On the Centrosome of Hepaticæ.¹⁾

Preliminary note.

BY

K. Miyake.

In the summer 1903 in "Beihefte zum Botanischen Centralblatt," Ikeno²⁾ made a remarkable report on the occurrence of Centrosome in the antheridial cells of *Marchantia polymorpha*. He found Centrosome in every dividing cells of the antheridium. According to his observation just before the cell divides the Centrosome comes out from the nucleus into the Cytoplasm where it divides into two and each of them is later found at the opposite side of nucleus. When the spindle is formed one can recognize Centrosome in each pole of the spindle. The Centrosome disappears at the end of each division and appears again at the beginning of next division. Only the Centrosome of the last division, i.e. the division in the formation of the spermatid, persists and functions as a blepharoplast. The Centrosome is always found without any sign of cytoplasmic radiations as usually seen in both animal and plant Centrosomes. The observations of Ikeno are so remarkable and in many points so different from what has hitherto been described in the cells of Hepaticæ that I found it desirable to repeat his observations. At first I studied the dividing cells of antheridium in *Marchantia polymorpha*. Then I was able to extend my studies to (*Conocephalum conicum*, *Fegatela conica*) *Pellia Epiphylla*, *Makinoa crispata* and a species of *Aneura*. The material was usually fixed with Flemming's solution and stained either with Flemming's tripple methods or with Haidenhains's iron-alum hæmatoxylin.

Although my study is not yet completed I may be allowed to present some of the results so far obtained. In *Marchantia polymorpha* I studied the nuclear division in antheridium of various stages of development from very young antheridium consisting only of a few cells to the fully developed

1) Read before Section K of the British Association, Cambridge, Aug. 1904.

2) Die Spermatogenese von *Marchantia Polymorpha*. Beihefte z. Bot. C. Bd. XV, 1903.

one. The structure of the cells and the process of division are practically the same throughout the whole cell-generations. The nucleus contains in its centre a granular mass of chromatic substance and does not seem to have any nucleolus-like body. When the nuclear division is about to take place the nucleus which is usually spherical elongates and assumes a more or less elliptical shape. At each pole of the nucleus there appears a cytoplasmic radiation. Each radiating structure or aster seems to centre to a point just outside of the nuclear membrane almost in close contact with the latter. Here in the centre of the radiation a minute dot which might be taken for a Centrosome has sometimes been observed. But it is not at all a distinct or constant structure and I am not inclined to give any importance to it. When the spindle is formed the aster entirely disappears, and one also fails to see in the spindle pole any structure which might be taken for a Centrosome. Either in the resting stage or in any other stages of the dividing nucleus of the young antheridium I failed to see the structure corresponding to the Centrosome of Ikeno. Only in the last division of the antheridium I found two deeply staining bodies at the spindle poles as figured by Ikeno. Although I have not studied the further behaviour of this body in the development of the spermatozoid, there would be little doubt that it will take part in the formation of cilia as Ikeno described, and may properly be called a blepharoplast.

I obtained a similar result in the study of *Fegatela conica*. The antheridial cells of this plant are larger than those of *Marchantia* and therefore are more favourable for the study. In the resting nucleus of the antheridial cells, instead of a granular mass of chromatic substance as seen in *Marchantia*, one large nucleolus was observed. The nucleolus has a diameter nearly $\frac{1}{3}$ of that of the nucleus, and very little chromatic substance is found in the nuclear reticulum. The nucleolus would probably contribute a considerable part of its substance to the formation of chromosomes.

The antheridial cells of *Pellia*, *Aneura* and *Makinoa* are considerably larger compared with those of *Marchantiaceæ*. The nuclear division in the antheridium of these three genera agrees in its essential points. The nucleus contains a nucleolus which is of ordinary size. Just before the nucleus divides, it assumes more or less elliptical shape and two cytoplasmic radiations or asters are seen at opposite poles of the nucleus. In the centre of the radiating structure I failed to recognize any distinct body which corresponds to the Centrosome. With the formation of the spindle, asters gradually disappear and at the poles of complete spindle one fails to

recognize either the asters or the Centrosomes. The kariokinetic figures in both aster and disaster stages resemble very much to that of the flowering plant.

Just before the last mitosis takes place in the antheridium of *Makinoa* the cells assumes a more or less spherical form somewhat like the pollen-mother-cells of many flowering plants. At the spindle-pole of the last division I was able to recognize neither centrosome or blepharoplast. I often observed two groups of granules nearly opposite to each other, in some distance from each pole of the spindle. I have not yet succeeded in following the fate of these granular bodies. It is not improbable that these bodies would function as a blepharoplast in the cilia-formation of the spermatozoid. In the fully developed spermatozoid I often observed a deeply staining spherical body in the cytoplasm which is very probably a blepharoplast. The identity of these two structures and their relations to cilia-formation would only be revealed by future careful studies which I hope to undertake.

The occurrence of Centrosome in the Hepaticæ has at the first time been reported by Schottländer¹⁾ in 1892. The first careful study about this subject has been made by Farmer. In 1894 he described together with Reeves asters and centrosome for the early mitosis in the germinating spore of *Pellia*.²⁾ In the following year he reported the occurrence of centrosome in several other species of Hepaticæ.³⁾ In 1899 Davis⁴⁾ studied the division of the spore-mother-cells of *Anthoceros* and failed to recognize any centrosome at the spindle-pole. In the following year Van Hook⁵⁾ confirmed Davis' results concerning the absence of Centrosome in *Anthoceros* and described definite Centrosome in the vegetative cells of the gametophyte of *Marchantia*. Davis⁶⁾ in 1901 and Chamberlain⁷⁾ in 1903 confirmed and extended the studies of Farmer in regards to the presence of centrosome in *Pellia*. However, Davis failed to observe centrosome in the division of the spore-mother-cell and the seta of the sporophyte in *Pellia*. Chamberlain has not been able to see centrosome in the antherid-

1) Cohn's Beiträge zur Biologie der Pflanzen, Bd. VI, p. 267.

2) Farmer and Reeves, Ann. of Bot., Vol. VIII, p. 219.

3) Farmer, Ann. of Bot. Vol. IX, p. 469.

4) Bot. Gaz. Vol. XXVIII, p. 89.

5) Bot. Gaz. Vol. XXX, p. 394.

6) Ann. of Bot. Vol. XV, p. 147.

7) Bot. Gaz. Vol. XXXVI, p. 28.

ial cells of *Pellia*. Very recently Grégoire and Bergh¹⁾ took up the same question in *Pellia* and came to the conclusion that there is no true Centrosome.

The presence of Centrosome in the flowering plants and ferns seems to have been almost conclusively disproved by the careful researches of cytologists during the last ten years. On the other hand it is still generally believed that in the Bryophytes and Thallophytes Centrosome does exist. But my present study seems to show that there is no true Centrosome at least in the Hepaticæ, agreeing with the conclusion of the recent study of Grégoire and Bergh. The centrosome hitherto reported in the cells of the Hepaticæ are nothing but a centre of cytoplasmic radiation.

The question of the homology of centrosome and blepharoplast is another interesting problem which has not yet been solved. I am not in the position to express any definite opinion about this question. However, my present study and that of spermatogenesis of *Zamia* induce me to incline more towards the standpoint of Strasburger and Webber who consider the two bodies as different Morphological structures.

DOSHISHA COLLEGE, KIOTO.

1) La Cellule, t. XXI, p. 193, 1904.