WIDTH OF THE CONTRACTILE REGION IN SAND DOLLAR (ECHINARACHNIUS PARMA) EGG CLEAVAGE FURROWS

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The tip of the active furrow in animal cells is underlain by a ring of circumferentially oriented microfilamentous actin approximately 10 µm wide and 0.1 - 0.2 µm thick (Schroeder, T. E., J. Cell Biol. 53, 419-434, 1972). This ultrastructurally distinctive region is generally assumed to be the force producing mechanism that divides the cell by contraction and that its characteristic structure is necessary to produce the force that deforms the cell. The purpose of this investigation was to determine the width of the equatorial cortex region that is capable of autonomous equatorial constriction and compare it with the width of the ultrastructurally demonstrable contractile ring.

Gametes were obtained by KCl injection and the hyaline layer was removed from fertilized eggs by glycine treatment or multiple rinses with calcium-free artificial sea water. When cleavage began, apposed stout needles were inserted through the polar regions and oriented parallel to and in the same plane as the mitotic axis (figure 1).

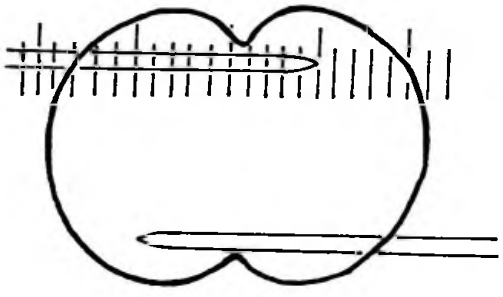

Figure 1. Diagrammatic representation of the relation between the sand dollar egg, the needles and the ocular micrometer. Not to scale.

When the underside of the cortex at the furrow tip contacted a needle its progress toward the mitotic axis was locally halted. The needles did not move. As contraction of the unblocked furrow regions progressed, its shape changed from a circle to an ellipse to parallel strips stretched between the needles. Concurrently the width of the equatorial cortex in contact with the needle widened. The mean of the widths of the flattened regions of 22 eggs was 25.6 $\pm$ 4.4 µm. The extremes were 15 and 31 µm.

The flattening of the furrow tip resulted from the resistance of the needles. Had the capacity for autonomous equatorial constriction been restricted to the region where the microfilaments are circumferentially oriented, the flattened region would have been about 10 µm wide. The greater width strongly suggests that force production sufficient for deformation is possible in cortical regions that lack oriented microfilaments so that a portion of the furrow wall, as well as the tip, are actively contractile. Since calculations of contractile tension exerted per unit cross sectional area of the furrow are based upon the ultrastructural dimensions of the contractile ring, its magnitude may have been overestimated about two fold.

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