

MICROBIAL DECOMPOSITION OF PINE
(*Pinus kesiya*) LITTER : AN ECOLOGICAL STUDY



BY

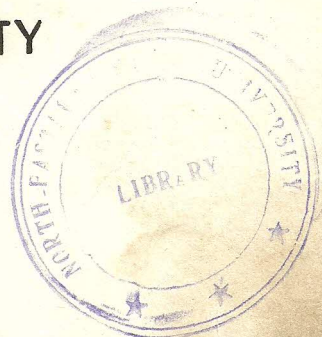
PIJUSH KANTI DAS, M.Sc.

DEPARTMENT OF BOTANY

THESIS SUBMITTED IN FULFILMENT OF THE
REQUIREMENT OF THE DEGREE OF
DOCTOR OF PHILOSOPHY IN BOTANY

TO

THE NORTH EASTERN HILL UNIVERSITY
SHILLONG (INDIA)
1980



SUPERVISOR'S CERTIFICATE

I certify that the thesis entitled "Microbial Decomposition of Pine (Pinus kesiya) Litter : An Ecological Study" submitted by Mr. Pijush Kanti Das for the Degree of Doctor of Philosophy of the North-Eastern Hill University, Shillong embodies the record of original investigation carried out by him under my supervision. He has been duly registered and the thesis presented is worthy of being considered for the Award of the Ph.D. Degree. This work has not been submitted for any Degree of any other University.

Date 7.2.1980
Place shillong

R.R. Mishra

Signature of the Supervisor

Dr. R. R. Mishra
Professor of Botany
School of Life Sciences
NEHU, Shillong-793003, India



ACKNOWLEDGEMENTS

I wish to express my deep sense of gratitude to Dr. R.R.Mishra, Professor, Department of Botany, North-Eastern Hill University, Shillong for his able guidance, valuable suggestions and constant encouragement throughout the course of present investigation.

I also acknowledge indebtedness to Professor P.S. Ramakrishnan, Head of the Department of Botany, North-Eastern Hill University for his keen interest in the present study and providing laboratory facilities.

I am obliged to U.G.C. for providing the grant to carry out the present investigation.

Shillong

Dated 7.2.1980

Pijush Kanti Das

(Pijush Kanti Das)

CONTENTS

Page Nos.

GENERAL INTRODUCTION	1
CHAPTER I - SEASONAL VARIATION IN THE POPULATION AND ACTIVITY OF THE SOIL MICROORGANISMS IN THE PINE FOREST	
INTRODUCTION	6
REVIEW OF LITERATURE	12
MATERIALS AND METHODS	23
RESULTS	35
DISCUSSION	49
CHAPTER II - ECOLOGY OF LEAF SURFACE MICROORGANISMS OF PINE NEEDLES	
INTRODUCTION	59
REVIEW OF LITERATURE	62
MATERIALS AND METHODS	70
RESULTS	76
DISCUSSION	86
CHAPTER III - MICROBIAL DECOMPOSITION OF PINE LEAF LITTER	
INTRODUCTION	94
REVIEW OF LITERATURE	98
MATERIALS AND METHODS	109
RESULTS	124
DISCUSSION	147

CONTENTS

Page Nos.

CHAPTER IV - EFFECT OF THE AMENDMENT OF
PINE LEAF LITTER ON
SOIL MICROBIAL POPULATION

INTRODUCTION	160
REVIEW OF LITERATURE	163
MATERIALS AND METHODS	166
RESULTS	170
DISCUSSION	179
GENERAL DISCUSSION	183
ABSTRACT	190
BIBLIOGRAPHY	195

*
*
* GENERAL INTRODUCTION *
*
*

Decomposition of litter is one of the most important phenomenon in the ecosystems. The biological degradation of the plant litter represents one of the essential links in the natural process of carbon circulation (Vladimir, 1970).

The role of microorganisms in the decomposition of plant material is of immense importance. The microbes are primarily responsible for the release of various nutrients locked up in the plant tissue which in turn are utilized by other organisms. The cycling of minerals in an environment is to a great extent influenced by the microbial activities of the region. Obviously, any influence in the normal functioning of the microbes during decomposition processes will effect the cycling of the minerals.

The increased interest in the role of microorganisms in nutrient and energy flow relationships in natural as well as man-manipulated environments has emphasized the need of litter decomposition studies. In the process of litter decomposition microbial attack is the most important and the process becomes further complicated since large variety of microorganisms are involved. To understand this complex phenomenon of decomposition of plant litter it is logically important to evaluate the role of the most important groups of organisms, their succession and their natural influence.

In north-eastern part of the country where the climatic fluctuations are extreme, the studies relating to role of microorganisms in the decomposition of litter in the forest, release of nutrients and phytotoxins during decomposition and the effect of litter on soil microflora

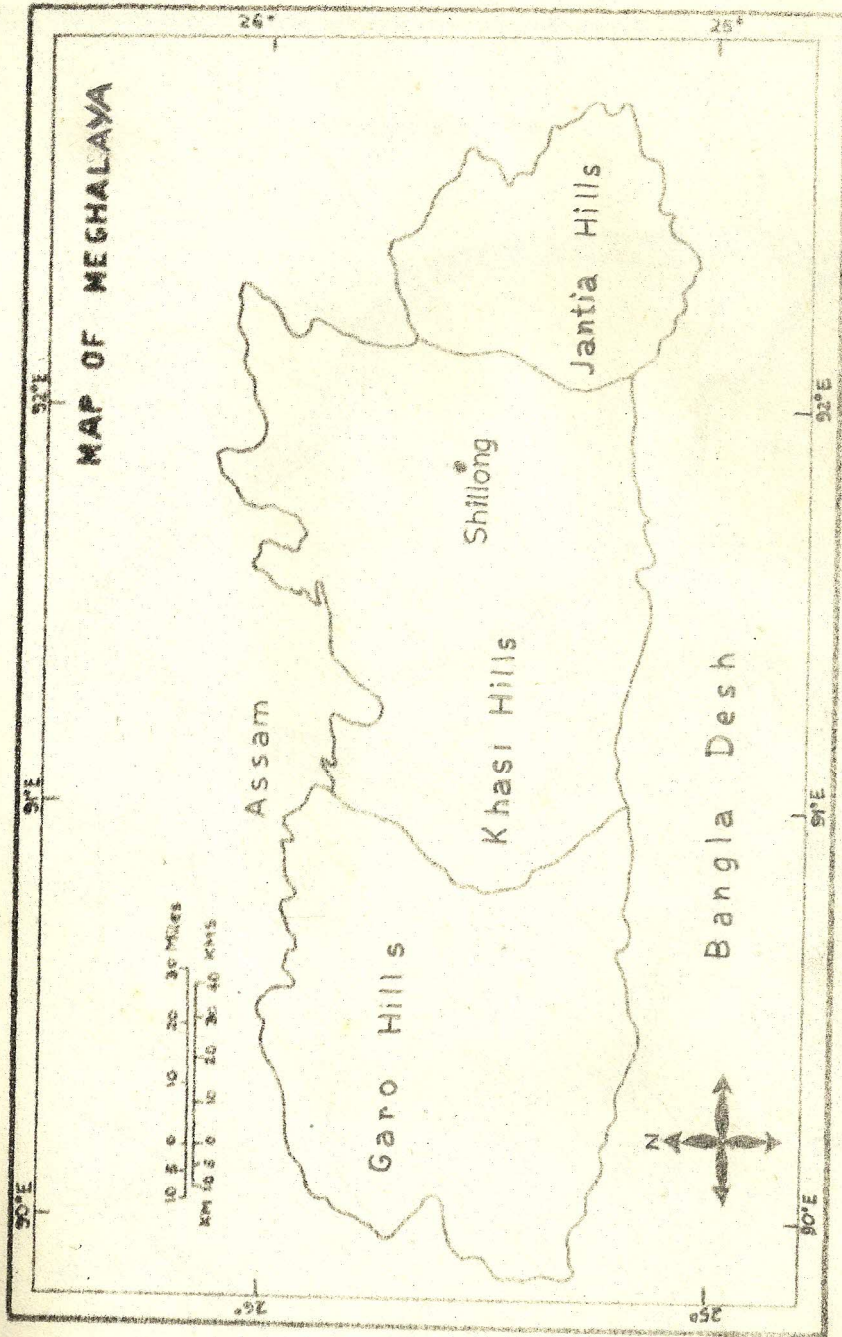
are of much importance.

The successive colonization of pine leaf litter by fungi in relation to various environmental factors is little understood. Very little information is available at present about the role of yeast, bacteria and actinomycetes in pine litter decomposition for which the present investigation was undertaken. Pinus kesiya Royle ex-Gordon was selected because of its economic importance and wide coverage in the region. The plants also produce abundant litter which are added to the soil after the leaf fall and this contributes significantly in the cycling of the nutrients. Moreover, presence of some acids that occur in pine needles (Freedi et al, 1975) may play a dominant role in litter decomposition under natural condition.

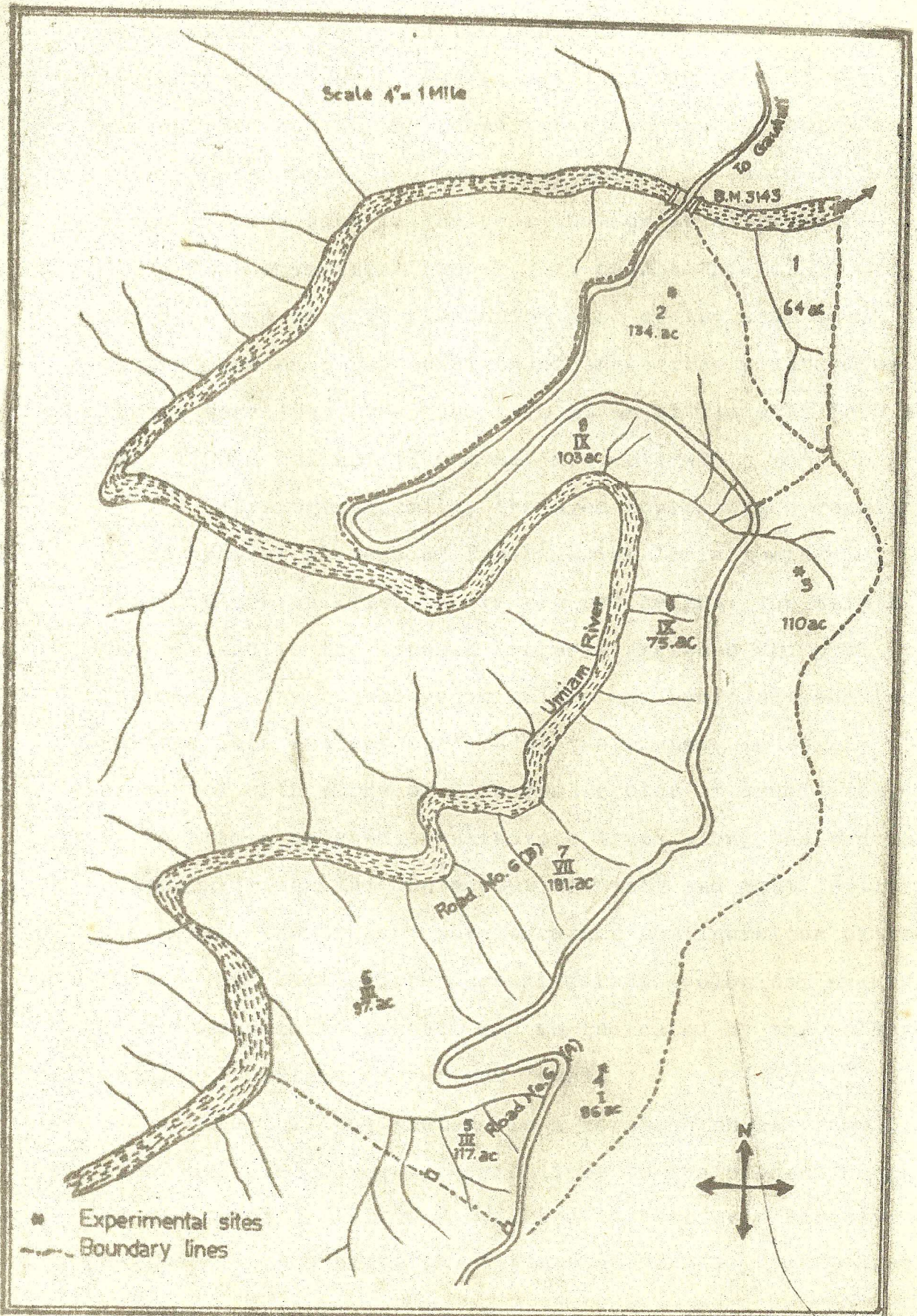
The present investigation was undertaken with a view to understand the "ecosystem function of Pine forest of Meghalaya" and the investigation was carried out in a reserve pine forest maintained by Government of Meghalaya adjacent to Shillong. The detail description of the experimental site is given below :

Description of the experimental site :-

Geographical location : The study area as shown in the map is named as "Riatkhwan reserve forest" is about 15 km from Shillong city (Latitude 25°34' N and longitude 92°47' E) on the western side of Gauhati-Shillong road. The area has an altitude range of 950 m to 1280 m MSL. Khasi pine (Pinus kesiya Royle ex-Gordon) plantations raised by the Meghalaya Government is the main vegetation of this area. The dominant pine vegetation is associated with



Map 1: LOCATION OF SHILLONG IN MEGHALAYA



Map 2: RIATKWAN RESERVE FOREST, SHILLONG (enlarged)

certain weeds. It occupies a narrow zone just above the Barapani lake. The slope of these hills is adjacent to Umiam river as shown in the map (2). The study area is divided into several compartments and the present work was carried out in the compartment numbers 2,3 and 4 as shown in the map(2). Compartment number 2 consists of the plant species sown in the year 1961 on an altitude of 950 m MSL. Compartment number 3 at an altitude of 1190 m MSL consists of pine plantation also of the same age. Compartment number 4 consists of three pine plantations of the year 1955, 1965 and 1970 at an altitude of 1250 m MSL, 1200 m MSL and 1280 m MSL respectively.

Physiographically, the area represents a remnant of an ancient plateau of Pre-cambrian India peninsular shield block uplifted to its present height. The Kernel of the plateau is the exposed Archaean gneisses and phyllites intruded later by younger granites and basic/ultrabasic suites. This ancient surface of the plateau is still preserved with marks of different cycles of denudation. It is hidden beneath the Mesozoic traps along the central Southern fringe and Cretaceous Tertiary and post Tertiary sediments. The present physiographic configuration of the plateau was attained through different geological events since Mesozoic to present day as indicated by the polycyclic erosional surface at various levels.

The Shillong plateau is a horst which has been block uplifted since zurassic times to its present height of 610 to 1544 m above M.S.L. and its tactionic history begins with the effusion of plateau basalts (Sylhet traps)

through fractures and faults in the basement and uplift and subsidence of adjacent basement blocks. These were followed by upper Cretaceous Tertiary sedimentation into the relatively down thrown portions along faults. The tectonic force has been vertically dominated and controlled by differential movements along these basements fractures.

Vegetation :- A list of the plants including undergrowths present in the area of study is detailed below. The plants were almost the same for all the plantations studied.

Trees : Pinus kesiya Royle * ex Gordon

Schima wallichii

Herbs : Eupatorium adenophorum*

Pouzolzia zeylanica

Urena lobata

Oxalis corniculata

Oxalis corymbosa

Frageria indica

Rubus ellipticus

Commelina benghalensis

Oldenlandia burmanniana

Hedychium coronarium

Erigeron linifolius

Scutellaria bicolor

Anemone rivularis*

Hypochaeris radicata

Shrubs : Lantana camara

Desmodium triflorum

Osbeckia crinata

Grasses : Setaria glauca*
Capillipedium assimile*
Imperata cylindrica*
Paspalum dilatatum*
Digitaria adscendens*
Saccharum officinalis
Eriantnus sps.
Poa annua

* Indicates dominant plants.

Environmental condition :- The region experiences a tropical monsoonic climate, the summer temperature recording as high as 28°C and the mean winter temperature falling down to 6°C with periodic fluctuations below the freezing point, marked by appearance of ground frost at night and morning. The average annual rainfall of the state is around 205 mm. The periodic climatic data is represented in the Fig.13.