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PROBABILITIES OF DROUGHTS AND FLOODS OVER INDIA DURING THE SOUTHWEST MONSOON SEASON

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ABNORMALITIES in the performance of the southwest monsoon manifested as floods and droughts have disastrous effects on agriculture, industry and the generation of hydroelectric power, causing severe strain to the national economy. Almost every year some part or the other of the country suffers from such calamities. During the last two decades, the country experienced severe and widespread droughts during 1965–66, 1972 and 1979 which affected adversely the food production, power generation and industrial output. The drought of 1979 affected 240 districts covering 11 states and 240 million people; the Government had to spend Rs 1,600 crores on relief works[1]. Due to floods, on an average, during 1953–1978, an area of about 8.2 million hectares was affected, 9.2 million houses were damaged, 1240 human lives and 7700 cattle were lost per year[2]. In view of their great impact on the national economy a study of the probabilities of incidence of droughts and floods over different parts of the country has been made by utilising the southwest monsoon rainfall data for the 108 years, 1871–1978.

Three hundred and six stations, one from each of the districts in the plain regions of India were selected to form the network of raingauge stations. These stations are fairly uniformly distributed over the country and have rainfall data from 1871 onwards. The relevant rainfall data of southwest monsoon (June to September) were collected from the national data centre of the India Meteorological Department, Poona. Mean and standard deviations computed for all these stations for southwest monsoon have been utilised in this study.

Figure 1 shows the normal isohytal map of India for the southwest monsoon season drawn on the basis of the data of the 306 stations. Shaded hilly portions showed in the map have not been considered in the present study. High rainfall amounts over west coast and over Assam region and low rainfall over northwest India, central and eastern parts of southern peninsular India, are the salient features of the mean rainfall distribution. The central parts get moderate rainfall.

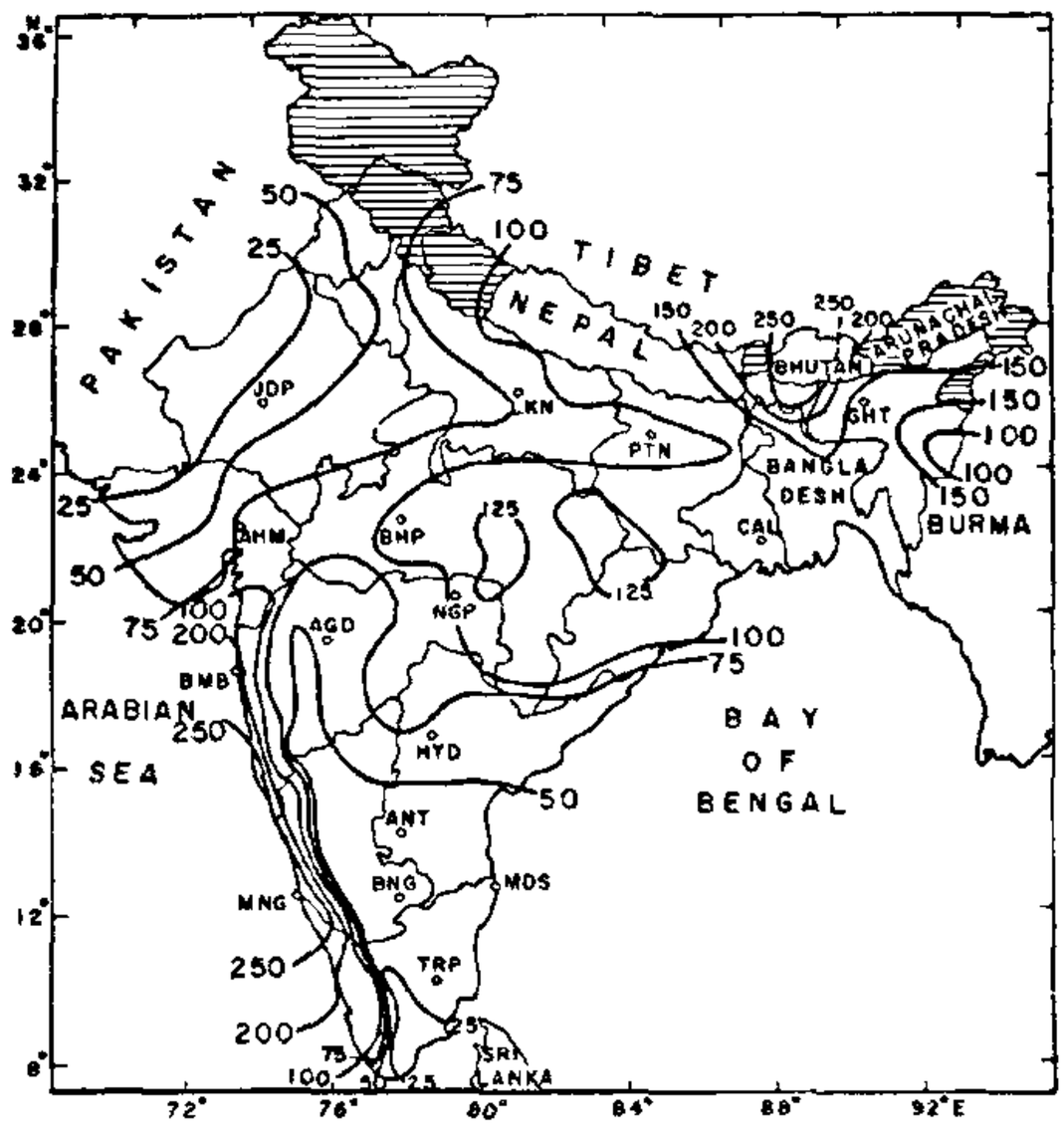

Figure 1. Normal southwest monsoon (June to September) rainfall (cm) of India: 1871–1978.

The inter-annual variation is a measure of the dependability of the rainfall from one year to another. The mean inter-annual variability (s) of rainfall at any station is defined as follows:

$$s = \frac{1}{N-1} \sum_{i=1}^{N-1} \left| R_{i+1} - R_i \right|$$

where R_i is monsoon rainfall for the ith year and N is the total number of years. The inter-annual variability was calculated for each of the 306 stations. A map showing the spatial variation of s is shown in figure 2. The highest values are noticed over the west coast and the lowest values over the west Rajasthan and the

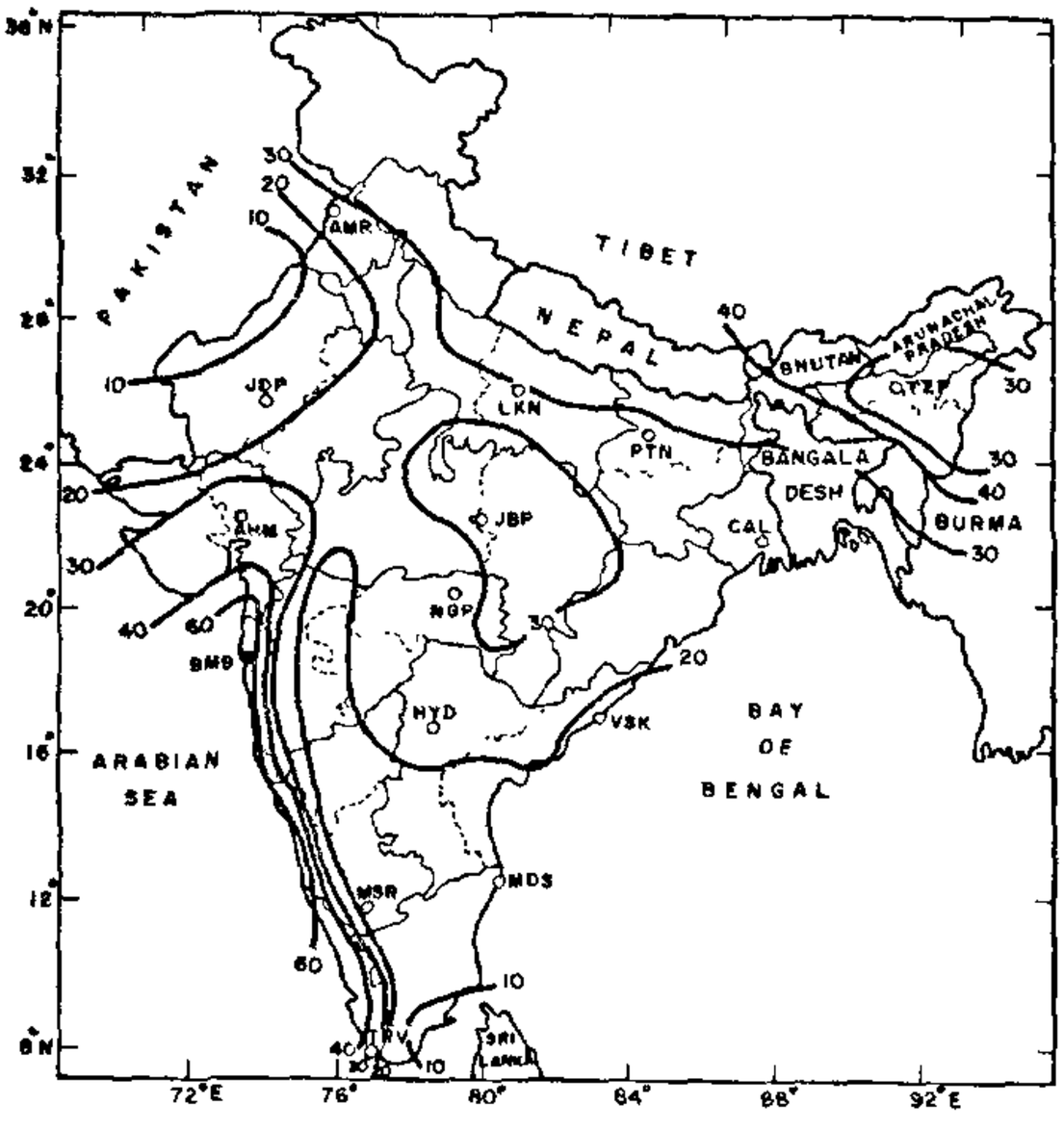

Figure 2. Inter-annual variation of southwest monsoon rainfall over India: 1871–1978.

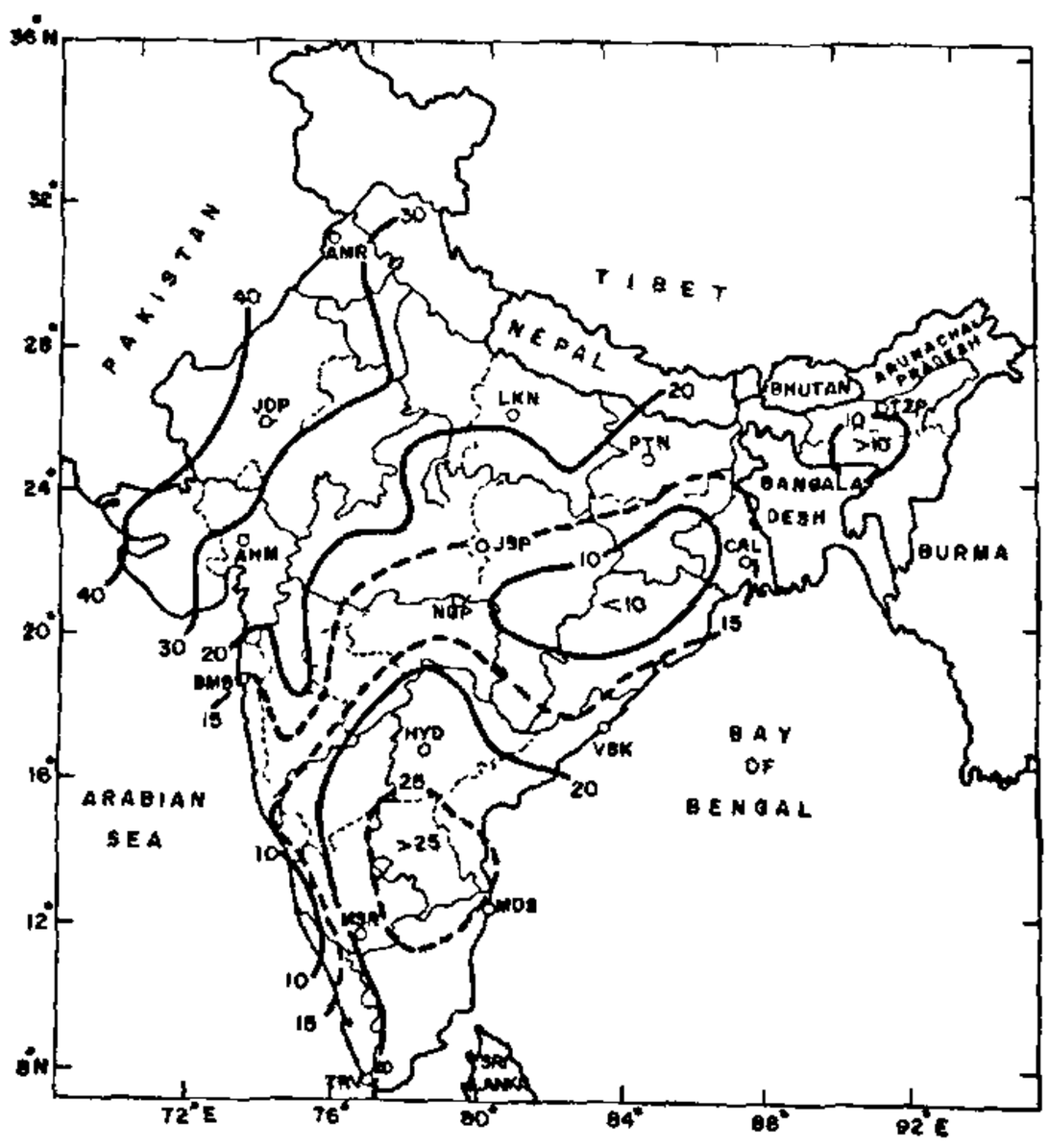

Figure 3. Empirical probability distribution of droughts over India during southwest monsoon season: 1871–1978. (Drought: seasonal rainfall less than -25% of normal).

extreme southeast of the peninsula. These are the regions of high and low normal rainfall (vide figure 1).

There are no accepted definitions for drought/flood. Various definitions have been used by research workers, depending on the purpose in view. Meteorological drought/flood can be defined as a situation over a region when the seasonal rainfall is much lower/higher than the climatologically expected value, because the natural vegetation and economic activities of the region get adjusted to the long-term average rainfall. The following criteria adopted here are accepted by the Irrigation Commission[1] and also by the India Meteorological Department[3,4]. A station or area is categorised as having experienced drought (flood) in a particular monsoon season if the percentage departure of monsoon rainfall from normal over that station or area is more than $\pm$ 25%. Further, a station or area where drought (flood) occurred, as defined above, in 20% of the years examined, is considered as 'drought-prone' (flood prone) and where it has occurred in more than 40% of the years the incidence is regarded as 'chronic'. On the basis of the above criteria the number of years of drought/flood for each of the 306 stations were worked out for the period of study. The spatial variation of the frequency distribution expressed as percentages (empirical probabilities) is shown in figures 3 and 4.

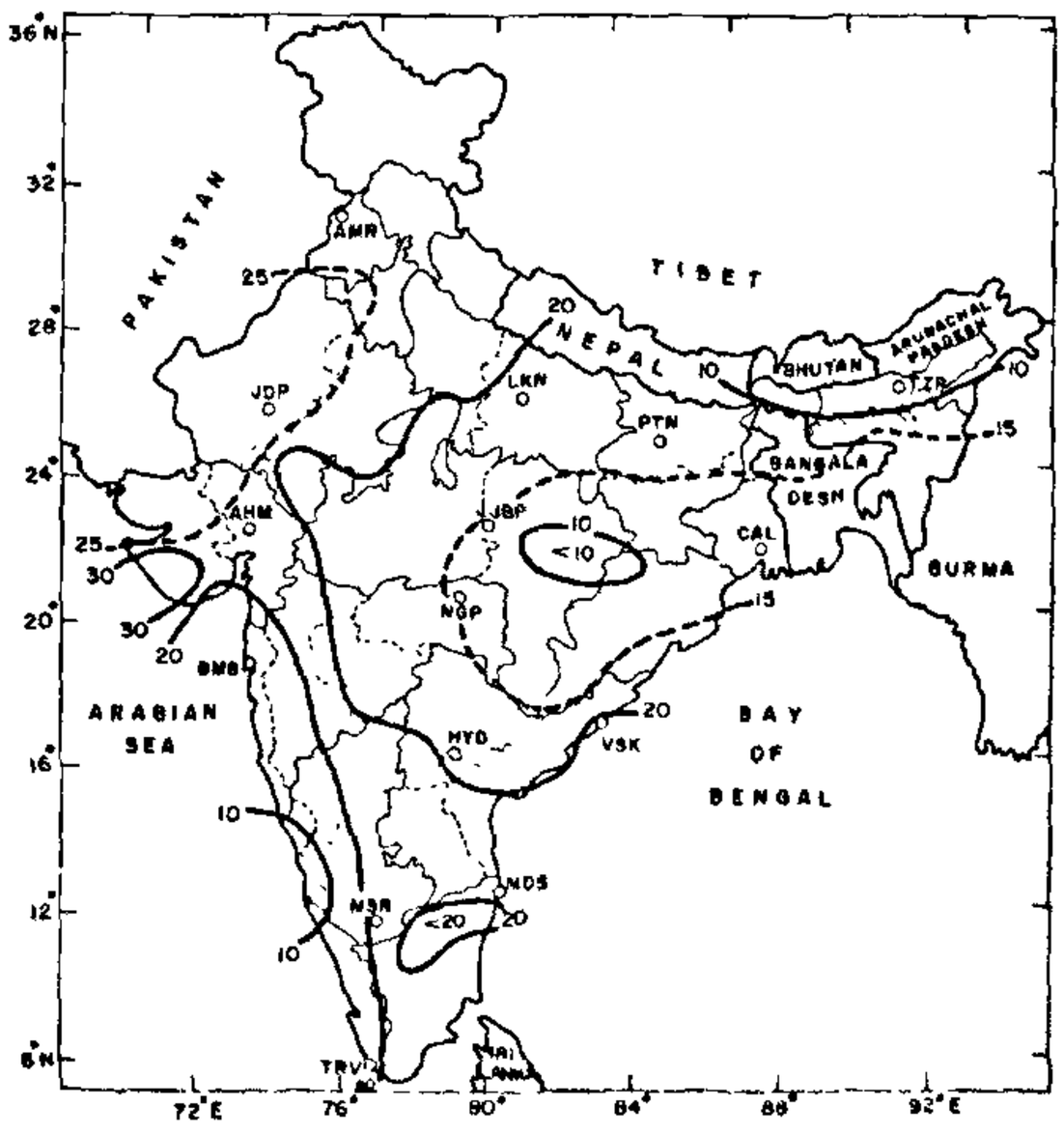

Figure 4. Empirical probability distribution of floods over India during southwest monsoon season: 1871–1978. (Flood: seasonal rainfall more than +25% of normal)

Figure 3 shows that the drought-prone regions are Punjab, Haryana, Rajasthan and the adjoining areas, large parts of Uttar Pradesh, Gujarat and most of the southern parts of the peninsula east of western ghats. The extreme western parts of west Rajasthan and Gujarat are chronically drought-prone areas. Figure 4 shows that the flood-prone areas are Punjab, Haryana, Rajasthan, Gujarat, West Uttar Pradesh and South-eastern parts of peninsula. There are no chronically flood-prone areas. It may be noted that in general the areas which are prone to droughts and floods are nearly the same. These are the regions of low rainfall and high rainfall variability. The quantitative figures presented here may be useful for planning purposes.

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22 March 1983

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CATENARIA VERMICOLA IN *HETERODERA AVENAE* NEMATODE—A NEW RECORD

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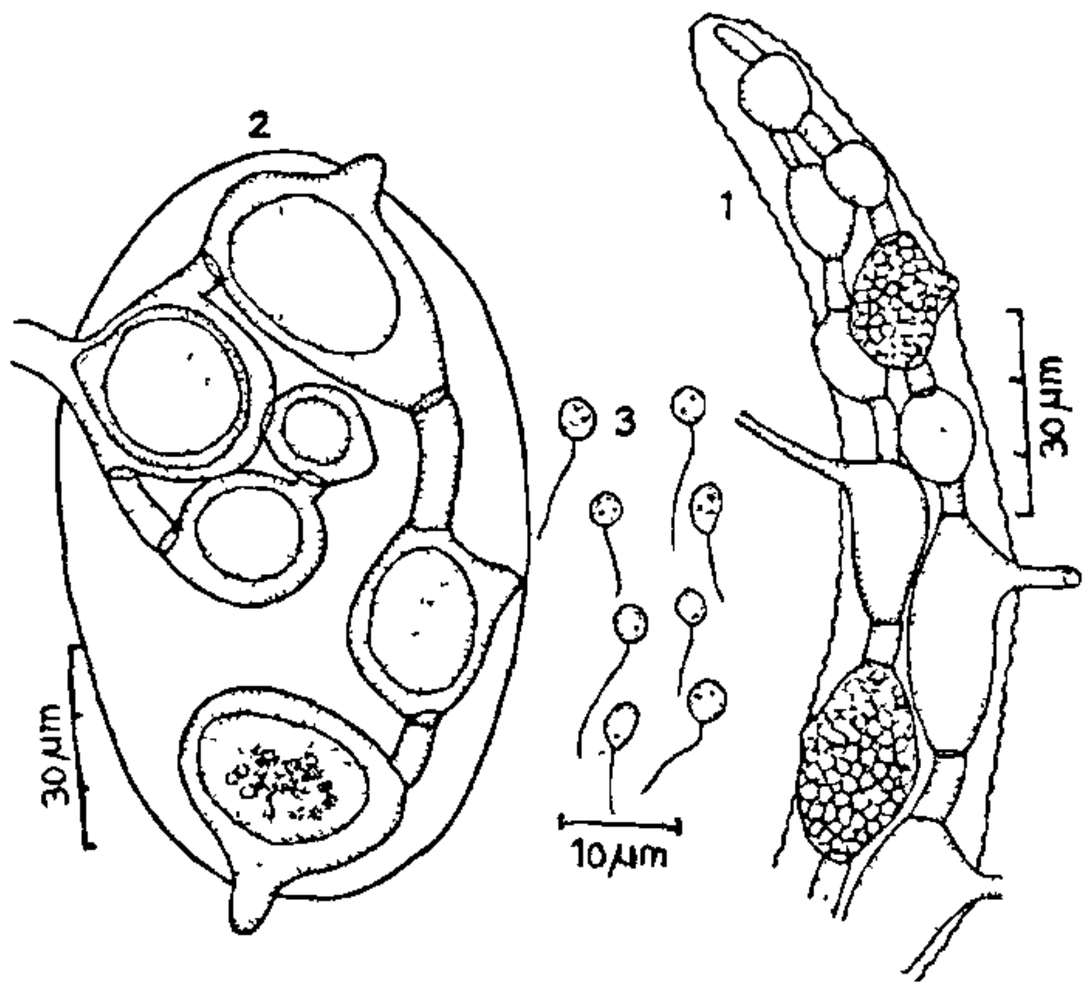
DURING an investigation for parasitic fungi of *Mastigomycotina* (Chytridiomycetes) group, a species of *Catenaria* Sorokin, is being reported in *Heterodera avenae* a parasitic nematode to graminaceous crops. This fungus has been recorded in these nematodes as well as in their eggs for the first time from India. The slide and specimens have been kept in *Herbarium cryptogame Indiae orientalis*, IARI, New Delhi. The taxonomic characters of this fungus have been described as follows.

Catenaria vermicola Birchfield, *Mycopath. Mycol. Appl.*, 1960, 13,331.

Thallus endobiotic, polycentric, consisting of septate mycelium without rhizoids. Sporangia double walled, intercalary, variable in shape, spherical, ovoid or oblong, triangular, 8–70 × 8–25 μm size, proturberances which later form discharge tube by dissolving cuticle and discharge zoospores. Thick walled resting sporangia present. Zoospores posteriorly whiplash, uniflagellate with cluster of lipids, body 2.5–5 μm, oval to oblong in shape and flagellum 7–15 μm long (figures 1–3).



Figures 1–3. *Catenaria vermicola*. **1.** Nematode infected with fungus showing chains of sporangia. **2.** Egg showing resting sporangia. **3.** Zoospores.

In larvae and their eggs (*H. avenae*), Hyatpur village (Gurgaon Distt.), S. C. Dhawan, October, 1981, HCIO 34074.

The above specimen differs from the type description (18–40 × 16–24.4 μm) in having bigger sporangia and in the discharge of zoospores individually than in gelatinous mass.

4 February 1983; Revised 29 August 1983.