Cell Division in the Pennate Diatom *Diatoma vulgare*

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With 33 Figures

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**Summary**

Mitosis and cytokinesis in the pennate *Diatoma* is described. Prior to division, a doubled "Persistent Polar Complex" (PPC), the focus of numerous cytoplasmic microtubules, migrates from near the nucleus to one side of the cell near the girdle bands, followed by the nucleus. The central dense core of the doubled PPC breaks down as a central spindle grows between the two PPCs, which now each become characteristically associated with a small vacuole and other features of unknown significance. The tubules of the central spindle terminate in a layer, the "Spindle Insertion" (SI), close to the PPCs; other, "polar" tubules radiate from each SI, mostly toward the nucleus, which becomes increasingly deformed by them until the nuclear envelope is ruptured. The elongating spindle enters one side of the nucleus laterally; as shown previously, the central spindle consists of two interdigitated half spindles, but the polar tubules which diverge laterally from the SI, by metaphase form a complex, cone-shaped array emanating from each pole. Some polar tubules penetrate the chromatin and may represent true kinetochore tubules; others, which persist conspicuously throughout mitosis, extend tangentially past the chromatin, out into the cytoplasm, intersecting with those from the other pole. The core structure of the PPCs alters from being plate-shaped at prophase, to being rod-like by metaphase. The chromosomes form a donut-shaped mass of chromatin penetrated by the central spindle throughout metaphase and anaphase. Chromosomal separation is accomplished in two stages: the chromatin splits and moves up to the SI, and then the central spindle elongates, concurrent with its overlap region decreasing markedly in extent. Thus, this latter part of anaphase movement could be generated by microtubule sliding past microtubule. Then each PPC distinctly separates from its SI, and moves away from the daughter nucleus during cytokinesis; it again becomes the focus of numerous tubules and often ends up in one corner of the daughter cell. Meanwhile, the central spindle and the SIs, now surmounted by the reforming telophase nuclei, slowly disintegrate during cleavage.

Cytokinesis proceeds in two stages. The cleavage furrow is very broad around the cell periphery; this broadened profile is maintained thereafter, and may later serve to mould the edge of the newly secreted valve. From the broad furrow grows a much narrower cleavage furrow, whose ingrowing edge is lined with dense (contractile -?) filaments; some larger cell organelles are drawn in to line the surface of this furrow. Secretion of the new valve is briefly described.
1. Introduction

Cell division in diatoms has a number of interesting features that have been revealed by the careful work of early light microscopists (e.g., Lauterborn's 1896, classic monograph). Microtubules were known to be present in the spindle (e.g., Coombs, Lauritis, Darley, and Volcani 1968), but it was Manton, Kowallik, and von Stosch (1969 a, b, 1970 a, b) in a series of four very important papers on the centric diatom Lithodesmium, who confirmed that these spindles have various unusual characteristics, for example, a continuous (central) spindle, consisting essentially of two interdigitated half spindles, which forms first outside the nucleus between two polar structures differentiated by a distinctive "spindle precursor". They analyzed the structure of this spindle in more detail than had been previously attempted, and they also made the important observation that the basal body that arises de novo during meiosis and spermiogenesis, is apparently differentiated by the complex structure formerly at the poles of the meiotic spindle. However, while the structure of the forming spindle was described in great detail, various other stages of mitosis were not comprehensively documented by these authors, and a number of intriguing issues raised in these papers have not yet been clarified (e.g., whether chromosomes are attached to the spindle by kinetochore tubules, the function of the overlap region in the continuous spindle and the fate of the spindle and its constituents at telophase). Consequently, we have undertaken a detailed study of the entire course of mitosis and cytokinesis in a centric (Melosira: Tippit, McDonald, and Pickett-Heaps 1975) and a pennate diatom (present paper), thereby obtaining more detailed information on those aspects of division that have not been investigated in detail. We were also interested to see what differences, perhaps of phylogenetic significance, might exist between the spindle of these two groups of diatoms.

2. Materials and Methods

Diatoma vulgare Bory, collected from a local stream, was fixed (for one hour) in 1% glutaraldehyde made up in filtered pond water; after washing, the material was postfixed in 1% osmium tetroxide in pond water for one hour, then washed and dehydrated slowly in acetone at 0°C. Cells were flat embedded in Spurr's (1969) resin and dividing cells were selected and remounted for sectioning. Very precise orientation of these individually chosen cells with respect to the plane of sectioning was maintained at all times. Sections

Abbreviations Used on Figures

b = bacterium, cf = cleavage furrow, cs = costae, ch = chloroplast, cv = cleavage vesicles, f = filaments, gb = Golgi body, gb = girdle band, gv = girdle view, m = mitochondrion, n = nucleus, ne = nuclear envelope, o = overlap region of the central spindle, t = microtubules, v = polar vesicle, vv = valve view, w = cell wall