

Observations on the butterflies feeding on non-nectar sources in the Kolhapur District, Maharashtra, India

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ABSTRACT: This study aimed to collect seasonal data on butterfly species that feed on various non-nectar sources. The photographic records of 68 butterfly species from six families, which feed on nutrients from six different non-nectar food sources, including dung, bird droppings, caterpillar excreta, ripened fruit, plant exudates, plant oozing sap, and mud, are provided. Among these 68 butterfly species, the Nymphalidae family were the most speciose with a total of 39 species, followed by the Lycaenidae with eight species, Hesperidae with nine species, Papilionidae and Pieridae with five species each and Riodinidae with a single species. Seasonal observations showed that the highest number of species was observed consuming food components during the summer season (45 species), followed by the rainy (17 species) and winter (13 species) seasons. The present study highlights the importance of all these non-nectar food sources of butterflies for their survival. Additionally, the findings of this study would be crucial in framing conservation strategies of butterflies. © 2025 Association for Advancement of Entomology

KEY WORDS: Food, mud puddling, excreta, plant metabolites, sap, conservation

INTRODUCTION

Insects obtain their food from a variety of sources (liquid, solid, etc.). Butterflies have a feeding apparatus in the form of a long, hollow, sucking tube called a proboscis to extract liquid food (Haribal, 1992). Although flower nectar is the main food source for a number of butterflies, they also absorb nutrients from other sources such as wet soil, urine, bird droppings and mammal excrement, plant exudates (metabolites), overripe fruits, and tree sap etc. (Haribal, 1992; Krenn, 2008; Gunathilagaraj *et al.*, 2015; Bhakare and Ogle, 2015). Mud puddling is a phenomenon in which butterflies aggregate on soil or dung to absorb moisture and nutrients like Sodium (Inoue *et al.*, 2015; Vinod and Kumar, 2021).

Some butterfly species engage in mud puddling in groups of the same species or of diverse species, while others do it independently. When there is nectar scarcity, butterflies prefer mud puddling, from which they absorb essential nutrients for flight, survivability and mating (Ankola *et al.*, 2021). In addition to mud puddling, butterflies are attracted to the volatiles produced by fruits during fermentation, which provide sugar and alcohol for energy (Sourakov *et al.*, 2012; Bhakare and Ogale, 2015). For feeding, butterflies belong to the subfamily Danainae, congregate on plants such as *Crotalaria* spp. and *Helitropium indicum*, which contain pyrrolizidine alkaloids, used to produce sex hormones and used in their defence mechanisms (Bhakare and Ogale, 2015), while some feed on

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sticky plant sap oozing from plant stem like *Cassia* (Bhakare and Ogale, 2015). In this study, we aimed to collect data on butterfly species feeding on various non-nectar sources in relation to the season. We presented season wise photographic records of 68 butterfly species belonging to six families feeding on non-nectar food sources.

MATERIALS AND METHODS

Field observations were carried out targeting various habitats in Kolhapur district, such as: Grassland and Savanna at Shivaji University campus; semi-evergreen forest at Ajara, Giroli, Konewadi, Manoli, Padsali, Pawangad, and Talaye Bk.; and modified habitats such as plant nurseries- Akshay and Sajeev nurseries in Kagal and Kolhapur respectively. Observations were recorded between December 2022 to April 2025, targeting all three seasons. Opportunistic observations were made visually during the daytime (0700-1600 hrs) and documented using Nikon D500 and Nikon D5600 DSLR cameras mounted with Nikor 70-300 and 200-500mm lenses. Butterfly species were mostly recorded feeding on natural sources, but additional ripped orange fruits were also provided during some observations. Butterfly species identification was done using Haribal (1992); Gunathilagaraj *et al.* (2015); Kunte (2000); Bhakare and Ogale (2015); Kasambe (2016), as well as the website Butterflies of India (<http://www.ifoundbutterflies.org> Accessed on 30th May, 2025) and confirmed by M.J. Palot, Zoological Survey of India, WRC, Pune. Dr. M.M. Lekhak, of the Department of Botany, Shivaji University, Kolhapur, identified the plants. Identification of the moth *Mangina syringa* (Cramer, [1775]) was done using Kirti and Singh (2013), as well as from the website, Moths of India (<http://www.mothsofindia.org>, Accessed on 18th June, 2025).

RESULTS AND DISCUSSION

A total of 68 species of butterflies belonging to six families, namely Nymphalidae, Lycaenidae, Papilionidae, Pieridae, Riodinidae and Hesperidae were observed feeding on the non-nectar sources such as mud, plant exudates, plant oozing sap, bird droppings, moth caterpillar excreta, dung and ripped

orange fruit (Table 1). Among these, a maximum of 40 species were observed obtaining nutrients by mud puddling on wet soil located along the streams and lakes etc., while nine species from excrement of birds, eight species from plant exudates, six species from plant oozing sap, three species from dung and two species from ripped fruit.

Among the butterflies that obtain food components through mud puddling, 20 species of the family Nymphalidae, five species of the family Pieridae, four species of Papilionidae, five species of Hesperidae, five species of Lycaenidae and one species of Rhodidae were recorded. Nymphalidae was the only family recorded feeding on plant exudates and plant oozing sap, with eight and six species, respectively. Three species of Nymphalidae, three species of Lycaenidae, two species of Hesperidae and one species of Papilionidae were observed feeding on bird droppings and moth caterpillar excreta. Two species of the family Lycaenidae and one species of the family Nymphalidae were recorded feeding on the essential food components of dung. Only two species of the family Nymphalidae were recorded feeding on ripe orange fruit. The species *Euploea core core* was observed consuming food components from the excreta of the caterpillar of the moth *M. syringa*.

This study showed that the number of species and individuals of each species feeding on non-nectar sources varied seasonally. The summer season had the maximum number of butterfly species feeding on non-nectar sources (45 species), followed by monsoon (17 species) and winter (13 species) (Table 1; Fig. 1). Additionally, four species (*E. aconthea*, *P. A. polymnestor*, *T. liminace exotica*, *E. core core*) were observed feeding on non-nectar sources in both summer and winter seasons, three species (*H. bolina jacintha*, *D. genutia genutia*, *E. core core*) in summer and rainy seasons, one species (*E. core core*) in rainy and winter seasons, and only a single species (*E. core core*) was recorded throughout the year (Fig.1).

In the summer season, maximum species (29 species) were recorded during mud puddling, six species on plant exudate, three species on plant

PLATE I **Butterflies recorded during Mud puddling**



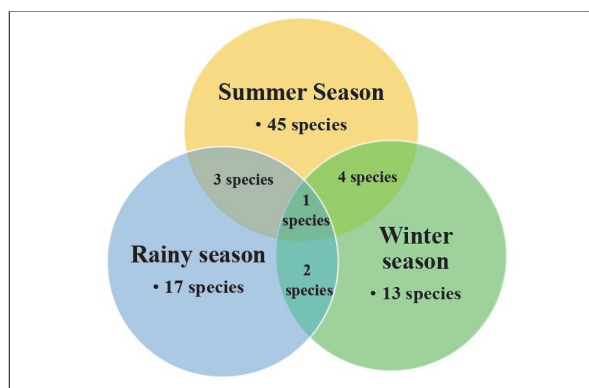


Fig. 1 Diagram showing seasonal observations of butterfly species feeding on non-nectar sources

metabolites, six species on bird excreta and only one species on dung. In the rainy season, the maximum species (eight) observed during mud puddling, two species on bird excreta, two species on fruits and five species on plant metabolites. No species observed on dung and on plant exudate in the rainy season. In the winter season, the maximum species (six) during mud puddling, five species on plant metabolites, two species on dung and one species on excreta were recorded. No species recorded on plant exudate and fruits in the winter season (Table 1).

Table 1. List of butterflies feeding on the non-nectar sources along with respective season

Family/ Species	Locality	Seasons		
		Summer	Rainy	Winter
Feeding Source/ 1. Mud puddling				
Family Nymphalidae				
1. <i>Charaxes solon solon</i> (Fabricius, 1793)	SUK	-	+	-
2. <i>Cirrochroa thais thais</i> (Fabricius, 1787)	Manoli	+	-	-
3. <i>Danaus genutia genutia</i> (Cramer, [1779])	Manoli	+	-	-
4. <i>Danaus chrysippus chrysippus</i> (Linnaeus, 1758)	SUK	-	+	-
5. <i>Doleschallia bisaltide</i> (Cramer, [1777])	Manoli	+	-	-
6. <i>Elymnias caudata</i> Butler, 1871	Manoli	+	-	-
7. <i>Euploea core core</i> (Cramer, [1780])	Manoli	+	-	-
8. <i>Euthalia aconthea</i> (Cramer, [1777])	AN	+	-	+
9. <i>Euthalia lubentia arsada</i> Fruhstorfer, 1913	Manoli	+	-	-
10. <i>Hypolimnas bolina jacintha</i> (Drury, 1773)	Manoli	+	+	-
11. <i>Junonia iphita</i> (Cramer, [1779])	Manoli	+	-	-
12. <i>Kallima horsfieldii</i> (Kollar, [1844])	Manoli	+	-	-
13. <i>Melanitis leda</i> (Linnaeus, 1758)	Manoli	+	-	-
14. <i>Neptis hylas varmona</i> Moore, 1872	Manoli	+	-	-
15. <i>Neptis jumbah</i> Moore, [1858]	Manoli	+	-	-
16. <i>Pantoporia hordonia hordonia</i> (Stoll, [1790])	Manoli	+	-	-
17. <i>Parantica aglea aglea</i> (Stoll, [1782])	Manoli	+	-	-
18. <i>Tirumala limniace exoticus</i> (Gmeilin, 1790)	Manoli	+	-	-
19. <i>Tirumala septentrionis dravidarum</i> (Fruhstorfer, 1899)	Manoli	+	-	-
20. <i>Moduza procris</i> (Cramer, [1777])	Manoli	+	-	-
Family Pieridae				
1. <i>Appias albina swinhoei</i> (Moore, [1905])	Manoli	+	-	-
2. <i>Catopsilia pomona</i> (Fabricius, 1775)	SN	-	-	+
3. <i>Eurema brigitta rubella</i> (Wallace, 1867)	Ajara	-	+	-
4. <i>Eurema hecabe hecabe</i> (Linnaeus, 1758)	Ajara	-	+	-
5. <i>Leptosia nina nina</i> (Fabricius, 1793)	SUK	-	-	+
Family Papilionidae				
1. <i>Graphium doson eleius</i> (Fabricius, 1907)	SN	-	+	-
2. <i>Graphium teredon</i> (C. & R. Felder, 1865)	Manoli	+	-	-
3. <i>Papilio Agenor polymnestor</i> Cramer [1775]	Talaye Bk.	+	-	+
4. <i>Papilio polytes polytes</i> Cramer, [1775]	Manoli	+	-	-
Family Hesperidae				
1. <i>Badamia exclamationis</i> (Fabricius, 1775)	Manoli	+	-	-
2. <i>Caprona agama agama</i> (Moore, [1858])	Manoli	+	-	-
3. <i>Notocrypta curvifascia</i> (C. & R. Felder, 1862)	Manoli	+	-	-
4. <i>Udaspes folus</i> (Cramer, [1775])	Manoli	+	-	-
5. <i>Hasora chromus chromus</i> (Cramer, 1780)	SUK	-	+	-

Family Lycaenidae				
1. <i>Chilades pandava pandava</i> (Horsfield, [1829])	SN	-	-	+
2. <i>Eucrysops cnejus cnejus</i> (Fabricius, 1798)	Giroli	-	+	-
3. <i>Prosotas dubiosa indica</i> (Evans, [1925])	Manoli	+	-	-
4. <i>Neopithecops zalmora</i> (Butler, [1870])	Manoli	+	-	-
5. <i>Zizina otis</i> (Fabricius, 1787)	SUK	-	-	+
Family Riodinidae				
1. <i>Abisara bifasciata bifasciata</i> Moore, 1877	Manoli	+	-	-
Feeding Source/ 2. Plant Exude				
Family Nymphalidae				
1. <i>Elymnias caudata</i> Butler, 1871	SUK	+	-	-
2. <i>Euthalia aconthea</i> (Cramer, [1777])	SUK	+	-	-
3. <i>Charaxes bharata</i> (C. & R. Felder, [1867])	SUK	+	-	-
4. <i>Kallima horsfieldii</i> (Kollar, [1844])	SUK	+	-	-
5. <i>Melanitis leda</i> (Linnaeus, 1758)	SUK	+	-	-
6. <i>Melanitis phedema Varaha</i> Moore, 1857	SUK	+	-	-
Feeding Source/ 3. Plant metabolites: a) <i>Crotalaria retusa</i>				
Family Nymphalidae				
1. <i>Tirumala limniace exotica</i> (Gmeilin, 1790)	SUK	+	-	+
2. <i>Euploea core core</i> (Cramer, [1780])	SUK	-	+	+
3. <i>Danaus genutia genutia</i> (Cramer, [1779])	SUK	+	+	-
4. <i>Danaus chrysippus chrysippus</i> (Linnaeus, 1758)	SUK	-	+	-
5. <i>Parantica aglea</i> (Stoll, [1782])	SUK	-	+	-
Feeding Source/ 3. Plant metabolites: b) <i>Helitropium indicum</i>				
6. <i>Parantica aglea</i> (Stoll, [1782])	SUK	-	-	+
7. <i>Danaus chrysippus chrysippus</i> (Linnaeus, 1758)	SUK	-	-	+
8. <i>Euploea core core</i> (Cramer, [1780])	SUK	+	+	+
Feeding Source/ 4. Excreta				
Family Nymphalidae				
1. <i>Hypolimnas bolina jacintha</i> (Drury, 1773) *	SUK	-	+	-
2. <i>Euploea core core</i> (Cramer, [1780]) *	Pawangad	-	+	-
3. <i>Euploea core core</i> (Cramer, [1780]) **	SUK	-	-	+
Family Papilionidae				
1. <i>Papilio polymnestor polymnestor</i> Cramer [1775]	Manoli	+	-	-
Family Hesperidae				
1. <i>Caprona agama agama</i> (Moore, [1858])	Manoli	+	-	-
2. <i>Udaspes folus</i> (Cramer, [1775])	Manoli	+	-	-
Family Lycaenidae				
1. <i>Aceytlepis puspa felderi</i> Toxopeus, 1972	Manoli	+	-	-
2. <i>Prosotas nora ordates</i> (Moore, [1875])	Manoli	+	-	-
3. <i>Lampides boeticus</i> (Linnaeus, 1767)	Konewadi	+	-	-

Feeding Source/ 5. Dung Family Nymphalidae				
1. <i>Cyrestis thyodamas indica</i> Evans, 1924	Talaye Bk.	-	-	+
Family Lycaenidae				
1. <i>Zizeeria karsandra</i> Moore, 1865	Padasali	+	-	-
2. <i>Nacaduba beroe</i> (C. & R. Felder, [1865])	Talaye Bk.	-	-	+
Feeding Source/ 6. Fruit Family Nymphalidae				
1. <i>Melanitis leda</i> (Linnaeus, 1758)	SUK	-	+	-
2. <i>Euthalia aconthea</i> (Cramer, [1777])	SUK	-	+	-

SUK - Shivaji University Campus, Kolhapur; SN - Sajeev Nursery, Kolhapur; AN - Akshay Nursery, Kagal; Summer (Feb.-May); Rainy (June-Sept.); Winter (Oct.-Jan.); * bird excreta, ** caterpillar excreta; + presence, - absence.

Chandekar *et al.* (2018) recorded feeding of butterflies on mud, tree sap, dung and alkaloids from Mulshi Tahsil, Pune district, Maharashtra. Ganeshwari *et al.* (2022) recorded 111 species of butterflies belonging to six families during mud puddling from Algarkovil Hills, Madurai, Tamil Nadu. Out of the six families, they recorded the highest number of Nymphalid species, 34. The present study also found that out of the recorded six families of mud puddling butterflies, the Nymphalidae family accounted for the highest number of species (19). Of the 25 butterfly species recorded by Suwarno *et al.* (2019) from four families (Lycaenidae, Nymphalidae, Papilionidae and Pieridae) during mud puddling from the Alas River at the Soraya Research Station in Subulussalam district, Aceh Province, Indonesia, the present study recorded six species (*Euthalia aconthea*, *Graphium doson*, *Papilio polytes polytes*, *Appias albina*, *Catopsilia pomona* and *Eurema hecabe*) during mud puddling. Few studies have documented the sap-feeding behaviour of butterflies. Salazar-E (2013) reported that 17 species of butterflies were attracted to the exuding sap of two trees in Colombia, the Escobo tree and the Aguacate tree. Bhakare and Ogle (2015) observed that nymphalid butterflies feed on the sticky sap of *Cassia* trees. The present study is consistent with the observations of the above two studies, i.e., six species of nymphalid butterflies feed on the sap of *Cassia siamea* out of the total recorded species. However, Young (1975) did not find any nymphalid species of butterflies feeding on sap in the Barranca Forest of Costa Rica. After examining plant metabolites, Nakka *et al.* (2013) reported the presence of

pyrrolizidine alkaloids in *Crotalaria retusa* and Stegelmeier (2011) in *Helitropium* sp. According to Bhakare and Ogale (2015), butterflies use pyrrolizidine alkaloids in their defence mechanisms and to produce sex hormones. In the present study, three species of butterflies were observed feeding on the sap of *C. retusa* and *Helitropium indicum*.

According to Bhakare and Ogale (2015), some species of butterflies feed on the sweet secretions (honeydew) of Homoptera such as aphids, while the present study has found that the lycaenid butterfly (*Lampides boeticus*) feeds on the aphid's honeydew-like secretion/ excreta. In the present study, when ripe oranges were broken open and kept outside, it was found that *Melanitis leda* and *E. aconthea* species feed on the ripe orange fruits. Similarly, Shiha (2016) have recorded *M. leda* feeding on Carambola fruits and *E. aconthea* feeding on Pineapple, Carambola, Papaya, Litchi, Mango and Guava from some areas of Bangladesh. The present study on butterfly feeding from non-nectar sources reveals that such behaviour plays a significant role in fulfilling the nutritional requirements of butterflies beyond what floral nectar provides. Butterflies were observed utilizing various alternative sources such as ripened fruits, animal excreta, plant exudates, and moist soil (mud-puddling). Such non-nectar sources might play a vital role in maintaining butterfly physiology, reproduction, and survival, especially during periods of nectar scarcity. These findings emphasize that butterfly conservation strategies should consider the availability of both nectar and non-nectar resources in natural habitats.

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REFERENCES

- Ankola K., Aishwarya D., Anusha R., Vaishnavi N., Supriya V.K. and Puttaraja H.P. (2021) Ecological significance of puddling as a behavioural phenomenon in the life history of butterfly *Papilio polytes* Linn. (Lepidoptera: Papilionidae). *Journal of Asia-Pacific Entomology* 24: 1–6. doi: 10.1016/j.aspen.2020.10.014.
- Bhakare M. and Ogale H. (2018) A Guide to Butterflies on Western Ghats (India): Includes Butterflies of Kerala, Tamil Nadu, Karnataka, Goa, Maharashtra, and Gujarat states. Milind Bhakare (privately published). 496pp.
- Chandekar S.K., Karkar H.S., Nimbalkar R.K. and Mahajan D.M. (2018) Study of butterfly diversity in Mulshi Tahsil, Pune District, Maharashtra, India. *International Journal of Scientific Research in Science and Technology* 5(2): 21–26.
- Ganeshwari C., Kavibharathi P., Meenakshi P., Preethi S. and Rajendran P. (2022) A study on the mud puddling activity of butterflies in Alagarkovil Hills, Madurai, Tamil Nadu, India Uttar Pradesh *Journal of Zoology* 43(2): 1–10.
- Gunathilagraj K., Perumal T.N.A., Jayaram K. and Ganesh Kumar M. (2015) South Indian Butterflies. Krab media & Marketing, Bangalore. 357pp.
- Haribal M. (1992) The Butterflies of Sikkim Himalaya and their Natural History. Sikkim Nature Conservation Foundation, Gangtok. 217pp.
- Inoue T.A., Ito T., Hagiya H., Hata T., Asaoka K., Yokohari F. and Niihara K. (2015) K⁺ Excretion: The other purpose for puddling behaviour in Japanese *Papilio* Butterflies PLoS ONE 10(5): e0126632. doi: 10.1371/journal.pone.0126632.
- Kasambe R. (2016) Butterflies of Western Ghats. An e-Book. Self-published, Mumbai. https://www.researchgate.net/profile/RajuKasambe/publication/312056076_Butterflies_of_Western_Ghats_First_edition/links/59f06f18458515bfd07bf16c/Butterflies-of-Western-Ghats-First-edition.pdf. 327pp. (Accessed on 1 July, 2024).
- Kirti J.S. and Singh N. (2013) Studies on external genitalia of *Mangina syringa* (Cramer) (Lepidoptera: Erebidæ: Arctinae) *ENTOMON* 38(2): 59–64.
- Krenn H.W. (2008) Feeding on neotropical butterflies (Lepidoptera, Papilionoidea). *Stapfia* 80: 295–304.
- Kunte K. (2000) India a Lifescape: Butterflies of Peninsular India. University Press (India) Private Limited, Hyderabad. 254pp.
- Nakka S., Kumar B.V. and Devendra B.N. (2013) Analysis of pyrrolizidine alkaloid from *Crotalaria retusa* L. *Der Pharma Chemica* 5(6): 6–11.
- Salazar-E J.A. (2013) Butterflies (Lepidoptera: Papilionoidea) attracted to tree sap (Exudates) in Colombia. *Boletín Científico Centro De Museos Historia Natural* 17(2): 227–245.
- Shihan T.R. (2016) An observation on the fruit feeding behavior of butterflies in some areas of Bangladesh. *Journal of Threatened Taxa* 8(12): 9479–9485. doi: 10.11609/jott.2519.8.12.9479-9485.
- Sourakov A., Duehl A. and Sourakov A. (2012) Foraging behaviour of the Blue Morpho and other Tropical butterflies: The chemical and electrophysiological basis of Olfactory preferences and the role of color. Hindawi Publishing Corporation *Psyche* (Article ID 378050). pp10. doi: 10.1155/2012/378050.
- Stegelmeier B.L. (2011) Pyrrolizidine Alkaloid – Containing toxic plants (*Senecio*, *Crotalaria*, *Cunoglossum*, *Amsinckia*, *Helitropium*, and *Echium* spp.) *Veterinary Clinics of North America: Food Animal Practice* 27(2): 419–428.
- Suwarno S., Rasnovi S., Utami S.D., Rizki A. and Dahelmi D (2019) Mud-puddling behavior of butterflies in the Soraya research station, district of Subulussalam, Aceh, Indonesia. *IOP Conference Series: Earth and Environmental Science* 364: 012027. doi: 10.1088/1755-1315/364/1/012027.
- Vinod M. and Kumar K.S. (2021) Puddling an interesting behaviour in butterflies. *Kerala Karshakan e-journal* 9(5): 8–11.
- Young A.M. (1975) Feeding behaviour of Morpho butterflies (Lepidoptera: Nymphalidae: Morphinae) in a seasonal tropical environment. *Revista De Biologia Tropical* 23(1): 101–123.