Proceedings of the Iowa Academy of Science

Volume 68 | Annual Issue Article 11

1961

Organization of the Centroplasm in Nostoc pruniforme

T. E. Jensen
Iowa State University

C. C. Bowen
Iowa State University

Organization of the Centroplasm in *Nostoc pruniforme*[1]

T. E. Jensen[2] and C. C. Bowen[3]

Abstract. Electron micrographs of thin sections of *Nostoc pruniforme* fixed in $KMnO_4$ and embedded in Epon consistently revealed structure in the centroplasm. Organization of the continuous phase, as well as several kinds of included bodies, are described. Elongate structures with highly ordered, fine, lamellae stacked normal to the long axis were the most striking objects observed.

The cellular structure of the Cyanophyta has long been a controversial subject. Generally considered primitive, the blue-green algal cell has frequently been regarded as representative of cells in early evolutionary development. Regardless of the merits of this suggestion, a better understanding of these simple organisms, and, in particular, their genetic apparatus and mechanisms, should aid us in understanding more complex cells.

The protoplast of these organisms can roughly be divided into two components—the peripheral chromatoplasm surrounding a poorly defined centroplasm or "central body". The centroplasm differs from the nucleus of higher plant and animal cells in that it is not bounded by a membrane system. Although Haupt (1923), Biswas (1957), Fuhs (1958), and others have demonstrated the presence of feulgen-positive "chromatic threads", homology of these structures with the chromosomes of higher forms has never been convincingly demonstrated.

Previous electron-microscopic studies of the Cyanophyta have largely employed methacrylate resins as embedding media with consequent distortion, since so-called "explosion artifacts" due to non-uniform methacrylate polymerization are especially severe with this group of organisms. For this reason several representative Cyanophyta were investigated utilizing epoxy resins as well as methacrylate as embedding media. This preliminary report presents some observations of centroplasmic structure in a relatively large and complex blue-green alga, *Nostoc pruniforme*.

Materials and Methods

Nostoc pruniforme C.A. Agardh. was collected and identified by Dr. J. D. Dodd. Colonies varied between 1 mm and 10 mm

[1] This investigation was supported in part by grant C-3982 of the National Cancer Institute, U.S. Public Health Service.

[2] National Science Foundation High School Teacher Research Participant, Iowa State University, summer of 1960.

[3] Department of Botany and Plant Pathology, Iowa State University.

in diameter. Colonies about 2 mm in diameter were fixed in 4% $KMnO_4$ buffered at pH 7.5 at room temperature for from 4 to 20 minutes. Material was rapidly dehydrated in an ethanol, propylene dioxide sequence and embedded in Epon. Polymerization of the Epon was induced by maintenance at 50°C for eighteen hours. Thin sections, cut on a Porter-Blum ultramicrotome, were studied in an RCA EMU2A electron microscope.

Observations

The centroplasm is somewhat irregular in shape due to the intrusion of whorls of the paired chromatoplasmic membranes (Figures 1 and 2). The continuous phase of the cell, which extends through the centroplasm and in which the chromatoplasmic membranes are embedded, appears finely granular (Figure 2). However, in the regions of the chromatoplasm free from membranes and especially in the centroplasm, anastomosing, lighter, apparently structureless, regions are seen. Numerous, electron-dense, spherical granules of varying size are seen throughout the cell, but are much larger (up to 0.4μ in diameter) in the centroplasm than in the chromatoplasm (Figure 1).

On the periphery of the centroplasm, spherical, vacuole-like regions, containing scattered small dense granules, are observed (Figures 1 and 2). Ranging up to 2μ in diameter, these "vacuoles" are not bounded by membranes. They are consistently in contact with both chromatoplasm and centroplasm.

Two kinds of inclusions are regularly located in the centroplasm. For convenience, we designate these as "polyhedral bodies" (Figure 1) and "lamellar bodies" (Figures 2 and 3).

The polyhedral bodies are roughly isodiametric, and exhibit polygonal profiles in cross section, each with from four to six sides. With profiles ranging in size from about 50mμ to 350mμ in diameter, these bodies have a fairly uniform, medium electron density, are not delimited by an electron dense membrane, and show no regular internal structure. Frequently they do appear to be closely surrounded by an unstained region or sheath about 20mμ to 30mμ thick. We estimate there are between 25 and 40 of these per cell, and are not yet prepared to state whether this number is constant. From five to eight profiles of polyhedral bodies, packed together in one or two irregular clusters appear in a typical median section of a cell. The fact that profiles on the outsides of the cluster show the same straight sides as those on the interiors suggests that the polyhedral shape of these bodies is not a compression phenomenon.

The lamellar bodies are found in about one out of ten median

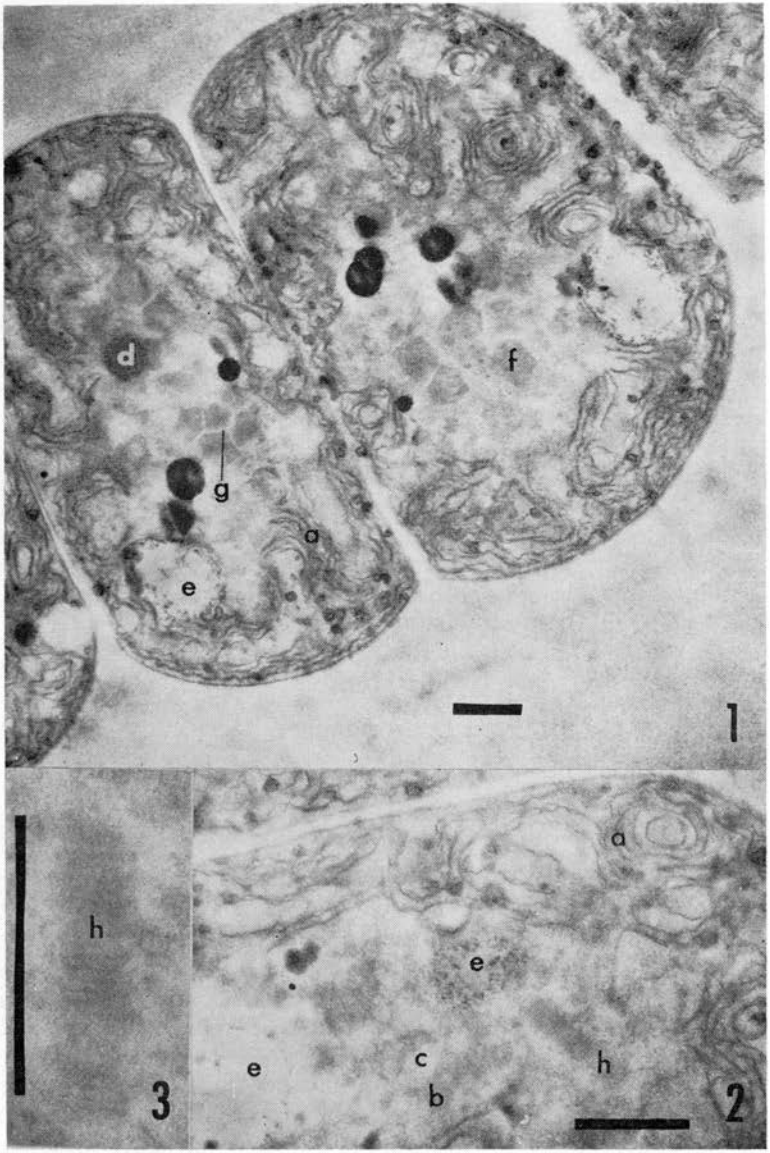

Figure 1. Median longtitudinal section of filament of *Nostoc pruniforme.*

Figures 2 and 3. Portions of cells of *N. pruniforme.* Legend: a—chromatoplasmic membranes; b—dark continuous phase; c—light continuous phase; d—dense granules; e—vacuole-like bodies; f—polyhedral body; g—polyhedral body sheath; h—lamellar bodies. Length of dark lines—0.5 micron.

sections of cells, and we feel it is probable that they are regular components of these cells. They have no limiting membrane, and, because they show so little staining contrast, we doubt if we would recognize them if sectioned other than longitudinally. These bodies are from 500mμ to 600mμ long and are consistently about 100mμ wide. Their profiles show a very regular periodicity of straight, parallel striations precisely normal to their long axes and spaced about 20mμ apart. With no additional evidence to substantiate our model, we presently interpret these bodies as being long stacks of circular lamellae.

Until serially-sectioned cells are studied, and until material is examined after cytochemical treatment, we will not attempt to categorize the observed structures in terms of function. It is obvious, however, that electron microscope studies to date emphasize basic differences of the blue-green algae from higher plants and animals rather than similarities.

Literature Cited

Biswas, B. B. 1957. Cytochemical studies on the central body of the Cyanophyceae, Cytologia 22: 90-95.

Fuhs, G. W. 1958. Bau, Verhalten und Bedeutung der kernaquivalenten Strukturen bei *Oscillatoria amoena* (Kutz.) Gomont, Arch. Mikrobiol. 28: 270-302.

Haupt, A. W. 1923. Cell structure and cell division in the Cyanophyceae. Bot. Gazette 75: 170-191.