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## A NEW ANOMALOUS ADAPTIVE STRUCTURE IN ROOTS OF *CROTALARIA BURHIA* HAMILTON

*Crotalaria burhia* Hamilton are characteristic leguminous species of sand dunes and sandy plains of Indian desert[1]. The species once established is not liable to be killed inspite of very unfavourable environment from November onwards till the next rainfall in June–July. The apparent secret of perennation of this species lies in a deep, strong and tapering root which hardly has many laterals (Fig. 1, A). The lateral roots, being thin cannot survive because of the desiccating sand surrounding the root system.

Strangely enough, adult plants of this species were found to have twisted rope-like irregularly thickned main root (Fig. 1, B). At places, this main root was found to have several surrounding thinner root abrest and at times separating for short distances. Although very much different in structure from the anomalous root of *Asphodelus tenuifolius*[2], it gives superficial resemblance with this species in having multiple roots running nearly parallel, forming a rope-like structure. This type of root structure in *C. burhia* aroused curiosity of the author, while studying root system of plants in Indian arid zone.

On sectioning the root, an unusual structure was discovered. Besides the central main stele, the root possessed a series of supernumerary roots in different stages of thickness (Fig. 2). These roots do not present cases of lateral roots arising from the main root, but is a pattern of an anomalous structure in *C. burhia*. On closer examination it became evident that strips of cambia developed somewhere in the cortex to produce xylem and phloem, form separate steles away from the main central one, although the growth is mainly accentric. The other possibility is that cambia have got detached from the main cambial ring in an irregular manner, thus producing a number of steles outside in the cortex. Thus, a fully mature root would have the main central stele surrounded all around by these supernumerary steles, in different stages of secondary growth.

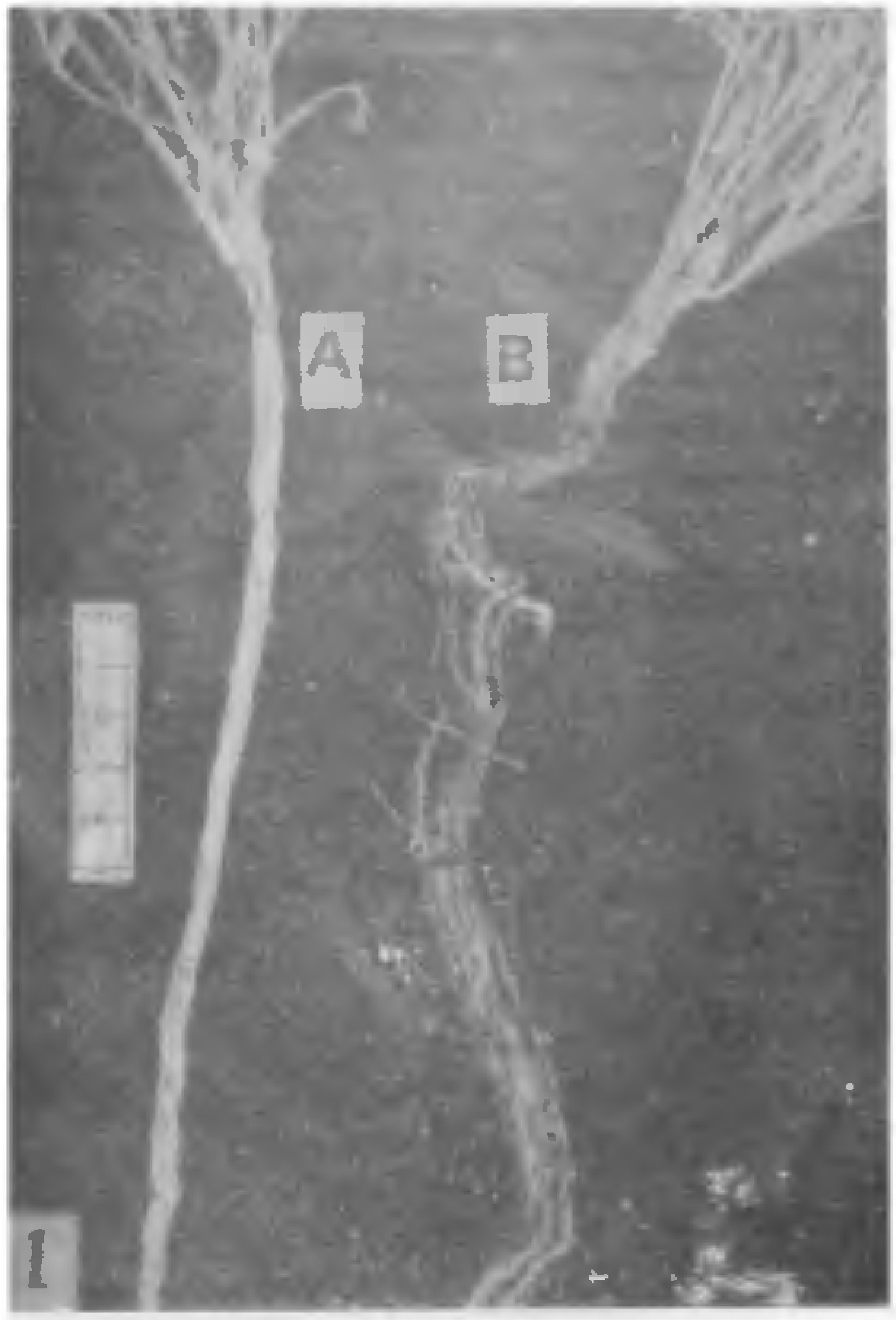


FIG. 1. Young normal root (A) together with twisted rope-like irregularly thickened root (B) in *C. burhia*.

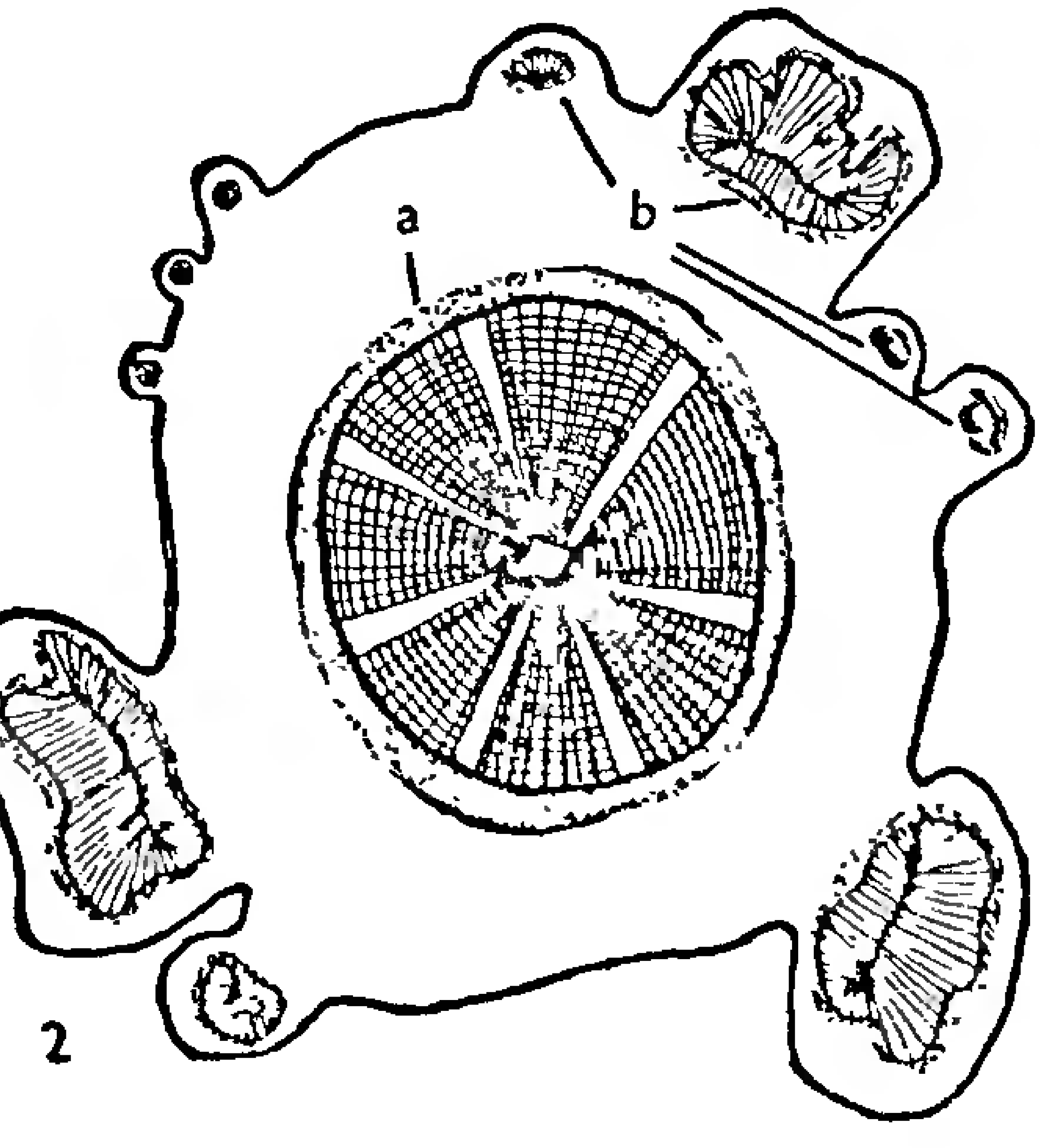


FIG. 2. Transection of anomalous adaptive root showing central stele (*a*) surrounded by a number of supernumerary steles (*b*) in the cortical region of *C. burhia* × 10 nat. size (diagrammatic).

This root structure shows an extremely interesting example of ecological adaptation in the desert plants. Since the species survives year after year by means of this perennating root, the centrally placed stele surrounded by 8–10 smaller steles has the additional advantage of being protected from the uncongenial surrounding atmosphere. The environmental conditions in the Indian desert are extremely dry, leading to the disappearance of most of the plants except *C. burhia*, which although has an average height of only about 50 cms, with a tapering root of few meters deep. This is a new adaptive structure in the root patterns of the plants of the Indian desert.

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## HETEROCYST SPACING IN THE SYMBIOTIC BLUE-GREEN ALGA *ANABAENA AZOLLAE*

THE blue-green alga *Anabaena azollae* occurs in symbiotic association with the free floating ferm *Azolla* in its dorsal lobes and nitrogen fixed by the alga is available to the fern. Multiplication of *Azolla* and its utilization in rice cultivation in India have recently been studied[1, 2]. Since a direct correlation between the heterocyst and nitrogen fixation exists in blue-green algae[3,4], the heterocyst spacing in the filaments of *Anabaena azollae* was studied in leaves of different developmental stages. Singh[1] reported earlier, the variation in algal heterocyst frequency in plants grown on different soils.

*Azolla pinnata* was collected from the local pond and the Institute multiplication tanks. Plants were dissected from the oldest leaf to the apex until apical leaf could be removed. The individual leaves were teased with the help of needles and examined under the microscope to find out the heterocyst frequency. The mean of twenty readings is presented.

The heterocyst frequency was found to increase linearly from the apical to the basal 10th leaf in both wild and cultivated *Azolla*. The lowest (9·5%) heterocyst frequency was found in the second leaf and the highest (25%) was observed in the oldest leaf of the plants (Fig. 1). Very few or no heterocysts were observed at the growing point. The vegetative cells of the algae were also found to be bigger in size in older leaves than in apical ones.

The heterocyst is known as the site of nitrogen fixation in aerobic conditions in blue-green algae and a

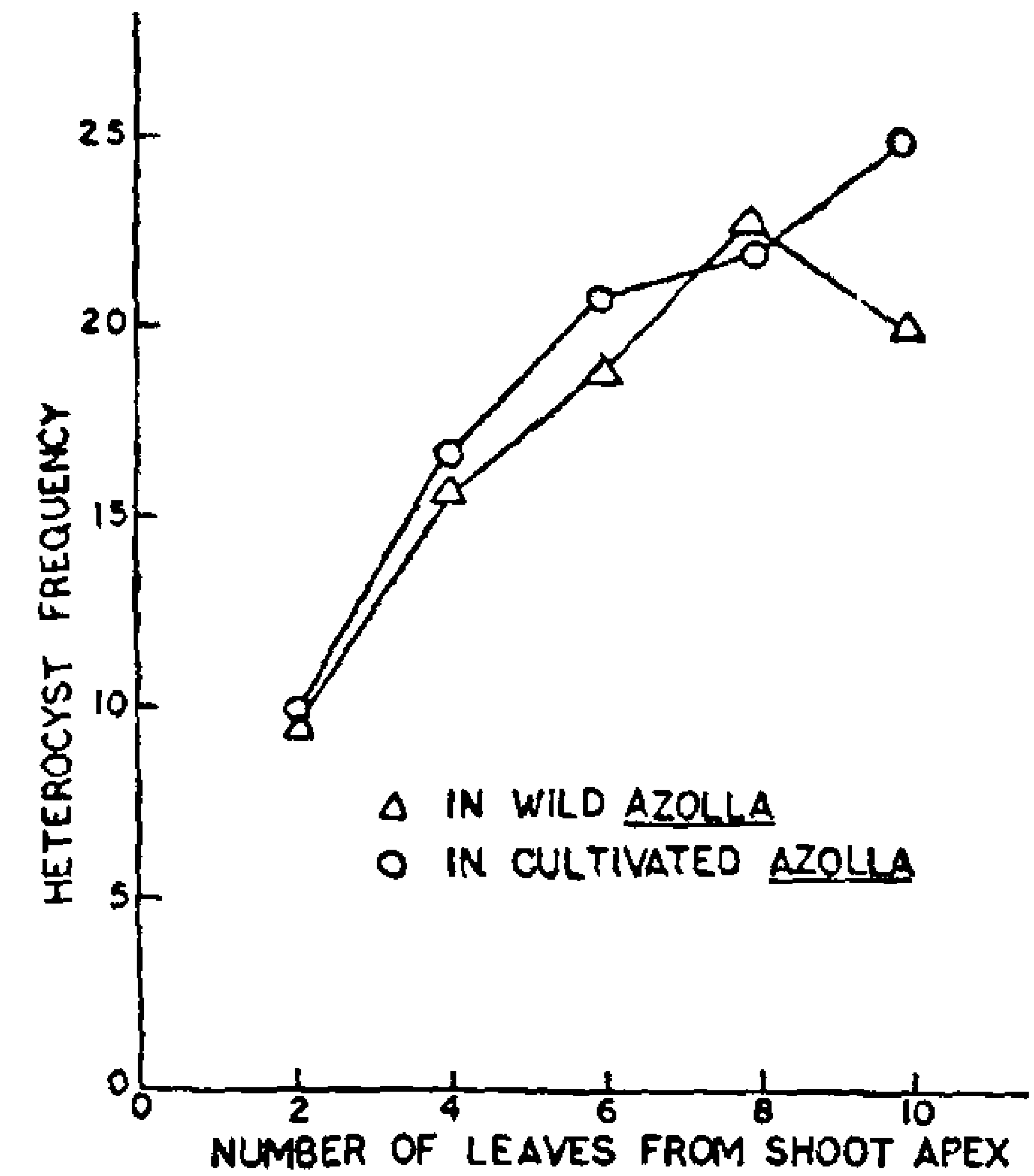


FIG. 1

direct relationship between the heterocyst and the capacity to fix nitrogen has been demonstrated in them[3,4,5]. The nitrogen fixed by free living blue-green algae was reported as 1–2 (rarely 4–5) $\mu$ mole $C_2H_4$/mg protein/min whereas *Anabaena azollae* fixed 5–7 $\mu$moles/mg protein/min in symbiotic association[6]. Hill[7] reported a similar pattern of algal development in *Azolla filiculoides*. The present finding of a higher heterocyst frequency in the symbiotic alga as compared to the free living state[8] indicates the efficiency of symbiotic algal nitrogen fixation. The stimulation of heterocyst differentiation and developmental pattern of the alga, paralleling that of the fern are very interesting.

The glutamine synthetase (GS) a key enzyme in the utilization of fixed $NH_3$ is reported to be low in the symbiont of the cavity and arises from the host. The low/lack of this enzyme might be responsible for the occurrence of increasing heterocyst frequency with aging of algal filaments and leaves. Ammonia from $N_2$-fixation is released in the cavity and removed by ammonia assimilating the enzymes specifically GS in the host through epidermal hair cells lining the cavity[9].

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