日本古生物學會報告

(Transactions of the Palaeontological Society of Japan)

99. Notes on *Heterophyllia* and *Hexaphyllia*

By

Hisakatsu YABE and Toshio SUGIYAMA

(Read October 7th; received October 14th, 1939)

In the fifteenth Meeting of the Palaeontological Society of Japan held June 17, this year at the Geological Institute, Tokyo Imperial University, the present writers reported on a new discovery of some fossil corals belonging to the genera *Hexaphyllia* and *Heterophyllia* in a Lower Carboniferous Limestone of Hikoroitamura, Kesen-gun, Iwate-ken in the Kitakami Mountainland¹⁾. At that time two new species were distinguished of *Hexaphyllia*, but only mere mention of the occurrence of *Heterophyllia* could be given, owing to its scanty material. Subsequently better specimens of the latter genus were found in the same material and a careful examination of them has not only revealed that there is a new species, but further, what is more important is that the material brought forth good evidence confirmatory to the close relationship of the two genera, and moreover, that they are not in harmony with the view of their being hexacorals or tetracorals in ordinary sense. The present note is devoted to the description of the new species of *Hexaphyllia* and a consideration on the systematic position of the two genera as indicated by the arrangement of septa.

The genus *Heterophyllia* was first erected by F. M'Coy²⁾ in 1849 on *H. grandis* M'Coy and *H. ornata* M'Coy; the original generic diagnosis runs as follows:

"Stem elongate, subcylindrical, irregularly fluted longitudinally: *horizontal section*, few, distant lamellae destitute of any order of arrangement, but irregularly branching and coalescing in their passage from the thin solid external walls towards some indefinite point near the center, where the few main lamellae irregularly anastomose: *vertical section*, showing about the middle an irregularly flexuous line (the edge of one or two of the radiating vertical lamellae), from which on each side a row of thin, distant, sigmoidally curved plates extend obliquely upwards and outwards, forming a row of large rhomboidal cells on each side."

In 1869, P. M. DUNCAN³⁾ extended the genus *Heterophyllia* to include his new

1) H. YABE and T. SUGIYAMA: Discovery of *Hexaphyllia* in the Lower Carboniferous of Japan. Trans. Pal. Soc. Japan, No. 16, Art. 91, pp. 85-88, pl. 13, 1939.

2) F. M'Coy: On Some New Genera and Species of Palaeozoic Corals and Foraminifera. Ann. Mag. Nat. Hist., Ser. 2, Vol. III, p. 126, 1849.

3) P. M. DUNCAN: On the Genera *Heterophyllia*, *Battersbyia*, *Palaeocyclus*, and *Asterosmilina*; the Anatomy of Their Species, and Their Position in the Classification of the Sclerodermic Zoantharia. Phil. Trans. Roy. Soc., London, Vol. 157, pp. 644-648, 1867.

species *m'coyi*, *lyelli* and *mirabilis*, aside from *sedgwicki*, *granulata* and *angulata* which are closely allied to the previously known species (*Het. grandis* and *ornata*), and distinguished two groups of species; in the first three species coralla are small and constant in bearing only 6 septa; these species were correctly transferred by later authors to an allied genus *Hexaphyllia* STUCKENBERG, 1904¹⁾ with the genotype *Hex. prismatica* STUCKENBERG from the Lower Carboniferous of Central Russia. It is hence quite natural that the generic diagnosis of *Heterophyllia* given by DUNCAN²⁾ differs from that of M'COY. The members of the other group of DUNCAN being left in *Heterophyllia*, its confine is now almost reduced to the original one.

Heterophyllia, in this revised sense, has only those species reported from the Lower Carboniferous of Scotland, and it is by the present discovery of a new species of it in the Kitakami Mountainland that it to the first time has been found to have had its geographical distribution outside of Scotland, and extended to the Far East; it is particularly interesting that the genus occurs in association with *Hexaphyllia* in the contemporaneous deposits in Japan as in Scotland.

Heterophyllia kitakamiensis, sp. nov.

Pl. 4 (1), Figs. 1-7

Corallum (or corallites) cylindrical, somewhat attenuated posteriorly calical and basal parts not preserved, oblong in cross section, slightly arcuate, over 30 mm long, up to 2.5 mm broad; wall 0.15 mm thick, consists of thin primordial wall and rather thick stereozone, the latter composed of, under high magnification, numerous concentric layers arranged as in *Hexaphyllia elegans* YABE and SUGIYAMA and *Hex. japonica* YABE and SUGIYAMA. Septa 13; two opposite septa, presumably cardinal (c) and counter (c') septa, meeting at the center of corallum, lying on a medial plane and dividing it symmetrically into two bilateral parts, alar septa (a) as large as cardinal and counter septa, strongly converged towards cardinal side, united by their inner margins to cardinal septa at or near the center of corallum; other septa strictly confined in counter quadrants, 9 in number in the type specimen, comprising 5 in right side and 4 in left side. Tabulae few, distant, either ascending close to wall or nearly horizontal (Pl. 4 (1), Figs. 6a, 6a' 6b, 6b'). Outer surface more or less costulated along the inner margin of septa; otherwise smooth.

Remarks: At present having no evidence of colony building, the coral in question is considered as forming simple corallum. It agrees well with *Heterophyllia* in every feature and especially is similar to *Het. angulata* and *Het. sedgwicki* in the general outline of corallum and in the arrangement of septa; but the two foreign forms are larger, bear a greater number of septa and tabulae.

1) A. STUCKENBERG: Anthozoen und Bryozoen des unteren Kohlenkalkes von Central Russland. Mém. Com. Géol. Russie, n. s. No. 14, p. 72, 1904.

2) P. M. DUNCAN: l. c. "The corallum is simple, long and slender. The gemmation takes place around the calicular margin, and is extracalicular. The septa are either irregular in number and arrangement, or else are six in number and regular. The costae are well developed, and may be trabecular, spined, and flexuous. The wall is thick, there is no epitheca, and the endotheca is dissepimental."

Besides the typical examples of *Het. kitakamiensis* there are several coralla in transverse section which diverge from the typical examples in certain respects, namely, subquadratic outline, prominent costa-like ridges, and slender septa; these are for a while distinguished as *Het. sp. nov.*, cfr. *kitakamiensis* (Text-fig. 1, (8); Pl. 4 (1), Figs. 8, 9).

Localities and geological horizons; Pass between Higuti-zawa in Kawauti and Onimaru in Ômori (Reg. No. 63272, holotype, and 63279), Yuba-zawa in Sakamoto-zawa (Reg. No. 65280), both in Hikoroiti-mura, Kesen-gun, Iwate-ken. Lower Carboniferous Onimaru Series; found in limestone in association with *Lithotroton irregularis* (PHILLIPS), *Syringopora* spp., *Hexaphyllia japonica* YABE and SUGIYAMA, *Hex. elegans* YABE and SUGIYAMA, *Ozawainella*, *Endothyra*. *Het. cf. kitakamiensis* is from the first locality.

Manner of Increase of Septa in Number

In the former paper dealing with the Japanese species of *Hexaphyllia* the writers¹⁾ referred to the particular mode of thickening of the stereozone of wall, namely, each of its lamellae which are parallel to the primordial wall bend abruptly backwards or outwards in approaching the proximal end of septa. The very same feature is visible also in *Hexaphyllia kitakamiensis* and *Het. cf. kitakamiensis*. In these two genera, the enlargement of corallum takes place along the proximal end of septa; in *Heterophyllia* with more than 6 septa, the points of most vigorous growth of wall increase in number with new addition of septa.

While *Hexaphyllia* possesses only 6 septa throughout its individual life (except the youngest stage, of which nothing is known to the writers), *Heterophyllia* in advanced stages of growth is always provided with more than 6 septa and it is now found that there is a young stage with 6 septa only, which are arranged similarly as in *Hexaphyllia* (Text-fig. 1, (1); Pl. 4 (1). Fig. 1).

There are numerous young coralla or younger parts of the mature coralla of the Japanese species of *Heterophyllia*, in transverse section, which serve for deciphering the manner of addition of new septa in the genus; the following inter-

Text-fig. 1. Sketches of *Heterophyllia*
1-7. *Heterophyllia kitakamiensis*, sp. nov., shown in Pl. 4 (1), Figs. 1-7.
8. *Heterophyllia cf. kitakamiensis*, sp. nov., shown in Pl. 4 (1), Fig. 8.
9. *Heterophyllia granulata* DUNCAN, $\times$ ca. 1.8
10. *Heterophyllia sedgwicki* DUNCAN, $\times$ ca. 2
11. *Heterophyllia angulata* DUNCAN, $\times$ ca. 2

1) H. YABE and T. SUGIYAMA: l. c.

pretation is proposed in harmony as possible with that now current as to the septa of tetracorals and hexacorals.

Some of the most typical ones observed are selected for illustration in the annexed Text-figures 1 (1-7). Fig. 1 represents one of the youngest or smallest coralla, measuring 0.6 mm in diameter; it is quite similar to *Hexaphyllia* in possessing 6 septa, but differs from it by thinner stereozone of the wall and angular outline; in this the writers assume c, c', a, a and $1, 1$ to be the cardinal, counter, alar and first secondary septa respectively, the last two appearing in the counter quadrant. In Fig. 2, there appears a septum $\underline{2}$ between $\underline{1}$ and a in the right counter quadrant (or the quadrant assumed to correspond to counter quadrant of tetracorals). Next in Fig. 3, another septum $\underline{2}$ appears in the left counter quadrant, and in Fig. 4 one more $\underline{3}$ in the right. In Fig. 5, there are already four septa ($\underline{1-4}$) in the right counter quadrant and three ($\underline{1-3}$) in the left. In Fig. 6, the right counter quadrant has five septa ($\underline{1-5}$) and the left four ($\underline{1-4}$); in Fig. 7, the former six ($\underline{1-6}$) and the latter five ($\underline{1-5}$). In the Japanese species, there is no example possessing more than eleven septa aside the cardinal, counter and alar septa. According to this interpretation, the younger septa appear successively close to alar septa in the counter quadrants and none in the cardinal.

At present the writers have no material of *Heterophyllia* from Scotland for comparative study, but can find good illustrations of Scottish forms in several papers consulted¹⁾. These figures show that all the species surpass the Japanese form in number of septa, though only by a few, and at the same time that the former do not essentially differ from the latter in general plan of the arrangement of septa which makes it very probable that in these species the succession of septa also follows the same rule as observed in the Japanese, though it is not excluded that some of the septa, especially smaller ones, may belong to a different cycles than others or may be different nature, as the exosepta of the Hexacoralla are.

Accepting the view of six primary septa in all corals—Hexacorals, Tetracorals and those now in concern—every corallum can be considered as being divided into six sextants. These sextants are all equivalent in hexacorals younger septa appearing symmetrically in regular cycles in each of them. In tetracorals, two sextants adjacent to the counter septa are suppressed and younger septa are added only in the two other pairs of sextants, where the addition of septa takes place always one-sidedly. In *Heterophyllia* and *Hexaphyllia*, on the other hand, four sextants—two

Text-fig. 2. Scheme of orthogenetic septal arrangement of Hexacorals, Tetracorals and Heterophyllidae.

1. Hexacorals
2. Tetracorals
3. Heterophyllidae

1) Beside those already cited, to mention at this place is. H. A. NICHOLSON and R. LYDEKKER: Manual of Palaeontology, 3rd Ed., Vol. I, p. 271, 1889.

adjacent to the cardinal septum and two to the counter—are suppressed and new septa appear only in two intermediate sextants; further they are related nearer to the Tetracoralla than to the Hexacoralla in the arrangement of new septa in the two sextants, always being one-sided and never symmetrical as in hexacorals.

In his paper of 1887, DUNCAN¹⁾ discussed the systematic position of *Heterophyllia*, including also *Hexaphyllia* of the present day in his conception, and eventually brought them under Hexacoralla and especially included them in the Family Astraeidae, erecting a new subfamily Palastraceae for them. Later, F. ROEMER²⁾ recognized their affinity to tetracorals, and in consequence raised the subfamily to the family Palastraeidae in transferring it to the Tetracoralla, in his *Lethaea Palaeozoica*, 1880. M. NEUMAYR also sustained ROEMER's view after a lengthy discussion in his "Die Stämme des Tierreiches, I, 1889."³⁾ STUCKENBERG,⁴⁾ founder of the genus *Hexaphyllia*, however, simply followed DUNCAN in 1904, as to the systematic position of this genus, without any particular comment. In later editions of K. v. ZITTEL: "Grundzüge der Palaeontologie,"⁵⁾ *Heterophyllia*, *Hexaphyllia* and *Battersbyia* are all placed in the Cyathophyllidae. Very recently W. G. SANFORD⁶⁾ in his thorough revision of the families of the Tetracoralla, threw *Heterophyllia* and *Hexaphyllia*, together with *Battersbyia*, aside in his "Unresolved genera."

The writers have shown above that *Heterophyllia* and *Hexaphyllia* are quite different from hexacorals, in spite of their having in common six primary septa; likewise they can not be included in tetracoralls in the ordinary sense. Certainly they need their own family, distinct from any other coral families, for which Heterophyllidae is here proposed on the typical genus *Heterophyllia*, to substitute Palastraceae of DUNCAN and Palastraeidae of ROEMER, as the older names are in disharmony with the International Rule of Zoological Nomenclature.

As to the systematic position of the family Heterophyllidae, the writers now bear in mind an idea as the following scheme shows:

Hexacoralla

Tetracoralla

Dycoelia—including the single family Heterophyllidae.

Tetracoelia—including all other families hitherto assigned to the Tetracoralla.

1) P. M. DUNCAN: l. c., p. 650.

2) F. ROEMER: *Lethaea Palaeozoica*, I, p. 412, 1880.

3) M. NEUMAYR: *Die Stämme des Tierreiches*, I, p. 275, 1889.

4) A. STUCKENBERG: l. c.

5) K. A. VON ZITTEL: *Grundzüge der Palaeontologie Invertebrata*, p. 108, 1924.

6) W. G. SANFORD: A Review of the Families of Tetracorals. Part II, *Amer. Jour. Sci.* Vol. 237, No. 6, p. 416, 1939.

Explanation of Plate 4 (1)

- 1-7. *Heterophyllia kitakamiensis*, sp. nov.
 1. Cross section, 0.6 mm broad; $\times 20$
 2. Ditto, 0.7 mm broad; $\times 20$
 3. Ditto, 0.9 mm broad; $\times 20$
 4. Ditto, 1.1 mm broad; $\times 20$
 5. Ditto, 2.2 mm broad; $\times 20$
 6a. Ditto, 2.5 mm broad; $\times 20$
 6a' Microstructure of wall and septa of the specimen shown in 6a; $\times$ ca. 20
 6b Longitudinal section of the specimen shown in 6a; $\times 20$
 6b' Microstructure of wall and septa of the specimen shown in 6b; $\times$ ca. 20
 7. Cross section, 2.1 mm broad; $\times 20$
 8, 9. *Heterophyllia* of *kitakamiensis*, sp. nov.
 8. Cross section, 2.8 mm broad; $\times 20$
 9. Ditto, 2.3 mm broad; $\times 20$
 10a, 10b. Microstructure of wall and septa of *Hexaphyllia elegans* YABE and SUGIYAMA
 $\times$ ca. 15
 10a Cross section
 10b Longitudinal section

Heterophyllia 並に *Hexaphyllia* に就いて (摘要)

矢部長克・杉山敏郎

筆者等は前回の本會席上に於いて岩手縣氣仙郡日頃市村の下部石炭紀の石灰岩から *Hexaphyllia* の 2 新種を報告し、同時に *Heterophyllia* の共産するを指摘したが、其後研究を續けた結果其 *Heterophyllia* も 1 新種なることを確め得た。是等兩屬は日本種を合せ合計 6 種づゝ世界から知られ、殊に日本が *Heterophyllia* の第 2 の産地である。幸ひ日本産此兩屬の種は何れも保存良く、内部構造を充分伺ひ得たのみならず、*Heterophyllia* に於いては幼期から成熟期に至る間の縦隔壁の變化並に配列の順序を窺ふことが出來た。此の結果によると是等兩屬は互に密接なる關係を示し、六射珊瑚並に四射珊瑚中の何れの既存の科にも入れられない性質を示してゐる。従つて是等兩屬を包含する 1 新科 *Heterophyllidae* を此處に提唱する。

既に知られた如く六射珊瑚では縦隔壁が 6 ケ所に一樣に而も放射狀に現はれるが、四射珊瑚では 4 ケ所に限られてゐる。*Heterophyllidae* では更に 2 ケ所に限られるのみならず、縦隔壁が左右對稱に配列される事並に骨格の内部構造等は四射珊瑚に近縁である。従つて四射珊瑚を新に *Tetracoelia* と *Dycoelia* とに新に 2 分し *Heterophyllidae* を後者に入れるが最も妥當である。