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Some new records of mites occurring on mushroom in South Bengal

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Abstract
The present paper reports 37 species of mites under 3 orders, 18 families and 26 genera occurring on edible mushrooms viz. Milk mushroom (*Calocybe indica*) and Oyster mushroom (*Pleurotus ostreatus*) from some parts of South Bengal. This includes species like *Caloglyphus berlesi, Glycyphagus bicaudatus, Tydeus collyerae, Resinacarus resinatus, Antennoseius indicus, Veiga uncata* and *Lasioseius quadrisetosus* and genera like *Tydeus, Lorrya, Raphignathus, Pyemotes, Neognathus, Crassicheles, Veiga, Rhodacarus, Typhlodromous, Resinacarus, Polyaspis, Trematula, Gamasellodes* which are being reported here for the first time on mushroom. This report also includes 3 species of the family Phytoseiidae belonging to genus *Typhlodromous* and 1 species of family Cunaxidae belonging to genus *Neocunaxoides* which appear to be new to science. Apart from these, the occurrence of *Tydeus collyerae* and *Resinacarus resinatus* were not earlier reported from India.

Keywords: mushroom mites, south Bengal, new report, Mesostigmata, Astigmata, Prostigmata

Introduction
Mushrooms are sources of human food with rich source of vitamins and proteins. Among the edible mushrooms like button mushroom, oyster mushroom, paddy straw mushroom and milk mushroom, the species like milk mushroom and oyster mushroom are more commonly cultivated in South Bengal. Because of importance of mushroom for its food value, many people have started consuming mushroom in different forms. Consequently, the cultivation of mushroom has also increased in South Bengal and these, in term, have invited many pest species which in many a cases have not been documented earlier. Gupta (2012) [4] in his book included a chapter on mushroom mites where he provided updated information about mushroom mites from India. That included 17 species under 9 genera known till that time. Thereafter, Gupta & Pal (2017) and Gupta & Mondal (2019) provided additional information on mushroom mites of India. The earlier workers who contributed mushroom mites from India are Das *et al.* (1987) [2], Somchoudhury *et al.* (1989) [3], Mukherjee & Somchoudhury (1972) [7] etc. Considering the lacuna of knowledge, it was thought desirable to explore the occurrence of mites on mushrooms like *Calocybe indica* and *Pleurotus ostreatus* which are grown extensively in South Bengal and document the mites thereon. The present paper is based on that study conducted during January-August, 2019.

Material and Methods
Most of the mite specimens included in this study were collected from mushroom cultivated in R K Mission, Narendrapur (Dist- South 24 Pargana) and R K Mission, Sargachi (Dist- Murshidabad). Besides, some private cultivars, who also had grown these mushrooms. Samples from mushroom beds consisting of straw material, as well as casing material and fruit bodies were collected. All mites were extracted therefrom by heat desiccation method using Tullgren's funnel. While collecting the mushroom samples, the nature of damage was recorded and so also the temperature and relative humidity. The mites were preserved in 70% ethyl alcohol and permanent mounting was done in Heinz's medium followed by sealing with nail polish.

Results and Discussion
The examination of the collected mite specimens from mushroom samples revealed the occurrence of 37 species which belonged to 18 families under 26 genera and 3 orders which included some new species which will be described later and also some new records of genera and species which were earlier unknown from India. All these species have been taxonomically arranged as below, providing remarks giving therein collection data, distribution and nature of association with mushroom.

Order- Sarcoptiformes, Cohort- Astigmata
Family- I. Acaridae
1. *Tyrophagus putrescentiae* Schrank
This species was collected from straw bed of milk mushroom and oyster mushroom during June-July, 2019 from Sargachi and Narendrapur by extraction of mushroom beds through Tullgren's funnel. It was associated with *Rhizoglyphus echinopus* and *Acarus siro*. The occurrence of this mite in mushrooms in West Bengal is quite common as was reported earlier by Mukherjee & Somchoudhury (1972) [7]. The association of this mite with the mushroom bed was for feeding of mycelium and damaged the mushroom culture affecting its growth and development.

Distribution: Worldwide
2. Tyrophagus longior Gervais
This species was collected from straw bed of milk mushroom during June, 2019 at Narendrapur, by extraction of mushroom bed. This mite is common in stored products, cheese, haystacks etc. (Huges 1976). It has been reported that this mite was carried to beds through manure and compost (Gupta, 2012) [4]. Because of the feeding of mycelium, those turned brown and growth was affected.

According to some other reports, this mite was carried into mushroom bed through Dipteran flies as because a good number of Dipteran flies were recorded in association with this mite. However, this is a controversial issue that needs to be confirmed by further investigation.

Distribution: Worldwide

3. ***Acarus siro*** Linn.

This mite was collected from straw bed of oyster mushroom and milk mushroom and also from casing material of milk mushroom, during May-June, 2019 both from Narendrapur and Sargachi. This storage mite is very common in mushroom as has been observed in the present study. It was found to damage the mushroom by turning those to light brown to deep brown colour. On some occasions, the infestation on oyster mushroom (*Pleurotus ostreatus)* and milk mushroom (*Calocybe indica)* was quite enormous. It is also known to cause serious damage on stored products (Gupta, 2012) [4].

Distribution: Worldwide

4. ***Acarus gracilis*** Hughes

It was collected from bed and casing material of milk mushroom during June- July, 2019 at Narendrapur. According to Hughes 1976, this mite is more common in bat roosts as well as in grain debris but its occurrence in mushroom was not reported earlier.

Distribution: England, Argentina, India

5. ***Acarus farris*** Oudemans

This species was collected from bed of oyster mushroom during July, 2019 at Sargachi. The occurrence of this mite was earlier reported from various stored products as well from birds' nest (Hughes 1976). It was not seen to cause any damage on mushrooms.

Distribution: England, Scotland, Netherland, Germany, Kenya, USA, Poland, Slovakia, Wales, India (West Bengal)

6. ***Rhizoglyphus echinopus*** Fumouze and Robin

This species was collected from infected bed of Oyster mushroom during June, 2019 at Narendrapur. It was found to make small holes on mycelium mats and at bases of stalks during fruit body stage. The coloration of affected strips changed to yellowish brown. The bud stage was found more susceptible to be attack of this mite. The population was reasonably high.

Distribution: Australia, New Zealand, USA, China, Denmark, Japan, Irish Republic, Korea, North America, Taiwan, Turkey, India (West Bengal)

7. ***Rhizoglyphus robini*** Claparede

This species was collected from bed and casing materials of milk mushroom during June- July, 2019 at Narendrapur. This mite is more common in decaying material but was not reported from mushroom earlier. It was also found in hypopial stage.

Distribution: Australia, New Zealand, Iran, India (West Bengal)

8. ***Caloglyphus oudemansi*** Zachvatkin

It was collected from bed of Oyster mushroom during July, 2019 at Sargachi. The bed from where the species was collected was dampy and damaged. Earlier habitat from where this mite was collected was from stored products.

Distribution: England, Italy, USSR, Australia, Java, India (West Bengal)

9. ***Caloglyphus berlesei*** Michael

This mite was collected from straw bed of Oyster mushroom during July, 2019 at Sargachi. The population in the extracted sample was not much. The affected bed turned blackish and mycelium growth was reduced drastically. Hence, such beds were discarded. According to Hughes 1976, this mite is a pest of stored products and preferred damp habitat. Apart from stored products it also was reported from the litter of broiler chicken.

Distribution: Italy, Germany, Holland, England, Australia, USA, Russia, India (West Bengal). It is probably cosmopolitan.

Family- II Glycyphagidae

10. ***Glycyphagus domesticus*** **De Geer**

This was collected from straw bed of milk mushroom during June-July, 2019 at Narendrapur. The infestation of this mite checked the development of fruit bodies which had shown shrinkages. Initially, it caused appearance of yellowish patches which later turned brown and finally dried up. The occurrence of this mite also noticed on casing material of milk mushroom where some greenish tinge developed.

Distribution: Cosmopolitan but more frequently found in Europe, Canada, Japan, Australia and India (West Bengal)

11. Glycyphagus bicaudatus Hughes

This mite was collected from fresh spawn of Oyster mushroom during July, 2019 at Sargachi. The spawns were put under extraction funnel and the mites were collected in very small number. It caused no noticeable damage symptoms on spawns. Earlier to this, it was recorded from rodent's nest.

Distribution: England, Russia, India (West Bengal)

12. ***Lepidoglyphus destructor*** Schrank

This mite was collected from straw bed of Oyster mushroom and casing material of milk mushroom during July- August, 2019 at Sargachi and Narendrapur respectively. The level of infestation was not much and the damage was also not noteworthy excepting the infected beds were blackish and damp. The casing materials when were examined under stereo-binocular microscope, the mites were seen moving on those.

Distribution: worldwide

Family-III Histiostomidae

13. ***Histiostoma feroniarum*** **Dufour**

This mite was collected from infected fruit body of milk mushroom and these were collected by hand picking after examining the samples under stereo binocular microscope during May 2019 at Narendrapur. The population of this mite was moderate and was dominated by its hypopial stage. The infested fruit body did not develop further and gradually retarded. As per Hughes (1976), this mite was recorded in sewage bacteria beds and known to be distributed in decaying vegetable matter.

Distribution: England, Holland, France, Italy, Germany, USA, Australia, New Zealand, India (West Bengal)

14. ***Histiostoma sapromyzarum*** Dufour
The collection of this mite was from infested bed of Oyster mushroom during July, 2019 at Sargachi. The straws of the infested beds turned blackish. No mycelium growth was noticed. It was earlier recorded from decaying fungi as well as decaying hyacinth branch. The population was moderate along with hypopial stage.
Distribution: England, Germany, Holland, France, Italy, Brazil, Bolivia, Philippines, Australia, India (West Bengal).

Order- Trombidiformes
Family- IV Tydeidae
15. ***Tydeus collyerae***
This mite was collected from both fresh and infested beds of Oyster mushroom and milk mushroom as well as casing material of milk mushroom during June- July, 2019 from Sargachi and Narendrapur. Its population was good. Its nature of association with mushroom was unknown. Basically, this is a predatory mite and its association with Acarid mites indicated that it might be feeding upon those mites. Another mite species i.e. *Veiga uncata* was also associated with this mite.
Distribution: New Zealand, India (West Bengal)

16. Lorrya **sp.**
This mite which is more common on plants has been collected from bed of milk mushroom through extraction during June, 2019 from Narendrapur. Only two species of this genus are known from India and the present one is likely to be a new one.

Family-V Raphignathidae
17. Raphignathus **sp.**
An undetermined species of *Raphignathus* was collected from infested bed of Oyster mushroom in association with *Acarus siro* might be as predator.

Family-VI Pyemotidae
18. Pyemotes herfsi (Oudemans)
This mite was collected from mushroom bed of Oyster mushroom and casing material of milk mushroom through extraction process from Narendrapur. The population of this mite was huge and found freely moving on the casing material. It is an ectoparasite of insects and found associated with Dipterran flies and collembolans.
Distribution: England, Holland, India (West Bengal)

Family-VII Caligonellidae
19.Neognathus **sp.**
Some representatives of this genus were collected from infested bed of Oyster mushroom through extraction process during June, 2019 from Narendrapur and its nature of association with mushroom was not known. Most probably, these are predator mites feeding upon Acaride species.

Family-VIII Cunaxidae
20. Neocunaxoides **sp.n.**
An undescribed species of *Neocunaxoides* was collected from bed of Oyster mushroom during July, 2019 from Sargachi. This species is close to *Neocunaxoides biswasi* (Gupta & Biswas 1978) but the differences exist in relative length of palp, in palp chaetotaxy, presence of a process at the base of palp tarsal claw and as well as in leg chaetotactic formula.

Order- Mesostigmata
Family- IX Blattisocidae
21. Lasioseius quadrisetosus **Chant**
Only two specimens of this mite were collected from straw bed of Milk mushroom during June, 2019 from Narendrapur. This is known to be a predator of Acarid mites.

Distribution: India (Assam, West Bengal)
22. ***Lasioseius*** **sp.**
It was collected through extraction of casing material of milk mushroom during July, 2019 from Narendrapur. Only one specimen was collected where its nature of association with mushroom is unknown.

Family- X Ascidae
23. ***Antennoseius indicus*** Bhattacharya
This species was collected from infested bed of Oyster mushroom during June, 2019 from Narendrapur. Its population was very poor. It may be a predatory mite. This mite was earlier collected from leaf litter from Khashi, Jayantia hills of Assam (Bhattacharyya, 1972).

Distribution: India (Assam, West Bengal)
24. ***Gamasellodes*** **sp.**
An undescribed species of *Gamasellodes* was collected from casing material of milk mushroom. This is in fact is a soil mite and its occurrence in mushroom was somewhat interesting. It may be mentioned here that earlier to this no report of occurrence of *Gamasellodes* mite on mushroom was available.

Family-XI Parasitidae
25. ***Parasitus assamensis*** **Bhattacharya**
Several specimens of this mite were collected from bed of Oyster mushroom during May-June, 2019 from Narendrapur. This in fact is a predatory mite and its association with Acarid mites indicated that it might have fed on acarids.

Distribution: India (Assam, West Bengal)
26. ***Parasitus consanguineus*** Oudemans & Voigts
Some representatives of this mite were collected through extraction process of bed of Oyster mushroom during July, 2019 from Sargachi. It was reported earlier on mushroom bed of *Agaricus bisporus* byTrivedi (1988) from Karnataka.

27. ***Pergamasus crassipes*** Berlesei
A single specimen of this mite was collected from milk mushrooms bed during June, 2019 from Narendrapur. This is a predatory mite known to feed upon collembolans. But in the present investigation, such behavior was not seen and on the contrary, it might have fed on Acarid mites.
Distribution: Europe, USA, India (West Bengal)

Family-XII Veigaidae
28. ***Veiga uncata*** Farrier
Several specimens of this species were collected from bed of milk mushroom and Oyster mushroom and from casing material of milk mushroom during June-July, 2019 from

Narendrapur. The occurrence of this genus was earlier unknown in mushroom. Therefore, the present one is new habitat record of this mite. Its nature of association with mushroom is unknown.
Distribution: USA, Mexico, Guatemala, Costarica, Russia, India (West Bengal)

Family- XIII Eviphidae
***29. Crassicheles* sp.**
An undetermined species of Crassicheles was collected from infested bed of Oyster mushroom through extraction process during June, 2019 from Narendrapur. The occurrence of this genus in mushroom was not reported earlier. The lack of literature of this genus prevented the species identification of this mite.

Family- XIV Phytoseiidae
***30. Typhlodromous* sp.n.1**
An undescribed species of *Typhlodromous* representing both sexes were collected through extraction process of milk mushroom bed during June-July,2019 from Narendrapur. This species is quite close to *Typhlodromous gopali* Gupta, but differs in relative length of z4, s4, j5, z3 and R1, which are longer while setae S4, Z4, s6 and r3 are shorter as compared to those of *T. gopali*. The measurements of the different taxonomic characters have already are taken. The structure of spermathecal process of both the species also differs. This new species will be described elsewhere after preparation of illastrations. Earlier to this, no report of occurrence of the genus *Typhlodromous* on mushroom was made either from India or from abroad.

***31. Typhlodromus* sp.n.2**
Another *Typhlodromous* species likely to be new was collected through extraction of bed of milk mushroom and oyster mushroom. This is close to *Typhlodromous divergentis* Gupta but differs in respect of relative length and width of dorsal shield, setae z2, S2, z3, s4, z4 are smaller in this new species compared to those of *divergentis* as well as in macro setal length of basitarsus iv and in relative length and width of ventrianal shield.
Those apart, the differences also exist in the spermathecal structure. Measurements of all the taxonomic parts have been taken and it will be described after preparation of illustrations.

***32. Typhlodromus* sp.n.3**
This species of *Typhlodromous* was collected from bed of Oyster mushroom. This is close to *Typhlodromus nilgiriensis* Gupta but the differences exist in the relative lengths of setae J2, z2, s6, R1, r3, S4, j4, z4, Z4, j5, j6 which are longer compare to those in case of *nilgiriensis.* But the setae S5, Z5 are smaller in case of *nilgiriensis*. Differences also exist in relative lengths of macroseta on leg IV. This new species will be described elsewhere after preparation of illastrations.

Family-XV Rhodacaridae
***33. Rhodacarus* sp.**
Some specimens of this mite were collected from casing material of milk mushroom during July, 2019 from Narendrapur. These mites ware basically inhabitants of soil and are predators of small insects and immature mites. The occurrence of this mite in mushroom in association with acarid mite probably indicated that this mite might be feeding on the acarids. Since, it was collected through extraction process whether it feed on acarid mites or not is somewhat uncertain.

Family- XVI Resinacaridae
34. Resinacarus resinatus Vitzthum
This mite was collected from casing material of milk mushroom during July, 2019 from Narendrapur. Its association with mushroom is uncertain. May be it is associated with insects and thus collected in this study along with some dipterans which were also in the extracted material. The present record of this species has been made for the first time from India.
Distribution: Australia, Europe, India (West Bengal) and Worldwide.

Family-XVII Polyaspididae
35. Polyaspis sp.
This mite was also collected from the casing material of milk mushroom during July, 2019 from Narendrapur. This species was associated with nematodes. May be, it is a nematode feeding mite as has been reported by Krantz and Walter, (2009).

Family- XVIII Uropodidae
***36. Fuscuropoda marginata* C.L. Koch**
Only one specimen of this species was collected from extraction of fruitbody of milk mushroom in association with fly larvae from Narendrapur, during August, 2019. This is known to be a scavenger mite and mycelium feeder. Availability of further material will indicate its nature of association with mushrooms.
Distribution: England, Netharland, Germany, Italy, Servia

37. *Trematrura* sp.
An unidentified species of this genus was collected associated with fungus grown on mushroom.

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