STUDIES ON THE BRACHYPYLINE ORIBATID MITES OF KERALA

SYNOPSIS OF THE
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SYNOPSIS

India being an agricultural country primarily, the fertility of soil is of utmost importance. The richness and variety of soil in different parts of the country provide an ideal habitat where a wonderful array of mites thrives luxuriously. Among the various groups of soil mites, the maximum credit goes to the oribatid mites because of their vital role in the break down of litter thereby helping in soil humification process. As Kerala is enriched with varied floral elements, providing bountiful food resources not only to the plant parasitic forms but also the members of soil fauna, when the floral rudiments reach as litter in the soil. Oribatid mites which are known to be free-living, detritus feeders are abundant in such litter accumulated areas. The detection of panphytophagy (wide range of feeding habits) in majority of species studied earlier indicates that in Kerala soils, mites take part a much significant role in degradation. Most of the barchypyline oribatid mites are panphytophagous in nature, which exert an energetic influence on soil humification process, leading to enrichment of soil fertility. They show uniform, world wide distribution and high adaptability to survive and replenish in altering environmental conditions. The present study was carried out on the systematic and biological details of some brachypyline taxa of oribatid mites, which exert a terrific impact on soil humification and nutrient cycling, leading to enrichment of soil fertility. In the present study, assessment of the potential of these mites to degrade highly recalcitrant materials like coconut pith, left behind after coir retting process was made. Quantitative studies were also carried out to analyse the positive impact, resulted due to feeding activity of these oribatid mites, towards the enrichment of the fertility status of soil.

The first part of the thesis was focused to gather information on the habitat, distribution pattern, species diversity, abundance and systematic details
of the most common and locally important taxa of brachypyline oribatid mites. The above objective was achieved through intermittent sampling of soil/litter samples covering different seasons from varied habitats like forest ecosystems, river banks, coir retting areas, water logged area, mangrove ecosystems, agricultural lands, secondary shrub jungles, biowaste accumulated and isolated litter accumulated areas, distributed over 6 districts of Kerala viz., Wayanad, Kozhikode, Malappuram, Thrissur, Idukki and Thiruvananthapuram. The collected samples were subjected to extraction through modified Berlese-Tullgren funnel apparatus to separate the mites. The mites were collected in preserved condition for taxonomic studies and live condition for biological studies. Preserved specimens were dehydrated in alcohol series and cleared in 1:1 mixture of lactic acid and ethanol, mounted in Hoyer’s/PVA media and identified following appropriate keys and relevant literature and confirmed with the help of concerned experts. Drawings of the various species were made with the help of Camera lucida attached to a Meopta research microscope.

The results of the survey yielded 57 species of brachypyline oribatid mites belonging to 36 genera, 20 families and 14 superfamilies. The 14 superfamilies of brachypyline mites recorded during the study were Oripodoidea, Amerobelboidea, Tectocepheoidea, Otocepheoidea, Gustavioidea, Carabodoidea, Licneremaeoidea, Microzetoidea, Oppioidea, Galumnoidea Phenopelopoidea, Plateremaeoidea, Trizetoidea and Zetomotrichoidea. Among the 20 families, Haplozetidae and Oppiidae showed maximum generic diversity, supporting 6 genera each. The families Scheloribatidae and Galumnidae were represented by members of 3 genera each, while Basilobelbidae and Carabodidae included members of two genera. The rest of the families were found represented by a single genus each.

*Scheloribates* was recognized as the most diverse genus represented by members of 7 species. The second position was achieved by *Galumna* which
included members of 5 species. The third position was shared by *Eremulus* and *Protoribates*, comprising 4 species each, followed by *Pergalumna* with 3 species. The genera *Dolicheremaeus, Ischeloribates, Trachyoribates* and *Brachioppia* were represented by a single species each there by disclosing the minimum diversity.

Results of the quantitative and qualitative distribution pattern of the various oribatid species recovered during the study provided substantial evidence to confirm the influence of vegetational characteristics on the faunal composition of brachypyline oribatids. This was quite evident in the Wayanad District, where Kalpetta, Sultan Battery and Muthanga Reserve Forest with 9 varied vegetational and geographical peculiarities were the sites surveyed which enabled to procure 40 species of brachypyline oribatid mites. Out of the 19 sites surveyed, site 10 was a fully water logged area with no evidence of litter accumulation and which was found devoid of any oribatid species. The species diversity of oribatid mites in the Kozhikode District was comparatively low with a total of 15 species as the 5 sites selected in the District were highly contrasting, comprised of the mangrove vegetation, river banks and retting grounds. The soil samples collected from 4 sites in Malappuram District comprising mixed vegetation, water logged area, paddy field, homeyard etc. yielded a total of 28 species. The single site at Thrissur District occupied by *A. heterophyllus* with low litter accumulation yielded a total of 6 species. Similarly, the single site at Idukki District with medium litter accumulation revealed the presence of 14 species. In the Thiruvananthapuram District, the 3 sites surveyed comprising herbal garden, area of biowaste accumulation and mixed vegetation, yielded a total of 33 species. Results of the survey enabled to recognize *T. (Rostrozetes) foveolatus* as a widely distributed species, as it was recovered from 14 out of 25 sites surveyed. *T. laevis* showed preference to semi-water logged area. Some of the species like *M. kizhisseriensis* sp. nov.,
P. ciliata sp. nov., A. pellucida and G. (Indogalumna) intermedius sp. nov. were unique with respect to their sites. The immature stages of most of the species were also present in abundance in all the sites surveyed.

In the systematic part of the thesis, detailed morphological descriptions of 20 species of brachypyline oribatid mites were included along with appropriate figures. The above 20 species were found representing 18 genera, 13 families and 8 superfamilies. Of these, 8 species representing 8 genera, 6 families and 6 superfamilies appeared to be new to science. All relevant morphological structures of taxonomic importance of the various species were represented through drawings, supplemented by detailed descriptions.

The second part of the thesis envisages studies on the biological aspects of selected species of brachypyline oribatid mites, comprising both feeding and breeding parameters. The occurrence of oribatid mites in a multitude of micro-conditions of the soil is mainly determined by their ability to consume the available food items present in their natural habitats. This has led to the development of a variety of feeding responses among oribatid mites. To ascertain the food preference of field collected oribatid mites, gut content analysis of 20 species was performed. Food boli and gut contents of live mites were dissected out on microscopic slides, spread out evenly in glycerine and observed under a research microscope. Appropriate stains were applied for better observation. Results of gut content analysis of the 20 species of oribatid mites collected during the present study revealed that P. ciliata sp. nov. was the only species which showed a deviation in the nutritional habit. Remaining species showed the presence of varied food items like fungal hyphae, spores and remnants of leafy/woody components of litter in various stages of digestion, pollen grains etc. along with some unidentified particles in highly advanced stage of digestion. Food choice test was conducted under laboratory condition
by providing an array of test food items comprised of varied species of fungi, leaf litter of different plants, coconut pith, decayed pneumatophores, cow dung, filter paper etc. Ten out of the 20 species considered for gut content analysis were subjected to food choice test. Of these, *P. ciliata* was proved as macrophytophagous species while the other 9 species were categorized as panphytophagous.

The potential of oribatid mites in enriching soil fertility and productivity was analysed quantitatively by recording the levels of 3 important micronutrients viz., Nitrogen, Phosphorous and Potassium present in the soil samples. Soil samples collected from 6 sites with varied vegetational composition were subjected to micronutrient analysis. The collected samples of soils from the above sites were thoroughly extracted for 72 hours in order to remove all faunal members and transferred to earthen flower pots. In experimental samples, 150 live adults, *P. ciliata* sp. nov., *P. punctata*, *M. kizhisseriensis* sp. nov., *D. indicus* were introduced in to the soil sample containing litter collected from the study sites. While control samples contained only the soil and litter collected from the study sites. Soil samples in both experimental and control samples were adequately watered frequently and kept undisturbed for a period of about 6 months. These pots were covered with fine mesh to prevent the invasion by other organisms. After a period of 6 months, the soil samples of both experimental set ups and respective controls were subjected to chemical analysis for determining the quantities of N, P, K. Chemical analysis was carried out in the District Soil Testing Laboratory, Thikkodi. Results of chemical analysis conducted in the present study showed a general increase in the concentration of 3 elements tested viz., Nitrogen, Phosphorous and Potassium in the experimental soil samples where the mites were released. Preliminary studies on the potential of these mites in the degradation of highly recalcitrant wastes like the coconut pith on retting ground
have provided very promising results. An analysis of oribatid potential in the
degradation of coconut pith was made by quantitative estimation of
micronutrients present in the pith before and after feeding by selected species
like *P. punctata*. For the purpose, pure pith samples were collected from retting
grounds which were treated as experimental and control sets separately. For
each set, 10-12gm of samples were taken and dried up in an oven at 103⁰C for a
period of 1-2 days. Such oven dried samples were kept in separate bottles. For
the experimental purpose, 2 gm of the dried sample was taken in a fresh culture
cell into which 25 live specimens of *P. punctata* were introduced. The sample
was adequately moistened with distilled water and kept for 6 months. The
control set was also prepared similarly, but without the mite specimens. The
pith from the control sample and faecal pellets were collected separately laid by
*P. punctata* offer feeding the pith and subjected to micronutrient analysis in the
Sophisticated Test and Instrumentation Center, Cochin University. The analysis
of N and C was carried out with CHNS analyzer and that of K and P was done
with the ICP-AES system. Results of micronutrient analysis showed that the
faecal pellets of *P. punctata* which fed on coir pith showed an increase in
concentration against the respective elements in the control sample containing
only the coir pith.

Population density of any organism depends greatly on their
reproductive potential. Since oribatid mites form a major component of soil
mesofauna, an understanding of the reproductive strategies is highly essential.
Hence in the present work, breeding biology of 5 species of panphytophagous
brachypyline oribatid species viz., *C. ajaii* sp. nov., *R.philippinensis*,
*T. (Rostrozetes) striata* sp. nov., *S. praecinus interruputs* and *P. punctata*
were selected for developmental studies. Live adults were reared in special
culture cells containing plaster of paris-charcoal base by offering them their
most preferred food items. Observations were made on oviposition, hatching,
active and quiescent phases, moulting, duration of individual instars, duration of \( F_1 \) generation etc. Morphological details of each stage were studied and presented through illustrations and drawings. Two mode of reproduction were shown by the species. Spermatophores were laid in abundance in culture cells by the males of \( S. \ praensisus \ interruptus \) and \( P. \ punctata \). Other 3 species showed parthenogenetic mode of reproduction since in no instance, male progeny was found developed and the entire population of the mite comprised of only females. This was proved by the results of field sampling also. The egg after incubation hatched out into a hexapod larva, followed by an inactive quiescent phase which subsequently moulted into the next active phase. The duration of development varied with respect to variation in individual species. The above 5 species, viz., \( C. \ ajaii \) sp. nov., \( R. \ philippinensis \), \( T. \ (Rostrozetes) \ striata \) sp. nov., \( S. \ praensisus \ interruptus \) and \( P. \ punctata \) completed their life cycle from egg to adult from 17-21, 14.5-19, 51-59, 27-31 and 29.5-34.5 days respectively. The duration of \( F_1 \) generation of the above species were 25-31, 21.5-27, 66-71, 33 to 38 and 37.5-43.5 days respectively.

Detailed study on the comparative morphology of the life stages of the 5 species showed an increase in the number of notogastral setae from larva to tritonymph in \( S. \ praensisus \ interruptus \) and \( P. \ punctata \) could be observed. However, during final moult 5 pairs of setae were lost in both the species. But in the other 3 species, \( C. \ ajaii \) sp. nov. and \( T. \ (Rostrozetes) \ striata \) sp. nov., a progressive trend was observed in the number of notogastral setae from the larval to the protonymphal stage and then it was retained until the completion of the tritonymphal stage. In \( R. \ philippinensis \) a progressive trend was observed in the number of notogastral setae from the larval to the deutonymphal stage. At the final moult, setal regression was observed in the adult species. The number of epimeral, genital, anal and adanal setae increased from larva to
adult. In all the 5 species, the larva was always a hexapod, devoid of genital plates and suckers.

Thus, the present study helped to identify and contribute 8 new species coming under 8 genera, 6 families and 6 superfamilies, to science. The results of feeding studies brought out the biodegradative potential of 10 species of brachypyline oribatid mites, on a variety of food items. One of the most interesting observations made during the study was the potential of oribatid mites to feed and survive on highly recalcitrant solid waste, coconut pith. Further the study also revealed an increase in the nutrients after the feeding of coconut pith by selected species like *P. punctata*. Quantitative studies were carried out to analyse the positive impact resulted due to feeding activities of oribatid mites towards the enrichment of fertility status of soil.