日本古生物學會報告

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48. *On the Ordovician Climate of the Northern Hemisphere deduced from the Growth Rate of Tabulate Corals*¹⁾

By

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The annual growth rate of *Calapoecias* was measured from the figures given by several authorities in a previous work with the view of find the Ordovician climatological conditions of the Arctic regions as well as several European provinces.²⁾ In the present article, emphasis is laid on the development of seasonal change and annual length in growth of a number of tabulate corals as a further detailed study on the climate of the northern hemisphere during the Ordovician period.

Measurements

I. Genus *Calapoecia* BILLINGS, 1865

1. *Calapoecia canadensis* BILLINGS

- 1876 *Houghtonia huronica* (pars) ROMINGER: Fossil Corals, Geol. Surv. Mich., vol. 3, pt. 2, p. 18, pl. 3, fig. 3.
- 1908 *Calapoecia cribriformis* CUMINGS: The Stratigraphy and Paleontology of the Ordovician Rocks of Indiana, 32nd Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1907, p. 701, pl. 1, figs. 3, 3a, 3b, pl. 5, figs. 1, 2.
- 1928 *Calapoecia huronensis* TROEDSSON: Middle and Upper Ordovician Faunas

1) Publication permitted by the permission of the Director of the National Geological Survey of China.

2) T. Y. H. MA: On the Growth Rate of *Calapoecia canadensis* BILLINGS and the Climate of the Arctic Regions During the Ordovician Period, Bull. Geol. Soc. China, vol. XVII, No. 2, 1937.

- of Northern Greenland, Med. om Greenland, Bd. 72, pt. 2, p. 124, pl. 28, figs. 7-9. pl. 33, figs. 2a-b, pl. 34, fig. 3.
- 1928 *Calapoecia borealis* (pars) TROEDSSON: Ibid., p. 125, pl. 34, figs. 2, 3, pl. 36, figs. 1a-c.
- 1936 *Calapoecia canadensis* Cox: Revision of the Genus *Calapoecia* BILLINGS, Nat. Mus. Canada, Bull. No. 80, Geol. Ser. No. 53, p. 7, pl. 1, figs. 1, 3, 5, pl. 2, figs. 1, 2, 5-9.

Locality	Author	Plate	Figure	Annual Length
Cape Calhoun, N. Greenland	TROEDSSON	33	2 b	8.00 mm.
Ditto.	TROEDSSON	36	1 b	No seasonal change
Ditto.	COX	2	1 a	Ditto.
Richmond, Indiana	CUMINGS	1	3 c	Ditto.
Warren county, Ohio	COX	2	7	Ditto.
Cape Smyth, Lake Huron	COX	2	9 a	Ditto.
Drummond Island, Michigan	ROMINGER	3	3	11.00
Akpatok Island, Canada	COX	2	8	4.80

2. *Calapoecia canadensis* var. *anticostiensis* (BILLINGS)

- 1861 *Syringophyllum organum* ROEMER: Die Fossile Fauna der Silurischen Diluvial-Geschiebe von Sadewitz bei Oels in Nieder-Schlesien, p. 20, pl. 4, figs. 2a, 2b.
- 1928 *Syringophyllum organum* TROEDSSON: Loc. cit., pp. 121, 122, figs. 3-8.
- 1928 *Calapoecia borealis* (pars) TROEDSSON: Loc. cit., p. 125, pl. 35, figs. 1a-b, pl. 37, figs. 1a-b, 2a-b, pl. 38, figs. 1a-d.
- 1928 *Calapoecia arctica* TROEDSSON: Loc. cit., p. 127, pl. 39, figs. 1a-b, pl. 40, figs. 1a-b.
- 1936 *Calapoecia canadensis* var. *anticostiensis* Cox: Loc. cit., p. 12, pl. 1, fig. 6, pl. 3, figs. 1a-c, 3, 5-7.
- 1936 *Calapoecia canadensis* var. *anticostiensis* forma *arctica* Cox: Loc. cit., p. 16, pl. 4, figs. 1a-b, 2a-b, 3.
- 1936 *Sarcinula organum* Cox: Loc. cit., pl. 4, figs. 4-7.

Locality	Author	Plate	Figure	Annual Length
Cape Calhoun, N. Greenland	TROEDSSON	35	1 b	13.00 mm.
Ditto.	TROEDSSON	37	1 b	11.00
Ditto.	TROEDSSON	38	1 a	10.00
Ditto.	TROEDSSON	39	1 b	12.00
Cape Hilgard, Ellesmere Land	COX	4	1	8.00
Norman Lackyer Island, Ellesmere Land	COX	3	5 a	9.00 (?)
Ditto.	COX	3	5 c	7.50
Akpatok Island, Canada	COX	3	7	7.10

Anticosti Island, Canada	Cox	3	6	7.00 mm.
High Haume, England	Cox	4	7	5.75
Oscarskal, Herö, Norway	Cox	4	6	5.30
Oslo, Norway	Cox	4	8	5.31
Ditto,	TROEDSSON		7	3.10
Yamingbo, Gotland	Cox	4	4 b	3.54
Gotland	TROEDSSON		4	3.50
Oels, Germany	ROEMER	4	2 b	2.70

II. Genus *Columnaria* GOLDFUSS, 18263. *Columnaria alveolata* GOLDFUSS1876 *Columnaria alveolata* ROMINGER: Loc. cit., p. 90, pl. 34, figs. 1, 2, 4.1908 *Columnaria alveolata* CUMINGS: Loc. cit., p. 703, pl. 1, figs. 4, 4a.

Locality	AUTHOR	Plate	Figure	Annual Length
Escanaba River, Michigan	ROMINGER	34	2	20.00 mm
Osgood, Indiana	CUMINGS	1	4	20.00

4. *Columnaria alveolata* var. *interventa* FOERSTE1914 *Columnaria alveolata* var. *interventa* FOERSTE: The Rogers Gap Fauna of Central Kentucky, Journ. Cincinnati Soc. Nat. Hist., vol. 21, No. 4, p. 122, pl. 4, figs. 1a-j.

Locality	Author	Plate	Figure	Annual Length
Brannon near Lexington, Kentucky	FOERSTE	4	1 c	7.50 mm.
Ditto.	FOERSTE	4	1 h	9.00
Ditto.	FOERSTE	4	1 j	5.00

5. *Columnaria alveolata* var. *minima* FOERSTE1925 *Columnaria alveolata* var. *minima* HUME: The Palaeozoic Outlier of Lake Timiskaming, Ontario and Quebec, Geol. Surv. Canada, Mem. 145, p. 60, pl. 5, figs. 2a, 2b.

Locality	Author	Plate	Figure	Annual Length
Lake Timiskaming, Ontario	HUME	5	2 a	13.00 mm.

6. *Columnaria halysitoides* TROEDSSON1928 *Columnaria halysitoides* TROEDSSON: Loc. cit., p. 113, pl. 28, figs. 1-5b.

Locality	Author	Plate	Figure	Annual Length
Cape Calhoun, N. Greenland	TROEDSSON	28	5 b	13.00 mm.

7. *Columnaria parvituba* TROEDSSON

1928 *Columnaria parvituba* TROEDSSON: Loc. cit., p. 114, pl. 28, fig. 6, pl. 29, fig. 4.

Locality	Author	Plate	Figure	Annual Length
Gonoceras Bay, N. Greenland	TROEDSSON	28	6	No seasonal change

III. Genus *Heliolites* DANA, 1846

8. *Heliolites intricatus* var. *lamellosa* LINDSTRÖM

1899 *Heliolites intricatus* var. *lamellosa* KIAER: Die Korallenfauna der Etage 5 des norwegischen Silursystems, Palaeontogr., Bd. 46, p. 42, pl. 7, figs. 3-5.

Locality	Author	Plate	Figure	Annual Length
Asker Norway	KIAER	7	4	3.00 mm.

9. *Heliolites parvistella* ROEMER

1899 *Heliolites parvistella* KIAER: Loc. cit., p. 39, pl. 7, figs. 6-8.

Locality	Author	Plate	Figure	Annual Length
Östre Svartö, Ringerike, Norway	KIAER	7	8	1.20 mm.
Estland	KIAER	7	7	1.70

IV. Genus *Proheliolites* KIAER, 1899

10. *Proheliolites dubius* (SCHMIDT)

1861 *Heliolites dubia* Roemer: Loc. cit., p. 26, pl. 4, figs. 5a, 5b.

Locality	Author	Plate	Figure	Annual Length
Oels, Germany	ROEMER	4	5 a	2.25 mm.

V. Genus *Propora* MILNE-EDWARDS and HAIME, 1849

11. *Propora conferta* MILNE-EDWARDS and HAIME

1899 *Propora conferta* LINDSTRÖM: Remarks on the Heliolitidae, p. 93, pl. 8, figs. 32-39, pl. 9, figs. 1-23, 31, 32, 35.

1899 *Plasmopora conferta* KIAER: Loc. cit., p. 27, pl. 4, figs. 3, 4.

Locality	Author	Plate	Figure	Annual Length
Borkholm in Estland	LINDSTRÖM	8	34	4.00 mm.
Ditto.	LINDSTRÖM	9	2	4.00
Ringerike, Norway	KIAER	4	4	3.00
Anticosti Island, Canada	LINDSTRÖM	9	12	4.25

12. *Propora tubulata* (LONSDALE)1861 *Propora tubulata* ROEMER: Loc. cit., p. 22, pl. 4, figs. 3a, 3b.1899 *Propora tubulata* LINDSTRÖM: Loc. cit., p. 89, pl. 8, figs. 18-21.

Locality	Author	Plate	Figure	Annual Length
Oels, Germany	ROEMER	4	3 a	2.25 mm.
Borkholm in Estland	LINDSTRÖM	8	19	2.75

13. *Propora bacillifera* LINDSTRÖM1899 *Propora bacillifera* LINDSTRÖM: Loc. cit., p. 97, pl. 10, figs. 8-21.

Locality	Author	Plate	Figure	Annual Length
Borkholm in Estland	LINDSTRÖM	10	18	5.00 mm.
Ostbjörka in Dalecarlia	LINDSTRÖM	10	9	4.50

14. *Propora* cfr. *goldfussi* BILLINGS1932 *Propora* cfr. *goldfussi* KIAER: The Coral Fauna of the Kalstad Limestone in Medalen, The Hovin Group in the Trondheim Area, Vid.-Akad. Skr. I. M.-N. Kl. 1932, No. 4, p. 109, pl. 14, figs. 1-3.

Locality	Author	Plate	Figure	Annual Length
Kalstad, Medalen, Trondheim	KIAER	14	3	5.50 mm.

15. *Propora* sp.1899 *Nicholsonia megastoma* KIAER: Loc. cit., p. 37, pl. 6, figs. 8, 9, pl. 7, figs. 1, 2.

Locality	Author	Plate	Figure	Annual Length
Soida, Estland	KIAER	7	2	2.00 mm.

VI. Genus *Nyctopora* NICHOLSON, 187916. *Nyctopora* (?) *parvotabulata* KIAER1932 *Nyctopora* (?) *parvotabulata* KIAER: Loc. cit., p. 106, pl. 13, figs. 1-4.

Locality	Author	Plate	Figure	Annual Length
Bakkenknausen, Medalen, Trondheim	KIAER	13	2	5.00 mm.

VII. Genus *Plasmopora* MILNE-EDWARDS and HAIME, 1849

17. *Plasmopora lambi* SCHUCHERT

1925 *Plasmopora lambi* HUME: Loc. cit., p. 18, pl. 5, figs. 1a, 1b.

1928 *Plasmopora lambi* TROEDSSON: Loc. cit., p. 118, pl. 31, fig. 3a, pl. 33, figs. 1a, 1b.

Locality	Author	Plate	Figure	Annual Length
Cape Calhoun, N. Greenland	TROEDSSON	31	1 b	10.00 mm.
Ditto.	TROEDSSON	32	2	8.00
Lake Timiskaming, Ontario	HUME	5	1 a	9.00

VIII. Genus *Plasmoporella* KIAER, 1899

18. *Plasmoporella convexotabulata* KIAER

1899 *Plasmoporella convexotabulata* KIAER: Loc. cit., p. 35, pl. 5, figs. 9-11.

1936 *Plasmoporella convexotabulata* Cox: Loc. cit., pl. 3, figs. 4a, 4b.

Locality	Author	Plate	Figure	Annual Length
Ringerike, Norway	KIAER	5	10	Longer than 5.00 mm.
Ditto.	KIAER	5	11	2.70
Oslo, Norway	Cox	3	4 b	6.62

19. *Plasmoporella convexotabulata* var. *vesiculosa* KIAER

1899 *Plasmoporella convexotabulata* var. *vesiculosa* KIAER: Loc. cit., p. 36, pl. 6, figs. 1-2.

Locality	Author	Plate	Figure	Annual Length
Ringerike, Norway	KIAER	6	1	2.70 mm.

20. *Plasmoporella* sp.

1912 *Plasmoporella* sp. REED: Ordovician and Silurian Fossils from the Central Himalayas, Pal. Indica, ser. 15, vol. 7, No. 2, p. 160, pl. 3, figs. 1. 1a.

Locality	Author	Plate	Figure	Annual Length
Pethathali Nullah, Central Himalaya	REED	3	1 a	Somewhat less than 5 mm.

From the obtained values of the growth length and degree of development of the seasonal change in the interior structure tabulated above, it may be said that temperatural differentiation existed already in the Ordovician coralline reef-seas. The annual length as measured above, is longer in all of the forms from the Arctic regions than in those from Northern Europe, and the development of seasonal change of growth is remarkable in the corals from the latter region and hardly observable or lacking in those from the former. This striking contrast between the Arctic and Northern Europe reef corals may certainly indicate the existence of different climatic environments during the Ordovician in the high latitudes of the northern hemisphere. From the measurements of the species in *Columnaria* and *Calapoecia* together with *Plasmopora lambi* SCHUCHERT, it is assumed that the water temperature of the Ordovician coralline seas in Timiskaming of Ontario, Warren of Ohio, Cape Smyth of Lake Huron, Drummond Island and Escanaba of Michigan and Osgood of Indiana may have been warmer than that of Lexington of Central Kentucky and may have been similar closely to that of the Arctic regions. The growth rate in the same species in *Calapoecia* and *Propora* indicate that the temperature of the Ordovician waters in Anticosti Island of Canada may have neither much warmer nor cooler than that of the British Islands and Norway, and the water for Gotland may have been slightly warmer than in Oels of Germany and more or less cooler than in Norway and British Islands. From the measurements of the forms in *Plasmoporella* it is assumed that the Ordovician water temperature of Central Himalaya may have been similar to that of Norway. From the data now at hand, it is concluded that the sea area of Northern Europe and Central Himalaya together with Anticosti Island of Canada were probably a portion of the marginal belt of the Ordovician coralline seas, and the zone combining the Arctic regions, Timiskaming of Ontario, Warren of Ohio, Cape Smyth of Lake Huron, and Osgood of Indiana as well as Drummond Island and Escanaba of Michigan belong to the inner or central zone of the coralline reef seas.

床板珊瑚の成長率より推定されたる北半球に
於ける奥陶紀の氣候 (摘要)

馬 廷 英

現生及び化石造礁珊瑚類の骨骼に季候成長構造があるのみならず其年成長が海水温度の高低と一定の關係を有することは已に筆者によつて證明されたところである。

本篇は文献の挿圖より北半球各地產出八屬二十種の奥陶紀床板珊瑚の成長率及び季候成長構造發達程度を比較研究し以て當該時代に於ける北半球各地の氣候狀態を推想しやうと思ふ。是より得た結論としては北極地方及び北米の Huron 湖, Ohio, Michigan, Indiana 一帶の產地の海水温度は最も溫く, 英國諾威瑞典及び獨逸等の北歐造礁珊瑚化石產地は上記の諸地方より寒い, 加拿太の Anticosti Island は英國と大差がない, 諾威及び英國は獨逸より溫く中央ヒマラヤ地方は稍々諾威に近い。上記の事實より考へれば北極地方及び北米の Huron 湖, Ohio, Michigan, Indiana 諸產地の一帶は當時造礁珊瑚の内側或は内帶に屬すべく北歐の英國諾威瑞典獨逸及び亞細亞の中央ヒマラヤ地方は珊瑚海の外側又は外縁に相當するものと思はれる。