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Title	On the Coral Genus <i>Carinthiaphyllum</i> Heritsch, with a Description of <i>Carinthiaphyllum Carnicum</i> Heritsch from the Carnic Alps
Author(s)	Minato, M. ; Kato, M.
Citation	Journal of the Faculty of Science, Hokkaido University. Series 4, Geology and mineralogy, 13(4), 313-320
Issue Date	1967-04
Doc URL	https://hdl.handle.net/2115/35968
Type	departmental bulletin paper
File Information	13(4)_313-320.pdf



ON THE CORAL GENUS *Carinthiaphyllum* HERITSCH, WITH
A DESCRIPTION OF *Carinthiaphyllum carnicum*
HERITSCH FROM THE CARNIC ALPS

by

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(with 2 Text-figures and 1 plate)

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Introduction

Recently corals assignable to the genus *Carinthiaphyllum* were unexpectedly found in Hokkaido, Japan, a region in which Palaeozoic fossils have been very scarce.

This specimen resembles corals collected several years ago by the senior author from the Carnic Alps. The Carnic Alps specimen has been identified as *Carinthiaphyllum carnicum* HERITSCH (1936), and will be described in this paper. Many ambiguities remain as to the generic characters of *Carinthiaphyllum*. The present revision of this genus is based on the investigation of the Carnic Alps material and is necessary prior to the description of the newly discovered Hokkaido specimens. It thus is the purpose of this short note to redescribe *Carinthiaphyllum carnicum*, and to discuss the generic status of *Carinthiaphyllum* HERITSCH.

Acknowledgements

The senior author is indebted to Prof. F. KAHLER, Drs. WEISS and S. PREY for their kindnesses during the field excursion in the Carnic Alps in 1963 under the auspices of the 8th Anniversary Meeting of Palaeontological Society of Europe. On this occasion the corals here dealt with were collected and Prof. KAHLER provided valuable information as to the exact locality and stratigraphical horizon. Our thanks are due to Prof. KAHLER in this connection.

We thank Dr. C. L. ROWETT, visiting member of our department, for this part in discussions of problems concerning *Carinthiaphyllum*, and critically reading the manuscript.

Thanks are also due to Mr. S. KUMANO for his kind assistance in the preparation of the accompanying plate.

Genus *Carinthiaphyllum* HERITSCH, 1936

Carinthiaphyllum HERITSCH, 1936, p. 134.

Carinthiaphyllum, SCHOUPPÉ, 1961, p. 123.

Carinthiaphyllum, DOBROLYUBOVA, 1962, p. 330.

Type species (by original designation): *Carinthiaphyllum kahleri* HERITSCH, 1936, p. 135 pl. 17, Fig. 29, pl. 18, figs. 5, 7–13, text-figs. 39, 40.

Generic diagnosis: Fasciculate corals with a long cardinal septum, the axial end of which usually is expanded to form a prominent, solid columella in the neanic to ephebic stages. The columella may be, however, somewhat modified to form an axial structure with a median plate, a few septal lamellae, and some irregular axial tabellae-like structures in the latest ontogenetic stage. Septa are of two orders, pinnately arranged, especially in the early ontogenetic stage, but tend to show more or less radial symmetry in the mature stage. The fine structure of septa is fibro-normal to diffuso-trabecular. Dissepiments are concentrically disposed between septa in transverse sections. Lonsdaleoid dissepiments occur only rarely in late stages. Tabulae are mostly inclined axially and include steeply or gently inclined clinotabulae.

Discussion: HERITSCH (1936) established the genus *Carinthiaphyllum* and designated *C. kahleri* from the Carnic Alps as the type species. He thought this coral to be solitary in form, and stated that the corallites were separated from one another by some distance. However, this does not necessarily imply a solitary growth form. In many specimens of *Carinthiaphyllum* the corallum consists of loosely aggregated corallites, which nevertheless are basically fasciculate. The specimen of *Carinthiaphyllum* from Hokkaido, for example, consists of corallites many of which are in close contact and which apparently reproduced by lateral budding, as will be described later. Therefore it can be deduced that HERITSCH's specimens of *Carinthiaphyllum* may actually have represented a widely spaced fasciculate corallum, rather than solitary forms.

The longitudinal characters of *Carinthiaphyllum* had not heretofore been studied in detail, which prevented determination of the actual systematic position of this genus. Our study of new material indicates that *Carinthiaphyllum* has distinct clinotabulae. The presence of clinotabulae can also be deduced in HERITSCH's (1936) figures of obliquely cut examples of the type species, *C. kahleri*, although this fact seems not to have been noted until now (see especially text-fig. 40, p. 139, mislabeled as *C. carnicum*).

HERITSCH also stated that the axial structure in *Carinthiaphyllum* is continuous with the counter septum. However, close examination of illustrated species of *Carinthiaphyllum* and study of new material clearly reveals that the column actually is formed from the axial end of the cardinal septum.

In summary, we conclude that the genus *Carinthiaphyllum*, as here emended, can be regarded as a valid genus and, as discussed below, one with potential stratigraphic and phylogenetic significance.

HERITSCH (1936) placed *Carinthiaphyllum* in the Clisiophyllidae. However, clisiophyllid corals are characterized by a distinct axial column with regular thin septal lamellae, trabecular septa, axially ascending tabulae, and a prominent cardinal fossula. *Carinthiaphyllum* lacks all of these characters.

WANG (1950) regarded *Carinthiaphyllum* as synonymous with *Koninckophyllum* THOMSON & NICHOLSON (1876), but the latter possesses a columella consisting of a simple lath and tented or arched tabulae. Whatever the correct familial assignment of *Koninckophyllum* may be, the internal characters of *Carinthiaphyllum* indicate a completely different systematic position.

FOMITCHEV (1953) admitted the generic validity of *Carinthiaphyllum* and included it in his Family Neokoninckophyllidae, formed to include corals having a wide dissepimentarium composed of both lateral dissepiments and well developed pseudoherringbone dissepiments. These are not present in *Carinthiaphyllum*.

HILL (1956) doubted the validity of *Carinthiaphyllum*, and questionably placed it in synonymy with *Amygdalophyllum* DUN & BENSON (1920), regarding the latter as a member of the Aulophyllidae. GRÄF and RAMOVŠ (1965), in describing *Carinthiaphyllum* from N. W. Yugoslavia, by implication recognized this genus as distinct from *Amygdalophyllum*; those authors referred *Carinthiaphyllum* to the Aulophyllidae. However, *Amygdalophyllum* has trabecular septa, arched tabulae and a distinct cardinal fossula, and may be related to clidiophyllid corals, or as HILL believed, to the Aulophyllidae. *Carinthiaphyllum* is clearly only distantly related to *Amygdalophyllum*.

DOBROLYUBOVA (1962) and FLÜGEL (1964) held the view that *Carinthiaphyllum* was valid and assigned this genus to the Carcinophyllidae HUDSON (1942). *Carcinophyllum*, the type genus for this family, however, has trabecular or lamellotrabecular septa (KATO, 1963), and subhorizontal, complete tabulae. Thus there is no significant resemblance between *Carcinophyllum* and *Carinthiaphyllum*.

The senior author placed *Carinthiaphyllum* in the then newly established family Geyerophyllidae (MINATO, 1955). Taking into consideration presence of clinotabulae in *Carinthiaphyllum*, as well as the unusual origin of the axial structure, i.e., from the cardinal septum, this assignment can be accepted. MINATO's original diagnosis of the family Geyerophyllidae was revised by HAYASAKA and MINATO (1966), however, this does not materially affect the assignment of *Carinthiaphyllum* to this group. Amongst genera now included in the Geyerophyllidae, *Carinthiaphyllum* is characterized by its weak development of lonsdaleoid dissepiments and most nearly resembles *Amygdalophylloides*, which is, however, a solitary coral. Both genera possess a rather thick stereozone in the peripheral region and a solid columella. The columella of *Carinthiaphyllum* in the early growth stage strongly

resembles that of the mature stage of *Amygdalophylloides*, which suggests that the former may have branched off from the latter sometime during or prior to Middle Carboniferous time.

Included species:

- Carinthiaphyllum kahleri* HERITSCH, 1936
carnicum HERITSCH, 1936
suessi HERITSCH, 1936
yezoense MINATO & ROWETT, sp. nov.*

Carinthiaphyllum carnicum HERITSCH

pl. 38, figs. 1-12, text-figs. 1 and 2

1936. *Carinthiaphyllum carnicum* HERITSCH, 1936, p. 137, pl. 16, figs. 11-13, text-fig. 41.

Material: A black, algal limestone cobble containing a number of slender, flexuous loosely aggregated corallites. The specimen was collected by M. MINATO from the lower "Schwagerina" limestone at P. 1885 m Garnitzen Berg, Karnischen Alpen. Registration numbers UHR 18811—limestone chip with corallites, 18800-18803, thin section; 18804-18810, replica films. All material is now stored at the Department of Geology and Mineralogy, Faculty of Science, Hokkaido University. During the preparation of replica films from the polished surface of the limestone chip, a tangential section of a fusulinid was observed. Septa are considerably folded, a coarse keriothecal structure is well developed in relatively thick spirotheca, and chomata are almost absent. Although this specimen certainly is of the schwagerinid type, the absence of primitive characters suggesting affinity to Permian forms.

Description: Various oriented small corallites are scattered within a limestone chip. Some corallites are relatively widely spaced, while others are in contact with each other. Several corallites show signs of lateral budding. It thus is possible that these specimens represent fasciculate and dendritic growth form.

Each corallite is rather small, trochoid in form, and as large as 9.5 mm in calicular diameter. Faint septal grooves and fine growth striations are observed on weathered corallite surfaces. Calices are moderately deep with prominent columellas.

In transverse section corallites are round, with somewhat crenulated outlines.

* Recently discovered from the Middle Carboniferous of Hokkaido.

Internally, corallites have three distinct zones as was noted by HERITSCH (1936), namely, the axial structure, tabularium and dissepimentarium. The axial structure originates from the axial end of the cardinal septum, which expands to form a prominent columella in the early growth stage. A median dark line is present and radially disposed fibres form a spindle shaped columella, which in some instances has a denticulated outline with septal lamellae-like projections. The tabularium is wide. Major septa do not reach the axial structure, except for the cardinal septum. Although as many as 24 major septa may be present, 20 or 21 occur in corallites of 5 to 6 mm in diameter. Minor septa alternate with the major septa, are equal to about one half the radius in length and extend a short distance into tabularium. The fine structure of septa is fibro-normal to diffuso-trabecular. An inner wall is present and when well developed may form a stereowall, especially in young corallites. The dissepimentarium is narrow with two or three rows of concentric dissepiments. In mature corallite the dissepimentarium is normal and is free of stereoplastic thickening but a stereozone may be developed in earlier stages as stated above. Lonsdaleoid dissepiments were not observed.

In longitudinal section the zonal arrangement of skeletal elements is also

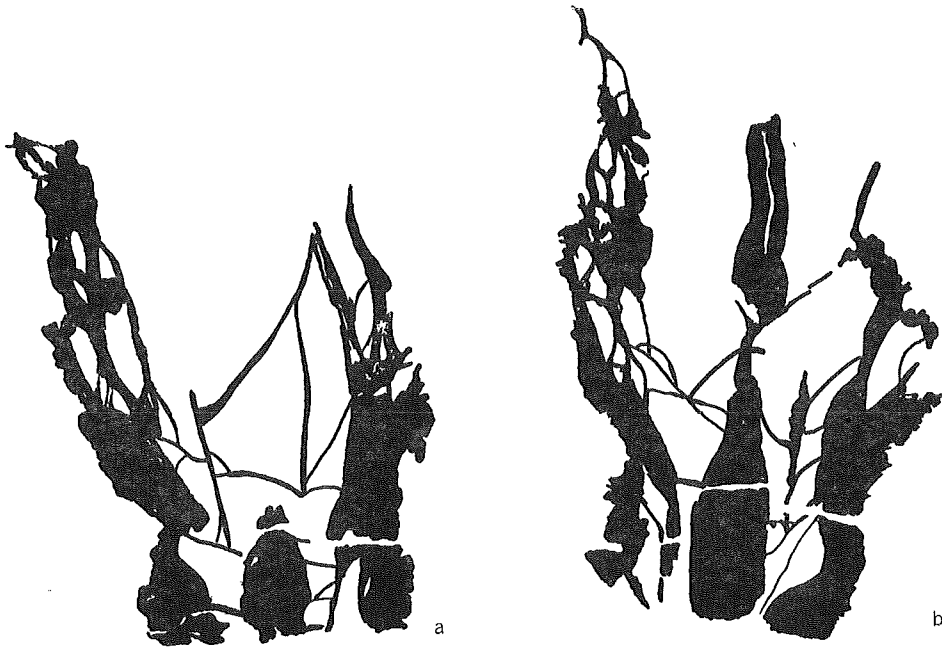
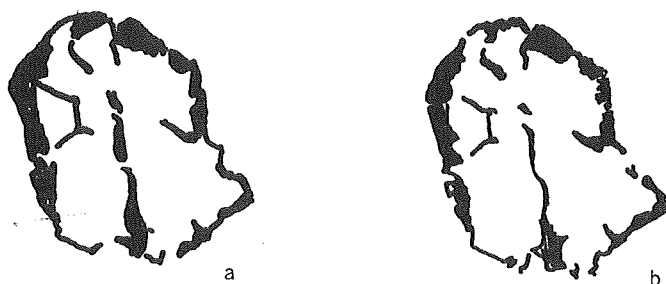


Fig. 1

Carinthiaphyllum carnicum HERITSCH

a: UHR. 18807. $\times 14.5$

b: UHR. 18806. $\times 14.5$

**Fig. 2***Carinthiaphyllum carnicum* HERITSCHa: UHR. 18805 $\times 14.5$ b: UHR. 18807 $\times 14.5$

clearly observed. Dissepiments are irregular in size. Clinotabulae are present, steeply inclined axially towards the columella and rather distantly spaced. The columella is wide, solid, and possesses a dark median line.

Ontogeny: The earliest growth stage observed was studied in replica film 18806, in which a corallite 1.6 mm in diameter has six primary septa. The cardinal septum is flexuous and already extends into the axial area. Tabulae and dissepiments are not present. In a successive replica film (18807) the minimum diameter of the corallite is 1.9 mm and one new septum is inserted in the counter quadrant.

Septal formula in successive replica films of a corallite.

$\begin{array}{c} \diagup \quad \diagdown \\ 0 \quad 0 \\ \hline 0 \quad 0 \\ \diagdown \quad \diagup \end{array}$	$\begin{array}{c} \diagup \quad \diagdown \\ 1 \quad 0 \\ \hline 0 \quad 0 \\ \diagdown \quad \diagup \end{array}$	$\begin{array}{c} \diagup \quad \diagdown \\ 1 \quad 0 \\ \hline 1 \quad 1 \\ \diagdown \quad \diagup \end{array}$	$\begin{array}{c} \diagup \quad \diagdown \\ 1 \quad 1 \\ \hline 1 \quad 1 \\ \diagdown \quad \diagup \end{array}$
UHR 18806	UHR 18807	UHR 18804	UHR 18808
ϕ -1.6 mm	ϕ 1.9 mm	ϕ -2.2 mm	ϕ -2.4 mm
		ϕ -shorter diameter of corallite	

In UHR 18804, major septa are short except for the cardinal, which is flexuous and slightly thickened axially. In UHR 18808 the outline of the axial structure becomes somewhat crenulated, and the first cycle of insertion of major septa is completed. The diameter of the corallite in this replica is 2.4 mm. Septa are more widely spaced in the cardinal quadrants than the counter quadrants, but minor septa and dissepiment are not developed. Peripheral concentric rings in this stage suggest the presence of a few tabulae.

Study of thin sections of many corallites in later growth stages permits the

following deductions pertaining the ontogeny of this coral.

Following the early stage described above, the columella becomes thicker and somewhat denticulated, and a stereowall may be prominent. Also, minor septa begin to appear. In a corallite with a diameter of 4 mm, dissepiments are present and a pinnate arrangement of septa is still pronounced. The columella is connected with the cardinal septum. In later stages, stereoplastic thickening becomes weak, and major septa are arranged radially in a corallite with a diameter of 6 mm. In this stage the columella is detached from the cardinal septum and dissepiments are numerous. In the largest corallite (more than 8 mm in diameter) dissepiments show a normal concentric pattern with no prominent thickening. As many as six rows of dissepiments are present including occasional inosculating dissepiments. The width of the columella varies from corallite to corallite, but may be nearly 1 mm in diameter.

Remarks: *Carinthiaphyllum kahleri* HERITSCH (1936), the type species of *Carinthiaphyllum*, resembles the present species, but has slightly thicker septa, a compact axial column, longer minor septa, a more distinct inner wall, and (uncommonly) lonsdaleoid dissepiments. Therefore these two species can be distinguished from one another. *Carinthiaphyllum suessi* HERITSCH (1936) has larger corallites and more numerous and thinner septa than *C. carnicum*. It also has a more conspicuous inner wall, and lonsdaleoid dissepiments, besides having more expanded axial column. Thus *C. suessi* is easily distinguishable from *C. carnicum*.

Among these three species of *Carinthiaphyllum*, *C. kahleri* has the simplest internal morphology and may have given rise to *C. carnicum* and subsequently, perhaps, to *C. suessi*. *Carinthiaphyllum carnicum* has been known only from Uralian (*Triticites* zone) thus far, but the present discovery extends the geological range of this species into "Schwagerina limestone".*

* Prof. F. KAHLER kindly provided the senior author with age and locality information at the time these specimens were collected in the Carnic Alps (Sept. 29, 1963, Aniv. Meeting Paleont. Soc. Europe). Unfortunately, during the course of sectioning, labels containing the original precise information were lost; locality information consequently is limited to dark brown limestones exposed at 1885 m, Garnitzen Berg, Carnic Alps.

These strata represent the lower *Pseudoschwagerina* zone in this region. Although *Carinthiaphyllum kahleri* HERITSCH had been described from this horizon, *C. carnicum* previously had been recorded only from the Uralian *Triticites* zone. The range of this species accordingly can now be extended into the Lower Permian.

In this concern, we would like to quote here the information given by Prof. KAHLER in letter to the senior author:

"Wir waren glaube ich am ersten Tage zuerst auf dem Auernig, haben in der Schichtes gesammelt, die die verkieselten Fusuliniden hat.

Dann sind wir nach Osten über einen kleinen Sattel zur Höhe 1885 gegangen und haben dort hauptsächlich in vorbereiteten Material gesammelt. Und auf einer kleinen Halde. Ich glaube dass Ihre Koralle aus diesem Material stammt, aber ich habe die Arbeit von HERITSCH nicht zur Hand: er müsste von hier die Art beschrieben haben! Ist in der Probe eine Fusulinid mit grösserer Aufrollung (*Pseudoschwagerina alpina*)? Es gibt allerdings auch andere Formen von dort.

Wenn dies alles stimmt, dann wäre die Schichte unteres Unterperm (Unterer Pseudoschwagerinenkalk der Karnischen Alpen).

A new species of *Carinthiaphyllum* recently found in Middle Carboniferous of Japan has internal morphology quite similar to that of the younger stage of *C. kahleri* and may be important in considerations of the phylogeny of the genus *Carinthiaphyllum*.

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(Manuscript received December 1, 1966)

PLATE 38 AND EXPLANATION

Explanation of Plate 38

Carinthiaphyllum carnicum HERITSCH

Showing early stage of ontogeny of corallites

Fig. 1 UHR. no. 18809 $\times 7.3$

Fig. 2 UHR. no. 18807 $\times 7.3$

Fig. 3 UHR. no. 18804 $\times 7.3$

Fig. 4 UHR. no. 18805 $\times 7.3$

Longitudinal section

Fig. 5 UHR. no. 18804 $\times 3.0$

Cross section

Fig. 6 UHR. no. 18803 $\times 5.0$

Fig. 7 UHR. no. 18801 $\times 5.0$

Fig. 8 UHR. no. 18800 $\times 5.0$

Fig. 9 UHR. no. 18800 $\times 5.0$

Fig. 10 UHR. no. 18802 $\times 5.0$

Showing fine structure of corallites

Fig. 11 UHR. no. 18801 $\times 25.0$

Fig. 12 UHR. no. 18800 $\times 25.0$

Plate 38

