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Some observations on the butterfly mud puddling in and around Mumbai

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Abstract

Out of 142 species of butterflies recorded 128 (90.14%) species were seen puddling and 14 species never came to wet soil. The family Riodinidae was the dominant species as there is only one species that has high affinity for puddling followed by Nymphalidae where 95% species puddled where as in Papilionidae 80% species puddled. Based on behavioural few hypotheses are proposed like groupism, fight, predation, hangover etc.

Keywords: Butterflies, mud puddling, Mumbai

Introduction

Butterflies sit on the wet soil for absorbing minerals which fulfil their various physiological requirements. It has also been observed that not only butterflies but moths, bugs, wasps, ants are also engaged in this activity. Mud puddling is synonymous with the 'salt licking' performed by higher land vertebrates. Incidentally, this puddling is not at all confined to mud but also to carrion, urine, excreta, sweat, tears and baits. Some species can be seen feeding on such variety of mineral rich sources^[1]. It is indeed a complex process which was studied by many workers^[1, 19]. It is thought that the mud puddling acts as supplementary diet rather than as an energy provider.

Sanjay Gandhi National Park in Mumbai is home to 142 species of butterflies^[20]. Around Mumbai there are many protected forests which harbour almost similar diversity of rhopalocera. The present study reports the observations at Yeoor block, Nagla block of Sanjay Gandhi National Park, Pelhar dam on the outskirts of Tungareashwar Wildlife Sanctuary and a stream in Karnala Sanctuary.

Materials and Methods

Duration of the study

The study sites were visited at least twice a month during puddling season (February to April) since 2004 to 2018.

Identification

The butterfly's nomenclature in the present paper follows Evans^[21], Kunte^[22], Wynter Blyth^[23] although I am aware of the nomenclatural advancements that are being suggested.

Study area

Four puddling sites were studied. Two sites were in Sanjay Gandhi National Park (SGNP), one site in Tungareashwar Wildlife Sanctuary (TWLS) and in Karnala Bird Sanctuary (KBS) respectively. Sanjay Gandhi National Park is located in Mumbai Suburban District and Thane District. Tungareashwar Wildlife Sanctuary is located in Thane District, north of Sanjay Gandhi National Park. Karnala Bird Sanctuary is located in northern part of Raigad district.

Description of the puddling sites

1. **Yeoor:** The puddling sites are located in the stream locally called 'Bhendi Nala' which originates near Yeoor village and passes North West through the Yeoor block and meets Chena River. These puddling sites are located on the section of stream which runs east west. During monsoon the stream is flooded and impossible to cross. After November the flow reduces and by December there remain lots of pools.

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During February March these pools start drying up exposing the mud below it which attracts butterflies. The stream width varies from 10 to 20 meters.

- Nagla:** The puddling sites in Nagla are located along the forest path which runs parallel to the Ulhas River Estuary which flows east to west. There are many small streams which run down the adjoining hill however the main puddling occurs along the forest path as well as the 1 meter wide stream adjoining the path which collects water from the streams coming from the hill.
- Pelhar:** It is a manmade dam located to the north-west periphery within the boundary of Tungareshwar Wildlife

Sanctuary. There are numerous streams coming from adjoining hill which drain water into this dam. The dam is surrounded by dry deciduous forest with some tall, evergreen trees. The small streams get exposed from January onwards as the backwater of the dam starts recedes.

- Karnala:** The puddling site is located on the stream which run east to west on the western slopes of Karnala hill. The terrain is extremely hilly. The puddling occurs along the flat section of stream of about 50-60 meters. The stream is not wider than 5 meters.

Table 1: Description of puddling sites

No.	Name	Forest type	Terrain	Flow direction of the stream
1	Yeor	Dry deciduous	Undulating	East to west
2	Nagla	Dry deciduous + tidal mangrove swamps	Flat adjoining the estuary	East to west
3	Pelhar	Dry deciduous with tall evergreen trees	At the north western base of Tungareshwar hill	East to west
4	Karnala	Dry deciduous	On the western slopes of Karnala hill	East to west

The puddling affinity

The puddling affinity of the individual species is counted on the scale of 0 to 5. '0' means the butterfly never visits the puddling patches while '5' the butterfly with very strong affinity towards puddling. It is based on visual observation.

Hypotheses

Based on observations the various hypotheses are proposed which are given under General Observations section. To assert the hypotheses, photographs from taken from regions outside the present study area by various contributors are used.

Results and Discussion

Out of 142 species observed 128 were seen puddling against the 14 species that were never recorded on wet patches. (Table 2 and 3; Fig. 1).

Following is a list of species that were never seen at the puddle.

Papilionidae: Common Rose *Atrophaneura aristolochiae*, Crimson Rose *Atrophaneura hector*.

Pieridae

Small Salmon Arab *Colotis amata* is common in Nagla block where its food plant *Salvadora persica* is abundant, otherwise it was rare or absent in other sites of the study area.

Chocolate Albatross *Appias lyncida* is Rare in the park and was recorded only during November – December months when puddling proper does not occur. This species otherwise possesses affinity 4 in North East India.

Lycaenidae: Apefly *Spalgis epius*, Common Acacia blue *Surendra quercetorum*, Yamfly *Loxura atymnus*, Monkey Puzzle *Rathinda amor*, Common Tinsel *Catapaecilma elegans*.

Nymphalidae: Common Palmfly *Elymnias hypermenstra*, Painted Lady *Cynthia cardui*.

Hesperiidae: Orange Awlet *Bibasis jaina*, Tamil Grass Dart *Taractrocera ceramas*, Indian Palm Bob *Suastus gremius*
Orange Awlet was never seen during February – April months when actually puddling proper occurs rather it was recorded during monsoon (August – September) and post monsoon (October – November) months.

Table 2: Species wise mud puddling and affinity for puddling

		Puddling	Affinity
I	Family Papilionidae		
1	Common Rose <i>Atrophaneura aristolochiae</i> (Fabricius, 1775)	N	0
2	Crimson Rose <i>Atrophaneura hector</i> (Linnaeus, 1758)	N	0
3	Common Mime <i>Chilasa clytia</i> (Linnaeus, 1758)	Y	1
4	Lime butterfly <i>Papilio demoleus</i> (Linnaeus, 1758)	Y	1
5	Common Mormon <i>Papilio polytes</i> (Linnaeus, 1758)	Y	1
6	Blue Mormon <i>Papilio polymnestor</i> (Cramer, 1775)	Y	1
7	Common Blue Bottle <i>Graphium sarpedon</i> (Linnaeus, 1758)	Y	5
8	Common jay <i>Graphium doson</i> (C & R Felder, 1864)	Y	5
9	Tailed jay <i>Graphium agamemnon</i> (Linnaeus, 1758)	Y	2
10	Spot swordtail <i>Pathysa nomius</i> (Esper, 1785-98)	Y	5
II	Family Pieridae		
1	Common Grass Yellow <i>Eurema hecabe</i> (Moore, 1886)	Y	5
2	Spotless Grass Yellow <i>Eurema laeta</i> (Moore, 1906)	Y	4
3	Small Grass Yellow <i>Eurema brigitta</i> (Wallace, 1867)	Y	4
4	Common Emigrant <i>Catopsilia pomona</i> (Fabricius, 1775)	Y	5
5	Mottled Emigrant <i>Catopsilia pyranthe</i> (Linnaeus, 1758)	Y	5
6	Common Jezebel <i>Delias eucharis</i> (Drury, 1773)	Y	3
7	Small Salmon Arab <i>Colotis amata</i> (Fabricius, 1775)	N	0

8	Psyche <i>Leptosia nina</i> (Fabricius, 1793)	Y	3
9	Common Gull <i>Cepora nerissa</i> (Fabricius, 1775)	Y	4
10	Pioneer <i>Anaphaeis aurota</i> (Fabricius, 1793)	Y	2
11	Common Albatross <i>Appias albina</i> (Boisduval, 1836)	Y	3
12	Striped Albatross <i>Appias libythea</i> (Fabricius, 1775)	Y	3
13	Chocolate Albatross <i>Appias lycinda</i> (Boisduval, 1836)	N	0
14	White Orange Tip <i>Ixias marianne</i> (Cramer, 1779)	Y	3
15	Yellow Orange Tip <i>Ixias pyrene</i> (Butler, 1989)	Y	3
16	Great Orange Tip <i>Hebomoeta glaucippe</i> (Linnaeus, 1758)	Y	4
17	Common Wanderer <i>Pareronia valeria</i> (Fabricius, 1787)	Y	3
III	Family Lycaenidae		
1	Apefly <i>Spalgis epius</i> (Westwood, 1852)	N	0
2	Indian Sunbeam <i>Curetis thetis</i> (Westwood, 1882)	Y	4
3	Angled Sunbeam <i>Curetis dentata</i> (Moore, 1882)	Y	4
4	Large Oak blue <i>Arhopala amantes</i> (Hewitson, 1862)	Y	5
5	Western Centaur Oak blue <i>A. centaurus</i> (Fabricius, 1775)	Y	5
6	Common Acacia blue <i>Surendra quercetorum</i> (Moore, 1857)	N	0
7	Leaf blue <i>Amblypodia anita</i> (Hewitson, 1862)	Y	5
8	Silverstreak blue <i>Iraota timoleon</i> (Stoll, 1790)	Y	4
9	Yamfly <i>Loxura atymnus</i> (Cramer, 1782)	N	0
10	Monkey Puzzle <i>Rathinda amor</i> (Fabricius, 1775)	N	0
11	Redspot <i>Zesius chrysomallus</i> (Hubner, 1819)	Y	4
12	Peacock Royal <i>Tajuria cippus</i> (Fabricius, 1798)	Y	3
13	Tufted White Royal <i>Pratapa deva</i> (Moore, 1884)	Y	3
14	Guava blue <i>Deudorix isocrates</i> (Fabricius, 1793)	Y	5
15	Cornelian <i>Deudorix epjarbas</i> (Moore, 1858)	Y	4
16	Indian Red Flash <i>Rapala iarbas</i> (Fabricius, 1787)	Y	5
17	Indian Slate Flash <i>Rapala manea</i> (Moore, 1879)	Y	5
18	Indigo Flash <i>Rapala varuna</i> (Hewitson, 1863)	Y	4
19	Common Tinsel <i>Catapaecilma elegans</i> (Druce, 1873)	N	0
20	Common Silverline <i>Spindasis vulcanus</i> (Moore, 1881)	Y	5
21	Long banded Silverline <i>Spindasis lohita</i> (Moore,)	Y	5
22	Shot Silverline <i>Spindasis ictis</i> (Hewitson, 1865)	Y	5
23	Abnormal Silverline <i>Spindasis abnormis</i> (Moore, 1883)	Y	4
24	Pointed Ciliate blue <i>Anthene lycaenina</i> (R. Felder, 1868)	Y	4
25	Common Pierrot <i>Castalius rosimon</i> (Fabricius,1775)	Y	5
26	Angled Pierrot <i>Caleta caleta</i> (Hewitson,1876)	Y	5
27	Rounded Pierrot <i>Tarucus nara</i> (Kollar, 1848)	Y	4
28	Zebra blue <i>Leptotes plinius</i> (Fabricius,1793)	Y	5
29	Dark Grass blue <i>Zizeeria karsandra</i> (Moore, 1865)	Y	5
30	Pale Grass blue <i>Pseudozizeeria maha</i> (Kollar, 1844)	Y	5
31	Tiny Grass blue <i>Zizula hylax</i> (Fabricius,1775)	Y	5
32	Lesser Grass blue <i>Zizina otis</i> (Fabricius,1787)	Y	5
33	Grass Jewel <i>Freyria trochilus</i> (Freyer, 1845)	Y	5
34	Gram blue <i>Euchrysops cnejus</i> (Fabricius, 1798)	Y	4
35	Pea blue <i>Lampides boeticus</i> (Linnaeus, 1767)	Y	4
36	Common Cerulean <i>Jamides celeno</i> (Cramer, 1775)	Y	5
37	Dark Cerulean <i>Jamides bochus</i> (Stoll, 1782)	Y	4
38	Forget – me –not <i>Catochrysops strabo</i> (Fabricius, 1793)	Y	5
39	Common Line blue <i>Prosotas nora</i> (C. Felder, 1860)	Y	5
40	Tailless Line blue <i>Prosotas dubiosa</i> (Semper, 1879)	Y	5
41	Dingy Lineblue <i>Petrelaea dana</i> (de Nicéville, 1883)	Y	5
42	Malayan <i>Megisba malaya</i> (Moore, 1879)	Y	5
43	Common Hedge blue <i>Acytolepis puspa</i> (Horsfield, 1828)	Y	5
44	Indian Cupid <i>Everes lacturnus</i> (Godart, 1824)	Y	4
45	Plains Cupid <i>Chilades pandava</i> (Horsfield, 1892)	Y	4
46	Lime blue <i>Chilades laius</i> (Cramer, 1878)	Y	5
IV	Family Riodinidae		
1	Plum Judy <i>Abisara echerius</i> (Moore, 1878)	Y	5
V	Family Nymphalidae		
1	Plain Tiger <i>Danaus chryssipus</i> (Linnaeus, 1758)	Y	4
2	Common Tiger <i>Danaus genutia</i> (Cramer, 1779)	Y	4
3	Blue Tiger <i>Tirumala limniace</i> (Butler, 1886)	Y	5
4	Dark blue Tiger <i>Tirumala septentrionis</i> (Butler, 1874)	Y	4
5	Glassy Tiger <i>Parantica aglea</i> (Moore, 1883)	Y	5
6	Common Crow <i>Euploea core</i> (Cramer, 1790)	Y	5
7	Brown king Crow <i>Euploea klugii</i> (Moore, 1858)	Y	5
8	Tawny Rajah <i>Charaxes bernardus</i> (C. & R.Felder, 1867)	Y	5

9	Black Rajah <i>Charaxes solon</i> (Fabricius, 1781)	Y	5
10	Common Nawab <i>Polyura athamas</i> (Drury, 1770)	Y	5
11	Anomalous Nawab <i>Polyura agraria</i> (Swinhoe, 1887)	Y	4
12	Common Evening brown <i>Melanitis leda</i> (Cramer, 1775)	Y	1
13	Bamboo Tree brown <i>Lethe europa</i> (Fruhstorfer, 1911)	Y	1
14	Common Bush brown <i>Mycalesis perseus</i> (Fabricius, 1798)	Y	5
15	Dark brand Bush brown <i>Mycalesis mineus</i> (Linnaeus, 1765)	Y	5
16	Long Brand Bush brown <i>Mycalesis visala</i> (Moore, 1858)	Y	5
17	Common Four Ring <i>Ypthima huebneri</i> (Kirby, 1871)	Y	3
18	Common Five Ring <i>Ypthima baldus</i> (Fabricius, 1775)	Y	3
19	Common Palmfly <i>Elymnias hypermenstra</i> (Linnaeus, 1763)	N	0
20	Tawny Coaster <i>Acraea violae</i> (Horsfield, 1829)	Y	1
21	Common Leopard <i>Phalanta phalantha</i> (Drury, 1770)	Y	5
22	Commander <i>Moduza procris</i> (Cramer, 1777)	Y	5
23	Chestnut Streaked Sailer <i>Neptis jumbah</i> (Moore, 1857)	Y	5
24	Common Sailer <i>Neptis hylas</i> (Moore, 1872)	Y	5
25	Short banded Sailer <i>Neptis columella</i> (Cramer, 1780)	Y	5
26	Common Baron <i>Euthalia aconthea</i> (Hewitson, 1874)	Y	5
27	Gaudy Baron <i>Euthalia lubentina</i> (Cramer, 1777)	Y	5
28	Baronet <i>Symphadra nais</i> (Forster, 1771)	Y	4
29	Common Castor <i>Ariadne merione</i> (Cramer, 1771)	Y	4
30	Angled Castor <i>Ariadne ariadne</i> (Linnaeus, 1763)	Y	4
31	Painted Lady <i>Cynthia cardui</i> (Linnaeus, 1758)	N	0
32	Yellow Pansy <i>Junonia hierta</i> (Evans, 1923)	Y	2
33	Blue Pansy <i>Junonia orithya</i> (Huebner, 1816)	Y	2
34	Lemon Pansy <i>Junonia lemonias</i> (Linnaeus, 1758)	Y	5
35	Peacock Pansy <i>Junonia almana</i> (Linnaeus, 1758)	Y	5
36	Grey Pansy <i>Junonia atlites</i> (Johanssen, 1764)	Y	5
37	Chocolate Pansy <i>Precis iphita</i> (Cramer, 1779)	Y	5
38	Danaid Eggfly <i>Hypolimnas missipus</i> (Linnaeus, 1764)	Y	4
39	Great Eggfly <i>Hypolimnas bolina</i> (Linnaeus, 1758)	Y	5
40	Blue Oak leaf <i>Kallima horsfieldi</i> (Kollar, 1844)	Y	5
VI	Family Hesperidae		
1	Brown Awl <i>Badamia exclamationis</i> (Fabricius, 1775)	Y	3
2	Plain Banded Awl <i>Hasora vitta</i> (Butler, 1870)	Y	3
3	Common Banded Awl <i>Hasora chromus</i> (Cramer, 1780)	Y	3
4	Common Awl <i>Hasora badra</i> (Moore, 1858)	Y	3
5	Orange Awlet <i>Bibasis jaina</i> (Moore, 1866)	N	0
6	Malabar Spotted Flat <i>Celaenorrhinus ambareesa</i> (Moore, 1866)	Y	3
7	Common Spotted Flat <i>Celaenorrhinus leucocera</i> (Kollar, 1844)	Y	3
8	Tricolored Pied Flat <i>Coladenia indrani</i> (Moore, 1866)	Y	2
9	Fulvous Pied Flat <i>Pseudocoladenia dan</i> (Fabricius, 1787)	Y	2
10	Common Small Flat <i>Sarangesa dasahara</i> (Moore, 1866)	Y	3
11	Spotted Small Flat <i>Sarangessa purendra</i> (Moore, 1882)	Y	3
12	Golden Angle <i>Caprona ransonnetti</i> (R. Felder, 1868)	Y	5
13	Angled Flat <i>Tapena thwaitesi</i> (Moore, 1881)	Y	5
14	Indian Skipper <i>Spialia galba</i> (Fabricius, 1793)	Y	2
15	Tamil Grass Dart <i>Taractrocera ceramas</i> (Hewitson, 1868)	N	0
16	Dark Palm Dart <i>Telicota ancilla</i> (Herrich-Schaeffer, 1869)	Y	3
17	Pale Palm Dart <i>Telicota colon</i> (Fabricius, 1775)	Y	3
18	Grass Demon <i>Udaspes folus</i> (Cramer, 1775)	Y	2
19	Common Red Eye <i>Matapa aria</i> (Moore, 1866)	Y	3
20	Straight Swift <i>Parnara guttatus</i> (Bremer & Grey, 1852)	Y	2
21	Rice Swift <i>Borbo cinnara</i> (Wallace, 1866)	Y	3
22	Small Branded Swift <i>Pelopidas mathias</i> (Fabricius, 1798)	Y	2
23	Great Swift <i>Pelopidas assamensis</i> (de Niceville, 1882)	Y	2
24	Conjoined Swift <i>Pelopidas conjuncta</i> (Herrich-Schäffer, 1869)	Y	2
25	Chestnut Bob <i>Iambrix salsala</i> (Moore, 1866)	Y	3
26	Vindhyan Bob <i>Arnetta vindhiana</i> (Moore, 1884)	Y	5
27	Indian Palm Bob <i>Suastus gremius</i> (Fabricius, 1798)	N	0
28	Moore's Ace <i>Halpe porus</i> (Mabille, 1877)	Y	3

Table 3: Puddling and non-puddling species

No.	Family	No. of Puddling species	No. of Non puddling species	Total	% species puddling
1	Papilionidae	8	2	10	80
2	Pieridae	15	2	17	88.23
3	Lycaenidae	41	5	46	89.36
4	Riodinidae	1	0	1	100

5	Nymphalidae	38	2	40	95
6	Hesperiidae	25	3	28	89.29
		128	14	142	90.14

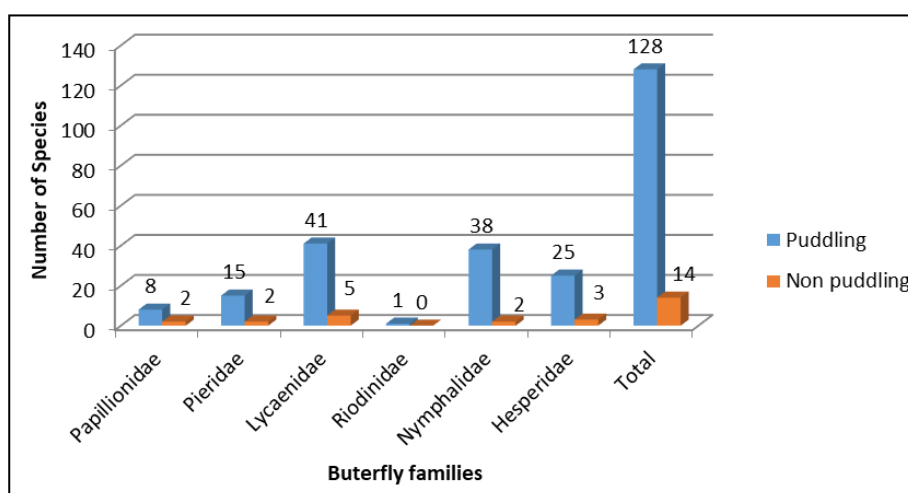


Fig 1: Ratio of puddling to non-puddling species. 128 species out of 142 (90.14%) were engaged in mud puddling.

As per the Table 3 the percentage of minimum number of species that mud puddle is 80% in Papilionidae and the maximum percentage is 100% in Riodinidae followed by 95% in Nymphalidae. This suggests that the butterflies invariably supplement their diet by the minerals from the soil. Males also selectively puddle for specific nutrients like Sodium and Potassium which they transfer to the female during copulation [13, 16, 19, 24]. Smedley and Eisner [19] calculated that males of *Gluphisia septentrionis* transfer 10 µg sodium. Adler and Pearson [4] found out that sodium in the eggs was much higher than the total body sodium content. Beck, Muhlenberg and Fiedler [6] found that all the 102 individuals observed on the soil were males. Apart from nuptial gift, the sodium is also required for neuromuscular activity, males which are much more active flyers, puddle as suggested by Arms [25]. Parson [27] added that the species which perform mud puddling more are those whose larval plant contain less sodium. Inoue, Ito,

Hagiya, Hata, Asaoka, Yokohari *et.al.* [28] reported that the eggs contain between 8 to 9 times more potassium than sodium, therefore females who puddle absorb all the potassium and do not secrete it at all, Therefore, the puddling behaviour seems to be an integral part of life of butterflies.

Table 4: Family wise affinity for mud puddling

	Affinity					
	0	1	2	3	4	5
Papilionidae	3	4	0	0	0	3
Pieridae	2	0	1	7	4	3
Lycaenidae	5	0	0	2	14	26
Riodinidae	0	0	0	0	0	1
Nymphalidae	2	3	2	2	8	23
Hesperiidae	3	0	8	14	0	3

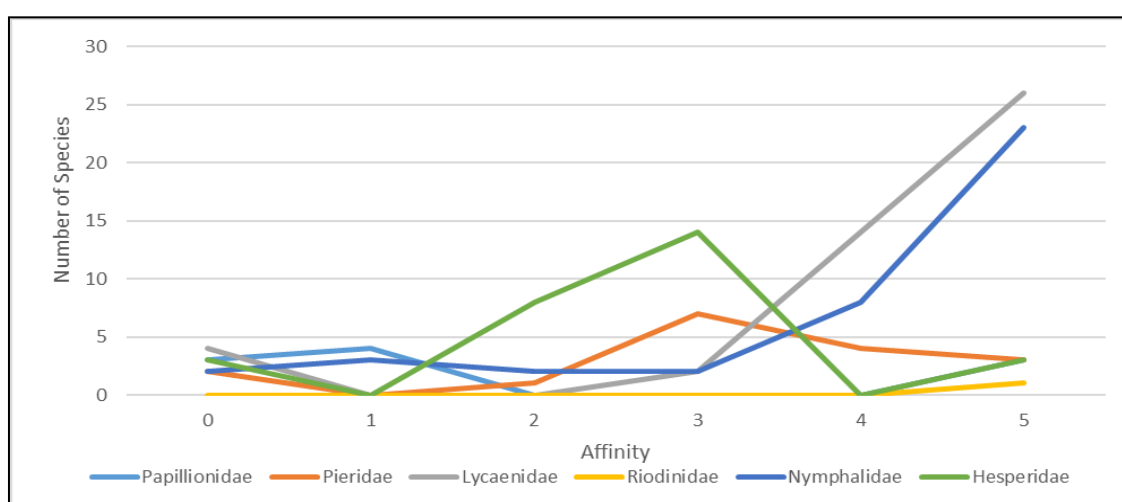


Fig 2: Family wise Affinity for mud puddling

The family Riodinidae was monospecific and the only species of the family showed very high affinity towards puddling. Overall the species of Lycaenidae and Nymphalidae showed more affinity for mud puddling whereas Hesperiidae showed medium affinity. The Papilionidae showed very less affinity where as Pieridae showed slightly higher affinity.

General observations

1. Groupism: Three distinct types of formations were seen as follows.

- i. Individual. A sole individual of the particular species was seen puddling without any company of other individuals of the same species of different species.

ii. Single Species Group or Closed group. Individuals of single species gather together at the spot. The term closed group is applied because the group composed of only single species and absence of other species. This phenomenon of closed group was seen in Plains Cupid *Everes lacturnus* and Spot Swordtail *Graphium nomius*, Common Grass Yellow *Eurema hecabe* predominantly. This kind of formation of single species group might be regulated by specific pheromone and colour perception by an individual. Individuals flying by might be able to identify individuals of the same species based on colour. But the pheromone must be the dominant factor.



Fig 3: Plains cupid *Chilades pandava* puddling in closed group. 11th March 2007. Yeoor.



Fig 4: Two distinct Closed Group of Spot Swordtail *Pathysa nomius* and Common Emigrant *Catopsilia pomona*. 7th March 2003. Yeoor



Fig 5: Two distinct Closed Group of Grass Yellows *Eurema sp.* and Straight Pierrot *Caleta roxus*. April 2019. South Garo, Meghalaya. Photograph by Mr. Divakar Thombre



Fig 6: Closed Group of Straight Pierrot *Caleta roxus* together. A single Common Bluebottle *Graphium serpedon* puddling in the background. April 2019. South Garo, Meghalaya. Photograph by Mr. Divakar Thombre



Fig 7: Papilionids and pierids in two distinct Closed Group formations. April 2019. Namdapha National Park, Arunachal Pradesh. Photograph by Roshan Upadhyay



Fig 8: Distinct groups of swallowtails and pierids from Buxa Tiger Reserve. April 2019. Photograph by Kunal Chakraborty.

iii. Multiple Species Group or Open Group or Mixed Group. Individuals of two or more species were together. The terminology Open Group is applied because there were no restrictions for multiple species to form a group or rather the group was open to all.



Fig 9: Five species in an open group. 3rd March 2006. Yeoor

2. Head Butting: The individuals while puddling pushed the other individual with the head. This was probably to push away the other individual to reach for the more nutrient rich spot. The individual which was pushed sometimes accepted the butting or fought back.

3. Gender biased: It has been proved that males visit damp patches for puddling as they require nutrients many of which are either assimilated in the body or transferred to female during mating. Females were also seen very rarely performing the puddling. Otis *et.al.* [9] observed a single female *Battus philenor* on the mud puddle. This probably asserts that the nutrients were also incorporated in the body. Sporadic presence of the females on the puddle proves the fact the males puddle more than the females.



Fig 10: Common Emigrant *Catopsilia pomona* female, *catilla* form. 3rd March 2006. Yeoor



Fig 11: Common Tiger *Danaus genutia* female. 8th February 2009. Yeoor.

4. Substratum. The substratum probably does not regulate the activity as butterflies were observed to sit on sand, soil, boulders, clothes, wet socks, cement culverts, human sweaty skin etc. Therefore, what attracts them is probably the moisture containing the 'smell' of the minerals into it. Dunn *et al.* [26] observed male *Papilio aegaeus* drinking from a seepage on sandstone outcrops in Australia. Further study on relation of soil texture with other probable parameters is required.



Fig 12: Angled Sunbeam *Curetis dentate* male sipping moisture from wet rock. Yeoor. 19th March 2006.

Probably sipping from solid substratum might be termed as 'drinking' and from mud might be termed as 'puddling'.

5. Attraction to human urine: The forest soil wetted with human urine attracts butterflies almost instantly rather than the soil wetted with only water. Higher content of proteins and sodium are probably the key attractants. Urine of adult humans attract more butterflies. Also the urine of a person who had consumed alcohol the previous night attracts more butterflies.



Fig 13: Papilionids attracted to the urine of a drunk man. 22nd May 2012. South Garo. Meghalaya

6. Predation during puddling: Butterflies are vulnerable during puddling activities. The individuals while in non puddling activities are very wary of any other movements and respond by escape flight. While when engaged in puddling the individuals respond only by flapping of wings or no response at all. In other words, puddling individuals have shorter distance for of tolerating intrusion than that of the non puddling individuals. This makes puddling individual prone to danger. Forest Calotes *Calotes calotes* was seen stalking the puddling butterflies in Yeoor. It was hiding under the stone or a boulder. Interestingly the Common Indian Toad *Duttaphrynus melanostictus* which was stalking the butterflies was killed by Buff Striped Keelback *Amphiesma stolatum* snake. In May 2012 at Siju, Meghalaya Collared Falconet *Microhierax caerulescens* attacked the group of Common Raven *Papilio castor*. Lycaenids and hesperids were not attacked probably owing to their smaller size and camouflaging colours. Papilionids, nymphalids and pierids were preyed upon.

7. Intermittent Puddling: Some species like The Barons, the Rajahs, the Maps, the Oakblues do intermittent puddling. They will puddle for a while and then they will fly and sit on tree close to the puddling site. After some time again they will come back to the same patch.

8. Hangover: Butterflies get hangover of the puddling activity. Otherwise very active individuals when they puddle they are so engrossed in it that any other activity or intrusion does not deter or make them fly. This is why there are prone to predation.

9. Shade vs. sun: The shady stream very rarely attracted butterflies instead area directly under the sun or with intermittent sun and shades was favoured. Logically the water evaporation under the sun is higher than that in the shade hence the water vapour arising from the stream in the sunny

spot attracts butterflies to the site.

10. Puddling site: It was observed that the puddling site was never a deep, narrow ravine under the shade. In Pelhar there are some flat areas exposed by drying of dam water also attracts butterflies to puddle. However, the individuals cannot sit tightly as wind activity is higher than the closed area. The best suitable site for mud puddling is river or stream which is minimum 3 to 5 m wide. The banks of such water body have forest around it. Very few butterflies coming to the ideal puddling site which is away from the forest.

11. Time: The puddling activity normally starts at around 08.00 AM local time and lasts up to around 13.00 PM local time. The peak activity is at around 11.30 AM.

Conclusions

- Butterflies engage actively in the mud puddling activity, 128 species out of 142 were involved in puddling.
- They prefer a puddling site which is relatively flat, which is around 3 to 5 meters wide.
- The puddling time in the present study area was between 08.00 AM to 13.00 with high activity at around 11.30 AM.
- Some species puddle intermittently.
- Butterflies get hangover while puddling.
- During puddling butterflies are prone to predation.
- Human urine attracts butterflies than the normal water.
- Butterflies fight for good puddling site – head butting was observed.
- Some species form Single Species Group or Closed Group while some species form Multiple Species Group.
- Sometimes there is no such group formation.
- Species of Lycaenidae and Nymphalidae showed overall higher puddling affinity while Papilionidae showed overall less affinity.

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