PHYSIOLOGICAL DOMINANCE AS A FACTOR IN CILIARY COORDINATION IN THE PROTOZOA

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The hypothesis of a localized co-ordination center or "neuromotorium" in the Ciliata has been advanced by Sharp (10), *et seq.* without regard for the work of Verworn (1) and Jennings and Jamieson (2), who have maintained that provided sufficient cilia were present any piece of a ciliate could react as a whole organism. Obviously if such pieces are co-ordinated in themselves there can be no localized center for the animal as a whole.

The question of the behavior of pieces of ciliates has been reopened by Alverdes (3) and Worley (4). Their results would indicate that the more posterior pieces are generally not able to react as the whole organism.

In an effort to clear up part of the situation at least the writer undertook a study of the reactions of pieces of *Spirostomum*. It was found that they are co-ordinated in inverse ratio to their distance from the anterior tip, and that the controlling factor is the amount of anterior material present (this control being especially concentrated in the first few microns of the anterior tip and fading rapidly posteriorly), but that *no definite area* is necessary. The co-ordinating ability therefore lies along the same axis as the metabolic gradient and is present to the same degree as is metabolic activity expressed in that gradient.

Alverdes' results (3) indicate the same condition in *Paramecium*, whereas Worley (4) in the same form suggests a localized "receptor center" on the surface of and anterior to the middle of the animal, in the area asserted by Rees (5) to contain a "neuromotorium." In the latest adjustment however of the Paramecium "neuromotorium" Lund (6) places it internally—aboral to the floor of the gullet and posterior to the position assigned by Rees. In this connection it should be noted that Taylor (7) in his microdissection study of *Euplotes* was not able to find any evidence of function of the alleged "neuromotorium" in that ciliate.

Observations made upon the membranelle series of *Stentor*

roeseli during binary fission by the present writer throw further light upon the question. The first evidence of division is the appearance of the new membranelles in a line down the side of the individual. They are totally unco-ordinated. As the new peristomial field develops and begins to project outwardly its membranelles still strike at random, while those of the anterior and older field show a trace of hindrance in their hitherto smoothly co-ordinated action. When the new field has grown to morphological equality with the older and lies in the same plane so that the dividing organism appears to be twinned, *both* membranelle series become co-ordinated and unco-ordinated irregularly, showing obvious lack of control. However, now as the older peristome following the normal course of fission in *Stentor* proceeds to grow on anteriorly from the newer, it *regains its co-ordination*, but the posterior field *relapses into unco-ordination*. This status obtains until division is nearly completed, when the anterior daughter is attached to the posterior merely by a thin stalk, (as the animal normally attaches to the substrate), at which time the posterior daughter slowly establishes co-ordination. This becomes complete just before the moment of separation. Bishop (8) has observed that the membranelles of the posterior daughter in the division of *Spirostomum* are unco-ordinated and the writer finds that they remain so for about a second after the completion of division, whereupon they suddenly "snap" into perfect action.

There seems to obtain, then, in the vegetative individual a condition where the more active end maintains ciliary co-ordination, whereas in fission where really two organisms are concerned the second individual is unable to set up its own co-ordination until freed from the domination of the first. There is therefore definitely an *anterior-posterior differential* in behavior in the ciliates discussed and the writer wishes to propose the theory that physiological dominance in the sense used by Child and his school is in some way an important if not the controlling factor in ciliary co-ordination in such forms.

Gray (9) quotes electrical experiments on metazoan ciliated tissue in which ciliary action is inhibited or enhanced by the electric current depending upon its direction of flow. This indicates the influence of dominance and the writer has experiments along that line in progress.

Further analysis of the subjects discussed in this paper will be available for subsequent publication.

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