Unequal Cytokinesis in *Cyclotella meneghiniana* f. *unipunctata* A. Cl.

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Cell division in diatoms proceeds similarly to typical mitosis except for progressive decrease in cell size after each generation as the newly formed cells have always have to synthesize hypotheca (Mazia 1961). Although each daughter cell forms a new hypotheca, it is still not known as to which cytological event gives decisive signal for the formation of valve (Werner 1977). However, it is believed that valve formation which is the final preceding event of cell division may be a dependent factor on cytokinesis as discussed by earlier workers (Geitler 1962, von Stosch and Kowallik 1969). Cytoplasmic cleavage in diatom cells advances from periphery to centre similar to cell furrow method in animal cells (Giri and Chowdary 1991). Cytokinesis in dividing cells sometimes appears to deviate from the normal process leading to unequal cytoplasmic cleavage.

Material and method

Cyclotella meneghiniana f. *unipunctata*, a freshwater centric diatom was grown axenically in Chu-10 medium (Chu 1942) supplemented with 10% soil extract, under standard laboratory conditions (Giri and Chowdary 1991). Exponentially growing algal cells were fixed in 3:1 ethanol acetic acid mixture and studied for cytological details in 1.5% acetocarmine.

Observation and discussion

Cell-plate formation in *C. meneghiniana* f. *unipunctata* initiated after the migration of daughter nuclei to respective poles, while in some cells daughter nuclei failed to migrate to respective poles and instead cytokinesis proceeded normally but outside the two daughter nuclei resulting in an anucleate cell and corresponding binucleate cell (Fig. 1a–c). Up to 0.5% enucleate cells were observed in each generation while rest of the dividing cells underwent equal cytokinesis (Fig. 2a, b). Probably, migration of daughter nuclei and cell-plate formation are two independent mechanisms. Eventhough it is difficult to explain various cytological events in diatoms, cytokinesis is thought to operate subsequently to migration of daughter nuclei to respective valves (Duke and Reimann 1977). The event of cytokinesis occurring prior to nuclear migration did not happen in the median zone and lead to formation of bigger and smaller cells which could contribute to further narrowing of the cells in each generation. However, in such instances smaller daughter cell was found to be without nucleus and therefore their viability is hard to exist.

Apart from normal cell division, unequal cytokinetic and acytokinetic divisions were also reported in diatoms. Only bigger cells synthesize new valves in case of unequal cytokinesis, while the smaller one with or without a nucleus forms no new valve (von Stosch and

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Kowallik 1969). In acytokinetic divisions the resultant binucleate cell may plasmolyze and form new valves as in *Skeletonema subsalum* (Paasche *et al.* 1975). In contrast to earlier observations of von Stosch and Kowallik (1969) unequal cytokinesis invariably led to formation of binucleate and anucleate cells.

Silica deposition, starting in centrally located silica deposition vesicle (SDV), was also recorded in enucleate as well as binucleate cells prior to their separation into individual cells (Giri 1989). Badour (1968) experimentally proved in *Cyclotella cryptica* that cytokinesis and silicalemma formation are two different processes. Further, neither complete cytokinesis associated with nuclear migration nor mitosis seem to compulsory prerequisites for silica deposition (Giri 1989).

Figs. 1–2. 1a–c. Enucleate and corresponding binucleate cells of *C. meneghiniana* f. *unipunctata* formed due to unequal cytokinesis. 2a–b, Median cytokinesis resulting in two uninucleate daughter cells. Bar: 1 μ m.

Accordingly Oey and Schnepf (1970) demonstrated in *Cyclotella cryptica* that formation of silica shells depends upon DNA replication which is probably induced by factors of S or G2 phase. Nonexistence of enucleate cells as individual entities subsequently to their separation from corresponding binucleate cells was due to absence of viable nuclear material. Silica deposition in these cells might have been triggered by the factors of the parent cell. However, formation of new valves in binucleate cells due to subsequent plasmolysis as reported by Paasche *et al.* (1975) needs to be investigated.

Failure of migration of daughter nuclei to different poles is an ion dependent factor which could be due to magnesium deficiency. Microtubules which are operating at poles and involved in pulling of daughter nuclei might have become unfunctional resulting in subsequent failure of their migration. At least 10^{-3} M cellular magnesium is necessary for normal polymerization and depolymerization of microtubules operating at the poles (Borisy *et al.* 1975, Giri 1989). Nonavailability of sufficient magnesium could affect nuclear migration. In another experiment it was

found that number of enucleate cells further increased up to 15.0% with deficiency of magnesium in the medium (Giri 1989). However, cell-plate formation is effected by cellular calcium which might have enabled its successful completion. Magnesium ion concentration might not affect nuclear spindles operating in equatorial region, possibly due to which chromosomal groups could segregate into distinct daughter nuclei.

Summary

Apart from normal cell division, unequal cytokinetic divisions leading to formation of enucleate cells also occur in *Cyclotella meneghiniana* f. *unipunctata*. Migration of daughter nuclei and cell-plate formation seem to be independent mechanisms. Silica deposition on the walls of enucleate cells indicates neither complete cytokinesis nor mitosis are prerequisites

for silicification.

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