AMMONITES FROM THE UPPER CRETACEOUS OF THE JAMES ROSS ISLAND GROUP

By M. K. HOWARTH*

ABSTRACT. Amongst a new collection of ammonites from the James Ross Island group, *Submortoniceras chicoense* (Trask) and *Kitchinites darwini* (Steinmann) are important new species to Antarctica, the former giving accurate dating of the beds in which it occurs as Lower Campanian. These beds are below the Snow Hill Island Series. New specimens of *Gaudryceras varagurense* (Kossmat) and *Maorites densicostatus* (Kilian and Reboul) are also figured and described. A compilation is made of all ammonites from the main localities in the James Ross Island group in present and past collections, and, after a discussion of the specific classification of the genera *Gunnarites* and *Maorites*, it is concluded that the faunas at the main Snow Hill Island Series localities of Lachman Crags, Cape Lamb (Vega Island), The Naze (Dagger Peak), Humps Island, Snow Hill Island and Seymour Island are all of the same date, which is upper Lower Campanian to Middle Campanian. There is another fauna on Seymour Island consisting of *Maorites tuberculatus* Howarth and a species of *Pachydiscus* which is probably Upper Campanian in age.

DURING the years 1958 to 1960 members of the Falkland Islands Dependencies Survey visited the James Ross Island group (Fig. 1) to investigate the stratigraphy and structure of the Mesozoic and Tertiary sedimentary and volcanic rocks. These included the Upper Cretaceous beds from which came the very fine ammonite faunas described by Kilian and Reboul (1909), Spath (1953) and Howarth (1958), and about which nothing was known stratigraphically. It was found that the Cretaceous sequence consists only of those beds which contain the Campanian ammonite fauna and their immediate associates, and that they are overlain unconformably by a Miocene volcanic group. The Cretaceous beds consist of coarse conglomerates, grits and sandstones at the base, followed by some shales and sandstones, then a series of loose sands and gravels containing calcareous glauconitic sandstone nodules in places. It is these nodules that contain most of the ammonite fauna. Uncertainties about the interpretation of the structure make an estimation of the total thickness difficult; it seems that there cannot be less than 1,500 m. of Cretaceous beds present, and the highest figure claimed is about 5,200 m. Estimation of these thicknesses depends on the interpretation of the relationships between the main ammonite assemblages in the area, and a full discussion of this aspect is given below. A result emerging from this discussion is the possibility that Upper Campanian beds occur on Seymour Island, in contrast to the Lower and Middle Campanian age of the other main assemblages.

During the work, considerable numbers of ammonites were collected belonging largely to forms already well known from the James Ross Island group. The specimens described below are the only ones new to Antarctica or that add anything to the previous descriptions of the ammonites. They consist of single examples of *Submortoniceras chicoense* (Trask) and *Gaudryceras varagurense* (Kossmat), two specimens of *Kitchinites darwini* (Steinmann) and several beautifully preserved examples of *Maorites densicostatus* (Kilian and Reboul). The example of *Submortoniceras chicoense* is from a lower assemblage and is of especial interest for, as described below, its age is known accurately to be Lower Campanian in California and Texas, and this gives good confirmation of the dating of the James Ross Island group ammonites as Lower and Middle Campanian arrived at earlier (Howarth, 1958, p. 15). *Kitchinites darwini* is also new to Antarctica but it is not accurately dated at its only other known locality in Chile.

All the specimens listed in this paper have been deposited in the collections of the British Museum (Nat. Hist.), and their numbers are quoted below with the prefix "C". I have to thank Dr. R. J. Adie for entrusting the description of this collection with me.

* Department of Palaeontology, British Museum (Nat. Hist.), London.

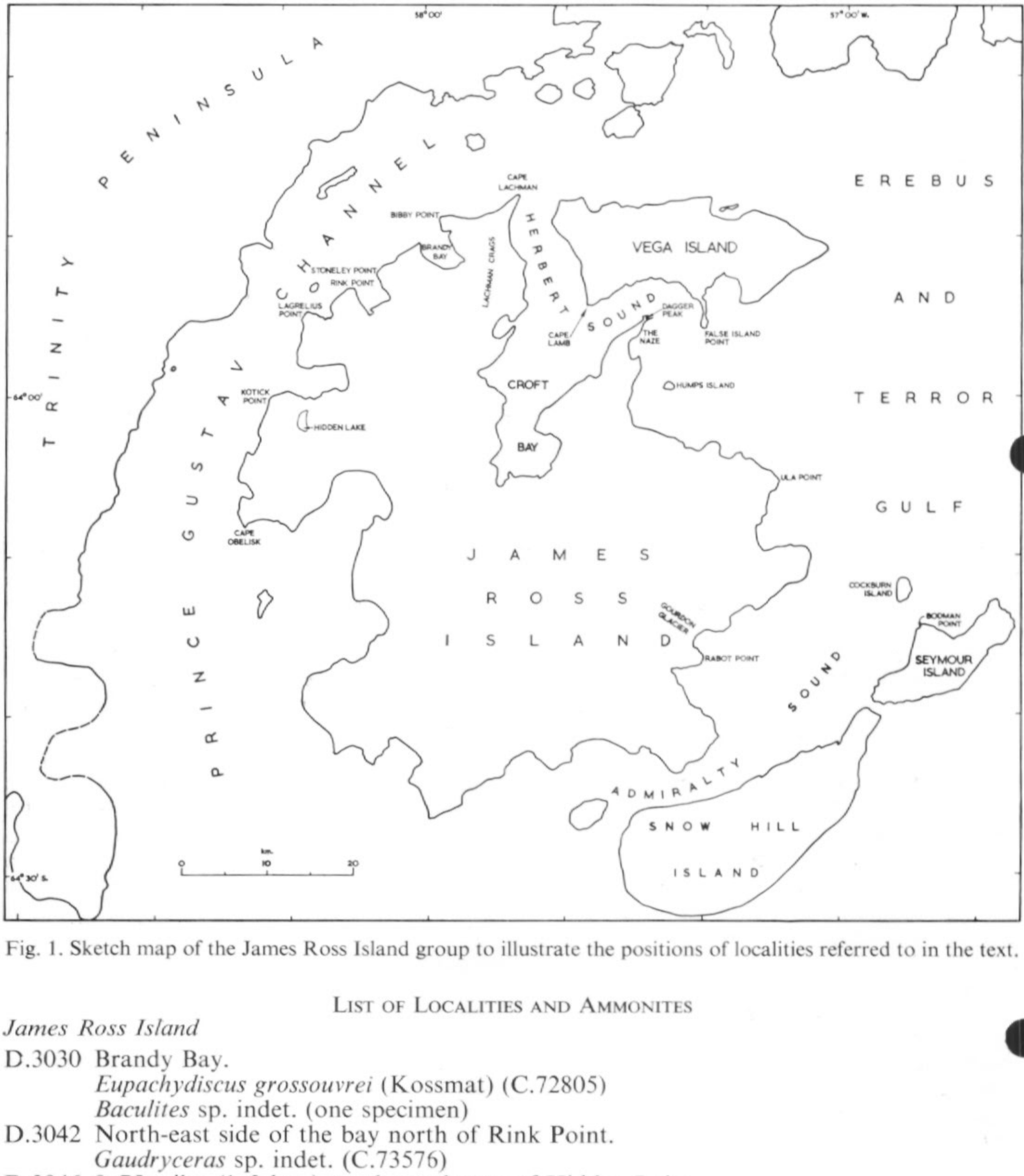

Fig. 1. Sketch map of the James Ross Island group to illustrate the positions of localities referred to in the text.

List of Localities and Ammonites

James Ross Island

D.3030 Brandy Bay.
Eupachydiscus grossouvrei (Kossmat) (C.72805)
Baculites sp. indet. (one specimen)

D.3042 North-east side of the bay north of Rink Point.
Gaudryceras sp. indet. (C.73576)

D.3046 0·75 miles (1·2 km.) north-north-east of Hidden Lake.
Gaudryceras varagurense (Kossmat) (C.72803)

D.3057 North-east side of bay, 3 miles (4·8 km.) north of Cape Obelisk.
Submortoniceras chicoense (Trask) (C.72807)

D.3062 Brandy Bay.
Gaudryceras varagurense (Kossmat) (C.72804)

D.3063 3·5 miles (5·6 km.) south-south-west of Kotick Point.
Desmoceratid indet. (C.72808)

D.3068 Brandy Bay.
Baculites sp. indet. (C.72806)

D.3756 Small knoll 0·5 miles (0·8 km.) west of Lachman Crags.
Pseudophyllites sp. indet. (C.73577)
Gaudryceras sp. indet. (C.73578–79)
Maorites cf. *seymourianus* (Kilian and Reboul) (C.73580–81)
Polyptychoceras sp. indet. (C.73582–83)
Polyptychoceras (? *Phylloptychoceras*) sp. indet. (C.73584)
Solenoceras cf. *mortoni* (Meek and Hayden) (C.73585–86)

D.4011 Raised beach terrace, 1 mile (1·6 km.) south-west of Ula Point.
Gunnarites antarcticus (Weller) (C.73587)
Jacobites crofti Spath (C.73588)

D.4045 Southern slope of Gourdon Glacier, 3·5 miles (5·6 km.) north-west of Rabot Point.
Pseudophyllites sp. indet. (C.73589)
Gaudryceras sp. indet. (C.73591–93)
Neograhamites cf. *taylori* Spath (C.73590)

Vega Island

D.3123 Cape Lamb.
Gunnarites antarcticus (Weller) (one specimen)
Maorites densicostatus (Kilian and Reboul) (C.72800)

D.3126 Cape Lamb.
Maorites densicostatus (Kilian and Reboul) (C.72794–96, 72801)
Grossouvrites gemmatus (Huppé) (C.72802)
Kitchinites darwini (Steinmann) (C.72790)

D.3127 Cape Lamb.
Maorites densicostatus (Kilian and Reboul) (C.72797–99)

D.3715 Cape Lamb.
Maorites densicostatus (Kilian and Reboul) (C.72792–93)
Kitchinites darwini (Steinmann) (C.72791)

Systematic Descriptions

Family Tetragonitidae Hyatt 1900

Genus *Gaudryceras* Grossouvre 1894

Gaudryceras varagurense Kossmat

Fig. 2c

Lytoceras (*Gaudryceras*) *varagurense* Kossmat, 1895, p. 122, pl. 17, fig. 9; pl. 18, figs. 2a–c.
Lytoceras (*Gaudryceras*) *varagurense* Kossmat; Kilian and Reboul, 1909, p. 12, pl. 1, fig. 6.
Gaudryceras (*Neogaudryceras*) *pictum* Yabe; Spath, 1953, p. 12, pl. 1, fig. 10.
Gaudryceras varagurense (Kossmat); Collignon, 1956, p. 56, pl. 5, fig. 6.
Gaudryceras varagurense Kossmat; Howarth, 1965, p. 361, pl. 4, fig. 5; pl. 5, figs. 1, 2.

Description

The specimen figured here is from a locality near Hidden Lake and shows the characteristic ribbing of this species very well. A second, smaller specimen, more poorly preserved but with definite traces of similar ribs in a few places, was found at Brandy Bay. Neither of the two Antarctic specimens figured previously by Kilian and Reboul, and Spath, shows any ribbing owing to their poor preservation. The ribbing of the example now figured agrees exactly in style and density with that of Kossmat's holotype. Size of umbilicus and whorl height also agree, but the specimen is only preserved on one side and the whorl thickness cannot be seen. In southern India the age is probably Santonian.

The species occurs commonly in Madagascar in the Coniacian and Santonian; and a list of all the figured specimens is given in Collignon's (1956, p. 56) synonymy. Collignon's (1956, p. 53–54) Coniacian Madagascar species *G. beantalyense* and *G. analabense* are probably conspecific, for neither their whorl dimensions nor their style of ribbing differ significantly from

G. varagurense. In Japan, *G. striatum* (Jimbo, 1894) and its variety *pictum* (Yabe, 1903) are very closely related or conspecific forms occurring in Santonian to Maastrichtian beds, but these species are known only from the original drawings of the type specimens, and await a modern revision. Species of *Gaudryceras* also occur in Campanian rocks in California and Alaska, and their description by Matsumoto (1959*b*, p. 141–45; Jones, 1963, p. 26–28) also includes an assessment of the nomenclature of the genus.

Family Kossmaticeratidae Spath 1922

Genus *Maorites* Marshall 1926

Maorites densicostatus (Kilian and Reboul)

Figs. 2d, e; 3c, d

Madrasites bhavani (Stoliczka) var. *densicostata* Kilian and Reboul, 1909, p. 30, pl. 15, fig. 4; pl. 18, fig. 1.
Maorites suturalis Marshall, 1926, p. 179, pl. 23, fig. 3; pl. 43, fig. 1; pl. 45, fig. 5.
Maorites densicostatus (Kilian and Reboul); Spath, 1953, p. 23, pl. 2, figs. 7–9; pl. 7, fig. 6.
? *Maorites subtilistriatus* Collignon, 1955, p. 36, pl. 11, fig. 3.

Description

Amongst a collection of eight specimens of *M. densicostatus* from Cape Lamb (Vega Island) are the two examples figured here that are beautifully preserved with most of their iridescent shell complete. This preservation is better than that of any examples figured previously except perhaps the lectotype (Kilian and Reboul, 1909, pl. 18, fig. 1), and the material is much better than that available to Spath (1953, p. 23) when he revised the original description.

One of the specimens is wholly septate up to its maximum size of about 70 mm. diameter; the remainder have some body chamber preserved, but none shows any part of a mouth border. The largest specimen (Fig. 3c, d) has a maximum diameter of 83 mm., but preservation of a further length of the umbilical part of the whorl indicates a diameter of 110 mm. at its broken aperture. It has half a whorl of body chamber and is not complete, and no adult characters are shown. Details of ornament and growth can be seen very well on the figured specimens, and it is particularly noticeable that the constrictions have a marked effect on many other shell features. There are four to seven constrictions per whorl, and at each one, both the height and breadth of the whorl contract slightly. The constrictions are strongly prorsiradiate, slightly sinuous or biconcave, and cut acutely five to seven of the ribs immediately behind. In front of a constriction the ribs start again exactly parallel to it; i.e. prorsiradiate, but they change direction less rapidly than the spiral of the whorl, so that by the time the next constriction is reached they are radial or slightly rursiradiate, and this constriction cuts acutely through them. Immediately after each constriction, the whorl breadth and height increase rapidly again to reach the line of steady increase occurring before the constriction. The umbilical spiral is modified in a curious way by the constrictions; the umbilical seam is angled at each constriction, and it runs in an almost straight line between consecutive constrictions. This character occurs to some degree on every specimen and is best seen on the example of Fig. 3c, where at each constriction the umbilical seam turns rapidly through about 70°, then runs with only a slight curve to the next constriction. There are small radially elongated tubercles at the umbilical edge which commence on the inner whorls at sizes at least as small as 6 to 8 mm. diameter. Two to four ribs issue from each tubercle and there are occasional intercalated ribs. Some ribs are simple, others bifurcate once or twice on the side of the whorl, and there is a slight bend backwards at about the middle of the whorl side. On the inner whorls the ribs are slightly biconcave. Rib density is high on all whorls of all the specimens seen and there are no modifications suggesting approach to an adult mouth border.

Remarks

M. densicostatus is the most densely ribbed Antarctic species of *Maorites*. The type species of the genus, *M. tenuicostatum* (Marshall) from New Zealand, is the only more densely ribbed species of the genus, but two other New Zealand examples (Marshall, 1926, p. 178–79, pl. 23, fig. 3; pl. 24, fig. 1; pl. 43, fig. 1 (type of *M. suturalis* Marshall); pl. 44, fig. 2; pl. 45, figs. 4, 5)

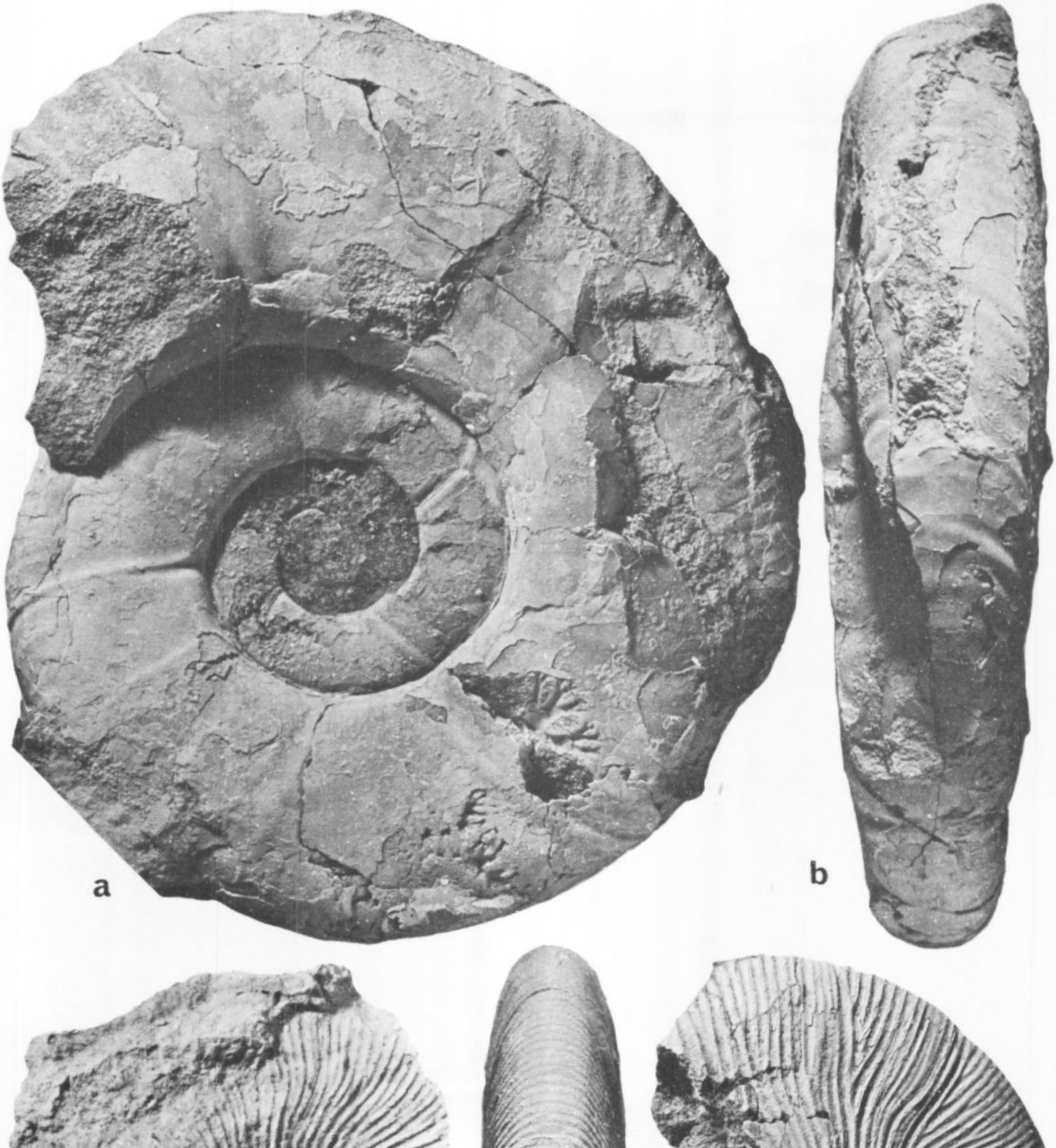

Fig. 2. a and b. *Kitchinites darwini* (Steinmann). Lower–Middle Campanian. Station D.3126, Cape Lamb, Vega Island. (BM. C.72790)
c. *Gaudryceras varagurense* (Kossmat). Lower–Middle Campanian. Station D.3046, 0·75 miles (1·2 km.) north-north-east of Hidden Lake, James Ross Island. Latex cast of external mould. (BM. C.72803)
d and e. *Maorites densicostatus* (Kilian and Reboul). Lower–Middle Campanian. Station D.3715. Cape Lamb, Vega Island. (BM. C.72792)
All figures natural size.

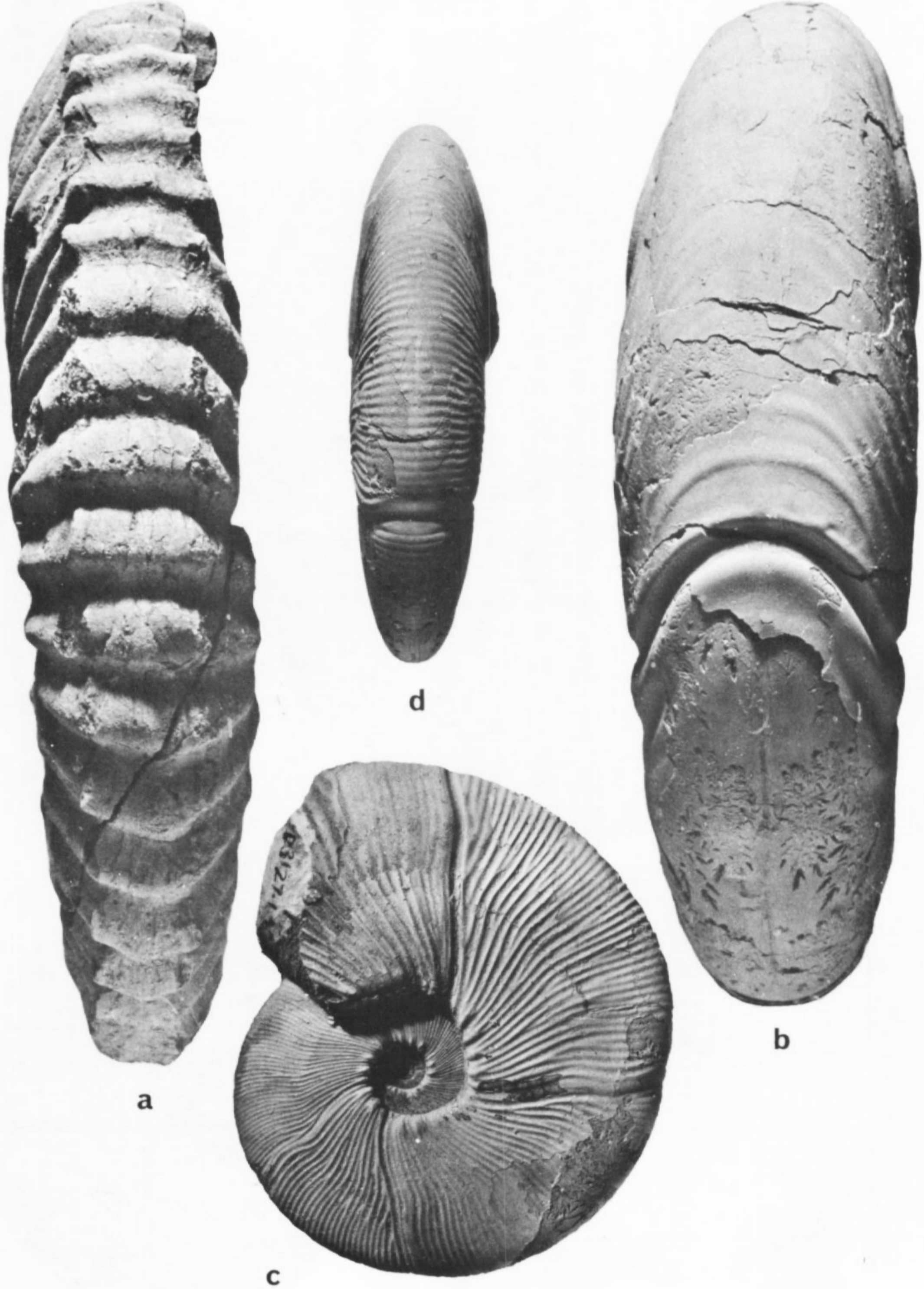

Fig. 3. a. *Submortoniceras chicoense* (Trask). Lower Campanian. Station D.3057, north side of the bay north of Cape Obelisk, James Ross Island. (BM. C.72807)
Ventral view. See Fig. 5.
b. *Kitchinites darwini* (Steinmann). Lower–Middle Campanian. Station D.3715, Cape Lamb, Vega Island. (BM. C.72791)
Ventral view. See Fig. 4.
c and d. *Maorites densicostatus* (Kilian and Reboul). Lower–Middle Campanian. Station D.3127, Cape Lamb, Vega Island. (BM. C.72797)
All figures natural size.

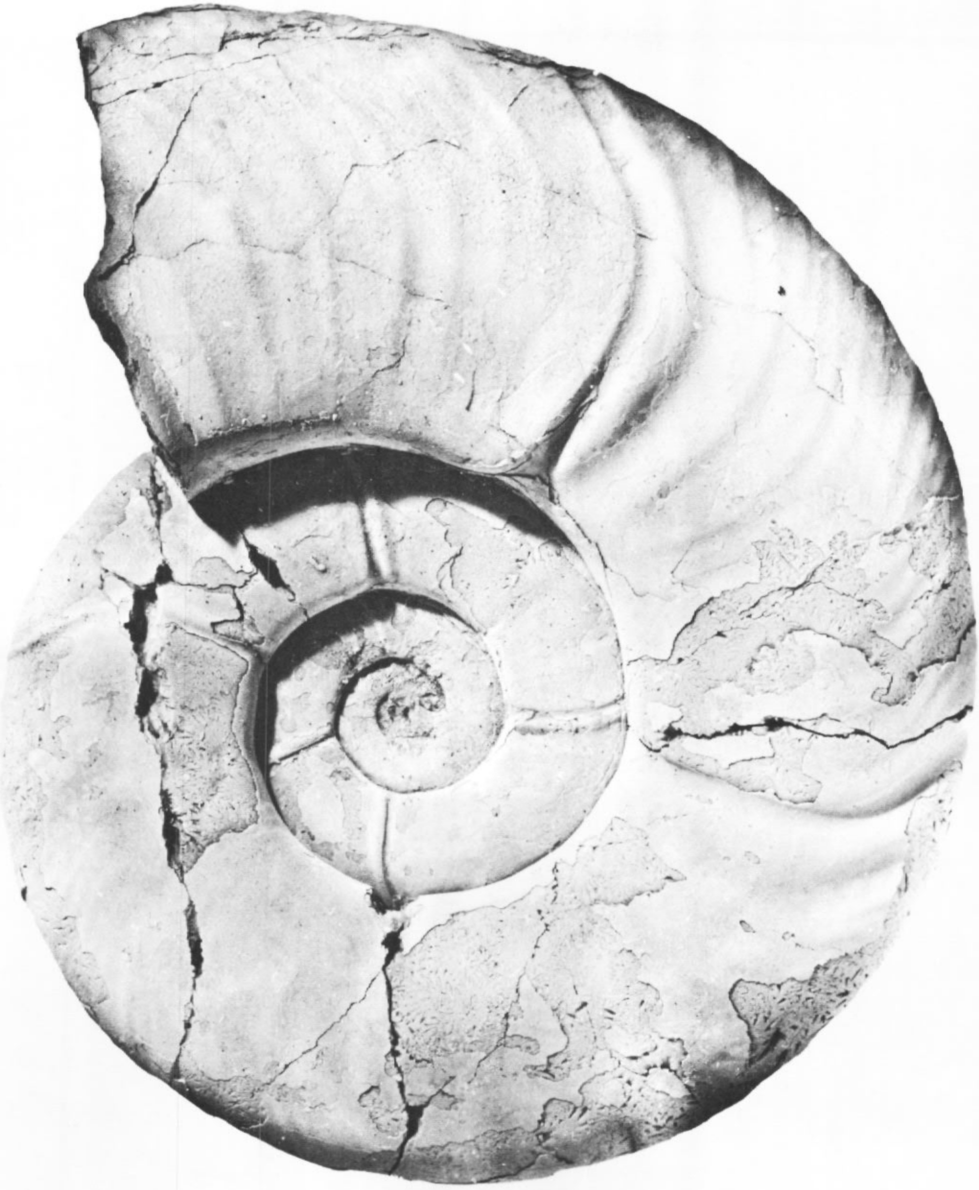

Fig. 4. *Kitchinites darwini* (Steinmann). Lower–Middle Campanian. Station D.3715, Cape Lamb, Vega Island. (BM. C.72791)
Natural size. For ventral view see Fig. 3b.

Fig. 5. *Submortoniceras chicoense* (Trask). Lower Campanian. Station D.3057, north side of the bay north of Cape Obelisk, James Ross Island. (BM. C.72807)
Natural size. For ventral view see Fig. 3a.

do not differ in any way from *M. densicostatus*. The type specimen of *M. mckayi* (Hector) (Marwick, 1950, p. 482, pl. 59) is so fragmentary and poorly preserved that comparison with *M. densicostatus* is hardly possible. In Madagascar, the Lower Campanian species *M. subtilistriatus* Collignon (1955, p. 36, pl. 11, fig. 3) shows the same characters and density of ribs and constrictions as *M. densicostatus* and may be another synonym. Finally, in southern India *M. aemilianus* (Stoliczka, 1865, p. 140, pl. 70, fig. 4) has similar ribbing, but differs in its much thicker whorls.

The species *Haploceras cumshewaensis* Whiteaves, which was compared with *M. densicostatus* by Spath (1953, p. 24), has recently been shown by Matsumoto (1959*a*, p. 63) to be a Cenomanian *Marshallites*, a close homeomorph of *Maorites* except that it lacks the umbilical tubercles of the latter genus, and no species of intermediate age are known. Spath (1953, p. 24) also referred a specimen from St. Vincent, New Caledonia, and another from Patagonia to *Maorites*. Both are densely costate like *M. densicostatus*, but the preservation of both is very poor and neither can be identified definitely as a *Maorites*.

FAMILY DESMOCERATIDAE ZITTEL 1895

Genus *Kitchinites* Spath 1922

Kitchinites darwini (Steinmann)

Figs. 2a, b; 3b; 4

Puzosia darwini Philippi MS; Steinmann, 1895, p. 73–74, pl. 5, fig. 3.

Description

Two large specimens were found at Cape Lamb (Vega Island). The larger specimen (BM. C.72791) is preserved entirely uncrushed and consists of septate whorls up to a diameter of 140 mm. followed by a quarter of a whorl of body chamber ending at a broken aperture at 170 mm. diameter. The smaller specimen (BM. C.72790) is crushed laterally throughout and has septate whorls up to 100 mm. diameter, then half a whorl of body chamber up to the broken aperture at about 140 mm. diameter. Dimensions of the two specimens are as follows:

	D	Wh	Wb	U
BM. C.72791	170	63·7 (0·37)	48 (0·28)	63·4 (0·37)
C.72791	109	40·3 (0·37)	31·2 (0·29)	40·8 (0·37)
BM. C.72790	117	43 (0·37)	—	44·2 (0·38)
C.72790	87	34 (0·39)	20·3 (0·23)	32·2 (0·37)
Steinmann's lectotype	187	75 (0·40)	50·5 (0·27)	65 (0·35)

D=diameter, Wh=whorl height, Wb=whorl breadth, U=umbilical width.

The small figure of 0·23 for Wb in the second measurement of BM. C.72790 is due to lateral crushing. The measurements of Steinmann's lectotype were taken directly from his figure (Steinmann, 1895, pl. 5, fig. 3) and adjusted for its magnification of $\times\frac{2}{3}$. Except for a slight obtuse angle at the umbilical edge, the whorl section is smoothly rounded at all diameters, and there is no trace of a keel or angle on the venter. The greatest whorl breadth occurs near the middle of the side of the whorl, but on the body chamber of the larger specimen the whorl section becomes more triangular, with the greatest width near the umbilical edge and marked narrowing towards the venter.

Iridescent shell is preserved in places on both specimens. It appears to be very thin, and the ornament on the internal mould hardly differs from that on the shell. The whorl sides are smooth and unribbed on all the septate whorls up to about half a whorl before the beginning of the body chamber; but prorsiradiate ribs on the outer third of the side of the whorl and on the venter are present from the smallest diameter (45 mm.) at which the venter is visible. About half a whorl before the body chamber, ribs start to appear on the whole of the side of the whorl; they are radial from the umbilical edge, then curve strongly forwards and pass without interruption over the venter. Strong constrictions are the most obvious feature of the ornament at all the growth stages seen. On both specimens the first visible constrictions occur at about 35 mm. diameter, then there are four to six per whorl up to the apertures. The constrictions follow the line of the ribs closely, but on the venter they swing forwards slightly more than the ventral ribs behind, so that two or three of these are truncated by a constriction, although those ribs in front of a constriction are parallel to it. The shell is collared on both sides of the constriction. The advent of ribs on the whole of the side of the whorl and the increase in the number of the constrictions on the body chamber suggests that it is adult.

The suture line is highly complex and has large, basically bifid first and second lateral saddles, and a large, deep, basically trifid first lateral lobe. The first lateral lobe is much deeper than the external lobe.

Remarks

Steinmann's Quiriquina Beds species is the only one which resembles the two Antarctic specimens in any way. Two specimens were available to Steinmann and, although only one was figured, neither was designated as type; therefore both are syntypes. The larger, figured, specimen (Steinmann, 1895, pl. 5, figs. 3a, b) is here designated lectotype. It was originally in Strasbourg Museum, but it cannot be found there at present, and it is not at Bonn, to where Steinmann transferred some of his collection. The smaller unfigured paratype was in the Natural History Museum at Santiago and bore Philippi's manuscript name *darwini*; this specimen is now lost or is not available for study. The species can only be interpreted from the characters shown on the figured lectotype, and this is not entirely satisfactory for Steinmann stated that his figures were drawn in restored form from an original that was broken into several pieces and somewhat crushed in places. In particular he said that the whorl breadth shown on his figure of the venter (fig. 3b) might be slightly too wide. Nevertheless, the figures show great resemblance to the two Antarctic specimens figured here, and as there are no other known species that are at all similar, Steinmann's species as known from the figure of the lectotype is used, therefore, for the Antarctic specimens. Differences between them are only slight: Steinmann's original may have slightly more compressed whorls and the ribs on the venter may be larger than those of the Antarctic specimens; it also has the appearance of being slightly more involute. These differences might be due to inaccurate drawing or to Steinmann's inability to deduce accurate characters (especially whorl proportions) from the fragmentary original. In any case the range of variation of many well-known ammonite species frequently encompasses variations of this order of magnitude. Steinmann's original is also said to be wholly septate up to its maximum size of 187 mm. diameter, while the last septum on the largest Antarctic specimen occurs at 140 mm. diameter.

The age of *K. darwini* in the Quiriquina Beds is not accurately known, for as Spath (1953, p. 46–47) has pointed out it is likely that ammonites of several different ages are present there. Some of the ammonites (e.g. *Eubaculites*) are definitely Maastrichtian, while others (e.g. *Grossouvrites*, ? *Maorites*, ? *Gunnarites*) are equally clearly Lower or Middle Campanian; the position of *Kitchinites darwini* in the sequence is not known.

All other species of *Kitchinites* differ from *K. darwini* in having fairly strong ribbing at most growth stages, except for *K. angolaensis* Howarth (1965) from the Upper Campanian of Angola, which is the only one that has smooth whorl sides at sizes above 45 mm. diameter with ribs confined to the venter. It is much more involute than *K. darwini*. The type species of the genus, *K. pondicherryanus* (Kossmat, 1897, p. 40, pl. 6, fig. 6) from the Campanian of southern India, has strong, nearly straight ribs up to the largest sizes known. The New Zealand Campanian species *K. brevicostata* (Marshall, 1926, p. 183, pl. 24, fig. 3; pl. 43, fig. 2) also has well-developed, straight ribs that do not fade on the side of the whorl. *Neopuzosia* is usually considered a subgenus of *Kitchinites* in which the ribs are sigmoidal and strongly projected on the venter. The type species, *K. (N.) japonica*, and a second species have been described from the Santonian and Lower Campanian of Japan by Matsumoto (1954, p. 85–95), and five species have been described by Collignon (1961, p. 55–58) from the Lower Campanian of Madagascar. All these differ from *K. darwini* in having strong ribs throughout growth.

K. darwini shows considerable resemblance to *Hauericeras*, except for its complete lack of a keel or any sharpening of the venter at all growth stages. The possibly related genus *Oiophyllites* is poorly known; although it has a rounded venter and no keel, the largest known specimen is only 22 mm. in diameter and there are no means of deducing its characters at much larger sizes. Reference of *K. darwini* to *Kitchinites* is at least in keeping with the present state of knowledge.

FAMILY COLLIGNONICERATIDAE WRIGHT AND WRIGHT 1951

Genus *Submortoniceras* Spath 1921

Type species: *S. woodsi* Spath 1921

The characters and distribution of this genus have been described by Collignon (1948) and Matsumoto (1959*b*, p. 125). *Butticeras* Anderson (1958; type species: *B. buttense* Anderson, 1958) is a synonym of *Submortoniceras*, and Matsumoto (1959*b*, p. 126) considers that *Delawarella* is best placed as a subgenus of *Submortoniceras*. Somewhat different relationships were put forward by Young (1963, p. 28, 39, 97–106) when discussing the "morphological sequence" of a series of species he described from the Lower and Middle Campanian of Texas; Young does not consider *Delawarella* to be so closely related to *Submortoniceras*. The single specimen described below is referred to *Submortoniceras* s.s. and it is an exact match for a species hitherto unrecorded outside California and Texas.

Submortoniceras chicoense (Trask)

Figs. 3a; 5; 6

Ammonites chicoense Trask, 1856, p. 92, pl. 2, fig. 1.
Ammonites chicoense Trask; Gabb, 1864, p. 68, pl. 13, fig. 17; pl. 14, fig. 17c.
Ammonites chicoense Trask; Taff, Hanna and Cross, 1940, p. 1320, figs. 1, 2 (neotype figured).
Submortoniceras chicoense (Trask); Hanna and Hertlein, 1943, p. 168, figs. 61–13, 14.
Mortoniceras (*Submortoniceras*) *chicoense* (Trask); Anderson, 1958, p. 269, pl. 60, figs. 1, 2.
Submortoniceras chicoense (Trask); Matsumoto, 1959*b*, p. 126, pl. 32, fig. 1; pl. 33, fig. 1; pl. 34, figs. 1–3; pl. 35, figs. 1, 2.
Submortoniceras chicoense (Trask); Young, 1963, p. 106, text-figs. 11e, f, 12d; pl. 57, figs. 1–3.

Description

One specimen was found at station D.3057, on the north side of the bay north of Cape Obelisk, in the Hidden Lake Beds. The specimen is large and considerably crushed laterally, so that, apart from a short length near the aperture, the true whorl thickness is not shown. The maximum diameter is 175 mm. Dimensions at the aperture and half a whorl before the aperture are as follows:

Diameter	175 mm.	116 mm.
Whorl height	77 (0·43)	54 (0·465)
Whorl breadth	50 (0·29)	—
Umbilical width	46 (0·26)	28 (0·24)

On a short length of the whorl just before the aperture the breadth is almost uncrushed; the outline whorl section (Fig. 6) was taken from this part, and the whorl breadth of 50 mm. obtained from the outline is probably not more than 5 mm. less than the correct figure. Though crushed, the whorl section of the separate whorls can be clearly seen to have been trapezoidal, with a narrow flat venter and greatest width only slightly ventral of the umbilical edge. The last half whorl of the specimen is body chamber and is probably adult, for both the umbilical and ventral spirals are slightly modified just before the aperture. The septate whorls are more badly crushed than the body chamber and details of the final suture lines are not shown well. It can be seen, however, that the first lateral saddle is large and bifid, the first lateral lobe is bifid and the second lateral saddle is much smaller and more rounded than the first lateral saddle.

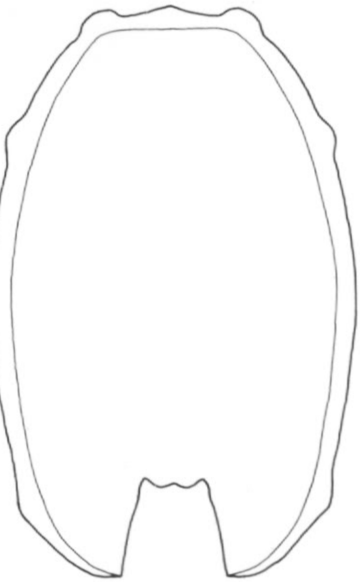

Fig. 6. *Submortoniceras chicoense* (Trask). Lower Campanian. Station D.3057, north side of the bay north of Cape Obelisk, James Ross Island. (BM. C.72807). Cross-section at a diameter of 175 mm. and whorl height of 78 mm.; left-hand half of section drawn from specimen, right-hand half drawn as mirror image of left; cross-sections over ribs and tubercles (outer line) and in bottom of sulci (inner line) are shown. Natural size.

The ornament consists of strong primary ribs that are nearly straight and radial at all growth stages and a roughly equal number of intercalated secondaries that start about one-third of the way across the side of the whorl and are as large as the primaries on the outer third of the whorl. There are 20 primary ribs and 24 secondaries on the outer whorl ending at 175 mm. diameter. At 115 mm. diameter there are 15 primary ribs and 19 secondaries per whorl. The ribs continue unbroken across the venter; on the septate whorls there is a keel along the middle of the venter which undulates across the somewhat diminished ribs, but on the body chamber the keel is reduced and near the aperture it remains only as a series of tubercles surmounting each undiminished rib in the middle of the venter. Sharp, radially elongated tubercles occur at the umbilical edge on each primary rib; on the body chamber these are reduced and almost disappear near the aperture. Each primary and secondary rib has a prominent tubercle at the ventro-lateral edge, which is clavate on the septate whorls but becomes rounded on the body chamber. There are 19 umbilical and 44 ventro-lateral tubercles on the last whorl. Lateral tubercles are more weakly developed; a small outer lateral (or lower ventro-lateral) tubercle is developed on most ribs of all whorls, and a weaker inner lateral tubercle occurs on some ribs just dorsal of the middle of the whorl side.

Remarks

The type population of this species occurs in the Upper Chico Formation in California and has been described at length by Matsumoto (1959*b*, p. 126–32). Its date in California has been accurately fixed as the lower half of the Campanian (Matsumoto, 1960, p. 13–19, 170, 176). Matsumoto recognized and described the wide variation of this species seen amongst a collection from a single bed at one locality and used the designations *forma* α, β and γ for this variation, between which varieties every gradation exists. The Antarctic specimen can be referred to *forma* α–β, occupying a position intermediate between these two forms. It agrees very closely with the neotype of the species (Taff, Hanna and Cross, 1940, p. 1320, pl. 1, figs, 1, 2), when compared at equivalent sizes, which was also referred to as an intermediate *forma* α–β by Matsumoto. Of the Chico examples figured by Matsumoto (1959*b*), the Antarctic specimen shows most resemblance to the specimens of his pl. 32, fig. 1 and pl. 34, fig. 2. It differs from the first figure by being a little less coarsely ribbed and in having weaker lateral tubercles; it has the same sized tubercles as in the second figure, but its ribs are all nearly straight. The ratio of whorl breadth to whorl height (0·65 to 0·71) and the ratio of umbilical width to diameter (0·24 to 0·26) of the Antarctic specimen also agree with its position as *forma* α–β. It is clear that the morphology of the specimen occupies a position close to the middle of the range of variation of the species in California. The species is also known from Texas (Young, 1963, p. 106, pl. 57, fig. 1) where its age can be proved to be Lower Campanian (Young, 1963, p. 28, 39). The Antarctic specimen is the first record of *S. chicoense* from outside California and Texas, although some of the Madagascan species may be synonymous (see below).

The full synonymy of *S. chicoense* has been listed and discussed by Matsumoto and it is not repeated here. Matsumoto put six named Californian species into synonymy with *S. chicoense*, after examining most of the type specimens at first hand. The closely allied species *S. vanuxemi* (Morton) occurs in the Merchantville and Woodbury Formations of Delaware and New Jersey (Reeside, 1962, p. 133, pl. 72, figs. 4, 5), where it is accompanied by the type population of *Delawarella delawarensis* (Morton), the zone index ammonite of the Middle Campanian. Six more closely related species occur in the Lower and Middle Campanian of Texas (Young, 1963, p. 28, 97–106). Outside North America *Submortoniceras* is best known in Madagascar, where species occur in the Lower and Middle Campanian only, giving good confirmation of the dating in California and Texas. Collignon (1948, p. 96–107) described and figured 14 species; several of these were associated together in single beds and there is some doubt whether these really represent different species, e.g. the seven species in Berere bed 2 of the Lower Campanian or the five species in Berere bed 5 of the Middle Campanian. Matsumoto (1959*b*, p. 130–31) has pointed out that the range of morphology of *S. chicoense* is matched closely by specimens figured by Collignon (1948, pl. 13, fig. 2 (≡ *forma* α); pl. 16, fig. 3 (≡ *forma* β); pl. 16, figs. 1, 2; pl. 14, fig. 1 (≡ *forma* γ)), all from closely similar horizons in the Middle Campanian. The Antarctic specimen falls between the specimens of Collignon's pl. 13, fig. 2 and pl. 16, fig. 3 of this sequence. Thus *S. chicoense* may be present in Madagascar. *Submortoniceras* does not occur in the Campanian of Japan (Matsumoto, 1955, p. 44; 1959*c*, p. 68), and the only other recorded occurrence of the genus is the rather poorly known *S. woodsi* (Spath, 1921, p. 232, pl. 21, fig. 1) from Umkwelane Hill, Zululand, and *S. vanuxemi* (Morton) (Spath, 1921, p. 308, pl. 23, fig. 4) from False Bay, Zululand. Both are definitely of Campanian age in Zululand, but more accurate dating is not possible.

Ammonite Assemblages in the Upper Cretaceous

The ammonites described here were collected during stratigraphical work in the James Ross Island group. The stratigraphical results have been presented by Bibby (1966). He has described an Upper Cretaceous succession that consists of six formations. The lowest ammonite found is a single specimen in the third formation from the base, the Upper Kotick Point Beds, and its determination is discussed below. The next ammonites known are a small collection of five specimens from the fifth formation from the base, the Hidden Lake Beds, also discussed below. The main ammonite fauna comes from the highest formation, the Snow Hill Island Series, and this is discussed in detail because the stratigraphical results to be arrived at depend upon the relationships that can be deduced between the ammonite assemblages at the six main localities in these beds.

Upper Kotick Point Beds

The lowest ammonite found in the Cretaceous sequence is an indeterminate fragment of a desmoceratid (BM. C.72808) from station D.3063, 3·5 miles (5·6 km.) south-south-west of Kotick Point. It comes from the Upper Kotick Point Beds and is said to be at least 400 m. below the ammonite in the Hidden Lake Beds. It consists of one-third of a well-preserved septate whorl about 60 mm. diameter, that has a compressed, smoothly rounded whorl shape, no keel, and a smooth shell except for three constrictions that are slightly flexuous on the side and projected forwards on the venter. A small portion of the next larger whorl is also preserved: it is still septate and has a smooth unornamented shell, but the ventral half of the whorl is not preserved. The suture line is highly complex. The characters that can be seen on this specimen are the same as those of several ammonites from Cenomanian to Campanian rocks of Madagascar figured by Collignon (1961, pl. 2, fig. 1; pl. 5; pl. 7, fig. 1; pl. 20–22; 1964, pl. 332, figs. 1493–95; 1965, pl. 377, 378) as various species of *Puzosia* and *Mesopuzosia*. Some of the examples of *Kitchinites* (*Neopuzosia*) from the Santonian of Japan figured by Matsumoto (1954) are nearly as smooth as the Antarctic example. However, the preservation of this specimen is just insufficient for a determination to be made, particularly as the venter of the larger whorl is missing, and it can only be said to be a desmoceratid of Cenomanian to Campian age.

Hidden Lake Beds

Only five ammonites have been found in the Hidden Lake Beds, but one of these enables their age to be fixed exactly. They are the single specimen of *Submortoniceras chicoense* described in this paper and the single examples of *Desmophyllites* sp. indet. and *Tetragonites* (*Saghalinites*) cf. *cala* described by Howarth (1958, p. 9 (station D.2212), 10, pl. 1, figs. 11, 12), all from the north side of the bay 3 miles (4·8 km.) north of Cape Obelisk, the *Gaudryceras varagurense* described in this paper from locality D.3046, 0·75 miles (1·2 km.) north-north-east of Hidden Lake, and a ? *Gaudryceras* sp. indet. (BM. C.73576) from locality D.3042 on the north-east side of the bay between Rink Point and Stoneley Point. The last ammonite is a flattened impression on a slab of green glauconitic sandstone and is not really determinable, but it has the appearance of a *Gaudryceras*. The *Submortoniceras chicoense* is sufficient to fix the age of the beds exactly as Lower Campanian (see p. 63), and this fits in well with the Lower to Middle Campanian age of the main part of the Snow Hill Island Series that overlies the Hidden Lake Beds. The other ammonites are long-ranging forms.

Mention must be made of the Lower Kimmeridgian ammonite *Perisphinctes* cf. *transatlanticus* (Steinmann) figured by Spath (1953, p. 3, pl. 12, fig. 5) from a locality on the south side of Hidden Lake (the original field label says south side, not west side as in Spath's paper). This specimen greatly resembles the two further examples of the same species from Alexander Island figured by Howarth (1958, p. 3, pl. 1, figs. 1, 2), and although it is a crushed fragment there is no reason to doubt its identity as a perisphinctid of Upper Oxfordian–Lower Kimmeridgian age. The presence of such an Upper Jurassic ammonite (admittedly not *in situ*) in the middle of an area of Lower Campanian Hidden Lake Beds, has yet to be explained.

Snow Hill Island Series

These beds consist of uncemented sands and gravels, dark brown or green, that contain horizons of calcareous glauconitic sandstone doggers. Ammonites occur abundantly in the doggers, and extensive collections have been made from Lachman Crags, Cape Lamb (Vega Island), The Naze (Dagger Peak), Humps Island, Seymour Island and Snow Hill Island. It is apparently possible to show that a thickness of 700–1,000 m. of the Snow Hill Island Series occurs at one locality, but the total thickness present (claimed as 3,600 m.) depends on the interpretation of the structure and of the age relations of the ammonite faunas at the six localities listed above.

The faunas at these six localities will now be considered in some detail to see what conclusions can be drawn as to their age relationships. Approximately 750 ammonites are known from the Snow Hill Island Series: four were collected in 1902 by Stokes and described by Weller (1903), these being the first ammonites ever found in Antarctica, but their exact localities are not known; 369 ammonites were described by Kilian and Reboul (1909), all collected from known localities by the Swedish South Polar Expedition in 1902 and 1903; 255 ammonites were described by Spath (1953), 88 by Howarth (1958) and 37 were collected during the work upon which the present paper is based, all collected since 1945 by members of the Falkland Islands Dependencies Survey. All the determinable specimens in these collections that are known to have come from the six localities are listed below, and the number of specimens is given because this is of some importance for the understanding of the relative abundancies of the components of such fauna. In each list Kossmaticeratidae are given first, then Desmoceratidae and Pachydiscidae, finally Phylloceratidae followed by Lytoceratidae and their uncoiled derivatives.

a. *Lachman Crags*

1 *Gunnarites paucinodatus* Spath
13 *G. rotundus* Spath
1 *G. kalika* (Stoliczka)
13 *Maorites pseudobhavani* Spath
2 *M. seymourianus* (Kilian and Reboul)
1 *M. densicostatus* (Kilian and Reboul)
2 *M. suturalis* (Marshall)
1 *Maorites* sp. ind.
1 *Neograhamites taylori* Spath
1 *Eupachydiscus grossouvrei* (Kossmat)
1 *Hoepenites* aff. *amarus* (Paulcke)
5 *Oiophyllites decipiens* Spath
1 *Parapuzosia* sp.
1 *Gaudryceras varagurense* (Kossmat)
2 *G. pictum* (Yabe)
2 *Gaudryceras* sp. ind.
2 *Pseudophyllites peregrinus* Spath
2 *Baculites* aff. *rectus* (Marshall)
2 *Baculites* sp. ind.
6 *Solenoceras* aff. *mortoni* (Meek and Hayden)
5 *Polyptychoceras* sp. ind.
1 *Phylloptychoceras zelandicum* (Marshall)
1 *Hoploscaphites quiriquinensis* (Wilckens)

b. *Cape Lamb, Vega Island*

7 *Gunnarites antarcticus* (Weller)
10 *Maorites densicostatus* (Kilian and Reboul)
2 *Maorites* sp. ind.
1 *Grossouvrites gemmatus* (Huppé)
2 *Kitchinites darwini* (Steinmann)

c. *The Naze and Dagger Peak*

68 *Gunnarites antarcticus* (Weller)
2 *G. gunnari* (Kilian and Reboul)
28 *G. bhavaniformis* (Kilian and Reboul)
20 *G. kalika* (Stoliczka)
4 *Maorites densicostatus* (Kilian and Reboul)
1 *Jacobites crofti* Spath
2 *Eupachydiscus grossouvrei* (Kossmat)
1 *Neophylloceras meridianum* Spath
5 *Pseudophyllites peregrinus* Spath
19 *Diplomoceras lambi* Spath

d. *Humps Island*

5 *Gunnarites pachys* Spath
5 *G. flexuosus* Spath
2 *G. kalika* (Stoliczka)
2 *Neograhamites kiliani* Spath
1 *N. taylori* Spath
1 *Neophylloceras hetonaiense* Matsumoto
6 *Phyllopachyceras forbesianum* (d'Orbigny)
1 *Gaudryceras pictum* (Yabe)
1 *Tetragonites* (*Saghalinites*) *cala* (Forbes)
1 *Pseudophyllites peregrinus* Spath

e. *Seymour Island*

18 *Maorites tuberculatus* Howarth
M. densicostatus (Kilian and Reboul) (said to be common)
M. seymourianus (Kilian and Reboul) (said to be common)
7 *Grossouvrites gemmatus* (Huppé) (common)
1 *Pachydiscus* aff. *gollevillensis* (d'Orbigny)
1 *Neophylloceras ramosum* (Meek)
Gaudryceras sp. (recorded by Kilian and Reboul)

f. *Snow Hill Island*

Gunnarites antarcticus (Weller) (abundant)
2 *G. gunnari* (Kilian and Reboul)
G. bhavaniformis (Kilian and Reboul) (common)
2 *G. kalika* (Stoliczka)
2 *Maorites* sp. ind.
6 *Jacobites anderssoni* (Kilian and Reboul) (said to be abundant)
1 *J. crofti* Spath
Grossouvrites gemmatus (Huppé) (said to be common)
Neograhamites kiliani Spath (rare)
1 ? *Eupachydiscus* sp. ind.
1 ? *Puzosia* sp. ind.
2 ? *Hauericeras* sp. ind.
Damesites loryi (Kilian and Reboul) (a few specimens)
1 *Epiphylloceras surya* (Forbes)
Neophylloceras ramosum (Meek) (rare)
Gaudryceras spp. (a few specimens)
Tetragonites cf. *epigonus* Kossmat (rare)
1 *T.* (*Saghalinites*) *cala* (Forbes)
1 *Pseudophyllites* sp.
Diplomoceras lambi Spath (common)

The phylloceratids, lytoceratids and uncoiled forms are of little use for correlation. They occur in small numbers but considerable variety at Lachman Crags, Humps Island and Snow Hill Island, while there are fewer species at The Naze and Seymour Island. Species of *Neophylloceras*, *Gaudryceras* and *Pseudophyllites* are common to many localities. *Diplomoceras lambi* occurs commonly at The Naze and Snow Hill Island but nowhere else, which perhaps suggests the equivalence of the beds at those two localities, but its absence from other localities may reflect limited geographical distribution of the species or chance preservation. The ammonites of these groups are relatively long ranging in the Campanian.

Ammonites of the families Desmoceratidae and Pachydiscidae occur in such small numbers (five is the maximum number of specimens of any one species at a locality) that their distribution has little significance. Thus the two specimens of *Kitchinites darwini* found only at Cape Lamb can just as easily be explained as due to chance preservation and discovery as due to an age difference of the beds at Cape Lamb. *Eupachydiscus grossouvrei*, known to be Middle Campanian in age in Madagascar, occurs at both Lachman Crags and The Naze, and the inner whorls of a similar very large ammonite from Snow Hill Island were figured by Kilian and Reboul (1909, pl. 6, fig. 2); equivalence of the beds is suggested but not proved. The specimens of *Hoepenites*, *Oiophyllites*, *Parapuzosia*, ? *Puzosia*, ? *Hauericeras* and *Damesites* at Lachman Crags and Snow Hill Island are mainly poorly preserved and none of them indicates any particular horizon within the Campanian. However, the single large example of *Pachydiscus* aff. *gollevillensis* from Seymour Island figured by Kilian and Reboul (1909, pl. 19, 20) is difficult to reconcile with a Lower or Middle Campanian age. That specimen is very close to French examples of the species that occur in the Upper Campanian and Lower Maastrichtian, and the genus as a whole is a late Campanian and Maastrichtian form. The presence of a unique fauna of *Maorites* at Seymour Island (discussed below) together with this *Pachydiscus* suggests that some of the beds there are of later date than the main Snow Hill Island Series ammonites and are probably of Upper Campanian age.

The Kossmaticeratidae are the only ammonites present in sufficient numbers to be of any use for correlation. *Neograhamites*, *Jacobites* and *Grossouvrites* can be discarded owing to their small numbers. *Neograhamites* is represented by a total of four specimens, one from Lachman Crags and three from Humps Island, there are eight specimens of *Jacobites*, one from The Naze and seven from Snow Hill Island (where Kilian and Reboul said it was abundant), and there is one *Grossouvrites* from Cape Lamb, seven from Seymour Island and it was said to be common at Snow Hill Island by Kilian and Reboul. The numbers at some localities are so small that their absence at others is without significance. There remain the genera *Gunnarites* and *Maorites*, which are present in sufficient numbers and variety at different localities for comparisons to be made. The typical fauna occurs abundantly at The Naze, and consists of the evolute, round-whorled and coarsely ribbed species *Gunnarites antarcticus* grading almost continuously through the intermediate *G. bhavaniformis* to the much more involute, compressed and fine-ribbed species *G. kalika*. The division of the series into the three species is somewhat arbitrary, but there is considerable variation within each species and the two ends of the series are very different. A further step beyond the *G. kalika* stage is represented by the involute, compressed and very fine-ribbed *Maorites densicostatus*. What is clearly the same fauna also occurs at Snow Hill Island, again with abundant *G. antarcticus* and many *G. bhavaniformis*, but with only a few *G. kalika* and some specifically indeterminate specimens of *Maorites*. Two specimens of *Gunnarites gunnari* occur at both The Naze and Snow Hill Island, but these are only examples of the variable inner whorls of *G. antarcticus* of which the species is a synonym. *G. antarcticus* and *Maorites densicostatus* also occur at Cape Lamb.

The faunas at Lachman Crags and Humps Island seems to be different, for although *G. kalika* is present at each locality and *Maorites densicostatus* (including the two specimens figured as *M.* aff. *suturalis* by Spath (1953, pl. 5, figs. 6, 7)) is present at Lachman Crags, all the more evolute and coarsely ribbed species were given different specific names. These are *G. pachys* and *G. flexuosus* at Humps Island, and *G. paucinodatus*, *G. rotundus* and *Maorites pseudobhavani* at Lachman Crags, all new species of Spath. However, when the specimens are examined it is found that the same variable series of *G. antarcticus*–*G. bhavaniformis*–*G. kalika* is present at both localities. The following table shows the series at The Naze and the equivalent specific names given to the same variable series at Lachman Crags and Humps Island:

	The Naze	Lachman Crags	Humps Island
Increase in involution, whorl compression and fineness of ribbing ↓			*G. pachys*
	G. antarcticus	*G. paucinodatus*	
		G. rotundus	*G. flexuosus* var. *transitoria*
	G. bhavaniformis		*G. flexuosus*
		M. pseudobhavani	
	G. kalika	*G. kalika*	*G. kalika*
Break in series	— — — — — — — —		
	M. densicostatus	*M. densicostatus*	

Gunnarites pachys is the only one of the Lachman Crags or Humps Island specific names that is worth retaining, for its very wide and robust whorls are more massive than any of *G. antarcticus*, but its flexuous ribbing, on which stress was laid by Spath, can be matched amongst several examples of the latter species. An intermediate example between *pachys* and *antarcticus* was figured by Spath (1953, pl. 9, fig. 3); it differs only marginally from Spath (1953, pl. 7, fig. 1). *Gunnarites flexuosus* from Humps Island represents both *G. antarcticus* and *G. bhavaniformis* at The Naze; the holotype (Spath, 1953, pl. 3, fig. 3) can be matched exactly by several examples of *G. bhavaniformis* from The Naze (e.g. BM. C.41820) (it is very close to Spath (1953, pl. 8, fig. 2)) and the specific name is a synonym of *G. bhavaniformis*. The example figured (Spath, 1953, pl. 9, fig. 5) as var. *transitoria* can, on the other hand, be matched exactly by several specimens of *G. antarcticus* from The Naze (e.g. BM. C.41816, C.41829, C.41895).

Similarly, the series at Lachman Crags is exactly the same as the series at The Naze. The unique holotype of *G. paucinodatus* (Spath, 1953, pl. 7, fig. 4) has more widely spaced ribbing and fewer tubercles than the average *G. antarcticus*, but very close matches amongst individuals of the latter species at The Naze can be found (e.g. BM. C.41798, C.41894) which lack the typical *Gunnarites* rib crenulation because they too are internal moulds. Most of the specimens of *G. rotundus* occupy a position somewhat intermediate between *G. antarcticus* and *G. bhavaniformis*; the holotype (Spath, 1953, pl. 12, fig. 1) does not differ in any way from an example from The Naze figured by Spath (1953, pl. 4, fig. 9) and said to be intermediate between *antarcticus* and *bhavaniformis*; other slightly more fine-ribbed and involute examples called var. *kalikaformis* (Spath, 1953, pl. 12, fig. 3) can again be matched exactly by examples from The Naze (e.g. BM. C.41405). All the specimens of *G. rotundus* are internal moulds, and like similarly preserved specimens from The Naze, they do not show rib crenulation. *G. rotundus* is a synonym of *G. antarcticus*. The position of *Maorites pseudobhavani* is more complicated. The holotype (Spath, 1953, pl. 6, fig. 7) is a precise match for the two examples of *Gunnarites kalika* from The Naze and Lachman Crags figured by Spath (1953, pl. 10, figs, 1, 3) (again the lack of crenulation in all examples of *pseudobhavani* is due to their preservation as internal moulds). Comparison with the holotype of *G. kalika* (Stoliczka, 1865, pl. 70, fig. 5) confirms the conclusion that *Maorites pseudobhavani* is to be considered a synonym of *G. kalika*. Other figured specimens of *pseudobhavani* are rather different. One (Spath, 1953, pl. 11, fig. 2) is slightly more evolute and coarse-ribbed, and it is instructive to note that the trio formed by that specimen, the holotype of *G.* "*flexuosus*" from Humps Island (Spath, 1953, pl. 3, fig. 3), and an example of *G. bhavaniformis* from The Naze (Spath, 1953, pl. 8, fig. 2), do not differ in any character and are undoubtedly conspecific. Another (Spath, 1953, pl. 11, fig. 3) is little different from one of the paratypes of *G. rotundus* (Spath, 1953, pl. 12, fig. 2), or from a Dagger Peak *G. antarcticus* figured by Spath (1953, pl. 6, fig. 2) as a typical young example.

In summary, it can be said that the series of *Gunnarites* at both Lachman Crags and Humps Island is exactly the same as the series at The Naze, except for the presence of the massive-whorled *G. pachys* at Humps Island; *G. paucinodatus*, *G. rotundus* and *G. flexuosus* var. *transitoria* are synonyms of *G. antarcticus*, *G. flexuosus* is a synonym of *G. bhavaniformis*, and *M. pseudobhavani* is a synonym of *G. kalika*. Thus Lachman Crags, Cape Lamb, The Naze, Humps Island and Snow Hill Island all have the same fauna of *Gunnarites* in some abundance. It is not possible to find any significant differences between any of the constituents of the ammonite faunas of these five localities, and palaeontologically the beds are of the same date. That date has been stated previously to be Lower and Middle Campanian (Howarth, 1958, p. 15), and this dating can be confirmed now that a rather more detailed list of the ammonites in the Campanian zones of Madagascar is available (Besairie and Collignon, 1960, p. 77–78), showing *Eupachydiscus grossouvrei* in the Middle Campanian and species of *Maorites* in the upper half of the Lower Campanian.

The only locality not yet discussed is Seymour Island, where at least part of the fauna shows significant differences from those of the other five localities. From localities in the south-east of the island (Andersson, 1906, pl. 6; Spath, 1953, map on p. 59) Kilian and Reboul (1909, p. 49, locality 8) list a large number of ammonites that include *Gunnarites antarcticus*, *Maorites densicostatus*, *M. seymourianus* and *Grossouvrites gemmatus*. The presence of the last three species was confirmed by examples figured (Kilian and Reboul, 1909, pl. 15, fig. 4; pl. 17; pl. 18, fig. 1; pl. 19, figs. 1, 2), but no example of *Gunnarites antarcticus* was figured, and as none have been found by any of the more recent expeditions, its presence in that island must remain unproved (it is listed by Kilian and Reboul, but there are many discrepancies between the ammonites quoted in their list of localities (p. 47-49), their table (p. 50–53) and the distribution given in the systematic part (p. 9–44)). Even without the proved presence of *G. antarcticus* it is likely that these beds are of the same age as the other five localities, for *M. densicostatus* occurs at Lachman Crags, Cape Lamb and The Naze, *M. seymourianus* occurs at Lachman Crags, and *G. gemmatus* occurs at Cape Lamb (one good example, BM. C.72802) and was said to be "common" by Kilian and Reboul (1909, p. 48) on Snow Hill Island. Examples of *G. gemmatus* from other localities on Seymour Island that have not yielded any other ammonites, were figured by Spath (1953, p. 29, pl. 5, fig. 1) and Howarth (1958, p. 8, 12, pl. 2, fig. 4—wrongly stated to have been associated with *M. tuberculatus*). However, localities at or just west of Cape Bodman yielded *Pachydiscus* aff. *gollevillensis* (Kilian and Reboul, 1909, p. 43, pl. 19, 20) and *Maorites tuberculatus* (Howarth, 1958, p. 11, pl. 2, figs. 1–3). Kilian and Reboul (1909, p. 49) also listed but did not figure *M. densicostatus* and *Grossouvrites gemmatus* from Cape Bodman, but their presence is not considered proved. The *Pachydiscus* has been shown above to be probably indicative of an Upper Campanian rather than a Middle Campanian date, and the presence of 18 examples of *Maorites tuberculatus* (without associated ammonites) at nearby localities, appears to be additional evidence for a date at least slightly different from the rest of the ammonites of the Snow Hill Island Series. *M. tuberculatus* is not found at any other locality, and it is distinctively different from any other species of *Maorites*.

In summary, the ammonite faunas at Lachman Crags, Cape Lamb, The Naze, Humps Island and Snow Hill Island can only be considered as contemporaneous and as upper Lower Campanian and Middle Campanian in age. Ammonites of the same age also occur on Seymour Island, but the example of *Pachydiscus* and fauna of *Maorites tuberculatus* on that island are more likely to be of Upper Campanian date.

MS. received 26 January 1966

REFERENCES

ANDERSON, F. M. 1958. Upper Cretaceous of the Pacific Coast. *Mem. geol. Soc. Am.*, No. 71, 378 pp. 75 pls.

ANDERSSON, J. G. 1906. On the geology of Graham Land. *Bull. geol. Instn Univ. Upsala*, 7, 19–71.

BESAIRIE, H. *and* M. COLLIGNON. 1960. *Lexique stratigraphique international, Vol. 4, Afrique, Fasc. 11, Madagascar (supplément)*. Paris, Centre National de la Recherche Scientifique, 192 pp.

BIBBY, J. S. 1966. The stratigraphy of part of north-east Graham Land and the James Ross Island group. *British Antarctic Survey Scientific Reports*, No. 53, 37 pp.

COLLIGNON, M. 1948. Ammonites néocrétacées du Menabe (Madagascar). I. Les Texanitidae. *Annls géol. Serv. Mines Madagascar*, Fasc. 13, 49–107, pl. 7–20; Fasc. 14, 7–60, 99–101, pl. 15–32.

————. 1955. Ammonites néocrétacées du Menabe (Madagascar). III. Les Kossmaticeratidae. *Annls géol. Serv. Mines Madagascar*, Fasc. 22, 1–54, pl. 1–12.

————. 1956. Ammonites néocrétacées du Menabe (Madagascar). V. Les Gaudryceratidae. *Annls géol. Serv. Mines Madagascar*, Fasc. 23, 39–73, pl. 5–9.

————. 1961. Ammonites néocrétacées du Menabe (Madagascar). VII. Les Desmoceratidae. *Annls géol. Serv. Mines Madagascar*, Fasc. 31, 1–115, pl. 1–32.

COLLIGNON, M. 1964. *Atlas des fossiles caracteristiques de Madagascar (Ammonites). XI. Cenomanien.* Tananarive, Service Géologique, xii + 152 pp., pl. 318–75.
———. 1965. *Atlas des fossiles caracteristiques de Madagascar (Ammonites). XII. Turonien.* Tananarive, Service Géologique, iv + 82 pp., pl. 376–413.
GABB, W. M. 1864. *Geological Survey of California. Palaeontology.* **1**, 57–217, pl. 9–32. Philadelphia.
HANNA, G. D. *and* L. G. HERTLEIN. 1943. Characteristic fossils of California. (*In* JENKINS, O. P., *ed.* Geologic formations and economic development of the oil and gas fields of California. *Bull. Calif. Min. Bur.*, **118**, 165–82.)
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., 5 pls.
———. 1965. Cretaceous ammonites and nautiloids from Angola. *Bull. Br. Mus. nat. Hist.*, Geology, **10**, No. 10, 335–412, pl. 1–13.
JIMBO, K. 1894. Beiträge zur Kenntnis der Fauna der Kreideformation von Hokkaido. *Paläont. Abh.*, (N.F.), **6**, 149–94, pl. 17–25.
JONES, D. L. 1963. Upper Cretaceous (Campanian and Maestrichtian) ammonites from southern Alaska. *Prof. Pap. U.S. geol. Surv.*, No. 432, 1–53, pl. 1–41.
KILLIAN, W. *and* P. REBOUL. 1909. Les céphalopodes néocrétacés des îles Seymour et Snow-Hill. *Wiss. Ergebn. schwed. Südpolarexped.*, Bd. 3, Lief. 6, 1–75, pl. 1–20.
KOSSMAT, F. 1895–98. Untersuchungen über die südindische Kreideformation. *Beitr. Paläont. Geol. Öst.-Ung.*, **9**, 97–203, pl. 15–25; **11**, 1–46, pl. 1–8; 89–152, pl. 14–19.
MARSHALL, P. 1926. The Upper Cretaceous ammonites of New Zealand. *Trans. Proc. N.Z. Inst.*, **56**, 129–210, pl. 19–47.
MARWICK, J. 1950. The type of the ammonite *Madrasites mckayi* (Hector). *Trans. R. Soc. N.Z.*, **78**, 482–84, pl. 59.
MATSUMOTO, T. 1954. Family Puzosiidae from Hokkaido and Saghalien. *Mem. Fac. Sci. Kyushu Univ.*, Ser. D, **5**, 69–118, pl. 9–23.
———. 1955. Evolution of the Peroniceratidae. *Trans. Proc. palaeont. Soc. Japan*, **18**, 37–44.
———. 1959*a*. Cretaceous ammonites from the upper Chitina Valley, Alaska. *Mem. Fac. Sci. Kyushu Univ.*, Ser. D, **8**, 49–90, pl. 12–29.
———. 1959*b*. Upper Cretaceous ammonites of California. Part 2. *Mem. Fac. Sci. Kyushu Univ.*, Ser. D, Special Vol., **1**, 1–172, pl. 1–41.
———. 1959*c*. Zonation of the Upper Cretaceous in Japan. *Mem. Fac. Sci. Kyushu Univ.*, Ser. D, **9**, 55–93, pl. 6–11.
———. 1960. Upper Cretaceous ammonites of California. Part 3. *Mem. Fac. Sci. Kyushu Univ.*, Ser. D, Special Vol., **2**, 1–204, pl. 1, 2.
REESIDE, J. B. 1962. Cretaceous ammonites of New Jersey. (*In* RICHARDS, H. J. *and others. The Cretaceous fossils of New Jersey*, **2**. Trenton, New Jersey, Geological Survey, 113–37, pl. 68–75.)
SPATH, L. F. 1921. On Cretaceous Cephalopoda from Zululand. *Ann. S. Afr. Mus.*, **12**, No. 16, 217–321, pl. 19–26.
———. 1953. The Upper Cretaceous cephalopod fauna of Graham Land. *Falkland Islands Dependencies Survey Scientific Reports*, No. 3, 60 pp., 13 pls.
STEINMANN, G. 1895. Die Cephalopoden der Quiriquina-Schichten. *Neues Jb. Miner. Geol. Paläont.*, **10**, 64–94, pl. 4–6.
STOLICZKA, F. 1865. The fossil Cephalopoda of the Cretaceous rocks of southern India. Vol. 3. Ammonitidae. *Mem. geol. Surv. India Palaeont. indica*, **6–9**, 107–54, pl. 55–80.
TAFF, J. A., HANNA, G. D. *and* C. M. CROSS. 1940. Type locality of the Cretaceous Chico formation. *Bull. geol. Soc. Am.*, **51**, No. 9, 1311–27, pl. 1, 2.
TRASK, J. B. 1856. Description of a new species of ammonite and baculite from the Tertiary rocks of Chico Creek, California. *Proc. Calif. Acad. Sci.*, **1**, 52–93, pl. 1.
WELLER, S. 1903. The Stokes collection of Antarctic fossils. *J. Geol.*, **11**, No. 4, 413–19, pl. 1–3.
YABE, H. 1903. Cretaceous Cephalopoda from Hokkaido. Part 1. *J. Coll. Sci. imp. Univ. Tokyo*, **18**, No. 2, 1–55, pl. 1–7.
YOUNG, K. 1963. Upper Cretaceous ammonites of the Gulf Coast of the United States. *Bull. Univ. Tex. Bur. econ. Geol. Technol.*, No. 6304, 1–373, pl. 1–82.