

other records of such work should be presented for the benefit of those working on this group. Personally we should appreciate any such contribution as bearing on some work now in hand.

Closterium lanceolatum, Kg.,

Closterium moniliferum, Ehrb.,

Closterium Leibleinii, Kg., Var. *curtum*, West.

Staurastrum muticum, Berb.

Staurastrum botrophilum, Wolle.

Calocyclus Thwaitesii, Ralfs.

Penium Berbissonii (Mench), Ralis.

Penium margaritaceum, Berb.

Cosmarium pseudobroomci, Wolle.

Cosmarium granatum, Berb.

Cosmarium speciosum, Lund.

Cosmarium Holmiense, Var. *integrum*, Lund.

Cosmarium polymorphum, Nord.

Cosmarium Naegelianum, Berb.

Cosmarium Cordanum, Berb.

KARYOKINESIS IN THE EMBRYO-SAC WITH SPECIAL REFERENCE TO THE BEHAVIOR OF THE CHROMATIN. BY D. M. MOTTIER.

[Published in Jahrb. für wiss. Botan., Bd. XXX, 1897.]

NUCLEAR DIVISION IN VEGETATIVE CELLS. BY DAVID M. MOTTIER.

[Abstract.]

In my paper "Ueber das Verhalten der Kerne bei der Entwicklung des Embryosacks und die Voränge bei der Befruchtung,"¹ I gave a brief account of karyokinesis in the vegetative cells of *Lilium*. My remarks there are confined largely to the behavior of the chromatin, the formation of the spindle being only incidentally referred to. As regards the latter process, however, it is stated that the kinoplasm is present in a much

¹ Jahrbücher für wiss. Bot., Bd. XXXI, 1897.

smaller quantity than in the sexual cells of the same plant. As a rule it is not at first arranged radially about the nucleus, but forms a delicate weft which may be closely applied to the nuclear membrane. Not infrequently a few radiating kinoplasmic fibres are present in addition to the weft. Frequently, and especially in the earlier stages, this weft is so delicate and equally distributed about the nucleus that the most careful staining is necessary to detect its presence, and that for this reason it may be easily overlooked.

In many cases the fibres of this weft are collected in larger and looser masses at different parts on the nuclear membrane, when the weft is more easily demonstrated. The kinoplasmic fibres of the weft form a multipolar spindle which is rapidly transformed into the typical bipolar type. In the cells of the ovule of *Helleborus* the cap-like masses of kinoplasmic fibres upon diametrically opposite sides of the nucleus is often more readily seen than in *Lilium*.

Recent investigations which tend to confirm the above statement, have shown that these accumulations of kinoplasmic fibres are characteristic of a definite phase in the development of the spindle in certain vegetative cells.

The results recently published by Hof¹, which are in accord with the foregoing statement, have contributed much valuable and additional data to our knowledge of the formation of the karyokinetic spindle in higher plants.

Hof finds further that the anlage of the spindle may be bipolar from the beginning, but in *Vicia faba* and *Pteris* sp. along with this type, the monoaxial multipolar anlage occurs.

Thus no fundamental difference exists between the origin of the spindle in vegetative and reproductive cells of the higher plants, save that in the latter (pollen, and embryosac-mother-cells) the anlage of the spindle is multipolar, with little or no definite indication of the future longitudinal axis, while in the former the bipolar anlage may occur side by side with the multipolar mono-axial type. It may be, therefore, as stated by Hof, that "es ergibt sich, so scheint mir, aus den bisherigen Untersuchungen, dass ein principieller Unterschied zwischen den multipolaren und bipolaren Anlagen der Kernspindel nicht gegeben ist, beide Vorgänge sind durch die monoaxial-multipolaren mit einander vereint."

¹ Hof, A. C.: "Histologische Studien an Vegetationspunkten," Botanisches Centralbl. Bd. LXXVI, 1898.

The development of the karyokinetic spindle as it is now known proves conclusively that centrosomes do not exist in the higher plants.

My own studies, now in progress, confirm my previous statement, and so far as they have extended are not at variance with the results of Hof.

THE CENTROSOME IN *Dictyola*. BY DAVID M. MOTTIER.

[Published in Ber. d. deutsch. Botan. Gesell., Bd. XVI, 1898.]

THE CENTROSOME IN CELLS OF THE GAMETOPHYTE OF *MARCHANTIA*.

BY DAVID M. MOTTIER.

[Abstract.]

While making preparations to demonstrate to a class the archegonium and its development in *Marchantia polymorpha*, my attention was attracted by conspicuous aggregations on opposite sides of certain nuclei in the stalk cells of the receptacle. Closer observation showed that these aggregations were due to the presence of "centrospheres," about which and among whose radiations were collected chloroplasts and finer cytoplasmic granules.

For our knowledge of centrosomes or "centrospheres" in liverworts, we are indebted largely to the recent researches of Farmer.¹

"When nuclear division is about to take place," says Farmer, in speaking of the germinating spores in *Pellia epiphylla* Nees, "two structures of a minute size appear on the outside of and in contact with the nuclear wall, and from them beautiful radiations extend. These bodies, or centrospheres, are commonly seen to be diametrically opposite to each other in position, for we have not succeeded in demonstrating them in the perfectly resting cells, nor have we been able to ascertain the existence of any definite particle within them which would indicate the presence of a centrosome. It is true that in some instances such a point could be distinguished, but we do not attach much importance to it, since in the great majority of centrospheres it completely eluded recognition."

¹ Farmer, J. B., and Reeves, Jesse: "On the Occurrence of Centrospheres in *Pellia epiphylla* Nees." Ann. Bot., VIII, 219-224, 1894.

Farmer, J. B.: "On Spore-Formation and Nuclear Division in the Hepaticae," Ann. Bot., IX, 469-523, 1895.

Recent researches upon certain brown algae (*Dictyota*,¹ *Stypocaulon*² and *Fucus*³) have shown that the centrosome in plants is in all probability something more than a mere point of insertion of the kinoplasmic radiations. In *Dictyota* there seems to be no doubt but the centrosome is a definite body, being here relatively large and rod-shaped, and from which kinoplasmic fibres radiate. In the vegetative cells of *Marchantia* I can not assert with absolute certainty that a definite central body or centrosome exists in all cases, but I believe that such is the case. In some in which the kinoplasmic radiations are densely stained, the dark center seems to be merely the point of union of the radiations, but if the stain be washed out so that the radiations are almost colorless, a well-defined and densely-stained central body is generally to be seen. Since it is now known that the small hyaline space in which the centrosome is sometimes seen to lie, is an artefact, the term centrosphere at present has reference to the centrosome with its radiations, and it is in this sense that the word is here used. By the time the chromosomes are differentiated, and even earlier, the centrospheres lie nearly diametrically opposite each other, and appear to be in all cases attached to the nuclear membrane. The nucleus is now generally elliptical in shape with rather pointed ends at which the centrosomes are situated. As Farmer states, it does seem that the centrospheres exert a pulling strain upon the nucleus, and I have often found that the ends were prolonged into slender beaks terminating in the centrospheres.

I have not as yet been able to obtain a series of stages illustrating the formation of the spindle. The mature spindle consists of delicate bundles or strands of kinoplasmic fibres extending from pole to pole. The fibres stain readily with gentian violet, so that the spindle although often quite small is not an inconspicuous object even when observed by means of dry lenses.

As soon as the chromosomes are regularly arranged in the equatorial plate, the polar radiations become faint and soon disappear. In some cases no polar radiations were visible at this stage.

¹ Mottier, D. M.: "Das Centrosom bei *Dictyota* (Vorläufige Mittheilung)." Ber. der deutsch. bot. Gesellsch., XVI, 1898.

² Swingle, W. T.: "Zur Kenntniss der Kern- und Zelltheilung bei den Sphaecelariaceen." Jahrb. für wiss. Bot., XXX, 1897.

³ Strasburger, E.: "Kerntheilung und Befruchtung bei *Fucus*," Jahrb. für wiss. Bot XXX, 1897.

When the daughter chromosomes have arrived at the poles and before any trace of a nuclear membrane is visible, neither centrosome nor polar radiations are to be seen. Sometimes a small, densely-stained body may be seen lying against the nuclear wall, but since these bodies are precisely like others scattered about in the cytoplasm, it would be mere empiricism to speak of them as centrosomes.

The vegetative cells of the gametophyte of *Marchantia* can not be said to be especially favorable for the study of the karyokinetic process. The nuclei are small and the chloroplasts as a rule collect about the centrospheres, thus obscuring many of the finer details.

ENDOSPERM HAUSTORIA IN *LILIUM CANDIDUM*. BY DAVID M. MOTTIER.

[Abstract.]

So far as the writer is aware, there is as yet no case on record in which it is known that a special provision is made by the endosperm of any of the *Liliaceae* for increasing the absorbing surface in the chalazal region.

During a study upon the fecundation in *Lilium candidum*, it was noticed that cells of the developing endosperm bordering upon the chalazal surface were rendered strikingly conspicuous by their denser contents and the presence of karyokinetic figures, and that the sharp and regular line of demarkation between endosperm and the tissue of the ovule almost disappears at the chalaza. Here the endosperm cells send out short, irregular tubes which penetrate the tissue of the chalaza in a way similar to that in which the cells of the foot of the sporophyte in *Anthoceros* become rooted in the tissue of the gametophyte.

The growth of the developing seed is such that, before the endosperm completely fills the cavity of the embryo-sac, the chalazal region is forced into a lateral position with respect to the longer axis of the seed. The chalazal end of the embryo-sac originally occupied by the antipodal cells persists as a small cavity, which is now filled with a few endosperm cells, projecting into the chalazal tissue. A longitudinal section of the endosperm at this stage in development, coincident with the plane of the funiculus, presents, in the chalazal region, a picture recalling that of a longitudinal section through the foot of the sporophyte of *Anthoceros*.

There seems to be no doubt but this behavior of the endosperm in *Lilium candidum* is a provision for increasing the absorbing surface of that tissue in the region of greater food supply. These cells of the endosperm may, therefore, be known as *endosperm haustoria*.

A similar behavior of the epidermal cells in certain parts of the embryo, such as the cotyledons, serving as special organs of absorption, is well known, and a few striking illustrations of the same are brought together by Haberlandt in his "Physiologische Pflanzenanatomic."

The narrowed end of the embryo-sac, which extends into the chalazal region in certain *Compositae* (*Senecio*), is doubtless associated with a like function. In *Senecio*, however, the antipodal cells not only persist but multiply, while in *Lilium candidum* these disappear early, and the space which they formerly occupied is soon filled by endosperm cells.

THE EFFECT OF CENTRIFUGAL FORCE UPON THE CELL. BY DAVID M. MOTTIER.

[Pub. in Annals of Botany, 1899.]

ABSORPTION OF WATER BY DECORTICATED STEMS. BY G. E. RIPLEY.

It is probably known to all students of botany that the sap in a plant rises chiefly through the wood-cells, and not through the cortex-cells. This can be easily demonstrated by securing two similar leafy shoots from a tree or bush. From one, remove all the cortex for about an inch above the cut end, and from the other the wood for about the same distance. Now place the two prepared ends in water, and observe the rate of wilting as shown by the turgescence of the foliage. In a few hours, if transpiration is rapid, the shoot from which the wood has been removed will begin to wilt, and after a time will lose all turgescence, while the decorticated one will appear almost as fresh as at first and will continue so for a considerable time. This proves that the wood-cells and not the cortex-cells supply the water to the shoot.

Last spring, while performing this experiment in the laboratory of vegetable physiology at Purdue University, it was observed that the third unprepared shoot, used as a control on the other two, wilted much sooner than the decorticated one. This observation at once raised the question