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ON THE SEASONAL GROWTH IN PALAEOZOIC TETRACORALS AND THE CLIMATE DURING THE DEVONIAN PERIOD

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中國古生物誌乙種第二號

第三册

古生代四射珊瑚成長上的季候變化與泥盆紀的氣候

馬廷英著

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CONTENTS

古生代四射珊瑚成長上的季候變化與泥盆紀的氣候

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緒論

著者自民國二十二年發見古生代四射珊瑚化石中，有若干種在其泡沫組織上帶有類似季候成長變化以後（參考文獻見英文），便專心考察古今各珊瑚是否亦有此現象，及其發達程度如何。結果發見同樣現象亦存在於古生代與中生代各紀的 Stromatoporoids，與陶紀的 Bryozoa，各時代的 Tabulate Corals 以及化石與現代造礁六射珊瑚的組織上，並由研究現代造礁珊瑚，而證明此種現象確係因海水溫度之季候變化而生；因之又發見同一種或屬之成長率，是在寒處較短，而在暖處較長。不僅如此，著者更由比較日本、琉球與臺灣各處同一種或屬之化石與現代造礁珊瑚成長率之大小，而推出日本本島與琉球羣島各地最近地質時代之海水溫度，測定的結果是：日本本島千葉縣館山一帶，在隆起珊瑚礁的時代（Lower Holocene），海水溫度當略高於現在日本本島中最暖的地方——和歌山縣串本，而不能過低於現在琉球羣島中的奄美大島一帶，卽在隆起珊瑚礁時代，館山一帶最寒月份之平均水溫，當比現在高出攝氏五度左右；奄美大島一帶的當時水溫，當與現在的小笠原羣島相仿，在最寒月份平均溫度似比現在高出三度上下。至於散布於琉球羣島的琉球石灰岩的沈積時代（Lowest Pleistocene），日本各地之海水溫度當不至高過現在太多。

本篇之工作係用同樣方法，先推究泥盆紀各國各地氣候之冷暖，然後再進而推測該時代歐亞

大陸之赤道之分布，所用材料則只限於泥盆紀四射珊瑚。

論古生代四射珊瑚成長上的季候變化，我們必須注意兩點：其一是珊瑚化石外表的 Annulations，這種現象據著者研究的結果，完全與內部構造上的季候成長一致；其二是 R. Wedekind 教授的"Theorie der Septalkegel"。Wedekind 教授最近由研究 *Zonophyllum* 的個體發生而主張原來一般所目爲泥盆紀的 *Cystiphyllidæ*，及其近似之刺狀隔壁(Spinose Septa)，乃由 Stereoplasma 塊羣繼續分割而成。大要是：*Zonophyllum* 最幼的部分，在珊瑚體內泡沫組織的中央部生有 Stereoplasma 小塊，此小塊隨着珊瑚的成長而漸擴大，變爲 Stereoplasma 杯，此杯隨着珊瑚的成長而漸增大其口，遞減其厚，在平面上遂消滅於珊瑚體內的外緣或外壁上。新生的 Stereoplasma 杯常出現於舊杯消滅以前，如此層出不窮，有新舊杯底相接連與不相接連者的兩種，此杯更常以放射狀縱分爲板，同一列之各杯體，縱板上下相連接者，造成板狀隔壁，其不相連接者造成刺狀隔壁。Wedekind 教授以此種現象爲泥盆紀一部分四射珊瑚的特徵，並根據 Stereoplasma 杯羣的發達與分割的情形及刺狀隔壁連接的程度，把原來一般目爲泥盆紀的 *Cystiphyllid.e* 及其相近的珊瑚，分爲若干屬與若干種。現代歐洲一部分古生代四射珊瑚化石專家如 Dr. E. Vollbrecht 與 C. Walther 等，多根據是說，從新整理德國泥盆紀的四射珊瑚化石之一部。據著者對 Wedekind 與 Vollbrecht 所作之圖及日本東北帝國大學教授矢部長克博士採自德國 Eifel 採來之中泥盆紀珊瑚化石觀察所得之結果，Wedekind 教授之說似是而實非，試述要點如下：

一　在 Stereoplasma 杯存在的部分，泡沫組織亦同時受其影響而增厚構造，如果刺狀隔壁生

自Stereoplasma杯，則泡沫組織亦當出自Stereoplasma杯，然而泡沫組織往往發生於Stereoplasma塊出現以前。

二 *Cystiphyllum*的刺狀隔壁，往往存在於不受Stereoplasma影響的部分。

三 在隔壁不到中心部的種類，其中心部亦有Stereoplasma杯的存在，而且該部分的杯部常較珊瑚體外緣的部分爲厚。

上列三點，已足證明Wedekind教授學說之謬誤。據著者研究現代珊瑚與化石珊瑚之結果，此種現象實不外表示季候的成長變化而已。

季候成長變化的構造

橫的組織　帶有季候成長變化的珊瑚，其泡沫組織可以看出密疎不同之兩部，其一是由小而密列的泡沫與橫板Tabula組成的部分，其二是由大而疎列之泡沫與橫板組成的部分；此二部由下而上排成極整齊的互層，自下而上，由一層向他層，泡沫形之大小的變遷通常爲漸移的，不過由密層向疎層的遷移往往亦有突變者，密層中最上部往往因受了Stereoplasma的影響而增厚構造。

縱的組織　縱的組織對於水温之季候變化，似較橫的組織更爲敏銳，在泡沫組織密的部分，縱的組織如隔壁在橫面上是長與厚幷增的。

成長率測算的結果與所得的結論

同種或同屬的現代造礁珊瑚之成長率，既然是暖處較長寒處較短，則古生代珊瑚化石上之同

樣現象，大概亦表示同樣性質。我們由同種或屬的珊瑚化石之成長率，可以比較追究各地水溫之高下。考究泥盆紀四射珊瑚化石的結果（詳見英文與別表）如下：

在歐亞兩洲，以中國雲南四川等省與俄國 Ural 及 Timan 諸處一帶珊瑚化石成長上的季候變化之現象，發達最弱，或完全缺如，由此可以想見當時此等地方氣候最暖。由 *Disphyllum, Macgeea, Prismatophyllum, Endophyllum, Ceratophyllum, Gryophyllum, Spongophyllum, Dolmophyllum, Mesophyllum, Diplochone, Cystiphyllum* 等屬成長上之季候變化發達的情形與長成率推論之，則英、德、法各地之泥盆紀海水溫度當低於上列各地與西伯利亞之 Kusnetzk 與印度之 Chitral 及 Northern Shan States 由 *Disphyllum, Prismatophyllum, Endophyllum, Ceratophyllum* 與 *Cystiphyllum* 各屬中同種的成長率看起來，英國泥盆紀海水溫度當略高於德、法兩國，而法國又比德國微暖。由 *Disphyllum, Tabulophyllum, Ptenophyllum, Dialytophyllum, Mesophyllum* 各種類成長上的季候變化發達的情形與成長率，可以推知小亞細亞之 Anatolia 與 Turan 等處之泥盆紀海水溫度當較德國各地爲低；由 *Dohmophyllum tinocystis*(Frech) 與其變種，不難推想到意大利之泥盆紀必寒於德國。看 *Campophyllum lindstroemi* (Frech) 與 *Keriophyllum heterophylloides* (Frech) 成長上的季候變化發達的情形，中國廣西與湖南一帶的泥盆紀海當更暖於德國各地。在北美洲，由 *Macgeea, Prismatophyllum, Pachyphyllum, Tabulophyllum, Campophyllum, Cystiphyllum* 各種的成長率，不難推想到美國 Iowa, Illinois 與 Missouri 各省的泥盆紀海水溫度，當低於印度之 Chitral, Northern Shan States 與中國雲南，與德國似不相上下。更由 *Keriophyllum* 與 *Cystiphyllum* 的成長率亦

可推想到美國 New York 與 Maryland 兩省在泥盆紀時其海水溫度當高於 Missouri 省與德國。由 *Tabulophyllum elliptieum* (Hall and Whitfield) 的成長率，可以看出 Mackenzie River 盆地在泥盆紀時必更寒於 Missouri 省。由以上所得之結果，可進一步得下列之結論。

泥盆紀的赤道

對於這個複雜的問題，用以上有限的材料只能論其大概。如上所述，在歐亞兩洲，中國雲南四川等省與俄國的 Ural 及 Timan 一帶，珊瑚化石成長上的季候變化現象，完全缺如或發達極弱，這不外表示當時的赤道通過這一帶或近於這一帶。上列產化石的諸地點，因受以後的地殼運動，自應略變其原來位置，而且等溫線也大概與現在一樣，要受地理環境的影響，不過在大體上，由以上的材料，可以推想當時的赤道，在歐亞大陸，大概不至離附圖上所繪的線很遠，若然，則當時的北美大陸與歐亞大陸較現在當更形接近。此外有一點頗耐人尋味者即美國 New York 與 Maryland 兩省泥盆紀的海水溫度高於 Missouri 省與德國，而德國當時的海溫又不甚低於美國 Iowa, Illinois, Missouri 諸省，由此可以推知歐美兩大陸在當時似非如 A. Wegener 教授所想像之兩相聯接。

澳洲在泥盆紀是否占有現在之位置，因爲缺乏材料，無從推論，只就 *Gryzophyllum* 與 *Cystiphyllum* 成長上的季候變化發達之情形而論，Queensland 當不至比德國更冷。

最後對於矢部長克教授的懇切指導，實業部地質調查所計榮森先生的中國材料之供給與畑井小虎君的英文修正，著者敬表十二分謝意。

On the Seasonal Growth in Palaeozoic Tetracorals and the Climate During the Devonian Period

By

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Contribution from the Institute of Geology and Palæontology, Tôhoku Imperial University, Sendai, Japan.

I. INTRODUCTION

During the Year 1933, the present author has detected periodic change of growth of the irregularity of the size as well as arrangement of the elements in the vesicular tissue of some Palæozoic Tetracorals,[1] and successively he also found that the same phenomenon occurs in Stromatoporoids from every Palæozoic and Mesozoic formation,[2] certain Palæozoic and Mesozoic Tabulate Corals, recent as well as fossil Hexacorals, and furthermore in an Ordovician Bryozoa which he occasionally examined.[3] In the works entitled "On the Seasonal Change of Growth in a Reef Coral, *Favia speciosa* (Dana), and the Water-Temperature of the Japanese Seas During the Latest Geological Times" and "On the Growth Rate of Reef Corals and the Water Temperature of the Japanese Islands During the Latest Geological Times" the same author has demonstrated not only that this feature in the recent as well as fossil forms indicates but nothing more than the annual cycle of growth in response to the seasonal change of the water temperature under which the animals had lived, but found also the fact that the temperature of the district, in which the polyps lived, is warmer and the length of the annual growth longer in the same species or in the same genus of the recent reef corals. From the length of annual growth in the same species of the recent as well as fossil reef corals obtained from various places and from different geological formations, the author has pointed out, furthermore, that the sea water temperature may have been much

1) T. Y. H. Ma: On the Seasonal Change of Growth in Some Palæozoic Corals, 1933.

2) See Bibliography 2, 5, 7, 22, 42, 62, 80, 83 and 85.

3) K. Ozaki: On Two Species of Ordovician Bryozoa from South Manchuria, 1930.

warmer during the time of the Raised Coral Reef (Lower Holocene) developed in the Japanese Islands than in the recent as well as the time during the Ryûkyû Limestone (Lowest Pleistocene in age according to S. Nomura and N. Zinbô)[1] at the same district; and from the measurements of the annual growth in the reef corals he has concluded that the temperature of Tateyama district of the Main Islands of Japan at the time during the Raised Coral Reef may have been neither warmer nor much colder than that of the present sea of Amami-ôsima Islands of the Ryûkyû Group, and the temperature of the latter at that time may have been nearly similar to that of the present Ogasawara-zima i.e., 5°C or thereabout higher than that of the present-day at Tateyama and about 3°C for the monthly mean average of the coldest month at Amami-ôsima, and that the temperature of the Ryûkyû Limestone does not seem to have been much warmer than that of the present-day.

In the present work, the author has attempted to apply the same method to the Devonian Tetracorals, as far as possible, and from the measurements of annual length of growth in the same species or the same genus from various places, he also has tried to locate the equator during that time in Eurasian Continent.

In discussing seasonal change of growth in fossil corals there are two matters of prime importance; one is the exterior feature, the annulations or periodic swellings of growth, and the other is the interior peculiarities of the corals, R. Wedekind's theory of the septalcone of the Palæozoic Tetracorals.[2] The present author has examined samples of *Mesophyllum*, *Cystiphyllum*, *Keriophyllum*, *Ceratophyllum*, *Campophyllum* and *Ptenophyllum* as well as other forms from Eifel in Germany, Kwangsi in China and New York in North America together with the figures given by Edwards and Haime,[3] and Wedekind and Vollbrecht,[4] and in his opinion such phenomenon as the annulation in growth as well as the feature

1) S. Nomura and N. Zinbô: Marine Mollusca from the "Ryûkyû Limestone of Kikai-zima, Ryûkyû Group, p. 111, 1934.

2) R. Wedekind: Das Mitteldevon der Eifel, T. I, pp. 21-25, 1924.

3) Milne-Edwards and J. Haime: British Fossil Corals, pl. 31, fig. 2a; pl. 33, figs. 3b, 4, 1850-1854.

4) R. Wedekind: Das Mitteldevon der Eifel, T. II, pp. 25-41, figs. 32-64, 1935; R. Wedekind und E. Vollbrecht: Die Lytophyllidae des mittleren Mitteldevon der Eifel, pls. 1-38, 1931-1932.

upon which the theory of Professor R. Wedekind was based merely indicates the annual cycle of growth in response to the seasonal change of the water temperature.

II. THE CHARACTER OF SEASONAL CHANGE IN GROWTH

Horizontal elements. In the forms which exhibit the feature of seasonal change in growth, the vesicular tissue or the horizontal elements are arranged in different densities at different heights above the base of the corallite; namely, a part of the corallite in this type is provided with minute and densely crowded dissepiments or vesicles as well as tabulae, while the parts under and overlying it possess larger and less crowded dissepiments or vesicles and tabulae: and the elements in the densely crowded portion are, usually, thickened by the stereoplasmic deposits.

Vertical elements. The vertical elements or the septa as well as the other vertical tissue, in general, are more sensitive than the horizontal ones to the seasonal change of the water temperature, they are stronger in development in both the length and breadth at the densely crowded portion of the horizontal tissue.

III. MEASUREMENT OF ANNUAL LENGTH IN GROWTH

I. Genus **DISPHYLLUM** de Fromentel 1861.

1. **Disphyllum stachei** (Penecke)

1894 *Thamnophyllum Stachei* Penecke: Das Grazer Devon, p. 594, pl. VIII, figs. 1-3; pl. XI, figs. 1, 2.

1894 *Thamnophyllum Hornesi* Penecke: Ibid., p. 595, pl. VII, figs. 13, 14; pl. XI, fig. 3.

1894 *Thamnophyllum Murchisoni* Penecke: Ibid., p. 595, pl. VII, figs. 15-17.

Locality	Author	Pl.*	Fig.*	Annual Length
Plabutsch in Graz of Austria	Penecke	7	13, 14	4.50 mm.
„	„	7	17	3.50
Gaisberg in Graz of Austria	„	8	2	4.00

*Indicates the orginal plate and figure or figures of the author cited at the left.

2. **Disphyllum goldfussi** (Geinitz)

Pl. I, Figs. 1a-1d.

1826 *Cyathophyllum cæspitosum* Goldfuss: Petr. Germ., T. l, p. 60, pl. XIX, figs. 2a, 2b, 2c, 2d.

1826 *Cyathophyllum hexagonum* Goldfuss (pars): Ibid., p. 61, pl. XIX, figs. 5a, 5b, 5c. 5d.

1843 *Cyathophyllum cæspitosum* Römer: Verstein. d. Harzgebirges, p. 4, pl. II, fig. 10.

1853 *Cyathophyllum cæspitosum* Edwards and Haime: British Fossil Corals, p. 229, pl. 51, figs. 2, 2a, 2b.

1866 *Tæniocalamolopas adhæsa* Ludwig: Corallen aus paläolithischen Formationen, p. 218, pl. LXIII, figs. 4, 4a, 4b.

1866 *Astrocalamocyathus cæspitosus* Ludwig Ibid., p. 222, pl. LXII, figs. 2a-c.

1886 *Cythophyllum cæspitosum* Frech: Cyath. u. Zaphr., p. 70, pl. III, figs. 9-14.

1892 *Campophyllum Gregorrii* Jack and Etheridge: Geology and Palæontology of Queensland and New Guinea, p. 60, pl. III, figs. 15-18.

1900 *Cyathophyllum cæspitosum* Lambe: A Revision of the Genera and Species of Canadian Palæozoic Corals, p. 145, pl. XII, figs. 3, 3a, 3b.

1900 *Caythophyllum Araxis* Frech: Das Palëozoicum in Hocharmenien und Persien, p. 184, pl. XVII, figs. 5a, 5b, 5c, 5d, 5e.

1902 *Cyathophyllum cæspitosum* Lebedew: Bedeutung der Korallen in den devonischen Ab lagerungen Russlands, p. 149, pl. II, figs. 18, 19, 20.

1903 *Cyathophyllum cæspitosum* Penecke: Das Sammelergebnis aus dem Oberdevon von Hadschin, p. 146, pl. IV, figs. 2a, 2b, 3a, 3b; pl. V. fig. 1.

1908 *Cyathophyllum cæspitosum* var. *breviseptatum* Reed: Devonian Faunas of the Northern Shan States, p. 4, pl. I, figs. 3-6.

1920 *Cyathophyllum cæspitosum* var. *breviseptata* Yabe and Hayasaka: Palæont. of S. China, p. 136, pl. VIII, fig. 7.

1935 *Disphyllum goldfussi* Lang and Smith: On *Cyathophyllum cæspitosum* Goldfuss, p. 568, textfigs. 23, 24; pl. XXXV, figs. 4-8.

Locality	Author	Pl.	Fig.	Annual Length
Eifel or Bensberg, Germany	Goldfuss	19	2a	6.00
,,	,,	19	5b	7.00
	Lang &			

Locality	Author	Pl.	Fig.	Annual Length
Bensberg, Germany	Smith	35	4	7.00
Harz, Germany	Römer	2	10	6.50
„	Ludwig	63	4, 4a	5.00
Reinland, Germany	„	62	2	10.00(?)
Refrath near Köln, Germany	Frech	3	9	5.00
„	„	3	13	5.00
Sadarak in Turan, Asia Minor	„	17	5e	4.00
Uchta in Timan, Northern Russia	Lebedew	2	19	No seasonal change
Hadschin in Asia Minor	Penecke	5	1	2.50
„	„	4	4a	2.50
Padaukpin, North Shan State	Reed	1	4-6	No seasonal change
Ping-wu-hsien, Szechuan, China	(6283)*	1	1b, 1c, 1d	„
Pas de Calais, France				10.00
Torquay, England	Edwards & Haime	51	2	16.00

3. **Disphyllum cæspitosum** (Goldfuss)

Pl. I, Fig. 2; Pl. II, Figs. 2a-2d.

1881 *Fascicularia cæspitosa* Schlüter; Anthozoen des Devon, p. 103, pl. IX, figs. 6, 7.

1894 *Thamnophyllum trigeminum* Penecke: Das Grazer Devon, p. 596, pl. VIII, figs. 4-6.

1902 *Cyathophyllum carbonicum* Lebedew; Korallen in den devonischen Ablagerungen Russlands, p. 179, pl. IV, figs. 54-57.

1909 *Phacellophyllum cæspitosum* Gürich: Leitfossilien, 2, Devon, p. 102, pl. XXXI, figs. 5a, 5b.

1935 *Disphyllum cæspitosum* Land and Smith: On *Cyathophyllum cæspitosum* Goldfuss, p. 573, textfigs. 28, 29; Pl. XXXV, figs. 1, 2.

1935 *Disphyllum trigemme* Lang and Smith: Ibid., p. 575, textfigs. 30, 31.

*Registered Number of the Institute of Geology and Palæontology, Tôhoku Imperial University, Sendai, Japan.