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Isolation of Gut Fungi and Feeding Behavior of Some Selected Soil Microarthropods of Wastelands of Burdwan District

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Abstract : Based on gut content analysis, *Alternaria humicola* and *Cladosporium cladosporioides* were found as the most prevalent fungi in the gut of Acarina and Collembola respectively .Altogether 21fungal species were isolated and identified. Out of which 10 were common to both Acarina and Collembola. Among 21 isolates 18 obtained from Acarina and 13 from Collembola. Acarines and Collembolan species showed different feeding habits and strategies. *Oppia yodai* was found to be truely fungivorous and *Gamasiphis benghalensis* was completely predatory in nature. Out of the 10 Collembolan species *Lepidocyrtus medius* is an obligatory fungivorous species and *Proisotoma* sp. showed facultative predatory habits. Despite preferences for certain fungal species most oribatid mites are best considered as 'choosy generalists' whereas the Collembola may be conversely considered as 'selective' opportunistic feeder.

Key words : Fungivory, Collembola,Acarina,Gut analysis.

Introduction

Soils contain highly diverse communities of microorganisms and invertebrates. The trophic interactions between these species are largely unknown. Trophic niche differentiation may explain the high diversity of soil animal species. However, trophic niches of soil invertebrates are little understood and it appears that different decomposer soil animal species prefer similar food substrates. Food specialization remains a key issue for understanding animal species diversity in soil. Surprisingly, knowledge on feeding biology of many soil invertebrates is poor and the available information in part is contradictory. It is still not clear if soil living animals are specialist or generalist feeders (Schneider and Maraun, 2005).The influence of soil fauna on soil biological processes is well documented (reviews by Lussenhop,1992).Microarthropods are among the most abundant decomposers in soil. Collembola, Acarines and Enchytraeids are the major taxa belonging to this group. These animals live in the pore system of the soil and most of them preferentially feed on fungi, but also ingest decomposed plant material and mineral particles. These fungal grazing micro arthropods affects microbial respiration (Kaneko *et al.*1998), decomposition rates (Cortet *et al*.2003), nutrient cycling (Bonkowski *et al*.2000), plant growth (Klironnomes and Kendrick,1995), fungal biomass (Bardgett *et al*.1993),fungal succession and the distributation of fungi in soils (Lussenhop, 1992) and the interaction between competing fungal species (Tiunov and Scheu, 2005).

In accordance, fungivory stands up as a key interaction to be study if we aim to understand the dynamics of the decomposition

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process (Swift *et al*.,1979) and its implications to soil fertility. Interactions between micro arthropods and fungi are central to many processes in soil. Surprisingly, the possible mechanisms of these interactions, such as grazing, disturbance and dispersal, have been little studied. Grazing of soil animals on fungi may affect the competition between saprophytic and mycorrhizal fungi (Tiunov and Scheu, 2005), the recovery and succession of saprophytic fungi (Maraun *et al.*1998 b**)** and the dispersal of fungal propagules (Anderson, 1988). In the rhizosphere, micro arthropods affects saprophytic and pathogenic fungi, as well as vesicular-arbuscular and ectomycorrhizal fungi via selective grazing and dispersal (Lussenhop,1992). However, recent choice experiments suggest that Collembola preferentially feed on non mycorrhizal fungi in the rhizosphere and therefore, might indirectly benefit plants through an enhancement of mycorrhizal functioning (Gange,2000). One of the main aims of this study was to explore the importance of partitioning of food resources for high diversity of micro-arthropods particularly Collembolans and Acarines in soil.

Materials and Methods

The present study has been undertaken at Dihika**(**Ward No-49)and Kalajharia(Ward No-37), Burnpur under Asansol Municipal Corporation of Burdwan district in West Bengal, India..It is situated at a distance of about 12 km(approx) in the south –west of Asansol Railway station. These area falls between 86^{0}15’14"N latitude and 23^{0}30’15"E longitude at an altitude of 100m above sea level. Dihika is a natural forest zone at the bank of River Damodar and Kalajharia is characterized by coal mine fallow land zone (considered as Site-I and Site-II respectively in the present study). The soil characteristics of the studied area are sandy loam to laterite with high porosity. In the present investigation Tullgren funnel as modified by Murphy (1962) was used for extraction of the arthropods. Gut content analysis was made following the methodology of McMillan and Healy(1971)and Seymour *et al*.(1984). Adults Acarines and Collembola were extracted from the soil samples of the two sites. Three collecting sessions were conducted at each location during February, May and September, 2005-2006. Each isolated colony obtained from gut content was identified at Mycology and Plant pathology laboratory, Department of Botany, The University of Burdwan, West Bengal, India under an optical microscope (Magnus, Olympus).The specimens were stained with lacto phenol with cotton blue .All the isolated fungi were preserved with PDA for future use and as voucher specimen.

Results and Discussion

Fungal isolates obtained from gut content

Based on gut content analysis, *Alternaria humicola* and *Cladosporium cladosporioides* were found as the most prevalent fungi in the gut of Acarina and Collembola respectively (Table:1). Altogether 21fungal species were isolated and identified. Out of which 10 were common to both Acarina and Collembola. Among 21 isolates 18 obtained from Acarina and 13 from Collembola. Fungi like *Aspergillus flavus, Curvularia* sp., *Cladosporium cladosporioides, Alternaria* spp. were the most prevalent and common fungi found in the gut content of both the micro arthropods.

Functional Composition of Micro arthropods (Acarina and Collembola):

Community ecologists commonly place organisms that process and utilize resources in similar ways into ‘functional group’. Luxton(1972) categorized Cryptostigmatid (oribatida) mites into six feeding groups according to their feeding strategies. Combining both approaches the entire micro arthropod fauna (Acarines and Collembolans) extracted

Table 1 : Fungal isolates obtained from the gut content of Acarina and Collembola (values within the parenthesis is the mean value of five replicates expressed in percentage of total) sampled during the period 2005-2006

Fungi / VAM	Acarina	Collembola
Aspergillus flavus	6	4
Aspergillus niger	6	-
Aspergillus terreus	-	1
Penicillium purpurogenum	± (1)	-
Paecilomyces sp.	-	1.5
Fusarium chlamydosporium	1	2.5
Mucor hiemalis	± (1)	-
Curvularia spp.	12	11.2
Cladosporium cladosporioides	18	27
Alternaria humicola	26	20.5
Alternatia alternata	18	23.5
Trichoderma spp	1	-
Hemicola sp.	1.8	13
Piricularia sp.	9	-
Bipolaris spicifera	7	-
Phialophora sp.	7.8	-
Verticillium sp.	1	± (0.5)
Rhizoctonia sp.	2	8
Mycelia sterilia	0.5	-
Glomus spp	3	9.8
Phoma sp.	-	2

from the soil of Site-I and Site-II has been tentatively placed into two broad functional groups- Fungivorous and Non-fungivorous. The second broad group is again subdivided into three group viz. Herbivorous, Predators and others. The last sub group includes any functional groups other than fungivory, herbivory and predators.

It is evident from the table-2A that distribution of different functional groups varied significantly in and within the sites under study. Fungivory found dominant in rhizosphere than non-rhizosphere of both the sites except in site-I. The fungivorous Collembola showed almost equal distribution and abundance in both rhizosphere and non-rhizosphere of site-I but it was out numbered in the site-II where only 3% of total Collembolan species found fungivorous; majority of them was predatory (67%) and distributed mainly in the non-rhizosphere zone. Acarina population also showed similar trend of distribution .Among the non-fungivory, the predatory Acarines and Collembola found dominant in the non-rhizosphere of site-II (43% and 67% respectively). Herbivorous acarines and collembolans found dominant in the rhizosphere of site-I but not in the site-II. Predatory collembolan species remained absent completely in the rhizosphere of site-I during the entire period of sampling .It is evident from the table-2A that the predatory micro arthropods were dominant in the non-rhizospheric soil of Coal mine fallow land and the fungivory as well as herbivory were the dominant micro arthropods in the forest floor.

Table 2A : Functional composition (% of total) of Acarina and Collembola population at Site I and Site II

Organism \ Functional Group	Site	Fungivorous		Non Fungivorous					
		NR	R	Herbivorous		Predators		Others	
				NR	R	NR	R	NR	R
ACARINA	S-I	49	61	27	13	6	2	18	24
	S-II	12	30	8	22	43	20	37	28
Collembola	S-I	70	68	14	8	1	0	15	24
	S-II	3	38	2	12	67	18	28	32

Feeding habits

Acarines and collembolan species showed different feeding habits and strategies. From table-2B it is evident that among 15 acarines 10 species were fungivorous with different intensity .Fungivory is the most common habit for 2 species ,moderate for 4 species and least for 4 species.*Oppia yodai* was found truly fungivorous and *Gamasiphis benghalensis* was completely predatory in nature. Other fungivorous species were found to adopt a mixed feeding habits and generally panphytophages.

Most of the collembolan species were found strongly fungivorous and weakly herbivorous. Out of the 10 Collembolan species (Table:2C) *Lepidocyrtus medius* is an obligatory fungivorous species and *Proisotoma* sp. showed facultative predatory habits. The specimen of *Proisotoma* sp obtained from site-II was an obligatory predator. However, fungivory was found to be the most common feeding habit of most of the collembolan species than that of acarines (Table:2B and 2C).

In the present study on the basis of gut content analysis and existing information on the feeding biology of each species (after Luxton, 1972) the Acarines and Collembolans were grouped into two broad 'functional group'-fungivorous and non-fungivorous. The distribution and relative abundance of these

Table 2B : Feeding habits of different Acarina species found in the study sites

Organisms	Fungivorous	Non Fungivorous		
		Herbivorous	Predators	Others
Scheloribates albialatus	+++	+	-	+
S. preincisus	++	+	-	+
Lamellobates palustris	+	-	-	+
Epilomannia pallida indica	++	+	-	-
Oppia yodai	+++	-	-	-
Tectocepheus velatus	++	-	-	+
Galumna sp.	++	-	-	+
Bultoribates sp.	-	+	-	+
Hypozetes sp.	+	+	-	+
Pachylaelaps sp.	-	-	+	+
Gamasiphis benghalensis	-	-	++	-
Asca sp.	-	+	-	+
Tydeus sp.	+	-	-	++
Cunaxa sp.	-	-	+	+
Tyrophagus sp.	+	+	-	+

Table 2C : Feeding habits of different Collembola species found in the study sites

Organisms	Fungivorous	Non Fungivorous		
		Herbivorous	Predators	Others
Lepidocyrtus suborientalis	+++	+	-	±
Lepidocyrtus medius	+++	-	-	-
Cyphoderus albinos	+	-	-	-
Hypogastrura sp.	-	-	-	++
Lobella sp.	+	-	-	+++
Cryptopygus thermophilus	+	-	-	±
Entomobrya sp.	+++	+	-	+
Onychiurus indicus	+++	+	-	+
Folsomia sp.	+++	+	-	+
Proisotoma sp.	-	-	-	+

functional groups were varied in the different sites under study. Rhizosphere found to be suitable and the most favoured micro-habitat for the fungivorous species particularly in the forest floor. Numerically fungivorous Collembola showed relative dominance over fungivorous Acarines in both the rhizosphere and non-rhizosphere soil and litter of forest floor. Contrary to this, fungivorous Collembola and Acarina showed very scanty and patchy distribution in the non-rhizosphere of Coalmine fallow land vegetation. The rhizosphere effect remained insignificant in the forest floor but highly significant in the coalmine fallow land. This opposite mode of rhizosphere effect may be due to the presence of highly favoured resources in the non-rhizosphere soil of forest floor than that of coalmine fallowland. In the forest floor accumulation of leaf litter in the non-rhizosphere may provide heterogeneous and complex habitat and the guild structure of fungi as well as other decomposers that may be affected by the chemical nature of leaf litter and this in turn may affect the distribution of the fungivorous as well as herbivorous microarthropods (Rooney *et al.*2000). Coal mine fallow land usually suffers from poor bottom-up resources both in quality and quantity as well as in complexity. The leaf litter quality provides more or less homogeneous micro-habitat that in turn may affect the distribution and abundance of these fungivorous fauna (Bandyopadhyay and Chatterjee, 2005).

Among the studied species of Acarines and Collembolans, in which the gut content analysis were made, about 67% Acarina species and 80 % Collembola were found fungivorous. These fungivorous species were mostly generalists feeder on fungi, fragmented litter and bacteria i.e. they were panphytophages and showed opportunistic feeding behaviour. But the selective foraging of fungi by Collembolans in soil found more than that of Acarines except in *Oppia yodai* which may be an obligate fungivorous species. This may indicate that Collembola are much more sensitive than fungivorous Acarines particularly at the level of functional groups (Petersen, 2002; Zaitsev, 2002).This is most probably because Collembolan responded to qualitative rather than to quantitative changes of fungal community, because Collembola are able to sensitively discriminate between fungi (Hedlund, 1995).

It is evident from the gut content analysis that trophic niche differentiation among the fungivorous microarthropods (Acarines and Collembola) is very limited but never the less may contribute to the high diversity of these microarthropods group .Dark pigmented fungi are generally preferred as diet by these organisms than the hyaline fungi and mycorrhizal fungi. These results also revealed that there is trophic niche differentiation concerning dark pigmented fungi and there are species specific feeding preferences for 'Dematiacea'. Among the dematiacea *Alternaria, Cladosporium and Bipolaris* are most preferred fungi for these micro arthropods which is consistent with the previous findings of Schneider *et al.(*2004),Jorgensen *et al.(*2003) and several others. Overall, findings of this present study indicate that oribatid mite species and collembola generally feed on a wide spectrum of fungal species. Despite preferences for certain fungal species most oribatid mites are best considered as 'choosy generalists'(Schneider and Maraun,2005)because they feed selectively when high quality food is available but in shortage of the preferred food they are also able to feed on other low quality fungi. The Collembola on the other hand may be considered as 'selective' opportunistic feeder and are very sensitive to their feeding behaviour (Petersen, 2002; Zaitsev,2002).

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