7. Subramaniam, A. P., *Bull. Geol. Soc. Am.*, 1956, 67, 317.
8. Mazumder, S. K., *Rec. Geol. Surv. India.*, 1978, 110, 60.
9. Ramasamy, R. *Seminar on Remote sensing*, IPI, Dehra Dun, 1980, abstract No 23, pp. 14.
10. Ramasamy, R. Sympet, Jaipur, *Geol. Surv. India*, Abstracts, pp. L2, (paper in press).

ACHLYA FLAGELLATA COKER PARASITIC ON WHEAT SEEDLINGS

B. L. VERMA AND R. D. KHULBE
Department of Botany, Kumaun University, Nainital 263 002, India.

DURING the course of a study on lower Phycomycetes in some crop fields of Tarai region of Nainital, *Achlya flagellata* Coker was isolated from living wheat seedlings. The pathogenicity tests of the isolate were conducted in the original host in the laboratory.

Infected seedlings and roots were collected aseptically from the wheat fields and washed several times with sterilized water. The pathogen was isolated and cultured on boiled hempseed halves in sterilized water. Pure, bacteria-free culture was prepared on the line of Johnson[1]. The isolate was identified as *A. flagellata* Coker with monographs of Coker[2] and Johnson[1]. The type culture has been deposited in the herbarium, Department of Botany, Kumaun University, Nainital.

The pathogenicity of the isolate was tested by placing the surface-sterilized wheat seeds for germination on agar plates. Seedlings were inoculated with small masses of fungal mycelium[3]. In control experiment, seedlings were not inoculated. All the petri dishes were kept at room temperature (15-20° C). Seedling growths and fungal infection were observed after every 24 hr of inoculation. After 5 days of inoculation 80-90% of seedlings were found infected (figure 2), while in control the seedlings were healthy with normal growth (figure 1). The pathogen was isolated from the infected seedlings and compared with original isolate, which proved the Koch's postulates.

Figure 1 & 2. 1. Controlled seeds with young root-**seedlings. 2.** Damaged seedlings after fungal infection.

A. flagellata Coker as parasite of wheat seedlings and roots is being reported for the first time. The pathogen may cause greater damage to growing seedlings in the fields.

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1. Johnson, T. W Jr., *The genus Aachlya: Morphology and taxonomy*, Univ. Michi., Press, Ann Arbor., 1956.
2. Coker, W. C., *The Saprolegniaceae with notes on other watermolds*, The Univ. of Chapel-Hill, North Caroline, USA, 1923.
3. Ito, S. and Nagai, M., *J. Fac. Agric. Hokkaido Imper. Univ.*, 1931, 32, 45.

NITROGENASE ACTIVITY IN THE RICE RHIZOSPHERE SOIL AS AFFECTED BY *AZOSPIRILLUM* INOCULATION AND FERTILIZER NITROGEN UNDER UPLAND CONDITIONS

J. L. N. RAO AND V. RAJARAMAMOHAN RAO
Division of Soil Science and Microbiology, Central Rice Research Institute, Cuttack 753 006, India.

NITROGEN fixation and the population of free-living nitrogen-fixing microorganisms were higher in lowland soil than in an upland soil[1-3]. Inoculation of nitrogen-fixing microorganisms increased the nitrogenase associated with crop plants[4,5]. It has been demonstrated that low levels of combined nitrogen favour the nitrogen fixation by *Azospirillum* in association with rice under submerged conditions[6,7]. Moreover inoculation of *Azospirillum* with low levels of combined nitrogen significantly increased the yields of several crop plants including rice[7-9]. Information is scanty on the influence of *Azospirillum* inoculation with and without fertilizer nitrogen on the soil nitrogenase activity under rainfed upland conditions. The influence of two levels of fertilizer

nitrogen on the rhizosphere nitrogenase activity was studied in the presence and absence of *Azospirillum* inoculation under rainfed upland conditions.

In a field trial the influence of *Azospirillum* inoculation on the rhizosphere soil nitrogenase activity was examined during the 1982 wet season. Three levels of urea nitrogen at 0, 30 and 60 kg N/ha were maintained with and without *Azospirillum* inoculation. The rice seeds (MW-10) were mixed with a peat bound culture of *Azospirillum* and were kept overnight under moist conditions. The experiment was conducted in randomized plots (24 m^2) with four replications for each treatment. Urea nitrogen was applied in three splits as 50% at sowing and 25% each at 30 and 60 days after sowing. The crop was raised to maturity according to the recommended cultural practices. Rhizosphere soil (2g fresh weight) was collected by uprooting three plants from each plot (12 plants for each treatment) and the nitrogenase activity was determined following the incubation and analytical methods as described earlier[10,11]. The rhizosphere soil nitrogenase activity was expressed as nmol of C_2H_4 formed, g dry soil/24 hr.

Highest activity was noticed 88 days after sowing under upland condition, the activity started decreasing after 97 days in uninoculated soil (table 1); but in lowland conditions the activity reached the peak at 4-5 weeks after transplanting and declined after 86 days[10,11]. Moreover, the activity in upland soil was lower as compared to that of lowland soils. That soil submergence accelerates nitrogen fixation was clearly demonstrated by earlier workers[1,3,7,11]. *Azospirillum* inoculation slightly enhanced the rhizosphere nitrogenase activity at least upto 88 days after sowing. Application of urea nitrogen stimulated nitrogenase activity. *Azospirillum* inoculation in the presence of urea nitrogen further stimulated the rhizosphere soil nitrogenase under upland conditions. Perhaps the application of urea provided better nutrition to the plant and the microorganisms. Microbial analysis of the soil samples indicated that the population of anaerobic nitrogen fixers and *Azotobacter*, (but not *Azospirillum*,) increased following the application of fertilizer nitrogen and *Azospirillum* inoculation. This would have contributed to the overall increase in the nitrogenase activity. The population of nitrogen-fixing microorganisms and the soil nitrogenase was not correlated[12].

Recent investigations suggest that *Azospirillum* inoculation to crop plants increased the dry matter production and nitrogen uptake by plants[5,8]. The present study clearly indicates the beneficial effect of *Azospirillum* inoculation on the rhizosphere soil nitrogenase activity in the presence of urea nitrogen under upland conditions. Further, evidence was provided to implicate other nitrogen-fixing microorganisms to the overall contribution to the rhizosphere soil nitrogenase activity in addition to inoculated *Azospirillum*.

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TABLE 1

Rice rhizosphere soil nitrogenase activity as influenced by Azospirillum inoculation and fertilizer nitrogen under upland conditions

Treatment (kg/ha)	Nitrogenase activity (n moles C_2H_4 formed/g soil/24 hr)					
	Days after sowing					
	72	80	88	97	102	108
Without fertilizer	209*	396	305	531	406	135
+ *Azospirillum*	213	523	472	516	389	549
+ 30 N*	159	707	705	523	433	139
+ 60 N*	149	579	420	620	437	321
+ 30 N* + *Azospirillum*	253	722	509	564	504	727
+ 60 N* + *Azospirillum*	229	724	418	1002	574	499
L. S. D. 5%	NS	87	104	117	70	113
1%	NS	124	148	167	99	161

Mean of three replicates from each plot.

* Urea was applied as nitrogen source in three splits as 50% at sowing, 25% after 30 days and the remaining 25% after 60 days.

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1. Charyulu, P.B.B.N. and Rao, V. R., *Soil Sci.*, 1979, **128**, 86.
2. Rao, V. R., *Soil Biol. Biochem.*, 1976, **8**, 445.
3. Yoshida, T. and Ancajas, R. R., *Soil Sci. Soc. Am. Proc.*, 1973, **37**, 42.
4. Barber, L. E., Tjepkema, J. D., Russel, S. A. and Evans, H. J., *Appl. Environ. Microbiol.*, 1976, **32**, 108.
5. Nur, I., Okon, Y. and Henis, Y., *Can. J. Microbiol.*, 1980, **26**, 482.
6. Nayak, D. N. and Rao, V. R., *Archiv. Microbiol.*, 1977, **115**, 359.
7. Nayak, D. N., Charyulu, P.B.B.N. and Rao, V. R., *Plant Soil.*, 1981, **41**, 429.
8. Smith, R. L., Schank, S. C., Bouton, J. H. and Quesenberry, K. H., *Ecol. Bull. Stocholm.*, 1978, **26**, 380.
9. Rao, V. R., Nayak, D. N., Charyulu, P.B.B.N. and Adhya, T. K., *J. Agric. Sci. Cambridge.*, 1983 (in press).
10. Nayak, D. N., Pasalu, I. C. and Rao, V. R., *Curr. Sci.*, 1980, **49**, 118.
11. Mahapatra, R. N. and Rao, V. R., *Plant Soil.*, 1981, **59**, 473.
12. Charyulu, P.B.B.N., Ramakrishna, C. and Rao, V. R., *Bull. Environ. Contamin. Toxicol.*, 1980, **25**, 482.

VESSELS IN ORCHIDACEAE

H. SINGH
School of Plant Morphology, Meerut College,
Meerut 250 001, India.

VESSELS are of rare occurrence in the stems or rhizomes of Orchids. However, they have been reported to occur in the roots of a number of taxa which may have scalariform perforation plates or simple perforation plates with scalariform thickenings[1-3].

Tracheid-like vessels or vascular tracheids[4] in the stems or leafy shoots of both epiphytic and terrestrial orchids have been observed in *Aerides odoratum* Lour., *Arundina graminifolia* Hochr., *Epipactis helleborine* Crantz., *Habenaria arietina* Hook. f., *H. marginata* Colebr., *H. pectinata* D. Don, *Herminium lanceum* Vuijk., *Luisia zeylanica* Lindl., *Rhynchostylis retusa* Bl., *Vanda cristata* Lindl., *V. roxburghii* Br. and *Zeuxine strateumatica* Schlechter.

The vessels have small to very long oblique end walls and multiple scalariform perforation plates (figures A-C). They show remarkable variations in their length and diameter. They range from 376 (*Luisia*)to 4385 μ (*Arundina*) in length and 4.5 (*H. pectinata*) to 68.4 μ (*Epipactis*) in diameter. The vessels have usually elliptical pits arranged in one to three alternate or opposite rows (figures A,D). Occasionally they may have partly scalariform thickenings and elliptical pits or scalariform thickenings only in *Habenaria* (Figures C,E).

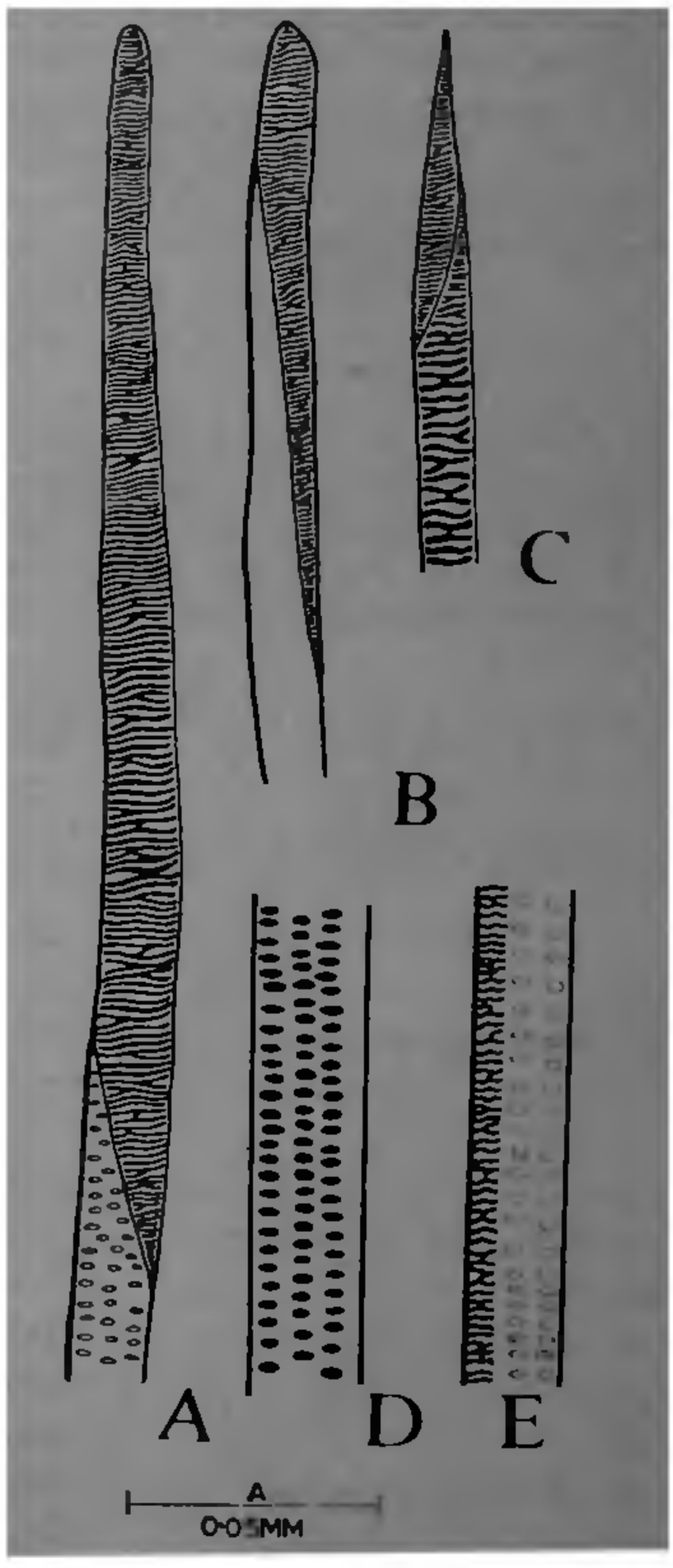

Figure A-E **A.** Vessel from the stem of *Arundina graminifolia* showing long oblique end wall. **B,C.** Vessels from the stems of *Rhynchostylis retusa* and *Habenaria pectinata* respectively. **D, E.** Parts of vessels from the stems of *Aerides odoratum* and *Vanda cristata* respectively.