

# A REVIEW OF THE CARBONIFEROUS GONIATITE ZONES IN DEVON AND CORNWALL

by N. E. BUTCHER AND F. HODSON

**ABSTRACT.** A re-examination of existing museum collections of goniatites from the Culm Measures of Devon and Cornwall shows that most of the Carboniferous goniatite zones and subzones are represented in this region. The only zones for which there is at present no evidence are the *Eumorphoceras* and Lower *Gastrioceras* Zones.

ALTHOUGH Carboniferous goniatites have been known from Devon and Cornwall since they were figured and described by J. de C. Sowerby (*in* Sedgwick and Murchison 1840) and J. Phillips (1841), little modern work has been done on these faunas. The present study, largely a re-examination of existing museum specimens, most of which were collected fifty years or more ago, was initiated by N. E. B.; the identifications have been attempted by F. H. Much of the material is poorly preserved and precise identification has proved difficult in some cases. A description is given below of the main elements of the goniatite faunas from the Lower and Upper Carboniferous as they are now known.

*Material.* All the specimens referred to in this paper, with the exception of those in the collection of Dr. D. E. Owen, Keeper of the Manchester Museum, are deposited in the following museums, abbreviated in the text as indicated: BM—British Museum (Natural History). EM—Exeter Museum. GSM—Geological Survey Museum. NDA—North Devon Athenaeum, Barnstaple. SM—Sedgwick Museum, Cambridge. TM—Museum of the Torquay Natural History Society.

*Acknowledgements.* Our thanks are due to Mr. E. W. J. Moore and Dr. W. H. C. Ramsbottom for commenting on some of the material examined. We are also grateful to the following museum officials for their assistance: Dr. R. C. Blackie (EM), Mr. A. E. Blackwell (NDA), Mr. A. G. Brighton (SM), Mr. H. L. Douch of the County Museum, Truro, Mr. J. M. Edmonds of the University Museum, Oxford, Mr. W. E. Hall (TM), Mr. A. D. Hallam of the County Museum, Taunton, Dr. M. K. Howarth (BM), Miss M. E. Jenkinson of Bideford Museum, Dr. W. H. C. Ramsbottom (GSM), and Mr. T. Williams of the Royal Geological Society of Cornwall. Dr. D. E. Owen kindly made his collection available. Mr. C. W. Taylor gave valuable assistance with the collections in the North Devon Athenaeum, Barnstaple. N. E. B. acknowledges financial assistance from the Research Board of Reading University. We are grateful to Professor P. Allen for his critical reading of the manuscript.

## LOWER CARBONIFEROUS

Strata of Lower Carboniferous age are found in relatively narrow outcrops on and near the northern and southern margins of the great central outcrop of Upper Carboniferous sediments. There are thus two separate east-west belts to be considered.

*1. The Northern Belt.* The Pilton Beds of north Devon contain a mainly trilobite-brachiopod fauna in which ammonoids are rare. From a study of the trilobites from the Barnstaple area Goldring (1955) proved the presence in these beds of the Upper Famennian *Wocklumeria* Zone (the topmost zone of the Devonian) and the basal Carboniferous

[*Palaeontology*, Vol. 3, Part 1, 1960, pp. 75-81, pls. 17-19.]

*Gattendorfia* Zone. Goldring's discovery of *Gattendorfia* itself near Barnstaple confirms the latter correlation.

J. G. Hamling found several small ammonoids (TM Hamling Coll. 2190-1 and BM C19564-8) in black shales from two wells near Mount Sandford, 2 miles south-east of Barnstaple. These specimens are important in view of the fact that this locality is near the junction between the Pilton Beds and the succeeding Lower Culm Measures (see Hamling and Rogers 1910, pl. 33). Hamling (1908, p. 279) recorded them as *?Clymenia*, with which Paul (1937, p. 436) tentatively agreed, but Goldring (1955, p. 48) suggested they might be *Nomismoceras*. The poor state of preservation of these evolute forms unfortunately does not permit even generic identification. We are, however, indebted to Dr. M. R. House for his opinion that they are not Clymenids. It seems most probable that they are Prolecanitids (Pl. 17, fig. 1), and possibly of Tournaisian age.

Hamling also collected a goniatite (BM C19550) from the railway cutting west of Swimbridge Station. The locality is shown on Hamling's geological map of north Devon (Hamling and Rogers 1910, pl. 33) as occurring at the junction between the Pilton Beds and the Lower Culm Measures near Swimbridge. This specimen (Pl. 17, fig. 2) is identified as *Pericyclus (Rotopericyclus) aff. homoceratoides* Schindewolf which thus indicates the *Pericyclus* Zone of the German zonal scheme (Schindewolf 1951).

## EXPLANATION OF PLATE 17

- Fig. 1. Prolecanitid. From a well, 80 yards north of Venn Cross Quarry, near Barnstaple. TM Hamling Coll. 2190,  $\times 2$ . The label on this specimen states 'south' of Venn Cross Quarry, but this must be an error (see Hamling 1908, p. 279). Goldring (1955, p. 48) has given the locality correctly with map reference SS 57883132.
- Fig. 2. *Pericyclus (Rotopericyclus) aff. homoceratoides* Schindewolf. Railway cutting west of Swimbridge Station. BM C.19550,  $\times 1\frac{1}{2}$ .
- Fig. 3. *Merocanites cf. henslowi* (J. Sowerby). Westleigh, near Burlescombe. GSM 59906,  $\times 1$ .
- Fig. 4. *Bollandoceras micronotum* (Phillips) group. Doddiscombsleigh. BM C.9103,  $\times 2$ .
- Fig. 5. *? Pericyclus sp. or Imitoceras ornatissimus* (de Koninck) group. Quarry east of Bableigh, near Barnstaple. NDA 789,  $\times 1$ .
- Fig. 6. *Sudeticeras aff. ordinatum* Moore. Spara Bridge, near Ashton Station. GSM US 1810,  $\times 2$ .
- Fig. 7. *Merocanites aff. applanatus* Frech. Codden Hill Quarry, near Barnstaple. NDA 823,  $\times \frac{3}{4}$ .
- Fig. 8. *Entogonites grimmeri* (Kittl). Just north of Canonteign, near Trusham. GSM US 1438,  $\times 4$ .
- Fig. 9. *Goniatites concentricus/striatus* group. Hele Quarries,  $\frac{3}{4}$  mile south of Dulverton Station. GSM US 965,  $\times 1\frac{1}{2}$ .

## EXPLANATION OF PLATE 18

- Fig. 1. *Goniatites crenistria* Phillips. Venn, near Barnstaple. TM Hamling Coll. 690,  $\times 2$ .
- Fig. 2. *Goniatites falcatus* Roemer. Hele Quarries,  $\frac{3}{4}$  mile south of Dulverton Station. GSM US 963,  $\times 2$ .
- Fig. 3. *Goniatites sphaericostriatus* Bisat. Bonhay Road, Exeter. BM C.9111,  $\times 3$ . (a) Ventral view, (b) lateral view.
- Fig. 4. *Girtyoceras burhennei* (H. Schmidt). Fremington. NDA 875c,  $\times 1\frac{1}{2}$ .
- Fig. 5. *Goniatites bisati* Moore. Bampton. BM C.1641b,  $\times 2$ .
- Fig. 6. *Paragoniatites newsomi* (J. P. Smith) group.  $\frac{3}{4}$  mile south of Ugbrooke House, near Chudleigh. GSM US 436,  $\times 5$ .
- Fig. 7. *Bollandites* of the *castletonense* (Bisat) group. Westleigh, near Burlescombe. BM C.9113,  $\times 2$ . (a) Ventral view, (b) lateral view.
- Fig. 8. *Goniatites aff. granosus* Portlock. Waddon Barton, near Chudleigh. EM Downes Coll.,  $\times 2$ .

It is possible that the Codden (or Coddon, see Woodward 1902, p. 481, footnote) Hill Chert Beds may in part be of *Pericyclus* Zone age, since several poorly preserved impressions of a coarsely ribbed goniatite referred to *Pericyclus* sp. (Crick, in Hinde and Fox 1895, p. 653) have come from these beds. Where the state of preservation allows it is seen that many of these specimens are involute. The best-preserved specimen (NDA 789 Partridge Coll.), from a quarry east of Bableigh, near Barnstaple, is illustrated in Pl. 17, fig. 5. These involute forms do not appear to agree with any of the figured and described species of *Pericyclus*. They may represent a new species of this genus or may even possibly belong to the *Imitoceras ornatissimus* (de Kon.) group, known from the *Pericyclus* reefs of western Ireland (Foord 1897-1903).

This coarsely ribbed goniatite is associated in the Codden Hill Beds with large, poorly preserved prolecanitids, the two forms having been found on the same bedding-plane (e.g. SM E16049). The latter have been referred to '*Prolecanites compressus*' (see Hudson and Turner 1933, p. 478). The specimens in the museum collections are too poorly preserved for specific identification, with the exception of one recently found loose in Codden Hill Quarry by Mr. C. Winzar. This large specimen (NDA 823, Pl. 17, fig. 7) may be referred to *Merocanites* aff. *applanatus* (Frech) which would suggest the B<sub>1</sub> zone.

The B<sub>2</sub> zone is certainly present at the eastern end of this northern belt near Burlescombe because the Westleigh limestones (Owen 1939) have yielded a *Bollandites* of the *castletonense* (Bisat) group (BM C9113 Vicary Coll., Pl. 18, fig. 7). *Merocanites* cf. *henslowi* (Sow.) (GSM 59906 Harding Coll.) also occurs at Westleigh (Pl. 17, fig. 3).

The subdivisions of the P<sub>1</sub> zone can now all be identified in these northern outcrops. The P<sub>1a</sub> subzone occurs at the old Venn Quarry near Barnstaple where the limestones yielded *Goniatites crenistria* Phillips (TM Hamling Coll. 690, Pl. 18, fig. 1). The P<sub>1b</sub> index fossil *Goniatites falcatus* Roemer was collected by Ussher from shales in Hele quarries,  $\frac{3}{4}$  mile south of Dulverton Station (GSM US 963, Pl. 18, fig. 2). These quarries also yielded him a *Goniatites* of the *concentricus/striatus* group, also indicative of P<sub>1b</sub> (GSM US 965, Pl. 17, fig. 9). The succeeding P<sub>1c</sub> subzone is indicated by several specimens, collected from Fremington by T. M. Hall, of *Goniatites sphaericostratus* Bisat, with which is associated *Girtyoceras burhennei* (Schmidt) (NDA 875c, Pl. 18, fig. 4). Bampton is the type locality of Phillips' (1841) species, *Goniatites spiralis*. Bisat (1955) has redescribed material from this P<sub>1d</sub> locality under the modern name of *Neoglyphioceras spirale*. J. E. Lee collected from Bampton a form which can be compared with *Goniatites bisati* Moore which would again indicate the P<sub>1d</sub> subzone (BM C1641b, Pl. 18, fig. 5).

The P<sub>2a</sub> subzone is suggested by some spirally ornamented goniatites collected by Dr. D. E. Owen from Whipcote Quarry near Burlescombe which approach *Goniatites granosus* Portlock (Owen 1949). This species was also collected by I. Rogers, from a locality near Yelland Farm, near Fremington. Higher Viséan subzones have not yet been recognized in these northern outcrops.

2. *The Southern Belt.* As in North Devon, the *Wocklumeria* and *Gattendorfia* Zones are now both known from the southern Upper Devonian and Lower Carboniferous outcrops. House and Selwood (1957) record the discovery of *Wocklumeria* near Launceston, and Selwood (1958) has in addition found *Gattendorfia* near this town. The beds containing these ammonoids are, on their lithology, referred to the Transition Series of Dearman and Butcher (1959).

The succeeding Lower Culm Measures stand in contrast to the northern Lower Culm outcrops in that, with the exception of the higher Viséan horizons, they have yielded very few goniatites. Of the Lower Culm goniatites, most have come from the outcrops east of the Dartmoor granite. The Vicary Collection (BM) contains a B<sub>2</sub> goniatite preserved in limestone from Doddiscombsleigh (C9105) which may be referred to the *Bollandoceras micronotum* (Phillips) group (Pl. 17, fig. 4). The top of the B<sub>2</sub> zone is proved in shales just north of Canonteign near Trusham by the occurrence of *Entogonites grimmeri* (Kittl) (GSM US 1438 Ussher Coll., Pl. 17, fig. 8).

The P<sub>1a</sub> and P<sub>1b</sub> subzones have not yet been recognized, but the occurrence of P<sub>1c</sub> limestones is indicated at Bonhay Road, Exeter, by the subzonal index fossil *Goniatites sphaericostriatus* (BM C9111 Vicary Coll., Pl. 18, fig. 3).

Waddon Barton (Dewey 1948) has yielded abundant impressions of the P<sub>1d</sub> form, *Neoglyphioceras spirale*, preserved in distinctive reddish-coloured shales. A few specimens of *Goniatites* aff. *granosus* (Pl. 18, fig. 8) are also known from here (EM Downes Coll.), so that this locality must lie close to the P<sub>1</sub>/P<sub>2</sub> junction.

The P<sub>2</sub> goniatite, *Sudeticeras* aff. *ordinatum* Moore (Pl. 17, fig. 6) was collected by Ussher from black shales by Spara Bridge, near Ashton Station (GSM US 1810). The topmost subzone of the Viséan, P<sub>2c</sub>, has been identified  $\frac{3}{4}$  mile south of Ugbrooke House, near Chudleigh, by the occurrence in shales (GSM US 436 Ussher Coll.) of a goniatite of the *Paragoniatites newsomi* (J. P. Smith) group (Pl. 18, fig. 6).

#### UPPER CARBONIFEROUS

Goniatites are so far only known close to the northern and southern margins of the great central outcrop of Upper Carboniferous sandstones and shales, the Upper Culm Measures of Sedgwick and Murchison (1840).

1. *North.* The lowest Namurian horizon so far dated in north Devon is that of R<sub>1c</sub>, shown by Moore's (1929) record of *Reticuloceras reticulatum* (Phillips) (Pl. 19, fig. 5) near Fremington Station (NDA 792B). The locality must lie near to the R<sub>1</sub>/R<sub>2</sub> junction since Moore also found the R<sub>2a</sub> form *Reticuloceras gracile* Bisat close by.

Recently, one of us (N. E. B.) has found *Reticuloceras superbilingue* Bisat (Pl. 19, fig. 7) 1½ miles south of Bampton (GSM 87249). Because *Gastrioceras* has not been found

#### EXPLANATION OF PLATE 19

Fig. 1. *Homoceras magistrorum* Hodson. Bonhay Road, Exeter. BM C.9110, ×3.

Fig. 2. *Homoceras undulatum* (Brown). Bonhay Road, Exeter. BM C.9109, ×3.

Fig. 3. *Homoceras beyrichianum* (de Koninck) emend. Haug. Bottom of Idestone Hill, 3 miles south-west of Exeter. EM Collins Coll. 224, ×3.

Fig. 4. *Reticuloceras nodosum* Bisat and Hudson. Pinhoe, Exeter. BM C.9123, ×4. (a) Lateral view, (b) ventral view.

Fig. 5. *Reticuloceras reticulatum* (Phillips). Fremington (shore). NDA 792B, ×3.

Fig. 6. *Reticuloceras bilingue* Bisat. Ballast from Perridge Tunnel, 3½ miles west-south-west of Exeter. GSM US 1822a, ×2.

Fig. 7. *Reticuloceras superbilingue* Bisat. Quarry, 1½ miles south of Bampton, GSM 87249, ×3.

Fig. 8. *Reticuloceras* aff. *gracile* Bisat. Pinhoe brickfield, Exeter. EM Collins Coll. 145, ×1½.

Fig. 9. *Gastrioceras circumodosum* Foord. North of Shag Rock, near Knap Head, north Cornwall. SM E.14609, ×3.

associated with this species, the horizon is  $R_{2c}$ . This is the highest Namurian zone yet recognized in Devon.

*Gastrioceras* has long been known from north Devon but all the records are of the  $G_2$  *Gastrioceras circummodosum* Foord group of the Lower Westphalian. In addition to the well-known localities near Instow Station, Mouth Mill near Clovelly, and Hescott Quarry near Hartland (Rogers 1910), this horizon also occurs farther south on the coast, north of Shag Rock, near Knap Head, near Welcombe (SM E14609, Pl. 19, fig. 9).

2. *South.* Here, in contrast to the north, the *Homoceras* Zone can be shown to be present, both in the west and in the east. Collins (1911) records many goniatites from the Exeter region. Of these, specimens from the bottom of Idestone Hill, 3 miles south-west of Exeter, are *Homoceras beyrichianum* (de Kon.) emend. Haug, indicating the  $H_{1b}$  subzone (EM Collins Coll. 224, Pl. 19, fig. 3). The Vicary Collection (BM C9109) contains the  $H_{2b}$  form *Homoceras undulatum* (Brown) (Pl. 19, fig. 2) from Bonhay Road, Exeter, from which locality Vicary also collected *H. magistrorum* Hodson (BM C9110, Pl. 19, fig. 1) which marks the base of the *Reticuloceras* Zone. The *Homoceras* Zone is also tentatively identified on the north Cornish coast at Voter Run, near Crackington Haven, from material collected by Dr. D. E. Owen (Owen 1949), although specific identification is not possible.

Exeter is the type locality of *Reticuloceras inconstans* (Phillips 1841), from which record Bisat (1924, p. 67) inferred the presence of the Lower *Reticuloceras* Zone in Devon. The Pinhoe brick pit, near Exeter, yielded to Collins and Vicary *Homoceras striolatum* (Phillips), *Reticuloceras nodosum* Bisat and Hudson (BM C9123 Vicary Coll., Pl. 19, fig. 4), and *R. aff. gracile* (EM Collins Coll. 145, Pl. 19, fig. 8), and Collins also collected *R. nodosum*, *R. cf. regularum* Bisat and Hudson, and *R. moorei* Bisat and Hudson from Stoke Road, under Stoke Wood, also near Exeter. Thus the whole of  $R_1$  and the lower levels of  $R_2$  appear to be present in the Exeter area.

The highest zone so far recognized in the south is that of  $R_{2b}$ , proved by the occurrence of *R. bilingue* Bisat (Pl. 19, fig. 6) at Perridge Tunnel (GSM US 1822a Ussher Coll.),  $3\frac{1}{2}$  miles west-south-west of Exeter.

#### CONCLUSIONS

The sequence of Carboniferous goniatite zones and subzones now known to be present in Devon and Cornwall is shown in Table 1. This may be linked with the succession of Devonian ammonoid zones shown to be present in south Devon and north Cornwall by House (1958). Together they show that there is an almost continuous succession of strata to which the ammonoid chronology can be applied.

In Table 1 the most notable absentee is the *Eumorphoceras* Zone, the index fossils of which are unrepresented in the museum collections examined. It may be that in Devon and Cornwall strata of *Eumorphoceras* Zone age are really absent. Moreover, it is possible that the *Homoceras* Zone is absent in north Devon. It is perhaps worth emphasizing that no record has yet been obtained of the Lower *Gastrioceras* Zone. Further collecting, however, may well close these gaps in knowledge of this region.

TABLE 1. *The sequence of goniatite zones and subzones recognized in Devon and Cornwall*

	German Zones	British Zones	North	South	
Upper Carboniferous	Westphalian	G <sub>2</sub>	×	—	
		G <sub>1</sub>	—	—	
	Namurian	R <sub>2c</sub>	×	×	—
		R <sub>2b</sub>	—	—	×
		R <sub>2a</sub>	×	×	×
		R <sub>1c</sub>	×	×	—
		R <sub>1b</sub>	—	—	×
		R <sub>1a</sub>	—	—	×
		H <sub>2c</sub>	—	—	—
		H <sub>2b</sub>	—	—	×
		H <sub>2a</sub>	—	—	—
		H <sub>1b</sub>	—	—	×
		H <sub>1a</sub>	—	—	—
		E <sub>2</sub>	—	—	—
	E <sub>1</sub>	—	—	—	
	Lower Carboniferous	Viséan	P <sub>2c</sub>	—	×
P <sub>2b</sub>			—	—	
P <sub>2a</sub>			×	×	
P <sub>1d</sub>			×	×	
P <sub>1c</sub>			×	×	
P <sub>1b</sub>			×	—	
P <sub>1a</sub>			×	—	
B <sub>2</sub>			×	×	
B <sub>1</sub>			×	—	
II Pericyclus			—	×	—
Tournaisian		I Gattendorfia	×	×	
Upper Devonian Famennian	VI Wocklumeria	×	×		

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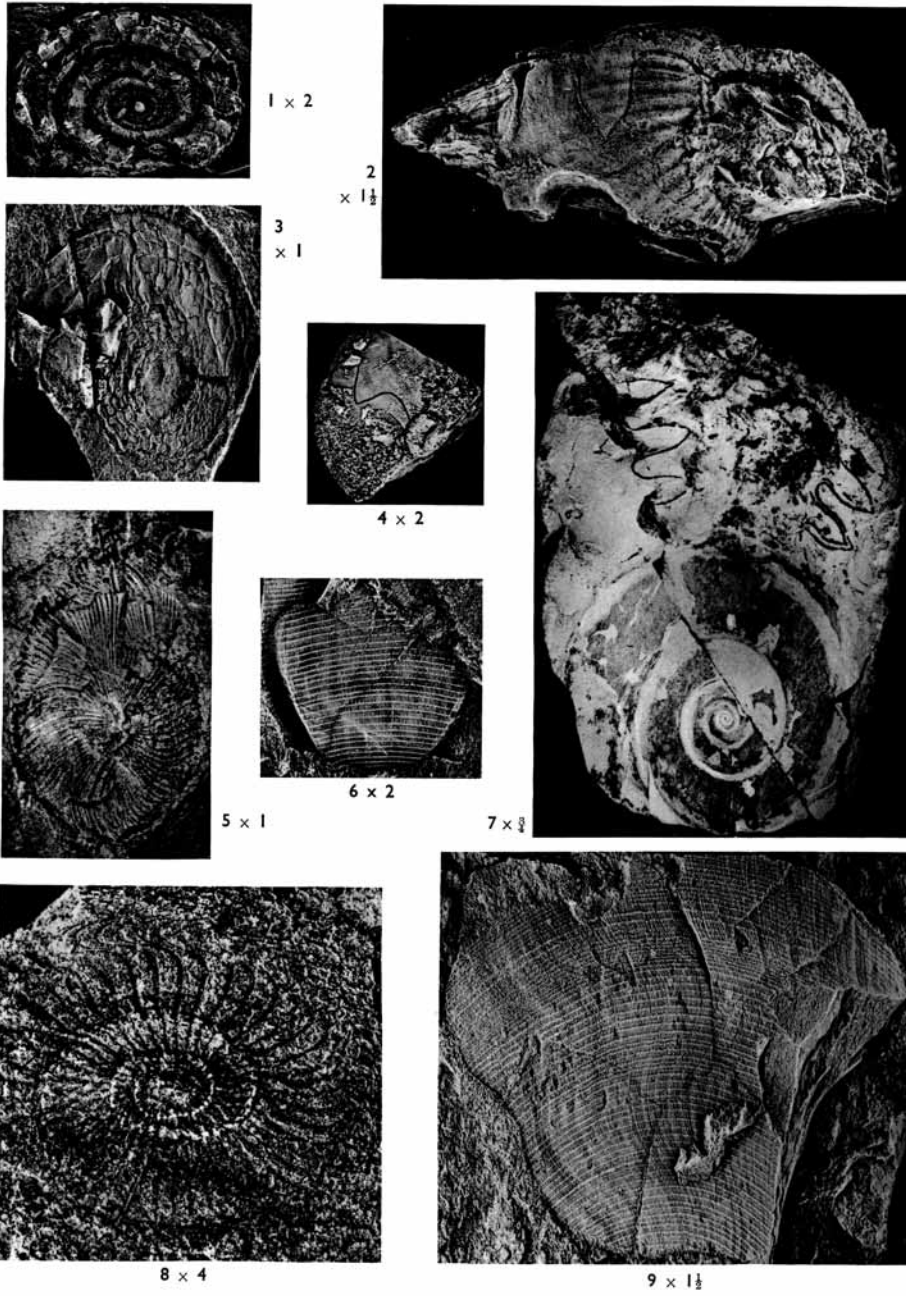
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N. E. BUTCHER  
The University,  
Reading

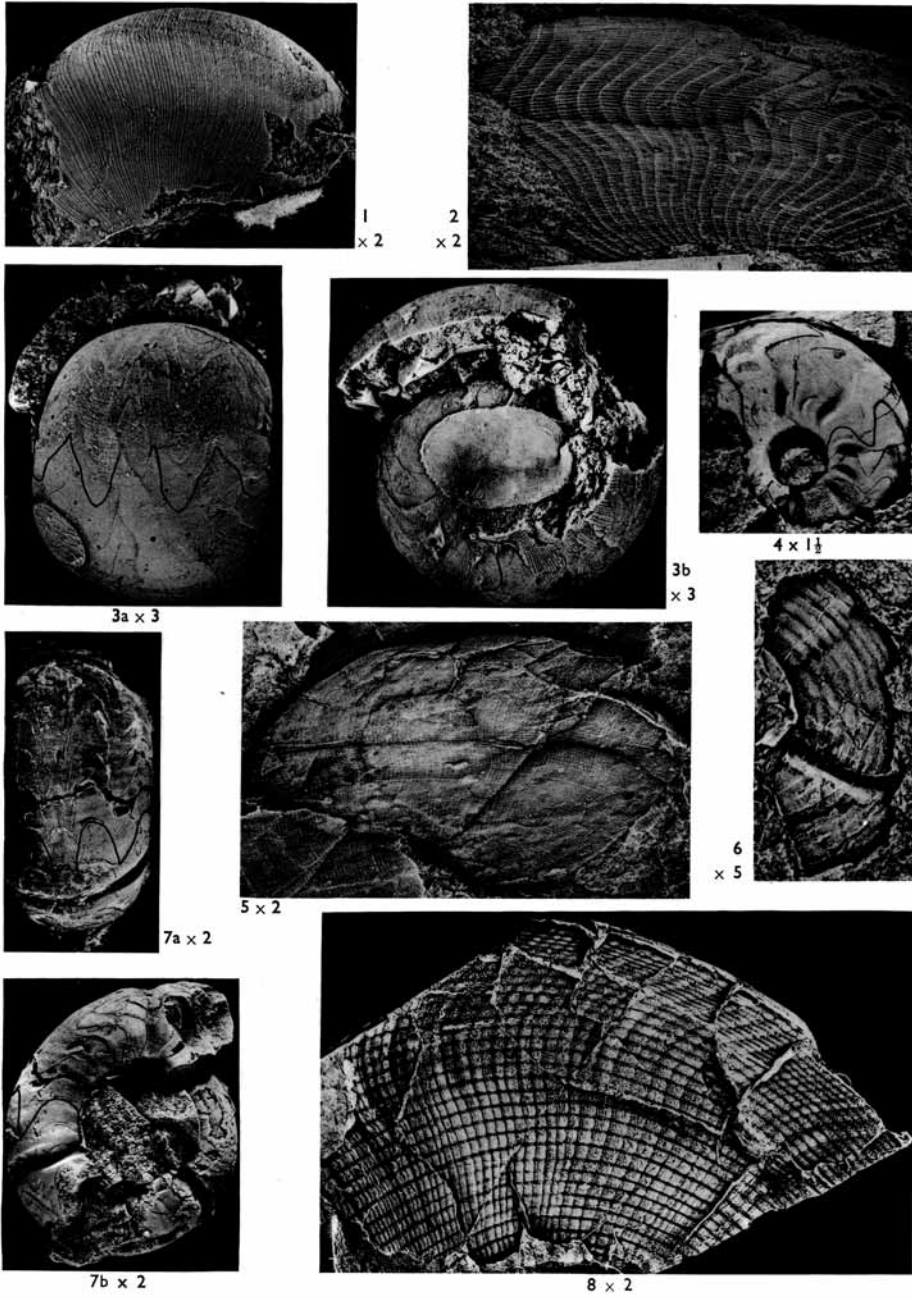
F. HODSON  
The University,  
Southampton

Manuscript received 8 May 1959

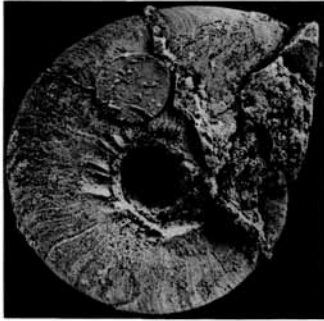


BUTCHER and HODSON, Carboniferous goniatites





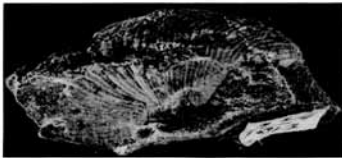
BUTCHER and HODSON, Carboniferous goniatites



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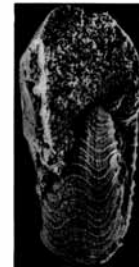
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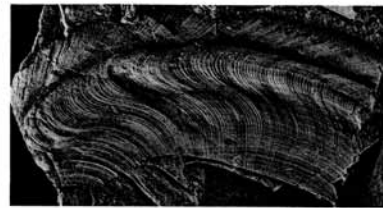
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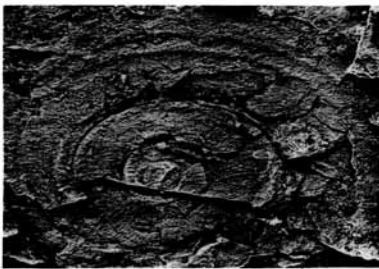
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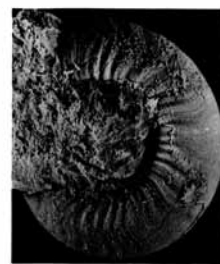
6 x 2



7 x 3



8 x 1½



9 x 3

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