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.

Ecology Laboratory,
Botany Department,
University of Jodhpur,
Jodhpur 342 001,
January 24, 1978.

DAVID N. SEN.

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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

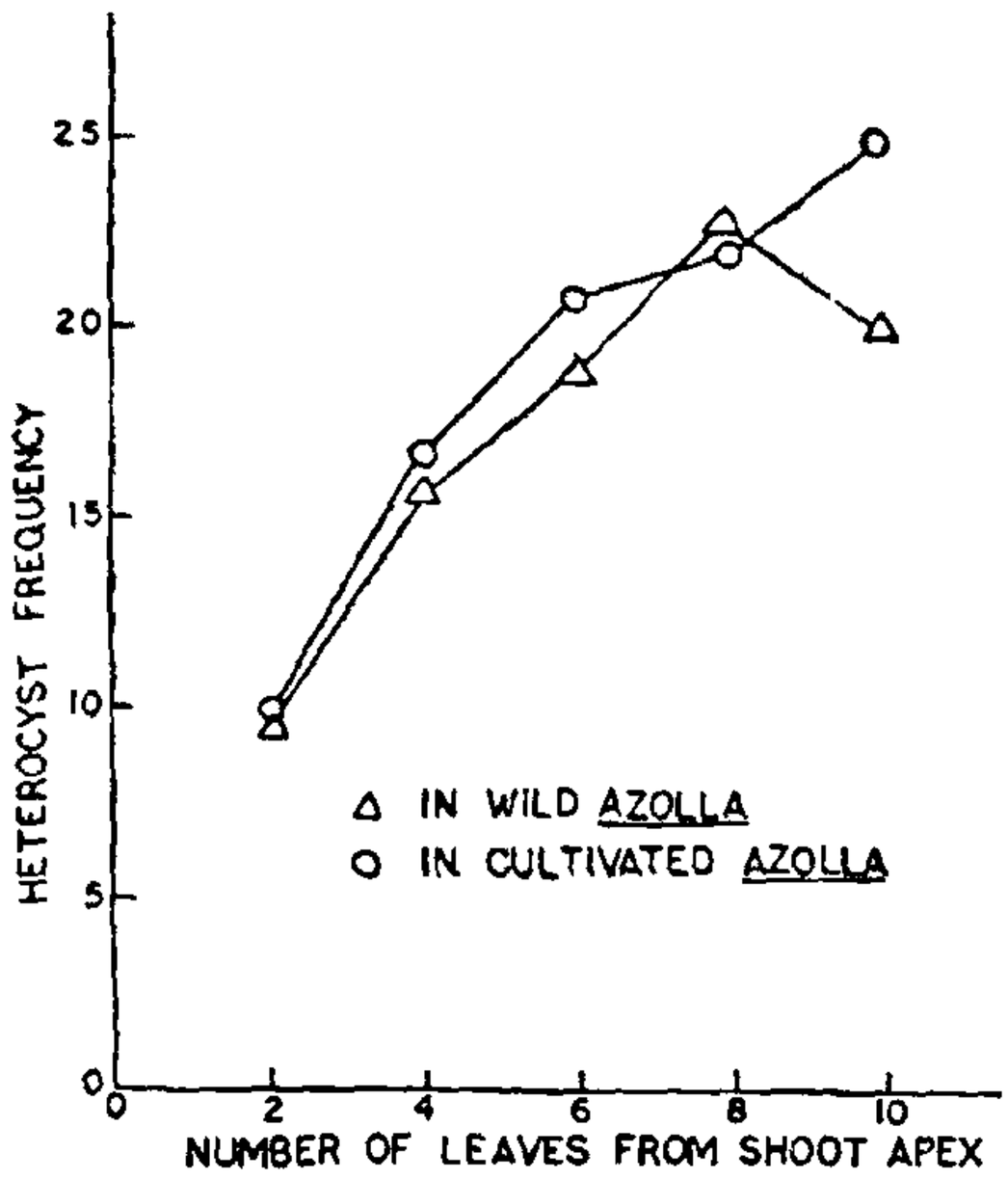

FIG. 1

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) μ mole C_2H_4/mg protein/min whereas *Anabaena azollae* fixed 5–7 μmoles/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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*Laboratory of Blue-green Algae, B. P. R. SUBUDHI.
Central Rice Research Institute, P. K. SINGH.*
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STUDIES ON THE ENTOMOGENOUS FUNGUS *NOMURAEA RILEYI* (FARLOW) SAMSON I

THE green muscardine fungus, *Nomuraea rileyi* (Farlow) Samson proved to be highly pathogenic to the three lepidopterous pests, *viz.*, tobacco caterpillar (*Spodoptera litura* F.), castor semilooper (*Achoea janata* L.) and jowar web worm (*Stenachroia elongella* H.) under laboratory trials. Two applications of the fungus at an interval of a week brought about total mortality of the semilooper within a period of two weeks. This fungus was non-pathogenic to the egg-parasite (*Telenomus proditor* Nixon) of the castor semilooper.

Introduction

Since the authors reported the occurrence and pathogenicity of the green muscardine fungus, *Nomuraea rileyi* on tobacco caterpillar (*Spodoptera litura*)[2], further studies were undertaken of its pathogenic behaviour on this and two other lepidopterous pests. The results are briefly reported here.

Castor semilooper (*Achoea janata* L.) is an important pest of castor and is wide-spread and destructive, particularly in parts of Andhra Pradesh[3]. Pathogenicity trials were carried out on this and other pests employing pure cultures of *N. rileyi*, which in our earlier trials,[2] was found to be a virulent pathogen of *S. litura*.

Materials and Methods

Pathogenicity trials were conducted by spraying a heavy aqueous spore-suspension on eggs and larvae of *A. janata* (obtained through the courtesy of Dr. V. V. Thobbi, Entomologist, I.A.R.I., Regional Research Station, Rajendranagar, Hyderabad, A.P.). The inoculum was obtained from pure cultures of the fungus grown on Sabouraud's maltose agar fortified with 1% yeast extract.

All trials were carried out under laboratory conditions, in specially designed insect-proof cages or in glass jars and plastic boxes with lids provided with perforations or fine muslin cloth to allow adequate aeration. The trials were conducted in four replications and the results are presented in Table I.

Results and Discussion

It could be seen from Table I that the incubation period of the fungus in younger caterpillars ranged from 12 to 14 days while per cent mortality was lower as compared with larvae of III and IV instars. This difference may be attributed to the process of early moulting after inoculation during their period of active growth[1]. In another set of trials, healthy eggs of the pest were sprayed with the fungus inoculum and this treatment resulted in very low per cent of

TABLE I

Results of pathogenicity tests with Nomuraea rileyi *on* Achoea janata *L.*

Eggs and larval instars	No. of applications	% Mortality in different Replications				Incubation period
		I	II	III	IV	
Eggs	One	5	5	10	5	10 to 12 days for newly hatched larvae
I instar	One	60	60	60	60	12 to 14 days
II instar	One	60	60	60	60	13 to 14 days
III instar	One	60	60	60	60	7 to 8 days
IV instar	One	80	80	80	80	7 to 9 days
II instar	Two	80	100	100	100	2 weeks