, with many fragmentary fossils, which towards the top of the bed, are often limonite coated.

Caumontisphinctes (*Infraparkinsonia*) cf. *bonarellii* (Parona), CP.3099

Leptosphinctes (*L.*) cf. *leptus* Buckman, CP.2802

L. (*L.*) cf. *davidsoni* (Buckman), CP.2803

L. (*Cleistosphinctes*) cf. *asinus* (Zatvornitzki), CP.2796

Strenoceras (*S.*) *subfurcatum* (Zieten), CP.2795

S. (*Garantiana*) *baculata* (Qu.), CP.2793

Spiroceras *sauzeanum* (d'Orb.),CP.2792

Lissoceras (*L.*) *oolithicum* (d'Orb.), CP.2797

L. (*L.*) *psilodiscum* (Schloenbach) s. sp. *inflatum* Wetzel, CP.2798

L. (*Microlissoceras*) cf. *pusillum* Sturani, CP.2799

S. (*Cadomoceras*) *sullyense* Brasil, CP.2801

S. (*C.*) *nepos* (Parona), CP.2800

Chondroceras *canovense* (de Gregorio), CP.2331

Sphaeroceras *auritum* cf. subsp. *auritum* Parona, CP.2332

0.15 - 0.20m

polygyralis Subzone

6c. A hard, blue 'hearted', oolitic limestone, highly bioturbated with a mixture of more sandy limestone, probably by the large species of *Pholadomya* present. This bed is poorly fossiliferous, with the few fossils being badly preserved and difficult to extract.

Caumontisphinctes (C.) cf. polygyralis Buckman, CP.2806

L. (Cleistosphinctes) sp.

Oppelia (Oecotraustes) cf. longarae Sturani, CP.2805

0.35 - 0.40m

'Sphaeroidothyris bed'

6b. Lenticular, hard, blue 'hearted', crystalline, 'iron-shot' limestone, which is irregular in thickness, and sometimes only with some difficulty separated from the bed above. This bed is very sandy in patches, and 'nests' of Sphaeroidothyris are common.

C. (Infraparkinsonia) phaulus Buckman, CP.2808

Strenoceras (S.) sp.

Orthogarantiana (O.) cf. densicostata (Qu. emend. Douv.) CP.2809

O. (O.) haugi Pavia, CP.2807

Torrensia gibba (Parona), CP.2804

Cadomites (C.) sp.

Chondroceras canovense (de Gregorio), CP.2345

Teloceras (T.) banksi

0.10 - 0.20m

banksi Subzone

6a. A soft brown, oolitic limestone sporadically preserved, where the large specimens of Teloceras, resting on the basal erosion plane, 'stick up' into the overlying bed.

Teloceras (T.) banksi (Sow.), CP.2647

0.0 - 0.18m

Total for bed 6 = 0.66 - 0.71m

planed surface

5b. A thin, soft, marly, densely oolitic limestone, with shiny, brown limonite ooliths set in a yellow-brown, often purple stained, matrix and divided by two poor partings, into three courses.

Caumontisphinctes (C.) cf. aplous Buckman, CP.2811

C. (Infraparkinsonia) sp.

Leptosphinctes (L.) sp.

L. (Cleistosphinctes) sp.

?Cadomites cf. humphriesiformis Roche, CP.3071

Chondroceras cf. tenue (West.), CP.2278

Teloceras (T.) banksi (Sow.), CP.2810

T. (T.) aff. blagdeni (Sow.), CP.2988

0.31 - 0.37m

humphriesianum Zone, blagdeni Subzone

5a. A hard, limestone with shiny ornage ooliths in a grey-brown matrix. There are patches of more sandy limestone, due to bioturbation, and numerous belemnites present.

Teloceras (T.) blagdeni (Sow.)

0.30m

humphriesianum Subzone

4c. A hard, grey limestone, with matt brown ooliths, and soft sandy patches, particularly towards the top. The bottom of the bed is marked by a poor parting, associated with a layer of large, flat lying ammonites.

Stephanoceras (S.) zieteni (Renz), CP.3751

S. (S.) cf. pseudohumphriesianum Maubeuge, CP.3753

S. (*S.*) aff. *crassicostatum* (Renz *ex.* Qu.), CP3761

S. (?*S.*) sp. nov. A.

Oppelia (*O.*) sp.

0.05 - 0.15m

romani Subzone

4b. Hard, grey, oolitic, extremely fossiliferous limestone, with shiny, brown ooliths and common ammonite fragments.

Chondroceras evolvescens (Waagen), CP.3727

C. cf. *gracile* (Westermann), CP.3726

Phaulostephanus paululum Buckman, CP.3730

Stephanoceras (*S.*) *mutabile* (Qu. emend. Renz), CP.3743

S. (*Normannites*) *latansatum* (Buckman), CP.3724

Teloceras (*T.*) *blagdeniformi* Roché, CP.3744

T. (*Epalaxites*) *portitor* (Maubeuge) CP.3724

Dorsetensia liostraca Buckman, CP.3748

D. *tecta* Buckman, CP.3746

D. *regrediens* Haug, CP.3723

Oppelia (*Oecotraustes*) *genicularis* Waagen, CP.3731

Poecilomorphus (*P.*) *cycloides* (d'Orb.), CP.3742

Strigoceras (*S.*) *bessinum* Brasil, CP.3725

0.15m

4a. Hard, dark brown, densely oolitic, "iron-shot" limestone, with a basal conglomerate, of derived lumps from beds 3a-b, thickly coated in limonite.

Phaulostephanus paululum, CP.3719

Stephanoceras (*S.*) *freycinetti* (Bayle), CP.3722

?*T.* (?*Epalaxites*) sp.

Chondroceras evolvescens CP.3720

0.15m

sauzei Zone

3b. Light grey, marly sparsely "iron-shot" limestone, with yellow-brown ooliths, and abundant broken shell debris and belemnites.

Stephanoceras (*Skirroceras*) *bayleanum* (Oppel), CP.3718

S. (*S.*) *Skolex* (Buckman), CP.3717

Emileia (*E.*) cf. *bubendorfense* Maubeuge, CP.3714

0.0 - 0.10m

laeviuscula Zone and Subzone

3a. Soft, light-grey limestone, speckled with green glauconite grains, and which weathers to a soft, pasty, white marl.

Emileia (*E.*) *pseudocontrahens* Maubeuge, CP.3688

E. (*Otoites*) *fortis* (Westermann), CP.3708

Frogdenites profectus Buckman, CP.3710

S. (*Skirroceras*) sp.

Witchellia (*W.*) *falcata* Buckman, CP.3692

W. (*W.*) *laeviuscula* (J. de C. Sow.), CP.3689

W. (*Pelekodites*) *macra* (Buckman), CP.3700

S. (*Papilliceras*) sp.

Bradfordia (*B.*) *inclusa* Buckman, CP.3704

0.05 - 0.10m

2. A hard, massive, blue 'hearted', glauconitic limestone, which

grades up into the bed above.

Emileia (*E.*) aff. *contrahens* Buckman, CP.3688

Witchellia spp.

0.25m

ovalis Subzone

1c. More massively bedded to the subjacent, thinly bedded glauconitic limestones.

Emileia (*Otoites*) sp.

?*Witchellia* (?*W.*) cf. *nodatipinguis* (Buckman), CP.3685

0.34m

1b. Thin bedded, yellow-grey, sandy, glauconitic limestones, interbedded with soft grey-brown marls. The basal 1.0m is more massively bedded.

Emileia (*E.*) *subcadiconica* Buckman, CP.3684
(-1.0m below bed 3a)

Witchellia (*W.*) aff. *romanoides* (Douvillé), CP.3683
(-1.8m below bed 3a)

+2·3m