



First record of picture winged fly *Physiphora sericea* (Ulidiidae: Diptera) on oyster mushroom from Kashmir, India

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ABSTRACT

Biological and morphological studies of *Physiphora* fly, *Physiphora sericea* (Ulidiidae: Diptera) was undertaken in the Division of Entomology, Faculty of Horticulture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Shalimar on oyster mushroom under temperate conditions of Kashmir. During the study it was observed that maggots of flies were found feeding on the substrate and fruiting bodies of oyster mushroom. The adult flies after emergence from reared maggots were identified as *Physiphora sericea*. The flies belonging to the family Ulidiidae have also been reported from other parts of the world. These are small, mainly dark coloured insects whose immature stages (maggots) usually develop on rotting plant remains permeated by fungal hyphae. This species causes significant damage to mushroom fruiting bodies. The life cycle of *P. sericea* passed through four active stages viz., egg, larva, pupae and adult. The larvae passed through three instars. The observations revealed that the females laid their eggs on the compost. The average incubation period of egg was observed to be of 3.5 ± 1.45 days while as other developmental periods i.e., 1st, 2nd and 3rd larval instar, and pupae were of 8.4 ± 0.68 , 9.45 ± 0.80 , 10.2 ± 0.79 and 12.4 ± 0.76 days at $25 \pm 5^\circ\text{C}$ respectively. The longevity of adult male and female were 5.6 ± 0.61 and 6.4 ± 0.76 days respectively.

Key words: Biology, identification, longevity, oyster mushrooms, *Physiphora*, ulidiidae,

From the last two decades, mushroom cultivation has become one of the most remunerative aspects in the field of agriculture in Kashmir. Mushroom is an abundant source of protein and nutritious food requiring low investment in terms of space and its cultivation is gaining pace around the globe. Over the years, mushroom cultivation has created a lot of profit to the farming community. However, there are several bottlenecks in its successful cultivation and arthropod infestation being one of them. The crop is reported to be infested by various insect pests and diseases accounting for the total loss of about 50 per cent. The unhygienic conditions of mushroom cultivation provide congenial atmosphere for many insect pests and diseases. Among them, the most devastating are nematodes, flies, beetles and springtail (Steyskal, 1980). Out of those, the mushroom flies belonging to different families of the order Diptera, have sharply increased in recent years (Conway and Forrester 2007, Martinez *et al*; 2007). Sciarid, phorid and cecidomyiid flies, being the most common species. Mushroom yield losses are either directly due to the maggots of mushroom flies feeding on the substrate or other pests and diseases vectored by these flies. Similarly, phorids as well as sciarids are described as vectors of pathogenic mites (Korneyev, 2001). Apart from *Physiphora* fly, sciarids and phorids also affect oyster mushrooms. The *P. sericea* (Diptera: Ulidiidae), is an obligate fungal feeder that infests mushroom farms in many parts of the Kashmir. It is one of the most abundant and problematic insect pests found on cultivated mushrooms and can significantly reduce mushroom yield by feeding on growing mycelia (Hendel, 1913 Hendel, 1913a). The abundance of adults is also posing a significant nuisance to the mushroom farms. In Kashmir, this fly can be regarded as secondary pest of cultivated mushrooms. The genus *Physiphora* belongs to the tribe Ulidiini of the subfamily Ulidinae (Korneyev, 2001, Kameneva, 2004, Kameneva & Korneyev, 2006). It

includes 30 species that are widespread in the tropical, subtropical and temperate areas. Some other species of the genus *Physiphora* are *P. alceae*, *P. clausa*, *P. leucotricha* and *P. smaragdina* (Kameneva and Chen, 2007, Kameneva and Korneyev, 1994, 2010 (a), 2010 (b)). Biology of *Physiphora* species is poorly known. Hennig (1940) summarized the larval habitats of *P. alceae* (Preyessler) that were collected from dung, rotting material bulbs and silage etc. Krivosheina & Krivosheina (1997) found larvae of *P. chalybea* under the bark of dead poplars. It was also reported by them that *P. euphorbiae* was reared from the tissues of *Euphorbia* sp. but without indicating further details. Further a key to species was compiled by (Steyskal, 1980) on the biology of *P. Clausa* (Macquart) which shows that its larvae are associated with woodmushrooms. So far, no comprehensive revision of *Physiphora* has been reported in literature.

MATERIALS AND METHODS

Morphology and Biology of *Physiphora sericea* (Hendel, 1913):

Morphology: Taxonomically, the *Physiphora* fly is a member of the Ulididae family which include around 30 species worldwide but the taxonomic report on this species has not been found from Kashmir, India. After emergence of adult, the specimens were sent for identification. The samples were identified as *Physiphora sericea* from the family Ulididae, Order Diptera. This species has previously been reported in Yemen by Hendel in 1913. The systematic position of *Physiphora sericea* is as under:

Kingdom	:	Animalia
Phylum	:	Arthropoda
Class	:	Insecta
Order	:	Diptera
Family	:	Ulididae
Super family	:	Tephritoidea
Subfamily	:	Ulidinae
Tribe	:	Uliini
Genus	:	<i>Physiphora</i>
Species	:	<i>sericea</i>

Biology: The study was carried out in the research laboratory, Division of Entomology, Faculty of Horticulture, SKUAST- K Shalimar during the year 2020-2021 on the biology of *Physiphora sericea*.

Collection and rearing of

***Physiphora sericea*:** The biology of fly was studied under laboratory conditions from April to July during the year 2021-2022. Infested fruiting bodies and substrate collected from different locations were examined under a binocular microscope (Make: Olympus, Model: CX20i). After mating the adult gravid females were segregated from males and transferred on fresh fruiting bodies of mushroom and were regularly monitored for egg laying. The eggs were counted after 24 hours to be put in batches. Eggs were laid either singly or in clusters. Deposited eggs were transferred on the next day to new mushroom fruiting bodies and substrate; (fig.1).



Fig. 1: Rearing of *Physiphora sericea*

Biological culture: Ten eggs of *P. sericea* were used to start a biological laboratory culture on fresh water-soaked substrate and fruiting bodies in plastic jars. For the life cycle study, eggs were placed on a new fruiting body that was kept in a plastic jar covered with lid at room temperature of $25 \pm 5^\circ\text{C}$ in the laboratory. A total of 10 plastic jars were used in the study. Tissue paper soaked in water was used to keep the substrate moist. After hatching, the maggots were transferred to fresh mushroom fruiting bodies. The maggots soon after hatching were pale white in colour. They feed on living plant tissues and fungal mycelium. Every day the maggots were measured with respect to length, and any change in length was considered as moulting and beginning of the next instar. The culture was changed every week to prevent any pathogenic growth and to maintain sanitation. Renewal of fresh mushroom as food for the maggots was done at an interval of 4-5 days till they pupated. As the maggots became sluggish and slowed down their feeding activity, they were shifted to fresh jars with lid closed and were kept undisturbed till adult emerged. Morphological features of the life stages were recorded with binocular microscope. The flies were kept in jars with fruiting bodies and substrate to check the survival of flies.

RESULTS AND DISCUSSION

Biology of *Physiphora sericea*

Egg: In the present study, ten eggs laid by each female were lifted carefully with the help of moistened zero size camel brush and shifted on the substrate. Tissue paper was kept below the jar that was moistened with sufficient water to keep the mushroom moist. A single female laid around 40 eggs in a 12-hour period. The eggs are elongate-ovoid, 0.65 -0.75 mm long, pale white four times as long as wide, bluntly rounded at both apices (Fig.2A) and hatching period was recorded to be around 2-4 days. The mean hatching period of eggs in April, May, June and July was worked out to be 4.0 ± 1.67 , $.9 \pm 2.91$, 3.2 ± 0.63 and 2.9 ± 0.60 days respectively with a range of 2.9-4.0 days.

Larva: *Physiphora* maggots are legless C shaped pale white in colour and vermiform (Fig.2B-C). After hatching the larvae was 4-8 mm in length, narrow seven times as long as wide, bluntly truncated at posterior end. There were three larval instars. The first instar larval period in April, May, June and July was worked out to be 8.9 ± 0.52 , 8.6 ± 0.76 , 8.5 ± 0.97 and 7.9 ± 0.49 days respectively. The second instar larva took 9.9 ± 0.52 , 9.7 ± 0.71 , 9.5 ± 0.97 and 8.7 ± 0.99 days to change into third

instar during the month of April, May, June and

July respectively. The third instar larval period in April, May, June and July were worked out to be 10.3 ± 0.51 , 10.2 ± 0.86 , 10.2 ± 0.93 and 10.1 ± 0.89 days respectively. The mean number of days larvae molted into next stage



Fig. 2 (A-F): Different stages of life cycle of *Physiphora sericea*

was recorded as 7.9-8.9, 8.7-9.9 and 10.1-10.3 days for 1st, 2nd and 3rd instar respectively. Pre-pupal stage of the fly lasted for a day.

Pupae: When full fed the maggots searched for the dry place to pupate on the substrate. Pupae are oval in shape metallic brown in colour strongly wrinkled measuring around 5- 6 mm in length (Fig. 2D-E). The anterior part of the puparium from the lateral view showed a tapered view. Posterior spiracles were very close to each other. Spiracles are oval and rounded, spiracle scar in the dorsal side and are excluded by the peritreme which is complete, thick and varies from dark- brown to black in colour, radial oriented respiratory slits. The pupal period was recorded to be 14.3±0.59, 12.8±0.66, 11.6±0.83 and 10.9±0.99 days in the month of April, May, June and July respectively with a range of 10.9-14.3 days.

Adult: Mature adult varied from 2-10 mm in length. Body is black; with strong green and golden metallic sheen (Fig.2F). Adult flies can be easily distinguished from the other species because of the colour of their legs, the wing shape and the microtrichose pattern on the frons. Initially 1-2 eggs were laid by adult and later increased in number up to 40. The mean number of eggs laid by each female throughout the life ranged from 200-400 eggs. The male adult survived for 4.9±0.49, 4.8±0.41, 4.5±0.63 and 4.5±0.93 days and female adult lived for 6.2±0.66, 6.4±0.55, 6.6±0.87 and 6.7±0.97 days in the months of April, May, June and July respectively. The mean longevity of adult male was approximately 4.5- 4.9 days measuring about 2-6 mm long, whereas mean longevity of adult female was 6.2-6.7 days and measured about 4-10 mm long. The total life cycle from egg to adult is approximately 40-50 days (Table 1).

Table 1: Time taken (in days ± SD) taken by *Physiphora sericea* during different months of the year for the completion of development

Stage	April*	May*	June*	July*	Range	(Mean ± SD)
Egg	4.0± 1.67	3.9± 2.91	3.2 ± 0.63	2.9± 0.60	2.9-4.0	3.5 ±1.45
Larva (Instar I)	8.9± 0.52	8.6± 0.76	8.5± 0.97	7.9± 0.49	7.9-8.9	8.4 ±0.68
Larva (Instar II)	9.9± 0.52	9.7± 0.71	9.5± 0.97	8.7± 0.99	8.7-9.9	9.4± 0.80
Larva(Instar III)	10.3±0.51	10.2± 0.86	10.2± 0.93	10.1±0.89	10.1-10.3	10.2± 0.79
Pupae	14.3±0.59	12.8± 0.66	11.6± 0.83	10.9±0.99	10.9-14.3	12.4 ±0.76
Adult Male	4.9± 0.49	4.8± 0.41	4.5± 0.63	4.5± 0.93	4.5-4.9	4.6± 0.61
Adult Female	6.2± 0.66	6.4± 0.55	6.6± 0.87	6.7± 0.97	6.2-6.7	6.4 ±0.76
Total life cycle male	52.3±0.61	50.0±1.05	47.5±0.82	45.0±0.81	45.0-52.3	48.5±0.84
Total life cycle female	53.6±0.74	51.6±1.07	49.6±0.86	47.2±0.83	47.2-53.6	50.3±0.87

* Mean of three replications

Diagnosis to species: The flies are small to medium-sized (2–10 mm long). They are metallic green or blue in colour with predominantly hyaline wings, often with sub basal and apical dark spots.

Head: Head is usually brown to black in colour. Frons light black, with faint bluish tinge, except anterolateral corners shining brown, without conspicuous setae, with a pair of tomentose areas near eye margins and clypeus(Fig. 3A); face dark brown to black, except facial carina partly brown, with λ-shaped pattern of white microtrichia separated from antennal grooves, ventral half of face shining black; eyes appear green and purple banded with narrow white para frontal microtrichose spot reaching anterior margin of eye; gena brown to dark brown, shining, without microtrichose areas except at orbit; occiput entirely black; antenna brown to black, inadequately greyish microtrichose, first flagellon are rounded apically, 1.5 times as long as wide; clypeus orange brown, often with a greenish tinge; mouthparts black in colour (Fig. 3B).

Thorax: Scutum and scutellum is black, sub shining, green to yellowish-green reddish reflections; deeply ruglose, antepronotum, post pronotal lobe and notopleuron shinning with greenish tinge, transverse suture scutellum is densely rugulose deep blue or violet reflection having short and sparse setulae and 2 pairs of black scutellar setae; postero-ventral margin is without microtrichose area; setae are black and hair like.

Wing: Wings are entirely hyaline, with pale yellow veins; cell r4+5 almost narrowly closed not forming petiole, costal vein from middle of costal cell to middle of r1 cell having thickened and thin setae in antero-dorsal and antero-ventral rows (Fig. 3C).

Legs: Legs are black in colour including whole fore-tarsus, mid and hind tarsi are yellow in colour; setae are black; fore-femur postero-ventrally with 5-7 thickened, rather short setae in apical half, the basal tarsomere of fore tarsus entirely black on ventral surface with brush of brown setulae (Fig. 3D).

Abdomen: Both tergites and sternites brown or black-brown, finely rugulose, with golden reflection and black setulae; female abdominal tergite 2 with pair of dimple-like structures having matt gray spots laterally; three spermathecae with papillose surface spherical often collapsed and appearing like mushrooms; male post abdomen brown to black in colour.

Genitalia: Genitalia are shining brown in colour; epandrium is a curved plate with short white hairs, cerci elongate with short hairs, extending beyond apex of epandrium, gonocoxite triangular, extending to middle of epandrium, with around 10 brown setae reaching to apex of epandrium (fig. 3E); aculeus around 6 to 8 times as long as wide at base and somewhat pointed at tip; gonostylus dark brown, pointed, almost reaching apex of shining brown; strongly curved aedeagus; parameres shining brown, narrow, elongate, as long as gonostylus; hypandrium small, triangular, with brown hair and posteriorly directed (Fig. 3F).

There are myriad of insect pests feeding on mushroom but out of those the mushroom flies belonging to different

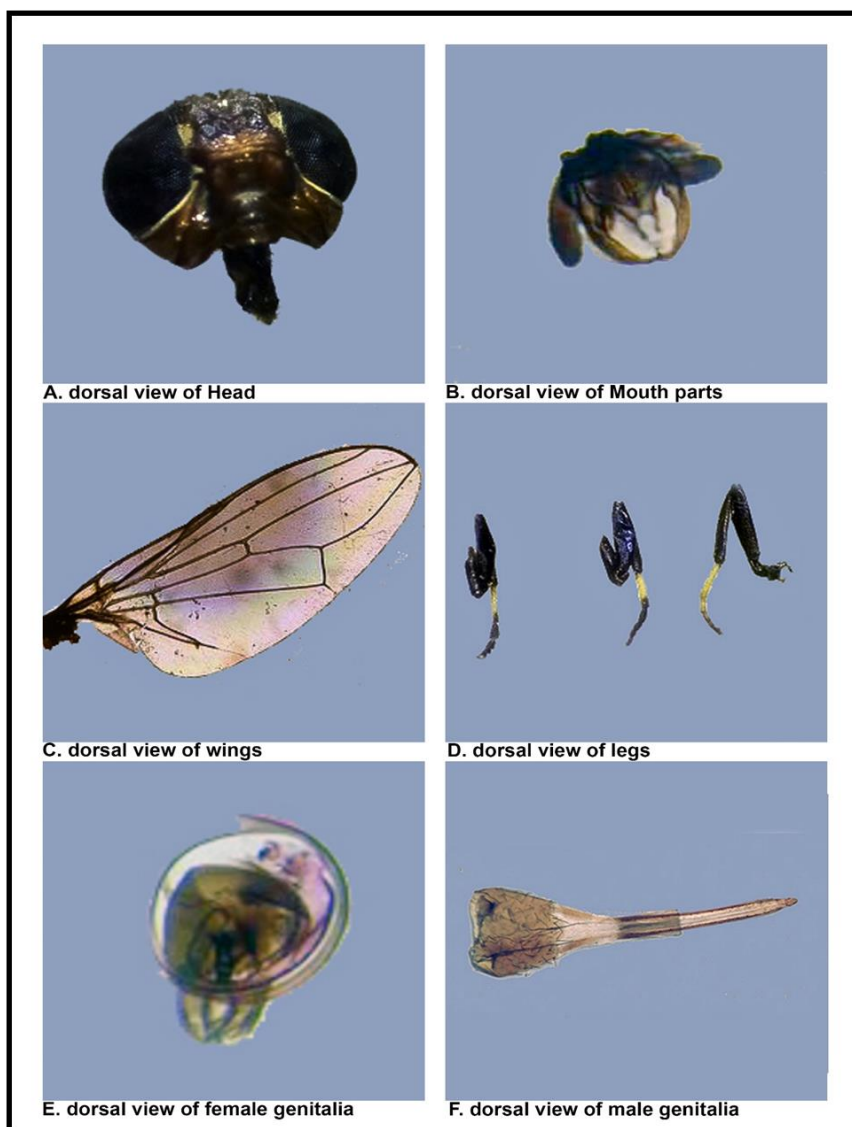


Fig. 3 (A-F): Different body parts of *Physiphora sericea*

families of the order Diptera like *Physiphora*, Sciarid, Phorid and Cecidomyiid have increased in serious proportions in recent times. Among them, *Physiphora sericea* is a direct pest as the maggots of this fly feed on the fruiting body of mushroom and substrate. The description of this fly in terms of biology and morphology has not been observed by previous workers as literature is silent about this pest albeit with some references. The genus *Physiphora* has a worldwide distribution and some authors have given few taxonomical aspects of this genus and its species like *P. alceae* (Preyssl), *P. chalybea* (Hendel), *P. clausa* (Macquart), *P. hainanensis* (Chenn) and *P. longicornis* (Hendel) *P. serricea* (Hendel). This paper is the first report of this insect pest of mushroom from Kashmir. *Physiphora sericea* (Diptera: Ulidiidae), is an obligate fungal feeder that infests mushroom farms in many parts of the Kashmir and causes nuisance to the mushroom farms in Kashmir. Biology of *Physiphora* species has not been well documented with only Hennig (1940) summarizing the larval habitats

of *P. alceae* (Preyssler). The insufficient data about this diverse dipteran is mainly attributed to few localized studies. Based on the unpublished data it is believed that the Ulidiidae fauna is exceptionally rich and few more species can be added to the checklist. The studies on the biological parameters have not been studied in India and abroad. So far, no comprehensive revision of *Physiphora* has been reported in literature.

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