UPPER JURASSIC AND LOWER CRETACEOUS GRAMMATODONTINAE (BIVALVIA) FROM SOUTHERN ALEXANDER ISLAND

By L. E. WILLEY

ABSTRACT. Seven species of Grammatodontinae (Bivalvia) are recorded from Mesozoic sediments of Upper Oxfordian–Kimmeridgian to Albian (or younger) age from southern Alexander Island. Five new species are described and formally named. The stratigraphical distribution of the subfamily in Alexander Island is discussed.

GRAMMATODONTINAE are widespread throughout most of the marine Mesozoic succession exposed in the southern part of Alexander Island. They are particularly common in the argillaceous sediments but also occur in arenaceous and rudaceous rocks. Several specimens have also been collected from a tuffaceous sequence of beds at locality A which is stratigraphically equivalent to sediments forming the upper parts of the section measured at locality B (Succession Cliffs) (Fig. 1).

Modern Arcidae can be broadly separated into two ecological groups:

i. The free burrowers.
ii. The bysally attached.

Stanley (1970, p. 90) has shown that the two groups are separated by a ratio of height to overall length of approximately 1 : 1·35. The degree of elongation of the Alexander Island specimens, coupled with the flattening of the ventral surface, would therefore appear to indicate an upright byssal form of attachment (Stanley, 1970, p. 22). The concentration of large numbers of valves, some articulated, at specific horizons was suggested by Taylor and others (1974) to indicate periods of reduced sedimentation during which hard grounds may have developed, thus enabling these bivalves to become attached. Kauffman (1969, p. *N*147) has suggested that most groups of byssate, closely attached bivalves "are inhabitants of shelf environments and are concentrated in, and especially adapted to, high-energy shallow-water conditions of the littoral and shallow sublittoral benthic zones." This view is in broad agreement to the environments suggested by the occurrence of Grammatodontinae in deposits from inter-deltaic and shelf-facies zones in Alexander Island (Horne, 1967, 1969; Taylor and others, 1974).

SYSTEMATIC DESCRIPTIONS

FAMILY PARALLELODONTIDAE DALL 1898

SUBFAMILY GRAMMATODONTINAE BRANSON 1942

Genus *Grammatodon* Meek and Hayden 1861
Type species: *Arca* (*Cucullaea*) *inornata* Meek and Hayden 1859
Grammatodon subrectangulus sp. nov.

Figs. 2a and 4a

Material

Nine internal and external moulds and two internal casts. Two specimens from both stations KG.719 and 720 (on the southern side of Ablation Valley) and seven from locality Z. Specimen KG.401.571, the external mould of a right valve from locality Z, has been designated as the holotype.

Diagnosis

Shell small for genus, equivalve, inequilateral, sub-rectangular in outline. Hinge line straight, about 0·9 of the overall length of the shell. Umbo slightly anterior of the mid-line,

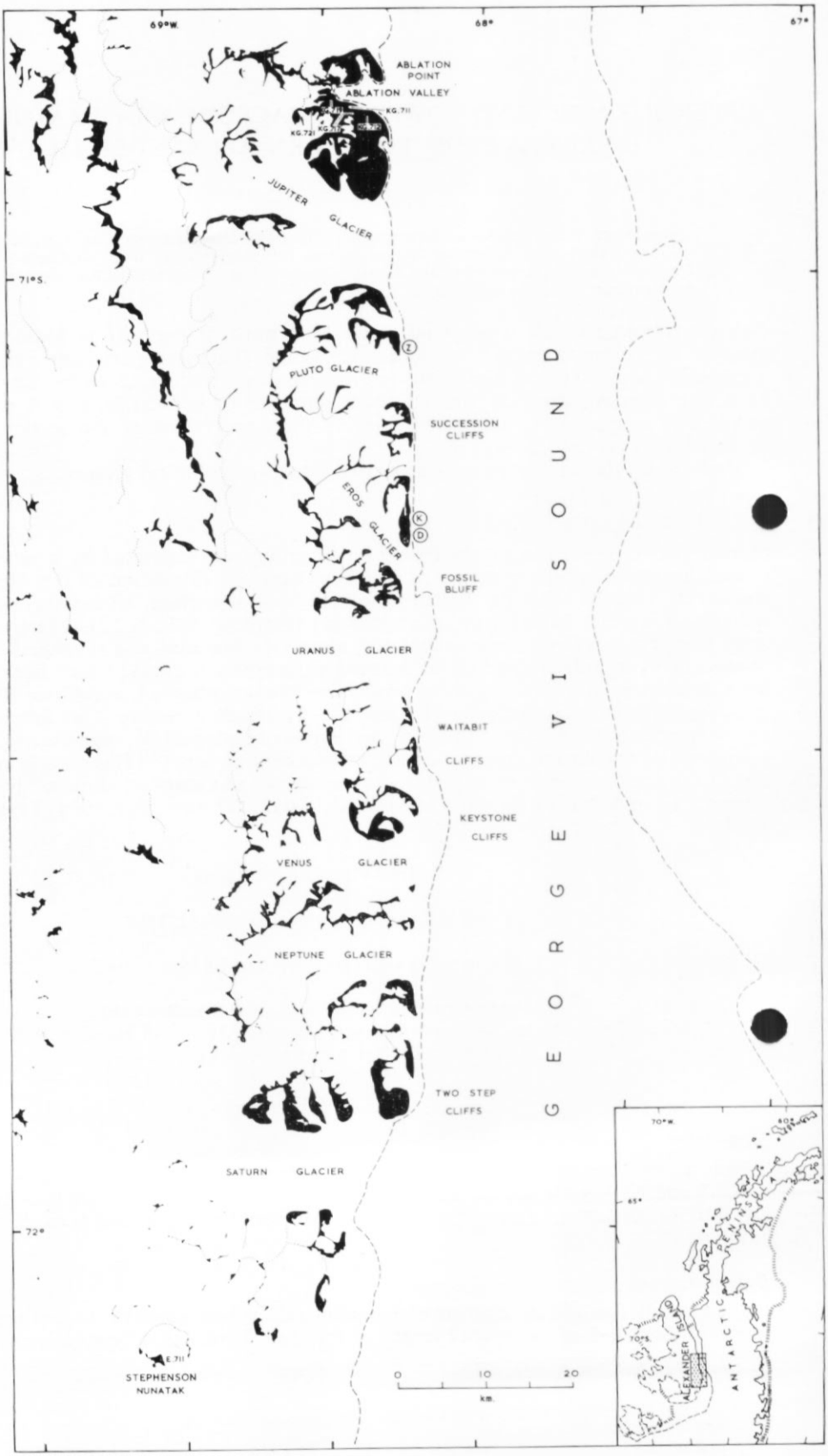


Fig. 1. Sketch map of part of Alexander Island showing the location of the area discussed and the locations from which specimens of Grammatodontinae were collected.

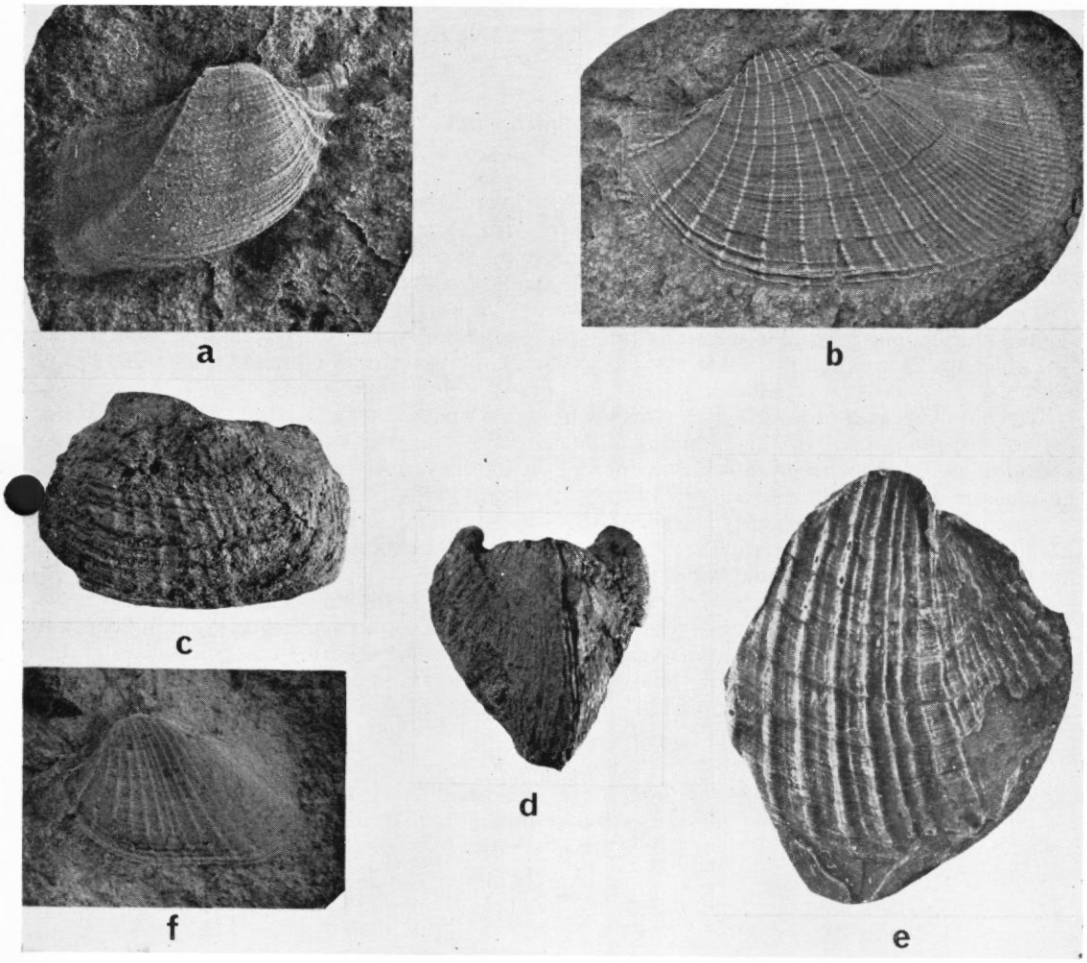


Fig. 2. a. *Grammatodon subrectangulus* sp. nov.; latex cast of a mould of the holotype, a right valve showing the external ornament, from locality Z; ×2, coated (KG.401.571).
b. *Grammatodon* (*Indogrammatodon*) aff. *fyfei* Marwick; latex cast of a mould of a left valve showing the external ornament, from the southern side of Ablation Valley; ×2, coated (KG.719.39).
c. *Grammatodon* (*Indogrammatodon*) cf. *robusta* (Etheridge); internal mould of the left valve of an articulated specimen, from the southernmost Tethys Nunataks; ×1, coated (KG.1616.8).
d. *Grammatodon* (*Indogrammatodon*) cf. *robusta* (Etheridge); posterior view of the same specimen illustrating the degree of inflation of both valves; ×1, coated (KG.1616.8).
e. *Grammatodon* (*Indogrammatodon*) cf. *robusta* (Etheridge); latex cast of a mould of a right valve showing the external ornamentation, from station KG.1716; ×2, coated (KG.1716.3).
f. *Grammatodon* (*Indogrammatodon*) *antarctica* sp. nov.; latex cast of the holotype, a mould of a right valve showing the external ornament, from locality Z; ×2, coated (KG.401.543).

broad and inflated. Beak projects above the hinge line and is incurved, orthogyrate and non-contiguous. Cardinal area concave. A prominent curved carina extends from the umbo to the postero-ventral margin and marks off a concave area against the posterior part of the dorsal margin. Carina at anterior end of the shell poorly defined. External ornament consists of radial ribs and faint threads, and concentric growth lines and undulations. One poorly defined radial rib ornaments the postero-dorsal area and three–four the anterior area. Across the main body of the shell several threads originate from the umbo and extend towards the ventral margin.

Description

The holotype of this species is the external mould of a right valve (Fig. 2a). The shell is small for the genus, equivalve, inequilateral and sub-rectangular in outline. The ratio of height to overall length is about 1 : 1·5. The hinge line is straight and extends about 0·9 of the total length of the shell. A broad and inflated umbo is situated about 0·3 of the length of the shell from the anterior extremity. The beak projects above the hinge line and is incurved, orthogyrate and non-contiguous. The cardinal area is concave (terminology of Reinhart (1943, p. 7)). A pronounced carina, dorsally concave, extends from the umbo to the postero-ventral margin and marks off a slightly concave area against the posterior part of the dorsal margin. A poorly defined, obtuse carina is developed at the anterior end of the shell. The line of the dorsal margin meets that of the almost straight posterior margin at an angle of about 90–100° and that of the slightly convex anterior margin at about 85–90°. The convex line of the anterior margin passes smoothly into that of the line of the anterior margin and rounds abruptly into that of the posterior margin. None of the margins is crenulated and there is no gape.

External ornament of both valves consists of radial ribs and threads, and concentric growth lines and undulations. In the holotype, the main body of the valve is crossed by a set of diverging radial threads originating in the region of the umbo. Concentric growth lines and undulations are also developed and become stronger towards the ventral margin. In other specimens three–four radial ribs, separated by broad interspaces containing two–four radial threads, ornament the anterior area. A single, poorly defined radial rib crosses the area between the dorsal margin and the postero-dorsal carina.

An incomplete pattern of the dentition of a right valve is shown by specimen KG.401.560 (Fig. 4a). Four sub-parallel, sub-horizontal pseudolaterals occupy the posterior margin and several short oblique cardinals and sockets occur towards the anterior margin. Although this specimen is incomplete in the region below the umbo, other fragments suggest that no additional cardinals are developed in this area.

Measurements

Specimen number	*Height* (mm.)	*Length* (mm.)	*Convexity*‡ (mm.)	*l/h*
KG.401.7	8·2	12·0*	2·5	1·46
KG.401.503	7·6	12·5*	2·3	1·56
KG.401.528	9·5	13·4	3·5	1·41
KG.401.529	7·0*	12·2	2·3	1·74
KG.401.560	8·5	12·0*	2·2	1·41
KG.401.571†	6·7	11·2	2·8	1·67
KG.719.46	8·2	13·7	2·9	1·67
KG.720.37	9·0*	16·0*	5·0*	1·67

* Estimated. † Holotype. ‡ After Reinhart, 1943, fig. 2a.

Remarks

Several of the specimens described as *Grammatodon takiensis* Kimura, from Upper Jurassic (? Tithonian) and Berriasian sediments of Japan (Tamura, 1959*a*, p. 54, pl. 6, figs. 1 and 2, 1959*b*, p. 172, pl. 19, figs. 4–6; Hayami and others, 1960, p. 91, pl. VIII, figs. 6 and 7) are closely comparable to the Alexander Island specimens. However, the holotype of *takiensis* (Kimura, 1956, p. 85, pl. 1, fig. 6) differs from the present species in several features:

i. It has a more elongate and quadrate outline.
ii. The main body of the shell is ornamented by a series of radial ribs.
iii. The anterior teeth are more oblique.

Although Hayami and others (1960, p. 91) noted similar differences between the holotype and many of the Japanese specimens described as *takiensis*, they considered these variations to be intraspecific. The author now believes that these specimens are more closely comparable to, if not conspecific with, the Alexander Island species.

Several North American species are similar to the Alexander Island specimens. The closest comparison is with *Grammatodon haguei* Meek from the Upper Jurassic of the western United States (Imlay, 1967, p. 75, pl. 1, figs. 2–6), but it has a more strongly developed radial ornament and the anterior teeth are almost horizontal. *Grammatodon inornatus* Meek, from Oxfordian sediments of the upper Missouri area (Meek and Hayden, 1865, p. 90, pl. III, fig. 9a–c), is distinguished by its greater degree of inflation, poorly developed posterior carina and the apparent absence of any radial ornamentation. The dentition of the Canadian species, *Parallelodon* [*Grammatodon*] *cardioceratanum* Crickmay, from the Upper Jurassic of British Columbia (Crickmay, 1930, p. 45, pl. VIII, figs. 1–3) is quite distinctive with the development, in the posterior part of the hinge plate of the left valve, of four sinuous pseudolaterals. This species is also almost devoid of any form of radial ornamentation.

The European species, *Grammatodon concinnus* (Phillips), from the Great Oolite and the Oxford Clay of England (Morris and Lycett, 1853, p. 50, pl. V, fig. 7; Arkell, 1930, p. 431, pl. XV, figs. 2–4, text-figs. 9 and 10; Newell, 1969, p. *N*258, figs. C6 and 8a and b), is distinguished from the Alexander Island specimens by its less prominent radial ornamentation and a more centrally positioned umbo. *Grammatodon hommeyi*, from Cordebugle (Normandy) (Chavan, 1952, p. 11, pl. 1, figs. 16–18), is sub-rhomboidal in outline, the concentric ornamentation is stronger and no radial threads are developed between the anterior radial ribs as in the Alexander Island examples.

Subgenus *Grammatodon* (*Indogrammatodon*) Cox 1937
Type species: *Cucullaea virgata* Sowerby 1840
Grammatodon (*Indogrammatodon*) aff. *fyfei* Marwick

Figs. 2b and 4b

aff. *Parallelodon egertonianus* (Stoliczka); Newton and Crick, 1908, pl. 1, figs. 1–4.
aff. *Parallelodon egertonianus* (Stoliczka); Trechmann, 1923, p. 263, pl. XIV, fig. 8.
aff. *Grammatodon* (*Indogrammatodon*) *fyfei* Marwick, 1953, p. 89, pl. 11, fig. 1.
Grammatodon sp.; Thomson, 1975, p. 32, fig. 3a.

Material

Eighteen internal and external moulds and one internal cast. Three from station KG.1748, 11 from the Ablation Point area and five from locality Z.

Description

These specimens are small to medium in size for the subgenus, equivalve and inequilateral (Fig. 2b). The outline of the shell is sub-trapeziform and maximum inflation takes place in the region of the broad umbo. The ratio of height to length is about 1 : 1·80. The hinge line is long and straight, extending almost the total length of the shell. The umbo is situated about 0·4 of the total length of the shell from the anterior margin. The beak projects above the hinge line, is incurved, prosogyrate and not contiguous. The triangular cardinal area is slightly concave. A carina extends from the umbo to the postero-ventral margin and marks off a flattened area against the posterior part of the dorsal margin. The line of the dorsal margin meets the convex line of the posterior margin at an angle of about 105–115° and the convex line of the anterior margin at an angle of about 70–80°. The slightly convex line of the ventral margin passes smoothly into that of the anterior margin and rounds, through almost 90°, into that of the posterior margin. In specimen KG.719.40, the test is 0·5 mm. thick in the umbonal region, thickening to 2·0 mm. near the ventral margin and to 3·7 mm. along the hinge margin. None of the margins is crenulated and there is no gape.

External ornament consists of two sizes of radial ribs, and weaker concentric growth lines and undulations. In the left valve a set of closely spaced radial ribs originates in the region of the umbo and diverges across the main body of the shell, becoming stronger and more widely spaced towards the ventral margin. Posteriorly, they are absent, the obtuse carina and the postero-dorsal area being ornamented by a series of closely spaced riblets. Across the main body of the valve, and in the antero-dorsal area of the larger specimens, the interspaces

between the ribs contain up to six fine intercallery riblets. A reticulate pattern results from the intersection of the radial ribs and the concentric growth lines and undulations. The external ornament of the right valve is not as strongly differentiated as that of the left valves.

Only one incomplete specimen, KG.1748.29 (Fig. 4b), has so far been obtained showing any dentition. This example is of a right valve with, at least, two strong sub-parallel pseudolaterals on the posterior part of the hinge plate and several moderately strong, short inclined cardinals towards the anterior.

Measurements

Specimen number	*Height* (mm.)	*Length* (mm.)	*Convexity* (mm.)	*l/h*
KG.401.521	9·1	14·7	3·6	1·62
KG.401.547	10·4	18·0*	3·2	1·73
KG.401.559	9·2	16·4	2·7	1·78
KG.701.20	10·5	16·0	3·2	1·51
KG.712.32	9·1	15·8	1·2	1·73
KG.712.107	10·0	15·3	2·8	1·53
KG.712.109	11·2	16·5	3·1	1·48
KG.719.13	18·4	32·7	4·3	1·73
KG.719.14	26·4	40·0*	5·1	1·52
KG.719.39	18·9	31·4	3·6	1·66
KG.719.53	10·5	16·7	3·8	1·59
KG.720.37	10·0	16·0*	4·6	1·60
KG.1748.31	11·1	16·9	4·5	1·52

* Estimated.

Remarks

The Alexander Island specimens are closely comparable to *Grammatodon* (*Indogrammatodon*) *fyfei* described by Marwick (1953, p. 89, pl. 11, fig. 1) from the Ohauan (Tithonian) of New Zealand. However, the radial ribbing of the holotype is more numerous and the shell inflated to a greater extent. A specimen figure is *Parallelodon egertonianus* Stoliczka, from the Upper Jurassic of New Zealand (Trechmann, 1923, p. 261, pl. XIV, fig. 8), is closely comparable to the Alexander Island specimens and was considered by Marwick (1953, p. 89) to be a juvenile of *fyfei*. Several specimens, figured as *egertonianus* from the (?) Oxfordian–Kimmeridgian of Arabia (Newton and Crick, 1908, p. 5–7, pl. 1, figs. 1–4), also appear to be more closely comparable to *fyfei* than to the holotype of *egertonianus* (Stoliczka, 1865, p. 89, pl. VIII, figs. 7, 7a and 7b).

Examples of *Grammatodon* sp. from late Jurassic (Kimmeridgian–Tithonian) sediments at Carse Point, Palmer Land (Thomson, 1975, p. 32, fig. 3a), have been examined and are considered to be conspecific with the Alexander Island specimens.

The Japanese specimens of *Grammatodon sachalinensis* (Schmidt), from the Upper Cretaceous of Hokkaido (Nagao, 1932, p. 31–34, pl. VI, figs. 1–5), can be distinguished from the Alexander Island specimens by their finer external ornament and by their distinctive dentition, consisting of four sub-horizontal pseudolaterals and a series of cardinals, sub-vertical beneath the umbo and slightly divergent upwards toward the anterior margin.

Grammatodon (*Indogrammatodon*) cf. *robusta* (Etheridge)

Fig. 2c–e

cf. *Cucullaea robusta* Etheridge, 1872, p. 340, pl. 20, fig. 1.
cf. *Cucullaea costata* Etheridge, 1872, p. 340, pl. 20, fig. 2.
cf. *Cucullaea robusta* Etheridge, Etheridge *Jr.* (*In* Jack and Etheridge, 1892, p. 565, pl. 26, figs. 1 and 11).
Indeterminate ribbed bivalve (*? Trigonia*) Cox, 1953, p. 3.
cf. *Grammatodon* (*Indogrammatodon*) *robusta* (Etheridge), Fleming, 1966, p. 13–16, pl. 5, figs. 1–5.
cf. *Grammatodon* (*Indogrammatodon*) *robusta* (Etheridge), Skwarko, 1973, p. 96, pl. 21, figs. (?) 1, 5, 8, 11, 14 and 17.

Material

Three external moulds and one internal cast. Two from station KG.1616 and one each from stations KG.1716 and 1721.

Description

The Alexander Island specimens are medium-sized for the subgenus, equivalve, inequilateral and sub-trapeziform in outline (Fig. 2c). The valves are highly inflated in the region of the broad umbo (Fig. 2d). The total thickness of an articulated example (KG.1616.8) is almost equal to the height of the shell. The hinge line is long and straight, extending almost the complete length of the shell. The beak projects above the hinge line and appears to be incurved and not contiguous. The triangular cardinal area is highly concave and the ligament areas are crossed by fine ligament grooves. A poorly defined convex carina extends from the umbo towards the postero-ventral margin, separating off a broad, triangular-shaped concave area below the dorsal margin. The line of the dorsal margin meets the line of the slightly convex posterior margin at an angle of about 95–100° and that of the convex anterior margin at about 70–80°. The convex line of the ventral margin passes smoothly into that of the anterior margin and rounds through almost 90° into that of the posterior margin. The margins are uncrenulated and there is no gape.

The external ornament of these valves is illustrated by a fragment of an external mould of a right valve (KG.1716.3; Fig. 2e). A series of strong radial ribs, separated by broad concave interspaces, extends from the umbo over the main body of the shell, becoming stronger and more widely spaced towards the ventral margin. One or more intercalated riblets occupy the interspaces. Concentric growth lines and folds are also developed. The ribs are much finer and more closely spaced on and above the posterior carina. The ornament of the left valve appears to be stronger and more widely spaced.

No dentition is preserved in these specimens.

Measurements

Specimen number	*Height* (mm.)	*Length* (mm.)	*Convexity* (mm.)	*l/h*
KG.1616.8	32·0*	48·0*	14·2	1·50
KG.1721.21	22·0*	35·9	7·0	1·63

* Estimated.

Remarks

The Alexander Island specimens appear to be closely comparable to several of the smaller examples of *Grammatodon* (*Indogrammatodon*) *robusta* (Etheridge), from the Lower Cretaceous of Queensland (Fleming, 1966, p. 13–16, pl. 5, figs. 1, 2 and 4a–b) and from the Aptian of the Wiso Basin, Northern Territory, Australia (Skwarko, 1973, p. 96–97, pl. 21, figs. (?) 1, 5, 8, 11 and 17). However, the poor preservation and, in particular, the lack of dentition information for the Alexander Island specimens prevent a closer comparison being made.

Similarities of outline and degree of inflation are apparent with *Grammatodon* (*Indogrammatodon*) *iddurghurensis* Cox, from the Argovian sediments of Kachh (Cox, 1940, p. 52, pl. III, figs. 3–6, pl. IV, figs. 1 and 2), but the variation and the coarseness of the external ornament of the Indian species distinguishes them from the Alexander Island specimens.

Through the courtesy of Dr. N. J. Morris (British Museum (Nat. Hist.)), a fragment (E.711.2), collected by V. E. Fuchs and R. J. Adie, from Stephenson Nunatak, Alexander Island (Cox, 1953, p. 3), has been examined and is considered to be conspecific with the present material.

Grammatodon (*Indogrammatodon*) *antarctica* sp. nov.

Figs. 2f and 4c

Material

Thirty-two internal and external moulds and two internal casts. One each from localities D and K, four from the Ablation Point area and the remainder from locality Z. Specimen KG.401.543, an external mould of a left valve from locality Z, has been designated as the holotype.

Diagnosis

Shell small for the subgenus, equivalve and inequilateral. Valve outline sub-trapeziform. Shell inflated in the region of the broad umbo which is situated slightly anterior of the mid-line. Hinge line long and straight. The beak projects above the hinge line, is incurved, orthogyrate and not contiguous. A small umbonal depression extends to the ventral margin, forming a sinus. The cardinal area is slightly concave. A prominent postero-dorsal carina extends from the umbo to the postero-ventral margin and marks off a flat triangular area below the posterior part of the dorsal margin. A poorly defined carina extends from the umbo to the antero-ventral margin. The external ornament consists of two sizes of radial ribs, and of weaker concentric growth lines and undulations. The ribs are separated by broad concave interspaces containing, mainly in the anterior region, one or two poorly defined intercallery riblets. The dentition of the posterior part of the hinge plate, of the left valve, consists of at least three sub-horizontal sub-parallel pseudolaterals. Several small obliquely inclined cardinals occur below the beak, and at the anterior extremity of the hinge plate are several short cardinals aligned sub-parallel to the hinge line.

Description

The holotype is an external mould of a left valve from locality Z (KG.401.543; Fig. 2f). The shell is relatively small for the subgenus, equivalve, inequilateral and sub-trapeziform. Maximum inflation occurs in the region of the umbo. The hinge line is straight and long, extending almost the full length of the shell. The broad umbo is situated about 0·4 of the length of the shell from the anterior end. The beak projects above the hinge line and is incurved, orthogyrate and not contiguous. The triangular cardinal area appears to be slightly concave. A small umbonal depression extends from the umbo towards the postero-ventral margin and widens, producing a broad sinus in the ventral margin. A carina extends from the umbo towards the postero-ventral margin and marks off a flat triangular area below the posterior part of the dorsal margin. A smaller, poorly defined carina is present at the anterior end of the shell. The line of the dorsal margin meets the almost straight line of the posterior margin at an angle of about 95–110° and the slightly convex line of the anterior margin at about 55–75°. The line of the ventral margin passes smoothly into the line of the anterior margin and rounds abruptly into that of the posterior margin. None of the margins is crenulated and there is no gape.

Ornament consists of two sizes of radial ribs and of weaker concentric growth lines and low concentric growth undulations. A series of ribs extends from the umbo and diverges across the main body of the shell towards the ventral margin. They are separated by broad interspaces which, mainly in the anterior region, contain one or two intercallery riblets. Posteriorly, the ribs are finer and over the postero-dorsal area they are closely spaced. The ornamentation of the right valve is finer and more closely spaced than that of the left valve.

In none of these specimens is the complete dentition pattern preserved. Based on information from fragmentary impressions of the hinge plates of several specimens, KG.401.324, 549, 613, 657 and 19.29, a composite sketch of the dentition of the left valve has been drawn (Fig. 4c). On the posterior part of the hinge plate of the left valve there are at least three sub-horizontal sub-parallel pseudolaterals. Below the umbo several short, obliquely inclined cardinals converge towards a point below the beak. Anteriorly, several short cardinals are aligned sub-parallel to the hinge line.

Measurements

Specimen number	*Height* (mm.)	*Length* (mm.)	*Convexity* (mm.)	*l/h*
KG.401.487	9·5	14·2	2·8	1·49
KG.401.543†	11·5	18·5	3·2	1·61
KG.401.586	8·5	12·3	2·3	1·44
KG.401.605	8·9	13·5	2·6	1·52
KG.401.627	14·5	20·8	3·1	1·43
KG.401.681	9·1	14·8	3·4	1·57
KG.401.714	13·7	20·0*	3·5	1·46
KG.402.56	9·9	14·1	4·2	1·43
KG.18.32	14·0	22·7	4·2	1·55

* Estimated. † Holotype.

Remarks

Whereas the development of a prominent postero-dorsal carina is more common in *Grammatodon*, the external ornament of the Alexander Island specimens is more typical of *Indogrammatodon* (Newell, 1969, p. *N*257–58, fig. C6).

Closely comparable to the Alexander Island specimens are two species, *Grammatodon crassilineatus* Imlay and *G. delicatulus* Imlay from the Upper Jurassic sediments of Mexico (Imlay, 1940, p. 400–01, pl. 53, figs. 16–19 and 22–25). However, compared to the present species, the major series of radial ribs as developed in *crassilineatus* is stronger, more widely spaced and has one to three intercallery riblets. In *delicatulus* the ribs are finer, more closely spaced than those in the Alexander Island species and also have one to three intercallery riblets. No umbonal depression is developed in either of the Mexican species.

The specimen of *Parallelodon* [*Grammatodon* (*Indogrammatodon*)] *egertonianus* (Stoliczka), from the Middle Kimmeridgian of Kenya (Weir, 1930, p. 81, pl. IX, figs. 12 and 12a), is similar to the Alexander Island specimens. However, the Kenyan specimen is proportionally more elongate, lacks an umbonal depression and appears to be lacking any intercallery riblets.

Immature examples of *Grammatodon* (*Indogrammatodon*) *virgatus* (Sowerby), from the Upper Jurassic sediments of India (Cox, 1937, p. 196, pl. 15, figs. 8 and 9, 1940, pl. II, figs. 25 and 30), are similar to the Alexander Island specimens. The Indian species can be distinguished by being proportionally more elongate, having a coarser, more variable ornament, a posterior carina which becomes less prominent in mature specimens and in lacking an umbonal depression.

An ornament similar to that of the Alexander Island specimen is developed in examples of *Grammatodon* [*Indogrammatodon*] *arahemense* Skwarko, from the late Neocomian of Northern Territory, Australia (Skwarko, 1966, p. 73, pl. 1, figs. 5, 7 and 8), but the Australian species is more robust, has a distinctive dentition and lacks both a pronounced posterior carina and an umbonal depression.

Both *Parallelodon* [*Grammatodon* (*Indogrammatodon*)] *montanayensis* (de Loriel), from the Oxfordian of the Swiss Jura (Arkell, 1930, pl. XV, fig. 6), and *Grammatodon* [*Indogrammatodon*] *jonesi* (Tate), from the Neocomian Uitenhage Series of South Africa (Tate, 1867, p. 161, pl. IX, fig. 9; Kitchin, 1908, p. 88–89, pl. II, figs. 14 and 14a), can be distinguished from the present species by their finer radial ornament and the absence of an umbonal depression. *G. jonesi* also lacks any intercallery riblets.

Grammatodon (*Indogrammatodon*) *elongatus* sp. nov.

Figs. 3a, b and 4d

Material

Eleven internal and external moulds and two internal casts. Three specimens from the Ablation Point area and ten from locality Z. Specimen KG.719.17, an incomplete external

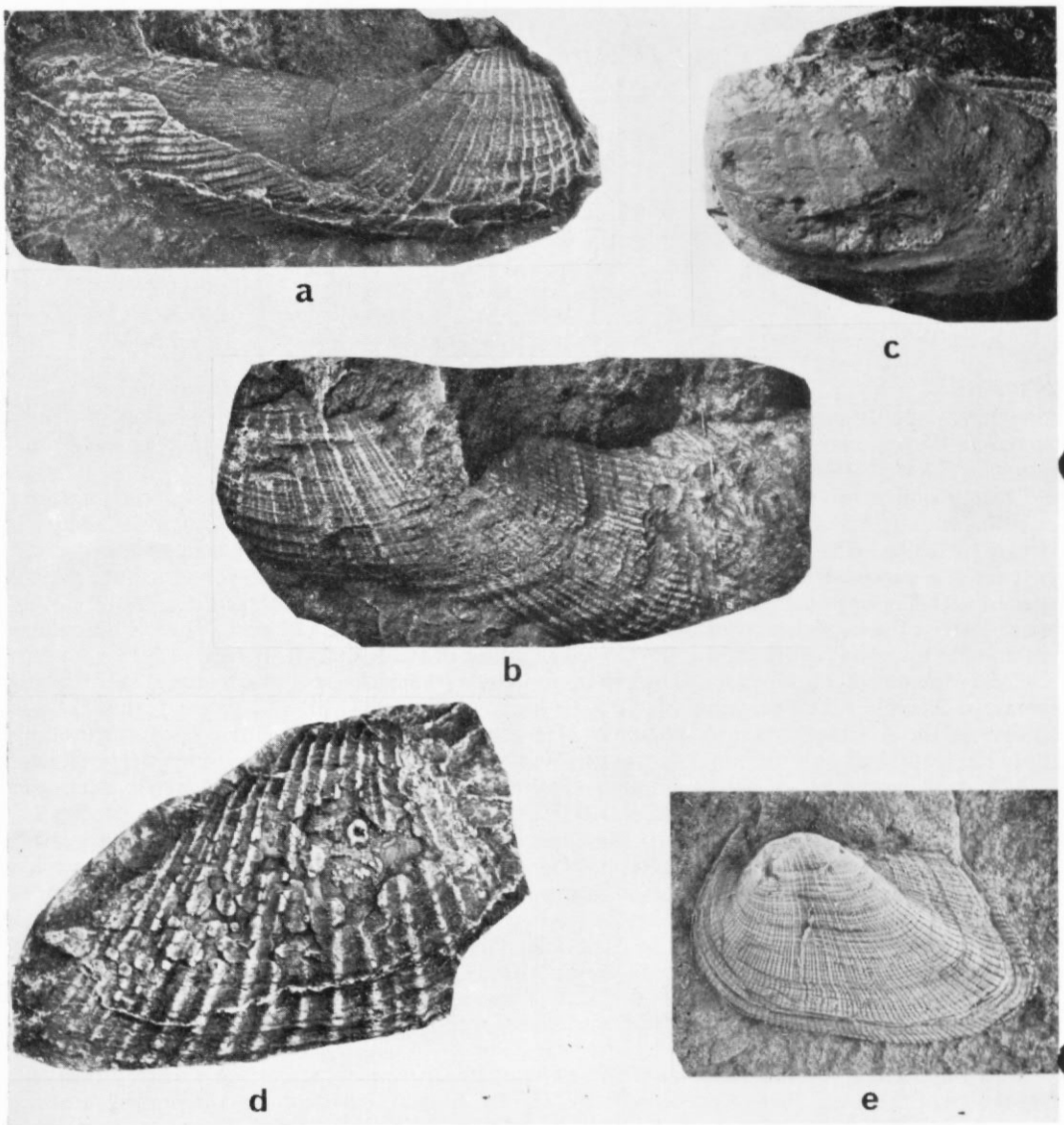


Fig. 3. a. *Grammatodon* (*Indogrammatodon*) *elongatus* sp. nov.; latex cast of the holotype, an external mould of a right valve showing the ornamentation, from the southern side of Ablation Valley; ×1·5, coated (KG.719.17).

b. *Grammatodon* (*Indogrammatodon*) *elongatus* sp. nov.; latex cast of an external mould of a left valve illustrating the variation of ornamentation, from locality Z; ×1·5, coated (KG.401.710).

c. *Grammatodon* (*Nanonavis*) *falcatus* sp. nov.; the holotype, an incomplete internal mould of a weathered left valve, from station KG.1748; ×1, coated (KG.1748.36).

d. *Grammatodon* (*Nanonavis*) *falcatus* sp. nov.; latex cast of an external mould of a right valve showing the ornamentation, from station KG.1669; ×1·5, coated (KG.1669.2).

e. *Grammatodon* (*Nanonavis*) *alexandra* sp. nov.; latex cast of the holotype, an external mould of a left valve, illustrating the ornamentation, from locality T; ×3, coated (KG.103.80).

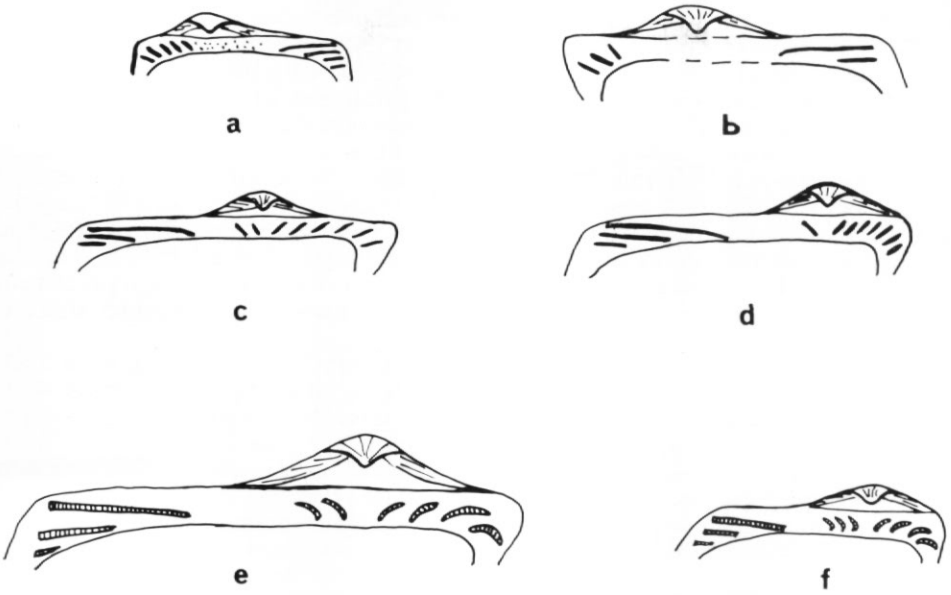


Fig. 4. a. *Grammatodon subrectangulus* sp. nov.; diagrammatic illustration of the dentition of a right valve; ×3 (KG.401.560).
b. *Grammatodon* (*Indogrammatodon*) aff. *fyfei* Marwick; diagrammatic illustration of the dentition of a right valve; ×3 (KG.1748.29).
c. *Grammatodon* (*Indogrammatodon*) *antarctica* sp. nov.; composite diagrammatic illustration of the dentition of a left valve; ×3.
d. *Grammatodon* (*Indogrammatodon*) *elongatus* sp. nov.; diagrammatic illustration of the dentition of a left valve; ×1·5 (KG.719.9).
e. *Grammatodon* (*Nanonavis*) *falcatus* sp. nov.; composite diagrammatic illustration of the dentition of a left valve; ×1·5.
f. *Grammatodon* (*Nanonavis*) *alexandra* sp. nov.; diagrammatic illustration of the dentition of a left valve; ×3.

mould of a right valve collected from the southern side of Ablation Valley, has been designated as the holotype.

Diagnosis

Shell medium-sized for the subgenus, equivalve and inequilateral. Valve outline sub-trapeziform, highly elongate posteriorly. Hinge line long and straight extending almost the complete length of the shell. Valves inflated in umbonal region. Beak projects above the hinge line, is incurved, prosogyrate and not contiguous. A well-defined carina extends from the umbo, becoming increasingly obtuse towards the postero-ventral margin and marks off a concave area below the posterior part of the dorsal margin. External ornament consists of two sizes of radial ribs, and of concentric growth lines and undulations. A series of ribs originates from the umbonal region and diverges towards the ventral margin. The broad interspaces between the ribs are occupied by two to six intercallery riblets. Towards the posterior carina, and over the postero-dorsal area, the ornament consists of closely spaced secondary ribbing. The ornament of the left valve is stronger than that of the right. In the left valve the dentition consists of three strong, sub-horizontal pseudolaterals and several short cardinals, steeply inclined below the umbo and becoming sub-horizontal towards the anterior margin.

Description

The holotype is an incomplete external mould of a right valve with a highly elongate posterior region (Fig. 3a). The shell is medium-sized for the subgenus, equivalve and inequilateral. The

valves are sub-trapeziform in outline and maximum inflation occurs in the region of the broad umbo. The hinge line is straight and extends almost the complete length of the shell. The umbo is situated about 0·25 of the length of the shell from the anterior margin. The beak projects above the dorsal margin, is incurved, prosogyrate and not contiguous. The cardinal area is slightly concave and fine ligament grooves ornament the triangular ligament areas. A well-defined carina extends from the umbo but it becomes increasingly ill-defined and obtuse towards the postero-ventral margin. It marks off a concave triangular area below the posterior part of the dorsal margin. A poorly defined antero-ventral carina is also developed. The line of the dorsal margin meets the convex line of the posterior margin at an angle of about 95–110° and that of the convex anterior margin at an angle of about 65–75°. The slightly convex line of the ventral margin passes smoothly into that of the anterior margin and rounds broadly into that of the posterior margin. None of the margins is crenulated and there is no gape.

External ornament consists of two sizes of radial ribs, and of concentric growth lines and undulations. In the left valves (Fig. 3b) a series of strong ribs originates from the umbonal region and diverges across the main body of the shell towards the ventral margin. The broad concave interspaces are occupied by two to six intercallery riblets. Towards the posterior carina and over the postero-dorsal area the strong radial ribs are absent. This area is ornamented by closely spaced secondary ribbing. The intersection of the radial ribbing and the concentric growth lines and undulations produces a reticulated pattern. In the right valves the major ribs are fewer in number and the riblets are not as prominent as those on the left valves (Fig. 3a).

An almost complete dentition of the left valve is preserved on specimen KG.719.9 (Fig. 4d). In the posterior part of the hinge plate there are at least three strong, sub-horizontal sub-parallel pseudolaterals, the upper one extending a considerable distance towards the beak. A series of short cardinals is steeply inclined below the beak and becomes increasingly more sub-horizontal towards the anterior margin.

Measurements

Specimen number	*Height* (mm.)	*Length* (mm.)	*Convexity* (mm.)	*l/h*
KG.401.455	5·3	10·9	2·4	2·06
KG.401.462	11·6	21·4	3·1	1·84
KG.401.496	7·3	15·1	2·2	1·84
KG.401.710	26·0*	52·0*	4·8	2·0
KG.719.9	16·5	30·0	4·4	1·82
KG.719.17†	20·0*	50·0	5·7	2·5
KG.719.42	7·0	15·9	2·7	2·27

* Estimated. † Holotype.

Remarks

These specimens are distinguished from other species described from Alexander Island by:

i. Their marked posterior elongation.
ii. Greater length/height ratio.
iii. Distinctive ornamentation with considerable variation between valves.
iv. Lack of an umbonal depression.

A posterior elongation of the shell similar to that developed in the Alexander Island specimens was reported by Nagao (1932, p. 31) in one specimen of *Grammatodon* [*Nanonavis*] *sachalinensis* (Schmidt) from the Upper Cretaceous of Hokkaido, Japan. Although *sachalinensis* has an *Indogrammatodon*-type external ornament, it differs from that of the present species in being finer and in having only a single riblet between the radial ribs. The Japanese species also has a distinctive dentition which includes three long anterior cardinals and one short ventral cardinal orientated sub-parallel to the hinge margin on the anterior part of the hinge plate.

One specimen of *Grammatodon* [*Nanonavis*] *yokoyami* Yabe and Nagao, from the Ishido and Kawarazawa Groups (Upper Hauterivian–Lower Aptian) of Japan (Yabe and others, 1926, pl. XII, fig. 25), is considerably more elongate than the other topotypes of *yokoyami* but its external ornament is much finer than that developed in the Alexander Island species.

Subgenus *Nanonavis* Stewart 1930
Type species: *Arca carinata* Sowerby 1812
Grammatodon (*Nanonavis*) *falcatus* sp. nov.

Figs. 3c, d and 4e

Material

Twelve specimens including eight external and two internal moulds and two external casts. Single specimens were obtained from both stations KG.1618 and 1680; two from station KG.1669 and the remainder from station KG.1748. Specimen KG.1748.36, an internal cast of a left valve, is designated holotype. The specific name is derived from the Latin *falcatus* (sickle) and refers to the shape of the cardinal teeth.

Diagnosis

Shell medium to large for the subgenus, equivalve and inequilateral. Valve outline sub-trapeziform. Umbo broad and inflated. Hinge line straight and long, extending almost the complete length of the shell. The beak projects above the dorsal margin, is incurved, prosogyrate and not contiguous. A large, concave, triangular cardinal area is developed below the beak. A poorly defined, obtuse carina extends from the umbo towards the postero-ventral margin, marking off a convex triangular area below the dorsal margin. External ornament consists of a series of strong radial ribs, separated by broad concave interspaces, and by concentric growth lines and ridges. Dentition of the posterior part of the hinge plate of the left valve (Fig. 4e) consists of three strong pseudolaterals. The upper pseudolateral lies sub-parallel to the hinge margin, whereas the lower ones are inclined at a low angle to it. In the anterior part of the hinge plate are a series of short falcate cardinals. All teeth are serrated.

Description

The holotype (KG.1748.36) is an incomplete internal mould of a badly weathered left valve (Fig. 3c). The shell is medium to large in size for the subgenus, equivalve and inequilateral. The valves are sub-trapeziform in outline. A long straight hinge line extends almost the complete length of the shell. The broad inflated umbo is situated about 0·3 of the total length of the shell from the anterior margin. The beak projects above the line of the dorsal margin, is incurved, prosogyrate and not contiguous. Below the beak is a large, concave, triangular cardinal area. A poorly defined carina extends from the umbo towards the postero-ventral margin, marking off a convex triangular area below the dorsal margin. A second, poorly defined, carina extends from the umbo towards the antero-ventral margin. The line of the dorsal margin meets the convex line of the posterior margin at an angle of about 100–105° and that of the convex anterior margin at about 70–75°. The convex line of the ventral margin passes smoothly into that of the anterior margin and rounds more abruptly into that of the posterior margin. None of the margins is crenulated and there is no gape.

External ornament is well illustrated on specimen KG.1669.2, and consists of a series of strong radial ribs, separated by broad concave interspaces, and by concentric growth lines and folds (Fig. 3d). The ribs are weaker and more widely spaced over the postero-dorsal area. The radial ribs are not as strongly developed in the right valves.

A composite sketch of the dentition of a left valve has been drawn from the fragmentary evidence preserved on the holotype and several topotypes (KG.1748.34, 35 and 37) (Fig. 4e). In the posterior region are three strong pseudolaterals. The upper pseudolateral lies sub-parallel to the hinge margin, whereas the lower ones are inclined at a low angle to it. A series of inclined falcate cardinals originates below the beak; towards the anterior margin they are

relatively strong and curve tangentially to both dorsal and anterior margins. All teeth are serrated.

Measurements

Specimen number	*Height* (mm.)	*Length* (mm.)	*Convexity* (mm.)	*l/h*
KG.1748.32	19·6	29·0*	7·1	1·48
KG.1748.33	12·8	18·9	2·3	1·48
KG.1748.34	37·5	55·0*	9·6	1·49
KG.1748.35	30·0*	45·0*	11·2	1·50
KG.1748.36†	35·0*	50·0*	10·6	1·43
KG.1748.37	30·0*	46·0*	10·8	1·53
KG.1748.38	29·0*	40·0*	10·3	1·38

* Estimated. † Holotype.

Remarks

These specimens are comparable in size, outline and dentition to the larger examples of *Grammatodon* (*Nanonavis*) *carinata* (Sowerby) (Sowerby, 1812, p. 96, pl. XLIV (lower figure); Woods, 1899–1903, p. 45–47, pl. VIII, figs. 3a–c and 8; Reinhart, 1937, p. 170–71, pl. 27, fig. 6a–c; Newell, 1969, p. *N*258, figs. C6, 6a and 6b). However, the ornament of the Alexander Island species is of an *Indogrammatodon*-type (Cox, 1937). Hayami (1965, p. 240) has ". . . recognized that several Cretaceous species of *Nanonavis* possess ornament of the *Indogrammatodon*-type". He suggested that *Nanonavis* probably developed from an *Indogrammatodon* stem and that such forms as *Nanonavis yokoyami* (Yabe and Nagao) and examples of *Indogrammatodon securis* (Leymerie) (Woods, 1899–1903, p. 44) were intermediate forms (Hayami, 1965, p. 238). These intermediate species can both be distinguished from the Alexander Island specimens by their finer ornament and, although they are not as robust, by being proportionally more elongate.

Although the external ornament of the Californian species, *Grammatodon* (*Nanonavis*) *brewerianus* (Gabb) (Stewart, 1930, p. 19–20, pl. 3, fig. 1), is poorly preserved, Stewart's description suggests that it is similar to the Alexander Island specimens. However, the Californian species has a well-defined posterior carina and a more centrally positioned umbo than the Alexander Island specimens.

Grammatodon (*Nanonavis*) *alexandra* sp. nov.

Figs. 3e and 4f

Material

Thirteen internal and external moulds and four internal casts. Single specimens from localities A, B and N; five each from localities R and T, and two each from stations KG.1743 and 1746. Specimen KG.103.80, an external mould of a left valve from locality T, is designated as the holotype.

Diagnosis

Shell small for the subgenus, equivalve and inequilateral. Valve outline sub-trapeziform. Hinge line long and straight, extending three-quarters of the total length of the shell. Umbo inflated, situated about one-quarter of the length of the shell from the anterior margin. Beak projects above the line of the dorsal margin, is incurved, orthogyrate and not contiguous. A dorsally concave carina extends from the umbo towards the postero-ventral margin and marks off a concave triangular area below the dorsal margin. A short, poorly defined carina is present at the anterior end of the shell. External ornament consists of numerous distinct, rather flattened radial ribs, separated by narrow grooves and by concentric growth lines and

folds. Dentition of the left valve consists of long, sub-parallel sub-horizontal pseudolaterals and short falcate cardinals. All teeth are finely serrated.

Description

The holotype (KG.103.80) is an external mould of a left valve (Fig. 3e). The shell has been slightly crushed below the umbo in the region of maximum inflation. These examples are small in size for the subgenus, equivalve and inequilateral. The valves are sub-trapeziform in outline and the hinge line is long and straight, extending about three-quarters of the total length of the shell. The broad inflated umbo is situated about one-quarter of the length of the shell from the anterior margin. The beak projects above the line of the dorsal margin, is incurved, orthogyrate and not contiguous. A dorsally concave carina extends from the umbo to the postero-ventral margin and marks off a concave triangular area below the dorsal margin. A short, poorly defined carina extends from the umbo to the antero-ventral margin. The line of the dorsal margin meets the almost straight line of the posterior margin at an angle of about 120–130° and that of the convex ventral margin at about 80–85°. The slightly convex line of the ventral margin passes smoothly into that of the anterior margin and rounds through an angle of about 120° into that of the posterior margin. The margins are uncrenulated and there is no gape.

The external ornament of both valves consists of a series of distinct, rather broad, flattened radial ribs separated by narrow interspaces, and by concentric growth lines and folds. The ornament is continued over the postero-dorsal area.

Fragmentary impressions of the hinge plate are preserved on specimens KG.1746.31b and 103.54 (Fig. 4f). On the posterior part of the hinge plate of the left valve there are three sub-horizontal sub-parallel pseudolaterals. A series of short falcate cardinals originates below the beak and those towards the anterior margin curve tangentially to the dorsal and anterior margins. The teeth are finely serrated.

Measurements

Specimen number	*Height* (mm.)	*Length* (mm.)	*Convexity* (mm.)	*l/h*
KG.1.767	10·0	21·0	2·3	2·10
KG.1.768	8·6	16·1	2·5*	1·89
KG.1.769	11·3	19·6	4·1	1·73
KG.6.18	11·8	21·7	2·2	1·84
KG.8.79b	3·6	5·9	1·6	1·64
KG.10.78	7·0	15·0	2·7	2·14
KG.103.54	9·0*	17·0*	2·5*	1·89
KG.103.80†	8·9	15·2	2·4	1·71
KG.1743.31	9·2	17·0*	3·3	1·84
KG.1746.31b	7·8	13·0	1·8	1·67

* Estimated. † Holotype.

Remarks

This species is distinguished from *Grammatodon* (*Nanonavis*) *falcatus* by its smaller size but proportionally greater elongation, and by its typical *Nanonavis*-type ornament.

Several of the smaller specimens of *Grammatodon* (*Nanonavis*) *carinata* (Sowerby), from the Gault and Upper Greensand of England (Woods, 1899–1903, pl. VIII, figs. 4–7), are similar in size and outline but have a coarser ornament than that of the Alexander Island specimens.

Grammatodon [*Nanonavis*] *yokoyami* (Yabe and Nagao), from the Upper Miyakoan (Upper Neocomian to Albian) sediments of Japan (Yabe and others, 1926, p. 44–45, pl. 12, figs. 12, 13 and 15; Hayami, 1965, p. 238–61, pl. 27, figs. 8–13), has a similar outline and length/height ratio to the Alexander Island specimens but has an external ornament of the *Indogrammatodon*-type.

Stratigraphical Discussion

The ages of most of the species described here have largely been determined from associated ammonites (Thomson, 1971, 1974), belemnites (Willey, 1972, 1973) and *Inoceramus* (Thomson and Willey, 1972) in stratigraphically equivalent or near-equivalent horizons (Table I). The Grammatodontinae appear to have evolved during the (?) Upper Carboniferous (Newell, 1969, p. *N*258) and the *Grammatodon* group was cosmopolitan in the Jurassic and Cretaceous. The first example from Alexander Island was collected in 1948–49 by V. E. Fuchs and R. J. Adie from station E.711 (Stephenson Nunatak) (Fig. 1). This specimen was examined by Cox (1953, p. 3), who suggested that it was "a fragment of an indeterminate ribbed bivalve (*Trigonia* ?)". It is now considered to be conspecific with *Grammatodon* (*Indogrammatodon*) cf. *robusta* (p. 6). Taylor (1971, p. 152) recognized the value of *Grammatodon* as a faunal horizon marker in Alexander Island, but no descriptions and stratigraphical discussion have been published until now. Some indication of the vertical stratigraphical distribution of

Table I

Age	*Grammatodontinae species*	*Remarks and associated stratigraphically significant faunas*
—?—?—?—	*Grammatodon* (*Indogrammatodon*) cf. *robusta*	(?) From Stephenson Nunatak conglomerate and from probable lateral equivalents at station KG.1616 stratigraphically above beds, at station KG.1615, containing a spindly heteromorph very like *Hamites tenuis* Sowerby, which themselves appear to be above mudstones at Stephenson Nunatak containing *Antarcticoceras* (Thomson, 1974) and a "silesitid" similar to those from locality W
Albian	*Grammatodon* (*Indogrammatodon*) cf. *robusta*	At station KG.1721 with an, as yet, undiagnostic heteromorph ammonite fauna and fragments of Dimitobelidae
	Grammatodon (*Nanonavis*) *falcatus* *Grammatodon* (*Nanonavis*) *alexandra*	At locality B with *Dimitobelus macgregori* (Glaessner), the heteromorph *Antarcticoceras* and a silesitid/desmoceratid fauna and stratigraphically above beds at localities A and T containing late Aptian–Lower Albian *Eotetragonites* faunas
	Grammatodon (*Nanonavis*) *alexandra*	At locality W in beds containing an ammonite fauna correlated with the Lower Albian fauna from locality B, and stratigraphically above beds containing an uppermost Aptian–Lower Albian fauna at locality T
Aptian	*Grammatodon* (*Nanonavis*) *alexandra*	In association with *Sanmartinoceras patagonicum* Bonarelli and *Peratobelus* sp. (?) nov. at locality T and in equivalent beds at locality N. At locality R with a rich ammonite fauna of Aconeceratinae including species of *Aconeceras* and *Theganeceras*

TABLE I—*continued*

Neocomian	Barremian Hauterivian Valanginian		Not yet proven in Alexander Island
	Berriasian	*Grammatodon* (*Indogrammatodon*) *antarctica*	In sediments at localities D and K equivalent to beds containing *Belemnopsis gladiatoris* Willey and *Hibolithes* sp. nov. (?)
		Grammatodon (*Indogrammatodon*) aff. *fyfei*	At locality J associated with *Spiticeras* sp. (not unlike *S. damesi* (Steuer)) and the belemnites *B. alexandri* Willey, *B. gladiatoris* Willey and *B.* aff. *uhligi* Stevens
		Grammatodon subrectangulus *Grammatodon* (*Indogrammatodon*) aff. *fyfei* *Grammatodon* (*Indogrammatodon*) *antarctica* *Grammatodon* (*Indogrammatodon*) *elongatus*	At locality Z in beds containing *Bochianites gracilis* Thomson, *Phyllopachyceras* (?) sp. *Himalayites* (?) sp. and *Neocosmoceras* aff. *sayi* Simionescu. On the southern side of Ablation Valley with *Haplophylloceras strigile* (?) Blanford and *Bochianites* aff. *versteeghi* (Boehm)
		Grammatodon subrectangulus	At locality Z with *Phylloceras* sp., *Substreblites* sp. and *Sarasinella* aff. *hondana* Haas
Tithonian		*Grammatodon* (*Indogrammatodon*) aff. *fyfei*	In association with a *Virgatosphinctes* / *Aulacosphinctoides* fauna from the southern side of Ablation Valley
Kimmeridgian to Upper Oxfordian		*Grammatodon* (*Indogrammatodon*) aff. *fyfei*	From the disturbed sediments on the southern side of Ablation Valley containing *Pachysphinctes* sp., *Belemnopsis* cf. *keari* Stevens, *B.* cf. *tanganensis* (Futterer), *Inoceramus haasti* Hochstetter and *I.* aff. *subhaasti* Wandel. (?) Equivalent to those sediments in which *Perisphinctes* (*Orthosphinctes*) *transatlanticus* Steinmann (Howarth, 1958), *B.* cf. *alfurica* (Boehm) and *B.* cf. *gerardi* (Oppel) occur

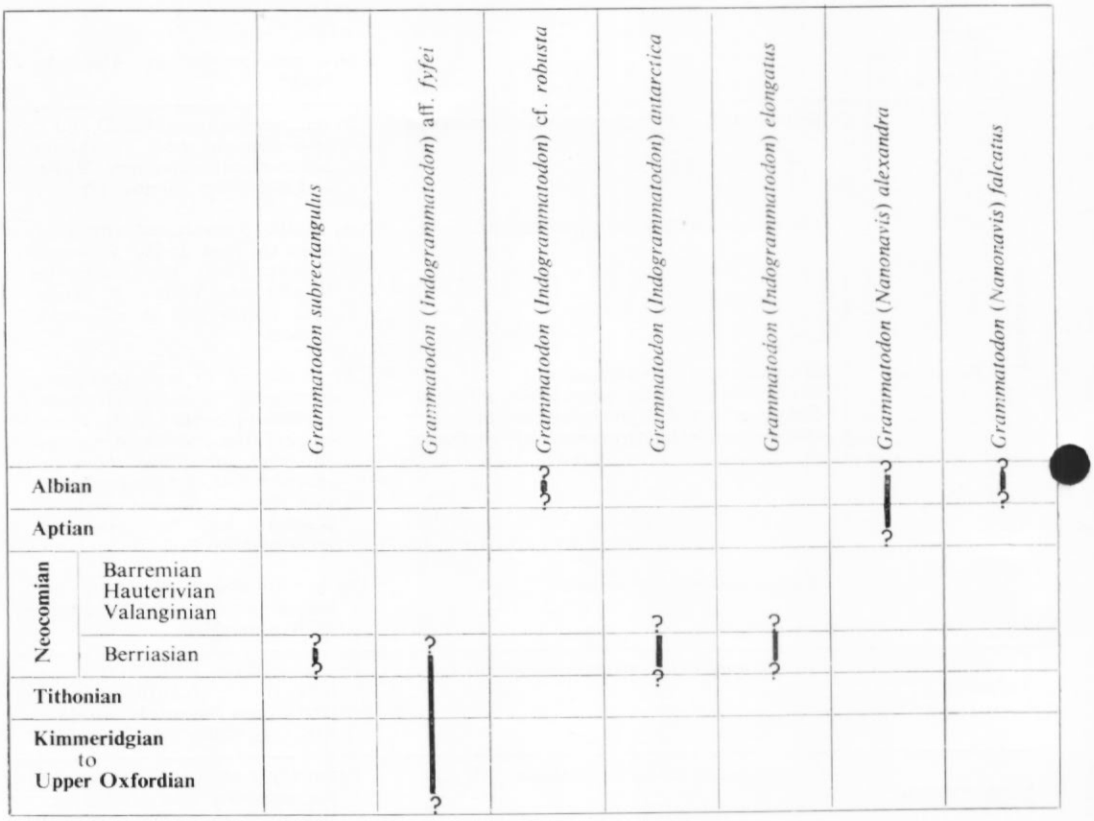
individual species in Alexander Island is given in Table II, but this is by no means definitive because many areas still remain to be examined.

None of the material from Alexander Island has been identified precisely with previously described species. However, considerable similarities have been noted with several of the species amongst the varied faunas from such regions as Australia, Japan, India, Mexico and Europe. The apparent absence of comparable faunas in South America may be partly a reflection of the lack or unavailability of literature relating to this region.

Grammatodon sp. has been described from late Jurassic (Kimmeridgian–Tithonian) sediments at Carse Point, Palmer Land (Thomson, 1975), and reported from (?) Upper Jurassic sediments in the Behrendt Nunataks and Weather Guesser Nunataks, eastern Ellsworth Land (Laudon and others, 1969).

Several specimens of Grammatodontinae have also been reported from northern Graham Land. Wilckens (1910, p. 26–28, pl. 2, fig. 10, *non* figs. 8, 9 and 11) described a specimen of

TABLE II



Nodenskjoldia nordenskjoldi Wilckens, from Cretaceous sediments on Snow Hill Island, and Bibby (1966, p. 25) reported the presence of *N. nordenskjoldi* Wilckens and *Cucullaea* (or *Grammatodon*) sp. from Upper Cretaceous sediments on Vega Island.

The Alexander Island examples of *Grammatodon* (*Indogrammatodon*) aff. *fyfei* Marwick are believed to be closely comparable to specimens from the Ohauan (Tithonian) of New Zealand (Marwick, 1953). Several specimens, figured as *egertonianus* from the Upper Jurassic of New Zealand (Trechmann, 1923) and the Oxfordian–Kimmeridgian of Arabia (Newton and Crick, 1908), appear to be more closely comparable to *fyfei* and are also similar to the Alexander Island specimens (p. 5). The specimens described by Thomson (1975) from late Jurassic (Kimmeridgian–Tithonian) sediments at Carse Point, Palmer Land, have been examined and are considered to be conspecific with the Alexander Island species.

Examples of *G.* (*I.*) aff. *fyfei* have been obtained from the disturbed sequence forming the basal 150 m. of sediments exposed at Ablation Point. These beds contain a poorly preserved Upper Oxfordian–Kimmeridgian fauna including:

Pachysphinctes sp.
Belemnopsis cf. *alfurica* (Boehm)
Belemnopsis cf. *gerardi* (Oppel)
Belemnopsis cf. *keari* Stevens
Belemnopsis cf. *tanganensis* (Futterer)
Inoceramus haasti Hochsetter
Inoceramus aff. *subhaasti* Wandel

and are probably equivalent to those beds from which a specimen of *Perisphinctes* (*Orthosphinctes*) cf. *transatlanticus* (Steinmann) was obtained (Howarth, 1958).

Immediately above the disturbed zone at Ablation Point, *Grammatodon* (*Indogrammatodon*) aff. *fyfei* has been obtained from sediments containing a varied ammonite fauna of Tithonian

age and dominated by species of *Virgatosphinctes* and *Aulacosphinctoides* (Elliott, 1974; Taylor and others, 1974). 1,000 m. higher in the stratigraphical sequence at Ablation Point *fyfei* re-appears associated with a Berriasian ammonite fauna rich in *Haplophylloceras strigile* (*?*) (Blanford) and *Bochianites* aff. *versteeghi* (Boehm) (Elliott, 1974; Taylor and others, 1974).

At locality Z, *Grammatodon* (*Indogrammatodon*) aff. *fyfei* occurs associated with a varied fauna of Berriasian age (Thomson, 1971, 1974; Thomson and Willey, 1972; Willey, 1973; Taylor and others, 1974) including:

Phyllopachyceras (*?*) sp.
Himalayites (*?*) sp.
Neocosmoceras aff. *sayi* (Simionescu)
Belemnopsis alexandri Willey
Belemnopsis gladiatoris Willey
Belemnopsis aff. *uhligi* Stevens
Hibolithes subfusiformis (Raspail)
Hibolithes antarctica Willey
Hibolithes aff. *marwicki mangaoraensis* Stevens
Hibolithes sp. nov. (*?*)
Inoceramus pseudosteinmanni Thomson and Willey.

Several specimens of *fyfei* have also been collected from mudstones overlying massive conglomerates west of a fault at locality J. They are associated with a fauna which included a fragmentary ammonite, *Spiticeras* sp. (not unlike *S. damesi* (Steuer)), and belemnites (*Belemnopsis alexandri* Willey, *B. gladiatoris* Willey and *B.* aff. *uhligi* Stevens), indicating a Berriasian age (Taylor and others, 1974).

Grammatodon (*Indogrammatodon*) *robusta* (Etheridge) has been described from several sequences of Lower Cretaceous (mainly Aptian) age in Australia (p. 7). The Alexander Island specimens considered to be comparable with *robusta* were collected from stations KG.1616, 1716 and 1721 (Fig. 1). No stratigraphically significant fossils have been obtained from station KG.1616 (the southernmost part of Tethys Nunataks) but pebbles from the interbedded pebble-conglomerates in a mainly sandstone sequence are of similar compositions to those forming the massive conglomerate at Stephenson Nunatak. A fragment (E.711.2) now identified as *G.*(*I.*) cf. *robusta* (p. 7), collected from an unknown horizon at Stephenson Nunatak, was probably obtained from within the conglomerate. Mudstones, about 150 m. below the base of the conglomerate at Stephenson Nunatak, contain a probable Albian fauna which includes the heteromorph *Antarcticoceras* (Thomson, 1974) (also known from locality B, Succession Cliffs (p. 16)) and a "silesitid" similar to those from locality W (Keystone Cliffs) (p. 16). In sediments at station KG.1615, stratigraphically above these ammonite beds at Stephenson Nunatak and below those containing *G.* (*I.*) cf. *robusta*, M. R. A. Thomson has identified a spindly heteromorph ammonite very like *Hamites tenuis* Sowerby from the mid Albian of Europe. A somewhat similar species has also been recorded by Spath (1925, p. 189) from the Upper Albian sediments of Portuguese East Africa as "*Torneutoceras*" sp. ind. and compared to *T.* [*Hamites*] *tenuis*. The conglomerate at Stephenson Nunatak and the sandstones and pebble-conglomerates at station KG.1616 probably represent the youngest part of the marine Mesozoic sedimentary sequence exposed in southern Alexander Island and are either Albian or younger in age.

A poorly preserved heteromorph ammonite fauna from station KG.1721 is, as yet, undiagnostic but fragments of Dimitobelidae suggest a probable Albian or younger age. No evidence is so far available to indicate the stratigraphical position of the sediments at stations KG.1669 and 1716.

Grammatodon subrectangulus sp. nov., *G.* (*Indogrammatodon*) *antarctica* sp. nov. and *G.* (*I.*) *elongatus* sp. nov. were collected with *G.* (*I.*) aff. *fyfei* and a Berriasian ammonite fauna, rich in *Bochianites* aff. *versteeghi* (Boehm), from the southern side of Ablation Valley (Taylor and others, 1974). In the lower 156 m. of sediments at locality Z *G. subrectangulus* was associated with a Berriasian ammonite fauna which includes *Phylloceras* sp., *Substreblites* sp. and *Sarasinella* aff. *hondana* Haas (Thomson, 1971, 1974; Taylor and others, 1974). Above these beds *G. subrectangulus*, *G.* (*I.*) *antarctica*, *G.* (*I.*) *elongatus* and *G.* (*I.*) aff. *fyfei* were obtained from sediments containing a varied Berriasian fauna (p. 17). *G.* (*I.*) *antarctica* has also been collected from localities D and K. Belemnites (including *Belemnopsis gladiatoris* and *Hibolithes* sp. nov. (*?*) (Willey, 1973)), collected from a sequence of beds partly equivalent to the lower

and middle parts of the stratigraphical section at locality D and above those at locality K, suggest that these sediments are Berriasian (or younger) in age.

G. (*Nanonavis*) *alexandra* sp. nov. was collected from a sequence of Aptian sediments at locality R (Fossil Bluff) containing a rich fauna of Aconeceratinae including species of *Aconeceras* and *Theganeceras* (Thomson, 1971, 1974; Taylor and others, 1974). Specimens of *G.* (*N.*) *alexandra* have also been obtained from Aptian sediments at locality T (Waitabit Cliffs) containing the ammonite *Sanmartinoceras patagonicum* Bonarelli and the belemnite *Peratobelus* sp. (*?*) nov. (Thomson, 1971, 1974; Willey, 1972; Taylor and others, 1974). Examples of *G.* (*N.*) *alexandra* were also collected from equivalent beds at locality N.

The sedimentary sequence at locality B (Succession Cliffs), where further specimens of *G.* (*N.*) *alexandra* were collected, contains the heteromorph *Antarcticoceras* (Thomson, 1974) and a silesitid/desmoceratid fauna which, as yet, cannot be satisfactorily correlated with extra-Antarctic faunas. However, this sequence lies stratigraphically above beds at locality A and the upper parts of those at locality T, containing *Eotetragonites* faunas which are believed to represent the uppermost parts of the Aptian or the lowest Albian (Thomson, 1974; Taylor and others, 1974). The presence of *Dimitobelus macgregori* (Glaessner) (typically Albian–Cenomanian) throughout the stratigraphical succession at locality B supports the Lower Albian or younger age suggested for these beds (Willey, 1972; Taylor and others, 1974).

G. (*Nanonavis*) *falcatus* sp. nov. was collected from sediments above the top of the stratigraphical section measured at locality A (KG.1748), in beds laterally equivalent to ones of Albian age which form the upper parts of the sequence at locality B. Further specimens were obtained from station KG.1680 (locality W, Keystone Cliffs), associated with ammonite faunas originally assigned to the Neocomian (? Barremian) (Thomson, 1971). However, a re-assessment of the ammonites suggested that they were more closely correlated with the Lower Albian faunas of Succession Cliffs (locality B) (Thomson, 1974). This re-appraisal of the stratigraphical position of the Keystone Cliffs faunas is in accord with field evidence which indicates that these beds lie stratigraphically above the uppermost Aptian–Lower Albian beds in the upper parts of the sequence at Waitabit Cliffs (locality T) (Taylor and others, 1974). No stratigraphically significant fossils have so far been identified from stations KG.1618 and 1669 where *G.* (*N.*) *falcatus* was also collected.

Although most of the Grammatodontinae described here have been assigned an age mainly on the basis of the ammonites, belemnites and *Inoceramus* associated with them, there are indications that, in Alexander Island, due to their wide distribution and specific variation they may be of increasing value for stratigraphical correlations.

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