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Heterocyst Division in Two Blue-Green Algae

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Abstract. The heterocysts of *Camptylonema lahorense* and *Aulosira fertilissima* have been observed to undergo division, as distinct from germination, either by the constriction of the heterocyst wall and protoplast or by the formation of a transverse furrow. A two-pored heterocyst divides in this way to form two one-pored heterocysts.

Key words: Camptylonema lahorense — *Aulosira fertilissima* — Heterocyst Division.

Although heterocyst *germination*, which leads to the emergence of new hormogones from the rejuvenated contents of a heterocyst, has been reported in diverse blue-green algae by many workers (see Fogg, 1949; Wolk, 1965; Singh and Tiwari, 1970), the *division* of a heterocyst to form two heterocysts has so far been reported only once, in *Camptylonema lahorense* Ghose (Kumar, 1963). Recently, we have observed several cases of this rare and novel phenomenon of heterocyst division in two cyanophytes, viz., *C. lahorense* and *Aulosira fertilissima* Ghose. This communication describes these observations and constitutes the second known case of heterocyst division in the Cyanophyceae.

C. lahorense was locally collected from grass lawns of the Banaras Hindu University campus and was found to agree in every respect with the material of the same organism described earlier from the same locality (Kumar, 1962). *A. fertilissima* is a potent nitrogen fixer in Indian rice paddies and was collected from rice fields of the Central Rice Research Institute, Cuttack. Its filaments are unbranched when young and 3.5—12 μ broad; cell length 4—8 μ; septa are distinct only during later stages of filament development; heterocysts 8—12 μ broad and 8—16 μ long, occasionally upto 35 μ long; spores 7—12 μ long and 9—10 μ broad; older filaments become branched and show pseudo-branching.

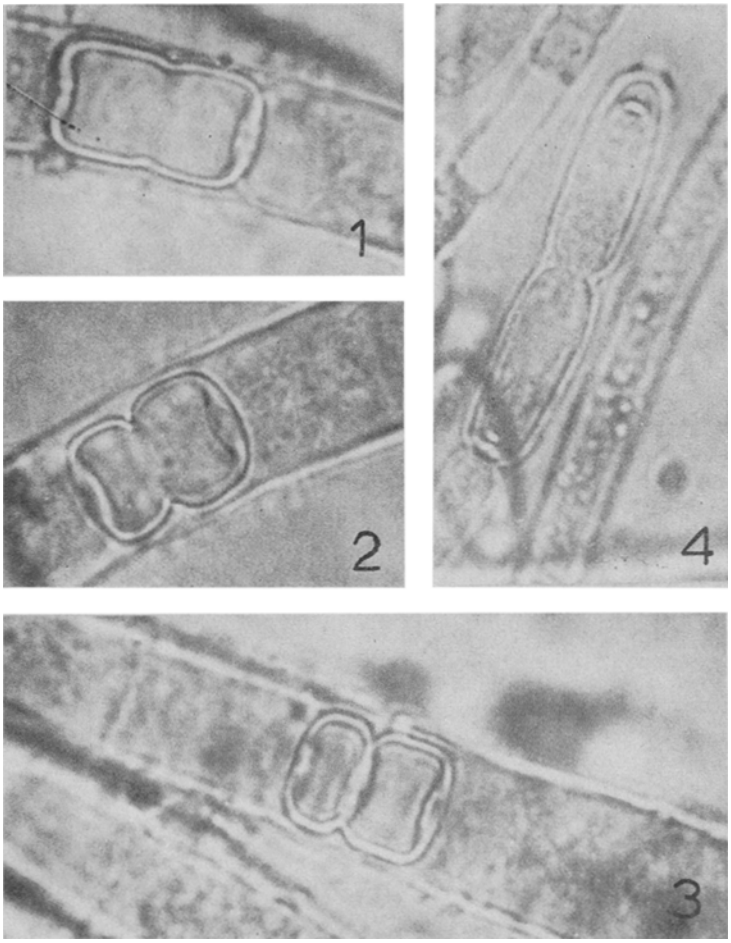
Unialgal cultures of the two algae were raised by pipetting out single filaments from the algal suspension made in sterile water under a dissecting binocular microscope and inoculating them in the mineral salts medium of Chu No. 10 as modified by Gerloff *et al.* (1950). Cultures were grown in liquid medium as well as on Petri dishes containing medium solidified with 0.8—1% agar. They were incubated at 30—31°C and illuminated with tungsten light (45 watt) from a distance of 15 cm.

Two modes of heterocyst division were observed: 1. division by the constriction of the heterocyst wall and the protoplast, and 2. division by the appearance of a transverse furrow or septum in the middle of the heterocyst. In the first case, an intercalary or terminal heterocyst showed a slight constriction in its protoplast (Fig. 1) and then the wall layers also underwent constriction (Figs. 2 and 4) resulting in the formation of two heterocysts. In *A. fertilissima* it was observed that a heterocyst frequently became very long (upto 35 μ long) and then underwent division by the process of constriction (Fig. 4). All the sequential stages during constriction and division have been observed and photographed (Figs. 1—3). In the second case, a transverse divisional furrow appeared in the middle of the heterocyst, leading to the formation of two heterocysts from the original single one.

Examination of a large number of filaments and heterocysts of the two algae from cultured material indicated that about 5% of the heterocysts were showing some stage in division.

The phenomenon of heterocyst division observed by us is similar to that reported by Kumar (1963) who had shown that a two-pored heterocyst of *C. lahorense* could divide to give rise to two one-pored heterocysts.

The heterocyst has often been regarded as an archaic reproductive structure which can rarely germinate and produce new filaments. Wolk (1965) and



Figs. 1–3. Sequential stages in heterocyst division by constriction in *Camptylonema lahorense*

Fig. 1. An initial, incipient stage in constriction (× 1550)

Fig. 2. A half-constricted heterocyst (× 1550)

Fig. 3. Almost complete constriction (× 1550)

Fig. 4. Median constriction in an abnormally long heterocyst of *Aulosira fertilissima* (× 1050)

Singh and Tiwari (1970) have demonstrated fairly frequent and consistent heterocyst germination in some blue-green algae when grown in a medium rich in ammonium chloride and it seems that heterocysts can germinate under certain environmental conditions. Our work further establishes that the cyanophycean heterocyst may also have the potentiality for division.

Heterocysts generally occur in a definite position in relation to the vegetative cells of the filament. The regular spacing pattern of heterocysts in most filaments led Fritsch (1951) to postulate that the heterocyst secreted some substance which stimulated vegetative cell division and that new heterocysts were formed only when the concentration of this substance fell below a critical level at some site remote from the heterocyst. It is now generally accepted that this substance is probably ammonia (see Fay *et al.*, 1968). Recently Reddy and Talpasayi (1974) have explained heterocyst formation on the basis of the same idea. The question arises whether the presence of more than one heterocyst or a chain of heterocysts (as has also been observed by us) can be explained by this theory of heterocyst spacing. This seems valid only on the presumption that either heterocyst division is a much more widespread and frequent phenomenon than hitherto recorded or that there is a set of vegetative cells (potential heterocysts) in the filament where the concentration of ammonia or the supposed inhibitory substance is less than the critical level, and that it is these cells which get differentiated into heterocysts.

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