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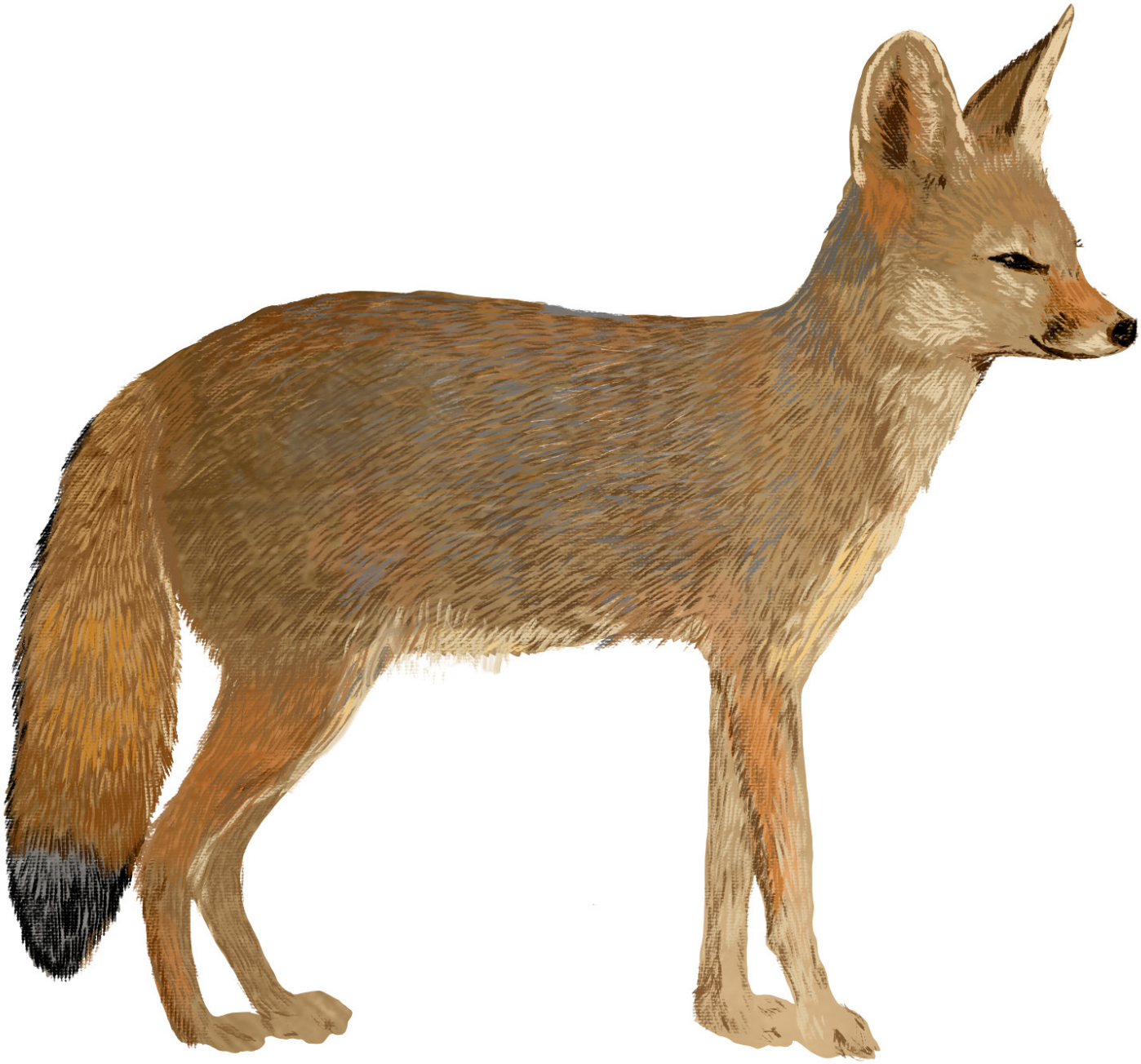

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Cover: Bengal Fox *Vulpes bengalensis*—digital illustration. © Alagu Raj.

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COMMUNICATION

A study on the association between Tridax Daisy *Tridax procumbens* L. and butterflies at Shivaji University Campus, Maharashtra, India

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Abstract: The objective of the present study was to study butterfly-*Tridax procumbens* interaction and test whether there is any correlation between lengths of corolla tube of the flowers and butterfly proboscis. Most butterflies visit flowers to obtain nectar. A common weed *T. procumbens* is an invasive species and a nectar plant for many butterflies. At Shivaji University campus, we documented a total of 42 species of butterflies belonging to three families (Lycaenidae, Nymphalidae, and Pieridae) of superfamily Papilionoidea visiting flowers of *T. procumbens* for nectar from December 2022 to November 2023. Among these, lycaenids were the most speciose with a total of 21 species, followed by the family Nymphalidae with 12 species, and the family Pieridae with nine species. Although the corolla length of *T. procumbens* flower is considered short, butterflies with both short (Lycaenidae and Pieridae) and long (Nymphalidae) proboscises were observed visiting these flowers for nectar. Seasonal studies carried out here showed that the highest number of butterfly species was recorded during monsoon season, mainly in June, than during other seasons. Among all species recorded, *Eurema laeta* was recorded at the highest temperature 35.8°C with 37% humidity. In the present communication photographs of all 42 butterfly species visiting *T. procumbens* flowers are provided.

Keywords: Butterfly, coat button, corolla tube, flower, humidity, interaction, monsoon, nectar, proboscis, temperature.

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Competing interests: The authors declare no competing interests.

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Author contributions: SMG involved in photography, design of the research and write-up of the manuscript. ANP is involved in photography, data compilation and manuscript preparation.

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INTRODUCTION

Butterflies (Lepidoptera: Papilionoidea) are one of the most common diurnal groups of flower visitors for taking nectar as main source of their diet (Bawa 1990; Haribal 1992). Being the specialized feeders, they are equipped with a long, hollow, sucking tube called proboscis and is coiled when not in use (Haribal 1992). The feeding of butterflies is not a random phenomenon; it has been shown that they prefer nectar plants having specific chemical composition (Kunte 2000). Hence, it becomes important to study interaction between butterflies and specific species of flowering plants. Several researchers (Tiple et al. 2009; Nimbalkar et al. 2011; Chandra et al. 2013; Sultana et al. 2017; Varalakshmi & Raju 2013; Mukherjee & Hossain 2021; Mallick & Virdi 2024) have studied interaction between butterflies and *Tridax procumbens*.

Tridax procumbens is an annual herbaceous invasive herb that belongs to Asteraceae family used by butterflies for food because this species blooms throughout the year (Nimbalkar et al. 2011; Rathore et al. 2020; Mukherjee & Hossain 2021). This plant is a valuable nectar source for butterflies (Mallick & Virdi 2024). In the present study, 42 species of butterflies feeding on the nectar of *T. procumbens* flowers were recorded. The number of species are significantly higher than species recorded in previous studies (Tiple et al. 2009; Nimbalkar et al. 2011; Chandra et al. 2013; Sultana et al. 2017; Varalakshmi & Raju 2013; Mukherjee & Hossain 2021; Mallick & Virdi 2024). Additionally, abiotic factors (temperature and relative humidity) during the observation period were recorded. This study highlights the significance of *T. procumbens* as a major source of nectar for many butterfly species.

MATERIALS AND METHODS

Field visits were made throughout the day to record visits by butterflies at the study area (Shivaji University Campus, Kolhapur) during December 2022 to November 2023. The visiting butterflies were identified by consulting field guides published by different workers (Haribal 1992; Gunathilagraj 2015; Kunte 2000; Bhakare & Ogale 2015; Kasambe 2016), and the images on the Butterflies of India website (https://www.ifoundbutterflies.org). Temperature and relative humidity were recorded during the observation period by using digital hygrometer. Butterflies were photographed using Canon 550D and Nikon D500 DSLR cameras.

RESULTS AND DISCUSSION

A total of 42 species of butterflies (Table 1) belonging to three families (Lycaenidae, Nymphalidae, and Pieridae), eight subfamilies, and 10 tribes were observed feeding on the flowers of *T. procumbens* at the Shivaji University campus, Kolhapur. Of these, lycaenids dominated (21 species) (Images 1–21) followed by nymphalids (12 species) (Images 22–33), and pierids (9 species) (Images 34–42).

The current study showed that the number of species and the number of individuals of each species visiting the flowers of *T. procumbens* varied seasonally. Table 2 shows that the highest number of butterfly species visited during rainy season (32), followed by winter (14), and summer season (11). The month-wise records (Table 2, Figure 1) showed the maximum number of species in June (19 species) and July (16 species). An almost equal number of species were recorded in October (10 species), November (9 species), and May (8 species). Also, four, five, and three species were recorded in August, September, and December, respectively (Figure 1). *Chilades pandava* (Horsfield, 1829) was not recorded during winter season. *Leptotes plinius* (Fabricius, 1793) was recorded only in February. Most of the butterflies visited the flowers in the morning hours (15 species, 0900–1200 h), followed by morning and afternoon hours (11 species, 0900–1600 h), afternoon hours (8 species, 1200–1600 h), and evening hours (4 species, 1600–1743 h). *Chilades pandava, Talicada nyseus* (Guerin-Meneville, 1843)*, Castalius rosimon* (Fabricius, 1775), and *Jamides celeno* (Cramer, 1775) showed foraging activity throughout the day (Table 2). The temperature and relative humidity recorded during the observation period is presented in Table 2. Two species *Catochrysops panormus* (C. Felder, 1860) and *Azanus uranus* (Butler, 1886) were recorded at low temperature (25^{0}C) and high humidity (89%) while *Eurema laeta* (Boisduval, 1836) was recorded at high temperature (35.8^{0}C) and low humidity (37%).

Many studies on butterfly-plant interactions exist (Nimbalkar et al. 2011; Rathore et al. 2020; Khandal & Sharma 2020) including the interactions between butterflies and *T. procumbens* (Tiple et al. 2009; Nimbalkar et al. 2011; Chandra et al. 2013; Sultana et al. 2017; Sharma & Sharma 2018; Khandal & Sharma 2020; Mukherjee & Hossain 2021; Mallick & Virdi 2024). Among these, pollination and nectar feeding relationships are the focus of the current study. In this study, 42 butterfly species were recorded on the flowers of *T. procumbens*. Tiple et al. (2009) recorded 11 species

Table 1. List of butterflies feeding on the nectar of *Tridax procumbens*.

Family	Subfamily	Tribe		Scientific name	Common name
LYCAENIDAE	1. Aphanaeninae	1. Aphaenini	1.	*Spindasis icitis* (Hewiston, 1865)	Common Shot Silverline
			2.	*Spindasis vulcanus* (Fabricius, 1775)	Common Silverline
	2. Polyommatinae	2. Polyommatini	3.	*Freyeria trochylus* (Freyer, 1845)	Grass Jewel
			4.	*Freyeria putli* (Kollar, 1844)	Oriental Grass Jewel
			5.	*Tarucus nara* (Kollar, 1848)	Stripped Pierrot
			6.	*Zizina otis* (Fabricius,1787)	Lesser Grass Blue
			7.	*Lampides boeticus* (Linnaeus, 1767)	Pea Blue
			8.	*Catochrysops strabo* (Fabricius, 1793)	Forget-me-not
			9.	*Chilades pandava* (Horsfield, 1829)	Plains Cupid
			10.	*Leptotes plinius* (Fabricius, 1793)	Zebra Blue
			11.	*Talicada nyseus* (Guerin-Meneville, 1843)	Red Pierrot
			12.	*Azanus ubaldus* (Stoll, 1782)	Bright Babul Blue
			13.	*Nacaduba berenice ormistoni* (Herrich- Schaffer, 1869)	Rounded Six-Line Blue
			14.	*Chilades parrhasius* (Fabricius, 1793)	Small Cupid
			15.	*Zizeeria karsandra* (Moore, 1865)	Dark Grass Blue
			16.	*Castalius rosimon* (Fabricius, 1775)	Common Pierrot
			17.	*Pseudozizeeria maha* (Kollar, 1844)	Pale Grass Blue
			18.	*Catochrysops panormus* (C. Felder, 1860)	Silver Forget-me-not
			19.	*Jamides celeno* (Cramer, 1775)	Common Cerulean
			20.	*Chilades lajus* (Stoll, 1780)	Lime Blue
			21.	*Azanus uranus* Butler, 1886	Dull Babul Blue
NYMPHALIDAE	3. Nymphalinae	3. Junonini	22.	*Junonia lemonias* (Linnaeus, 1758)	Lemon Pansy
			23.	*Junonia almana* (Linnaeus, 1758)	Peacock Pansy
			24.	*Hypolimnas misippus* (Linnaeus, 1764)	Danaid Eggfly
		4. Nymphalini	25.	*Vanessa cardui* (Linnaeus, 1758)	Painted Lady
	4. Danainae	5. Danaini	26.	*Danaus chrysippus* (Linnaeus, 1758)	Plain Tiger
			27.	*Danaus genutia* (Cramer, 1779)	Striped Tiger
			28.	*Tirumala limniace* (Cramer, 1775)	Blue Tiger
			29.	*Euploea core* (Cramer, 1780)	Common Crow
			30.	*Parantica aglea* (Stoll, 1782)	Glassy Tiger
	5. Heliconiinae	6. Vagarantini	31.	*Phalanta phalantha phalantha* (Drury, 1773)	Common Leopard
		7. Acraeini	32.	*Acarea terpsicore* (Linnaeus, 1758)	Tawny Coster
	6. Satyrinae	8. Satyrini	33.	*Ypthima philomela* (Marshall, 1883)	Baby Fivering
PIERIDAE	7. Coliadinae		34.	*Catopsilia pyranthe* (Linnaeus, 1758)	Mottled Emigrant
			35.	*Catopsilia pomona pomona* (Fabricius, 1775)	Common Emigrant
			36.	*Eurema laeta* (Boisduval, 1836)	Spotless Grass Yellow
			37.	*Eurema hecabe* (Linnaeus, 1758)	Common Grass Yellow
			38.	*Eurema brigitta* (Stoll, 1780)	Small Grass Yellow
			39.	*Eurema nilgiriensis* (Yata, 1990)	Nilgiri Grass Yellow
	8. Pierinae	9. Pierini	40.	*Belenois aurota* (Fabricius, 1793)	Pioneer White
			41.	*Cepora nerissa* (Fabricius, 1775)	Common Gull
		10. Leptosianini	42.	*Leptosia nina* (Fabricius, 1793)	Psyche

Table 2. Interaction between butterfly species and *Tridax procumbens* concerning season and abiotic factors.

	Name	Availability of species and abiotic factors	Rainy season				Winter season				Summer season				Foraging time
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
1.	*Spindasis icitis*	Presence	+	+	-	-	-	-	-	-	-	-	-	-	1058–1256 h
		Temperature (°C)	33.8	28.4											
		Humidity (%)	41	79											
2.	*Spindasis valcanus*	Presence	-	-	-	-	+	-	-	-	-	-	-	-	1711 h
		Temperature (°C)					28								
		Humidity (%)					72								
3.	*Freyeria trochylus*	Presence	+	-	-	-	-	-	-	-	-	-	-	-	0950 h
		Temperature (°C)	35.7												
		Humidity (%)	37												
4.	*Freyeria putli*	Presence	-	+	-	-	-	-	-	-	-	-	-	-	1128 h
		Temperature (°C)		26.7											
		Humidity (%)		84											
5.	*Taracus nara*	Presence	+	+	-	-	-	-	-	-	-	-	-	-	1100–1400 h
		Temperature (°C)	34.5	27.5											
		Humidity (%)	39	81											
6.	*Zizina otis*	Presence	+	+	-	-	-	-	-	-	-	-	+	-	0900 –1400 h
		Temperature (°C)	34.6	27.1									30.8		
		Humidity (%)	39	83									47		
7.	*Lampides boeticus*	Presence	+	-	-	-	-	-	-	-	-	-	-	-	1145 h
		Temperature (°C)	32.6												
		Humidity (%)	44												
8.	*Catochrysops strabo*	Presence	-	+	-	-	-	-	-	-	-	-	-	-	1344 h
		Temperature (°C)		28.5											
		Humidity (%)		79											
9.	*Chilades pandava*	Presence	+	+	+	+	+	+	-	-	-	+	+	+	0900–1630 h
		Temperature (°C)	32.6	28.4	27.1	26.3	28.1	27.9				30.1	33.3	35.5	
		Humidity (%)	44	79	65	95	34	52				21	26	40	
10.	*Leptotes plinius*	Presence	-	-	-	+	+	+	+	+	+	+	-	-	1140–1340 h
		Temperature (°C)				27.9	27.6	28.5	28.5	28.6	29.1	32.2			
		Humidity (%)				90	82	50	56	43	42	20			
11.	*Talicada nyseus*	Presence	-	-	-	+	+	+	+	+	-	-	-	-	1030–1721 h
		Temperature (°C)				28.9	28.0	28.8	28.1	27.6					
		Humidity (%)				70	72	53	55	46					
12.	*Azanus ubaldus*	Presence	-	+	-	-	-	-	-	-	-	-	-	-	1058 h
		Temperature (°C)		28.4											
		Humidity (%)		79											
13.	*Nacaduba berenice ormistoni*	Presence	-	+	-	-	-	-	-	-	-	-	-	-	1221 h
		Temperature (°C)		28.4											
		Humidity (%)		79											
14.	*Chilades parrhasius*	Presence	-	-	-	-	-	-	-	-	-	-	-	+	1040 h
		Temperature (°C)												32.5	
		Humidity (%)												45	

	Name	Availability of species and abiotic factors	Rainy season				Winter season				Summer season				Foraging time
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
15.	*Zizeeria karsandra*	Presence	+	-	-	-	-	-	-	-	-	-	-	-	1005 h
		Temperature (°C)	35.1												
		Humidity (%)	38												
16.	*Castalius rosimon*	Presence	-	+	-	-	-	-	-	-	-	-	+	+	0900–1630 h
		Temperature (°C)		28.3									33.1	35.4	
		Humidity (%)		78									26	35	
17.	*Pseudozizeeria maha*	Presence	-	-	+	-	-	-	-	-	-	-	-	-	1615 h
		Temperature (°C)			27.1										
		Humidity (%)			65										
18.	*Catochrysops panormus*	Presence	-	+	+	-	-	-	-	-	-	-	-	-	1346 h
		Temperature (°C)		25.0	27.7										
		Humidity (%)		89	68										
19.	*Jamides celeno*	Presence	-	-	-	-	+	+	+	+	-	-	-	-	1000–1700 h
		Temperature (°C)					28.3	28.5	27.8	27.6					
		Humidity (%)					81	57	55	46					
20.	*Chilades lajus*	Presence	-	-	-	-	+	-	-	-	-	-	-	-	1152 h
		Temperature (°C)					28.1								
		Humidity (%)					34								
21.	*Azanus uranus*	Presence	-	+	-	-	-	-	-	-	-	-	-	-	1346 h
		Temperature (°C)		25.0											
		Humidity (%)		89											
22.	*Junonia lemonias*	Presence	+	+	-	-	-	-	-	-	-	-	+	+	0930 –1400 h
		Temperature (°C)	32.6	28.7									30.8	32.5	
		Humidity (%)	44	78									47	45	
23.	*Junonia almana*	Presence	-	-	-	+	-	-	-	-	-	-	-	-	1247 h
		Temperature (°C)				27.9									
		Humidity (%)				90									
24.	*Hypolimnas misippus*	Presence	-	+	-	-	-	-	-	-	-	-	-	-	1444 h
		Temperature (°C)		29.2											
		Humidity (%)		76											
25.	*Vanessa cardui*	Presence	+	-	-	-	-	-	-	-	-	-	-	-	1213 h
		Temperature (°C)	32.6												
		Humidity (%)	44												
26.	*Danaus chrysippus*	Presence	+	-	-	-	-	+	-	-	-	-	-	+	1045–1330 h
		Temperature (°C)	33.5					28.8						33.8	
		Humidity (%)	42					53						40	
27.	*Danaus genutia*	Presence	-	-	-	-	-	+	-	-	-	-	-	-	1032 h
		Temperature (°C)						28.2							
		Humidity (%)						55							
28.	*Tirumala limniace*	Presence	+	-	-	-	-	-	-	-	-	-	-	-	1216 h
		Temperature (°C)	32.6												
		Humidity (%)	44												

	Name	Availability of species and abiotic factors	Rainy season				Winter season				Summer season				Foraging time
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
29.	*Euploea core*	Presence	-	-	-	-	+	-	-	-	-	-	-	-	1647 h
		Temperature (°C)					27.6								
		Humidity (%)					82								
30.	*Parantica aglea*	Presence	-	-	-	-	+	-	-	-	-	-	-	-	1743 h
		Temperature (°C)					28.3								
		Humidity (%)					75								
31.	*Phalanta phalantha phalantha*	Presence	+	-	-	-	-	-	-	-	-	-	-	-	1004 h
		Temperature (°C)	35.1												
		Humidity (%)	38												
32.	*Acarea terpsicore*	Presence	-	-	-	-	-	+	-	-	-	-	-	-	0934 h
		Temperature (°C)						28.5							
		Humidity (%)						57							
33.	*Ypthima philomela*	Presence	+	+	-	-	-	-	-	-	-	-	-	+	1020–1350 h
		Temperature (°C)	32.6	29.2										34.5	
		Humidity (%)	44	76										44	
34.	*Catopsilia pyranthe*	Presence	+	-	-	-	+	-	-	-	-	-	-	-	1000–1217 h
		Temperature (°C)	32.6				27.8								
		Humidity (%)	44				84								
35.	*Catopsilia pomona pomona*	Presence	+	-	-	-	-	-	-	-	-	+	-	-	1103–1230 h
		Temperature (°C)	35.1									32.2			
		Humidity (%)	38									20			
36.	*Eurema laeta*	Presence	+	+	-	-	-	-	-	-	-	-	+	+	0836–1354 h
		Temperature (°C)	35.8	27.56									29.2	35.6	
		Humidity (%)	37	81									50	43	
37.	*Eurema hecabe*	Presence	-	+	+	+	+	+	-	-	-	-	-	-	1000–1547 h
		Temperature (°C)		28.5	27.7	28.9	27.6	27.1							
		Humidity (%)		79	68	71	82	57							
38.	*Eurema brigitta*	Presence	+	-	-	-	-	-	-	-	-	-	-	-	1055 h
		Temperature (°C)	32.6												
		Humidity (%)	44												
39.	*Eurema nilgiriensis*	Presence	-	-	-	-	-	+	-	-	-	-	-	-	1000 h
		Temperature (°C)						28.2							
		Humidity (%)						60							
40.	*Belenois aurota*	Presence	+	-	-	-	-	-	-	-	-	-	-	-	1158 h
		Temperature (°C)	36.4												
		Humidity (%)	35												
41.	*Cepora nerissa*	Presence	+	-	-	-	-	-	-	-	-	-	-	+	1034–1108 h
		Temperature (°C)	30.2											35.5	
		Humidity (%)	49											40	
42.	*Leptosia nina*	Presence	-	-	-	-	-	-	-	+	-	-	-	-	1027 h
		Temperature (°C)								27.6					
		Humidity (%)								46					

+—Present | -—Absent

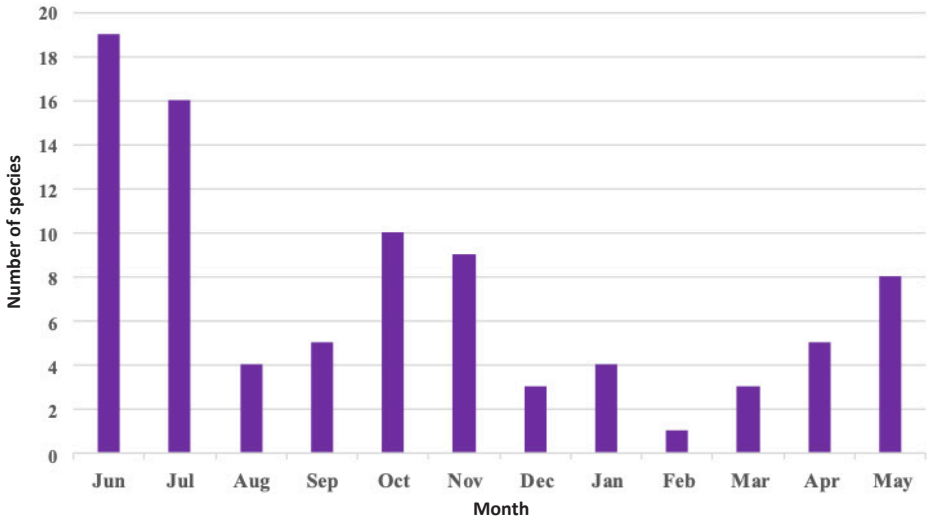

Figure 1. Month-wise number of butterfly species during the study period (December 2022 to November 2023).

of butterflies feeding on the nectar of *T. procumbens* in and around Nagpur. Nimbalkar et al. (2011) recorded a total of 34 species of butterflies feeding on the nectar of *T. procumbens* of which, nine were from Pieridae, four from Lycaenidae, 16 from Nymphalidae, three from Hesperiidae, and two from Papilionidae from Bhor Tahsil, Pune District, Maharashtra, India. Chandra et al. (2013) studied interactions of insects with herbaceous plants and reported 15 species of butterflies feeding on the nectar of *T. procumbens* from different localities of Visakhapatnam. Varalakshmi & Raju (2013) recorded a total of 27 species on *T. procumbens* out of which, five were from Papilionidae, four from Pieridae, 12 from Nymphalidae, five from Lycaenidae, and one from Hesperiidae. Sultana et al. (2017) reported two butterfly species from Pieridae, five from Lycaenidae, and two from Satyridae on *T. procumbens* from protected areas, botanical gardens, and butterfly germ plasm Centre in Bangladesh. Sharma & Sharma (2018) recorded only one Lycaenidae member *Horaga albimacula viola* from different localities of Jammu & Kashmir. Similarly, Khandal & Sharma (2020) recorded only one Hesperiidae species *Coladenia indrani indra* from Ranthambore Tiger Reserve, Rajasthan. Both species were not recorded in the present study because of differences in environmental conditions of the present study site (Maharashtra), Rajasthan, and Jammu & Kashmir. Mukherjee & Hossain (2021) recorded a total of seven butterfly species, all belonging to Lycaenids from Leprosy Mission Campus, West Bengal. Mallick & Virdi (2024) recorded 34 species of butterflies visiting the flowers of *T. procumbens*, of which eight species belonged to Nymphalidae, six species to Lycaenidae, three species to Papilionidae and seven species to Hesperiidae. From all the studies mentioned above, Nimbalkar et al. (2011) and Mallick & Virdi (2024) reported the highest number of 34 small and large butterfly species belonging to different families on T. procumbens. In the present study, 42 butterfly species (21 lycaenids, 12 nymphalids, and 9 pierids) were recorded (Table 1).

Sultana et al. (2017) and Mukherjee & Hossain (2021) noted that in *T. procumbens*, the corolla tube is 8 mm long. Meerabai (2013) documented that butterflies with short proboscis use flowers with 1–10 mm long corolla tubes and butterflies with long proboscis use flowers with 2–43 mm long corolla tube. Different authors (Nimabalkar et al. 2011; Mallick & Virdi 2024) reported that Papilionidae and Nymphalidae butterflies with long proboscis collect nectar from *T. procumbens* flowers. In the present study, Papilionidae butterflies were not recorded but Nymphalidae butterflies with long proboscis collected nectar from *T. procumbens* flowers.

CONCLUSION

The study showed that *T. procumbens* is an important source of nectar during its flowering season for 42 butterflies belonging to Pieridae, Nymphalidae, and Lycaenidae families. But, Lycaenidae represented more species which used this floral source for nectar.

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Image 1. *Spindasis ictis*

Image 2. *Spindasis vulcanus*

Image 3. *Freyeria trochylus*

Image 4. *Freyeria putli*

Image 5. *Taracus nara*

Image 6. *Zizina otis*

Image 7. *Lampides boeticus*

Image 8. *Catochrysops strabo*

Image 9. *Chilades pandava*

Image 10. *Leptotes plinius*

Image 11. *Talicada nyseus*

Image 12. *Azanus ubaldus*

Image 13. *Nacaduba berenice ormistoni*

Image 14. *Chilades parrhasium*

Image 15. *Zizeeria karsandra*

Image 16. *Castalius rosimon*

Image 17. *Pseudozizeeria maha*

Image 18. *Catochrysops panormus*

Image 19. *Jamides celeno*

Image 20. *Chilades lajus*

Image 21. *Azanus uranus*

Image 22. *Junonia lemonias*

Image 23. *Junonia almana*

Image 24. *Hypolimnas misippus*

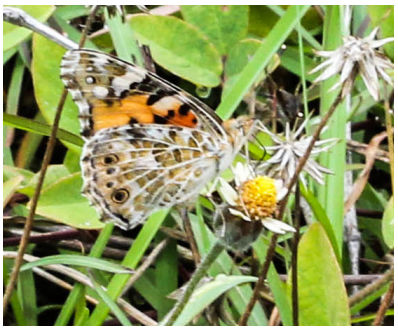

Image 25. *Vanessa cardui*

Image 26. *Danaus chryssipus*

Image 27. *Danaus genutia*

Image 28. *Tirumala limniace*

Image 29. *Euploea core*

Image 30. *Parantica aglea*

Image 31. *Phalanta phalantha phalantha*

Image 32. *Acarea terpsicore*

Image 33. Ypthima philomela

Image 34. *Catopsilia pyranthe*

Image 35. *Catopsilia pomona pomona*

Image 36. *Eurema laeta*

Image 37. *Eurema hecabe*

Image 38. *Eurema brigitta*

Image 39. *Eurema nilgiriensis*

Image 40. *Belenois aurota*

Image 41. *Cepora nerrisa*

Image 42. *Leptosia nina*

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