BELEMNITES FROM SOUTH-EASTERN ALEXANDER ISLAND: II. THE OCCURRENCE OF THE FAMILY BELEMNOPSEIDAE IN THE UPPER JURASSIC AND LOWER CRETACEOUS

By L. E. WILLEY

ABSTRACT. 16 species of Belemnopseidae are described from the Upper Jurassic and Lower Cretaceous sediments of south-eastern Alexander Island. Also described are five new species of which *Belemnopsis gladiatoris*, *Belemnopsis alexandri*, *Hibolithes antarctica* and *Hibolithes belligerundi* are sufficiently well preserved to be formally named. The stratigraphical distribution of the Belemnopseidae in Alexander Island is discussed.

BELEMNOPSEIDAE, which are widely distributed throughout the Mesozoic of the Southern Hemisphere (Stevens, 1965*a*), have been collected from the Upper Jurassic and Lower Cretaceous sediments at several localities in south-eastern Alexander Island (Fig. 1) by members of the southern sledge party of the British Graham Land Expedition (1934–37), V. E. Fuchs and R. J. Adie of the Falkland Islands Dependencies Survey (1948–50), and more recently by members of the British Antarctic Survey, notably B. J. Taylor, M. R. A. Thomson, M. H. Elliott, C. M. Bell and the author. The specimens collected by the British Graham Land Expedition, and V. E. Fuchs and R. J. Adie, are housed at the British Museum (Nat. Hist.), and these have been examined through the courtesy of Dr. M. K. Howarth.

Measurement of belemnite guards

The system for the measurement of belemnite guards, as initiated by Avias (1953, p. 158–59) and adapted by Stevens (1965*a*), and used in the study of Dimitobelidae from south-eastern Alexander Island (Willey, 1972, p. 31–32, fig. 2) is followed here with the addition of two symbols, *dt* and *ds*, which are used to represent respectively the transverse and sagittal diameters at any distance from the apex. In all tables of measurements those figures marked with an asterisk (*) have been estimated.

SYSTEMATIC DESCRIPTIONS

FAMILY BELEMNOPSEIDAE NAEF 1922

Genus *Belemnopsis* Bayle 1878

Belemnopsis gladiatoris sp. nov.

Belemnites (*Belemnopsis*) *patagoniensis* Favre; Feruglio, 1936, p. 81, pl. X, figs. 1–4.

Fig. 2a–e

Material

Six virtually complete specimens (KG.401.683, 698 and 702; 402.19, 33 and 41), 60 additional guard fragments and nine phragmocones. Specimen KG.401.702 has been designated as the holotype. Most of this material was collected from locality Z but additional specimens were collected from locality F, in the vicinity of locality D and from the cliffs on the southern side of Jupiter Glacier (KG.1301) (Fig. 1). The specific name *gladiatoris* is derived from the Latin *gladiator* (swordsman).

Age: Lower Neocomian (Berriasian).

Diagnosis

Cylindro-conical, elongate and robust guard. Outline symmetrical, slightly hastate; profile non-hastate, asymmetrical. Apical cross-sections slightly depressed, those from the stem and alveolar regions becoming increasingly compressed. Apical termination moderately acute. Median ventral groove prominent, not extending to apex. No dorsal grooves present.

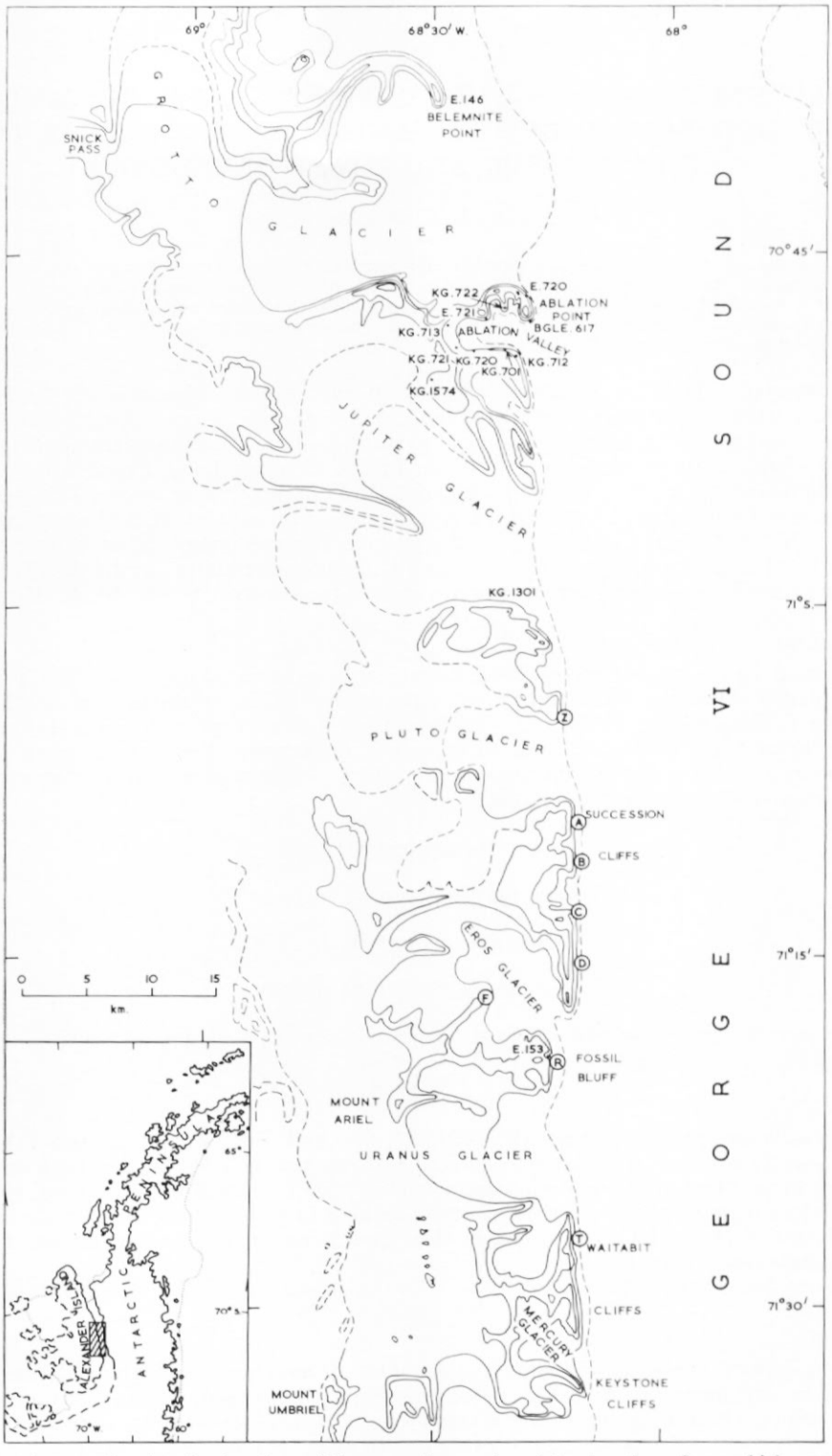

Fig. 1. Sketch map showing the location of the area discussed and the locations from which specimens of Belemnopseidae were collected.

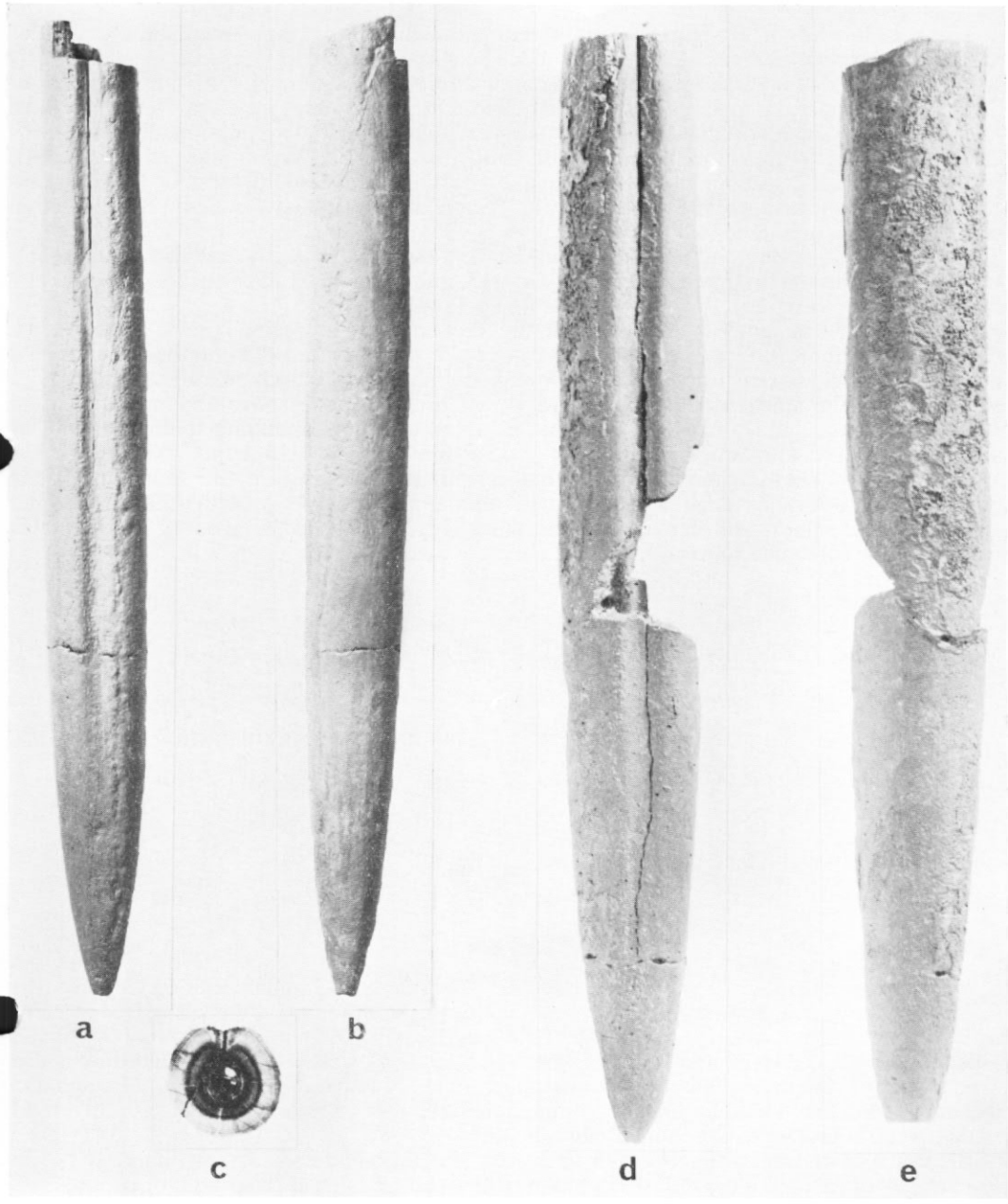

Fig. 2. a. *Belemnopsis gladiatoris* sp. nov.; ventral aspect of the holotype showing the development of the median ventral groove; ×1, coated (KG.401.702).
b. Right lateral aspect of the holotype showing the profile of the guard; ×1, coated (KG.401.702).
c. Cross-section in the alveolar region of the holotype showing the development of the median ventral groove; ×1 (KG.401.702).
d. Ventral aspect of a paratype showing greater lateral compression in the alveolar region; ×1, coated (KG.402.33).
e. Right lateral aspect of the same specimen; ×1, coated (KG.402.33).

Description

The holotype has an elongate, robust, cylindro-conical guard, complete in the apical, stem and lower alveolar regions (Fig. 2a and b). The guard, which is symmetrical and slightly hastate, is 9 to 11 times as long as the maximum transverse diameter. The maximum transverse diameter occurs towards the alveolar side of the mid-point between the protoconch and the apex. The moderately acute apex has an apical angle of approximately 40°. In the stem and alveolar regions the apical line is ventrally placed. The alveolar angle of the holotype is 24°. The apical region in this and all of the paratypes is weakly depressed. Lateral compression, which is also evident in the alveolar region of the holotype, is more accentuated in other specimens (e.g. KG.402.33; Fig. 2d).

In profile, the holotype is non-hastate and asymmetrical, the ventral surface of the apical region being inflated to a greater degree than its dorsal counterpart. The apex is thus directed slightly dorsally (Fig. 2b).

A median ventral groove extends from the broken alveolar region almost to the apex. Although the depth and breadth of this groove are constant throughout the alveolar and most of the stem region, it gradually shallows posteriorly before disappearing apically about 30 mm. from the apex in adult specimens. In the holotype the groove attains a maximum depth of 1·1 mm. and a breadth of 5·0 mm. at a point corresponding to the position of maximum transverse inflation (where $dtM = 15{\cdot}7$ mm. and $ds = 15{\cdot}1$ mm.). Anteriorly the groove shallows slightly and becomes narrower. In the stem region the shoulders of the groove are smoothly rounded and their slopes moderately inclined, whereas they are steeper in the alveolar region and flattened in the apical region. No dorsal grooves occur in this species but possible lateral lines may have been abraded.

Measurements

Specimen number	*L* (mm.)	*l* (mm.)	*u* (mm.)	*v* (mm.)	*dta* (mm.)	*dsa* (mm.)	*dtM* (mm.)	*u/v*	$\alpha°$	$\beta°$
KG.401.702	170*	117	82*	73	15·1	15·6	15·7	1·123	24	40
KG.401.683	180*	132	84*	72	16·8	17·6	18·0	1·179	–	50
KG.401.699	–	180*	110*	100	–	–	16·8	1·100	–	50
KG.402.19	–	–	–	77	–	–	16·9	–	–	41
KG.402.33	190*	142	95*	85	19·4	20·4	21·0	1·117	25	47
KG.402.41	–	105	70*	60	13·5	14·6	14·6	1·166	–	35

Remarks

Whereas the belemnites figured as *Belemnites* (*Belemnopsis*) *patagoniensis* Favre from the Lago Argentino area of Patagonia (Feruglio, 1936, pl. X, figs. 1–4) are probably conspecific with the Alexander Island specimens, the type specimens of *Belemnites patagoniensis* (Favre, 1908, p. 640, pl. 37, figs. 6 and 7) are characterized by an elongate, robust, non-hastate guard with a narrow deeply incised median ventral groove. However, both Feruglio's Patagonian specimens and the Antarctic ones are slightly hastate and have a distinct deep and broad median ventral groove with rounded margins.

There are close similarities between the Alexander Island specimens and the holotype of *Belemnopsis africana* (Tate) from the Neocomian Uitenhage Beds at the mouth of the Sundays River, South Africa (Tate, 1867, p. 151, pl. VII, fig. 2a and b). However, the South African specimen is somewhat shorter and comparatively more robust and Tate's (1867, pl. VII, fig. 2a) illustration also indicates that the median ventral groove is deep, almost flat-bottomed, and has concave sides and sharp margins. An apical fragment of *B. africana* from the Valanginian *Rogersites* Beds from Ambiky in the Malagasy Republic (Spath, 1939, p. 138, pl. XXIV, fig. 15a and b) has a much deeper and more rounded median ventral groove than that in Tate's holotype. A second apical fragment from the same area now housed at the British

Museum (Nat. Hist.) (specimen number C.46217*), has a median ventral groove of similar dimensions and character to that developed in the Alexander Island specimens and it is believed to be conspecific with them. There would therefore appear to be a transition between *africana* and *gladiatoris*.

A slender specimen of *Belemnopsis jonkeri* Stolley from the Mittle Malm (Middle Tithonian) of Timor (Stolley, 1929, pl. 5, fig. 11) is also similar in many aspects to the Alexander Island specimens, particularly in the development of the median ventral groove. However, the Indonesian specimen is more hastate and less robust.

The robust specimen of *Belemnopsis alfurica* (Boehm) from the Upper Jurassic of the Sula Islands, Indonesia (Boehm, 1907*a*, p. 56–57, pl. VIII, fig. 11a and b), has a similarly proportioned guard to that of the Alexander Island specimens but the median ventral groove is more extensive and reaches almost to the apex.

Belemnopsis alexandri sp. nov.

Belemnites (*Belemnopsis*) *gerardi* (Oppel); Uhlig, 1910, p. 386, pl. XCIII, figs. 10a–c and 11; *non* pl. XCIII, figs. 1, 2, 5, 7, 9, 12 and 13.

Belemnites (*Belemnopsis*) *tanganensis* (Futterer); Stefanini, 1925, p. 47, pl. VI, figs. 9a–c and 10a and b; *non* pl. VI., figs. 2–5 and 11–17.

Belemnopsis sp. ind. Spath, 1939, p. 110, pl. XXIV, fig. 14a and b.

Fig. 3a–e

Material

Approximately 40 guard fragments, of which specimens KG.13.15 (locality F), 401.682, 701 and 703, 402.20, 40, 48, 55a and b and 96 (locality Z), and 720.23 and 44 (Ablation Point area), are reasonably complete in the stem, apical or alveolar regions. Additional material was also obtained from near locality D. Specimens KG.402.55a and b, two adjacent fragments from the same specimen, are selected as the holotype.

Age: Lower Neocomian (Berriasian).

Diagnosis

Guard elongate and robust. Outline and profile hastate. Cross-sections from the apical and lower stem regions depressed, upper stem and alveolar region compressed. Apical termination moderately obtuse to obtuse. Wide and moderately deep median ventral groove not extending to apex. No dorsal grooves.

Description

The holotype, a cylindro-conical guard, is robust and elongate, the length being seven to nine times the maximum transverse diameter. The outline is hastate, the maximum transverse inflation occurring approximately two-thirds of the distance between the apex and protoconch. The apex of the holotype is obtuse (Fig. 3a), whereas in other specimens, e.g. KG.402.40 (Fig. 3d), it is less markedly so. Apical angles between 55° and 70° have been obtained from the paratypes. The apical line is ventrally situated throughout the length of the guard. The moderately acute alveolus, which has an alveolar angle of about 18°, terminates in a ventrally situated protoconch. The apical and lower stem regions are depressed in cross-section (Fig. 3c), whereas the upper stem and alveolar regions are compressed.

In profile the holotype is symmetrical and hastate (Fig. 3b). The apex is central, and the dorsal and ventral surfaces are equally developed.

A median ventral groove extends from the broken alveolus posteriorly into the apical region, terminating 30 mm. from the apex in the holotype. At a point corresponding to the position of the protoconch, the ventral groove is 7·5 mm. wide (where *dta* = 21·8 mm.) and 1·0 mm. deep (where *dsa* = 23·9 mm.). The consistently deep groove narrows anteriorly, whereas posteriorly it widens gradually and shallows until finally merging into the venter. In the region of maximum transverse diameter the ventral groove is 8·6 mm. wide and 0·3 mm.

* Numbers prefixed with "C" are those of specimens housed in the British Museum (Nat. Hist.).

Fig. 3. a. *Belemnopsis alexandri* sp. nov.; ventral aspect of the holotype showing the development of the median ventral groove; ×1, coated (KG.402.55a and b).
b. Right lateral aspect of the holotype showing the profile of the guard; ×1, coated (KG.402.55a and b).
c. Depressed cross-section from the lower stem region of a paratype; ×1 (KG.401.703).
d. Ventral aspect of a paratype with a short median ventral groove; ×1, coated (KG.402.40).
e. Right lateral aspect of the same specimen; ×1, coated (KG.402.40).

deep. No dorsal grooves were found in any of the specimens but possible lateral lines may have been abraded.

Measurements

Specimen number	*L* (mm.)	*l* (mm.)	*u* (mm.)	*v* (mm.)	*dta* (mm.)	*dsa* (mm.)	*dtM* (mm.)	*dsM* (mm.)	*u/v*	*α*°	*β*°
KG.402.55a, b	210*	145	100*	84	21·8	23·9	24·2	24·2	1·180	18	60
KG.402.20	180*	98	85*	65	25·4	25·7	26·4	26·2	1·308	15	58*
KG.402.40	–	–	–	74	–	–	21·9	–	–	–	55
KG.402.48	190*	112	87*	70	21·7	22·6	24·3	24·1	1·234	20	65
KG.402.96	–	–	–	92	–	–	27·1	–	–	–	62
KG.720.44	260*	180	115	92	25·5	26·0	27·1	27·2	1·141	18	67

Remarks

The differences between *Belemnopsis alexandri* and *Belemnopsis gerardi* (Oppel), as re-described by Stevens (1963*a*), are obvious, *B. gerardi* being slender and tapering and having a deeply incised median ventral groove extending almost to the guard's apex. For many of the more robust guards previously identified as *B. gerardi* Stevens (1963*a*) erected a new species *Belemnopsis uhligi*. Although several of the more robust examples of *B. uhligi* are somewhat similar to *B. alexandri*, they can be differentiated by their broad and deep median ventral grooves (which extend from the alveolar region almost to the apex) and by the guards' circular cross-sections. From amongst several specimens of *B. gerardi* from the Spiti Shales (Uhlig, 1910), not included by Stevens in the synonomy of either *B. gerardi* or *B. uhligi*, two (i.e. pl. XCIII, figs. 10a–c and 11) are considered to be conspecific with *B. alexandri*.

Two guards described as *Belemnites* (*Belemnopsis*) *tanganensis* (Futterer), from the Upper Jurassic of Somaliland (Stefanini, 1925, pl. VI, figs. 9a–c and 10a and b), are considerably more robust than *B. tanganensis* as re-described by Stevens (1963*c*). The similarities between these and the Alexander Island guards, especially the development of the median ventral groove, suggest that these specimens are also conspecific with *B. alexandri*.

A specimen of *Belemnopsis* sp. ind. from the Neocomian belemnite beds of the Salt Range was described by Spath (1939, p. 110), who noted that it ". . . has a shorter groove than any of Uhlig's examples of *B. gerardi* or the Madagascan specimen of *B. africana* (Tate), pl. XXIV, fig. 15, and may therefore be a distinct form." Similarities of the guard's outline, profile and the development of the median ventral groove suggest that Spath's specimen is conspecific with *B. alexandri*.

Belemnopsis alexandri is also closely comparable with several specimens of *Belemnopsis perlonga* Stolley from the Tithonian of Timor, Indonesia (Stolley, 1929, pl. 4, figs. 9 and 10), although the median ventral groove in the Indonesian specimens practically reaches the apex of the guards which are also almost circular in cross-section.

Belemnopsis aff. *uhligi* Stevens 1963

aff. *Belemnopsis uhligi* Stevens, 1963*a*, p. 694, pl. 99, figs. 1–3.

Fig. 4a and b

Material

Four specimens: KG.13.12 (locality F), 402.22 (locality Z), and 713·1 and 720·33 (Ablation Point area).

Age: Tithonian–Lower Neocomian (Berriasian).

Description

The guard is cylindro-conical, moderately elongate and robust. The outline and profile are symmetrical and non-hastate (Fig. 4a and b). Both flanks and the venter and dorsum

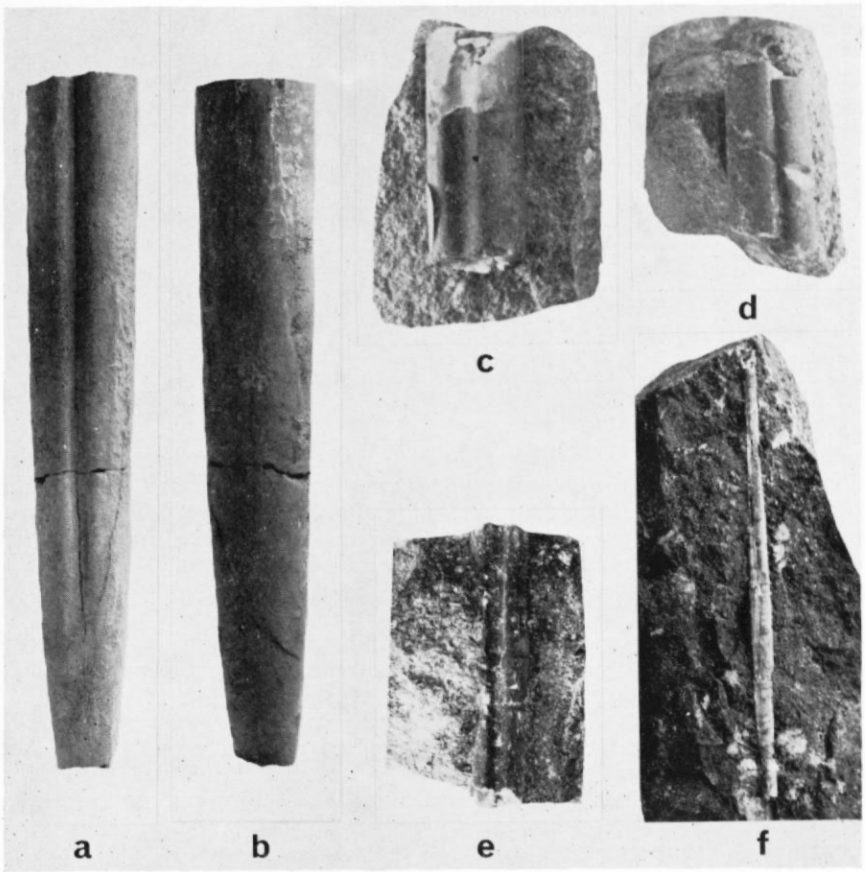

Fig. 4. a. *Belemnopsis* aff. *uhligi* Stevens; ventral aspect of a guard showing the development of the median ventral groove; ×1, coated (KG.713.1).
b. Right lateral aspect of the same specimen; ×1, coated (KG.713.1).
c. *Belemnopsis* cf. *alfurica* (Boehm); ventral aspect of a guard fragment from the stem region showing the development of the median ventral groove; ×1 (E.146.5).
d. *Belemnopsis* cf. *gerardi* (Oppel); ventral aspect of a guard fragment from the upper stem region showing the development of the median ventral groove; ×1 (E.720.8).
e. *Belemnopsis* cf. *tanganensis* (Futterer); ventral aspect of a guard fragment from the stem region showing the development of the median ventral groove; ×1 (E.146.1).
f. *Belemnopsis* cf. *keari* Stevens; ventro-lateral aspect of a juvenile guard embedded in a mudstone showing the development of the median ventral groove; ×1 (KG.722.8).

gradually taper, thus producing a moderately acute apex with an apical angle of approximately 35°. Slight inflation of the dorsum displaces the apex ventrally. Throughout the guard cross-sections are circular or slightly depressed. The phragmocone is dorsally displaced and in two specimens an alveolar angle of 16° was measured.

A medial ventral groove extends from the alveolar region and in specimen KG.402.22 it disappears approximately 12 mm. from the apex. The groove is deepest (1·2 mm.) in the alveolar region (where $ds = 12{\cdot}6$ mm.) and 5·2 mm. wide (where $dt = 12{\cdot}8$ mm.). The groove remains moderately deep throughout the stem region but it shallows appreciably in the apical region. No lateral lines are seen.

Measurements

Specimen number	*L* (mm.)	*l* (mm.)	*dta* (mm.)	*dsa* (mm.)	$\alpha°$	$\beta°$
KG.13.12	110*	75	13·3	12·8	16	32
KG.402.22	–	85*	13·0	12·6	–	35
KG.713.1	135*	90	15·5	15·5	16	40

Remarks

The holotype of *Belemnopsis uhligi* (Stevens, 1963*a*, p. 694, pl. 99, figs. 1–3) from the Spiti Shales, India, was originally figured as *Belemnites* (*Belemnopsis*) *gerardi* (Oppel) by Uhlig (1910, p. 368, pl. XCIII, fig. 9a and b). The Alexander Island specimens differ from it in being more elongate and having a slight inflation of the dorsal surface. Two other specimens (Uhlig, 1910, pl. XCIII, figs. 5a and b and 7a and b), included by Stevens in the synonomy of his new species, are closely comparable with the Alexander Island specimens.

An outline and profile comparable to that in the Alexander Island specimens can be seen in *Belemnopsis stolleyi* Stevens (1965*b*, p. 621–29, pl. 95, figs. 1–6) from North Jamdena, Indonesia. However, *B. stolleyi* has a much broader and deeper median ventral groove characterized by secondary deepening in the adult stages. As a result, the walls of the groove intersect the growth laminae of the guard.

Belemnopsis cf. *alfurica* (Boehm 1907)

cf. *Belemnopsis alfurica* Boehm, 1907*a*, p. 56–57, pl. VIII, figs. 4, 5 and 7–11; *non* text-figs. 16–18.
cf. *Belemnopsis alfurica* Boehm, 1907*b*, pl. X, fig. 8; *non* pl. X, fig. 7.

Fig. 4c

Material

Three fragments of guards including one juvenile and one phragmocone. Specimens E.146.5 and 9 (C.46248 and 46249) were collected from Belemnite Point, whereas the British Graham Land Expedition specimen (617 (C.46354)) came from the screes at the northern end of Ablation Point.

Age: Upper Oxfordian–Middle Kimmeridgian.

Description and remarks

These fragments are all characterized by having a very broad and deep median ventral groove compared with the respective sagittal and transverse diameters. In specimen E.146.5 (Fig. 4c) the ventral groove is 4·5 mm. wide (where $dt = 7·2$ mm.) and 1·2 mm. deep (where $ds = 6·0$ mm.). Two fragments appear to have been derived from the stem region and indicate that the guards were weakly hastate. All of the fragments are slightly depressed in cross-section. These fragments probably originated from guards similar to several specimens of *Belemnopsis alfurica* (Boehm, 1907*a*, p. 56–57, pl. VIII, figs. 4, 5 and 7–11; *non* text-figs. 16–18, 1907*b*, pl. X, fig. 8; *non* pl. X, fig. 7) and to a description of the lectotype for the nominal species *B. alfurica* (Boehm) (Stevens, 1963*b*, p. 101–04, pl. 1, figs. 1–13).

Belemnopsis cf. *gerardi* (Oppel 1865)

cf. *Belemnites gerardi* Oppel, 1865, p. 296–97, pl. 88, figs. 1 and 2; *non* fig. 3.

Fig. 4d

Material

Three fragments from the upper stem and apical regions of guards in a feldspathic grit (E.720.8 (C.46255)) from the northern face of Ablation Point.

Age: Upper Oxfordian–Middle Kimmeridgian.

Description and remarks

The fragments were derived from elongate, slightly hastate guards with a depressed cross-section in both the apical and stem regions. A deep and moderately broad median ventral groove becomes more incised towards the alveolar region and extends almost to the apex. In one fragment (Fig. 4d) it is 2·8 mm. wide (where $dt = 12 \cdot 2$ mm.) and 1·1 mm. deep (where $ds = 11 \cdot 5$ mm.).

The development of the median ventral groove and the overall proportions of the guard are similar to those of *Belemnopsis gerardi* (Oppel, 1865, p. 296–97, pl. 88, figs. 1 and 2; *non* fig. 3; Stevens, 1963*a*, p. 296–97, pl. 98, figs. 1–8).

Belemnopsis cf. *keari* Stevens 1965

cf. *Belemnopsis keari* Stevens, 1965*a*, p. 74–78, pl. 4, figs. 8–10, pl. 5, figs. 1–3.

Fig. 4f

Material

One guard (specimen KG.722.8) in a dark mudstone from the disturbed beds at the base of the cliffs at Ablation Point.

Age: Upper Oxfordian–Middle Kimmeridgian.

Description and remarks

This juvenile hastate guard is relatively slim and elongate (Fig. 4e), the overall length being about 18 times the maximum transverse diameter. Maximum inflation occurs adapically of the mid-point between the apex and the phragmocone. The apical region is fairly long and terminates acutely. Anteriorly the flanks gradually converge towards the protoconch, beyond which they begin to diverge to accommodate the phragmocone which has an acute alveolar angle. In the alveolar region the guard appears to be circular in cross-section, whereas the stem and apical regions are depressed. A relatively broad median ventral groove extends from the fragmented alveolar end to a few millimetres from the broken apex.

Juveniles of *Belemnopsis keari* from sediments of Heterian (Lower Kimmeridgian–Middle Kimmeridgian) age from New Zealand (Stevens, 1965*a*, p. 74–78, pl. 4, figs. 8–10, pl. 5, figs. 1–3) have a similar although more robust guard.

A juvenile *Hibolithes catlinensis* (Hector) from sediments of Temaikan (Bajocian–Callovian) age from New Zealand (Stevens, 1965*a*, p. 96–98, pl. 14, fig. 12) is similar in profile to the Alexander Island specimen but the guard is more hastate and lacks the distinctive broad median ventral groove.

Belemnopsis cf. *tanganensis* (Futterer 1894)

cf. *Belemnites tanganensis* Futterer, 1894, p. 30–32, pl. 5, figs. 2a–c and 3a–c.

Fig. 4e

Material

Seven guard fragments, one in a pebbly sandstone from Belemnite Point (E.146.1 (C.46247)), the others (KG.701.7 and 19) from the disturbed beds forming the base of the cliffs at Ablation Point.

Age: Upper Oxfordian–Middle Kimmeridgian.

Description and remarks

These fragments were derived from elongate, hastate guards. One (E.146.1) (Fig. 4f) originates from the depressed stem region in which a groove 3·4 mm. wide (where $dt = 7 \cdot 0$ mm.) and 0·7 mm. deep (where $ds = 4 \cdot 9$ mm.) is developed. The guard and groove characters are similar to those of specimens of *Belemnopsis tanganensis* described and illustrated by Futterer (1894, pl. 5, figs. 2a–c and 3a–c), especially fig. 3a–c.

Genus *Hibolithes* Montfort 1808

Hibolithes antarctica sp. nov.

Fig. 5a and b

Material

Thirty guard fragments (including two detached phragmocones) from locality Z and a single specimen from the scree at locality C (Fig. 1). Specimen KG.401.211 is the holotype. *Age:* Lower Neocomian (Berriasian).

Diagnosis

Guard elongate, robust and markedly compressed throughout. Outline symmetrical and hastate, maximum transverse inflation occurring about three-quarters of the distance between a moderately acute apex and protoconch. Profile asymmetrical and slightly hastate. Deep and narrow median ventral groove confined to alveolar and upper stem regions.

Description

The elongate and robust guard is about seven to nine times as long as the maximum transverse diameter. In outline (Fig. 5a) the guard is symmetrical and hastate, maximum transverse inflation occurring about three-quarters of the distance between apex and protoconch. Posteriorly the flanks gradually converge towards a moderately acute apex. The average apical angle from several fragments is 33° and the apical line is displaced ventrally throughout the length of the guard. The phragmocone, which is also displaced ventrally, has an alveolar angle of approximately 15°.

In the stem and alveolar regions the profile of the guard is slightly hastate and asymmetrical (Fig. 5b), the venter being more inflated than the dorsum. Ventro-lateral flattened surfaces are also developed. All regions are strongly compressed in cross-section.

A deep and narrow median ventral groove in the alveolar region is deepest at the broken alveolar end of the guard. On the holotype the groove shallows posteriorly, at first gradually and then disappears rapidly 60 mm. from the apex (Fig. 5a). Near the protoconch of this specimen the groove is 0·8 mm. deep (where $dta = 17{\cdot}7$ mm.) and 3·0 mm. wide (where $dsa = 19{\cdot}0$ mm.). Double lateral lines, which occur on several fragments (e.g. KG.401.222), begin dorso-laterally in the apical region and trend diagonally across the flanks before becoming ventro-lateral in the stem region, where they finally disappear.

Measurements

Specimen KG.401.211 has the following dimensions:

$L = 150$* mm., $l = 97$ mm., $u = 55$ mm., $v = 73$ mm., $dta = 17{\cdot}7$ mm., $dsa = 19{\cdot}0$ mm., $dtM = 18{\cdot}4$ mm., $dsM = 19{\cdot}3$ mm., $u/v = 0{\cdot}742$, $\alpha = 15°$* and $\beta = 32°$.

Remarks

Hibolithes antarctica is similar to *Hibolithes arkelli* Stevens from the Puaroan (Lower Tithonian) of New Zealand (Stevens, 1965*a*, p. 99–103, pl. 15, figs. 1–10, pl. 16, figs. 1–12, pl. 17, figs. 1–5, 7 and 8, pl. 18, fig. 10; text-figs. 24g and h and 25a–d). However, *H. arkelli* has a rather obtuse apex and its maximum transverse inflation occurs towards the posterior end. Moreover, the median ventral groove extends almost to the apex.

Hibolithes belligerundi sp. nov.

Fig. 5c and d

Material

Numerous guards including those from two samples (KG.712.63 and 64) of a "belemnite battle-field" from the Ablation Point area. Specimen KG.712.63a is the holotype. The specific

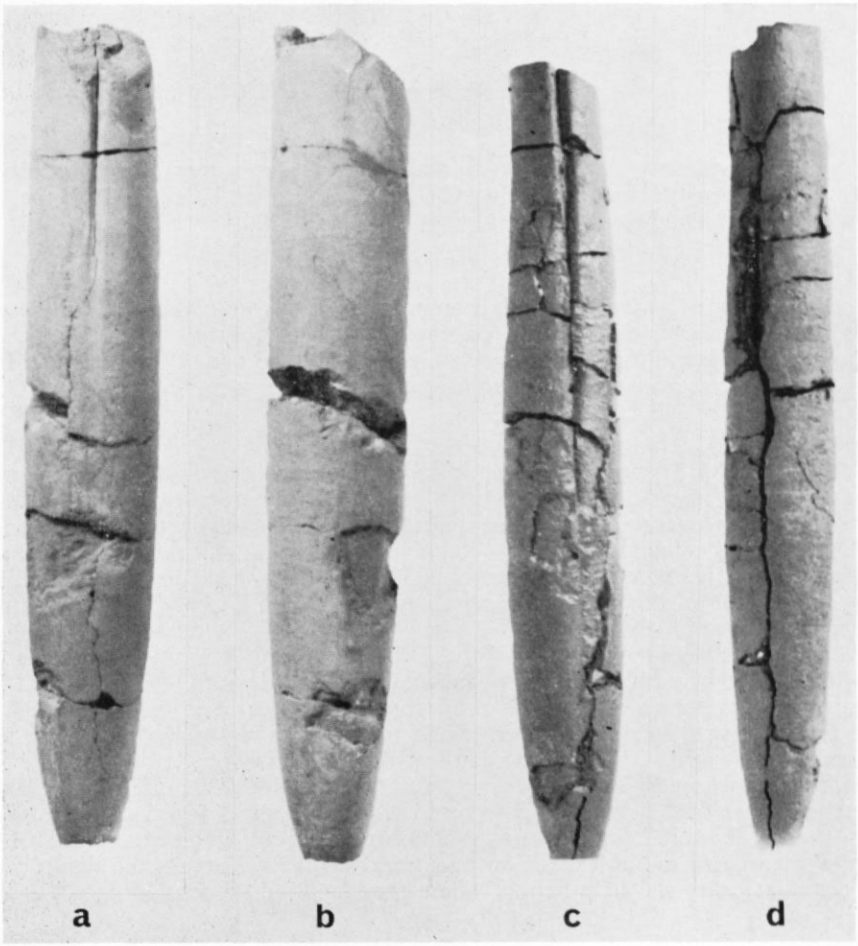

Fig. 5. a. *Hibolithes antarctica* sp. nov.; ventral aspect of the holotype showing the development of the median ventral groove; ×1, coated (KG.401.211).
b. Right lateral aspect of the holotype showing the profile of the guard; ×1, coated (KG.401.211).
c. *Hibolithes belligerundi* sp. nov.; ventral aspect of the holotype showing the development of the median ventral groove; ×1, coated (KG.712.63a).
d. Right lateral aspect of the holotype showing the profile of the guard; ×1, coated (KG.712.63a).

name *belligerundi* is derived from the Latin *bellum* (war) and *gero* (I wage); this refers to the occurrence of this species in a "belemnite battle-field".
Age: Tithonian.

Diagnosis

Guard elongate and moderately robust with a symmetrical and hastate outline, maximum transverse inflation occurring in the anterior half. Profile asymmetrical and hastate. Cross-sections in alveolar and upper stem region compressed, whereas those in the lower stem and apical regions are depressed. A median ventral groove extends from the alveolar to the apical region.

Description

The elongate and moderately robust guard is about nine to ten times as long as the maximum transverse diameter (Fig. 5c). The outline is symmetrical and hastate, maximum transverse inflation occurring anterior of the mid-point between apex and protoconch. From here the flanks gradually converge posteriorly to produce a moderately obtuse apex. An apical angle of 45–50° was measured from several specimens. Anteriorly, the flanks gradually converge to form an elongate stem, the position of minimum transverse inflation occurring near the protoconch. The phragmocone and apical line are central. An alveolar angle of 15° was determined from several fragments.

The profile is hastate and asymmetrical, and apically the venter is slightly inflated (Fig. 5d). The apex is displaced slightly dorsally. The guard is compressed in the alveolar and upper stem regions but depressed in the lower stem and apical regions.

A median ventral groove, which is 0·7 mm. deep (where $dt = 12{\cdot}3$ mm.) and 1·1 mm. wide (where $ds = 13{\cdot}0$ mm.) in the holotype, extends from the broken alveolar region into the upper stem region, shallows appreciably in the lower stem region and finally disappears a few millimetres from the apex. No dorsal grooves are developed and no lateral lines were observed.

Measurements

Specimen number	*L* (mm.)	*l* (mm.)	*u* (mm.)	*v* (mm.)	*dtM* (mm.)	*dtm* (mm.)	*dsM* (mm.)	*dsm* (mm.)	*u/v*	*β*°
KG.712.63a	140*	90	38	52	15·5	12·3	15·4	13·0	0·731	47
KG.712.63b	150*	100	45	55	15·7	12·5	14·7	12·1	0·818	49
KG.712.64a	–	95*	45*	50	14·2	10·2	12·6	10·5	0·900	–
KG.712.64b	–	85*	40*	45	13·8	–	11·8	–	0·889	–
KG.712.64c	–	82	42	47	13·2	9·9	11·7	–	0·897	–

Remarks

Although the development of the guard of *Hibolithes verbeeki* Kruizinga from the Upper Jurassic of Taliabu Island in the Sula Island group, Indonesia (Kruizinga, 1921, pl. VI, figs. 1 and 1a–c) is closely comparable with that of the Alexander Island specimens, there are several differences, viz.:

i. The median ventral groove of the Indonesian specimen appears to be relatively short and insignificant (Kruizinga, 1921, pl. VI, figs. 1 and 1a–c).
ii. The guard of the Indonesian species is compressed throughout.
iii. Maximum transverse inflation is more apical than in the Alexander Island specimens.

Hibolithes belligerundi is also similar to specimens of *Hibolithes catlinensis* (Hector) from the Tamaikan (Bajocian–Callovian) of New Zealand (Hector, 1878, p. 486, pl. XXII, fig. 3a and b; Marwick, 1953, p. 26, 125, pl. 17, figs. 1 and 2; Stevens, 1965*a*, p. 96–98, pl. 14, figs. 1, 2, 6–8, 12 and 16–18, text-fig. 26a). However, *H. catlinensis* has a more pronounced hastate outline, the guard is circular in cross-section in the apical and lower stem regions, and maximum transverse inflation occurs in the posterior half and the median ventral groove does not extend beyond the stem region.

Hibolithes sp. nov. (?)

Fig. 6a–c

Material

Twenty-four guard fragments (including several detached phragmocones) from localities Z and D and from the unnamed cliffs north of locality Z on the southern margin of Jupiter Glacier (KG.1301) (Fig. 1).

Age: Lower Neocomian (Berriasian).

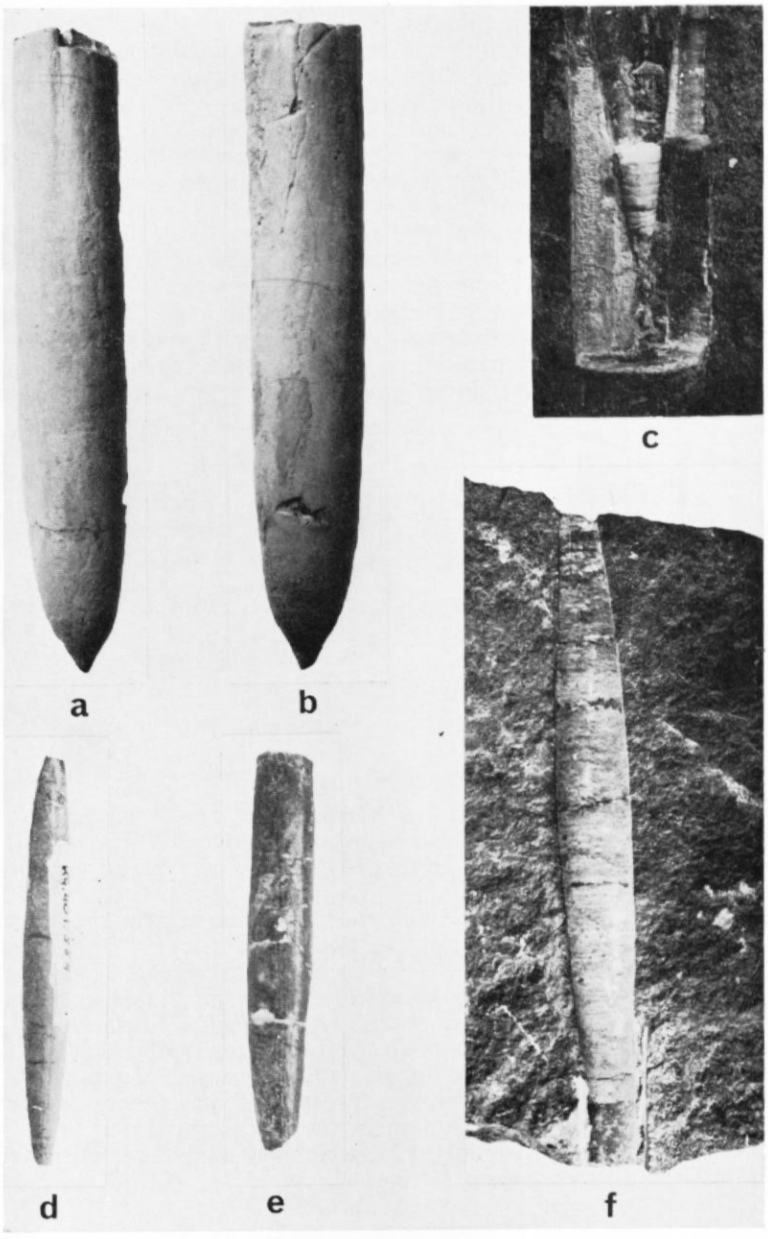

Fig. 6. a. *Hibolithes* sp. nov. (?); ventral aspect of a guard showing the development of the median ventral groove; ×1, coated (KG.401.152).
b. Right lateral aspect of the same specimen showing the profile of the guard; ×1, coated (KG.401.152).
c. Longitudinal section of a guard showing the early stages of the phragmocone; ×1 (KG.401.124).
d. *Hibolithes subfusiformis* (Raspail); right lateral aspect of an immature guard showing the development of lateral lines; ×1 (KG.401.554).
e. Left lateral aspect of a guard showing the development of lateral lines; ×1 (E.720.22).
f. Lateral aspect of a mature specimen embedded in a mudstone; ×1 (KG.402.5).

Description

The elongate and moderately robust guard is eight times as long as the maximum transverse diameter and is symmetrical and very slightly hastate in outline. Maximum transverse inflation occurs about one-third of the distance between apex and protoconch. Posteriorly, the flanks converge appreciably to produce a moderately obtuse mucronate apex (Fig. 6a and b). Inflation of the venter in the stem and alveolar regions has resulted in the apical line lying nearer the dorsum; these areas are oval in cross-section. Above the protoconch, which is displaced dorsally, a moderately acute phragmocone with an alveolar angle of about 18° is developed.

In the alveolar and upper stem regions a narrow, shallow, median ventral groove (with an associated splitting surface) is developed but it disappears when traced apically. In specimen KG.401.290 the groove is 0·5 mm. deep (where dt = 15·4 mm.) and 2·2 mm. wide (where ds = 17·5 mm.).

No lateral lines were observed.

Measurements

Specimen number	*L* (mm.)	*l* (mm.)	*u* (mm.)	*v* (mm.)	*dta* (mm.)	*dsa* (mm.)	*dtM* (mm.)	*u*/*v*	*α*°	*β*°
KG.401.152	–	82*	61*	45	14·4	15·6	14·6	1·355	18*	34
KG.401.290	–	88*	63*	44	–	–	15·8	1·432	–	36
KG.19.24	145*	98	78*	65	14·5	15·0	16·4	1·200	18	38

Remarks

Although *Hibolithes* sp. nov. (?) superficially resembles a specimen of *Belemnopsis brownei* [= *Hibolithes arkelli* Stevens] from the Ohauan (Tithonian) of Puti Point, New Zealand (Marwick, 1953, p. 124, pl. 17, figs. 3 and 4; *non* fig. 9), *B. brownei*'s prominent median ventral groove extends a considerably greater distance apically and there is no mucronate apex as in the Alexander Island specimens.

Apart from the affinities with *B. brownei*, the Alexander Island material appears to be distinct. However, the poor preservation is such that a holotype cannot be designated and the species is unnamed for the present.

Hibolithes subfusiformis (Raspail 1829)

Belemnites subfusiformis Raspail, 1829, pl. VIII, figs. 92 and (?) 93.
Belemnites subfusiformis Raspail; Noetling, 1902, p. 4, pl. 1, figs. 4–12.
Belemnites subfusiformis Raspail; Besairie, 1930, p. 548, pl. XIV, figs. 2 and 2a.
Hibolithes subfusiformis (Raspail); Stolley, 1934, p. 484.
Hibolithes subfusiformis (Raspail); Stolley, 1935, p. 61, pl. V, figs. 6–8.
Hibolithes subfusiformis (Raspail); Spath, 1939, p. 111–13, pl. XXIII, figs. 1–3, 9 and 12.

Fig. 6d–f

Material

Twelve incomplete guards, including specimens KG.401.447 and 554, and 402.5 from locality Z; KG.721.21 and 22, and E.720.22 (C.46256) and 721.5 (C.46257) from the Ablation Point area.

Age: Lower Neocomian (Berriasian).

Description

The guards are elongate and slender. Specimens KG.402.5 and 721.21 are of mature individuals, whereas the remainder are juveniles. The maximum transverse diameter of the largest fragment (KG.402.5; Fig. 6f) is about one-tenth of its measured length. Both outline and profile are symmetrical and hastate. Maximum transverse inflation occurs about mid-way between apex and protoconch. Posteriorly, the flanks gradually taper to produce a sharply

accuminate apex with an apical angle of about 22°. Anteriorly, the flanks converge and appear to be constricted near the protoconch. The apical line is centrally located. The depressed cross-sections throughout the guard become more accentuated in mature specimens.

A poorly preserved, narrow deep median ventral groove is confined to the alveolar and upper stem regions. Double lateral lines commence apically and dorso-laterally before extending diagonally towards the alveolus to become slightly ventro-lateral at the broken anterior end of the stem region (Fig. 6d and e).

Measurements

Specimen number	*l* (mm.)	*u* (mm.)	*v* (mm.)	*dtM* (mm.)	*dsM* (mm.)	*u/v*	*β*°
KG.401.447	58	28	30	5·4	–	0·933	22
KG.401.554	65	30	35	7·8	7·5	0·889	21
KG.402.5	80*	37*	43	10·1	9·5	0·861	–
KG.721.21	90	43	48	12·2	10·8	0·812	–
E.720.22	65*	28*	37	9·2	8·7	0·757	24

Remarks

From amongst the varieties of *Hibolithes subfusiformis*, the Alexander Island specimens belong to the elongate slender, rather than more robust *baluchistanensis* form (Noetling, 1902, p. 4).

A specimen of *Hibolithes flemingi* Spath from the Kimmeridgian of Andranosamota, Malagasy Republic (Spath, 1927, p. 13, pl. 1, fig. 2a–d), is comparable in some respects with the Alexander Island specimens but the cross-sections of *H. flemingi* are typically more depressed and the guard more robust.

Hibolithes cf. *compressus* Stolley 193[5]

cf. *Hibolithes compressus* Stolley, 1935, p. 58–60, pl. IV, figs. 1–5.

Fig. 7a

Material

Two specimens (KG.721.23 and 24) from the Ablation Point area.
Age: Lower Neocomian (Berriasian).

Description

The guard is elongate and slender, the length being about 20 times the maximum transverse diameter. Outline and profile are symmetrical and hastate (Fig. 7a). Maximum transverse inflation is approximately equidistant between the apices of the phragmocone and guard. The flanks gradually converge towards an elongate apex having an apical angle of about 17°. Anteriorly, the flanks gradually taper, the minimum transverse diameter corresponding approximately to the location of the protoconch. From here the flanks diverge to accommodate the centrally placed phragmocone which has an alveolar angle of about 22°. The apical line is centrally located throughout the length of the guard. The alveolar and stem regions are markedly compressed in cross-section, whereas the apical region is only slightly compressed.

Although a slit-like median ventral groove is confined to the alveolar and upper stem regions in these abraded specimens, it may have extended further. No lateral lines were observed.

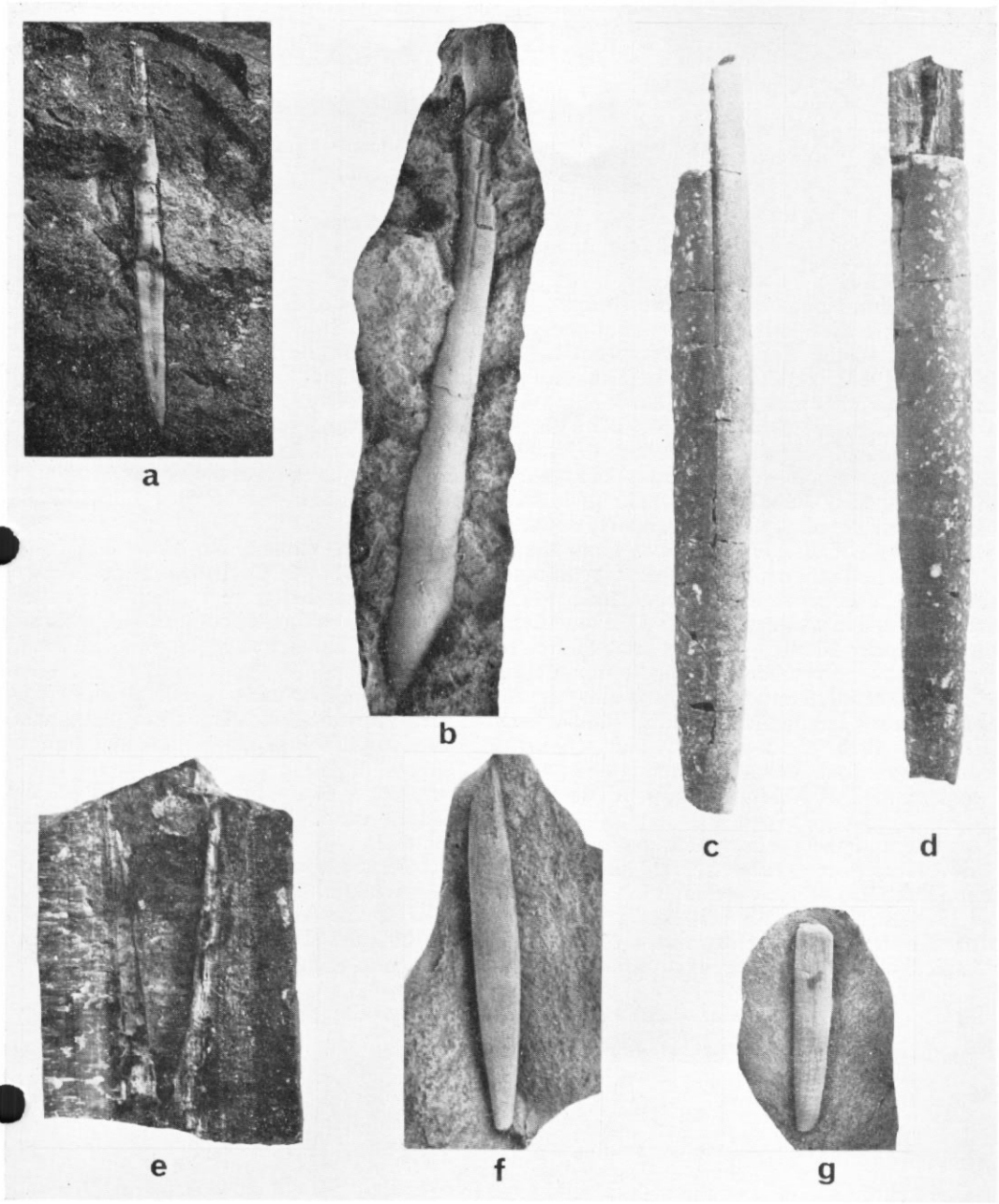

Fig. 7. a. *Hibolithes* cf. *compressus* Stolley; ventro-lateral aspect of a partially eroded guard showing the development of the median ventral groove; ×1 (KG.721.24).
b. *Hibolithes* aff. *marwicki mangaoraensis* Stevens; latex cast of an external mould showing the ventro-lateral aspect of the guard and the development of the median ventral groove; ×1, coated (KG.401.505).
c. *Neohibolites* cf. *miyakoensis* Hanai; ventral aspect of a guard showing the development of the median ventral groove; ×1 (KG.1574.60).
d. Right lateral aspect of the same specimen showing the profile of the guard; ×1 (KG.1574.60).
e. Longitudinal section of the same specimen in the region of the protoconch showing the development of the early stages of the phragmocone; ×3 (KG.1574.60).
f. *Neohibolites minimus* cf. var. *submedius* Swinnerton; latex cast of an external mould showing the right lateral aspect of the guard; ×2, coated (KG.103.4).
g. *Neohibolites minimus* cf. var. *oblongus* (Stolley); latex cast of an external mould showing the right lateral aspect of a guard; ×2, coated (KG.103.184).

Measurements

Specimen number	*l* (mm.)	*u* (mm.)	*v* (mm.)	*dta* (mm.)	*dsa* (mm.)	*dtM* (mm.)	*dsM* (mm.)	*u/v*	α°	β°
KG.712.23	65	26	25	2·1	2·9	3·0	4·2	0·784	22	16
KG.712.24	57	26	34	3·4	4·2	4·6	5·9	0·764	–	17

Remarks

These slim, elongate guards are comparable with specimens of *Hibolithes compressus* from the Lower Fatjet Shale of Misol, Indonesia (Stolley, 1935). Stolley (1934, p. 484) ascribed these beds to the Upper Oxfordian but they have since been given a Lower Tithonian age (Stevens, 1965*a*, p. 139, table 13). The example figured by Stolley (1935, pl. 4, fig. 5a and b) as *H. compressus* and those of *Hibolithes* aff. *compressus* (Stolley, 1935, pl. 4, figs. 6a and b, and 7a and b) are closely comparable with the Alexander Island specimens. However, other examples of *H. compressus* (Stolley, 1935, pl. IV, figs. 1a and b, 2a and b, 3a and b, and 4a and b) represent a more robust spatulate type. *Hibolithes compressus* from the Lower Tithonian of the Malagasy Republic also belongs to this robust type (Besairie, 1936, p. 146, pl. XXII, figs. 21 and 22, pl. XXIII, figs. 10, 11, 16 and 17).

Specimens of *Hibolithes joleaudi* from the Tithonian–Lower Valanginian of the Malagasy Republic, particularly the slender type (Besairie, 1936, p. 147, pl. XXII, figs. 5 and 6), are similar to those from Alexander Island. However, the apical and stem regions of *H. joleaudi* are depressed in cross-section, and the alveolar region seems to be slightly compressed, whereas the Alexander Island specimens are compressed throughout. The apical region of *H. joleaudi* is also not as prominently elongate nor the guard as hastate.

The Alexander Island specimens also superficially resemble specimens of *Hibolithes argentinus* from the Laguna Anita and l'Estancia Cristina area north of Lago Argentino, Patagonia (Feruglio, 1936, p. 85–86, pl. X, figs. 16–19). However, these are depressed and have more extensive median ventral grooves.

A specimen of *Hibolithes lagoicus* (Boehm) from the upper Wai Lagoi Taliabu, Indonesia (Boehm, 1907*a*, p. 57, pl. VIII, fig. 13), is also comparable although the apical region is more spatulate and the median ventral groove more prominent.

Several slender examples of *Hibolithes marwicki marwicki* Stevens from the Lower Tithonian (Puaroan) of New Zealand (Stevens, 1965*a*, p. 104–08, pl. 17, fig. 6, pl. 18, figs. 11–17, pl. 19, figs. 1–9 and 13–18, text-fig. 25e–h) are similar to the Alexander Island specimens, although the very prominent median ventral groove in this species extends almost to the apex, its apical elongation is not so prominent and the stem region is circular in cross-section.

Hibolithes aff. *marwicki mangaoraensis* Stevens 1965

aff. *Hibolithes marwicki mangaoraensis* Stevens, 1965*a*, p. 109–10, pl. 19, figs. 10–12, pl. 20, figs. 3–5 and 10–12.

Fig. 7b

Material

One guard (KG.401.505) in a dark mudstone from locality Z.
Age: Lower Neocomian (Berriasian).

Description

The guard is elongate and slender, the length being about nine to ten times the maximum transverse diameter. The outline is symmetrical and markedly hastate (Fig. 7b). Maximum transverse inflation occurs towards the apex which is broken and appears moderately obtuse. Anteriorly, the flanks gradually converge towards a narrow elongate stem region, whereas near the protoconch they diverge to accommodate the phragmocone.

The profile is not seen but the stem and apical regions appear to be circular in cross-section and markedly compressed in the alveolar region. The apical line is central in the alveolar

and stem regions but its position is indeterminate apically. The phragmocone is centrally located but the alveolar angle, which appears to be moderately acute, could not be measured accurately.

A narrow, shallow median ventral groove is deepest in the alveolar region before becoming indistinct posteriorly and it finally disappears in the upper stem region. No lateral lines can be distinguished.

Measurements

Specimen KG.401.505 has the following dimensions: $l = 58^*$ mm., $u = 39$ mm., $v = 22^*$ mm., $dtM = 7{\cdot}4$ mm., $dtm = 4{\cdot}0$ mm. and $u/v = 1{\cdot}77$.

Remarks

The holotype of *Hibolithes marwicki mangaoraensis* Stevens from the Puaroan (Lower Tithonian) of the Kawhia Harbour area, New Zealand (Stevens, 1965*a*, p. 109, pl. 19, figs. 10–12), is very similar to specimen KG.401.505, where the median ventral groove may have been foreshortened by abrasion.

A specimen of *Belemnopsis* sp. [= *H. marwicki marwicki* Stevens] from probable Kimmeridgian sediments of Te Puti Point, Kawhai, New Zealand (Trechmann, 1923, p. 261, pl. XVI, fig. 13), also has a similar guard. However, it differs in that the median ventral groove reaches the apical region and the guard is circular in cross-section throughout. Although maximum transverse inflation in *Belemnopsis* sp. is towards the posterior end, the apex is not markedly inflated.

The development of the guard in several New Zealand examples of *Hibolithes catlinensis* (Hector) (Marwick, 1953; Stevens, 1965*a*) is similar to that shown by the Alexander Island specimen. However, the New Zealand examples have a more extensive median ventral groove, they are more elongate and maximum transverse inflation is more adapical. An immature specimen from the Temaikan (Bajocian–Callovian) of South Island, New Zealand (Stevens, 1965*a*, pl. 14, figs. 16–18), has a median ventral groove confined to the upper stem region as in the Alexander Island specimen.

Genus *Neohibolites* Stolley 1911

Neohibolites cf. *miyakoensis* Hanai 1953

cf. *Neohibolites miyakoensis* Hanai, 1953, p. 69–77, pl. V, figs. 3 and 4, and 6–8, pl. VI, figs. 1–5, pl. VII, figs. 1–4.

Fig. 7c–e

Material

Two specimens, KG.1574.60 from a dark mudstone at a locality south-west of Ablation Valley, and E.153.3 (C.46252) from a moraine south of Fossil Bluff.

Age: Aptian.

Description

The guard is elongate and moderately robust, the overall length being about 12 times the maximum transverse diameter. Both outline and profile are symmetrical and slightly hastate (Fig. 7c and d), maximum transverse inflation occurring about midway between apex and protoconch. The guard tapers gradually posteriorly to produce a moderately acute apical angle with a central apex. Above the protoconch, which lies nearer the dorsum, an acute phragmocone with an alveolar angle of about 20° is developed (Fig. 7e).

The apical and stem regions are circular in cross-section, whereas the alveolar region is weakly compressed.

A narrow, shallow median ventral groove with an associated splitting surface is developed in the alveolar region. Posteriorly, the groove shallows appreciably before eventually merging with the venter in the upper stem region. Near the protoconch the groove is 1·8 mm. wide (where $dt = 11{\cdot}2$ mm.) and 0·5 mm. deep (where $ds = 11{\cdot}4$ mm.).

Measurements

Specimen KG.1574.60 has the following dimensions: $L = 145^*$ mm., $l = 97$ mm., $u = 82^*$ mm., $v = 50^*$ mm., $dsa = 11{\cdot}3$ mm., $dtM = 11{\cdot}8$ mm., $dsM = 11{\cdot}8$ mm., $u/v = 1{\cdot}640$ and $\alpha = 20°$.

Remarks

The Alexander Island specimens are more elongate than *Neohibolites miyakoensis* from the Miyako District, Japan (Hanai, 1953), which also appears more hastate because of exfoliation in the alveolar region. The spheroidal shape and development of the phragmocone of *N. miyakoensis* (Hanai, 1953, pl. VI, figs. 3, 4 and 5, pl. VII, figs. 1–4) is closely comparable with that in the Alexander Island specimen (KG.1574.60) (Fig. 7e) but in the latter the protoconch is more elongate than those illustrated by Hanai.

Neohibolites minimus cf. var. *submedius* Swinnerton 1936–55

cf. *Neohibolites minimus* var. *submedius* Swinnerton, 1936–55, p. 77, pl. XVII, figs. 19–21.

Fig. 7f

Material

Six guard fragments (several in dark mudstone), two (KG.103.3 and 144) from locality T and the remainder from locality KG.1574, south-west of Ablation Valley.
Age: Aptian.

Description

Each guard is small, slim and spindle-shaped (Fig. 7f). The length is about 14 times that of the maximum transverse diameter which is centrally located. The apical region is therefore relatively long with almost straight flanks that merge into an acute central apex with an apical angle of 14°. The guard is circular or weakly compressed in cross-section throughout. A narrow slit-like median ventral groove extends from the broken alveolar end to a point corresponding to the position of maximum transverse inflation where it shallows and disappears.

Measurements

Specimen KG.103.4 has the following dimensions: $l = 27^*$ mm., $u = 15^*$ mm., $v = 15$ mm., $dtM = 2{\cdot}8$ mm., $dsM = 3{\cdot}0$ mm. and $\alpha = 14°$.

Remarks

These specimens most closely resemble *Neohibolites minimus* var. *submedius* which Swinnerton (1936–55, p. 77) thought represented the extreme development of the slim spindle variants of *N. minimus s.s.* However, the median ventral groove in the specimens from the Gault at Folkestone and the Red Chalk at Speeton, Yorkshire, do not extend as far posteriorly as those in the Alexander Island specimens.

Neohibolites minimus cf. var. *oblongus* (Stolley 1911)

cf. *Neohibolites minimus* var. *oblonga* Stolley, 1911, p. 61, pl. VI, figs. 15–17.
cf. *Neohibolites minimus* var. *oblongus* (Stolley); Swinnerton, 1936–55, p. 75–76, pl. XVIII, figs. 13–23.

Fig. 7g

Material

Several fragmentary guards in a dark mudstone matrix from locality T.
Age: Aptian.

Description

These poorly preserved fragments originate from relatively small stout guards in which the position of maximum transverse inflation occurs in the posterior half (e.g. KG.103.184; Fig. 7g) thus producing a moderately obtuse apex. The alveolar region is not preserved. A narrow, deep, median ventral groove extends from the broken anterior end into the upper stem region.

Remarks

The Alexander Island forms most closely resemble *Neohibolites minimus* var. *oblongus* (Stolley) from the Lower Cretaceous of northern Germany (Stolley, 1911, p. 61, pl. VI, figs. 15–17). However, the median ventral groove of the German examples is considerably shorter, whereas specimens of the *same* variety from the Lower Cretaceous of England (Swinnerton, 1936–55, p. 75–76, pl. XVIII, figs. 13–23) have a similarly extensive groove but a more apical position of maximum transverse inflation.

Stratigraphical Discussion

The incomplete state of the Alexander Island belemnite collections is such that the precise stratigraphical ranges of the known species and possible inter-continental correlations can only be postulated in the most general terms. However, future collecting may remedy these inadequacies. Meanwhile, the age of many of the new beleminte species has been determined by ammonites (identified by M. R. A. Thomson) from stratigraphically equivalent or near-equivalent horizons.

A general synthesis of the world's Jurassic and Cretaceous belemnite faunas has been outlined by Stevens (1965*a*). *Belemnopsis* probably developed in the Middle Lias (Roger, 1952, p. 715), although none appears to have reached the Indo-Pacific region at this time. In the Bajocian a marked belemnite radiation occurred throughout the Tethyan realm and during the Bajocian–Bathonian *Belemnopsis* extended into the Malagasy Republic, South America and the Indo-Pacific, whereas *Hibolithes* reached the Indo-Pacific in the Bathonian–Callovian (Stevens, 1965*a*, p. 169).

Belemnites have previously been recorded from several areas in western Antarctica and from Coronation Island, South Orkney Islands. *Conodicoelites* has been described from Upper Jurassic sediments at the Lyon Nunataks, eastern Ellsworth Land (Stevens, 1967), and *Belemnopsis* sp. has been recorded in (?) Upper Jurassic sediments from the Behrendt Mountains and Weather Guesser Nunataks, eastern Ellsworth Land (Laudon and others, 1969). A varied marine fauna including belemnites was collected from the Lataday Formation, Lassiter Coast area, Antarctic Peninsula (Williams and others, 1971). Sediments on the western part of Byers Peninsula, Livingston Island, South Shetland Islands, contain a Tithonian–late Berriasian fauna including *Belemnites* (*Hibolites*) aff. *jaculum* (Phillips) (González-Ferrán and others, 1970; Tavera, 1970).

Several belemnite fragments in calciferous grit boulders containing a poorly preserved marine fauna from Coronation Island, South Orkney Islands (Matthews, 1959; Adie, 1964; Thomson, 1968), have been examined by the author. One fragment (H.1186.9) from the alveolar region of a moderately robust guard (split longitudinally along the ventro-dorsal plane) displays the alveolar cavity. Above the ventrally displaced protoconch is an acute alveolus. Several partially preserved alveolar septa about 5 mm. above the missing protoconch show the development of an external siphuncle. Although badly abraded, an incomplete cross-section in the upper stem region indicates an almost circular guard with a broad, shallow *Belemnopsis*-like median ventral groove. Other material from this area included part of a calciferous grit boulder (H.1340.5f) with moulds of bivalves, one of which appears to be of *Myophorella*. Both genera indicate a Middle–Upper Jurassic or possibly lowermost Cretaceous age.

Belemnites from south-eastern Alexander Island which were first reported by members of the British Graham Land Expedition (Fleming, 1938) have been referred to by several authors but no descriptions have been published until now. A preliminary summary of the postulated stratigraphical distribution of belemnites in south-eastern Alexander Island is given in Table I.

TABLE I.

	Age		Belemnite species
LOWER CRETACEOUS	Albian		*Dimitobelus macgregori* *Dimitobelus* sp. aff. *D. macgregori* *Peratobelus oxys* *Neohibolites minimus* cf. var. *oblongus*
	Aptian		*Peratobelus* aff. *australis* *Neohibolites minimus* cf. var. *submedius*
	Aptian		*Peratobelus* sp. nov. (?) *Neohibolites minimus* cf. var. *submedius* *Neohibolites* cf. *miyakoensis*
	Neocomian	Barremian	
	Neocomian	Hauterivian Valanginian	Not proven
	Neocomian	Berriasian	*Hibolithes subfusiformis* *Belemnopsis gladiatoris* *Belemnopsis alexandri* *Belemnopsis* aff. *uhligi* *Hibolithes subfusiformis* *Hibolithes subfusiformis* *Hibolithes* aff. *marwicki mangaoraensis* *Hibolithes antarctica* *Hibolithes* sp. nov. (?) *Belemnopsis alexandri* *Belemnopsis* aff. *uhligi* *Hibolithes subfusiformis* *Hibolithes* cf. *compressus*
UPPER JURASSIC	Tithonian		*Belemnopsis* aff. *uhligi* *Hibolithes belligerundi*
UPPER JURASSIC	Middle Kimmeridgian to Upper Oxfordian		*Belemnopsis* cf. *alfurica* *Belemnopsis* cf. *gerardi* *Belemnopsis* cf. *keari* *Belemnopsis* cf. *tanganensis*

Ablation Point and Belemnite Point

Specimens of *Belemnopsis* cf. *tanganensis* (Futterer), *Belemnopsis* cf. *alfurica* (Boehm), *Belemnopsis* cf. *gerardi* (Oppel) and *Belemnopsis* cf. *keari* Stevens were collected from the disturbed sequence forming the basal 150 m. of sediments exposed at Ablation Point. The known stratigraphical age range of *Belemnopsis tanganensis* is Oxfordian–Middle Kimmeridgian (Stevens, 1963*c*), *Belemnopsis alfurica* and *Belemnopsis gerardi* are Upper Oxfordian–Kimmeridgian (Stevens, 1963*a*, *b*), while *Belemnopsis keari* is Heterian (Lower–Middle Kimmeridgian) (Stevens, 1965*a*, p. 74–78). These same beds also contain *Inoceramus haasti* Hochstetter and *Inoceramus* aff. *subhaasti* Wandel (Thomson and Willey, 1972), and they are probably equivalent in age to those from which a specimen of *Perisphinctes* (*Orthosphinctes*) cf. *transatlanticus* (Steinmann) (Howarth, 1958) was obtained. Based on this evidence these sediments are probably Upper Oxfordian–Middle Kimmeridgian in age. In the absence of other evidence, a similar age is also suggested for those sediments at Belemnite Point containing *Belemnopsis* cf. *tanganensis* and *Belemnopsis* cf. *alfurica*.

At several stations (KG.701, 712 and 722) above the disturbed zone at Ablation Point, the sediments contain *Belemnopsis* aff. *uhligi* Stevens and *Hibolithes belligerundi* sp. nov., and a Tithonian ammonite fauna including:

Phylloceras serum (*?*) Oppel
Phyllopachyceras beneckei (*?*) Zittel
"*Lytoceras*" sp.
Pterolytoceras exoticum Oppel
Haploceras sp.
Uhligites sp.
Virgatosphinctes aff. *denseplicatus* (Waagen)
Aulacosphinctoides smithwoodwardi (*?*) (Uhlig)
Spiticeras s.l. sp.
Corongoceras cf. *lotenoense* Spath.

Belemnopsis uhligi has been recorded from the Indian sub-continent, Indonesia and New Guinea, and it ranges from Middle Kimmeridgian to Middle (or Upper) Tithonian (Stevens, 1963*a*, p. 695).

About 1,000 m. higher in the sequence, *Belemnopsis* aff. *uhligi* reappears associated with *Belemnopsis alexandri* sp. nov. and the following ammonites:

Haplophylloceras strigile (*?*) (Blanford)
Bochianites aff. *versteeghi* Boehm
Spiticeras aff. *spitiensis* (Blanford)
Raimondiceras sp. nov.

A lowermost Neocomian (Berriasian) age is suggested by these ammonites. Occurring immediately above these beds, but separated by a fault, are the argillites containing *Hibolithes subfusiformis* (Raspail) and *Hibolithes* cf. *compressus* Stolley with *Haplophylloceras strigile* (*?*) (Blanford) and *Bochianites* aff. *versteeghi* (Boehm). *Hibolithes subfusiformis* characterizes the Neocomian of Europe, India, the Malagasy Republic, Tanganyika, Somaliland and Indonesia, and its occurrence in the Ablation Point area and at other localities in south-eastern Alexander Island emphatically suggests a Neocomian age. The occurrence of *Belemnopsis* aff. *uhligi* here and at other localities in Alexander Island, associated with a Lower Neocomian fauna, suggests that its range in Alexander Island must be at least Tithonian–Lower Neocomian. *Hibolithes compressus* has been described from the Upper Jurassic sediments of Indonesia and the Malagasy Republic.

At station KG. 1574, south-west of Ablation Valley, a further 300 m. of apparently unfossiliferous sediments separate this Lower Neocomian fauna from *Neohibolites* cf. *miyakoensis* Hanai and *Neohibolites minimus* cf. var. *submedius* Swinnerton. At the same locality, ammonites similar to those of the Lower Aptian fauna at locality R (Thomson, 1971) have been collected.

Neohibolites ranges from Lower Aptian to Lower Cenomanian (Hanai, 1963, p. 65) and is particularly abundant in the Lower Aptian–Middle Albian of Europe, Asia, North and South

America, and the Malagasy Republic. *Neohibolites minimus* is common in the Gault of England and *Neohibolites miyakoensis* has been described from the Shimohei Formation of Japan which may be Lower Aptian–Middle Albian in age (Hanai, 1953).

The occurrence of these particular species of *Neohibolites* and the associated ammonite fauna at locality KG.1574 suggest that these beds are Aptian in age. The absence of any unconformity in the underlying unfossiliferous sediments also implies that this lower sequence may represent the time interval between the Berriasian and lowest Aptian in the Ablation Point area.

Coastal cliffs between Jupiter and Pluto Glaciers

The belemnites and ammonites at these localities are of Lower Neocomian (Berriasian) age. The lower 153 m. of the section at locality Z contain *Hibolithes antarctica* sp. nov. and *Hibolithes* sp. nov. (?) associated with *Substreblites* sp., *Phylloceras* sp. and *Sarasinella* aff. *hondana* Haas. Several fragmentary guards of both belemnite species together with *Hibolithes subfusiformis* have been collected from the overlying 53 m. thick sandstone. Above this sandstone, greywackes and argillaceous sediments contain an abundance of belemnite material. *Hibolithes subfusiformis* and *Hibolithes* aff. *marwicki mangaoraensis* Stevens are associated with *Phyllopachyceras* (?) sp., *Neocosmoceras* sp. and *Himalayites* (?) sp. in the first 60 m. of this sequence. In the succeeding 400 m. of predominantly argillaceous sediments *Belemnopsis gladiatoris* sp. nov., *Belemnopsis alexandri* and *Belemnopsis* aff. *uhligi* temporarily replace the *Hibolithes* fauna. However, towards the top of this sequence *Hibolithes subfusiformis* returns in association with a specimen of *Bochianites* sp. nov.

Belemnopsis gladiatoris is probably conspecific with specimens misidentified as *Belemnites* (*Belemnopsis*) *patagoniensis* Favre (p. 36) collected from several stratigraphical levels in the Lago Argentino area of Patagonia (Feruglio, 1936, p. 81–83). Several of these specimens were collected at Vallecito de la Cascada between l'Estancia Cristina and Laguna Anita associated with a doubtful species of *Spiticeras* and *Aptychus* (*Laeviaptycus*) *latissimus* Feruglio. South of Cerro de los Fósiles, additional specimens were obtained in association with poorly preserved ammonites having *both* Tithonian and Berriasian affinities. From a higher horizon, at this same locality, more guard fragments were obtained together with *Inoceramus* cf. *steinmanni* [= *Inoceramus pseudosteinmanni* Thomson and Willey], suggesting a further close correlation with locality Z in Alexander Island (Thomson and Willey, 1972).

A guard fragment from the *Rogersites* beds (Valanginian) of Ambiky, Malagasy Republic, illustrated by Spath (1939, pl. XXIV, fig. 15a and b) as *Belemnopsis africana* is closely comparable to *Belemnopsis gladiatoris* (p. 36–37) and a second fragment from the same beds is considered conspecific with the Alexander Island specimens.

Specimens probably conspecific with *Belemnopsis alexandri* occur in the Spiti Shales of India, the Upper Jurassic sediments of Somaliland and the Neocomian belemnite beds of the Salt Range (p. 39).

A similar Lower Neocomian (Berriasian) age is suggested for those sediments comprising the unnamed cliffs north of locality Z on the southern margin of Jupiter Glacier (Fig. 1). Scree fragments of *Belemnopsis gladiatoris*, *Belemnopsis alexandri* and *Hibolithes* sp. nov. (?) have been obtained from these cliffs.

Cliffs in the vicinity of locality D, and localities F and C

Belemnopsis gladiatoris and *Hibolithes* sp. nov. (?) occur in a sequence partly equivalent to the lower and middle parts of the stratigraphical section at locality D. These sediments are stratigraphically about 500 m. above a thrust zone at locality C, which, if extrapolated northward, would overlie beds at locality A and at locality B which contain a distinctive uppermost Aptian or (?) Albian fauna (Thomson, 1971; Willey, 1972). No other fossils suitable as age indices have been collected from the belemnite-bearing beds, but ammonites similar to those from the Aptian sediments of locality R have been collected from strata several hundred metres above them.

Specimens of *Belemnopsis gladiatoris*, *Belemnopsis alexandri* and *Belemnopsis* aff. *uhligi* from locality F were also derived from sediments apparently lacking in stratigraphically useful

fossils. Mainly palaeontological evidence has enabled Taylor (1971, fig. 2) to correlate this locality with adjacent ones in this area. He has demonstrated that locality F lies stratigraphically at least 350 m. below sediments exposed at locality R where an Aptian ammonite fauna is present (Thomson, 1971). A scree specimen from locality C has been identified as *Hibolithes antarctica*. Elsewhere in south-eastern Alexander Island, the *same* belemnite species indicate an early Neocomian age. Therefore, while the *Belemnopsis–Hibolithes* fauna may have survived into the late Neocomian (or possibly Aptian) in this area, the stratigraphical proximity of this and the Aptian fauna does not necessarily indicate an equivalent age. The absence of a distinctive fauna of Middle Neocomian–lowest Aptian in the sediments of the Ablation Point area suggests that this interval is marked in much of south-eastern Alexander Island by relatively unfossiliferous sediments.

Locality T and near locality R

Several specimens of *Neohibolites minimus* cf. var. *submedius* Swinnerton and *Neohibolites minimus* cf. var. *oblongus* (Stolley) have been obtained from locality T. Both are commonly found in the European Aptian sediments. Several of the Alexander Island specimens of *Neohobolites minimus* cf. var. *submedius* were obtained from a mudflake conglomerate containing *Peratobelus* aff. *australis* (Phillips) and above a dark mudstone containing *Peratobelus* sp. nov. (?) and an ammonite fauna comprising *Eulytoceras* aff. *polare* (Ravn), *Emericiceras* (?) sp. and *Sanmartinoceras patagonicum* Bonarelli, suggesting an Aptian age. Specimens of *Neohibolites minimus* cf. var. *oblongus* were collected from above the mudflake conglomerate from a dark mudstone associated with an uppermost Aptian ammonite fauna of *Eotetragonites* (?) sp. cf. *E. gardneri* Murphy and *Aconeceras* aff. *nisoides* (Sarasin).

A specimen (E.153.3 (C.46252)) of *Neohibolites* cf. *miyakoensis*, collected by V. E. Fuchs and R. J. Adie from a moraine "about half a mile [805 m.] south of 'Fossil Camp' [Fossil Bluff]", is probably derived from Aptian sediments equivalent to those at locality R.

ACKNOWLEDGEMENTS

The author wishes to thank Professor F. W. Shotton for facilities in the Department of Geology, University of Birmingham, and Dr. R. J. Adie for guidance in preparing the manuscript. Dr. I. Strachan of the same department made many helpful suggestions. The assistance of Dr. M. K. Howarth and Mr. D. Phillips of the British Museum (Nat. Hist.) is gratefully acknowledged as is the loan of belemnite material housed in this museum. Casts of belemnites from Professor Feruglio's Patagonian collection were kindly made available by Professor R. Selli and Dr. M. A. Padovani, University of Bologna. I am also grateful to Mrs. J. W. Thomson for allowing me to examine material collected by Dr. D. H. Matthews from Coronation Island, and to Drs. B. J. Taylor and M. R. A. Thomson for their co-operation and constructive criticism throughout the preparation of this paper. The co-operation of my colleagues, particularly C. M. Bell and M. H. Elliott, is acknowledged.

MS. received 14 April 1972

REFERENCES

ADIE, R. J. 1964. Geological history. (*In* PRIESTLEY, R. E., ADIE, R. J. *and* G. DE Q. ROBIN, *ed. Antarctic research*. London, Butterworth and Co. (Publishers) Ltd., 118–62.)

AVIAS, J. 1953. Contribution à l'étude stratigraphique et paléontologique de la Nouvelle-Calédonie centrale. *Sciences Terre*, **1**, Nos. 1–2, 1–276.

BAYLE, E. 1878. Fossiles principaux des terrains. (*In Explication de la carte géologique de la France. IV. Atlas*. Paris, Imprimerie Nationale, Pt. 1, Pl. I–CLVIII.)

BESAIRIE, H. 1930. Recherches géologiques à Madagascar. Contribution à l'étude des ressources minérales. *Bull. Soc. Hist. nat. Toulouse*, **60**, Fasc. 2 and 3, 345–616.

———. 1936. Recherches géologiques à Madagascar. 1. La géologie du Nord-ouest. *Mém. Acad. malgache*, Fasc. 21, 259 pp.

BOEHM, G. 1907*a*. Beiträge zur Geologie von Niederländisch-Indien. I. Abt. Die Südküsten der Sula-Inseln Taliabu und Mangoli. 2. Abs. Der Fundpunkt am oberen Lagoi auf Taliabu. *Palaeontographica*. 4 (supplement), Abt. 1, Lief. 2, 47–58.

BOEHM, G. 1907*b*. Beiträge zur Geologie von Niederländisch-Indien. 1. Abt. Die Südküsten der Sula-Inseln Taliabu und Mangoli. 3. Abs. Oxford des Wai Galo. *Palaeontographica*, **4** (supplement), Abt. 1, Lief, 2, 59–120.

FAVRE, F. 1908. Die Ammoniten der unteren Kreide Patagoniens. *Neues Jb. Miner. Geol. Paläont. BeilBd.*, **25**, 601–47.

FERUGLIO, E. 1936. Palaeontographica patagonica. Pt. 1. *Memorie Ist. geol. miner. Univ. Padova*, **11**, 1–192.

FLEMING, W. L. S. 1938. Geology and glaciology. (*In* FLEMING, W. L. S., STEPHENSON, A., ROBERTS, B. B. *and* G. C. L. BERTRAM. Notes on the scientific work of the British Graham Land Expedition, 1934–37. *Geogrl J.*, **91**, No. 6, 508–12.)

FUTTERER, K. 1894. Beiträge zur Kenntniss der Jura in Ost-Afrika. *Z. dt. geol. Ges.*, **46**, Ht. 1, 1–49.

GONZÁLEZ-FERRÁN, O., KATSUI, Y. *and* J. TAVERA. 1970. Contribución al conocimiento geológico de la Península Byers de la Isla Livingston; Islas Shetland del Sur, Antártica. *Ser. cient. Inst. antárt. chileno*, **1**, No. 1, 41–54. [*Contrnes Inst. antárt. chileno*, No. 19.]

HANAI, T. 1953. Lower Cretaceous belemnites from Miyako District, Japan. *Jap. J. Geol. Geogr.*, **23**, 63–80.

HECTOR, J. 1878. On the belemnites found in New Zealand. *Trans. Proc. N.Z. Inst.*, **10** (for 1877), Art. 76, 484–89.

HOWARTH, M. K. 1958. Upper Jurassic and Cretaceous ammonite faunas of Alexander Land and Graham Land. *Falkland Islands Dependencies Survey Scientific Reports*, No. 21, 16 pp.

KRUIZINGA, P. 1921. De belemnieten uit de jurassische afzettingen van de Soela-eilanden. *Jaarb. Mijnw. Ned.-Oost-Indië*, **49** (for 1920), 159–89.

LAUDON, T. S., LACKEY, L. L., QUILTY, P. G. *and* P. M. OTWAY. 1969. Geology of eastern Ellsworth Land (Sheet 3, eastern Ellsworth Land). (*In* BUSHNELL, V. C. *and* C. CRADDOCK, *ed.* Geologic maps of Antarctica. *Antarct. Map Folio Ser.*, Folio 12, Pl. III.)

MARWICK, J. 1953. Divisions and faunas of the Hokonui System (Triassic and Jurassic). *Palaeont. Bull. Wellington*, No. 21, 141 pp.

MATTHEWS, D. H. 1959. Aspects of the geology of the Scotia arc. *Geol. Mag.*, **96**, No. 6, 425–41.

MONTFORT, D. DE. 1808. *Conchyliologie systématique et classification methodique des Coquilles. Coquilles univalves, cloisonnées. Tome 1.* Paris, Chez F. Schoell.

NAEF, A. 1922. *Die fossilen Tintenfische. Eine paläozoologische Monographie.* Jena, Gustav Fischer.

NOETLING, F. 1902. Fauna of Baluchistan and N.W. Frontier of India. Vol. 1. The Jurassic fauna. Part 2.—The fauna of the (Neocomian) belemnite beds. *Mem. geol. Surv. India Palaeont. indica.*, Ser. 16, **1**, Pt. 2, 1–5.

OPPEL, A. 1865. Ueber ostindische Fossilreste aus den secundären Ablagerungen von Spiti und Gnari-Khorsum in Tibet. Beschreibung der von den Herrn Adolf Herrmann und Robert v. Schlagintweit während der Jahre 1854–1857 gesammelten Arten. (*In* OPPEL, A. *Palaeontologische Mittheilungen aus dem Museum des koenigl. bayer. Staates.* Stuttgart, Ebner & Seubert, Bd. I, 289–304.)

RASPAIL, M. F. W. 1829. Histoire naturelle des bélemnites, accompagnée de la description et de la classification des espèces que M. Émeric, de Castellane, a recueillies dans les Basses-Alpes de Provence. Pt. 1. *Annls. Sci. obs.*, 1–62.

ROGER, J. 1952. Sous-classe der Dibranchiata Owen 1836 (Coleoidea Waagen, Endocochlia Schwarz). (*In* PIVETEAU, J., *ed. Traité de paléontologie. Tome II. Problèmes d'adaptation et de phylogénèse* (*Brachiopodes, Chétnognathes, Annélides, Géphyriens, Mollusques*). Paris, Masson et Cie, 689–755.)

SPATH, L. F. 1927. Revision of the Jurassic cephalopod fauna of Kachh (Cutch). *Mem. geol. Surv. India Palaeont. indica*, N.S., **9**, No. 2, 1–71.

———. 1939. The Cephalopoda of the Neocomian belemnite beds of the Salt Range. *Mem. geol. Surv. India Palaeont. indica*, N.S., **25**, No. 1, 1–154.

STEFANINI, G. 1925. Molluschi del Giuralias della Somallia. *Palaeontogr. ital.*, **32**, Supplement 1, 1–53.

STEVENS, G. R. 1963*a*. The systematic status of Oppel's specimens of *Belemnites gerardi*. *Palaeontology*, **6**, Pt. 4, 690–98.

———. 1963*b*. Designation of a lectotype for the nominal species *Belemnopsis alfurica* (Boehm) 1907 (Cephalopoda, Dibranchiata). *Trans. R. Soc. N.Z.*, Geology, **2**, No. 6, 101–04.

———. 1963*c*. The type specimens of *Belemnopsis tanganensis* (Futterer) 1894 (Cephalopoda, Dibranchiata). *Trans. R. Soc. N.Z.*, Geology, **2**, No. 8, 131–35.

———. 1965*a*. The Jurassic and Cretaceous belemnites of New Zealand and a review of the Jurassic and Cretaceous belemnites of the Indo-Pacific region. *Palaeont. Bull., Wellington*, No. 36, 283 pp.

———. 1965*b*. A new belemnite from the Upper Jurassic of Indonesia. *Palaeontology*, **7**, Pt. 4, 621–29.

———. 1967. Upper Jurassic fossils from Ellsworth Land, west Antarctica, and notes on Upper Jurassic biogeography of the South Pacific region. *N.Z. Jl Geol. Geophys.*, **10**, No. 2, 345–93.

STOLLEY, E. 1911. Studien an den Belemniten der unteren Kreide Norddeutschlands. *Jber. niedersächs. geol. Ver.*, **4**, 174–91.

———. 1929. Über ostindische Jura-Belemnitiden. (*In* STOLLEY, E. *Palaeontologie von Timor*. Stuttgart, Sinsel & Co., Lief. 16, Abh. 29, 91–213.)

———. 1934. Beiträge zur Paläontologie des Ostindischen Archipels. XI. Zur Kenntnis des Jura und der Unterkreide von Misol. I. Stratigraphischer Teil. *Neues Jb. Miner. Geol. Paläont. BeilBd.*, Abt. B, **71**, 470–86.

———. 1935. Zur Kenntnis der Jura und der Unterkreide von Misol. Paläontologischer Teil. *Neues Jb. Miner. Geol. Paläont. BeilBd.*, Abt. B, **73**, 42–69.

SWINNERTON, H. H. 1936–55. A monograph of British Lower Cretaceous belemnites. *Palaeontogr. Soc.* [*Monogr.*], i–xl, 1–86.

TATE, R. 1867. On some secondary fossils from South Africa. *Q. Jl geol. Soc. Lond.*, **23**, Pt. 1, 139–75.

TAVERA, J., J. 1970. Fauna Titoniana–Neocomiana de la Isla Livingston, Islas Shetland del Sur, Antártica. *Ser. cient. Inst. antárt. chileno*, **1**, No. 2, 175–86. [*Contrnes Inst. antárt. chileno*, No. 23.]

TAYLOR, B. J. 1971. Stratigraphical correlation in south-east Alexander Island. (*In* ADIE, R. J., *ed. Antarctic geology and geophysics*. Oslo, Universitetsforlaget, 149–53.)

THOMSON, J. W. 1968. The geology of the South Orkney Islands: II. The petrology of Signy Island. *British Antarctic Survey Scientific Reports*, No. 62, 30 pp.

THOMSON, M. R. A. 1971. Ammonite faunas of south-eastern Alexander Island and their stratigraphical significance. (*In* ADIE, R. J., *ed. Antarctic geology and geophysics*. Oslo, Universitetsforlaget, 155–60.)

————. *and* L. E. WILLEY. 1972. Upper Jurassic and Lower Cretaceous *Inoceramus* (Bivalvia) from south-east Alexander Island. *British Antarctic Survey Bulletin*, No. 29, 1–19.

TRECHMANN, C. T. 1923. The Jurassic rocks of New Zealand. With an appendix on ammonites from New Zealand by L. F. Spath. *Q. Jl geol. Soc. Lond.*, **79**, Pt. 3, No. 315, 246–312.

UHLIG, V. 1910. The fauna of the Spiti Shales. *Mem. geol. Surv. India Palaeont. indica*, Ser. 15, **4**, Fasc. 3, 307–95.

WILLEY, L. E. 1972. Belemnites from south-eastern Alexander Island: I. The occurrence of the family Dimitobelidae in the Lower Cretaceous. *British Antarctic Survey Bulletin*, No. 28, 29–42.

WILLIAMS, P. L., SCHMIDT, D. L., PLUMMER, C. C. *and* L. E. BROWN. 1971. Geology of the Lassiter Coast area, Antarctic Peninsula: preliminary report. (*In* ADIE, R. J., *ed. Antarctic geology and geophysics*. Oslo, Universitetsforlaget, 143–48.)