

Changing landscapes, ecodiversity and insect faunal dynamics: The Tenmalai (Western Ghats) experience

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Substantial changes in vegetation in some areas of the Western Ghats like the Tenmalai region over a considerably long period, have resulted in extensive alterations in landscape profiles leading to changes in insect biodiversity with the loss of specific mix of insect species and their community organization, not to mention about the disappearance of species from the sites where they were once abundant. Heterogeneity of an area is strongly correlated with the number of species of the area and patterns of species diversity are associated with patterns of spatial and temporal variation. Stable ecosystems, diversity of habitats, abundant biomass and diversity of plant and animal species, undoubtedly add to species diversity, and increased denudation of natural forests and replacement by monoculture results in reduced insect abundance and species diversity. The impact of such disturbances in the Tenmalai region of the Western Ghats is examined in relation to the hitherto well-explored thrips faunal complexes as well as of other insects in the forest floor.

THE 1950s and 1960s have witnessed the advent of varying degrees of landscape changes involving diverse degrees of disturbance, mostly from deforestation, natural forests being replaced by monoculture plantations, mostly teak and rubber. The rich canopy, herbaceous ground layers with their tightly packed species guilds contribute considerably to insect diversity. With increased interference in natural forests such as in the Tenmalai ranges of the Western Ghats extending from Shencottah bordering Tamil Nadu to Punalur in Kerala, striking variations were evident with passing years in the periodicity and abundance of insects such as mycophagous and gall thrips as well as of others like Dermaptera, Hemiptera and diverse microarthropods. Frequent fields trips by the author during the 1960s and 1970s to study the thrips fauna of the area provided adequate material for subsequent comparison of these faunal elements through various stages of natural forest transformation. An understanding of the spatial distribution of biotic elements is an important aspect to assess changes in ecological structure, composition and function in response to natural as well as the disturbed conditions¹. Needless to emphasize that the diversity of insects and other microarthropods provides a wide array of ecological and biogeographical probes useful in their inventory². The extent of such changes in biodiversity in

interfered systems, as seen in Tenmalai forests is discussed.

Changing mosaics and patch dynamics

While the protection of terrestrial vegetation is positively correlated with plant species diversity, variation in physiological and biological patterns influences diversity. Heterogeneity is contributed by plants in diverse ways involving vertical structure and complexity produced by the roots, stems and leaves and ground vegetation. Beyond the species level, diversity includes patterns in nature up to the landscape level. The occurrence of continually changing mosaic from virgin or undisturbed forest patches and denuded patches to patches recovering from the disturbance is a typical present-day phenomenon, so that spatial and temporal patterns of differences are evident in the landscape. Maximum diversity within a local patch will be influenced by the number of species available in the landscape, i.e. the regional species pool for dispersal into the patch³. Denudation of natural forests and replacement by the monoculture results in mortality from different biotic and abiotic causes, reducing insect abundance especially in the forest floor. Large-scale clearing results in the break-up of recycling mechanisms leading to a rapid loss of accumulated nutrient capital. Once it is lost vegetation may not recover its former diversity or stature and regeneration will not involve the

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same species diversity. Local extinction of the species is thus an inevitable consequence of such disturbances. One of the best examples relates to the virtual disappearance of the primitive, mycophagous, merothripid Terebrantian thrips, *Erotidothrips mirabilis*⁴, which exhibits discontinuous distribution, being earlier recorded through a single individual from Belgian Congo and subsequently from Polynesia. Several individuals of this species in all the stages of development were recorded by the author from Tenmalai. Similarly on the rarity list are such unique genera of mycophagous Tubulifera as *Bunothrips*, *Neothrips*, *Plectrothrips* and *Opidnothrips*, earlier reported from this area. Similarly thrips galls containing complex communities have also dwindled due to the reduced or restricted availability of host plants of different species of *Memecylon* (*Crotonothrips*), *Pavetta hispidula* (*Teuchothrips*), *Mallotus phillipinensis* (*Mesothrips-Rhynchothrips-Liothrips*), *Maytenus senegalensis* (*Alocothrips*, *Aeglothrips*), *Linociera* (*Mesicothrips*) to mention a few⁵. While these host plants occur in scattered patches galling has not been as common. However an extraordinary species of gall thrips *Kochummania excelsa* has since virtually disappeared from this area.

Changing nutrient dynamics and litter insect diversity

The survival of the forest depends on the highly efficient mechanisms for recapturing of nutrients from the sequestered stocks at the surface of the living and decomposed organic matter. As such increased productivity of natural forests cannot be supported by soils of low fertility. Nutrients are generally accumulated in the litter zones which carpet the soil. Bacteria, fungi, myriad invertebrates mostly microarthropods, earthworms, millipedes, and mites participate in the release of nutrients in the soluble form required by the roots. Monocropping can lead to sharp reduction in genetic diversity, and clearing of forest lands reduces not only the variety of vegetation, but also has adverse effects on insect biodiversity. Such activities also result in the invasion of plants and animals with the result that many individual plants tend to alter the environment they invade especially the nutrient cycles of the ecosystem. Therefore the interaction between productivity and disturbance has a strong influence on the invasibility of the ecosystem, species complexity and diversity fluctuating within different regions and succession may occur at different rates in different localities⁶.

The leaf litter assemblage being composed of a high percentage of stenotypic species is highly responsive to changes in microclimate. Periodic burning in several places in the Western Ghats involving the removal of accumulated litter results in a substantial loss of organic

matter affecting faunal community notably populations of Collembola and Acarines⁷. Diversity of species is not only determined by the type of litter but also as a function of the complex biotic and abiotic components coupled with the heterogeneity of litter. Further, the chemical nature of litter involving the inorganic components as well as phenolics, volatiles and flavonoids also contributes considerably to the degree of complexity of litter insect community. As the litter layer becomes deeper and as it undergoes an orderly and sequential breakdown, the microfloral and faunal assemblages tend to succeed one another. The species comparison in natural forest litter in contrast to that of monoculture indicates the existence of potential complicated trophic links. Besides, the chemical diversity of litter in natural forest sustains biological diversity of litter with varying communities of micro- and macroarthropods becoming involved in spatial and temporal relationships. The impact of human interference therefore has considerable bearing on litter insect guilds resulting in their fragmentation and ultimate disappearance, positively affecting species diversity. In this connection one may mention Collembola, which are the most prominent of litter microarthropods followed by the mites. Species of Collembola, like *Cyphodera*, *Lepidocyrtus*, *Tomocrus*, *Entomobrya*, *Orchesella* and *Tullbergia* as well as of mites like *Galumna*, *Macrochaetes*, *Pergamasus*, *Steganocarus* and *Cosmolaelaps*, which normally abound in natural litter have considerably dwindled in population in the interfered forests or those in the process of degradation. The length of the food chain and the size of the organism are determined by resource quality which varies considerably between natural forest and monoculture forest ecosystems⁸.

Reduced phenotypic plasticity in mycophagous thrips

As understanding of multiscale variations in species diversity remains a fascinating challenge as a result of response of organisms and ecosystems to disturbance, stress and changing climatic conditions. In natural forest litter, in bark as well as in dried hanging climbers, mycophagous thrips species dominate. Functional diversity associated with structural polymorphism involving oedymery and gynaecoidy in males and major and minor females with or without alary polymorphism are typical of mycophagous thrips inhabiting the understorey and ground vegetation. Males with excessively developed structure patterns often involving bizarre structures in many species are oedymorous (Figure 1), as against the gynaecoid males where these characteristics are suppressed. Oedymery and gynaecoidism represent the two ends of a continuing series. Most of the species feed on a host of fungi such as Coelomomycetes (*Pestalotia*,

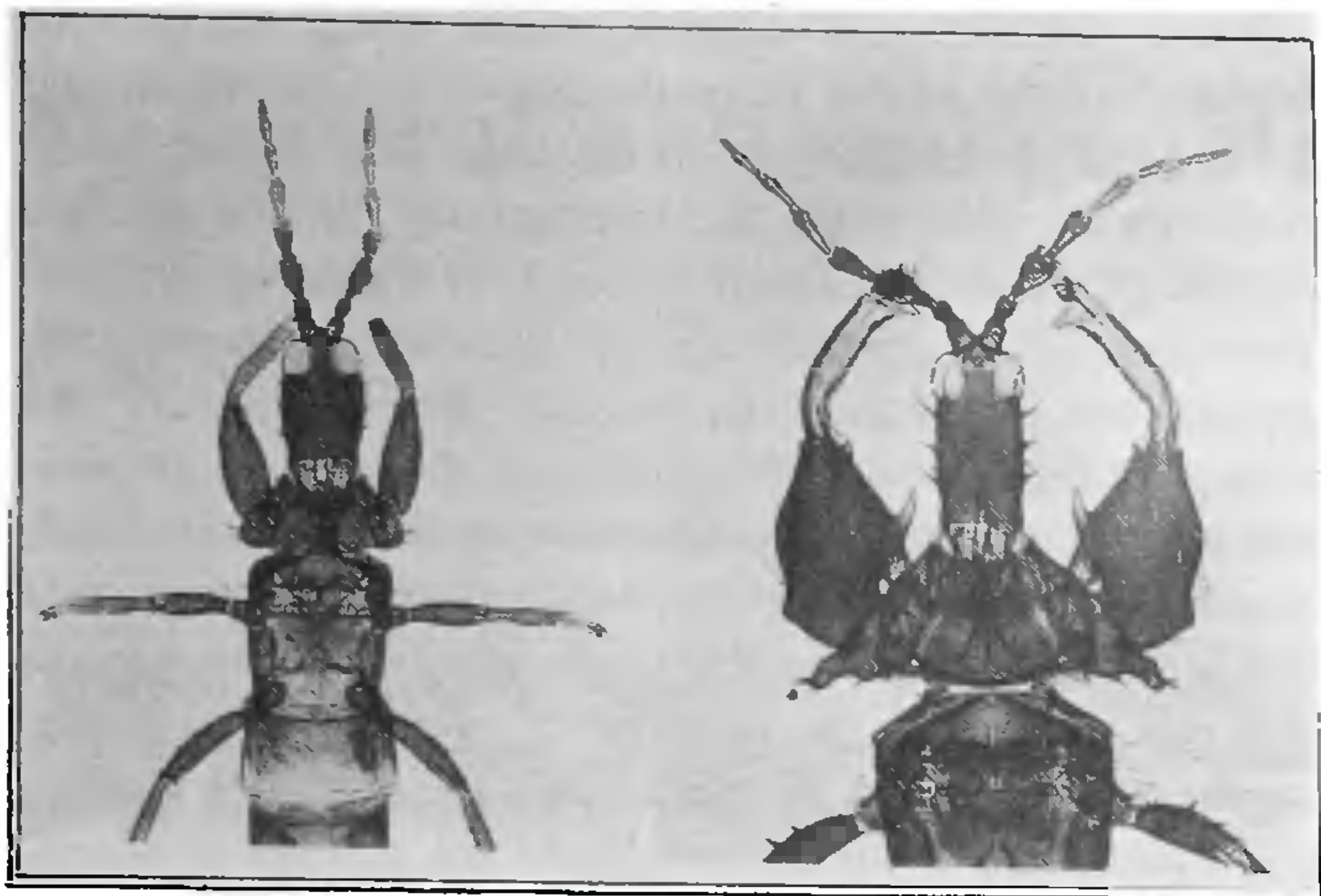


Figure 1. Polymorphic forms of *Ecacanthothrips* (Left) gynaecoid, (Right) oedymorous.



Figure 2. A colony of the mycophagous species *Tiarothrips subramanii*.

Lasiodiplodia, *Phomopsis*, *Cytospora*), Ascomycetes (*Anthostomella*), Hyphomycetes (*Melanographium*, *Alternaria*), etc.⁹⁻¹¹. The combination of oedymery and gynaecoidy with alary polymorphism results in a diverse variety of mating combinations and size assorted mating with variations in egg output, not to mention the occurrence of reproductive polymorphism resulting in oviparity, ovoviviparity and viviparity in species of *Dinothrips*, *Tiarothrips*, *Kleothrips*, *Hoplothrips*, *Bactrothrips*, *Elaphrothrips*, etc.^{12,13} (Figures 2 and 3). The occurrence of sex-limited polymorphism in mycophagous thrips in natural forest ecosystems where oedymery and gynaecoidy form the two ends of a continuous series adequately serves to highlight the fact that the 'genotype does not determine the phenotypes but the range of potentially possible phenotypes', of en

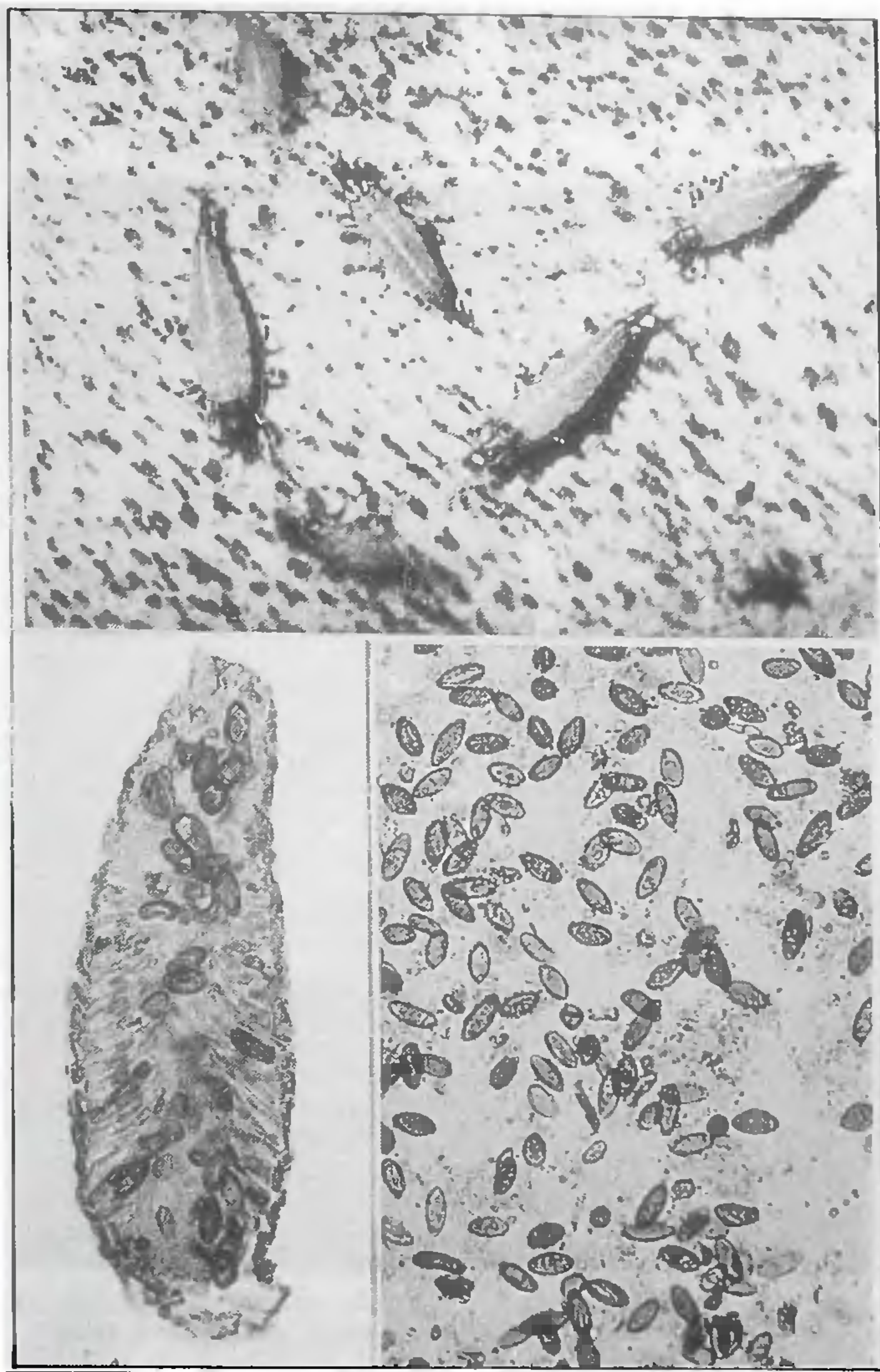


Figure 3. Larvae of *Tiarothrips* feeding on fungal spores. Bottom, Foregut with spores.

called 'the norm reaction of the genotype'^{14,15}. The manifestation of multiple phenotypes within a population is very characteristic of mycophagous Tubulifera which offers sufficient scope for numerous mating combinations leading to substantial variation in populations. The physiological nature of the difference in fitness of polymorphic individuals, in particular of the superior fitness of the oedymorous males and major females in terms of their reproductive efficiency is an important aspect. With increased number of individuals being produced, polymorphic populations are better adapted to exploit the environment and are better buffered against environmental variation. The behavioural diversities involved in oviposition are indicative of the degree of aggregation and hence of the build-up of small polymorphic colonies (Figure 4). It is this diversity resulting from phenotypic plasticity of species and the equally diverse patterns of variation that have visibly



Figure 4. Behavioural diversity in relation to mating and oviposition in *Tiarothrips subramanii*.

dwindled in the Tenmalai region in recent years. Of particular relevance is the fact that the populations of species such as *Bactrothrips*, *Dinothrips* and many species of *Elaphrothrips* are difficult to come across. Similarly the macrolabid, microlabid and cyclolabid forms of a number of dermapteran species have also become almost unnoticeable.

Therefore such community organization with high species numbers and complex food webs are part of history insofar as the Tenmalai forest is concerned, and having had the occasion to witness the richness of faunal diversity in this area, the present-day dismal picture should promote increased interest in biodiversity conservation efforts, which should provide increased emphasis on ecosystem processes. The result of the changing forest scenario is the loss of local populations enhancing erosion of biodiversity at the genetic, landscape and functional levels. Needless to emphasize that the determination of the maximum number of the species that can coexist, or the occurrence of the highest biodiversity is influenced by the size of the regional species pool, landscape heterogeneity and rates of immigration.

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