

# The Female Conceptacle and Young Sporeling of the Four New Zealand Species of *Carpophyllum*

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## Abstract

THE four New Zealand species of *Carpophyllum* agree closely in details of conceptacle development, oogonium maturation and early segmentation of the sporeling. The oogonium contents are liberated in an eight nucleate condition and the maturation of the oosphere is completed after extrusion. A mucilaginous stalk formed from the oogonium wall retains the fertilised egg until the rhizoidal system of the sporeling is established.

## INTRODUCTION

THE genus *Carpophyllum* is represented in New Zealand by four species—*C. elongatum* (Dickie) A. & E. S. Gepp, *C. flexuosum* (Esper) Grev., *C. maschalocarpum* (Turn.) Grev. and *C. plumosum* (Ach. Rich.) J. Ag.—and the variety *capillifolium* J. Ag. of *C. plumosum*. The only descriptions of the reproductive structures of these species are those of Delf (1939) and Dawson (1940) who worked in England on preserved material sent from New Zealand. Owing to the restricted nature of their material these accounts are not complete and the present investigation is an attempt to fill in some of these gaps.

The *C. elongatum* was collected from Mokohinau Island, from Cape Brett and from Tapeka Point, Russell, but owing to difficulties involved in collecting from these exposed habitats, the account of this species is still incomplete. The remaining species were collected principally from Castor Bay, Auckland, supplemented by material from Russell. The fixative used throughout was Papenfuss's modification of Karpechenko fluid (Laing, 1941). Sections were cut at  $8\mu$  and stained with crystal violet or Heidenhain's iron alum haematoxylin for cytological details and with erythrosin or Delafield's haematoxylin for segmentations of the sporeling.

## THE CONCEPTACLES

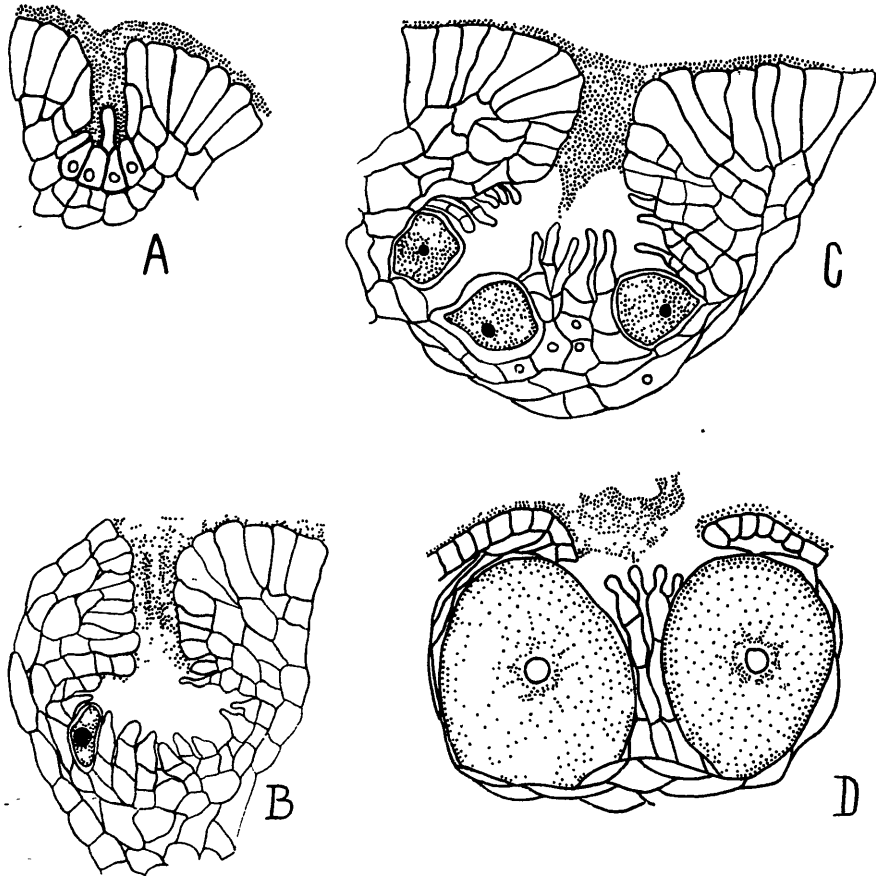
Early stages of conceptacle development have been described in *C. elongatum* and *C. maschalocarpum* by Delf and in *C. flexuosum* by Dawson and my observations show a similar sequence of divisions in *C. plumosum* (Text-figs. 1A–C).

In all four species only a few, relatively large oogonia develop in each conceptacle. At maturity they occupy almost the entire conceptacle cavity (Text-fig. 1D) and usually become angular as the result of mutual pressure. They are separated by groups of closely appressed moniliform hairs whose cells swell after the release of the oogonium contents and fill the spent conceptacles with pseudoparenchymatous tissue. Dawson found the average number of oogonia in a conceptacle to be nine in *C. flexuosum*. I find a similar number in *C. plumosum* and *C. elongatum* also, but in *C. maschalocarpum* usually only three or four reach maturity

and sometimes as few as two. In young conceptacles larger numbers of developing oogonia are seen, so possibly space considerations prevent their reaching maturity.

#### OOGONIUM DEVELOPMENT AND MATURATION

The oogonia and the sterile hairs which separate them are at first indistinguishable, as both arise as papillae from the lining layer of the conceptacle. Soon the oogonia can be distinguished by their more densely staining contents. The fully developed oogonia of *C. elongatum*, *C. maschalocarpum* and *C. plumosum* reach a length of about  $142\mu$  with a maximum diameter of  $123\mu$  in the first two species and  $95\mu$  in *C. plumosum*. After their liberation the oospheres become spherical with a diameter of up to  $160\mu$  in the two latter species, though *C. plumosum* tends to be rather smaller. A comparable measurement for extruded *C. elongatum* oospheres could not be obtained. The "almost mature oogonia" of *C. elongatum*



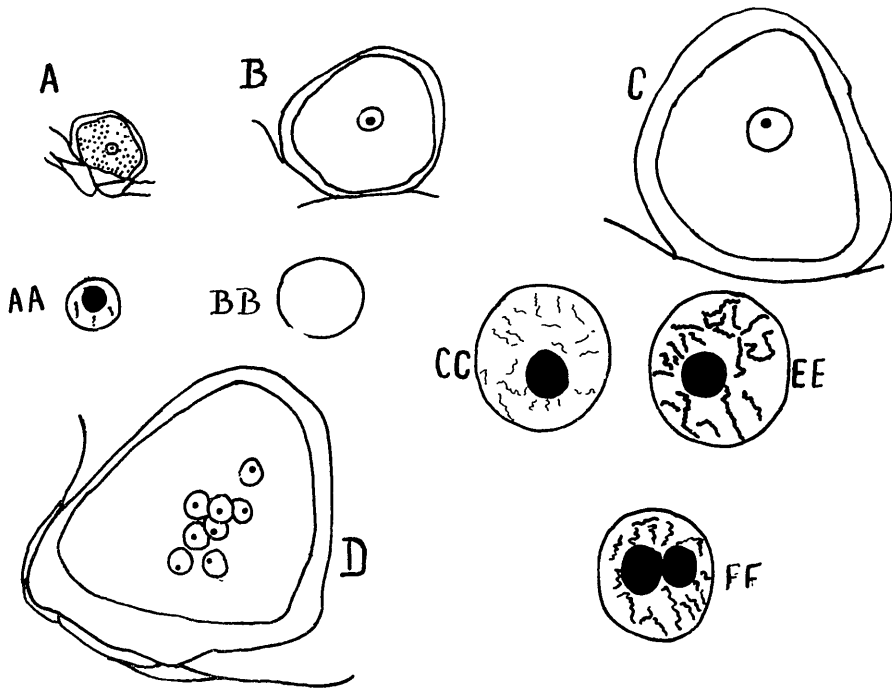
TEXT-FIG. 1.—A, B, C—Early stages of conceptacle development in *C. plumosum* var. *capillifolium*. A—Still within the apical groove and showing the formation of the tongue cell. B and C—Slightly older stages showing the concurrent development of the oogonia and the concentric hairs. Scale =  $\times 435$ .

D—Section of an almost mature conceptacle of *C. maschalocarpum* which contained 4 oogonia, showing the large oogonia and central tuft of hairs. Scale =  $\times 285$ .

All outlines drawn with the aid of a camera lucida.

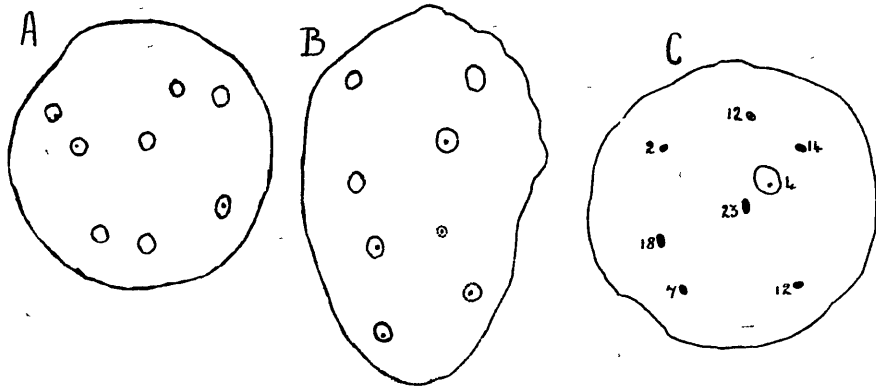
and *C. maschalocarpum* which Delf states to be “nearly spherical and have a diameter of 60–80 $\mu$ ” must in fact have been little more than half grown. The oogonia of *C. flexuosum* are considerably larger, reaching a length of 210 $\mu$  and width of 112 $\mu$  before extrusion, and a diameter of 180 $\mu$  after extrusion (cf. Dawson 178 $\mu$  x 137 $\mu$ ).

Cytological maturation of the oosphere has hitherto been followed only in *C. flexuosum* where Dawson found the prophase of a large central nucleus and, after extrusion, an eight nucleate stage, but no intervening stages. In the present investigation, for several successive days mature female plants of all species except *C. elongatum* were marked on the shore and receptacles fixed at half-hourly intervals over the two hours for which they were accessible at low tide. In all cases a large central nucleus divided to give an eight nucleate stage, whilst the oosphere was still within the conceptacle. At first the eight nuclei were central in position (Text-fig. 2D), but soon migrated to the periphery (Text-fig. 3A). In this condition, with eight peripheral nuclei of equal size, the oogonium contents—“oocyte” (Mitchell, 1941)—were liberated (Text-fig. 3B). Seven of the nuclei then degenerated, appearing smaller, flattened and densely staining during the process (Text-fig. 3C). In no case was there any evidence of degeneration of the supernumerary nuclei before extrusion; it was not possible to determine whether this degeneration took place *before* fertilisation or *after* as in *Sargassum horneri*



TEXT-FIG. 2.—A, B, C, D—Stages in the enlargement and maturation of the oogonium of *C. plumosum* var. *capillifolium* whilst still within the conceptacle. AA–CC—The nuclei from the oogonia to a higher magnification. EE—Nucleus from an oogonium similar to C, but with the chromatin more deeply staining. FF—A nucleus with two nucleoli. Similar stages have been found in *C. flexuosum* and *C. maschalocarpum*.

All outlines drawn with the aid of a camera lucida. Scale: A–D =  $\times 200$ ; AA–FF =  $\times 900$



TEXT-FIG. 3.—Oogonia of *C. maschalocarpum* showing the final stages of maturation. A—An eight nucleate oogonium still within the conceptacle as in 2D, but with the eight nuclei peripherally arranged. Built up from 12 consecutive sections. B—An eight nucleate oogonium after extrusion, but before degeneration of the supernumerary nuclei. Built up from 16 consecutive sections. C—An eight nucleate oogonium after extrusion, but with seven nuclei degenerating, and with the one functional nucleus in a peripheral position. Built up from 24 consecutive sections. The numbers indicate the level of the section in which that nucleus appeared. Scale =  $\times 275$ .

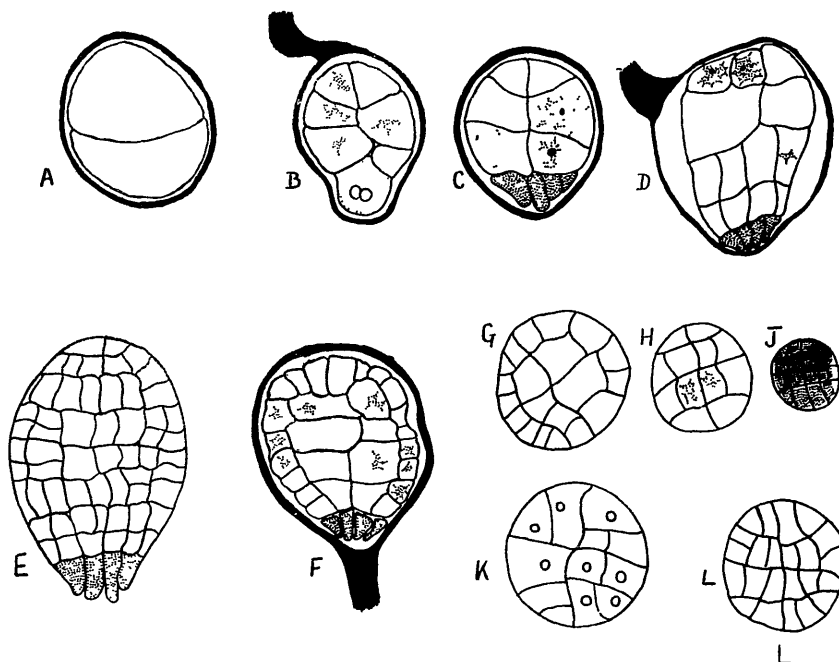
and *S. tortile*, or whether fertilisation took place whilst the nucleus was in a peripheral position or whether it first migrated to the centre.

No four-nucleate oogonia were found, nor any stages in nuclear division. This may be due to the limited time range over which fixations were made—i.e., from approximately 8.30 a.m. until 11.30 a.m.—as Abe (1938) found that nuclear division in *Sargassum tortile* commenced during the afternoon and was completed by the following morning when extrusion took place.

#### EXTRUSION AND EMBRYOLOGY

In all four species, the liberated oogonium contents are not released free into the sea but remain attached to the receptacle by a firm, mucilaginous stalk formed from the oogonium wall. In this position fertilisation takes place and sporeling development commences.

Dawson described sporelings with a tuft of sixteen rhizoids in *C. flexuosum*, and Delf described well developed sporelings but was unable to assign them to a species. In the present investigation sporeling development was followed from attached sporelings in the three species in which they were found—that is, in all except *C. elongatum*. The first median wall (Text-fig. 4A) dividing the sporeling into two multinucleate portions was seen only in *C. plumosum*, but the following stages were found in all three species. A protuberance next developed at one end and was cut off to form a relatively large, densely staining, multinucleate rhizoid initial (Text-fig. 4B), which soon divided longitudinally (Text-fig. 4C) to produce a basal tuft of sixteen rhizoids (Text-fig. 4J). Meanwhile subdivisions in the body of the sporeling had resulted in the formation of a small-celled surface layer enclosing a central region (Text-fig. 4F). In the most advanced of the attached sporelings, transverse sections showed about 16 peripheral cells surrounding 8 central ones (Text-figs. 4G and L), obviously the result of a regular sequence of cell division (Text-figs. 4G, H, K) which had consisted of two vertical walls at



TEXT-FIG. 4.—Sections and surface views of young sporelings. A, B, C, K and L. *C. plumosum* var. *capillifolium*. D—*C. flexuosum*. E, F, G, H, J—*C. maschalocarpum*. Except for stage A comparable stages were seen in all three species in which sporelings were found. A, B, C, D and F are median longitudinal sections. E—A surface view of a week-old living sporeling. G, H, J—Transverse sections of the same sporeling of *C. maschalocarpum* at different levels. K and L—Transverse sections of two sporelings of *C. plumosum* of slightly different ages showing the regular sequence of wall formation. Outlines drawn with the aid of a camera lucida. Scale =  $\times 140$ .

right angles, followed, in each quadrant so formed, by a wall approximately parallel to one of the first formed walls. Each portion so formed then gave rise to an inner and an outer cell by a fairly regular sequence of walls. There was no constant orientation of the longitudinal axis in relation to the receptacle, as can be seen by comparing the position of the attaching stalks in Text-figs. 4B, D and F.

By this stage the rhizoidal system was well established and the sporeling became detached. It was not possible to judge how long the sporelings remained attached in nature, but in all three species followed, attached sporelings were found which were comparable in size and differentiation with some in cultures of *C. maschalocarpum* a week after fertilisation.

#### DISCUSSION

In the formation of a tongue cell cut off by a curved wall, the species of *Carpophyllum* investigated resemble other members of the Sargassaceae, of which details are known.

Late maturation of the oosphere is characteristic of those Sargassaceae in which the oosphere is retained, and the degeneration in situ of the supernumerary nuclei is also in agreement with other members of the Sargassaceae and in contrast to the condition in the Cystoseiraceae where they are extruded from the cytoplasm.

The sequence of segmentation in the sporeling resembles that in *Coccophora langsdorffii* (Tahara, 1928), *Turbinaria fusiformis* and *T. thunbergii* (Tahara, 1929) and in *Cystophyllum sisymbrioides* (Okabe, 1929), but differs from that usual in *Sargassum* where the third vertical wall is radial, dividing the body of the sporeling into octants, a feature considered by Tahara (1928) to be of systematic value.

The production of a tuft of primary rhizoids is also a feature of the family Sargassaceae. Inoh (1930) attempted to correlate the number of primary rhizoids with the size of the oosphere in *Sargassum*. In all the species of *Carpophyllum* investigated the egg is considerably smaller than in any of the *Sargassum* species with the same number of rhizoids (16), but is more comparable with those producing only eight.

#### ACKNOWLEDGMENT

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#### LITERATURE CITED

- ABE, K., 1938. Über die Befruchtung und ihre folgende erste Kernteilung bei *Sargassum*. Sci. Repr. Tohoku Imp. Univ. Fourth Series. Sendai, Japan, 13: 253.
- DAWSON, A. E. E., 1940. Studies in the Fucales of New Zealand II. Observations on the Female Frond of *Carpophyllum flexuosum* (Esper) Grev. New Phytol., 39: 283.
- DELFT, E. M., 1939. Studies in the Fucales of New Zealand I. The genus *Carpophyllum* Grev. J. Bot., 77: 129.
- INOH, S., 1930. Embryological Studies on *Sargassum*. Sci. Repr. Tohoku Imp. Univ. Fourth Series. Sendai, Japan, 5: 423.
- LAING, E. M., 1941. A Note on *Bifurcaria laevigata* (Kütz.) Delf et Mitch. J. Bot., 79: 145.
- MITCHELL, M., 1941. Studies in the Fucales of New Zealand III. Some Investigations on *Xiphophora chondrophylla*. J. Bot., 79: 49.
- OKABE, S., 1929. Rhizoidenentwicklung im Embryo von *Cystophyllum*. Sci. Repr. Tohoku Imp. Univ. Fourth Series. Sendai, Japan, 4: 591.
- TAHARA, M., 1928. Contributions to the Morphology of *Coccophora langsdorffii* (Turn.) Grev. *Ibid.*, 3: 727.
- 1929. Rhizoid formation in the Embryo of *Turbinaria* (?) *fusiformis* Yendo and *Sargassum Thunbergii* O. Kuntze. *Ibid.*, 4: 1.

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New Zealand Hepaticae (Liverworts)—VIII  
A Review of the New Zealand Species of the Genera *Bazzania*  
and *Acromastigum*

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**Summary**

PART I. Introduction to *Bazzania*; 2 Sections represented in New Zealand, *Connatae* and *Vittatae*. Description of genus; Key to species; Description of species with one new combination, *Bazzania Hochstetteri* (Reichardt) Hodgson; Additional Notes.

Part II. Introduction to *Acromastigum*; 2 Sections represented in New Zealand, *Squarrosa* and *Inaequalatera*; Description of genus; Key to species; Descriptions of species including 1 new one, *Acromastigum marginatum*, 2 new combinations, *A. verticale* (Steph.) comb. nov., and *A. Mooreana* (Steph.) comb. nov.; *A. integrifolium* a Hawaiian species recorded in New Zealand for the first time; 2 plates, 16 figures.

PART I.

*Bazzania* and *Acromastigum* are closely related genera, belonging to the family *Lepidoziaceae*. *Bazzania* is a large genus, mostly of tropical and subtropical species. It is a well-marked genus, the leaves throughout having a uniformity of character which makes the species difficult to separate. In New Zealand there are 4 species with well-defined characters, *B. convexa*, *B. Tayloriana*, *B. monlinervis* and *B. Novae-Zelandiae*. But with *B. adnexa*, *B. involuta*, and *B. Hochstetteri*, the forms approach one another, and it is difficult to assign positive limits to the species.

All the New Zealand species belong to the subgenus TRIDENTATAE Steph., and to the following sections as revised by Fulford (1946).—

CONNATAE. *B. involuta*, *B. adnexa*, *B. Novae-Zelandiae*, *B. Hochstetteri*.

VITTATAE. *B. monlinervis*, *B. Tayloriana*, *B. convexa*.

The section *Connatae* includes all the species having the stipule connate with the leaf, on both or on one side, even if they are joined by 1 or 2 rows of cells.

The section *Vittatae* includes all the species whose leaves show a vitta of enlarged cells. Stephani places *B. Hochstetteri* in this section although the vitta often consists of a group of large cells in the interior of the leaf, instead of 2-4 distinct rows adjacent to the ventral margin.

GENUS BAZZANIA

*Bazzania* S. F. Gray, *Nat. Arr. Br. Pl.*, 1, 704, 1821 (as *Bazzanius*).

*Pleuroschisma* Dumort., *Syll. Jungerm.*, 68, 1831.

*Herpetium* Nees, *Nat. Eur. Leberm.*, 1, 96, 1833.

*Herpetium* Section *Mastigobryum*, *Nat. Eur. Leberm.*, 3, 43, 1838.

*Mastigobryum* G. L. et N., *Synopsis Hepaticarum* 1844-1847.

Plants medium to robust in tufts, loosely creeping, or forming cushions, in various shades of green or greenish brown, on earth, humus, rotting logs or rock. Stems furcately branched and bearing flagellae with minute, scale-like leaves from