A NEW BELEMNITE FROM THE UPPER JURASSIC OF INDONESIA

by G. R. STEVENS

ABSTRACT. *Belemnopsis stolleyi* sp. nov. is described, based on specimens originally identified by Stolley (1929) as *Belemnopsis aucklandica* (Hochstetter). Adult specimens of *B. stolleyi* usually show secondarily deepened ventral grooves, sometimes also found in *Dicoelites*, and the causes of this are discussed.

IN his monograph on the Jurassic belemnite faunas of Indonesia Stolley (1929, pp. 168–70, pl. 3, figs. 12–15, pl. 4, figs. 1–6) referred a number of specimens to the New Zealand species *Belemnopsis aucklandica* Hauer (species now attributed to Hochstetter, see Marwick 1953, p. 123). These specimens are from three islands: (i) Timor; (ii) Rotti (or Roti), an island off the south-west tip of Timor; (iii) Jamdena (or Yamdena), the main island of the Tenimber (or Timorlaut) Archipelago.

B. aucklandica (Hochst.) occurs abundantly in the Upper Jurassic of New Zealand, chiefly at Waikato Heads (type locality; Hochstetter 1863, p. 129, Hauer *in* Zittel 1864, p. 29) and Kawhia Harbour, and has also been recorded from New Caledonia (Avias 1953, pp. 161–3) and the Sula Islands, Indonesia (Kruizinga 1921, pp. 172–4). This species, along with other New Zealand belemnites, has recently been revised by the writer (Stevens, in press), from an examination of overseas belemnites, especially those from Indonesia, including those studied by Stolley. The specimens referred to in this paper are preserved in the geological collections of the Technical University, Delft (Molengraaff and Jonker Collections), and the Natural History Museum, Basel (Weber Collection).

Stolley's specimens of *B. aucklandica* from Timor and Rotti (Stolley 1929, pl. 4, figs. 4–6) appear to be unrelated to those from Jamdena, but for completeness may be briefly considered. The guard from Ofoe, Timor, figured by Stolley, pl. 4, fig. 5 (no. 14573, Molengraaff Collection, Delft), agrees most closely with specimens of *B. jonkeri* Stolley (e.g. Stolley 1929, pl. 5, figs. 1–3). The guard is cylindrical and elongate. A broad, shallow ventral groove is present, extending posteriorly from the alveolus, but not reaching the apical region. The groove deepens slightly in the alveolar region. A dorsal groove is not present and lateral lines appear to be absent, though the external surface of the guard has been slightly abraded. Hastation is not apparent, the guard being parallel-sided throughout the stem and alveolar regions. These characters agree with those of a typical *B. jonkeri* Stolley. The specimen also bears a slight resemblance to *Belemnopsis uhligi* Stevens (= *B. gerardi* auct.; see Stevens 1963) but typical specimens of this species tend to have a deeper ventral groove, and the groove extends into the apical region. Furthermore, the guard of *B. uhligi* is not as elongate as *B. jonkeri*, and usually gradually increases in width towards the alveolus. However, there seems to be a continuous gradation between the two typical forms, and until these intermediate forms have been studied it may be expedient to refer the specimen under discussion to the '*uhligi-jonkeri* group'. The other specimens, Stolley 1929, pl. 4, fig. 4 (Ofoe, Timor, no. 14572, Jonker

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Collection, Delft) and pl. 4, fig. 6 (Rotti, no. 14519, Molengraaff Collection, Delft), can also be tentatively referred to this group.

The specimens of *B. aucklandica* described by Stolley (1929) from Jamdena were collected by F. Weber (in 1928) from two localities. Further specimens of the same belemnite from the same localities were collected by Weber in 1930 and examined by Stolley in 1934 (Weber Collection, Basel). All these specimens were found by the writer to differ from *B. aucklandica* and to be quite distinct from other Indonesian belemnites and it is concluded that they represent a new *Belemnopsis* species to which is assigned the name *B. stolleyi*.

Belemnopsis stolleyi sp. nov.

Plate 95, figs. 1–12

1929 *Belemnopsis aucklandica* (Hauer) (*partim*); Stolley, pp. 168–70, pl. 3, figs. 12–15, pl. 4, figs. 1–3 (*non* pl. 4, figs. 4–6).

non 1863 *Belemnites aucklandicus* Hochstetter (*Belemnites aucklandicus* Hauer, *auct.*), p. 129, fig.

Diagnosis. A *Belemnopsis* with an elongate non-hastate guard. Cross-sections of guard usually equidimensional. Prominent lateral lines present on flanks of guard. Median ventral groove prominent, usually secondarily deepened in adult guards.

Holotype. Specimen J52/9 (Pl. 95, figs. 4–6), Weber Collection, Natural History Museum, Basel. Collected from the red and variegated marls of the Upper Oxfordian, 'Belemnitenbach', *c.* 6 km. from the west coast, North Jamdena, Tenimber Archipelago, Indonesia.

Localities and material. Unnumbered fossil localities; the source of the material described by Stolley (1929, pp. 121, 168–70). Weber Collection, Basel. (*a*) 'Belemnitenbach', *c.* 6–7 km. from the mud volcano Botendakoe (Botendohá), North Jamdena. (*b*) The mud volcano Tasik Selwasa, 50 km. from locality (*a*).

Numbered fossil localities; collected by F. Weber, 1930 (Weber Collection, Basel):

J52/4–8 (Pl. 95, figs. 7–12). From the red clay, 'Belemnitenbach', 6–7 km. south-east of the mud volcano Botendohá, North Jamdena. Five specimens.

J52/9–13 (Pl. 95, figs. 4–6). From the red and variegated marls of the Upper Oxfordian, 'Belemnitenbach', *c.* 6 km. from the west coast, North Jamdena. Five specimens.

J52/14–25 (Pl. 95, figs. 1–3) From the variegated marl-clays, North Jamdena. Twelve specimens.

Description. Guard elongate and moderately robust. Length about five times the maximum transverse diameter. Outline symmetrical and non-hastate. The flanks of the guard

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EXPLANATION OF PLATE 95

All figures natural size.

Figs. 1–3. *Belemnopsis stolleyi* sp. nov. Variegated clay-marls, North Jamdena, Indonesia. Specimen J.52/18, Weber Collection, Basel. 1, Ventral. 2, Dorsal. 3, Left lateral.

Figs. 4–6. *B. stolleyi* sp. nov. Holotype. Red and variegated marls, 'Belemnitenbach', *c.* 6 km. from the west coast, North Jamdena. Specimen J.52/9, Weber Collection, Basel. 4, Ventral. 5, Dorsal. 6, Left lateral.

Figs. 7–9. *B. stolleyi* sp. nov. Red clay, 'Belemnitenbach', 6–7 km. south-east of the mud volcano Botendohá, North Jamdena. Specimen J.52/6, Weber Collection, Basel. 7, Ventral. 8, Dorsal. 9, Left lateral.

Figs. 10–12. *B. stolleyi* sp. nov. Red clay, 'Belemnitenbach' 6–7 km. south-east of the mud volcano Botendohá, North Jamdena. Specimen J.52/4, Weber Collection, Basel. 10, Ventral. 11, Dorsal. 12, Left lateral.

gradually diverge towards the anterior. The apical angle is approximately 25°, and an apical perforation is normally present. The profile resembles the outline: symmetrical and non-hastate. The cross-sections of the guard are normally equi-dimensional.

The prominent median ventral groove extends posteriorly from the alveolus and in adult guards terminates some 8–10 mm. from the apex. The groove gradually shallows towards the apex, until its floor coincides with the surface of the guard. The groove deepens markedly in the posterior portion of the stem region (some 20 mm. from the apex), and continues to deepen, so that in the anterior portion of the stem region and in the alveolar region it is extremely deep and narrow. Unlike the ventral groove of other species of *Belemnopsis*, the groove of *B. stolleyi* has been secondarily deepened in the adult stage, and the walls of the groove intersect the growth lamellae of the guard (see discussion below). Secondary deepening of the groove may proceed to such a stage that the groove penetrates the alveolar wall.

Dimensions (in mm.) are given below for five specimens of *B. stolleyi*

Specimen	*Length (protoconch to apex)*	*Transverse diameter* (*at protoconch*)	*Sagittal diameter* (*at protoconch*)	*Depth of ventral groove*	*Width of ventral groove*	*Distance from apex to point of measurement of ventral groove*	*Transverse and sagittal diameter at point of measurement of ventral groove*
J52/4	60*	12	12	3·0	2·5	65	12
J52/6	54	11·5	11	2·5	2·0	56	11
J52/9	66*	12	12	3·0	2·5	63	12
J52/10	70*	13·5	13·5	3·0	2·5	78	13·5
J52/21	75*	15·5	15·5	3·0	2·0	78	15

*Estimate.

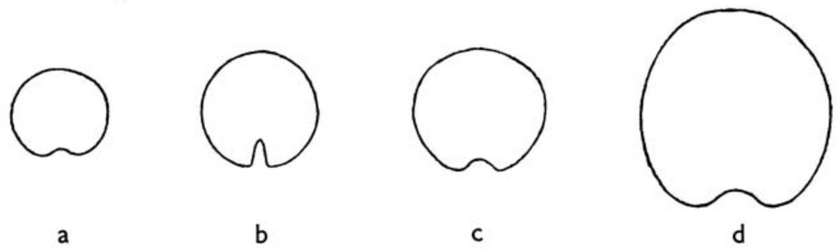
Lateral lines are present on the flanks of the guard. They commence posteriorly on the dorso-lateral surface of the apex, and extend anteriorly as two lines, almost parallel and 1 mm. apart, passing obliquely across the flanks of the guard. The course of the lateral lines in the anterior portion of the stem region and in the alveolar region has been obscured in most specimens by slight corrasion of the surface of the guard, but traces are often present, indicating that the lines diverge sharply in the anterior portion of the stem region. No vascular markings have been observed on the surface of the guard.

The apical line is excentric and ventrally placed. The maximum excentricity of the apical line that has been observed is a displacement of 2 mm. from the central axis of the guard (where the diameter is 13·5 mm.). In all the specimens examined the phragmocone is absent and the walls of the alveolus have collapsed. The alveolus is slightly excentric and ventrally placed.

Features of the ventral groove of Belemnopsis stolleyi (text-fig. 1). The grooves, both dorsal and ventral, of most belemnites are usually conformable with the growth-lines— i.e. the groove is reproduced in each growth-line. But in *B. stolleyi* the ventral groove intersects the growth-lines, and the truncated growth lamellae form striae along the walls of the groove. In juvenile specimens of *B. stolleyi* the ventral groove is usually deep and the growth-lines reproduce its depth. But in the adult secondary deepening of the groove occurs, usually commencing in the alveolar region and extending into the stem region. Incipient secondary deepening of the ventral groove in the alveolar region may be present in some 'adolescent' guards; but extensive secondary deepening is confined to the adult stage, sometimes proceeding so far that the alveolar wall is intersected.

The secondary deepening of the ventral groove in *B. stolleyi* may be considered to be a result of either:

(i) a weathering process (e.g. exfoliation), or
(ii) the development of a zone of incomplete calcification or resorption along the ventral groove.



TEXT-FIG. 1. Cross-sections of *Belemnopsis* guards.

a, *Belemnopsis gerardi* (Oppel). Lectotype. Upper Jurassic of Kalabagh, Upper Punjab. No. 1872. xv. 502, Schlagintweit Collection, Munich. Figured Stevens 1963, pl. 98, figs. 1–4. Cross-section 35 mm. from apex (×1½). *b*, *B. stolleyi* sp. nov. Holotype. Upper Jurassic of North Jamdena, Indonesia. Specimen J.52/9, Weber Collection, Basel. Cf. Pl. 95, figs. 4–6 of present work. Cross-section 63 mm. from apex (×1½). *c*, *B. aucklandica* (Hochstetter). Holotype. Upper Jurassic, mouth of Waikato River, New Zealand. No. 1865. xxxvii. 73, Hochstetter Collection, Vienna. Figured Hauer (in Zittel, 1864), pl. 8, figs. 2*a*, 2*b*. Cross-section 40 mm. from apex (×1½). *d*, *B. uhligi* Stevens. Upper Jurassic of Fatjet, Misol Archipelago, Indonesia. Specimen 116/1, Weber Collection, Basel. Figured Stevens 1963, pl. 99, figs. 6–9. Cross-section 75 mm. from apex (×1½).

If the secondary deepening is a weathering phenomenon, it is difficult to account for its localization in the groove, leaving the remainder of the guard unaffected. The guards of *B. stolleyi* from Jamdena are well preserved; their external surfaces show no traces of corrasion, chemical alteration, &c. Most of the guards show traces of lateral lines, and many show them very clearly. These are very delicate features of the guard's surface and it is probable that they would not survive any weathering process capable of decalcifying and deepening the groove.

Secondary deepening of the ventral groove is not confined to specimens from one locality. The specimens of *B. stolleyi* come from two regions of Jamdena, separated by 50 km.; and specimens of *Dicoelites* with secondarily deepened ventral grooves have been obtained from Timor, Jamdena, and the Himalayas (see below).

The secondary deepening of the ventral groove in *B. stolleyi* is normally so extensive that it cannot be the result merely of exfoliation of the thinned-out growth lamellae at the edges of a naturally deep groove. Slight exfoliation can occur in large specimens of *B. gerardi* (= *B. uhligi* Stevens), as observed by Uhlig (1903–10, p. 384), Boehm (1907, pp. 53–55; 1909), and by the writer in *B. uhligi* specimens from Indonesia; but this exfoliation is irregular, and usually affects only the two or three outermost growth lamellae.

If the secondary deepening is regarded as occurring during the animal's lifetime, two possibilities may be considered:

(*a*) a zone of incomplete calcification was developed along the ventral groove, this zone being particularly susceptible to weathering;
(*b*) resorption occurred along the line of the groove in the adult stage.

Incomplete calcification may have been induced by a shortage of calcium carbonate in the environment; but it is difficult to account for the restriction of decalcification to the ventral groove. The incomplete calcification along the ventral groove might have become apparent only in the adult stage, and been followed after the death of the animal by exfoliation of the incompletely calcified growth-layers. Individual specimens of many belemnite species of the boreal province (e.g. Russia) show exfoliation along the ventral groove (e.g. Murchison *et al.* 1845, pl. 31, figs. 1–4; and specimens from the Moscow basin in the Steinmann Collection, Freiburg) but the exfoliation is always irregular, leaving an uneven surface and unaffected areas. But the secondarily deepened ventral grooves of *B. stolleyi*, *Dicoelites*, &c., are always regular and smooth, except for the truncated edges of the growth lamellae of the guard, which form striae on the walls of the groove; and the groove deepens regularly towards the anterior.

In the writer's opinion, resorption along the line of the ventral groove while the animal was living provides the more likely explanation of such a regular and extensive deepening. The resorption probably occurred at the base of blood-vessels aligned along the groove and supplying lateral fins (Stevens, in press). If the lateral fins increased in size in the adult stage, or were used more frequently as a means of locomotion, an augmentation of the blood-supply would have been necessary; and if the blood-vessels were sited in the ventral groove as a protective measure (i.e. if the guard was enveloped by only a thin sheet of tissue), material may have been resorbed from the floor of the groove in order to accommodate the enlarged blood-vessels.

Secondary deepening of the ventral groove in the adult stage has also been observed in other belemnite species. Secondary deepening of the ventral groove to intersect the growth lamellae of the guard was one of the characters used by Neumayr (1889, p. 52) to distinguish his group of belemnites the 'Absoluti' from the 'Canaliculati'. *B. gerardi* (Oppel) [= *B. uhligi* Stevens], *B. sulcatus* (Miller), *Acroteuthis volgensis* (d'Orb.), and *Cylindroteuthis absolutus* (Pander) were included in the 'Absoluti' (see Uhlig 1903–10, pp. 383–4). Boehm (1907, pp. 53–55; 1909), supported by Uhlig (1903–10, p. 384), showed that in *B. gerardi* (= *B. uhligi*) intersection of the growth lamellae by the ventral groove was not a normal feature of the guard and was caused by exfoliation. The supposed secondary deepening of the groove in *A. volgensis* and *C. absolutus* is also a result of exfoliation and is not a normal feature of the guard. The writer has examined specimens of these species and *Pachyteuthis panderiana* (d'Orb.) from the Upper Jurassic of Russia (Steinmann Collection, Freiburg) and has found that the secondary deepening of the groove in them is very irregular and cannot be compared with the regular deepening present along the ventral groove of *B. stolleyi*.

Many of the belemnites in old Himalayan collections were identified as *Belemnites sulcatus* Miller: some of these specimens are in the collections of the British Museum

(Natural History) and have been examined by the writer. Four specimens are in the Strachey Collection, from the Niti Pass, Himalaya (referred to by Crick 1904, p. 64), C2565. Other specimens of *B. sulcatus* from Niti have been illustrated by Salter and Blanford 1865, pl. 10, figs. 1–8. It is probable that the *B. sulcatus* referred to in Neumayr's paper (see above) was based on these Indian specimens, as collections from the Himalayas (e.g. the Schlagintweit Collection) were available to Neumayr, who was at Munich, and as fossils collected by the Indian Geological Survey were sent to Munich, for study by Waagen and Uhlig. But the Himalayan specimens of *B. sulcatus* do not resemble the typical *B. sulcatus* recorded from localities in England (Miller 1823, pl. 8, figs. 3–5; Phillips 1865–1909, pl. 29, pl. 30, pp. 115–17) and France (Blainville 1827, pl. 2, figs. 1, 2). These Indian specimens have secondarily deepened grooves, and resemble the specimens of *Dicoelites applanatus* (Stolley) from Indonesia referred to below.

Secondarily deepened ventral grooves have been observed in specimens of *Dicoelites* (= *Prodicoelites* Stolley; see Stevens 1964) from Indonesia. The ventral groove in *Dicoelites* is normally deep and narrow, but secondary deepening has been observed, mainly in specimens of *D. applanatus*. This deepening is usually not as well developed as in *B. stolleyi*, and is not a consistent feature of the guard. The dorsal groove of *Dicoelites* specimens is not affected.

Stolley (1929) recognized secondary deepening of the ventral groove in *D. applanatus*: he figured (1929, pl. 6, figs. 12*c*, 14*c*, 20) specimens with secondary deepening, besides one (pl. 6, fig. 19*c*) without it. Stolley's specimens showing secondary deepening came from Rotti, and the writer has seen similar specimens in collections from J.197, 'Tasite Schwassa', South Jamdena (Weber Collection, Basel). This locality is probably the same as Stolley's locality 'Tasik Selwasa', whence he obtained specimens of *D. applanatus*.

In *D. applanatus* the alveolus is ventrally placed and the apical line follows a markedly excentric course, also ventrally placed (*not* dorsally placed, as stated by Stolley 1929, p. 187). In specimen J.197/5, the distance from apex to protoconch measures 73 mm., and at the position of the protoconch the apical line is 5 mm. from the venter; the sagittal diameter at this point is 13·5 mm. The apical line remains roughly parallel to the venter until about 13 mm. from the apex. Here the ventral surface converges sharply towards the dorsal surface and the apical line takes a similar course, terminating at the apex. The ventral groove normally attains a depth of 2 mm. and therefore only 3 mm. of secondary deepening is necessary in order to expose the apical line or the alveolus, especially towards the anterior portion of the guard, where the groove naturally deepens. In *B. stolleyi*, where the apical line is not so markedly excentric, some 4–5 mm. of deepening is often required.

Alveolus of B. stolleyi. An unusual feature of the guard of *B. stolleyi* is the loss of the phragmocone and collapse of the alveolar region. In *Belemnopsis*, the guard is usually robust; even with loss of the phragmocone the alveolar walls are usually capable of withstanding any sedimentary pressure. But in *B. stolleyi* the alveolus has invariably collapsed and this does not appear to be a result of abnormal sedimentary pressure as the guards are not deformed in any other way. The fragility of the alveolar wall in *B. stolleyi* seems to imply some difference in its structure, contrasting with that in other species of *Belemnopsis*. Crushing of the alveolar region has obscured the structure of the internal wall of the alveolus in all the *B. stolleyi* specimens available to the writer. A possible explanation of the fragility of the alveolar region is that the innermost layers of the alveolar wall have been partially decalcified by the process akin to that responsible for the production of the pseudoalveolus of *Dimitobelus*, *Actinocamax*, &c.

Comparison with the uhligi-*complex*. The Upper Jurassic belemnite fauna of the Indo-Pacific region is dominated by a number of apparently interrelated species which have been termed the *uhligi*-complex (Stevens 1963 and in press). The complex includes belemnites identified by previous workers (e.g. Stolley 1929, 1934) as *B. gerardi* (Oppel) (= *B. uhligi* Stevens), *B. aucklandica* (Hochstetter), *B. taliabutica* (Boehm), *B. moluccana* (Boehm), *B. sularum* (Boehm), *B. galoi* (Boehm), *B. indica* Kruizinga, *B. jonkeri* Stolley, *B. suavis* Stolley, and *B. rumphii* Kruizinga.

In general morphology the guard of *B. stolleyi* resembles that of the more slender variants of *B. uhligi*. A cylindrical guard gradually increasing in width towards the anterior is common to both species, as is an excentric alveolus and apical line, both ventrally placed. But there are considerable differences in groove characters. In the *uhligi*-complex the ventral groove does not extend as far posteriorly as in *B. stolleyi* and there is also no sign of the secondary deepening of the ventral groove shown by *B. stolleyi*. The ventral groove in adult specimens of *B. uhligi* of comparable dimensions has a maximum depth of 1·5 mm., compared with 3 or 4 mm. in *B. stolleyi*. Prominent lateral lines are normally present in *B. stolleyi*, but they are rarely present in members of the *uhligi*-complex.

A further difference is that an apical perforation is normally developed in *B. stolleyi*, but never in the *uhligi*-complex. This may indicate some difference in the construction of the guard or in the nature of the apical line. For example, in *B. stolleyi* an open canal occupying the position of the apical line may have persisted in the adult guard, opening to the exterior at the apex. The presence of this apical perforation allowed exfoliation of the apex to occur, considerably enlarging the aperture. In the *uhligi*-complex, the apical canal did not remain open in the adult stage, and so an apical perforation is not developed.

Though *B. stolleyi* may be distinguished from the belemnites of the *uhligi*-complex, it is probably closely related to them. Specimens that may be transitional between *stolleyi* and the *uhligi*-complex are present in collections from locality M.36, Fatjet (Weber Collection, Basel; see Stolley 1934, p. 484; Upper Fatjet Shale); and other transitional forms are present in collections from Beleberg, Timor (Molengraaff Collection, Delft), of which some examples were figured by Stolley 1929, pl. 1, figs. 30–32. Lateral lines are not shown in these latter specimens as the external surface of the guard has been slightly abraded. But the ventral groove is clearly shown, and is different from that of typical *uhligi*: it starts closer to the apex and deepens immediately to its full depth, instead of gradually deepening towards the alveolus. Both figs. 30 and 31 of Stolley's plate 1 (nos. 14574 and 14575, Delft) show considerable distortion of the alveolar region, as though slight thinning of the alveolar wall may have occurred.

Stratigraphic range. Apart from probable transitional forms in Fatjet and Timor, *B. stolleyi* has been found only in Jamdena. Stolley (1929, pp. 168–9) stated that *B. stolleyi* (i.e. '*B. aucklandica*') occurs above *B. uhligi* (i.e. '*B. gerardi*'), and in his evolutionary sequence of Indonesian *Belemnopsis* (Stolley 1934, p. 472), *B. stolleyi* is derived from *B. uhligi*. The writer has not found *B. uhligi* associated with *B. stolleyi*. The belemnite collections from Jamdena contain the following species, apart from *B. stolleyi* (identifications based on the Jamdena material in the Weber Collection, Basel):

(i) *Dicoelites mihanus* Boehm: 'Belemnitenbach', North Jamdena; Tasik Selwasa; Locality 12, North Jamdena; Locality J.197, Tasite Schwassa, South Jamdena.
(ii) *Dicoelites applanatus* (Stolley): Locality J.197, Tasite Schwassa, South Jamdena.
(iii) *Belemnopsis moluccana* (Boehm): Locality J.52, variegated marl-clays, 'Belemnitenbach', North Jamdena.

The *B. stolleyi* specimens from Jamdena were identified by Stolley as *Belemnites* sp., *B. gerardi* (= *B. uhligi*), and *B. aucklandica*, and these identifications probably provided the basis for the supposition that *B. stolleyi* occurs above *B. uhligi*, and presumably also for Wanner's stratigraphic table for Jamdena (1931, p. 611, table 2), in which he showed '*B. gerardi* mergelkalke' occurring below a 'Belemniten mergelkalke'.

Wandel (1936, p. 517) has recorded *Buchia malayomaorica* (Krumbeck) from Weber's 'Belemnitenbach' locality but there is no proof that these specimens and the specimens of *Dicoelites* identified by the writer from the same locality came from the same horizon as the specimens of *B. stolleyi*. As the collections were made from a stream bed, and presumably extended for some distance along it, a number of beds may be represented in the collections from the locality. It is, however, likely that the specimens of *Belemnopsis moluccana*, also present in the 'Belemnitenbach', came from roughly the same bed as *B. stolleyi* as the writer found the two species intermingled in Weber's collections. Elsewhere in Indonesia (e.g. Misol), *Buchia malayomaorica* is associated with *B. moluccana*, and it may be that the belemnite collections from the 'Belemnitenbach' came from a small number of beds.

B. moluccana is an early representative of the *uhligi*-complex, and is thought to be of Middle Kimeridgian age (Stevens, in press). *B. moluccana* and *Dicoelites mihanus* are found in the Demú and Lilintá Marls of Misol, and *B. malayomaorica* in the Lilintá Marls and Lower Fatjet Shale of Misol. *B. malayomaorica* also occurs in the Ohineruru-Takatahi horizons of the Kawhia Harbour section (New Zealand), of Lower-Middle Kimeridgian age (Fleming 1960; Fleming and Kear 1960). Thus there is every indication that *B. stolleyi* is of Lower or, more probably, Middle Kimeridgian age and precedes the main development of the *uhligi*-complex.

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G. R. STEVENS
New Zealand Geological Survey,
P.O. Box 368,
Lower Hutt,
New Zealand.

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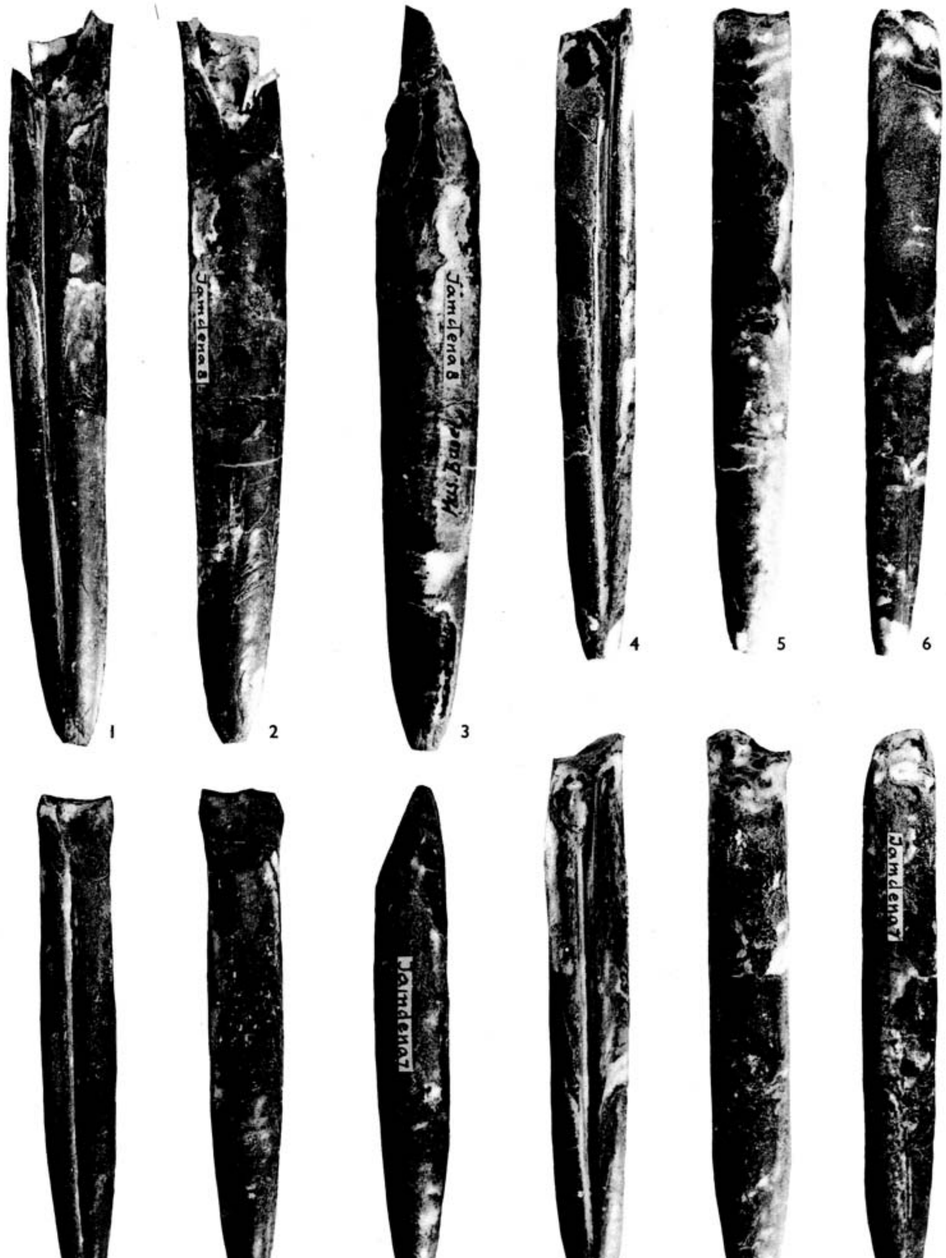

STEVENS, *Belemnopsis stolleyi*