

CLOISTERIUM MONILIFERUM

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Specimens of *Closterium moniliferum* were centrifuged by simply placing a quantity of the plants in a small amount of water in the glass cylinders. A large number of the specimens were easily obtained by filtering a considerable volume of water containing the plants through filterpaper. As the specimens lie in different positions the centrifugal force acted in a great many directions on these unicellular plants. The contents was therefore thrown sometimes to one end, at other times to the side or diagonally in the cell according to the direction the centrifugal force had acted.

A centrifugal force of 1207 g. acting for 1 minute is enough to displace the contents of the cell of *Closterium moniliferum*. The contents are displaced all along the walls almost to the centrifugal end of the cell, while in the center it remains in a string-like mass about two-thirds the length of the cell. The chlorophyll, as well as the gypsum particles, which latter showed the Brownian movement actively, were also displaced. A complete return of the cell contents took place at 22° C. in 3 days. Movement of the protoplasm can be clearly seen in *Closterium moniliferum* in the normal condition. As soon as the centrifugal machine could be stopped and the specimens examined, which was about two minutes, there could be seen an exceedingly rapid movement of the protoplasm in all directions. Part of the contents was forced very compactly into the centrifugal end of the cell. The movement was not visible before centrifuging, but was observable immediately after. There was shown a very beautiful arrangement of transparent polygonal protoplasmic plates so placed as to resemble a honeycomb. This same phenomenon I have observed in the cells of seeds of *Phaseolus multiflorus* when they had been allowed to germinate and were then centrifuged.

The cells were rarely killed by centrifuging and by the displacement of their contents. Unless accidentally killed the contents always returned sooner or later to its original position. This process began by a spreading out on all sides of the centrifuged mass. This at first was very slow, but gradually became more rapid. By the end of the first day at 22° C. only about one-tenth of the area of the cell, from which the contents had been displaced, had returned. On the second day about one-third of the displaced area was recovered and, as stated before, the contents had returned to all parts of the cell by the end of the third day. The contents as they spread out were not of the usual density but gradually became so as its return progressed. The return of the contents was materially assisted in its redistribution by the rapid streaming movements of the protoplasm above referred to. The gypsum crystals also eventually returned to their former position in the cell although they, like some other parts of the cell contents, were carried for a while in all directions by the mov-

ing protoplasm. When the movable contents was compactly thrown to one end of the cell, it could be ascertained that it equalled about one-seventh of the volume of the cell. When the contents were thrown to one side of the cell its redistribution was somewhat more rapid owing to the fact that there was a much greater surface over which redistribution could take place. The average time for redistribution of the contents of a larger number of specimens at 22° C. when their contents was centrifuged to one side was two days.

After the contents had returned, I centrifuged the same specimens of *Closterium moniliferum* again using 1207 g. as before. The contents were displaced as expected. One of the tubes of specimens I placed in the light and the other was put in the dark. The contents returned in all the specimens as before. In the case of those specimens in the light, however, the contents returned completely in three days at 22° C. The specimens which were placed in the dark required a considerably longer time, as complete redistribution of their contents only occurred in five days. As the contents returned to their normal position in the cell in the light after a second centrifuging in the same length of time as before, the activity of the cells did not seem to have been diminished. The cells did not seem to have been injured by such treatment. The influence of the light promoted a more rapid return of the contents and darkness had a somewhat retarding effect, as might be supposed.

The movements of *Closterium moniliferum* were not stopped by low centrifugal force as shown both before and after centrifuging.