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ON THE OCCURRENCE OF *KONINCKOPORA* (CALCAREOUS ALGA) FROM THE VISÉAN OF SHIKOKU, JAPAN

by

Hitoshi Nakai* and Makoto Kato

(with 5 text-figures and 1 plate)

Abstract

A new species of dasycladacean algae, *Koninckopora delicata,* is described from the Upper Viséan Buntoku Formation of the Mt. Yokokura, Shikoku, Japan. The genus *Koninckopora* is reviewed, and the following species, apart from the new one, are considered as valid and the member of the genus; *K. inflata, K. minuta, K.? mortelmansi, K. pruvosti, K. sahariensis* and *K. tenuiramosa.* The genus *Koninckopora* is widely distributed in Northern Hemisphere between the latitudes 20° and 70° North, and is almost completely confined within the Viséan, Early Carboniferous.

Introduction

In the years of 1976 and 1977 Nakai engaged in geological mapping in the field around the Mt. Yokokura, Kochi Prefecture, Shikoku, Japan. While mapping he was able to collect some fossil corals from two localities north of Buntoku, Ochi-cho. They turned up to be Upper Viséan forms, and this finding was orally presented by Nakai at the Annual Meeting of the Geological Society of Japan in 1978, since it was the first record of Lower Carboniferous deposits in the Shikoku island. This is also briefly stated in a paper he describes a new aulate coral collected from a locality north of Buntoku (Nakai, 1980).

Nakai called the Lower Carboniferous deposits the Buntoku Formation. It is in tectonic contact with the other younger and older formations, and is accompanied with the intrusion of serpentinite in between, in the eastern foot of the Mt. Yokokura.

While going through Nakai's fossil collection Kato found a characteristic alga, a form of *Koninckopora* in a thin section made from a limestone block collected at a locality (Locality B of Nakai, 1980), 700 m NW of Buntoku, Ochi-cho, Takaoka-gun, Kochi Prefecture, Shikoku, Japan (Text-fig.1). We jointly tried to identify it and found that it represented a new species.

The present paper is to describe a new species of *Koninckopora,* to review the genus *Koninckopora,* and to find geographical and stratigraphical distributions of the genus as long as our search through available literatures goes.

Systematic Description

Family Dasycladaceae Kützing 1843

Genus *Koninckopora* Lee 1912 emend Wood 1943

Type species: *Calamopora inflata* deKoninck 1842

Generic diagnosis: Thallus elongate, subcylindrical, circular in transverse section. Calcified

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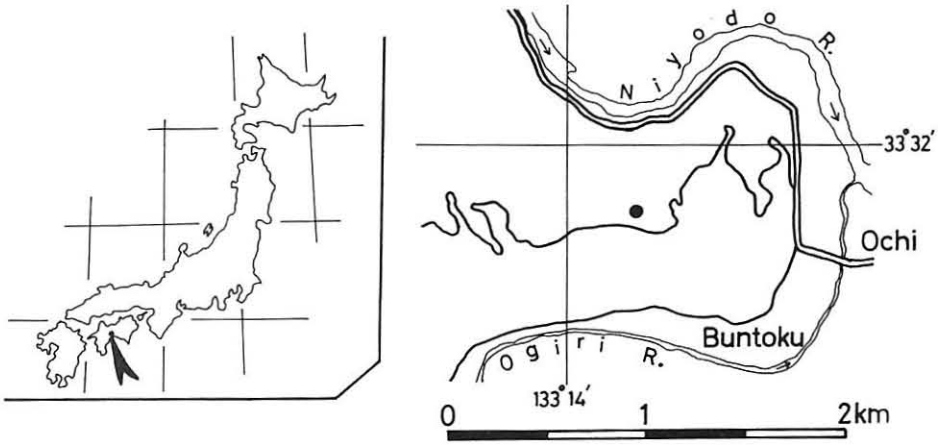
*Present address: Azabu University, Sagamihara City, Kanagawa Prefecture.

Contribution from the Department of Geology and Mineralogy, Faculty of Science, Hokkaido University, No. 1694.



Text-fig. 1 Maps showing the new locality of *Koninckopora*. Black arrow and dot indicate the locality.

external layer of the thallus is composed of numerous, closely packed, prismatic cells which are hollow tube like things. Cells are the calcified parts of terminal branches. Externally on the surface of thallus, round pores are distributed in dark matrix. From inside, polygonal cells with fibrous walls are packed together as to reveal alveolar appearance.

In longitudinal section each cell consists of dark outer zone and light coloured, fibrous inner zone, both of which are penetrated by wide or narrow central pores above mentioned. Constriction is normally present in the cells at about their middle length, which corresponds the boundary between the outer and inner zones. Sporangia are probably born in the outer zone of the external layer of thallus as spherical cavities.

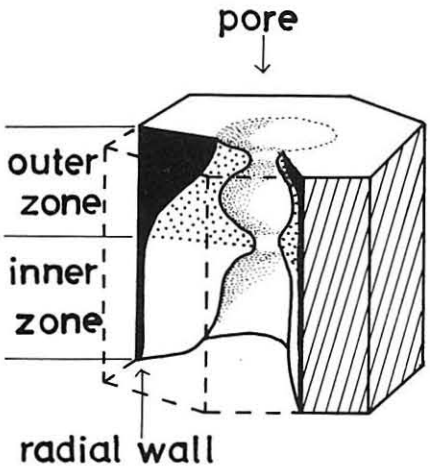
Remarks: For terminology we mostly follow Wood (1943), Johnson and Konishi (1956), Konishi (1956) and Petryk and Mamet (1972). Only the distinction between the dark outer zone and the light coloured inner zone of the external layer of the thallus is here introduced (Text-fig.2).

Wood (1943) clarified the algal nature of *Koninckopora* and assigned it to Dasycladaceae. Until that time it was considered either as a coral or a bryozoa. This opinion of Wood has been followed since. For earlier literatures see Wood (1943).

The genus *Koninckopora* is distinguishable from the other allied algal genera such as *Epimastopora* in having constriction in the cell and fibrous radial wall which forms polygonal cells in transverse section of the inner zone of the external layer of the thallus. Maslov (1956) regarded *Epimastopora* Pia and *Uragiella* Maslov as synonymous with *Koninckopora*. However all of them are now considered as distinct from each other (*e.g.* Maslov, 1963). Wood (1943) merged *Coeloceratioides* Derville with *Koninckopora* as a junior synonym of the latter. All subsequent authors follow Wood as to this procedure.

The following species have been created or housed within the genus *Koninckopora*.

Calamopora inflata deKoninck 1842
Coeloceratioides fragilis Derville 1931
Koninckopora tenuiramosa Wood 1943



Text-fig. 2 Diagram showing a cell in the external layer of the thallus.

Koninckopora micropora Maslov 1956
Koninckopora macropora Maslov 1956
Konickopora subcylindrica Maslov 1963 *(nomen nudum)*
Koninckopora pruvosti Güvenç 1966
Koninckopora sahariensis Chanton 1964
Koninckopora sp.A of Weyer 1968
Koninckopora minuta Weyer 1968
Koninckopora mortelmansi Mamet 1973

Apart from the above listed forms Maslov (1956) put such species of *Epimastopora* as *E. piai* Korde, *E. kansanensis* Johnson, *E. jewetti* Johnson and *E. regularis* Johnson into *Koninckopora.* They are not the members of the genus *Koninckopora* as we consider *Epimastopora* distinct from *Koninckopora. Koninckopora micropora* and *K. macropora,* both of Maslov (1956) are, to our mind, the species of the genus *Epimastopora,* and are better removed from *Koninckopora. Koninckopora subcylindrica* Maslov (1963) is illustrated by diagrams without proper description. It is best considered as a *nomen nudum* (Weyer, 1968). *Coeloceratioides fragilis,* the type species of the genus *Coeloceratioides* has been generally regarded as a synonym of *Koninckopora inflata* (Wood, 1943).

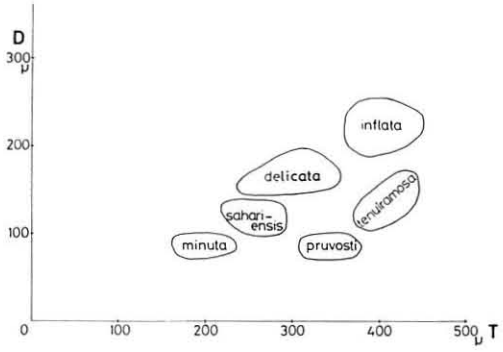
Affinity of *Koninckopora mortelmansi* Mamet is somewhat questionable, as it reveals slender thallus with extraordinarily large cells. No well oriented longitudinal section is provided, and we assign it in the genus *Koninckopora* with querry. Other species are all valid and the member of the genus *Koninckopora.*

Species classification: Quite recently Bassoullet et al. (1978) discussed on the taxonomic criteria in Dasycladaceae. We closely examined all available literatures on *Koninckopora* for us, and reached the following conclusion.

There are not many biocharacters left calcified for *Koninckopora,* and we checked every

one of them. The size and shape of thallus are presumably diagnostic to the species of *Koninckopora.* But they are normally not precisely known, so that they are not fully appreciated here as important biocharacters. The distribution and size of pore may be distinct when viewed from outside. However they are not readily known, unless weathered thallus is available and surface features of it become clear.

In thin sections, only the nature of cells is important in recognizing species of *Koninckopora.* At a glance there are two groups recognizable amongst forms of *Koninckopora.* One is the group with comparatively slender cells, while the other is with stumpy cells. Text-figure 3 is derived from the dimensions given for various forms of *Koninckopora* by authors, together with remeasured and recalculated figures where necessary. Thus *Koninckopora inflata, K. delicata* (n.sp.), *K. sahariensis* and *K. minuta* will consist a group with stumpy cells, while *K. pruvosti* and *K. tenuiramosa* are in the group with slender cells.



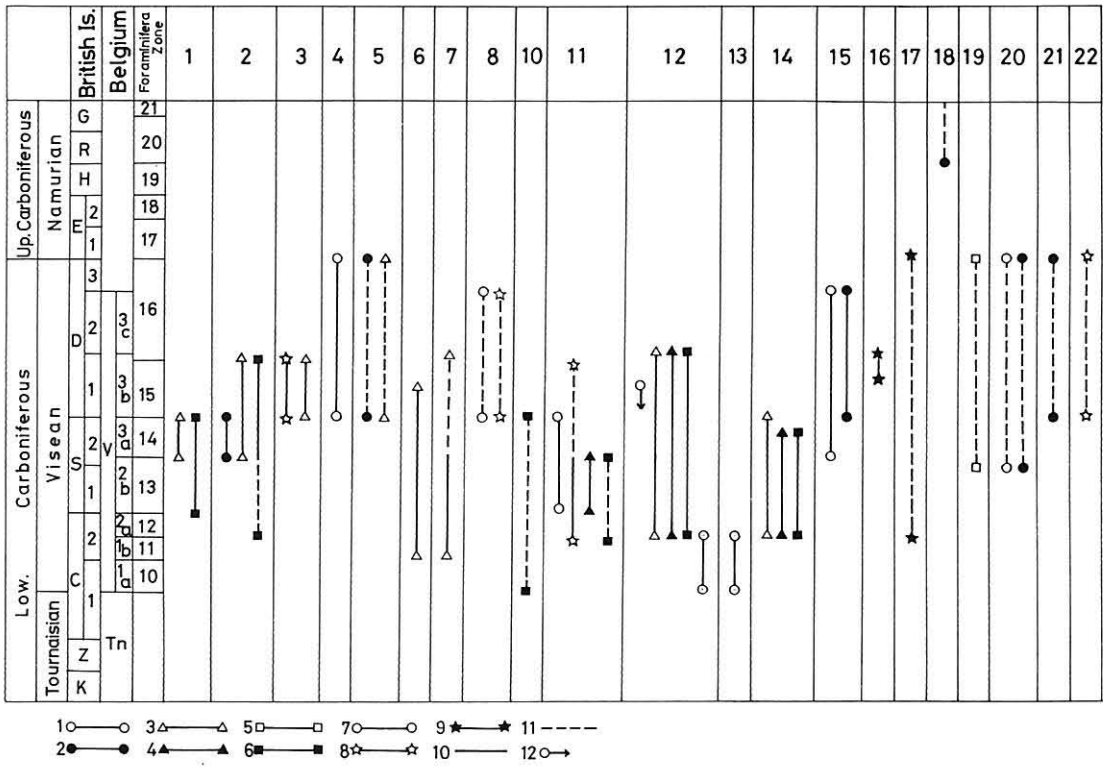
Text-fig. 3 Diagram showing the relationship between the diameter of cell (D) and the length of radial wall of the cell (T). Figures for *Koninckopora* ? *mortelmansi* are much larger than those appeared on the diagram.

These size differentiations will readily serve for the species distinction in *Koninckopora,* when combined with the other characters such as the size of thallus, the thickness of radial wall, the ratio between the thickness of outer and inner zone of external layer of the thallus. *Stratigraphic and geographic distribution:* According to Mamet and Rudloff (1972), Shuvashav (1965, *non vidi*) recorded *Koninckopora* sp. from the Etroeungtian of Ural. Unfortunately we are unable to comment on this form, but otherwise the genus *Koninckopora* is exclusively Carboniferous, and mostly confined within the Viséan.

Nakamura and Ota (1974) described *Koninckopora* sp. from the Moscovian *Fusulinella* zone of the Akiyoshi Limestone, Southwest Japan. If this is truly a *Koninckopora,* the stratigraphic range of the genus would have to be extended into Moscovian. However, their form is, in our opinion, rather close to their *Gyroporella ishijimae,* from the same horizon at the same locality, and is certainly not a member of *Koninckopora.*

Maslov (1963, 1973) figured *Koninckopora* sp. from the Bashkirian of Kirghiz. We consider that his form is identical with *K. sahariensis.* This would be the latest occurrence of the genus *Koninckopora.*

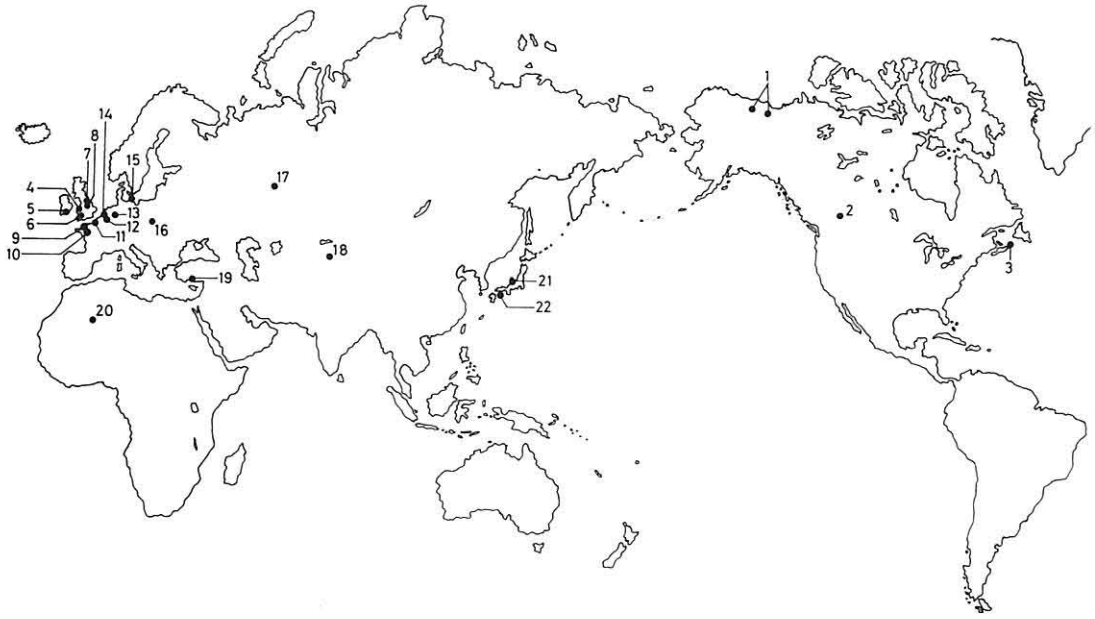
Our identification of *Koninckopora* species from literatures and their stratigraphic and



Text-fig. 4 Stratigraphic distribution of *Koninckopora* sepcies. Numerals on top of the diagram indicate regions where *Koninckopora* species occur. And they correspond to those mentioned in the text and in Text-fig. 5.
Column No.9 (Manche, France) is omitted because of insufficient data. Stratigraphic scales on the left hand columns are compiled after Bless et al. (1976) and Sando et al. (1969).
1- *K. minuta;* 2- *K. sahariensis;* 3- *K. inflata;* 4- *K.* ? *mortelmansi;* 5- *K. pruvosti;* 6- *K. tenuiramosa;* 7- *K.* sp. (primitive); 8- *K. delicata,* n.sp.; 9- *K.* sp.; 10- stratigraphic range of forms; 11- range (inferred); 12- derived forms.

geographic distributions are tabulated below (Text-figures 4 and 5). Identification is still somewhat questionable as to species marked with an asterisk*.

1. Arctic Alaska and North Yukon Territory (Mamet and Rudloff, 1972)
   Koninckopora inflata (Foraminifera zone 14)
   Koninckopora tenuiramosa (zone 13 and 14)
2. Alberta, Canada (Petryk and Mamet, 1972; Mamet and Rudloff, 1972)
   Koninckopora inflata (zone 14 and 15)
   Koninckopora sahariensis (zone 14)
   **Koninckopora tenuiramosa* (zone 14 and 15)
3. Nova Scotia, Canada (Wood, 1943; Mamet and Rudloff, 1972)
   Koninckopora delicata (zone 14)
   Koninckopora inflata (zone 15)



Text-fig. 5 Geographic distribution of *Koninckopora* species. For regions yielding *Koninckopora* indicated by numerals on the map, see text. Each numbered region corresponds to that appeared on the top column of the diagram showing the stratigraphic distribution of *Koninckopora* (Text-fig. 4).

4. Denbighshire, North Wales (Wood, 1943)
   Koninckopora minuta (zone D_1, D_2 and D_3)
5. Cork, Ireland (Wood, 1943)
   **Koninckopora inflata* (not figured)
   Koninckopora tenuiramosa ("Carboniferous Limestone")
6. Bristol, England (Wood, 1943)
   **Koninckopora inflata* (not figured, from C_2 to basal part of D_1)
7. Yorkshire, England (Wood, 1943)
   Koninckopora inflata (zone C_2 S_1 and D_1)
8. Derbyshire, England (Wood, 1943)
   Koninckopora delicata (zone D_1 and D_2)
   Koninckopora tenuiramosa (zone D_1 and D_2)
9. Manche, France (Weyant, 1967, *non vidi*)
   **Koninckopora inflata*
   **Koninckopora minuta*
10. Lavel basin, Mayenne, France (Pelhate, 1964)
    Koninckopora tenuiramosa (Viséen inférieur)
11. Boulonnais, France (Mamet, 1973)
    Koninckopora delicata (zone 12, 13 and 15)
    Koninckopora minuta (from zone 12 to 14)

Koninckopora mortelmansi (zone 13 and 15)
**Koninckopora tenuiramosa* (not figured, zone 12 and 13)

12. Visé, Belgium (Bless et al., 1976)
    Koninckopora inflata (from zone V2a to V3b)
    Koninckopora minuta (derived fossil found in V3b)
    **Koninckopora mortelmansi* (from zone V2a to V3b)
    Koninckopora cfr. *tenuiramosa* (from zone V2a to V3b)
    **Koninckopora* sp. (primitive) (not figured, zone V1a and V1b)
13. Wachtendonk, West Germany (Bless et al., 1976)
    **Koninckopora* sp. (primitive) (not figured, zone V1)
14. Woendrecht, Netherland (Bless et al., 1976)
    Koninckopora inflata (from zone V2a to V3a)
    **Koninckopora mortelmansi* (from zone V2a to lower part of V3a)
    Koninckopora cfr. *tenuiramosa* (from zone V2a to lower part of V3a)
15. Rügen island, East Germany (Weyer, 1968)
    Koninckopora minuta (zone S_2, D_1 and D_2)
    Koninckopora sahariensis (zone D_1 and D_2)
16. Gaezice, Poland (Jurkiewicz and Żakowa, 1978)
    **Koninckopora* sp. (upper part of zone 15)
    Koninckopora inflata of Jurkiewicz and Żakowa, non deKoninck, is probably a coral.
17. Usu-ili river, south Ural, USSR (Wood, 1943; Johnson and Konishi, 1956; Maslov, 1963)
    **Koninckopora* sp. (not figured, C_1^2)
18. Kirghiz, USSR (Maslov, 1963; 1973)
    Koninckopora sahariensis (Bashkirian)
19. Alanya, Turkey (Güvenç, 1966)
    Koninckopora pruvosti (Viséen niveau supérieur)
20. El Ahmer, Reggen basin, Algeria (Chanton, 1964)
    Koninckopora minuta (Viséen supérieur)
    Koninckopora sahariensis (Viséen supérieur)
21. Kotaki, central Honshu, Japan (Konishi, 1956)
    Koninckopora sahariensis (Upper Viséan)
22. Buntoku, Shikoku, Japan (This paper)
    Koninckopora delicata (Upper Viséan)

Bless et al. (1976) listed primitive *Koninckopora* from V1 of Belgium and Germany. This is virtually the earliest record of the genus, if Etroeungtian occurrence above quoted is proved to be doubtful. However this "primitive" form is neither described nor illustrated, so that we cannot mention what sort of *Koninckopora* would be primitive in nature. Other species are practically confined to the Viséan, and forms with small cells extend upward. From D_2 onward *K. delicata, sahariensis, minuta* and *pruvosti* are known.

Geographic distribution of Lower Carboniferous Dasycladaceae was once presented on a map by Johnson and Konishi (1956). Geographically the genus *Koninckopora* has been known from North America, Eurasia and North Africa. It is unknown from Australia, South

America and so on. Quite roughly speaking the geographic distribution would indicate a broad east-west zone (Text-fig. 5). All hitherto known localities fall in the zone stretching between the latitudes 20° and 70° North.

Koninckopora delicata Nakai et Kato, sp. nov.

(Pl. 1, figs. 1-7)

Holotype: Circular thallus represented by a transverse section (Pl. 1, fig. 1), UHR 30427, stored at Department of Geology and Mineralogy, Hokkaido University.

Other materials: Several other fragments appeared in the same thin section, UHR 30427.

Diagnosis: Koninckopora with small thallus. External layer of thallus is comparatively thick, in which two zones are clearly discernible. Diameter of cell ranges from 140 to 195μ. Length of radial wall ranges from 240 to 360μ. Radial wall is thick.

Description: The shape and external characters of thallus are unknown. Thallus may be subcylindrical, gently tapering, judged from its appearance in thin section (Pl. 1, fig. 1).

In transverse section thallus shows circular configuration, the shortest diameter of which is 3.3 mm. In one longitudinal section (Pl. 1 fig. 4) thallus is represented by two subparallel layers, the distance between them being about 2.4 mm.

External layer of the thallus is composed of small prismatic cells, which are laterally packed together, and are calcified portions of terminal branches. Dimension of the cell is as follows;

Diameter 140-195μ (commonly 145-160μ)

Length of radial wall 240-325, rarely 360μ

In longitudinal section cell is divisible into two parts, namely the dark outer zone and the light coloured, fibrous inner zone (Text-fig. 2). The thickness of the outer zone in longitudinal section measures 70 to 140μ, and there is distinct constriction on the radial wall, which corresponds the boundary between the outer and the inner zone. Both outer and inner zones are penetrated by pore open towards both outside and inside of the thallus.

In tangential section of the outer zone round pore is vaguely present in dark matrix (Pl. 1, figs. 2 and 3). In transverse section of the inner zone polygonal cells are so packed as to show alveolar structure as a whole. Radial wall of the cell is fibrous. Fibres are perpendicular to the dark wall of the cell. Radial wall is about 12 to 16μ in thickness. Spherical open spaces often filled with sparry calcite cement are seen in dark outer zone of the external layer. Wood (1943) interpreted them as sporangia, and we follow him in this concern.

Comparison: The present new species is at a glance very similar to *K. inflata,* but is distinguishable from the latter in having smaller cell diameter, shorter radial wall of the cell and probably smaller thallus. However no thin sections of deKoninck's original specimens of *K. inflata* have been illustrated so far. So, we have to rely upon Wood (1943) and Weyer (1968) who studied Belgian materials of that species, for the understanding of the specific contention of *K. inflata.* And we provisionally restrict *K. inflata* to only those forms with large cells (diameter 200-250μ) and long radial wall of the cell (370-440μ) (Text-fig. 3).

In defining *K. inflata* as such, a number of specimens of *"K. inflata"* show somewhat

smaller dimensions of cells, which are otherwise morphologically similar to *K. inflata.* These are the forms discriminated by Weyer (1968) as his *Koninckopora* sp. A, to which our new species is identical. *"K. inflata"* of Wood (1943, pl.8, fig.5; pl.9, fig.1; pl.10, fig.6) and Conil and Lys (1964, pl.3, fig.10) are here considered as representatives of the present new species. *K.* cfr. *inflata* of Konishi (1956) resembles the present new species, but has much smaller cell diameter, and is probably a member of *K. sahariensis. K. inflata* of Mamet (1973) from Boulonnais, France (pl.2, figs.9 and 15) and *K. inflata* of Mamet and Rudloff (1972, pl.3, fig.6) from Nova Scotia are both identified as *K. delicata* because of having comparable diameter of cells with *K. delicata.*

Now, the new species differs from *K. sahariensis* in having larger cell diameter, longer radial wall of the cell, and thicker radial wall. *K. tenuiramosa* has comparatively slender cell and thinner radial wall, compared to the present one. *K. pruvosti* is distinguishable from the new species in having more shorter diameter of cell, even if the former has almost equal length of radial wall of the cell with the latter.

Occurrence: All specimens were collected by Nakai from a limestone lens belonging to the Upper Viséan Buntoku Formation, at a locality about 700 m NW of Buntoku, Ochi-cho, Takaoka-gun, Kochi Prefecture, Shikoku, Japan. Lithology of the limestone is biosparudite bearing rugose corals, heterocorals, foraminifera, etc. Age determination of the limestone is derived from the evidence of the occurrence of *Lithostrotion* cfr. *somaense, Palaeosmilia murchisoni, Diphyphyllum kakisakoense, Hexaphyllia* sp., *Actinocyathus* sp. etc. in combination.

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Explanation of Plate 1

Koninckopora delicata Nakai et Kato, sp.nov.

All the thalli are in the thin section UHR 30427. Collected by H. Nakai from a locality, 700 m NW of Buntoku, Ochi-cho, Kochi Prefecture, from the Upper Viséan Buntoku Formation.

Fig. 1 Transverse section of a thallus (Holotype). x 20

Fig. 2 Tangential section partly of the outer zone, and partly of the inner zone of the external layer of the thallus. Another fragment. x 60

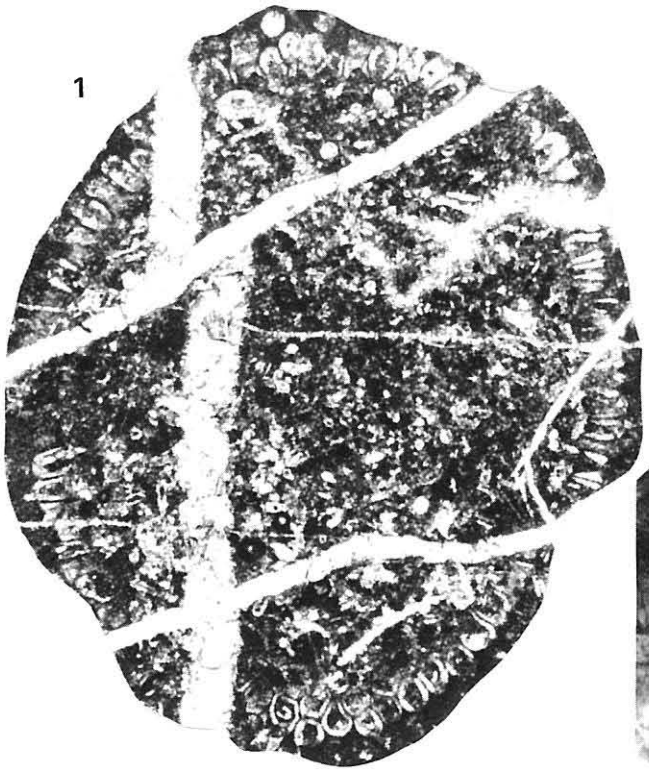
Fig. 3 Tangential section showing the alveolar nature of the inner zone of the external layer of the thallus. Radial wall is finely fibrous. A part of Holotype. x 60

Fig. 4 Longitudinal section of a thallus. x 20

Fig. 5 Longitudinal section of the external layer showing clear distinction between the outer and inner zones of the external layer of the other fragmental thallus. x 60

Fig. 6 Longitudinal section of the external layer of one thallus revealing characteristic constriction in the cell around the boundary between the outer and inner zones of the external layer of the thallus. Enlarged figure of the same specimen illustrated as Fig. 4. x 60

Fig. 7 Longitudinal section of a part of Holotype, showing spherical cavities in the outer zone of the external layer or the thallus, filled with sparry calcite cement. x 60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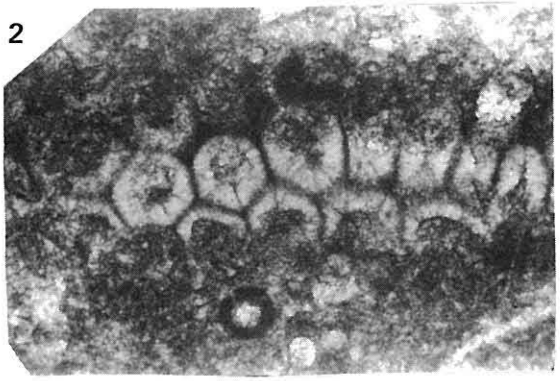
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