Physiological and Biochemical Studies on Nitrogen Fixation by Blue-green Algae

III. The growth and nitrogen fixation of Nostoc commune as influenced by culture conditions

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With 8 Figures in the Text

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The studies made for the elucidation of the various physiological and biochemical aspects of the local algae are few, still fewer are those concerned with the blue-greens, and as far as we are aware, no systematic work had been devoted to an investigation of the nitrogen fixation by the local blue-green algae as influenced by the various environmental conditions.

A local strain of Nostoc commune was found to be a good nitrogen fixer (T AHA et al. 1962). The experiments reported here were carried out to investigate the influence of the various culture conditions on its growth and its potentiality for nitrogen fixation. The results obtained lead to the formulation of optimum conditions for the fixation process in experimental cultures.

The studies carried out by various investigators indicated that the hydrogen ion concentration of the culture media of blue-green algae exerts a great influence on both the rate of growth and nitrogen fixation e.g. ALLISON et al. (1937), SINGH (1942), GERLOFF et al. (1950a), KEATZ et al. (1955) etc. The studies of the previously mentioned investigators indicated, however, that a neutral or alkaline medium was decidedly preferable for the growth of these groups of algae.

Blue-green algae are also well known for their ability to withstand extreme temperatures so that they are able to grow in very cold localities as well as in the hot springs.

In terms of number of species about 35°C is the optimum for the development of many of the blue-greens. Two species namely Phormidium and Oscillatoria were reported by FOOR (1956) to resist a temperature as high as 85°C, while Synechococcus spp. are frequently found at a temperature over 60°C.
As far as the laboratory studies of the effect of temperature on the growth of blue-green algae are concerned, BÜNNING and HERDTLE (1946) reported a temperature as high as 40°C for the optimal growth of Oscillatoria germinata. The same authors obtained growth of thermophilic species in cultures at the following temperatures: Fischerella sp. 55°C, Mastigocladus laminosus 55°C, Nostoc muscorum 55°C, Oscillatoria anguina, O. formosa, O. boryana 50°C, O. germinata 45°C, Phormidium luridum 45°C, P. ambiguum 48°C.

ALLISON (1937) in his experimental study on Nostoc muscorum used temperatures of 24—27°C. Though he did not determine the optimum temperature accurately, yet he stated, that there was great difference in the rate of growth over the range of 25—30°C. At higher temperatures specially at 35—40°C, the growth rate was much slower and the cells appeared to be abnormal. At lower temperatures 5—10°C vegetative cells went into resting condition.

KRAZ et al. (1955) also investigated the effect of temperature on the growth of blue-green algae and reported that the highest relative growth constants for the growth of Anabaena variabilis lie at about 35°C and for Nostoc muscorum at 32—35°C. They also found that Anabaena cylindrica and ALLISON’S strain of Nostoc muscorum grew more rapidly at 32.5°C than at 25°C. All the previously mentioned algae failed to grow at 40°C. ALLEN (1956) on examination of 40 species of pure cultures of various blue-green algae, without any attempt to obtain heat tolerant strains, showed that they all grew well at 35°C and most developed normally at 40°C.

A similar temperature of 35—40°C was also recorded by MAXÉ et al. (1957) for the maximum growth of Oscillatoria sublittorialis.

Extensive studies had been carried out to investigate the effect of light on the growth of blue-green algae and their ability for nitrogen fixation. Thus ALLISON et al. (1937) reported that the optimum light intensity for their experimental organism Nostoc muscorum depends to a marked extent upon the growth conditions particularly the medium used, amount of carbon dioxide, sugar available and upon the degree of aeration. Under most and possibly all conditions, direct sunlight was found to be too intense an illumination for best growth. Good growth and nitrogen fixation had been however, obtained when cultures were exposed to direct sunlight in the laboratory window for 4—6 h daily. Diffused light of an ordinary well lighted room was found to be very satisfactory for the maintenance of cultures in a healthy condition. A light intensity ranging from 175—350 foot candles from Mazda lamps gave satisfactory results. SINGH (1942) found that optimum light intensity depends to a large extent upon the growth condition mainly the medium used. He found that the growth and nitrogen fixation capacity of Aulosira fertilissima in nitrogen free medium were accelerated to a marked extent with increasing light intensity but the culture could not withstand the direct sunlight of very high intensity for a long time. He found, however, that the best light condition for maximum growth and nitrogen fixation was intermittent light.

KRAZ et al. (1955) found that either day light, fluorescent, or tungsten illumination well support maximum growth rate of their experimental species of blue-green algae.

ALLEN (1955, 1956) on the other hand reported that the growth of his experimental Anabaena cylindrica increased with increasing light intensity up to at least 16,000 lux, an intensity which is much higher than the light intensities used by other investigators. ALLEN, however, stated that the former ideas that blue-green algae are adversely affected by high light intensity are difficult to reconcile with either frequent occurrence of these organism on walls or rocks exposed to full sunlight. He thought that the earlier findings were the results of growing algae under unfavourable conditions.