

A revision of *Ammonites mitis* HAUER and *Ammonites glaneggensis* REDTENBACHER from the Gosau Beds (Upper Cretaceous) of Austria.

Revision von *Ammonites mitis* HAUER und *Ammonites glaneggensis* REDTENBACHER aus den Gosau-Schichten von Österreich.

von

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A b s t r a c t *Ammonites mitis* HAUER, 1866, type species of the genus *Gaudryceras* DE GROS-SOUVRE, 1894 is revised on the basis of a re-study of the holotype from the Coniacian Gosau Beds of Strobl, near Ischl, Salzkammergut, and shown to have priority over *G. varagurense* KOSSMAT, 1895 and *G. navarrense* WIEDMANN, 1962. *Ammonites glaneggensis* REDTENBACHER, 1873, a further *Gaudryceras* from the Gosau Coniacian is shown to have priority over *G. denseplicatum* (JIMBO, 1894), *G. amapondense* VAN HOEPEN, 1920 and *G. vascogoticum* WIEDMANN, 1962.

Z u s a m m e n f a s s u n g Eine Revision der beiden Gaudryceraten *Ammonites mitis* HAUER, 1866 und *Ammonites glaneggensis* REDTENBACHER, 1873 wird vorgelegt. Die Revision des Holotyps hat ergeben, daß *Ammonites mitis* HAUER, die Typusart der Gattung *Gaudryceras* DE GROS-SOUVRE, 1894, aus dem Coniac der Gosauschichten von Strobl (Salzburg) Priorität über *Gaudryceras varagurense* KOSSMAT, 1895 und *Gaudryceras navarrense* WIEDMANN, 1962 besitzt. Eine Revision des Holotyps von *Ammonites glaneggensis* REDTENBACHER, 1873 zeigt weiters, daß der REDTENBACHERschen Art aus dem Coniac der Gosauschichten von Glanegg (Salzburg) Priorität über *Gaudryceras denseplicatum* (JIMBO, 1894), *G. amapondense* v. HOEPEN, 1920 und *G. vascogoticum* WIEDMANN, 1962 zukommt.

I n t r o d u c t i o n The ammonite fauna of the Gosau Beds of Austria (Coniacian-Maastrichtian) is of great biogeographic and taxonomic interest, both as an essentially Mesogean assemblage moved far to the north of its original position, and as the source of the types of many key genera and species of evolutionary and stratigraphic significance. The main accounts of the ammonites are those of HAUER (1858, 1866) and REDTENBACHER (1873), followed by BRINKMANN's (1935) listing of all the then known specimens. Since this time, a few additional forms were described by PLÖCHINGER (1955), GERTH (1956, 1961), and THIEDIG & WIEDMANN (1976), and a number of REDTENBACHER's types have been revised by REYMENT (1958). In this contribution, part of an overall revision of the Gosau ammonite fauna, we describe the two species of *Gaudryceras* DE GROS-SOUVRE, 1894 which are based on Gosau material. *Ammonites mitis* HAUER (1866) is the type species of *Gaudryceras*, and thus the basis of the Family Gaudryceratidae SPATH, 1927, yet the type specimen has never been adequately illustrated photographically, and the name has fallen into disuse since the first decade of the century in favour of the better known *G. varagurense* KOSSMAT, 1895. As is shown below, the holotype of *G. mite* is adequate for clear definition of both species and genus, and has priority over *G. varagurense*. The second species described below, *G. glaneggense* (REDTENBACHER, 1873) has also been neglected in favour of the Japanese *G. denseplicatum* (JIMBO, 1894), until the recent works of COLLIGNON (e. g. 1965 a, b) where both species were described from the Upper Cretaceous of Madagascar. Our re-examination of the holotype shows that REDTEN-

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BACHER's figures are somewhat idealised, and that the two are in fact conspecific. In addition to redescribing and illustrating the types of the two Gosau species, the types and other relevant specimens of Japanese and African species are illustrated for comparative purposes, and the limits of the genus *Gaudryceras* are reviewed.

Location of Specimens

The following abbreviations are used to indicate the repositories of specimens mentioned in the text:

GBA: Geologische Bundesanstalt, Wien.

LL: Oberösterreichisches Landesmuseum, Linz.

NS: Haus der Natur, Salzburg.

BMNH: British Museum (Natural History), London.

Suture Terminology

The suture terminology of WEDEKIND (1916; see KULLMANN & WIEDMANN 1970 for a recent review) is followed in the present work: Is = Internal lobe with septal lobe; U = Umbilical lobe; L = Lateral lobe, E = External lobe.

SYSTEMATIC PALAEOLOGY

Order Lytoceratida HYATT, 1899

Superfamily Tetragonitaceae HYATT, 1900

The superfamily Tetragonitaceae HYATT, 1900 is a group of long ranging forms conservative in external morphology, but the most advanced of ammonites in terms of sutures, a sexlobate primary suture, with a formula $E L/U_2 U_3 U, I$ and a septal lobe, Is. As WIEDMANN (1963, 1973) and KULLMANN and WIEDMANN (1970) have demonstrated, this progressive septal pattern suggests that, had the ammonites weathered the Cretaceous/Palaeocene crisis, the tetragonitids would be the group which would probably still be with us. The group evolved from the Lytocerataceae during the Barremian, although no forms with intermediate sutures are known (WIEDMANN 1962, p. 147). There has been considerable disagreement as to the subdivision of the superfamily, and we have adopted WIEDMANN's conclusions in dividing the superfamily into two families, the Gaudryceratidae and Tetragonitidae.

Family Gaudryceratidae SPATH, 1927

The Gaudryceratidae range from Barremian to Maastrichtian, and have a world-wide distribution. They are, however, rare in the boreal areas of north-west Europe and the U.S.S.R., and the Western Interior of North America, being best known from the circum-Pacific area, north, east and west Africa, Madagascar and Antarctica. Typical gaudryceratids (*Gaudryceras*, *Vertebrites*) are evolute, many-whorled, depressed at first, becoming compressed as size increases, with an ornament of coarse to fine lirae, and bearing constrictions. The sutures are typically lytoceratid, with more or less symmetrical bifid saddles, and a prominent septal lobe. Departures from this type include compressed genera such as *Mesogaudryceras* SPATH, 1927 and *Zelandites* MARSHALL, 1926 or coronate forms with a keel-like lateral angle – *Jaubertella* JACOB, 1908 and *Gabbioceras* HYATT, 1900.

There have been a number of attempts to subdivide the family. *Kosmatella* JACOB, 1907 has been placed in a subfamily Kosmatellinae BREISTROFFER, 1953; *Vertebrites* MARSHALL, 1926 in a subfamily Vertebritinae WIEDMANN, 1962; *Gabbioceras* HYATT, 1900 and *Jauberticeras* JACOB, 1907 in a subfamily Gabbioceratinae BREISTROFFER, 1953.

All of the gaudryceratids appear to be intimately related, and species of individual genera often develop, at some stage in ontogeny, features which typify one or other subfamilies, as is clear from the discussions of WIEDMANN (1962), HENDERSON (1970) and KENNEDY & KLINGER (1979). We would not, therefore, subdivide the family here.

Genus *Gaudryceras* DE GROSSOUVRE, 1894

Type Species *Ammonites mitis* HAUER, 1866, by the subsequent designation of BOULE, LEMOINE and THEVENIN (1906).

Diagnosis Typically evolute, early whorls depressed, slowly expanding, later whorls compressed, expanding more rapidly. Ornament consists of lirae, flexuous or branched, fine and wire-like throughout ontogeny or coarsening and bunching on the outer whorl. Constrictions are present on the internal mould, being marked on the shell by faint collars and depressions. Suture with large bifid lobes and saddles, suspensive lobe typically retracted, with several auxiliaries.

Discussion The genus has been reviewed at some length by WRIGHT and MATSUMOTO (1954, p. 111–113); MATSUMOTO (1959, p. 141) and HOWARTH (1965, p. 360). WIEDMANN (1962, p. 156) provides a detailed synonymy for the genus, but we feel that, given currently accepted generic divisions of the gaudryceratids, *Anagaudryceras* SHIMIZU, 1934 and *Mesogaudryceras* SPATH, 1927 bear separation as either genera or subgenera.

About thirty names have been given to gaudryceratids which can be placed in the genus with certainty, as listed by COLLIGNON (1956, pp. 67–69) and HOWARTH (1965, p. 360), to which can be added *Gaudryceras anomalum* COLLIGNON, 1966 and *Gaudryceras yokoyamaiforme* COLLIGNON, 1969.

Species of the genus fall into three subgroups, which may be differentiated on characters of adult ornamentation. They probably do not merit subgeneric separation:

1. The group of *Gaudryceras mite* (HAUER), where fine, equal ribs are present throughout ontogeny. The chief named species are:

Gaudryceras mite (HAUER) (1886, p. 6, pl. 2, figs. 3, 4) Santonian to Campanian; *Gaudryceras varagurense* KOSSMAT (1895, p. 122, pl. 17, fig. 9, pl. 18, fig. 2) Turonian to Campanian, *Gaudryceras analabense* COLLIGNON (1956, p. 53, pl. 5, figs. 1–3) Coniacian, *Gaudryceras varicostatum* VAN HOEPEN (1921, p. 7, pl. 2, figs. 10–12), *Gaudryceras devallense* ANDERSON (1958, p. 183, pl. 41, fig. 4) Coniacian or Santonian, *Gaudryceras striatum* JIMBO (1894, p. 181, pl. 6, fig. 6) Santonian to Maastrichtian, *Gaudryceras stefanii* VENZO (1936, p. 21, pl. 2, figs. 3, 4) Cenomanian.

2. The group of *Gaudryceras denseplicatum* JIMBO, in which coarse, fold-like ribs appear in the adult in addition to finer lirae (= *Neogaudryceras* SHIMIZU, 1934). The chief named species are:

Gaudryceras denseplicatum (JIMBO 1894, p. 182, pl. 23, figs. 1–1 a) Turonian to Campanian, *Gaudryceras glaneggense* (REDTENBACHER) (1873, p. 119, pl. 27, figs. 3 a–b) Coniacian, *Gaudryceras lauteli* COLLIGNON (1956, p. 57, pl. 7, figs. 1–1 a) Santonian, *Gaudryceras vasco-goticum* WIEDMANN (1962, p. 159, pl. 9, figs. 2, 6, text-fig. 17) Coniacian, *Gaudryceras ampondense* VAN HOEPEN (1920, p. 142, pl. 24, figs. 1–3) Santonian to Campanian.

3. Group of *Gaudryceras tenuiliratum* YABE with finely ribbed inner and coarsely ribbed outer whorls.

Gaudryceras tenuiliratum YABE (1903, p. 19, pl. 3, figs. 3, 4) Coniacian to Campanian, *Gaudryceras denmanense* WHITEAVES (1930, p. 329) Campanian.

In addition there are almost a score of juvenile gaudryceratids described in the literature which may be valid species or mere inner whorls of well known forms. Many of these are listed by COLLIGNON (1956, p. 70).

Gaudryceras is readily separable from the more closely related gaudryceratid genera as follows: *Anagaudryceras* SHIMIZU, 1934 is typically very finely lirate, with widely spaced constrictions and collars when young, and has adult whorls which may or may not develop coarse folds (= *Paragaudryceras auctorum*) by approximation of constrictions.

Mesogaudryceras SPATH, 1927 is compressed, involute, and finely lirate, without constrictions. *Vertebrites* MARSHALL, 1926 is small, very evolute, serpenticone, with depressed whorls and an ornament of strong lirae on the flank which split into hairlike striae over the venter. Some *Gaudryceras* (e. g. *G. stefanii*) develop this feature when young, foreshadowing the persistence of the feature in adult *Vertebrites*.

O c c u r r e n c e *Gaudryceras* has a time range extending from Upper Albian to Maastrichtian; the geographic range includes Antarctica, New Zealand, Madagascar, South Africa (Zululand and Natal), Angola, North Africa, the Middle East, central and southern Europe, southern India, Japan, Sakhalin, Kamchatka, Alaska, British Columbia, California, Chile and southern Patagonia.

***Gaudryceras mite* (HAUER)**

(Plate 1, figs. 1 A–D; Plate 2, figs. 1 A–C, 2 A–B; Text-fig. 1)

- 1866 *Ammonites mitis* HAUER, p. 305, pl. 2, figs. 3–4.
 1873 *Ammonites mitis* HAUER; REDTENBACHER, p. 119, pl. 27, fig. 4.
 1894 *Gaudryceras mite* HAUER; DE GROSSOUVRE, p. 227, pl. 26, fig. 4; pl. 39.
 1895 *Lytoceras (Gaudryceras) mite* HAUER; KOSSMAT, p. 123.
 1895 *Lytoceras (Gaudryceras) varagurense* KOSSMAT, p. 122, pl. 17, fig. 9; pl. 18, figs. 2 a–c.
 1899 a *Lytoceras (Gaudryceras) mite* (HAUER); SIMIONESCU, p. 228.
 1899 b *Lytoceras (Gaudryceras) mite* (HAUER); SIMIONESCU, p. 252, pl. 1, fig. 1.
 1902 *Gaudryceras mite* (HAUER); WOLLEMAN, p. 93, pl. 4, fig. 6; pl. 6, fig. 1.
 ? 1909 *Lytoceras (Gaudryceras) mite* (HAUER); KILIAN & REBOUL, p. 13.
 ? 1909 *Gaudryceras* cf. *mite* (HAUER); BÖHM, p. 50, pl. 1, fig. 4.
 ? 1909 *Lytoceras (Gaudryceras) varagurense* KOSSMAT; KILIAN & REBOUL, p. 12, pl. 1, fig. 6.
 ? 1929 *Lytoceras (Gaudryceras) varagurense* KOSSMAT; BARRABE, p. 180, pl. 9, fig. 16.
 ? 1930 *Gaudryceras varagurense* KOSSMAT; BESAIRIE, p. 569, pl. 21, fig. 4.
 1931 *Lytoceras (Gaudryceras) varagurense* KOSSMAT; BASSE, p. 14, pl. 1, figs. 25, 26.
 1931 *Lytoceras (Gaudryceras) varagurense* KOSSMAT; COLLIGNON, p. 11, pl. 1, figs. 5, 6; pl. 8, fig. 2.
 1935 *Gaudryceras mite* (HAUER); BRINKMANN, p. 1 et. seq. (pars)
 1952 *Puzosia lytoceratoides* HAAS, p. 8, figs. 14–17.
 1953 *Gaudryceras (Neogaudryceras) pictum* (YABE); SPATH, p. 12, pl. 1, fig. 10.
 1956 *Gaudryceras varagurense* KOSSMAT; COLLIGNON, p. 56, pl. 5, fig. 6.
 1961 *Gaudryceras* cf. *mite* HAUER; GERTH, p. 120, pl. 24, figs. 10 a–b.
 1962 *Gaudryceras navarrense* WIEDMANN, p. 158, pl. 9, fig. 3.
 1965 *Gaudryceras varagurense* KOSSMAT; HOWARTH, p. 361, pl. 4, fig. 5, pl. 5, figs. 1–2.
 1965 a *Gaudryceras varagurense* KOSSMAT; COLLIGNON, p. 2, pl. 376, fig. 1635.
 1965 b *Gaudryceras varagurense* KOSSMAT; COLLIGNON, p. 2, pl. 414, fig. 1712.
 1966 *Gaudryceras varagurense* KOSSMAT; COLLIGNON; p. 2, pl. 455, fig. 1852.
 1966 *Gaudryceras varagurense* KOSSMAT; HOWARTH, p. 4, pl. 1, figs. 6, 7.

H o l o t y p e By monotypy, von HAUER's original specimen (1866, pl. 2, figs. 3–4), from the Gosau Beds of Strobl, near Ischl, GBA 1866/01/3.

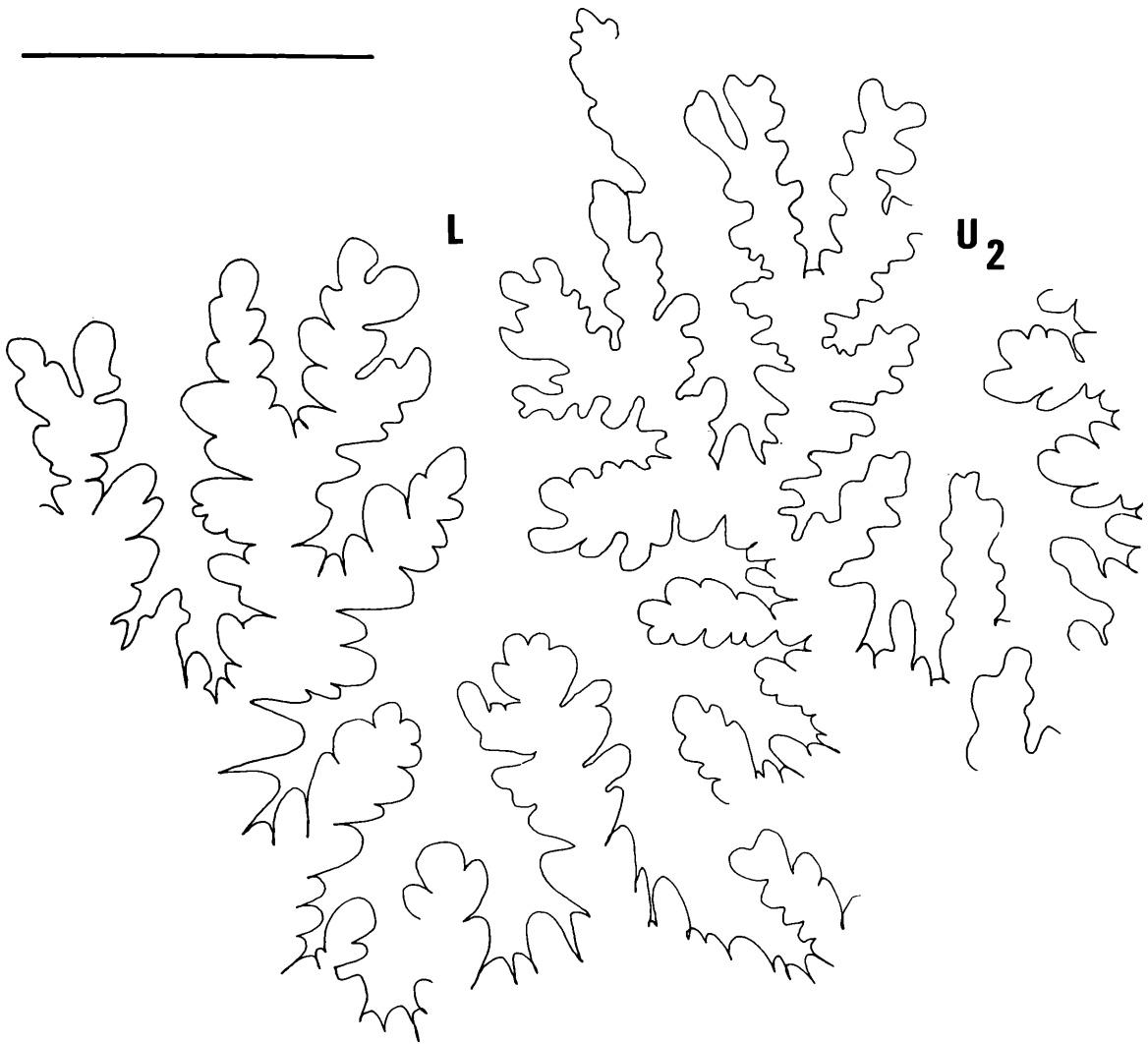
M a t e r i a l In addition to the holotype, LL 32.1938, also from Ischl (listed by BRINKMANN, 1935) and GBA 1935/01/49, from Grünbach (listed by BRINKMANN, 1935 as *Gaudryceras* ex aff. *mite*) are referred to the species.

D e s c r i p t i o n The holotype is a crushed composite internal mould, distorted into an ellipse. The major axis of the ellipse is 108 mm., the minor 69 mm. Half the last whorl is body chamber, and all but the last one and a half whorls – the nucleus – are too poorly preserved to be described.

Coiling is very evolute, and although accentuated by crushing, it seems that the umbilicus was broad and shallow (measurements of the holotype have little meaning). The umbilical wall appears to have been low and rounded, the whorl section is compressed, due to secondary deformation, and the greatest breadth lies low on the flanks close to the umbilical shoulder.

Ornament consists of fine, dense, flexuous wire-like lirae. Characteristically these arise at the umbilical seam, where they are exceedingly fine. They are concave, and sweep forwards across the umbilical wall, and are straight, prorsiradiate, and at their maximum strength across the shoulder and inner flank. At or close to the umbilical shoulder, the lirae branch, and sweep backwards across the mid flank region, and then forwards across the outer flank and ventrolateral shoulder to form a narrow convex peak over the siphonal line. Many lirae branch a second time in the middle or on the outer part of the flank, and there are many intercalated lirae, arising at various points on the flank.

There are estimated six or seven constrictions on the outer whorl, parallel to the ribs, and with a more prominent rib or collar both in front and behind.



Text-Fig. 1. Partial external suture of the holotype of *Gaudryceras mite* (HAUER), GBA 1935/01/3, from the Gosau Beds of Strobl, near Ischl, Austria. Bar scale is 5 mm.

The suture is well exposed, with typical, deeply incised elements (Fig. 1).

LL 32. 1938 is a distorted fragment, showing, however, absolutely typical lirate ornament and constrictions. GBA 1935/01/49 is also a fragment, but shows a relatively undeformed whorl section.

R e m a r k s *Gaudryceras mite* has long been a difficult species to interpret, for, as HOWARTH (1935, p. 361) notes, HAUER gave an idealised, very compressed whorl section. Apart from this, his other figure is remarkably accurate, other than the entirely fictitious restoration of the inner whorls. Judging from GBA 1935/01/49, the whorl section at moderate diameters varied from equidimensional to slightly compressed.

The name *mitis* or *mite*, in vogue during the last century, has been scarcely used by recent authors, who have preferred to use the name *Gaudryceras varagurens* KOSSMAT, in that that species is far more satisfactorily described and illustrated. On comparing our photographs of HAUER's type with KOSSMAT's figure, and also a fine series of Angolan specimens referred to the species (BMNH C 52649–59), we would conclude that the identity of ornament style and strength, together with the form of constrictions is so similar that *varagurens* should be treated as a junior synonym. The holotype of *varagurens* (KOSSMAT 1895, p. 122, pl. 17, fig. 9, pl. 18, figs. 2 a–c) is broken (see

Plate 2, figs. 2 a–b herein), but can be matched closely with parts of HAUER's specimen at the same size, given the differences in preservation.

Of other *Gaudryceras* which retain fine ornament to a large size, *Gaudryceras stefaninii* VENZO (1936, p. 21, pl. 2, figs. 3, 4) has curious, *Vertebrites*-like ornament on the inner whorls: straight lirae on the flank, and fine branching ribs over the venter (KENNEDY & KLINGER, 1979). *Gaudryceras varicostatum* VAN HOEPEN (1921, p. 7, pl. 2, figs. 10–12, text-figs. 3–4), of which *Gaudryceras cinctum* SPATH (1922, p. 118, pl. 9, figs. 3 a–b) is a synonym (KENNEDY & KLINGER, 1979) also has *Vertebrites*-like inner whorl (differing from *G. stefaninii* in whorl section) and coarser lirae in middle growth.

Two Madagascan species described by COLLIGNON (1956) are more closely related to *G. mite*. *Gaudryceras beantalyense* (op. cit., p. 53, pl. 5, figs. 1–1 a to 3–3 b) was differentiated on the basis of finer liration, lesser compression, and a larger umbilicus. *G. analabense* (op. cit., p. 54, pl. 6, figs. 1–1 b – 3–3 b) is a more massive, finely ribbed species with a smaller umbilicus. These differences are slight, and could be within the limits of variation of a single species; unfortunately our Gosau material does not permit resolution of the problem. *Gaudryceras navarrense* WIEDMANN (1962, p. 158, pl. 9, fig. 3) is a typical *G. mite*. *G. delvallense* ANDERSON (1958, p. 183, pl. 41, fig. 4) differs most obviously in having much markedly less flexed lirae in ANDERSON's poor, partially reconstructed figure.

O c c u r r e n c e The Gosau specimens are of Coniacian and Maastrichtian age.

Elsewhere, the species, as here interpreted, ranges from Turonian to Maastrichtian, being known from southern France, the Carpathians, northern Spain, ? North Africa, Angola, Zululand, Madagascar, southern India and the sub-Antarctic Islands.

Gaudryceras glaneggense (REDTENBACHER)

(Plate 3, figs. 1 a–b; Plate 4, figs. 1 a–b)

- 1873 *Ammonites glaneggensis* REDTENBACHER, p. 119, pl. 27, fig. 3.
 1894 *Lytoceras sacya* JIMBO (non FORBES), p. 180, pl. 22, figs. 1–1 a.
 1894 *Lytoceras denseplicatum* JIMBO, p. 182, pl. 23, fig. 1.
 1895 *Lytoceras (Gaudryceras) glaneggense* (REDTENBACHER); KOSSMAT, p. 117.
 1899 a *Lytoceras (Gaudryceras) glaneggense* (REDTENBACHER); SIMIONESCU, p. 228.
 1899 b *Lytoceras (Gaudryceras) glaneggense* (REDTENBACHER); SIMIONESCU, p. 253.
 1903 *Gaudryceras glaneggense* (REDTENBACHER); YABE, pp. 16, 24.
 1903 *Gaudryceras tenuiliratum* var. *infrequens* YABE, p. 28, pl. 4, figs. 3 a–b.
 1903 *Gaudryceras tenuiliratum* var. *intermedia* YABE, p. 27, pl. 3, figs. 1 a–b.
 1903 *Gaudryceras denseplicatum* (JIMBO); YABE; p. 16, 30.
 1906 *Lytoceras (Gaudryceras) glaneggense* REDTENBACHER; BOULE, LEMOINE & THÉVENIN, p. 13, text-fig. 6.
 1910 *Pachydiscus hellichi* FRITSCH, Pl. 5, fig. 14.
 1915 *Gaudryceras denseplicatum* (JIMBO); YABE, p. 13.
 1920 *Lytoceras (Gaudryceras) amapondense* VAN HOEPEN, p. 42, pl. 24, figs. 1–3.
 1921 *Gaudryceras amapondense* VAN HOEPEN; SPATH, table, p. 50.
 1922 *Gaudryceras amapondense* VAN HOEPEN; SPATH, p. 118.
 1924 *Gaudryceras denseplicatum* (JIMBO) var. *nonstriata* YEHARA, p. 35, pl. 2, fig. 1.
 1935 *Gaudryceras glaneggense* REDTENBACHER, BRINKMANN, p. 2.
 1942 *Neogaudryceras denseplicatum* (JIMBO) var. *kawadai* MATSUMOTO, p. 666 (nom. nud.).
 1956 *Neogaudryceras denseplicatum* JIMBO; COLLIGNON; p. 60, pl. 9, fig. 1.
 1958 *Lytoceras (Gaudryceras) aff. L. (G.) tenuiliratum* ANDERSON (non YABE); p. 183, pl. 40, fig. 1.
 1959 *Gaudryceras glaneggense* (REDTENBACHER); WIEDMANN, p. 715.
 1962 *Gaudryceras vascogoticum* WIEDMANN, p. 159, pl. 9, figs. 2, 6, text-fig. 17.
 1965 a *Neogaudryceras glaneggense* (REDTENBACHER); COLLIGNON, p. 4, pl. 415, fig. 1716.
 1965 b *Neogaudryceras denseplicatum* (JIMBO); COLLIGNON, p. 6, pl. 416, fig. 1719.
 1974 *Gaudryceras denseplicatum* (JIMBO); SZÁSZ & LÁCÁTUŠU, p. 206, p. 1, pl. 2, fig. 1.
 1979 *Gaudryceras denseplicatum* (JIMBO); KENNEDY & KLINGER, p. 140, pl. 5, figs. 1–2; pl. 6, fig. 2, pl. 7, fig. 1.

H o l o t y p e REDTENBACHER's unique specimen, NS 6373, from the Gosau Beds of Glanegg, near Salzburg.

D e s c r i p t i o n The holotype is a very fragmentary body chamber with a maximum length of 150 mm. and an estimated maximum whorl height of 60–70 mm. The whorl section appears to have been compressed, with a small umbilicus. The umbilical wall slopes outwards, to give a crater-like appearance to the umbilical region. The flanks are rounded and converge to an arched venter.

Ornament consists of narrow rounded flexuous ribs separated by wide flat interspaces, and fine wire-like lirae, developed over the whole of the surface of the composite mould.

Ribs and striae arise at the umbilical seam, and are concave on the umbilical wall, sweeping forwards and shallowly convex across the mid flank, and sweeping back across the outer flank to flex forwards over the venter. Because of compactional distortion, this flexuosity is exaggerated; on the venter there is in fact only a shallow and broad ventral peak. Lirae parallel the ribs, and there are from four to nine on each interspace, and four or five on each rib.

D i s c u s s i o n: REDTENBACHER's original figures are both restored and reversed; in particular, the inner whorl shown in his figure is entirely artistic licence.

Early workers tended to unite *G. glaneggense* and *G. denseplicatum*, but latterly, the two have been separated on the basis of stronger, more widely spaced ribs with more intermediate lirae in the former. One of us (WJK) recently studied the holotype, no MM 7491, in the Museum of the Department of Geology, Tokyo University (Pl. 4, figs. 1–2), and concluded that, given the imperfect preservation of both types, there were no grounds for separation, in consequence of which both are reunited here. We would also suggest that *G. vascogoticum* WIEDMANN (1962, p. 159, pl. (, figs. 2, 6; text-fig. 17) is best regarded as a synonym, as are certain other forms treated by MATSUMOTO (1959).

Gaudryceras amapondense VAN HOEPEN (1920; 42, pl. 24, figs. 1–3) appears to be based on a crushed specimen of this species.

O c c u r r e n c e: Coniacian of Austria; Coniacian to Campanian of Zululand, South Africa; Coniacian of Madagascar, northern Spain, Roumania; Turonian to Lower Campanian of Japan, California.

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Explanation of Plates

Plate 1

- Figs. 1 a, 1 b, 1 c, 1 d. *Gaudryceras mite* (HAUER). The holotype, GBA 1935/01/3, from the Gosau Beds of Strobl, near Ischl, Austria. x 1.

Plate 2

- Figs. 1 a, 1 b, 1 c. *Gaudryceras mite* (HAUER). BMNH C 77452, the original of HOWARTH 1966, pl. 1, figs. 6–7. A typical *Gaudryceras varagurense* KOSSMAT, from the Turonian of the Mocamedes Desert, Angola. x 1.
- Figs. 2 a, 2 b. *Gaudryceras mite* (HAUER). Copy of KOSSMAT's (1895) figures of the holotype of *Gaudryceras varagurense* KOSSMAT. x 1.

Plate 3

- Figs. 1 a, 1 b. *Gaudryceras glaneggense* (REDTENBACHER). The holotype, NS 6373, from the Gosau Beds of Glanegg, near Salzburg. x 1.

Plate 4

- Figs. 1 a, 1 b. *Gaudryceras glaneggense* (REDTENBACHER). The holotype of *Gaudryceras denseplicatum* (JIMBO), MM 7491, Department of Geology, Tokyo University, from the Ekimomaanoro, a branch of the Anoro, Oyubari Coal Field, Hokkaido, Japan. x 1.

Note added in proof

An interesting article by HIRANO (1978) has appeared since the present paper was submitted for publication. He suggests that specimens which he refers to as *Gaudryceras denseplicatum denseplicatum* and *G. denseplicatum intermedium* are sexual dimorphs. Both are, in our view, synonyms of *G. glaneggense*. In addition he reduces *G. tenuiliratum* to a mere variant of *G. denseplicatum*, differences reflecting no more than a transient polymorphism. If correct, then this too is a synonym of *G. glaneggense*. KENNEDY & KLINGER (1979) and HIRANO (1975) both give synonymies of *G. tenuiliratum*.

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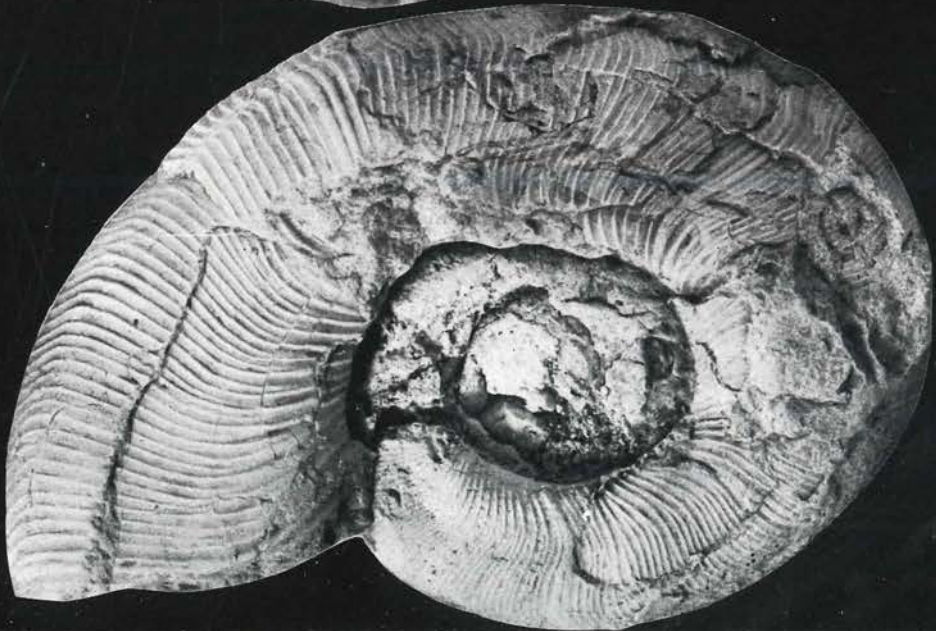
1 D



1 C



1 B



1 A



1 A



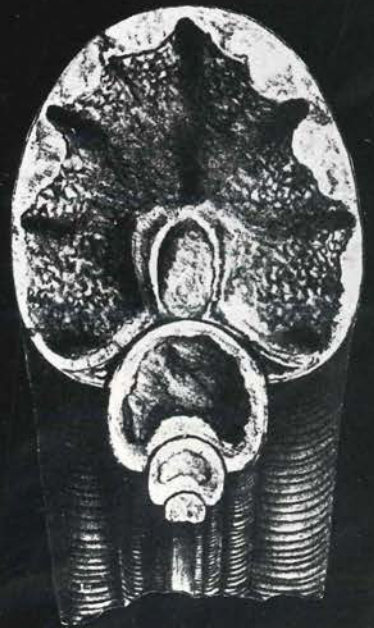
1 B



1 C



2 A



2 B

