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*With the Author's Compliments.*

# Cephalopods from the Drummuck Group of the Girvan District.

BY

**Dr. CURT TEICHERT,**
**University of Western Australia, Crawley,**
**Western Australia.**

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No. VIII.—**Cephalopods from the Drummuck Group of the Girvan District.** By Dr. Curt Teichert, University of Western Australia, Crawley, Western Australia. (Plates V and VI).

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## Introduction.

The cephalopods which are described in this paper were sent to me in 1939 by the Hunterian Museum, University of Glasgow, at the request of Dr. Archie Lamont who collected them in the field. I am indebted to Professor A. E. Trueman, Dr. E. D. Currie and Dr. Lamont for giving me an opportunity of studying these interesting fossils.

The specimens, numbering 68, all come from the Starfish Bed in the upper part of the Drummuck group of the Girvan district. For the stratigraphy of the sequence it is here sufficient to refer to Dr. Lamont's recent publication (1935) where the stratigraphical position and the correlation of the Drummuck group is discussed in detail. In a general way, the Drummuck group is correlated with the Kildare Limestone of Ireland, the Keisley Limestone of the Lake District, and other equivalent series in Great Britain; it is also correlated with Etage 5a of the Oslo area, Norway, and with the Lyckholm beds of Estonia (F. Schmidt's $F_1$). The suggested correlation of the Upper Leptaena Limestone of Dalarne, Sweden, with the Keisley Limestone and Upper Drummuck is regarded as not yet finally established. As regards America, Lamont supports the previously suspected correlation of the Drummuck with the American Richmond and, in particular, points out some interesting parallels of certain Drummuck fossils with Upper Ordovician (Middle to Upper Richmond) faunas from Percé, Quebec.

In connection with the study of the Drummuck cephalopods it is fortunate that the cephalopods from the strata in Norway, Estonia and Quebec, with which the Drummuck group has been correlated, have been described in fairly recent publications by

Foerste (1936), Strand (1933) and the present writer (1930) and that the cephalopod fauna of the American Richmond and earlier formations, thanks mainly to Foerste's work, is now very much better known than only ten or twelve years ago.

The cephalopod fauna of the Drummuck group comprises five species, one of them not definitely recognizable:

*Zitteloceras costatum* sp. nov.
*Neumatoceras drummuckense* sp. nov.
*Cyrtorizoceras* ? sp. ind.
*Diestoceras lamonti* sp. nov.
*Diestoceras scoticum* sp. nov.

The correlations worked out for the Drummuck group on the strength of non-cephalopod invertebrate faunas, chiefly brachiopods and trilobites, are in the main supported by the evidence furnished by the cephalopods.

*Zitteloceras* is the most abundant member of the Drummuck fauna. The genus is well represented in the Black River and Trenton of eastern and mid-western North America; together with many other characteristic Middle Ordovician genera it reinvaded the epicontinental seas in Richmond time. The genus has not been previously recorded from Europe, but the new *Zitteloceras costatum,* although an unmistakable *Zitteloceras,* is not very similar to any of the known American forms; on the other hand it shows certain affinities with the genus *Ringoceras* Strand, known at present only from Etage 5a of the Oslo area and with *Piersaloceras* Teichert which is restricted to the Lyckholm beds of Estonia. The genus is not known from Percé, Quebec.

Another genus not previously recorded from Europe is *Neumatoceras* which is at present known from the basal part of the Bighorn formation of Wyoming, from the lower part of the Fremont formation of Colorado, as well as from Percé. The two first-mentioned occurrences are regarded as of pre-Richmond rather than Richmond age and the Drummuck species *Neumatoceras drummuckense* is most closely related to *N. milleri* Foerste from the basal part of the Bighorn formation.

*Diestoceras* is widely distributed in the American Ordovician from the Black River up to and including the Richmond. It is also known from Norway and from Estonia. The Drummuck species *Diestoceras lamonti* is most closely related to *Diestoceras acuminatum* Strand from Etage 5a of the Oslo area, and



*Diestoceras scoticum* is almost indistinguishable from *Diestoceras isotelorum* Strand from horizon 4dγ of the same district. This species is also similar to species of *Diestoceras* from Percé and from the Richmond of the island of Anticosti, although these similarities are less striking.

*Cyrtorizoceras* is of limited use for correlation. The genus is widely distributed in the American Ordovician and Silurian and it is also known from Etage 5a in Norway and from the Lyckholm beds of Estonia, but the affinities of the one specimen from the Drummuck group which has been doubtfully referred to this genus cannot be accurately determined.

In conclusion, the following statements with regard to the cephalopod fauna of the Drummuck group can be made:

(1) The fauna contains a strong American element, represented by the genera *Zitteloceras* and *Neumatoceras* which have not been recorded previously from Europe.

(2) The affinities of the Drummuck cephalopod fauna are definitely with Ordovician, not with Silurian, faunas. In America, the three genera whose presence in the Drummuck group could be definitely established make their first appearance in pre-Richmond strata and do not continue beyond the Richmond.

(3) The fauna is not very intimately related to that of Percé, Quebec. Such genera as *Geisonoceras, Donacoceras, Metaspyroceras, Spyroceras, Schuchertoceras,* and *Apsidoceras* which are well represented in the Percé fauna are absent from the Drummuck fauna and the species of *Diestoceras* and *Neumatoceras* in both faunas are not very closely related. *Zitteloceras,* the most conspicuous of the Drummuck genera, is not known from Percé.

(4) Affinities of the Drummuck fauna are noticeable with that of Etage 5a of the Oslo area, but one species is intimately related to a species in horizon 4dγ of the same district. Affinities with the cephalopod fauna of the Lyckholm beds of Estonia are less noticeable. In both regions the contemporaneous cephalopod faunas are far more abundant than that of the Drummuck group, 36 species being known from the Lyckholm beds and more than 40 from Etage 5a.

The affinities of the Drummuck cephalopods will be discussed in more detail in the following descriptions of the species.

## Description of Species.

All the specimens described in the following pages come from the Starfish Bed in Threave Glen (*see* Lamont, 1935, p. 296 and accompanying map, locality 7). The types and figured specimens are in the Hunterian Museum, University of Glasgow.

### Genus *Zitteloceras* Hyatt.

### *Zitteloceras costatum* sp. nov.

Plate V, Figs. 5, 6, 9, 10, 11.
Plate VI, Figs. 1, 8, 9, 10.

*Material.* 45 internal and external moulds of specimens or fragments of specimens.

*Holotype.* S. 10890.

*Diagnosis.* Medium-sized species with crenulated lirae and longitudinal costae.

*Description.* The biggest and most complete specimen is here selected as holotype (Pl. V, fig. 6), although the specimen is rather much secondarily compressed. However, none of the many specimens at my disposal exhibit all the characteristics of the species equally well and the description has to be based on a number of individuals in addition to the holotype. The holotype is 32.5 mm. long, of which length 14.2 mm. are occupied by the living chamber. The dorso-ventral diameter of the holotype increases to 16.5 mm. at the aperture and the cross-section is strongly compressed laterally. In other specimens, however, the cross-section is depressed dorso-ventrally and from a comparison of numerous individuals it appears that the cross-section of the conch is most probably approximately circular in the adapical part of the phragmocone and becomes slightly compressed towards the adoral end (see Pl. V, figs. 9-11).

In the holotype the height of the camerae increases to 2.0 mm. in the second-last camera, but the last camera is only 1.6 mm. high. In the holotype the sutures seem to describe lateral sinuses, but this is probably due to distortion of the specimen. Better preserved fragments have straight sutures with a slight ventral saddle. The dorsal and ventral outlines of the conch are evenly curved, the former concave, the latter convex, and the diameter of the conch increases evenly towards the unconstricted aperture. The siphuncle is only seen in a few specimens. It is close to, but not actually in contact with, the ventral, convex side.



Distinct, though not very prominent, longitudinal costae are visible on the surface of the holotype and also traces of transverse markings. On some of the other internal moulds the longitudinal costae are slightly more prominent than on the holotype.

The transverse ornamentation can be studied far better in casts of the external side of specimens and must be described in some detail. It consists of wavy lirae, densely spaced and of equal prominence. The crests and sinuses of the lirae are in line; the crests are situated on low longitudinal costae, the sinuses in the depressions between the costae. In the early stages of the phragmocone the costae are close together and crests and sinuses of the lirae are acute. The lirae have here the appearance of zig-zag lines (Pl. VI, fig. 10). With the expansion of the conch the distance between the costae increases and the sinuses of the lirae become in consequence wider and more rounded; at this stage, in the adoral part of the phragmocone (Pl. VI, fig. 9), the crests are still acute. Still further on, along the adapical part of the phragmocone, the costae tend to become wider, the crests of the lirae become rounded and the lirae now present the appearance of wavy lines with evenly rounded crests and sinuses (Pl. VI, figs. 9 and 1). Close to the aperture, however, the pattern becomes irregular; the lirae here are not nearly as sinuous as in the earlier parts of the conch; some may be almost straight. Also, they are more crowded than they were before. On Pl. VI, fig. 1 may be seen the rather sudden change from the preceding type of ornamentation with regular wavy lirae to the one just mentioned. Similar breaks in the otherwise regular succession of the lirae can also be observed in other specimens. In some cases they are doubtless due to injuries received by the shell, as, for example, the irregular break visible at the end of approximately the lower third of the specimen figured on Pl. VI, fig. 8. The following break in the succession of the lirae in this specimen is, however, doubtlessly due to a pause in the growth of the animal. The shell here breaks off along one and the same lira which stands out above the level of the succeeding part of the conch.

In the early parts of the phragmocone there are usually about 9 lirae in a distance of 3 mm. The spacing widens to 7 lirae in 3 mm. in the adoral part of the phragmocone and to 5 lirae in 3 mm. in the adapical part of the living chamber, but near the

aperture there may again be as many as 8 or 9 lirae in the same distance. Along the convex ventral side of the conch the lirae form narrow and rather acute lobes (Pl. V, figs. 5, 9).

*Comparisons and affinities.* Among the known species of *Zitteloceras* there are only four with crenulated lirae: viz. *Z. hallianum* (d'Orb.) from the Trenton of New York (Foerste, 1917, p. 51; 1928, p. 193); *Z. clarkeanum* Foerste and *Z. percurvatum* Foerste from the Black River of Wisconsin (Foerste, 1928, p. 196; 1933, p. 83; McKelvey, 1939, p. 74); and *Z. fimbriatum* Fritz from the Black River of Paquettes Rapids, Ontario (Fritz, 1930). None of these species has, however, the longitudinal costae which are characteristic of *Zitteloceras costatum*. This species might have developed out of such forms as *Z. clarkeanum* of which McKelvey writes (1939, p. 76): " The crests and sinuses of adjoining lirae are lined up longitudinally so as to give the appearance of longitudinal ridges." These ridges, however, are not actually developed in that species.

The ornamentation in *Z. costatum* is rather similar to that of the genus *Piersaloceras* Teichert from the Lyckholm beds of Estonia (Teichert, 1930, p. 282, pl. 6, figs. 9, 10) which has longitudinal costae and transverse wavy lirae with the crests of the lirae situated on the longitudinal costae. In *Piersaloceras*, however, the siphuncle is sub-central. Nevertheless, the affinities of *Piersaloceras* may be closer with *Zitteloceras* than with the Kionoceratidae as originally suspected by me. *Ringoceras* Strand (1933, p. 24) from Etage 5a of the Oslo area has more conspicuous longitudinal costae and less prominent, straight transverse lirae. It is similar to *Zitteloceras* in the ventral position of the siphuncle. *Zitteloceras costatum* thus displays some features which are found in these two Baltic genera, but whether these resemblances are superficial or genetic is not easy to decide. It is, however, imaginable that *Ringoceras* is derived from such costate forms of *Zitteloceras* as *Z. costatum* and not related to the Kionoceratidae as suspected by Strand.

Genus *Neumatoceras* Foerste.

*Neumatoceras drummuckense* sp. nov.

Plate V, Figs. 1-4, 7, 8.

*Material.* Internal moulds of 12 specimens or parts of specimens.

*Holotype.* S. 10897.



*Diagnosis.* Species with the greatest gibbosity at the base of the living chamber, conspicuous external transverse striation and faint longitudinal ribbing.

*Description.* The holotype is 37 mm. long, 16 mm. of its length being occupied by the living chamber. The dorso-ventral diameter increases from 11 mm. at the adapical end of the phragmocone to a maximum of 22.8 mm. at the base of the living chamber and decreases again to 19 mm. at the aperture. As the specimen is secondarily compressed these measurements should not be taken literally to apply to the conch in its original shape. The actual dimensions were probably slightly smaller. The profile of the dorsal side of the holotype is quite straight, whereas that of the ventral side is evenly convex. The height of the camerae increases from 1.8 mm. to 2.8 mm. in the second-last camera, whereas the last camera is only 2.3 mm. high. The sutures form shallow lateral lobes and rise much higher ventrally than dorsally.

The siphuncle cannot be seen in the holotype. In other specimens it is close to the convex side, though not actually in contact with the wall of the conch.

The holotype shows very faint traces of longitudinal ribbing and faint indications of transverse striation. The transverse markings are better seen in another specimen, S. 10898 (Pl. V, fig. 1). Raised bands, a little less than 1 mm. wide, alternate with narrower fine ridges. These transverse bands and ridges curve increasingly backward from the dorsal towards the ventral side so as to form acute angles with the sutures on the ventro-lateral sides of the specimen. A very similar type of ornamentation is known in specimens of *Neumatoceras* from Percé, Quebec, and from the Bighorn formation of Wyoming.

In one specimen, S. 10899 (Pl. V, figs 2-4), the longitudinal ribbing of the mould is more distinct. The dorsal outline is distinctly convex and there is a marked gibbosity of the dorsal side at the base of the living chamber. This specimen thus recalls *Beloitoceras* and is only provisionally included in *Neumatoceras drummuckense*, since the possibility cannot be ruled out that the differences in shape of the dorsal side may be due to distortion, and the transverse ornamentation of this specimen is similar to that of typical *Neumatoceras drummuckense*.

*Comparisons and affinities.* The genus *Neumatoceras* was

established by Foerste in 1935 (p. 31) for forms differing from *Beloitoceras* " chiefly in being distinctly humped along the upper (adoral) part of the ventral outline of the phragmocone . . . the dorsal outline along the upper (adoral) part of the phragmocone and all of the living chamber tends to be relatively straight with faint incurvature at top and along the lower (adapical) part of the phragmocone." *Neumatoceras drummuckense* differs from the genotype, *N. gibberosusm* Foerste, and most other representatives of the genus in having the ventral hump at the base of the living chamber rather than in the anterior part of the phragmocone, but the straight dorsal outline removes it too far from typical *Beloitoceras* to be included in that genus. *N. drummuckense* is closely similar to *N. milleri* Foerste from the basal part of the Bighorn formation of Wyoming, from which it is almost indistinguishable. In that species, however (Foerste, 1935, p. 36, pl. 4, fig. 4), which was only referred to this genus by Foerste with some reservation, the living chamber seems to contract less rapidly and in *N. drummuckense* the dorsal side of the conchs tends to be straighter than in the Bighorn species. The relationships of both species are certainly closer with *Neumatoceras* than with *Beloitoceras*.

Genus *Cyrtorizoceras* Hyatt.

*Cyrtorizoceras* ? sp. ind.

Plate V, Figs. 12-14.

*Material.* One internal mould of living chamber and portion of phragmocone, S. 10900.

*Description.* The specimen is 40 mm. long, of which length 25 mm. are occupied by the living chamber. The characteristics of this shell are the slow rate of increase in diameter, the ventral position of the siphuncle close to the convex side of the conch, elliptical cross-section with more narrowly rounded ventral side, distinct lateral lobes of the sutures, and, at least dorsally, unconstricted aperture.

There is not enough of this form preserved for it to be placed with certainty. The specimen shows certain features characteristic of *Cyrtorizoceras,* but it might also belong to some more strongly incurved genus as *Manitoulinoceras* or *Richardsonoceras*, both well known from the Ordovician of North America.



Genus *Diestoceras* Foerste.

*Diestoceras lamonti* sp. nov.

Plate VI, Figs. 2, 3.

*Material.* One internal mould of an entire specimen and one fragment.

*Holotype.* S. 10901.

*Diagnosis.* Small species with straight and rapidly tapering phragmocone.

*Description.* The holotye is 56 mm. long, of which length 32.5 mm. are occupied by the almost completely preserved phragmocone. The dorso-ventral diameter of the phragmocone increases from about 8 mm. to 28 mm.; both dorsal and ventral outlines are slightly convex in the adoral part of the phragmocone. The dorso-ventral diameter then increases further to about 32 mm. at about 7 mm. above the base of the living chamber and decreases again to 28.5 mm. at the aperture which seems to be elliptical and entire. The specimen is not very much compressed secondarily, but is slightly distorted obliquely. The measurements of the lateral diameter are, therefore, probably almost correct. The lateral diameter increases from about 8 mm. to a maximum of 21 mm. and decreases again towards the aperture, but the actual figure for the lateral diameter here cannot be given. The height of the camerae increases from 1.8 mm. to 3.0 mm. in the second-last camera, but the height of the last camera is only 1.6 mm. The sutures are straight and there is no indication of a ventral saddle.

The siphuncle is close to the ventral wall of the conch; it is possible that it is actually in contact with the wall in the adapical part of the phragmocone.

The surface of the mould of the holotype shows faint traces of longitudinal ribbing.

*Comparisons and affinities.* In typical *Diestoceras* the greatest gibbosity of the conch is attained in the adoral part of the phragmocone, just behind the base of the living chamber. There are, however, a few species known in which the basal portion of the living chamber is the most inflated part of the conch as it is the case in *Diestoceras lamonti.* The only form with which this species can be in any way compared is *Diestoceras acuminatum* Strand (1933, p. 86, pl. 11, fig. 3) from Etage 5a of the Oslo area. In this species the phragmocone expands very rapidly and the greatest gibbosity is reached at the base of the

living chamber. In *D. lamonti* the rate of expansion of the conch is still more rapid and the greatest gibbosity is reached slightly, but distinctly, above the base of the living chamber.

*Diestoceras scoticum* sp. nov.
Plate V, Fig. 15.
Plate VI, Figs. 4-7.

*Material.* Five internal moulds of almost entire specimens and additional fragments.

*Holotype.* S. 10902.

*Diagnosis.* Small species, straight, with greatest gibbosity above the base of the living chamber.

*Description.* The holotype is 40 mm. long and half of this length is occupied by the living chamber. The dorso-ventral diameter at the base of the living chamber is 26.5 mm., increasing to 29 mm. at 6.5 mm. above the base of the living chamber. Further on the living chamber is contracted towards the aperture whose dorso-ventral diameter is probably not more than 26 mm. The aperture is entire and elliptical. The specimen is, unfortunately, rather much compressed secondarily and the original dorso-ventral diameter must have been smaller than the figures given above. On the other hand, the maximum lateral diameter, which is now only 17 mm., must have been larger originally. In another specimen which has been subjected to less compression the maximum dorso-ventral diameter is 26.5 mm., and the corresponding lateral diameter 19.5 mm.

The height of the camerae in the holotype increases to 3.2 mm. in the second-last camera, whereas the last camera is only 2 mm. high. The sutures are straight along one side of the holotype, whereas they form a sinus on the opposite side; this, however, is probably due to distortion of the specimen. If the other specimens are compared, it seems most likely that the sutures are straight with the exception probably of a slight saddle on the ventral side.

The phragmocone has an apical angle of approximately 35°. The siphuncle is close to, but not actually in contact with, the ventral wall of the conch. The segments seem to be about as wide as they are long, but their exact structure cannot be determined.

*Comparisons and affinities.* Several species of *Diestoceras* are known with which this species might be compared, but it is



most closely related to *D. isotelorum* Strand from horizon 4dγ of the Oslo area, immediately below Etage 5a. It is, in fact, difficult to find differences between the two species, but the fact must be kept in mind that the holotype of *D. isotelorum* is not a mature specimen. The only perceptible difference seems to be one of size. The holotype of *D. isotelorum*, though an immature specimen, is 55 mm. long. The holotype of *D. scoticum* is a mature specimen and is only 40 mm. long. Another difference may be found in the sutures which have slight lateral lobes in *D. isotelorum* whereas they are most probably straight, with a slight ventral saddle, in *D. scoticum*. If, however, mature specimens of *D. isotelorum* should be found, the two species may turn out to be identical.

Among the Percé species, *D. cooperi* Foerste (1936, p. 382, pl. 55, figs. 3, 4) is similar to *D. scoticum* in the slender and compressed shape of the conch, but is easily distinguished by its bigger size and its more strongly contracted aperture. Also *D. vagum* and *D. anticostiense* Foerste from the English Head formation and from the Vauréal formation of the island of Anticosti are comparable species, but *D. vagum* is a larger form with a smaller apical angle of the phragmocone and the otherwise similar *D. anticostiense* has its greatest gibbosity in the adoral part of the phragmocone instead of in the adapical part of the living chamber. Both the English Head and the Vauréal formations are equivalents of the Richmond of the American mainland.

## Summary.

A small cephalopod fauna from the Starfish Bed of the Upper Drummuck Group of the Girvan district is described. It consists of new species of *Zitteloceras, Neumatoceras, Diestoceras,* and an unrecognizable *Cyrtorizoceras*. *Zitteloceras* and *Neumatoceras* have not been previously recorded from any European deposits. The fauna has a strongly American aspect of decidedly Ordovician affinities, one species being very closely related to a species in the basal part of the Bighorn formation of Wyoming. No striking similarities exist with the cephalopod fauna of Percé, Quebec. Certain affinities are noticeable with species in the Norwegian zone 4dγ and Etage 5a. Affinities with the Lyckholm beds of Estonia are less striking.

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## EXPLANATION OF PLATES V. AND VI.

### PLATE V.

(All figures natural size).

Fig. 1. *Neumatoceras drummuckense* sp. nov. Lateral view of specimen showing traces of surface ornamentation. S. 10898.

Figs. 2, 3, 4. *Neumatoceras drummuckense* sp. nov. Lateral, dorsal and ventral views. S. 10899.

Fig. 5. *Zitteloceras costatum* sp. nov. Ventral view of specimen showing ventral sinuses formed by lirae. S. 10891.

Fig. 6. *Zitteloceras costatum* sp. nov. Holotype. Lateral view. S. 10890.

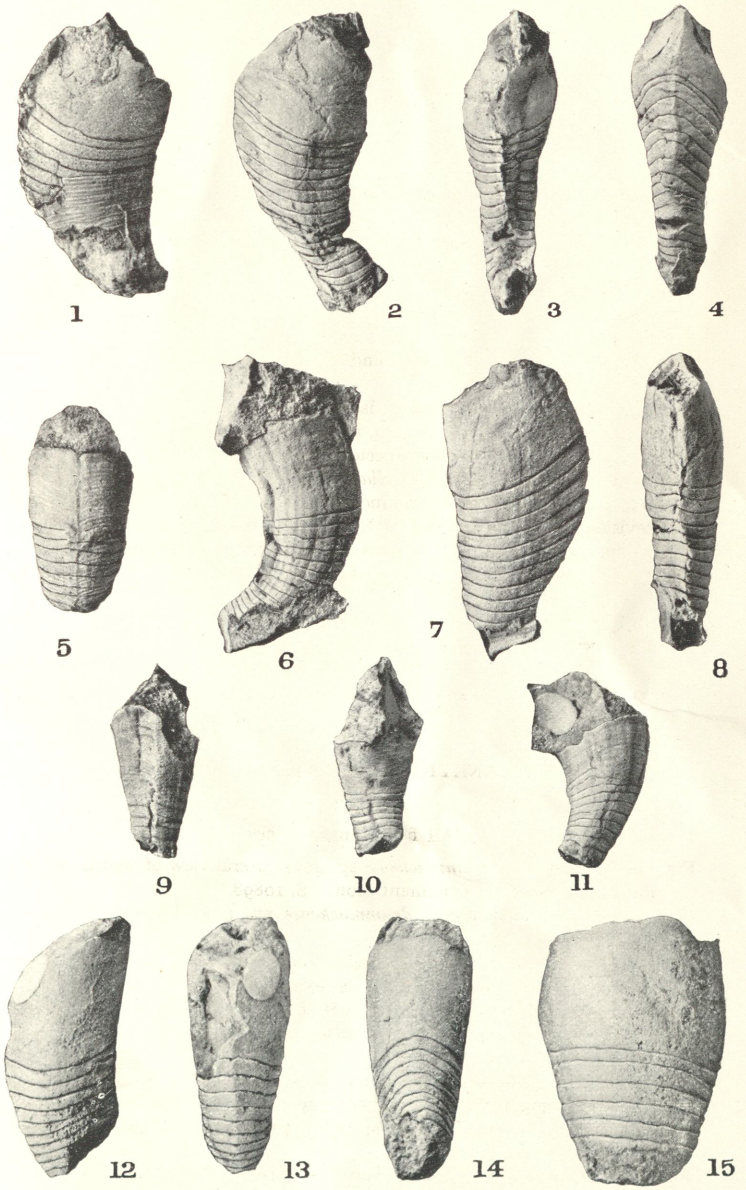
Figs. 7, 8. *Neumatoceras drummuckense* sp. nov. Holotype. Lateral and dorsal views. S. 10897.

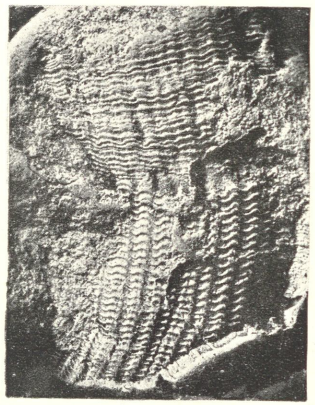
Figs. 9, 10, 11. *Zitteloceras costatum* sp. nov. Ventral, dorsal and lateral views of comparatively undistorted specimen. S. 10892.

Figs. 12, 13, 14. *Cyrtorizoceras* ? sp. ind. Lateral, ventral and dorsal views. S. 10900.

Fig. 15. *Diestoceras scoticum* sp. nov. Holotype. Lateral view. S. 10902.







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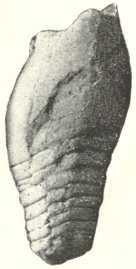

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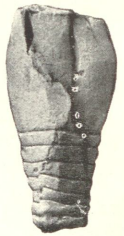

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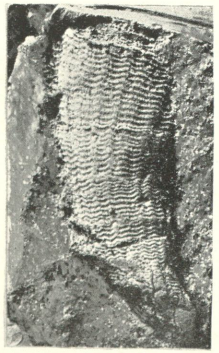

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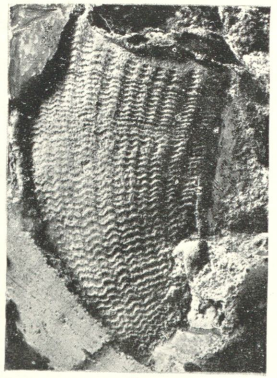

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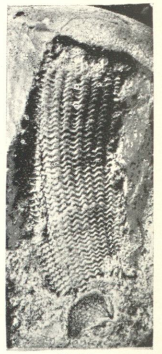

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## PLATE VI.

Fig. 1. *Zitteloceras costatum* sp. nov. Plasticine cast of external mould of living chamber, × 2.3. S. 10893.

Figs. 2, 3. *Diestoceras lamonti* sp. nov. Holotype. Dorsal and lateral view. Nat. size. S. 10901.

Fig. 4. *Diestoceras scoticum* sp. nov. Ventral view of but slightly distorted specimen. Nat. size. S. 10903.

Figs. 5, 6, 7. *Diestoceras scoticum* sp. nov. Lateral, ventral and dorsal views. Nat. size. S. 10904.

Figs. 8, 9, 10. *Zitteloceras costatum* sp. nov. Plasticine casts of external moulds of various parts of phragmocones. Slightly enlarged.

Fig. 8 S. 10894.
Fig. 9 S. 10895.
Fig. 10 S. 10896.

All the figured specimens are in the collection of the Hunterian Museum, University, Glasgow.