

First record of *Petelia distracta* in Uttar Pradesh, India, and the novel observation of puddling behavior in (Geometridae:Ennominae) from India

Taslima Sheikh¹ , Ratindra Pandey² , Rupak De³ , Abu Arshad Khan⁴ 

¹* Sunrise University Alwar, Rajasthan India

² Manager, UP Tourism Development Corporation Ltd., 216, Ravindra Palli, Ayodhya Road Uttar Pradesh, India.

³ Ex-Principal Chief Conservator of Forests & Head of Forest Force, Uttar Pradesh, India.

⁴ Wildlife Warden, Endangered Species Project, Sector 19, Sheesham Bagh, Indira Nagar, Lucknow, India.

* Corresponding author: email: sheikhtass@gmail.com

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Abstract

This study documents the first occurrence of *Petelia distracta* (Walker, 1860) in Uttar Pradesh, India. Additionally, it reports the unprecedented behavior of these moths engaging in nocturnal puddling on cow dung and wet old leaf. The observations contribute to the understanding of puddling behavior in Geometridae for the first time in India, offering new insights into the ecological interactions and resource utilization strategies of nocturnal Lepidoptera.

Key words: puddling behavior, nutrient acquisition, nocturnal Lepidoptera, Chandraprabha Wildlife Sanctuary, ecological interactions.

1. Introduction

Mud puddling is a behavior commonly documented in Lepidoptera, where adults are attracted to moist ground, perspiration, tears, excrements, or animal carcasses to suck salts and dissolved nutrients (Adler, 1982; Adler & Pearson, 1982; Bänziger, 1973). This behavior is predominantly observed in males, as the nutrients and minerals collected are essential for transferring nuptial gifts to females (Drummond, 1984; Smedley & Eisner, 1995, 1996; Lai-Fook, 1991; Eisner & Meinwald, 1995; Boggs & Gilbert, 1979). Although mud puddling is common in Rhopalocera, it has rarely been reported in Heterocera. Previous records include species from the families Notodontidae (Smedley & Eisner, 1995), Sesiidae (Volponi, 2020), and Noctuidae (Xiao et al., 2010). Additionally, (Hilgartner et al. 2007) reported an Erebidae, *Hemiceratoides hieroglyphica*, from Madagascar, which was observed sucking tears from sleeping birds (*Newtonia brunneicauda* and *Copsychus albospecularis*). Recently studies on Pyraloidea: Crambidae was published by (Talukdar & Chowdhury, 2024) and 9 species were recorded while mud puddling in Tippi, Arunachal Pradesh. But there are no reports on

Geometridae family globally. This paper presents the first record of *Petelia distracta* in Uttar Pradesh and describes the first novel observation of Geometridae moth engaging in puddling behavior on cow dung and wet leaf at night.

2. Materials and methods

Field observations were Recorded at in Chandraprabha Wildlife Sanctuary, Varanasi Forest Division of Uttar Pradesh (Figure 1: Map), on 17th September 2023 for butterflies and while returning to home in the evening at 8:00 PM, this puddling observation by *Petelia distracta* was documented and photographed. Eclipse of moths of this species were observed puddling on fresh cow dung and wet old leaf under natural nocturnal conditions, along with this species two species of Erebidae, *Anomis flava* (Fabricius, 1775) two to three individuals and *Hypena* sp. Schrank, 1802, one to two individuals were also seen and photographed while puddling. The behavior was observed, and specimens were photographed for documentation and identification. Morphological identification of *Petelia distracta* was confirmed by comparing the images available on Moths of India Website Reference Images and with the help of Moth expert Md. Jahir Rayhan. The map was Created with the help of ArcGIS 10.5 Software and the photography was done Nikon D750 DSLR.

Study Area and Habitat: The Chandraprabha Wildlife Sanctuary is situated in the Chandauli district of Uttar Pradesh and is part of the Kashi Wildlife Division. Located at geo-coordinates 25.7°N 83.27°E, the sanctuary covers an area of 78 km² within the Naugarh and Vijaigarh hills on the northern slope of the Kaimur Range. The Karamnasha and Chandraprabha Rivers flow through the sanctuary, enhancing its rich biodiversity and creating a variety of habitats including grasslands, caves, and waterfalls within the Vindhyachal range.

Flora and Fauna: The sanctuary hosts a diverse array of wildlife, including species such as the Leopard (*Panthera pardus*), Sloth Bear (*Melursus ursinus*), Chinkara (*Gazella bennettii*), Chital (*Axis axis*), Four-Horned Antelope (*Tetracerus quadricornis*), Hyena (*Hyaena hyaena*), Fox (*Vulpes bengalensis*), and Jackal (*Canis aureus indicus*). Approximately 150 species of birds inhabit the area, including the Peacock, Red Jungle Fowl, Quail, Partridge, Eagle, Vulture, Mynah, Parakeets, Cuckoo, and Barn Owl. Reptiles such as Python, Cobra, Krait, Water-Snake, Scorpion, and Monitor Lizard are also residents. The aquatic fauna of the Chandra Prabha and Karamnasha Rivers include species like Rohu, Magur, Nain, and Tegra. A colony of endangered Vultures inhabits the cavities found in the facade and flanks of the Devdari Waterfall. The flora of the sanctuary is diverse and rich, including a vast variety of plants with medicinal properties like various plants from Rhamnaceae family are present all around which also serves as the host plant of *Petelia* sp (Sato, 1976).

3. Results

More than 200 *P. distracta* individuals were observed engaging in puddling behavior at Chandraprabha Wildlife Sanctuary (CPWLS). The behavior was primarily nocturnal, with individuals observed puddling on cow dung and wet leaves. The environmental conditions during these observations were [specific temperature and humidity]. The findings are summarized in Table 1, which details the number of individuals observed, the particular locations, and the conditions under which puddling occurred.

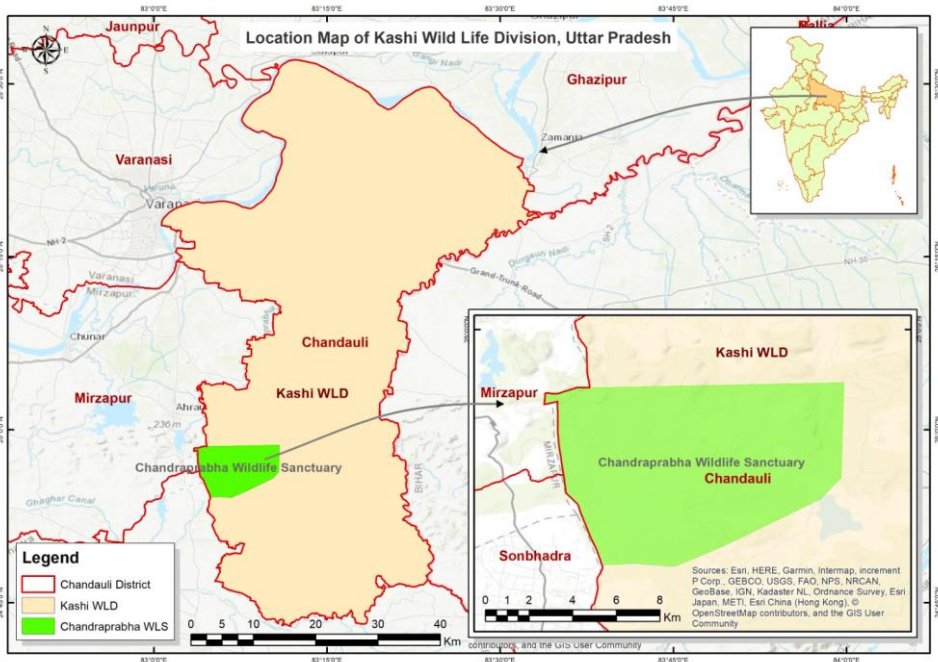


Figure 1. Map showing the study area (Source: ArcGIS 10.5 Software)

Table 1. Summary of Observations

Observation Date	Number of Individuals	Location	Substrate	Temperature (°C)	Humidity (%)
17 September, 2023	200	CPWLS	Cow dung	35 °C	80%
17 September, 2023	10	CPWLS	Wet leaves	35°C	80%

New Record for Uttar Pradesh

Petelia distracta Walker was identified as a new record for the state of Uttar Pradesh. The identification was based on the morphological characteristics described by Walker (1860).

Puddling Behavior

A congregation (Figure: 6) of *Petelia distracta* Walker was observed exhibiting puddling behavior on cow dung and wet rotten leaf at night. This is the first report of such behavior in the Geometridae family from India, along with this moth Congregation two other species *Anomis flava* (Figure: 6) and *Hypena* species (Figure: 6) of Erebidae were also seen puddling. The moths were seen actively probing the dung and leaf with their proboscis (Figure: 2-6) displaying a preference for the moist substrate.

TAXONOMIC ACCOUNT

Class Insecta Linnaeus, 1758

Order Lepidoptera Linnaeus, 1758

Family Geometridae Leach, 1815

Subfamily Ennominae (Duponchel, 1845)

Petelia distracta (Walker, 1860) (Figure: 2-6)

Bargosa distracta Walker, 1860, List Specimens Lepid. Insects Colln Br. Mus. 21: 481. Holotype: 1 ♂ (BMNH). Type locality: India Punjab.

Ephyra strigulararia Walker, 1863; List Specimens Lepid. Insects Colln Br. Mus. 26: 1575. Syntypes: 1 ♂, 1 ♀ (BMNH). Type locality: India.

Identification Features: Male: Reddish fawn color, whitish testaceous beneath. Head cinereous between the antennae. Wings minutely and transversely black streaked, with two nearly straight lines; interior line brown, contiguous to the black discal dot; exterior line and marginal points almost obsolete; underside with a blackish discal dot and a blackish sub marginal band. Forewings with a black subapical patch. Length of the body 10.6mm; of the wings 25.44mm (Walker & Gray, 1860).

Global Distribution: India, Sundaland, Sulawesi, New Guinea (Savelle, 2024); Bhutan (Bhutan Biodiversity Portal); Thailand (Flickr).

Distribution in India: Uttarakhand (Sanyal et al., 2017), Punjab (Holloway, [1994]), Maharashtra (Moths of India website), Kerala (Sondhi et al., 2021). Uttar Pradesh, India (Current Study).

Material examined: India. Uttar Pradesh: Chandraprabha Wildlife Sanctuary, 25.7°N 83.27°E, 233.47m approx. 17th September, 2023, observed more than 200 individuals puddling by Ratindra Pandey.

Remarks: While puddling on wet leaf and Cow dung, one *Petelia distracta* individual was seen excreting extra water (urine) from abdominal tip which is bent towards the ground and this is a part of recycling (Figure: 5).

4. Discussion

The observation of *Petelia distracta* engaging in puddling behavior on cow dung adds a new dimension to our understanding of nutrient acquisition in nocturnal moths. Puddling behavior in Lepidoptera is primarily associated with butterflies, where it plays a crucial role in sodium uptake, which is vital for reproduction and survival (Adler & Pearson, 1982; Smedley & Eisner, 1996). This behavior aligns with recent observations of nocturnal puddling in Pyraloidea moths. In a study conducted in Tippi, Arunachal Pradesh, India, several species of Pyraloidea were observed engaging in puddling at night on muddy patches and freshly splashed mud on vehicle surfaces (Talukdar & Chowdhury, 2024). The temporal partitioning of resources between nocturnal moths and diurnal butterflies suggests an adaptive strategy to reduce predation risk and competition for essential nutrients (Talukdar & Chowdhury, 2024). The ecological significance of puddling on cow dung might be linked to the high nutrient content, especially sodium, which is less available in other natural substrates. The moth *Petelia distracta* has known record from Dehradun in Uttarakhand where host plant of this

species belongs to Rhamnaceae (*Gouania* sp., *Ziziphus* sp., *Hovenia* sp.) (Sanyal et al., 2017) and these same plants are present in Chandraprabha Wildlife Sanctuary too and are expected as the host plants for this species in Uttar Pradesh as well. There is no previous record of *Petelia distracta* from Uttar Pradesh (Nayak & Ghosh 2020); (Farooqui & Parwez, 2022) and also this is the first observation of puddling in Geometridae from India. The nocturnal puddling behavior observed in *Petelia distracta* is a novel finding that expands our understanding of Lepidoptera ecology. The preference for cow dung and wet leaves suggests that these substrates may offer specific nutrients essential for the moth's survival, particularly during the nighttime when puddling is less commonly observed. These findings are consistent with previous studies on nocturnal Lepidoptera, but they also highlight the need for further research into the ecological roles of these behaviors.

Significance of puddling:

Puddling behavior, particularly among male moths and butterflies, is a fascinating phenomenon where these insects congregate on moist substrates like mud, dung, or urine to intake minerals, primarily sodium. The significance of this behavior extends beyond mere nutrient acquisition, impacting neuromuscular activity and mate selection.

1. *Neuromuscular Activity of Male Moths: Sodium's Role in Neuromuscular Function:* Sodium plays a critical role in the neuromuscular system of moths. The sodium absorbed during puddling helps maintain the ionic balance within muscle and nerve cells, which is essential for proper muscle contraction and nerve impulse transmission. In male moths, this enhanced neuromuscular activity is vital for behaviors such as sustained flight, rapid escape responses, and precise maneuvers during mating displays. The increased sodium levels can lead to improved endurance and agility, making males more competitive in both territorial disputes and during courtship flights (Arms, Feeny, & Lederhouse, 1974).

2. *Benefit of Sodium Absorption on Mate Selection Behavior: Influence on Mate Selection:* Sodium absorption during puddling has a direct impact on mate selection behavior. Studies suggest that males with higher sodium levels, obtained through puddling, are more successful in courtship and mating. This is partly because sodium contributes to the production of more potent pheromones, which are crucial for attracting females. Additionally, the energy boost provided by sodium may result in more vigorous courtship displays, making males more attractive to potential mates. Females may also select mates based on their ability to provide sodium during copulation, as this mineral is often transferred from males to females in the spermatophore, enhancing the female's reproductive success (Smedley & Eisner, 1996) (Table. 2).

5. Conclusions

This study provides the first report of *Petelia distracta* in Uttar Pradesh, India, and documents novel nocturnal puddling behavior in this species. The findings have broader implications for our understanding of Lepidoptera behavior and ecology, particularly in terms of nutrient acquisition strategies. Future research should explore the nutritional content of the substrates used for puddling and investigate whether this behavior varies across different seasons or environmental conditions. Continued monitoring and documentation are essential for informing conservation strategies and furthering our knowledge of biodiversity in the region.

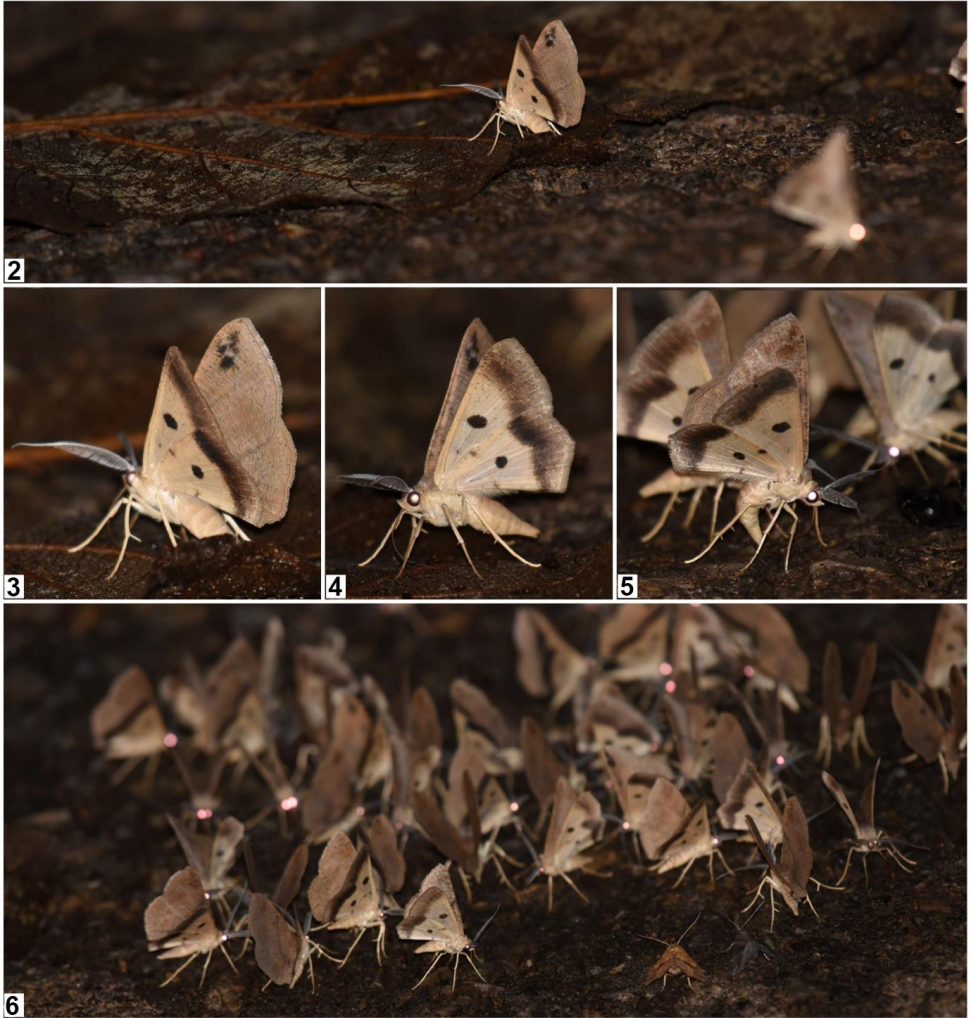


Figure 2-6. *Petelia distracta* Walker puddling on wet leaf, 3-4. Dorsum of wing and Underwing of *Petelia distracta* visible, 5. *Petelia distracta* Walker excreting urine, 6. Congregation of *Petelia distracta* Walker on cow dung and two Erebidae moths on right bottom side: *Anomis flava* and *Hypena* sp.

Table 2. Geometridae checklist on Puddling, (Alder, 1982); (Wylie,1982); (Grant et al., 2012)

Serial Number	Scientific Name	Subfamily
1	<i>Anaemoptodes ephyraria</i> (Wlk.)	Ennominae
2	<i>Anagoga oeciduaria</i> (Wlk.)	Ennominae
3	<i>Anavitrinella pampinaria</i> (Gn.)	Ennominae
4	<i>Antepione thisoaria</i> (Gn.)	Ennominae
5	<i>Biston betularia cognataria</i> (Gn.)	Ennominae
6	<i>Cepphis armataria</i> (H.-S.)	Ennominae
7	<i>Euchlaena irraria</i> (B. & McD.)	Ennominae
8	<i>Eusarca confusaria</i> Hbn.	Ennominae
9	<i>Haematopsis grataria</i> (Fab.)	Ennominae
10	<i>Homochlodes fritillaria</i> (Gn.)	Ennominae
11	<i>Iridopsis larvaria</i> (Gn.)	Ennominae
12	<i>Itame argillacearia</i> (Pack.)	Ennominae
13	<i>Itame pustularia</i> (Gn.)	Ennominae
14	<i>Lobophora niverata</i> Wlk.	Ennominae
15	<i>Lomographa semiclarata</i> (Wlk.) (diurnal)	Ennominae
16	<i>Melanolophia canadaria</i> (Gn.)	Ennominae
17	<i>Melanolophia signataria</i> (Wlk.)	Ennominae
18	<i>Metanema determinata</i> Wlk.	Ennominae
19	<i>Metanema inatomaria</i> Gn.	Ennominae
20	<i>Metarranthis angularia</i> B. & McD.	Ennominae
21	<i>Milionia isodoxa</i> Wlk.	Ennominae
22	<i>Nematocampa limbata</i> (Haw.)	Ennominae
23	<i>Phigalia strigataria</i> (Min.)	Ennominae
24	<i>Plagodis alcoolaria</i> (Gn.)	Ennominae
25	<i>Plagodis fervidaria</i> (H.-S.)	Ennominae
26	<i>Plagodis phlogosaria</i> (Gn.)	Ennominae
27	<i>Probole alienaria</i> H.-S.	Ennominae
28	<i>Probole amicaria</i> (H.-S.)	Ennominae
29	<i>Semiothisa bisignata</i> (Wlk.)	Ennominae
30	<i>Sicya macularia</i> (Harr.)	Ennominae
31	<i>Xanthotype urticaria</i> Swett.	Ennominae
32	<i>Petelia distracta</i> (Wlk.) (Current study)	Ennominae

Serial Number	Scientific Name	Subfamily
33	<i>Chlorochlamys chloroleucaria</i> (Gn.)	Geometrinae
34	<i>Nemoria bistrifaria</i> Hbn.	Geometrinae
35	<i>Nemoria rubrifrontaria</i> (Pack.)	Geometrinae
36	<i>Synchlora aerata</i> (F.)	Geometrinae
37	<i>Coryphista meadii</i> (Pack.)	Larentiinae
38	<i>Dyspteris abortivaria</i> H.-S.	Larentiinae
39	<i>Dysstroma hersiliata</i> (Gn.)	Larentiinae
40	<i>Euphyia unangulata intermediata</i> (Gn.)	Larentiinae
41	<i>Eupithecia</i> sp.	Larentiinae
42	<i>Heliomata cycladata</i> Grote (diurnal)	Larentiinae
43	<i>Heliomata infulata</i> Grote (diurnal)	Larentiinae
44	<i>Hydrelia lucata</i> (Gn.)	Larentiinae
45	<i>Hydria prunivorata</i> (Ferguson)	Larentiinae
46	<i>Hydriomena perfracta</i> Swett.	Larentiinae
47	<i>Mesoleuca ruficillata</i> (Gn.)	Larentiinae
48	<i>Orthonama centrostrigaria</i> (Wollaston)	Larentiinae
49	<i>Xanthorhoe ferrugata</i> (Clerck)	Larentiinae
50	<i>Xanthorhoe lacustrata</i> (Gn.)	Larentiinae
51	<i>Cyclophora myrtaria</i> (Gn.)	Sterrhinae
52	<i>Cyclophora packardi</i> (Prout)	Sterrhinae
53	<i>Idaea demissaria</i> (Hbn.)	Sterrhinae
54	<i>Scopula inductata</i> (Gn.)	Sterrhinae
55	<i>Scopula limboundata</i> (Haw.)	Sterrhinae
56	<i>Heterophleps triguttaria</i> H.-S.	Sterrhinae
57	<i>Hydriomena perfracta</i> Swett.	Larentiinae

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Conflict of interests

The authors declare that they have no competing interests.

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