

EARLY BARREMIAN (EARLY CRETACEOUS) MOLLUSCA FROM WESTERN IRIAN JAYA, INDONESIA

by

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SUMMARY

A small but diverse collection of Early Cretaceous molluscs from western Irian Jaya, Indonesia, consists of two new species and a possible new subspecies of Madagascan ammonite *Crioceratites (Menuthioceras)*: *C. (Menuthioceras) irianensis* and *C. (M.) compressus*, a poorly preserved *Hoplociocras*, a new subgenus and species of *Pseudothurmannia*: *P. (Ornicephalites) indonesiana*, and a new species of *Hemihoplites*: *H. taminabuanensis*.

The bivalves are few and largely indeterminate, and the gastropods even fewer and limited to two genera and species, *Pleurotomaria kadari* sp. nov. and *Viviparus* sp. nov.? The three new belemnite species associated with this fauna are described elsewhere.

The fauna, dominated by *Menuthioceras*, is dated as early Barremian, the horizon represented being possibly equivalent to the Zones of *Hoplociocras ruocinctum* and *fusicostatum* of northern Europe, the lower part of the Californian Zone of *Shastioceras patricki*, and particularly the zone of *Saynella besairiei* of Madagascar.

There are no links at the specific level between the actual fauna and any of the dozen or so previously described Early Cretaceous faunas from Irian Jaya and other parts of Indonesia.

INTRODUCTION

The molluscs described below were collected in 1979 in the course of the systematic geological mapping of western Irian Jaya, Indonesia. The source locality, numbered 79CP201 (also bearing an earlier number, 79BI175), is in the Taminabuan 1 : 250 000 Sheet area. The boulders which the number represents are in a channel of a northeast tributary of Ainim River (Photo Reference 8W/105). They consist of moderately bedded green quartz sandstone up to 2 m thick inter-

bedded with maroon and green claystone, and are derived from the base of the nearby outcropping Jass Formation. The mineral composition of the sandstone is quartz, calcite, glauconite and apatite. The contained fossils, which are almost entirely molluscs, were collected by C. Pigram of the Irian Jaya Geological Mapping Project team, B. Sidik, then of the Indonesian Geological Research and Development Centre, and mainly by one of the authors (S.K.S.).

The description below of the stratigraphy of the Jass Formation is abstracted from Pigram &

Sukamta (1981, pp. 38 – 40). In the original sense the Jass Formation included a host of sediments which overlie the Aifam Formation (Lehner & Schardji, 1954) and which have been since included in the Ainim, Tipuma, and Jass formation. The Jass Formation, now equated with the Kembelangan Group, consists of thinly bedded calcareous mudstone and lithic sandstone with a rich marine fauna, which overlies the Tipuma Formation. Pigram & Sukamta (op.cit.) write '..... In this report the Jass Formation is included in the Kembelangan Group on the grounds of age, though (its) rock types cannot be correlated with the lithological sub-divisions of the Kembelangan Group in its type are a..... The Jass Formation crops out as a narrow sinuous belt extending from the eastern edge of the Ayamaru Plateau to the eastern edge of the Sheet area in the Rawarra River. It is present in the Puragi 1 well in the south, but generally is absent in the wells to the west, with the exception of Petromer Trend well 385–370 (It) comprises black to brown, thinly to thickly bedded, calcareous mudstone and brown to greenish grey lithic sandstone. The base (In places) is marked by a thin bed 2 to 5 m thick of highly glauconitic marl to sandy limestone The sandstone appear (s) to be lenticular and the argillaceous facies are probably dominant. The lithic sandstone contain (s) volcanic detritus The maximum thickness in the northeast corner of the Sheet area is approximately 400 m. 349 m was penetrated in Puragi 1 Ammonites, belemnites, bivalves and rare gastropods occur in the basal horizons. *Inoceramus* sp. is common in the mudstones and *Globotruncana stuarti* and *Globotruncana laparenti* have been reported from Puragi 1 The Jass Formation was probably deposited in a shallow sea not far from the source area although the argillaceous facies could have been derived from the south (It) lies discontinuously on the Tipuma Formation and is apparently conformably overlain by the New Guinea Limestone Group The age of the base is Aptian in the Ainim River and ranges into the Late Cretaceous in the Ainim, Aifat and Rawarra Rivers. In Puragi 1 the Jass Formation is confined

to the Senonian ' (words in brackets are those of the present authors.)

EARLY CRETACEOUS MOLLUSCA IN INDONESIA

Few molluscs of Early Cretaceous age have been ever reported from Irian Jaya. Visser & Hermes (1962, pp. 55,56) list a fragment of an ammonite *Hoplites* from southwest of Manokwari, another fragment of an ammonite – possibly belonging to the Aptian – Alban *Aconecerasatinae* from the Baliem River, and an assemblage of Aptian ammonites with strong Australian affinities from the Kamundan area. These latter consist of *Sanmartinoceras olene* (Tenison – Woods), *Tropæum leptum* (Etheridge Jnr.), *T. aff. leptum*, *T. leptum?*, *Tropæum* sp. (*australe* Moore pars), *Australiceras* aff. *jacki* (Etheridge Jnr.), *Australiceras* sp. nov., *Australiceras* or *Tropæum* and a belemnite *Hibolites* sp.

Gerth (1965) described three ammonites, *Blanfordiceras novaguinense*, *Blanfordiceras* sp. nov. and *Berriassella* sp. from the Berriasian of Armatan, western New Guinea.

From the Central Mountain Ranges of Irian Jaya Helmcke *et al.* (1978) listed Early Cretaceous ammonites *Haplophylloceras strigile* (Blanford) and *H. pingue* Ryf, also *Blanfordiceras wallichi* (Gray), *B. aff. subquadratum* (Uhlig), *B. aff. tenuicostatum* (Collignon) and *Pterolytoceras exoticum* (Oppel); early Valanginian *Kilianella pexiptycha* (Uhlig), and Berriasian *Berriassella* (*Picteticeras*) *moesica* Nikolov & Mandov.

Elsewhere in Indonesia Early Cretaceous molluscs are known from Kalimantan, Sula Islands, Sumatra, Timor and Misool. From Kalimantan Martin (1889) described two rudistid bivalves *Sphaerulites* and *Radiolites*; Vogel (1902) described a new gastropod *Itieria scalaris*, and *Nerinea* sp., and the bivalves *Exogyra* sp., *Mytilus* cf. *arrialoorensis* Stoliczka, *Arca* sp., *Astarte* sp., *Lucina* sp., *Fimbria* sp., and *Corbula* sp.; Krause (1904) ammonites *Knemiceras pinax* Krause, *Schloenbachia* sp., *Ammonites* sp. and *Ammonites* sp. div.; and von Koenigswald (1939) ammonites *Hoplites* (*Neocomites*) *neocomiensis*

(d'Orb), *Thurmannia (Kilianella) roubaudiana* (d'Orb), *Phylloceras* sp. II (cf. *velledae* Mich.), *Punctaptychus zejimensi*, *P. crassicosatus*, *P. trauthi* and *Lamellaptychus hormoensis* von Koenigswald.

From the Jurassic–Cretaceous boundary in the Sula Islands Boehm (1904) described new bivalves *Mytilus diepenheimi* and *Nucula* cf. *taliabutica*, and ammonites *Himalayites neolurburghi* Boehm, *H. treudi* Boehm, *Phylloceras strigile* Blanford and *Lytoceras* sp., and new species *Bochianites wateringi* and *B. versteeghi*; the Cretaceous ammonites *Hoplites roosenbloomi*, *H. asseni*, *H. wallichi* Gray and *Hoplites* sp. Later, Krüzinga (1926) described *Phylloceras strigile* Blanford, *Streblites nouhuysi* Boehm, *Kosmatia indica* and *K. maxima* Krüzinga.

From Sumatra Baumberger (1925) described the Valanginian fauna of ammonites *Neocomites neocomiensis* (d'Orb), *N. pseudopexiptychus* (Baumberger), *N. teschenensis* (Uhlig), *Neocomites* 3 spp., *Thurnannites pertransiens* (Sayn), *T. cf. pertransiens* var. *loryi* (Sayn), *Thurnannites* sp., *T. (Kilianella)* sp.; a gastropod ?*Natica*; bivalves *Amusium* sp., *Nuculana (Leda)* 2 spp., *Nucula* 6 spp., *Arca* sp., *A. (Macradon?)* sp., *A. (Cucullaea?)* sp., *Cardita* sp., *Astarte* sp., *Astartidae?*, ?*Perrisonota* sp., ?*Solenella (Neilo)* sp.; and an echinoid fragment.

From Timor Stolley (1929) described belemnites, a Tithonian–Lower Cretaceous *Duvalia timorensis* and Tithonian–Lower Cretaceous? *Duvalia* cf. *timorensis*; and from the Neocomian of Misool *Hibolites subfusiformis* (Raspail).

AGE AND CORRELATION

The fauna described below is dominated by *Menuthiocrioceras*, a typical member of the 'Saynella' *besairiei* Zone of the Madagascar late Hauterivian *sensu* Collignon (1949; 1962). This Madagascan fauna with which our Indonesian fauna is compared,

i. Does not contain any species characteristic of and confined to the late Hauterivian,

ii. Contains a number of late Hauterivian and early Barremian species, viz. *Phylloceras spathi*, *Malgasaynella besairiei* and *M. saintoursi* (the descendant of *Subsaynella*), *Valdedorsella sormarianensis*,

iii. Contains species which favour early Barremian age, viz. *Eulytoceras belchastifakaense* (which exhibits affinities with the Barremian *E. phestus*), *Crioceras?* sp. (= Barremian *Paracrioceras*), "*Toxiceras*" *hourcq* (with affinities with the early Barremian *Moutoniceras*), "*Leopoldia*" *biassalensis* de Betsky (probably a species of the early Barremian *Torcapella*).

It is concluded, therefore, that generally an *Menuthiocrioceras* fauna points to early Barremian age, and this interpretation finds support in the Indonesian fauna with its *Pseudothurmannia (Ornicaphalites)* in which the absence of primary ribs is interpreted as an advanced characteristic, *Hoplocrioceras* of the European and American early Barremian, and *Hemihoplites* also from the Barremian

The age of our fauna is thus basal Barremian to late Barremian, the horizon being possibly equivalent to the zones of *Hoplocrioceras rorocinctum* and *fissicostatum* of the early Barremian of northern Europe, the lower part of Californian range–zone of *Shastiacrioceras patricki*, and the Zone of "*Saynella*" *besairiei* of Madagascar.

SYSTEMATIC DESCRIPTIONS

CEPHALOPODA

Family Ancyloceratidae Gill 1871

Subfamily Crioceratitinae Gill 1871

Most ammonites in our collection are, because of the type of coiling and morphology, referable to the Crioceratitinae. Together with their close relatives from Madagascar (see below) they form a separate group of ammonites characterised by the nature of evolute coiling in which the coils are in fact touching each other, ornamentation which consists of both trituberculate and intermediary smooth ribs, and stratigraphic position in sediments of early Barremian age.

Some members of *Crioceratites* from the European Tethys—particularly those from the southeast of France—exhibit similar morphological and ornamental characteristics and, apparently, at the same point of time. In the interest of biostratigraphic application they have been placed in a specially erected by Wiedmann (1962) subgenus *C. (Sornayites)* and include *C. (S.) edouardi* (Honnorat—Bastide), *C. (S.) monasteriensis* (Kilian & Lœnhardt), and *Crioceratoides?* (Torcapel). For similar biostratigraphic reasons we place our specimens in *Menuthiocrioceras*, whose status we change to that of the subgenus of the entirely evolute *Crioceratites*.

Genus *Crioceratites* Leveillé 1837

Type species: *Crioceratites duvali* Leveillé 1837

Subgenus *Menuthiocrioceras* Collignon 1949

Type species: *Crioceras (Menuthiocrioceras) lenoblei* (Collignon 1949)

Crioceratites (Menuthiocrioceras)

irianensis sp. nov.

(Pl. figs. 1, 2, 3, 4 – 10)

Material: Eight incomplete specimens, consisting mainly of fragments of whorls of immature specimens; two fragments of an apparently mature whorl.

Holotype: IMC 352 (Pl. 1 figs 8,9)

Paratypes: IMC 347 (Pl. 1 fig 1); IMC 348 (Pl. 1 figs 2,5); IMC 350 (Pl. 1 fig 4); IMC 351 (Pl. 1 figs 6,7); IMC 353 (Pl. 1 fig 10).

Diagnosis: The combination of large size, the development of spines, the number of smooth ribs in proportion to the primary tuberculate ribs and their relative inflation, and the presence on early and middle whorls and the nature of 'loops' formed by the tuberculate and smooth ribs.

Description: Shell at least 40 cm in diameter, planospiral, evolute, with wide umbilicus, ribbed with two-order sigmoidally shaped ribs, with primary ribs prominently tuberculate.

Whorls subcircular—trapezoid in cross-section, with umbilical wall perpendicular to commissure, tightly turned umbilical shoulder, gently con-

vex and slightly converging ventrally lateral walls, and broadly convex venter.

Ribs sigmoidally shaped, two orders differentiated poorly in juvenile and mature parts of shell, but well in immature part of shell. Tuberculate ribs with prominent radial tubercles or spines on umbilical shoulder, and two rows of prominent conical spines up to 7 mm long in ventrolateral position on each side of venter. Each set of tuberculate ribs separated by one, two, or usually three smaller smooth secondary ribs which, like tuberculate ribs, cross venter with no apparent loss of relief.

Separation from other species: The new species shares with its closest known relative, the type species *M. lenoblei*, the number and relief of the smooth ribs, but differs in the greater durability of the lateral tubercles, stronger relief of the tuberculate ribs on the middle whorls, greater on the venter difference of relief between the tuberculate and the smooth ribs (especially pl. 1 fig. 10), presence on the early and middle whorls of a 'loop' between the lateral and the ventral tubercles and between the two ventral tubercles formed by the tuberculate and the smooth ribs immediately in front of the letter (cf. IMC 345, 351 and 352, on plate 1).

The new species can be easily separated from *C. (M.) hourcaï* (Collignon 1949) which has numerous (5-10) and larger smooth ribs and more inflated umbilical tubercles.

Etymology: The species is named after its area of occurrence, Irian Jaya.

Crioceratites (Menuthiocrioceras)

compressus sp. nov.

(Pl. 2 figs 1, 2, 10, 11)

Material: One incomplete (almost complete?) specimen; two fragments of small specimens of inner whorls.

Diagnosis: Combination of compressed subrectangular – rounded whorl section with flexuous ribs of two orders, of which primary spinose ribs carry fine umbilical radial elongated tubercles and

two sets of ventrolateral conical small tubercles, and smooth fine riblets numbering three to five between each pair of tuberculate ribs.

Holotype : IMC 355 (Pl. 2 figs 10, 11)

Paratype : IMC 354 (Pl. 2 figs 1, 2)

Description : Shell of unknown size but probably well in excess of 12 cm diameter, discoidal, laterally compressed, evolute with wide open umbilicus, ribbed with two orders of sigmoidally shaped partly tuberculate ribs.

Whorls rectangular—rounded in cross-section, with flattish or gently convex sides and venter, with walls parallel or slightly inclined to each other, and with umbilical wall perpendicular to commissure.

Ribbing somewhat irregular, of two orders, with primary ribs slightly more robust than secondary ribs, directed to rear on umbilical wall but sigmoidally shaped on lateral walls, and practically straight across keel, and with umbilical and two sets of ventrolateral small cone-shaped tubercles. Secondary ribs devoid of tubercles, and usually three but occasionally four or five between each set of primary ribs.

Suture pattern complex, of ancyloceratid type.

Separation from other species : The new species can be distinguished from *C. (M.) lenoblei* (Collignon 1949) by the greater number and greater sinuosity of the smooth intercalating ribs and the more compressed vertical cross-section. From *C. (M.) hourcqi* (Collignon 1949) by the latter's more rigid and coarser intercalating ribs, and from *C. (M.) aonzyensis* (Collignon 1962) which has equally fine and flexuous intermediary riblets but lacks sufficiently well individualised principal tuberculate ribs.

Etymology : The name of the new species reflects one of its morphological characteristics.

Crioceratites (Menuthiocereras) sp. nov.
(Pl. 2 figs. 5,6)

Material : A single fragment of medium-sized whorl. IMC 356.

Discussion : The single fragment in the collection shows many characteristics of *C. (M.) compressus*. However, its secondary riblets are either absent, or if present are very fine, reduced to two or one in number between each pair of primary ribs, and originate well away from the umbilical shoulder.

Lack of sufficient material does not allow a definite conclusion on the validity of this possible subspecies. Additional material may well indicate that the figured specimen is little more than an example of intraspecific variation in *C. (M.) compressus*.

Subfamily Crioceratitinae Gill 1871
Genus Hoplocioceras Spath 1924
(? = Genus Aspinoceras Anderson 1938)
Type species : *Hoplocioceras phillipsi*
(Phillips 1829)

Hoplocioceras sp.
(Pl. 3 figs. 9, 10)

Material : A single large fragment of an almost entirely septate whorl.

Discussion : Our single incomplete specimen exhibits a number of morphological characters found in *Hoplocioceras phillipsi* and *H. laevisculum* (Koen.). These are, aspinoceratid coiling, dorsal grouping of flexuous riblets into bundles of convex multiple folds, absence of umbilical tubercles, swelling of endings of ribs ventrally without, however, formation of tubercles, and their straight passage across venter with much reduced relief.

It is, consequently, with the *laevisculum-Phillipsi-remondi* group that the Indonesian form must be compared. The age of *Hoplocioceras* (latest Hauterivian, basal Barremian: *rarocinctum* and *fissicostatum* zones, seem compatible with the fauna studied).

Family Hemihoplitidae Spath 1924
Genus Pseudothurnannia Spath 1923
Type species : *Ammonites angulicostatus*
d'Orbigny 1841
Subgenus Ornicephalites subgen. nov.
Type species : *Pseudothurnannia*
(*Ornicephalites*) *indonesiana sp. nov.*

Diagnosis : Shell small, possibly medium in size, planispiral, only slightly involute. Whorl section, compressed, subrectangular in cross-section with subangular ventral shoulders. Ribbing mainly of one order, sigmoidal, reaching greatest development on ventral shoulder and practically obliterated on venter. Venter almost flat.

Pseudothurmannia (Ornicephalites)
indonesiana subgen. & sp. nov.
(Pl. 2 figs 3, 4, 7-9; text—fig. 1)

Material : Three, possibly four incomplete specimens, of which three are small and probably immature and one much larger and probably mature representatives of the same species.

Diagnosis : Species compressed, only slightly involute, with open umbilicus, and whorls rectangular in cross-section; ribs prominent, sigmoidal, non-tuberculate but increasing in breadth ventrally; in small specimens prominent, of single order, usually continuous from umbilical wall; diminished in relief over flat venter; on maturity ribs possibly separated by irregular but small number of finer secondaries which originate half-way down lateral wall.

Holotype : IMC 358 (Pl. 2 figs 7, 9)

Paratypes : IMC 357 (Pl. 2 figs 3, 4); IMC 359 (Pl. 2 fig. 8); ?IMC 370 (Text-fig. 1)

Description : Species possibly at least 14 cm in diameter, compressed, mainly evolute, with wide, open umbilicus. Whorls subrectangular in cross-section, with flat sides and flattish venter, and fairly tightly rounded umbilical and ventral shoulders. Ribs in small (?immature) specimens mainly of single order, robust, closely spaced, continuous from umbilical wall, increasing in breadth ventrally, rarely bifurcating, crossing venter with greatly reduced relief. Possibly on maturity ribs more widely spaced and separated by irregular but small number of fine secondary ribs which originate about half-way down lateral wall, crossing venter with relief equally reduced to that of primary ribs.

Tuberculation not observed. Suture pattern not known.

Separation from other species : No closely related species are known among both the European and the North American species of *Pseudothurmannia*.

Discussion : The new ammonite shares with *Pseudothurmannia* the evolute coiling with but feeble overlapping of whorls, the subrectangular whorl cross-section, and the ventrolateral swelling of the external ribs. The distinguishing features are, the overall lack of differentiation of ribs, their cuneiform ventral broadening on the ventral shoulder, and their reduction of relief on the mid-venter.

Etymology : The subgenus is named after its occurrence in the Bird's Head, Indonesia - the latter being reflected in the name of the species.

Family Hemihoplitidae Spath 1924
Genus Hemihoplites Spath 1924
Type species : *Ammonites feraudianus*
d'Orbigny 1841
Hemihoplites taminabuanensis sp. nov.
(Pl. 4 figs 2-6)

Material : One fragment representing almost a quarter of the shell; two additional fragments which may or may not belong to the same genus and species.

Diagnosis : Combination of the presence of very thin secondary riblets, oblique slope on the umbilical shoulder where fine rursiradiate riblets are present, prorsiradiate costation on the upper part of the flanks and curved forward on the venter, pronounced thickening of ribs on ventral third of the flank, absence of ventrolateral tubercles and regular shape of the venter and the slope of flanks.

Holotype : IMC 367 (Pl. 4 figs 2, 6)

Paratypes : IMC 368 (Pl. 4 figs 3, 4);
IMC 369 (Pl. 4 figs 5)

Description : Shell at least 10 cm in diameter, discoidal, compressed, initially with open spiral, then

somewhat involute but with wide umbilicus, heavily ribbed with mainly single order broad prorsiradiate ribs.

Whorls suboval in cross-section, with gently converging slightly convex lateral walls. Venter rounded with ill-defined lateral shoulders; umbilical walls steep and tightly rounded.

Ribs initially tightly spaced and occasionally bifurcating; later thin, much more widely spaced, departing apparently entirely from umbilical wall, prorsiradiate; later still more robust and more closely spaced, possibly occasionally splitting up (Pl. 4 figs 3, 5) either dorsally or ventrally; ribs cross venter with no loss of relief and possibly with forward convexity.

Separation from other species : The combination of morphological characters listed above under the diagnosis separates the new species from the previously described species of *Hemihoplites* and its close relative *Matheronites*.

Age significance : European Tethyan species of *Hemihoplites* and the closely related *Matheronites* are all from the upper Barremian, more precisely from the *feraudi* zone. However, the Californian species *H. popenoei* Murphy is confined to the middle of the *Shastrioceras patricki* zone. It must be concluded that *Hemihoplites* probably originated in the early Barremian, being derived from *Pseudothurmannia*.

Etymology: Named after the Taminabuan River, Kepala Burung, Irian Jaya.

Hemihoplites sp.
(Pl. 4 figs 7, 8)

Material : A single fragment of a moderately large whorl.

Description: The specimen when complete is probably about 16 cm in diameter but the fragment in its present form tells little about the species, except in regard to its cross-section and ribbing.

The cross-section is rounded-quadrate, with lateral walls parallel to each other, ventral

wall flat apart from undulations caused by the ribs, and the ventral shoulders are subrounded.

The ribs are broadly convex and separated from each other by broadly concave interspaces about the same width as the ribs. The ribs apparently increase in breadth and relief with increasing distance from the umbilicus reaching maximum relief at ventral shoulder; they cross the ventricle with but slightly reduced relief.

Bivalvia

Family Pectinidae Rafinesque, 1815
Chlamys Group
Pectinidae indet.
(Pl. 4 fig. 1)

Material : Anteriorly incomplete proximal part of right valve.

Description : Posterior wing well-developed, with faint radial ribbing and more prominent growth rugae parallel to sigmoidally flexed posterior wing margin.

Umbo clearly defined in rear with sharp and gently and regularly concave posterodorsal shell margin.

Inflation of body of shell probably small. Ornamentation of numerous, closely spaced and fine radial riblets of apparently two orders, both order ribs punctate.

Remarks : Both the fine ribbing on the main body of the shell, and the structure of the rear ear point to the Chlamys Group, but inadequacy of material does not allow closer identification. Chlamids originated in the Triassic and persisted to the present day. They are generally regarded as shallow-water forms.

?Family Hiatellidae Gray 1924
?Genus *Panopea* Menard 1807
"Panopea" sp.
(Pl. 3 figs 1, 2, 4, 5)

Material : Two incomplete specimens of both valves in position, two fragments showing ornamentation of left valve.

Discussion : Posteriorly gaping laterally elongate blvalves of shape and ornamentation generally similar to our Irian Jaya specimens have been in the past referred — possibly incorrectly — to the Lower Cretaceous — Recent *Panopea* Menard 1807. No reliable identification is possible in the absence of preserved dentition. Our specimens are bottom burrowers, and appear to be somewhat more common at the collecting site than other non-cephalopod members of the assemblage.

Gastropoda

Family *Pleurotomaria* Swainson 1840

Genus *Pleurotomaria* Defrance 1826

'*Pleurotomaria*' *kadari* sp. nov.

(Pl. 3 figs 6–8)

Material : One almost complete specimen, and a small fragment of body whorl.

Holotype : IMC 363 (Pl. 3 figs 6–8)

Diagnosis : Trochiform, anomphalous, prominently gradate in later growth stages, with outer face of whorls flat but slightly risen in middle by selenizone well below ramp angle. Ornament of spiral cords cancellated by collabral threads; remnants of what may have been very weak tubercles in early stages of growth only.

Remarks : The new species is not a typical *Pleurotomaria* because of the absence of tubercles on the ramp angle (except possibly at the early growth stages), and should perhaps be separated as a new genus closely related to *Pleurotomaria*. Outwardly it closely resembles also *Bathrotomaria* Cox 1956 which, however, has its selenizone high up at the ramp angle. From *Leptomaria* Deslongchamps it can be distinguished by the angularity of its whorls and a flat outer whorl face; and from *Conotomaria* Cox, through its gradate non-conical shape.

Description : Shell trochiform, 40 mm high and 42 mm wide, high spired with spire angle about 80°. Whorls with flattened outer face inclined at angle to both general slope of spire, and to gently sloping sutural ramp. Base slightly convex with incipient umbilicus. Selenizone at middle of whorl outer face, of moderate width, convex or slightly

concave, bordered by spiral cords and collabral threads. Spiral cords of various width, wide and robust on ramp angle and on base, but thinner on peripheral bulge and haphazardly at various points of shell surface. Collabral threads prominent both on ramp and on outer face of whorl.

Discussion: The stratigraphic range of *Pleurotomaria* is Early Jurassic to Aptian, and of *Bathrotomaria* Early Jurassic to Senonian. However, as the structure of the new species points to a genus hitherto undescribed even though with marked similarities with both, it cannot therefore, be necessarily regarded as indicative of either *Pleurotomaria*'s or *Bathrotomaria*'s time range.

Etymology: The species is named in honour of Dr Darwin Kadar, Chief Palaeontologist, Geological Research and Development Centre, Bandung, Indonesia.

Family Viviparidae Gray 1847

Genus *Viviparus* Monfort 1810

Type species : *Viviparus stuvionum* Montfort 1810

· *Viviparus* sp. nov.?

(Pl. 3 figs 3, 11)

Material : A single specimen with top of spire missing, and somewhat damaged (subsequent to it being photographed) outer lip.

Description : Shell tubiform, phanerocephalous, mainly smooth, about 40 mm high and 30 mm across, with aperture 25 mm high and the last whorl just over 30 mm high. Apical angle about 60°. Walls evenly concave, unornamented except for numerous though somewhat irregular corrabral threads and occasional corrabral rugae. Sutures moderately deep. Aperture moderately narrow, labral inductura with low fold apparent, limited to columellar lip. Umbilicus narrow and deep.

Remarks : The genus has a world-wide distribution, and its range is not less than Jurassic to Recent. Because of the difficulty of comparing our sole specimen with any of the previously described species, it is not indicative of any particular age.

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PLATES

PLATE 1

All specimens of natural size, coated with ammonium chloride and photographed in lateral view unless stated to contrary.

Figs 1, 2, 4 – 10. *Crioceratites (Menuthiocrioceras) irianensis* sp. nov.

1. Paratype IMC 347. Spine from mature specimen.
- 2, 5. Paratype IMC 348. Fragment of immature whorl in lateral and ventral view.
4. Paratype IMC 350. Spine from mature specimen.
- 6, 7. Paratype IMC 351. Fragment of immature whorl in lateral and ventral view.
- 8, 9. Holotype IMC 352. Fragment of whorl of immature specimen, in ventral and lateral views.
10. Paratype IMC 353. Fragment of near-mature specimen in ventral view showing distribution of spines.

Fig. 3. *Crioceratites (Menuthiocrioceras) cf. irianensis* sp. nov.

Fragment of immature specimen showing early coiling. IMC 349.

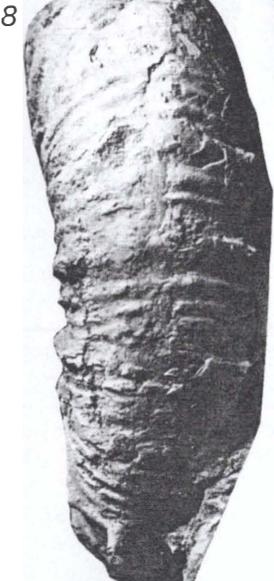
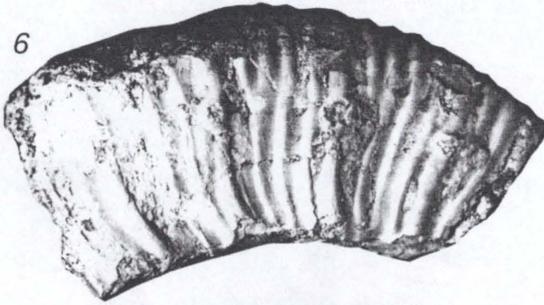
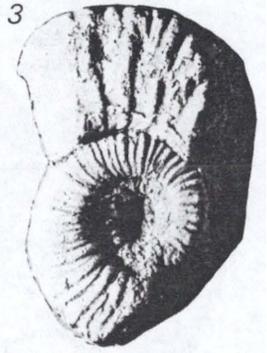


PLATE 2

All specimens of natural size, coated with ammonium chloride and photographed in lateral view unless stated to contrary.

Figs 1,2, 10, 11. *Crioceratites (Menuthiocrioceras) compressus* sp. nov.

1, 2. Paratype IMC 354 in ventral and lateral views.

10, 11. Holotype IMC 355 in ventral and lateral views.

Figs 5, 6. *Crioceratites (Menuthiocrioceras)* sp.nov.?

Specimen in ventral and lateral views.

IMC 356.

Figs 3, 4, 7-9. *Pseudothurnannia (Ornicephalites) indonesia* subgen. & sp. nov.

3, 4. Paratype IMC 357. Immature? part of whorl in lateral and ventral views.

7, 9. Holotype IMC 358. Immature? part of whorl in ventral and lateral views.

8. Paratype IMC 359. Immature? part of whorl.

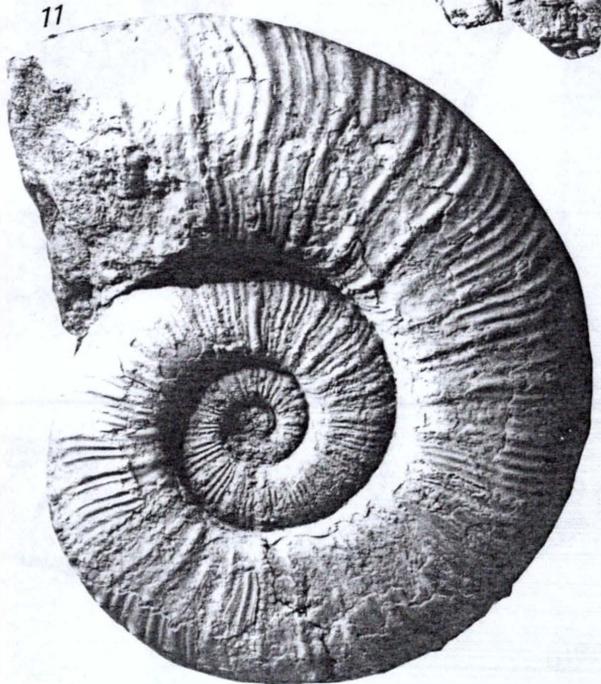


PLATE 3

All specimens of natural size, coated with ammonium chloride, and photographed in lateral view unless stated to contrary.

Figs 1-2, 4-5. "*Panopea*" sp.

1. Specimen IMC 360, right valve.
2. Specimen IMC 361, anteriorly incomplete right valve.
- 4, 5. Left valve in lateral and dorsal view.
IMC 362.

Figs 3, 11.

Viviparus sp.nov.?

IMC 363. Posterior and anterior views of shell.

Figs 6-8.

"Pleurotonaria" kadari sp.nov.

Holotype IMC 364 in dorsal, lateral and ventral views.

Figs 9-10.

Hoplocrioceras sp.

Incomplete specimen in lateral and ventral views. IMC 365.

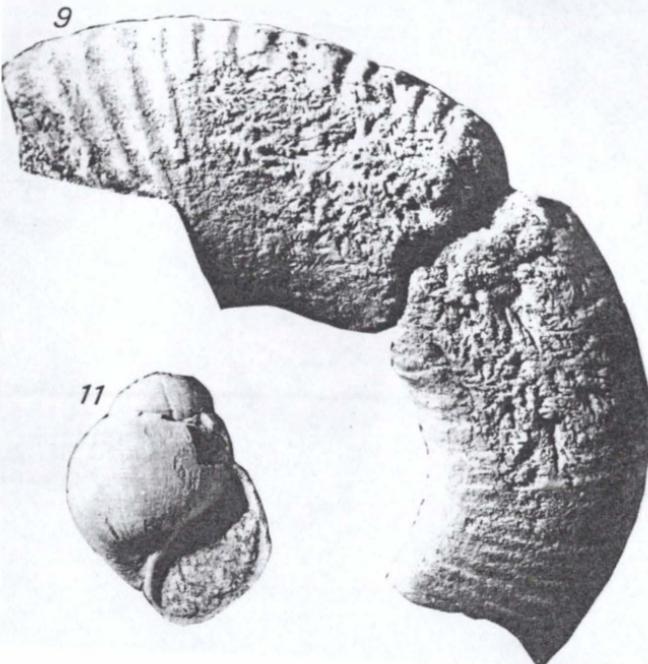


PLATE 4

All specimens of natural size, coated with ammonium chloride and photographed in lateral view unless stated to contrary.

Fig. 1. *Pectinidae* indet.
 Anteriorly incomplete proximal part of right valve. IMC 366.

Figs 2, 5, 6. *Hemihoplites taminabuamensis* sp.nov.
 2, 6. Holotype IMC 367 in ventral and lateral view.
 3, 4. Immature specimen IMC 368 in lateral and ventral views.
 5. Paratype IMC 369.

Figs 7, 8. *Hemihoplites* sp.
 Mature specimen IMC 370 in lateral and ventral views.

