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(Report, 3 plates and 1 figure)

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DEPARTMENT OF ENERGY, MINES AND RESOURCES

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ABSTRACT

This paper present a description of statoblasts of Cristatella mucedo Cuvier extracted from late Tertiary or early Pleistocene, interglacial and postglacial deposits. The methods of extraction and the paleoecological significance of the statoblasts are presented. The biostratigraphic importance of statoblasts in sequences consisting of strata produced by aquatic ecotones is also discussed. All locations of subfossil statoblasts are north of the recent northernmost limit of fresh-water bryozoans in Canada. Statoblasts occur most abundantly in interglacial sapropel and are helpful indicators of general climatic and environmental features of this period.

RÉSUMÉ

Ce mémoire offre une description des statoblastes du Cristatella mucedo Cuvier, extrait des dépôts datant de la fin du Tertiaire, du début du Pléistocène et des périodes interglaciaires et postglaciaires. L'auteur traite des méthodes d'extraction et de l'importance paléo-écologique des statoblastes, ainsi que de leur importance stratigraphique. Les statoblastes apparaissent dans des séries formées de couches produites par des frontières entre communautés écologiques. Toutes les venues de statoblastes non encore fossilisés sont au nord de la limite septentrionale récente des bryozoaires d'eau douce du Canada. Les statoblastes abondent dans les couches sapropéliques interglaciaires et facilitent l'étude des conditions climatiques et environnementales de la période en question.

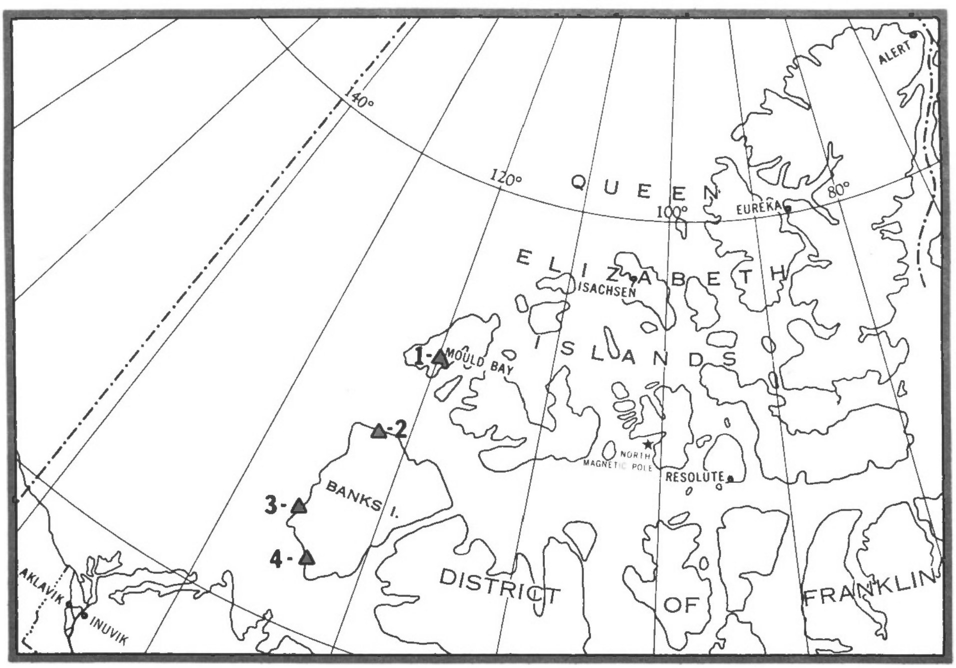
FOSSIL STATOBLASTS OF CRISTATELLA MUCEDO CUVIER IN THE BEAUFORT FORMATION AND IN INTERGLACIAL AND POSTGLACIAL DEPOSITS OF THE CANADIAN ARCTIC

INTRODUCTION

Sapropels and peat deposits are remarkably well preserved in the Canadian Arctic Archipelago thus providing an opportunity to study not only details of individual fossils, but also paleoecological relationships between deposits and to evaluate their past environments.

During paleobotanical analyses of aquatic sediments, statoblasts of freshwater bryozoans were found in relative abundance. They seem to be good indices of aquatic habitats, the trophism of water, its depth and climate, which are the subject of this paper.

Specimens have been deposited in the National Type Fossil Collection, Geological Survey of Canada, Ottawa, and have been given numbers 31168 to 31175.



1 - vicinity of Mould Bay, Prince Patrick Island

2 - Ballast Brook

3 - Worth Point

4 - Thesiger Bay

Figure 1. Location map of fossil statoblasts of Cristatella mucedo Cuvier.

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TABLE 1

Fossil statoblasts studied.

Location (see Fig. 1)	Deposit	Age	Abundance	Associated remains	Collector, date
Ballast Brook, ca. 74° 25'N, 122° 30'W NW Banks Island	Woody sapropel	Beaufort Formation, Late Tertiary to early Pleistocene (Kuc and Hills, 1971).	Frequent	Wood flakes, mosses, Potamogeton seeds, animals etc.	V. L. Hills 1968
Worth Point, 72° 15'N, 125° 37'W W Banks Island	Coarse detritus sapropel	Interglacial (Craig and Fyles, 1960) >49,000 C^{14} years, GSC-367 (Dyck et al., 1965).	Present	Potamogeton seeds, mosses, cuticles, diatoms, spicules, plankton	J. G. Fyles 1959 !
	Sapropelic peat		Very rare	Vascular plants, mosses, cuticles molluscs, diatoms, plankton, spicules	
	Sapropel		Present	Wood fragments, cuticles, roots, molluscs, diatoms, spicules, etc.	
Thesiger Bay between Sachs Harbour and Masik River, on the coastal cliff ca. 72° N, 124° W. SW Banks Island	Mossy pond peat	probably early postglacial (Craig and Fyles, 1960)	Rare	Mosses, grass-like vascular plant remains, diatoms, etc.	M. Kuc, 1969
Mould Bay, 76° 19'15"N 119° 21'03"W Prince Patrick Island	Drepanocladus peat	ca. 4280±140 C^{14} years (GSC-1194)	Only one statoblast was found in layer no. 8 but the deposit was not examined for statoblasts	Drepanocladus latifolius, D. revolvens, plankton	M. Kuc, 1968

Acknowledgments

The author gratefully acknowledges the help of Dr. D.M. Wood, who first noted the similarity of these fossils to Bryozoa, and to Drs. D.B.O. Savile, J.A. Palmeree, C. Francton, and W.J. Cody, all from the Central Experimental Farm, Canada Department of Agriculture in Ottawa, who kindly examined and commented on specimens. The help of Dr. N.A. Powell, Curator of Invertebrates at the National Museum of Natural Science, and the library facilities he provided are also appreciated.

DEPOSITS INVESTIGATED

Data presented in Table I show Bryozoa as relatively frequent constituents of shallow water sapropels of the early Pleistocene, interglacial and postglacial ages. The bryozoans were found mixed with a variety of plant remains, the mixture depending on the age of the deposit. Hitherto, statoblasts had not been recognized in redeposited materials.

DESCRIPTION OF FOSSIL STATOBLASTS AND THEIR PRESERVATION

To date, only fossil statoblasts of Cristatella mucedo Cuvier belonging to Phylactolaemata have been discovered in the samples studied. In the Canadian Arctic they are extremely well preserved and occur as ungerminated statoblasts, complete single valves, capsules with cutout hooks and, rarely, as fragments of spines and annulus (Plate I; A-E). Fragments of valves are probably the result of maceration of materials and the screening process. Valves and spines are a dark, dull brown and the annulus is pale and transparent with a clearly visible cell net (Plate II; E-O). The valves always display the shelf and the circular base of the spines, and fragments have surficial spicules and sculpture (Plate I; F, G). Spine ends have finger-like forms or are double, triple or dendroidal anchors (Plate II; A-D). Spine surfaces are rough (Plate III). Spines are straight or waved or, rarely, slightly branching.

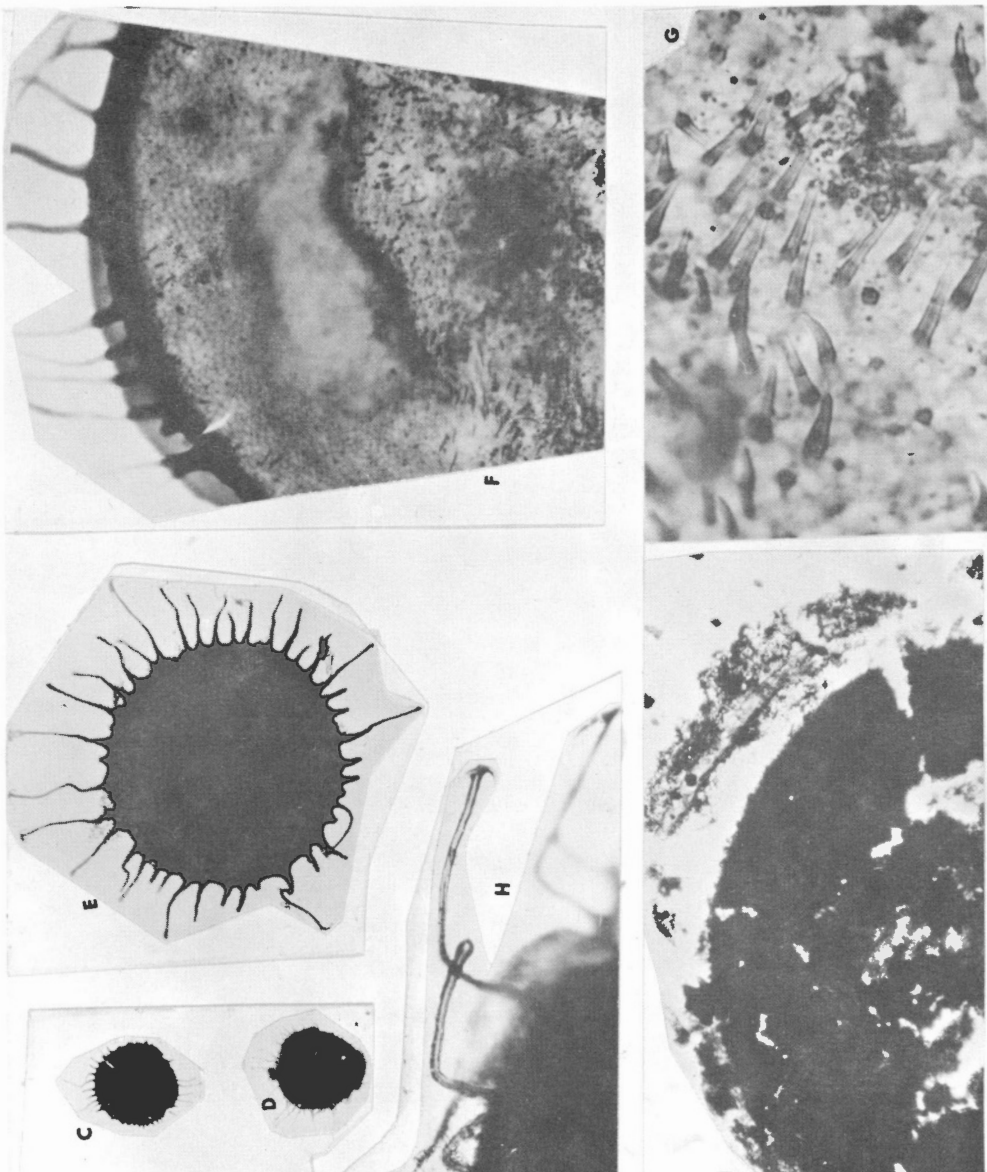
Whole statoblasts and valves occur in the screen-size fraction 1.75 to 2.00 mm and parts of spicules and annuli occur in the fraction 0.63 mm to 1.00 mm.

Valves from deposits of the Beaufort Formation (Pliocene/Pleistocene according to Craig and Fyles, 1960; Miocene according to Hills and Ogilvie, 1970) are compressed; the discs are flattened and commonly have deep folds. Other remains of these deposits, such as wood fragments, branches, stems, and even unilayer moss leaves are also compressed. Statoblasts in younger deposits do not bear such marks.

Methods of extracting statoblasts from sapropel

Statoblasts are most numerous in the size fraction 1 to 2 mm. Best results were obtained using 1.25 and 1.75 mm screens and a strong water spray to wash out coarse detritus, fragile remains, and long or thin fragments. Statoblasts may then be extracted from the size fractions by the following methods:

Plate 1.



Wet method. The dry material is dispersed in water on a flat white dish; the statoblasts can then be delicately removed with pincers. This method yields the best results.

Dry method. After being thoroughly dried, the screened and washed material is spread as a thin layer over a hard and smooth plate. It should then be pressed lightly to break the plant fragments, and dried again. On shaking the plate, plant dust accumulates on the spines of statoblasts as dust balls. These can be removed in water with minute portions of strong detergent. The detrimental aspect of this method is the mechanical destruction of the annulus, spines and valves, and of other fossils.

Heat method. The dry material is warmed to a temperature at which plant fossils will change into an ash, yielding statoblasts which usually lack the thinner parts of their spines. Fossil statoblasts are very resistant to fire. They do not burn as do plant fossils, but tend to disintegrate (Plate 1; I). This is a quick method, useful in estimating the number of statoblasts in the screened material.

H_2O_2 method. The screened and washed material is dried and then immersed in H_2O_2 for several hours. Most organic materials are changed into white ash but the statoblasts remain as black, rounded bodies that can be seen readily. When the ash is removed by washing, a concentrate of statoblasts remains.

It was found that one cubic centimetre of interglacial sapropel yielded twenty-three statoblasts as compared to three from another sample of the same age and two to eight from Postglacial material.

BIOLOGICAL PROPERTIES OF STATOBLASTS AS INDICES OF A PAST ENVIRONMENT

For information concerning the distribution, behaviour, ecology and physiology of bryozoans, the author has relied on the following works: Abricossoff, 1927; Allman, 1856; Brien, 1936, 1953, 1960; Brown, 1933; Bushnell, 1965; Dahlgreen, 1934; Hyman, 1959; Jullien, 1885; Marcus, 1925; Rogick, 1935, 1960; Rogick and Brown, 1942; Toriumi, 1942.

Of the 3,500 bryozoans that have been described in the literature, only about 50 species occur in fresh water and 14 of these have been reported from North America. The production of statoblasts is an exclusive feature of freshwater Bryozoa, and spinoblasts are characteristic of the family

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Plate 1 (opposite)

Statoblasts, whole and partial

A-D - statoblasts (8x),
E - statoblast (28x),
F - surface of statoblast between its centre and annulus (100x),
G - appendices on the surface of the disc (240x),
H - edge view of statoblast (120x),
I - a statoblast extracted by the heat method (90x) (Parts of GSC photos 201845 and 201845A).

Plate 2.

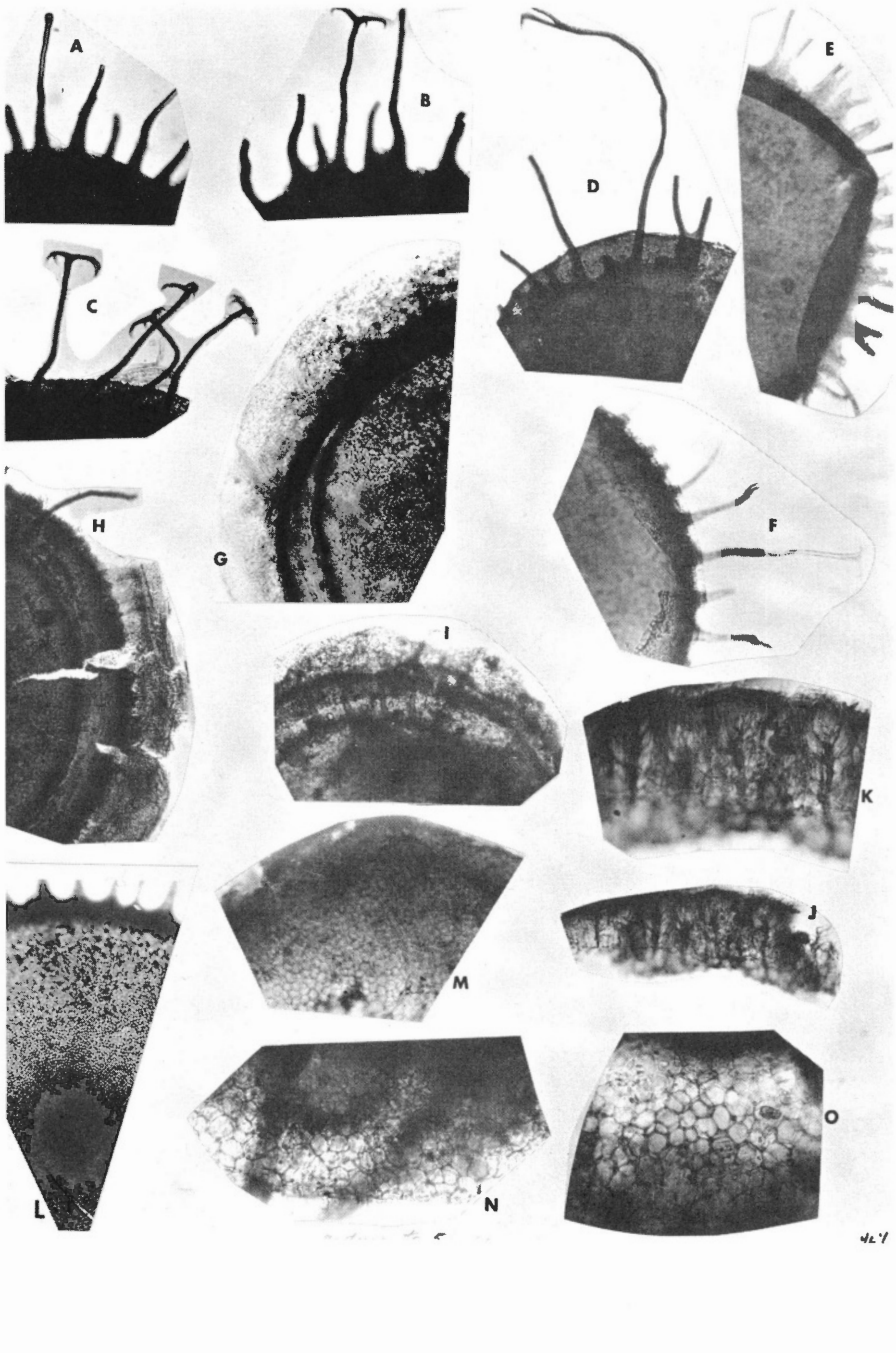

Plate 2. Morphological features of marginal parts of statoblasts:

A - Finger-like spines (60x)

B - same as A but anchor spines (60x)

C - same as A but dendroidal spines (60x)

D - forked spines (60x)

E,F - recurved peripheral portions of the valve and, behind it, bases of spines (60x)

G,H,I - details of ring (120x, 100x, 110x)

J - (200x)

K - veins of annulus (400x)

L - cell net between centre of valve and peripheral margin (80x)

M - (200x)

N - (400x)

O - cells of peripheral portions of valve (500x)

(GSC photo 201845-B)

Plate 3.

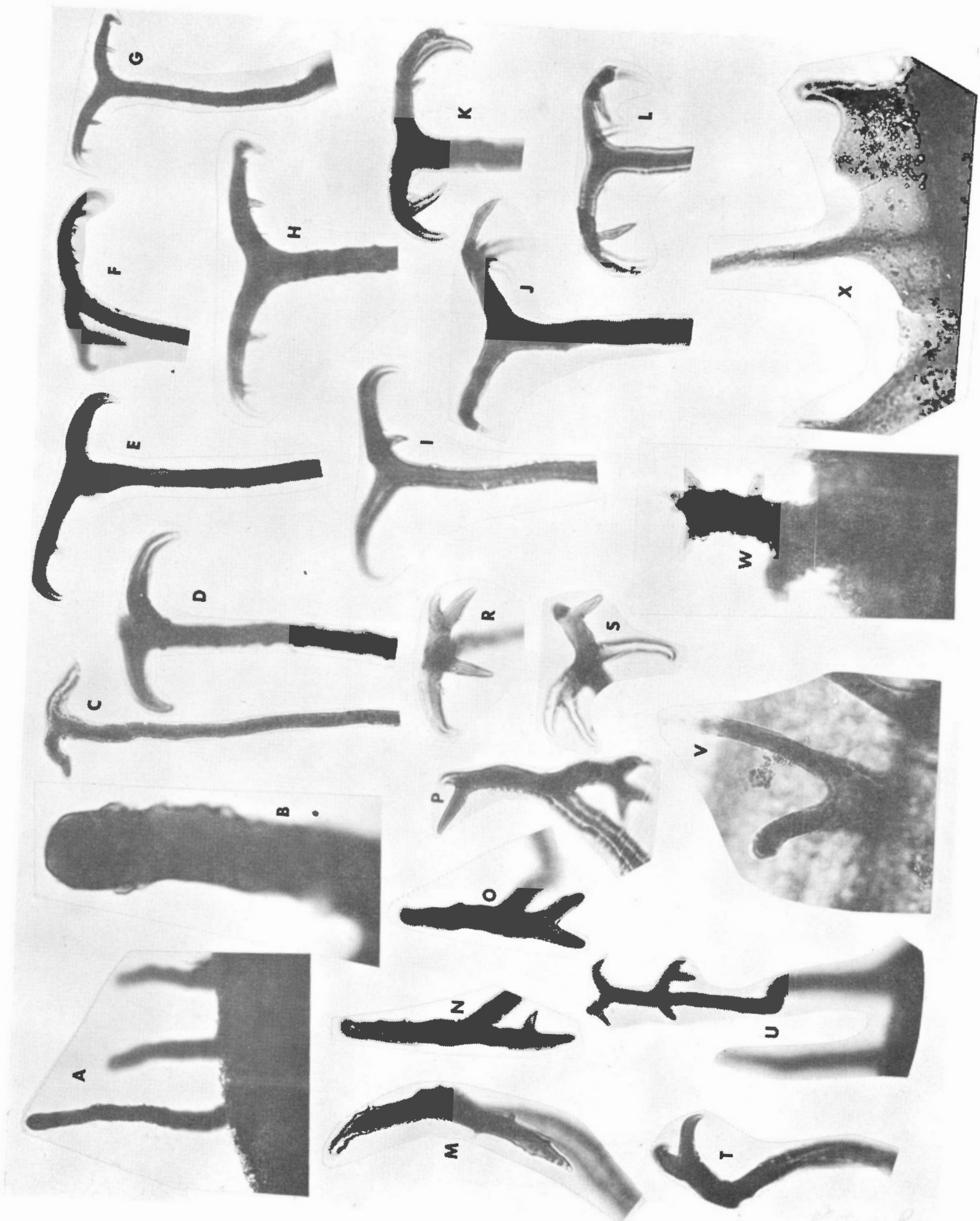

Plate 3

Spines of spinoblasts:

A - (150x);

B - details of finger-like spines (750x);

C, D - dichotomous ends of spines (250x);

E, H - dichotomous ends with lateral teeth (250x);

I - trichotomous ends of spine (250x);

J, L - dendroidal ends of spines (250x);

M - frontal view of anchor spine (250x);

N - same as M but the lower arm has teeth (250x);

O - same as N but with the lower arm branching (250x);

P - same as N but ends of an anchor with branching arms (250x);

R - frontal view of trichotomous end of spine (250x);

S - frontal view of dendroidal end of spine (250x);

T - (250x);

U - (100x);

V - (200x);

W - atypical forms of spines (500x);

X - joined basal parts of spines (150x)

(GSC photo 201845C)

Cristatellidae which consists of the single species Cristatella mucedo. The writer considers it to be a pan-continental species. Its northernmost extension in the Northern Hemisphere is not known precisely, but it is delineated by the Kola Peninsula, Lappland (just north of the Arctic Circle), Finland (63° N), Iceland, Japan, Kamchatka, and Lake Baykal. Hyman (1959, p. 493) defined its range as "distinctly a circumboreal and North Temperate species, wanting altogether in warmer climates and in the Southern Hemisphere". It also occurs in alpine regions up to an elevation of 3, 950 m.

The general ecology of phylactolaemates was summarized by Hyman (1959, p. 490) as follows: they "are found throughout the fresh waters of the world except in polar regions, at a wide range of altitude from sea level to high mountain lakes and at depths varying from the extremely shallow waters of small streams and pools to the bottoms of large lakes". In the light of this statement, fossil locations of statoblasts from the High and Low Canadian Arctic have a special significance.

Mature Cristatella colonies, unlike other phylactolaemates, are mobile (1 to 1.5 cm per day). Their diaspores can be dispersed by fish and other aquatic animals, birds, and water currents, and possibly also in other ways. Numerous hooked processes arranged in two equatorial rings are features of dissemination by attachment (Brown, 1933) rather than a float characteristic of floatoblasts of Hyallinella, Plumatella and Stolella dispersed by wind or water.

Cristatella mucedo, like other fresh water bryozoans, lives in still pools, shallow ponds, bays and backwaters with a pH of 5.3 to 8.0 at depths of less than one metre. It has rarely been collected from deeper waters.

Strongly acidic waters, bogs and polluted water in which the oxygen content falls below 30% saturation never contain bryozoans. Waters of interglacial and postglacial lakes were probably not oligotrophic because they were rich in plankton, aquatic plant remains, rotten material, sapropel-peat, etc.

Statoblasts function as survival forms during unfavourable conditions and during the winter and dry seasons.

Two to eight statoblasts are usually produced by a single zooid during the entire growing season, mostly in late summer and in autumn when colonies die off due to decreasing temperatures. In spring, or under suitable conditions, they germinate, emerging as soft bodied polyps. In northern and alpine regions the dormant period of statoblasts is much longer than one generation cycle. Dry statoblasts kept at room temperature for fifty months gave 70 per cent germination, but none germinated after seventy-four months. Statoblasts begin to germinate when the temperature reaches 10° to 19° C and start to die off when the autumn temperature drops below 5° to 10°C. They are most abundant at optimal summer temperatures.

Statoblasts occur most abundantly in interglacial beds, infrequently in the Beaufort Formation, and are quite rare in postglacial ones. In sapropels of the Beaufort Formation only single valves were found whereas, in interglacial deposits, ungerminated statoblasts were not rare. Future investigations of the proportions of germinated to non-germinated statoblasts may throw a light on the temperature of fossil lakes. Many other ecological and physiological features of a bryozoan life, useful for paleoecological purposes, could be drawn from the literature, but these are not within the scope of the present paper.

There is a voluminous literature on fossil marine bryozoans but very little on fossil Phylactolaemates. Hyman (1959, p. 500) states: "Phylactolaemates cannot be expected to leave fossil remains; one fossil from the Cretaceous of Bohemia is doubtfully supposed to be a relative of Plumatella" (cf. also Larwood et al. 1967) and Rogick (1960 p. 356) "Phylactolaemata .... objects interpreted to be statoblasts (hard-covered reproductive bodies) produced by this class of Quaternary rocks". Schofield and Robinson (1960) recently found statoblasts of late-Glacial and postglacial age in the water deposit of Gillis Lake (Nova Scotia) as did Kuc and Hills (1971) in sapropel on N.W. Banks Island (see Table I).

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