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GABBROIC ANORTHOSITE FROM TOGAMALAI AREA, COIMBATORE DISTRICT, TAMIL NADU.

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AN elliptical body of gabbroic anorthosite occurs at the top of the Togamalai hillock situated 3 km North-Eastern of Tolampalaiyam Village (N 11° 11′ and E 76° 50′) and 32 km NW of Coimbatore Town. It is a homogeneous, medium grained, melanocratic, non-porphyritic rock comprising of plagioclase and 17% (by volume) of hornblende and other accessory minerals and hence it is classified as gabbroic anorthosite. There are angular inclusions of both leucocratic and melanocratic anorthosite amidst the gabbroic anorthosite. Further, satellite bodies of gabbroic anorthosites and typical anorthosites (8% volume of mafic content) are also found in this area. The description of the new occurrence of gabbroic anorthosite from this area will contribute to the comparative studies of similar occurrences of gabbroic anorthosites already reported from the neighbouring areas of Kerala[1], Karnataka[2] and Tamil Nadu[3].

Geology

The main gabbroic anorthosite body is found amidst amphibolite (figure 1). The amphibolite is rich in hornblende and plagioclase. It has a core of hypersthene bearing pyroxenite or of olivine-rich peridotite. West of Tolampalaiyam and south-west of Sundakorai, the amphibolite has accessories of garnet and

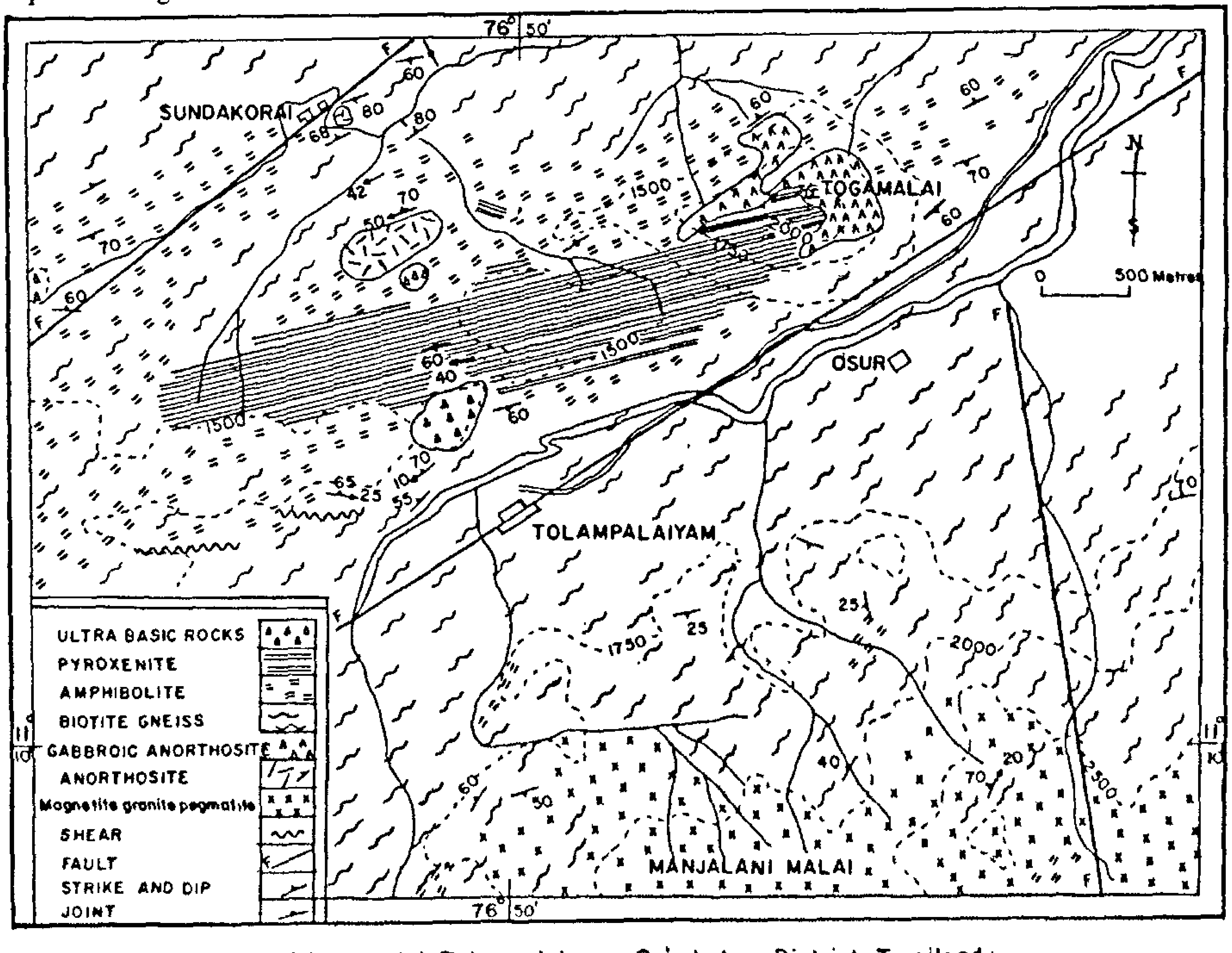

Fig. 1. Geological map of Togamalai, Tolampalaiyam, Coimbatore District, Tamilnadu.

hypersthene while along the eastern flank of Togamalai hillock it appears to be schistose in character with enrichment of biotite. The country rock is mainly of biotite granite gneiss which is the major rock formation in this area. The biotite gneiss is often interbanded with melanocratic lenses and bands of migmatitic variants. Contacts of anorthosites with amphibolite or with granite gneiss are sharp, but it is difficult to say whether the contacts are igneous or tectonic. However, apophyses and tongues of anorthosites are seen in some places at the contacts. At the top of the Manjalani Hills, magnetite-bearing granite pegmatite (rapakivi granite pegmatite) outcrops are seen to a greater extent. The nearest exposure of charnockite lies at a distance of 5 km. The Nilgiri Hills are mainly composed of charnockites. The steeply outward dipping main anorthosite body of Togamalai hillock is an elliptical intrusive plug. The emplacement of anorthosite bodies is controlled by regional stike-slip faults trending NE-SW.

Petrography

Modal composition of the gabbroic anorthosite consists of 83% of plagioclase (70-76% on 010 plane), 15% of tschermakitic hornblende and 2% of sphene, magnetite, ilmenorutile and hypersthene. Olivine and hypersthene are present in some thin sections. One or two large grains of recrystallized plagioclases are also found amidst fine-grained ground mass of plagioclases. Recrystallized plagioclases have lower anorthite content (65–70%) than the primary ones. In most of the plagioclases twinning is absent or obliterated. A few grains of plagioclases show twinning under albite, albite-carlsbad, or carlsbad twin-laws. More leucocratic varieties comprise of 92% bytownite (72% on 010 plane), 7.5% of tschermakitic hornblende and 0.5% of sphene, magnetite, olivine and biotite. Plagioclase inclusions are found in amphiboles. Tschermakitic hornblende is the major mafic constituent and is often euhedral in shape. Subhedral to euhedral grains of tschermkitic hornblende often exhibit interpenetration twins and growth twins. A reaction rim or corona of ilmeno-rutile is found around the amphibole. Prisms and needles of amphiboles exhibit $2V_X = 68°$, $Z \Lambda c$ 14°, $(\gamma - \alpha) = 0.023$ with feeble pleochroism. X-pale yellow to Y and Z are bluish green. They exhibit subophitic texture in the fine grained mass of plagioclases. Sometimes they show radiating features. In some thin sections amphiboles show growth twins within plagioclases. Amphiboles rarely consist of inclusions of magnetite or sphene. Small flakes of biotite are found at the peripheral portions of amphiboles. Euhedral olivine is occasionally found. In both varieties, the ratios of length and breadth of euhedral amphiboles exceed more than 15 times. Although these anorthosites exhibit some features like recrystallization of plagioclases with obliterations of twinning planes etc, original igneous textures like subophitic texture, radiating feature, presence of corona or reaction rim around amphibole, interpenetration and growth twins of hornblendes, igneous twin laws of plagioclases etc., are still well preserved.

TABLE 1

Chemical analyses of anorthosite, gabbroic anorthosite with an amphibole in anorthosite

Oxides (wt%)	11	16	A	A No. of ions on the basis of 24 (O, OH, F)		
SiO_2	46.30	48.34	44.48	Si	6.475	
TiO_2	0.20	0.37	0.52	Al^4	1.525	8.000
Al_2O_3	27.11	25.47	17.10	Al^6	1.415	
Fe_2O_3	1.64	2.51	3.83	Ti	0.062	
FeO	3.23	3.41	7.36	Fe^3	0.420	
MnO	0.12	0.08	0.28	Fe^2	0.983	4.925
MgO	3.79	3.55	9.66	Mn	0.035	
CaO	14.80	13.61	12.93	Mg	2.100	
Na_2O	2.10	1.96	1.42	Ca	2.021	
K_2O	0.18	0.18	0.30	Na	0.402	2.475
				K	0.052	
H_2O	1.12	0.32	1.26	OH	1.224	1.224
Total:	100.59	99.80	99.14			

11. Anorthosite; 16. Gabbroic anorthosite; A. Amphibole from anorthosite. Analyst: M. P. Ukina, Geology Faculty, Moscow University, Moscow.

Petrochemistry

Normal gravimetric chemical analyses show that the chemical variation between the anorthosite and the gabbroic anorthosite is only due to the small variation in the mineral content of plagioclase and hornblende (table 1). The anorthosite is richer in CaO content than the gabbroic anorthosite. Moreover, the higher ratios of FeO/MgO and Fe_2O_3/FeO + Fe_2O_3 for gabbroic anorthosite than the anorthosite indicate a trend of feeble differentiation from typical anorthositic to gabbroic anorthositic end in this area. The trace elemental distribution reveals that both rocks probably belong to the same source. In both varieties, trace elemental content of Cu, Zn, Zr, Mo, Bi, Ga, and Sc is all of less than 8 ppm (detection limit 8 ppm) and Ni 10 ppm, Cr 60 ppm, Sr 200 ppm. The variation of trace elemental content of the following elements between the anorthosite (sample No 11) and the gabbroic anorthosite (sample No 16) respectively may vary due to mafic concentraction of gabbroic anorthosite: Pb-less than 8 and 10 ppm, sn- 10 and 20 ppm, V- 30 and 100 ppm and Ba- nil and 100 ppm.

The amphibole analysed shows the following structural formula, $(Na_{0.402} K_{0.052})_{0.454} Ca_{2.021} (Mg_{2.100} Fe^{2}_{0.893} Fe^{3}_{0.420} Al^{6}_{1.415} Ti_{0.062})_{4.925} (Si_{6.475} Al^{4}_{1.525} O_{22.776}) OH_{1.224}$. In this structural formula of amphibole, Si is slightly excess by 0.475. Al is deficient in six-fold co-ordination by 0.585. Larger cations (Ca, Na, K) in the site X are slightly in excess by 0.475 and cations in the Y site are slightly deficient by 0.075. Hydroxyl ions are greatly deficient by 0.776 which indicates that the rocks composed with the minerals were formed in H_2O deficient environment. The distribution of Al^4 (1.525) with Na + K (0.454) and $Al^6 + Fe^3 + Ti$ (1.897) indicates that the mineral belongs to tschermakitic hornblende. X-ray powder diffraction data for the amphibole is in d Å as follows: 8.506 (100), 3.401 (13), 3.288 (24), 3.125 (100), 2.955 (14), 2.809 (19), 2.719 (28), 2.610 (14), 2.571 (10), 2.380 (12), 2.344 (19), 2.329 (14), 2.023 (17), 1.188 (11), 1.650 (16) and 1.439 (26).

Plagioclase separated from the anorthosite was subjected to partial chemical analysis by flame photometric method shows CaO 14.60%, Na_2O 2.50% and K_2O 0.20%. The partition coefficient of Ca/Ca + Na + K between the co-existing paragenesis of amphibole and plagioclase shows the temperature of formation of the rock is about 660° C for anorthosite member, on the geothermometer constructed by Perchuk and Riyasbchikov[4]. X-ray diffraction of plagioclases shows *d* spacings in Å; 4.047 (18), 3.754 (21), 3.619 (16), 3.451 (22), 3.207 (100), 2.938 (21), 2.828 (16), 2.518 (21), 2.139 (16), 1.181 (9) and 1.771 (10). The peaks of $1\bar{3}1$ (2θ 29.44) and 131 (2θ 31.64) were identified. $2\theta_{1\bar{3}1} - 2\theta_{131}$ Cu K_α is 2.20. From the optical and partial chemical analysis of feldspars, it is found that anorthite content of plagioclase is 72%. Using the above relationships in the diagram of Bambauer *et al*[5], it is found that the plagioclase is a high temperature feldspar possessing the highest stable state of Al, Si disorder and the Si/Al ratio is 1.32. The $24\bar{1}$ peak is not resolved. This feature indicates igneous character of the anorthosite.

Petrography and mineralogy of these anorthosites are comparable with those of gabbroic anorthosites of Hullahalli area, Karnataka[6]. Stratiform anorthosites of Sittampundi[7] and gabbroic anorthosite massifs of Kerala[1] and Karnataka[2] are situated not far from the location of newly reported anorthosites. Both anorthosites of high calcic (An 80-100%), metamorphosed, layered types as well as anorthosites of less calcic (An 45-80%) unmetamorphosed, unlayered types occur along the Eastern Ghats belt of Peninsular India[8]. Windley and Selvan[3] suggested that Precambrian anorthosites and their associated rocks can be used as a means of delineating an anorthosite—basic—ultrabasic tectonic belt. According to Ramasamy,[9,10] the Eastern Ghats belt extending from Palghat gap to Brahmaputra valley (3000 × 200 km) represents a palaeorift system comprising a number of magmatic rocks of carbonatites, kimberlites, alkaline rocks, anorthosites, charnockites and other associated supracrustal rocks. The present find is a new addition of igneous bodies in the palaeorift system.

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ACHLYA FLAGELLATA COKER PARASITIC ON WHEAT SEEDLINGS

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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.

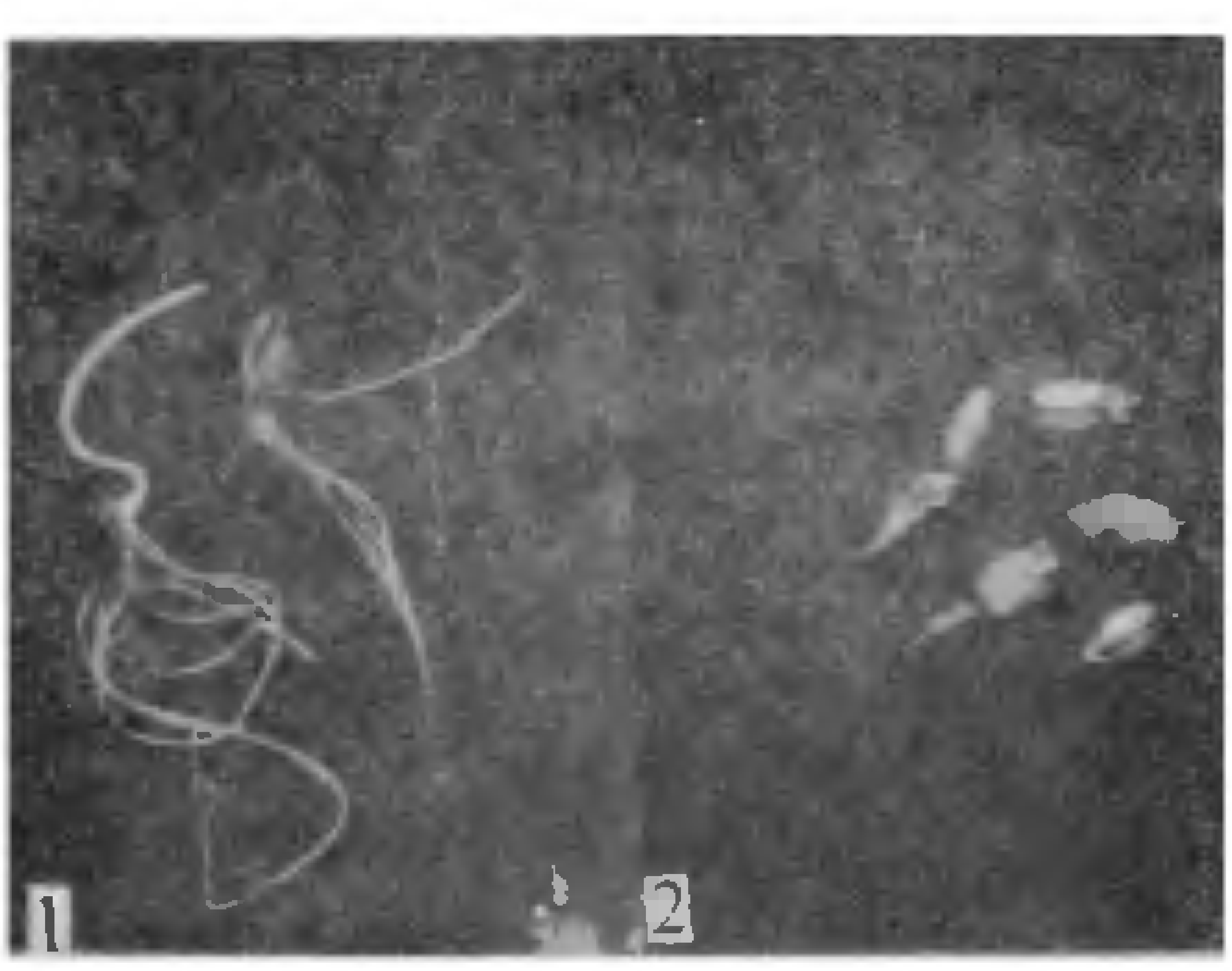

Figure 1 & 2. 1. Controlled seeds with young root-seedlings. **2.** Damaged seedlings after fungal infection.

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

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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