GENERAL INTRODUCTION

It is a well-known fact that in natural soils the annual fall of litter is the main source of mineral nutrition to the plants which grow on it. The litter which falls every year undergoes a process of decomposition before the nutrients are released for absorption by the roots. This process of decomposition is brought about by scores of microorganisms which live in the soil and involve a series of enzymatic processes which are needed to accomplish this decomposition. Thus the importance of the microorganisms and their activity in decomposition becomes apparent so far as the fertility of the land is concerned.

The study of the decomposition of organic matter can be made with several aspects in view. There is the floristic-ecological aspect by which the microorganisms, their environment and activity are specially studied. There are then the chemical and biochemical activities of individual or groups of microorganisms which act in a
particular way due to their enzymatic equipment. The resultant chemical changes observed are due to the combined activities of the total soil population. It is well-known that certain groups of fungi such as the cellulolytic and lignicolous ones are found commonly in the soil as well as in the forest litter. A large part of the vegetation added to soil is cellulosic. The decomposition of this substance has a special significance in the biological cycle of carbon. To understand the complexity of this process, it is necessary to resolve it in various ways by studying the individual species with respect to their physiological characteristics. It should, however, be noted that what is true in the Petri-dishes may not be happening exactly in the soil due to the highly complex biological and biochemical environments. But, in spite of this fact, these experiments do indicate to a large extent the nature of the role which different species are likely to play in these processes.

The present investigations were undertaken to understand the process of litter decomposition in the forests of Saugor. A glance at the literature on the subject shows that the bulk of the work on this subject has been done in Western countries and very little in the tropical zone. The conditions and so also the organisms which carry out these processes in the cooler regions are
substantially different from what exist in our country. The soils in the west are predominantly of 'mor' type in which the pH is acidic, and the rate of decomposition is slow. In the warmer parts the soils which are called 'mull' have a rapid phase of decomposition with often alkaline inclinations.

Saugor is situated in a locality where forests pre-dominate with such important species as Tectona grandis (teak), Diospyros melanoxylon ('Bidi' plant) and Anogeissus latifolia, etc. No work on the decomposition process of litter, which falls heavily in these forests every year, has been done so far. The importance of such a study, therefore, becomes obvious.

The present study has been organised in the following manner:

Section A : Deals with the general topography, site and geology of the forests, the methods of study, etc.

Section B : Deals with the isolation and study of fungal flora from different depths of soil and stages of decomposition of the litter. It also takes into account of variation in this flora in different seasons.
Section C: Deals with the successional pattern of fungi in the three different kinds of litter found in relation to the three different tree species.

Section D: Deals with the taxonomic aspects of the fungal species. The important ones are described in detail.

Section E: A detailed study of fifteen selected cellulose decomposing fungi with reference to their physiological activities.

Section F: Deals with lignin decomposing capacity of fourteen selected fungi.

Section G: Miscellaneous. This section contains bibliography, forest flora and climatological data.
Section A

GENERAL
Site and geology:

Ten different sites in the forests of Patheria hills were selected for the study. The forests are spread over hills constituted by basalt overlying sandstones. These basaltic rocks cover the majority of the area. In some areas the hill shows an out-crop of Vindhyan sandstones. The soils of most of the hill tops are red and due to free drainage become ferruginous. The valleys and other lowlying areas are occupied by black clays and black loams derived from the parent rocks. Soil tests and analyses for various characters were done by Saksena (1955) which showed that the forest soil has a low base status but possesses a good amount of organic matter and a fair degree of nutrient level.

Fixation of sites for study:

The area is demarcated into three parts (Map 1): (i) Rajababa hill, (ii) Saji bhatar hill and (iii) Gulla hill. These differ in the ground vegetation and type of soil which are recorded later. In the first two forest
SOIL AND CONTOUR MAP OF PATHARIA FOREST (SAUGOR)

INDEX

--- GRASS LAND
--- BLACK SOIL
--- DARK BROWN
+++ RED SOIL (VINDHYAN)
+++ BLACK WITH SURFACE LIME
--- RED SOIL

FIG. 1.

1/4 MILE
types three sites for the collection of soil and litter samples were fixed while in the third forest type (Gulla hill) four sites were taken for study.

**Collection of litter samples:**

Samples of freshly fallen, fragmented and older leaf litter were collected in new polythene bags for transport to the laboratory. Samples were collected from different selected sites in the forests. A pit about two ft. deep, two ft. wide and two ft. long was dug. The faces of the pit were carefully examined to note any stratification. General observations on the physical features of the litter were recorded. One of the faces of the pit was cleared and scrapped carefully with a sterilized spatula. Three samples were collected from three different depths of litter. The first sample was taken to represent first 6" of the litter, the second from the next 6" (7" - 12") and the third from further next 6" (13" - 18"). By cutting steps in pit faces, the litter was removed from desired depth. A special care was taken to avoid mixing of materials from different depths. The samples were numbered serially and marks $S_1$, $S_2$ and $S_3$ were given respectively for the samples of three depths. Samples brought to the laboratory for investigation were processed immediately or kept at $10^\circ$C until processed 2-3 days later.
Plating of the samples:

Each sample of litter was divided into two parts: one which was sieved through 3 mm. mesh and the other which was left with large pieces of leaves and twigs. The mycoflora was studied by Warcup's (1950) soil plate method and Waksman's (1927) dilution plate method. The latter was found to be more accurate as far as the relative frequency of the different species was concerned. The medium used was Peptone dextrose agar to which were added rose Bengal and 30 u g./ml. streptomycin (Martin, 1950 and Johnson, 1957). When a soil suspension was prepared many of the fungal hyphae remained at the bottom with the heavier soil particles. The residue was examined microscopically as described in the hyphal isolation method (Warcup, 1955a).

A variety of media were used in an effort to isolate as many fungi as possible from the litter samples. Most commonly used media were Corn meal agar, Czapeki agar and Blakeslee's malt agar (Raper and Thom, 1949). Twenty units of penicillin and 40 u g./ml. of streptomycin were usually added to all media to avoid the development of bacteria and actinomycetes. Penicillin and streptomycin were added after the media had cooled down.
The fungal species growing internally in the twigs, etc. were isolated by teasing the tissues after surface sterilization (0.1% w/v aqueous mercuric chloride solution) and washing with sterile water. For the isolation of Ascomycetous forms litter samples were plated after steam treatment (Warcup, 1951). Potato malt agar medium was used for the isolation of species of Chaetomium.

Isolation of water molds:

A portion from each litter sample was placed in the sterilized Petri dishes and sterilized mustard seeds, hemp seeds and house flies were added as baits. After about 3–4 days a white mycelial growth appeared around the baits. The baits were then taken out and after giving several washings with sterile water they were placed in fresh dish and again baits were added for further culturing. The first infection invariably consisted of a mixture of species hence it was necessary to isolate them and grow them in pure culture. Pure culture from single sporangium was made by taking out a mature sporangium which was placed in a drop of sterile water to give a suspension of zoospores. The suspension was streaked on an agar plate to give bacteria-free colonies. If necessary the process was repeated. For the purpose of identification the fungi were grown on hemp and mustard seeds.
Purification and identification of fungi:

In the dishes, when the colony of a species was seen for the first time, it was transferred to the other dish or slants of the suitable medium for the purpose of purification. Single spore isolation was done by the usual streak and dilution methods. Micromanipulator was also used to pick up spores from a mixture of fungi.

After ensuring the complete purity of culture the description and camera-lucida sketches were made. Micromeasurements for each fungus were recorded by culturing it on a suitable medium. Identifications were done with the help of literature available in the department. A few fungal cultures were also got identified from Commonwealth Mycological Institute, Kew, England.

Record of fungi:

The fungi isolated and identified from each depth (three depths) of each site (ten sites) were recorded in a tabular form for the purpose of study.

Quantitative study of fungi:

For counting the fungi of the litter samples from
different horizons, the soil dilution and plate count method was used with the help of Quebec colony counter. Estimation of the total population of fungi per gram of litter sample was calculated. Seasonal quantitative records were taken for different groups of fungi for three seasons, viz., Rainy, Winter and Summer with respect to all the three forest types. For the records, those Petri dishes were considered which were obtained from the dilution of 1 : 1000, in the case of the samples of $S_1$ layer, 1 : 100 for the sample of $S_3$ layer and for the sample of $S_2$ layer that dilution was considered which gave about 20-50 colonies per plate. The average number of colonies per dish was multiplied by the dilution factor to obtain the number per gram in the original litter sample, the unit being considered as any spore, hypha or hyphal fragment which was capable of giving rise to a colony. A correction of weight of soil in dishes was applied on the basis of moisture content present in the litter (found separately by drying the sample overnight in an oven at 105°C.) so that the figures would express fungi per gram of dry weight of litter.

Special techniques used for determining the cellulytic activity and lignin decomposing activity of various selected fungi are given in the appropriate sections dealing with these topics.