

Observations on underwater oviposition in *Pseudagrion indicum* Fraser (Odonata:Coenagrionidae): an endemic species from the Western Ghats

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Abstract

Underwater oviposition of the Western Ghats endemic *Pseudagrion indicum* Fraser is discussed as a part of the reproductive behavior of odonates in the present article. Opportunistic records from two localities in Northern and Southern Western Ghats highlight the lack of data on breeding biology of these odonates. Observations presented here throw light on the need for documentation of breeding season of these species, which appears to be the post-monsoon season for *P. indicum*. Our work concludes that more emphasis should be given on ecological studies of these insects, especially endemic species that can provide valuable inputs in designing conservation strategies for potential areas.

Keywords: *Pseudagrion indicum*, oviposition, behavior, Western Ghats, endemic.

Received: 24 November 2017; Revised: 2 May 2018; Online: 30 May 2018.

Introduction

Oviposition, which is the culmination of habitat selection in odonates, is of various forms. Endophytic oviposition is a specialized type of behavior of odonates (Corbet, 1962), typically shown by damselflies and some members of family Ashneidae (Anisoptera). Damselflies have elaborate, serrated ovipositor adapted for making incisions in the tissues of plants and placing the eggs in them (Subramanian, 2009). Most of the dragonflies show exophytic oviposition wherein female lays eggs directly over water either by dipping the abdomen in flight or by perching on rocks or logs (Nair, 2011).

Pseudagrion indicum Fraser

Pseudagrion indicum Fraser, 1924 belonging to family Coenagrionidae, commonly known as Yellow-striped Blue Dart, is an endemic species to the Western Ghats of India. It usually breeds

in marshes associated with hill streams (Subramanian, 2009) and streams in closed canopy forests (Koparde *et al.*, 2015). According to Varghese *et al.* (2014), this species is abundant in Thattekkaddu Bird Sanctuary, Kerala. It has been categorized as a Data Deficient species by IUCN Red List of Threatened Species (Dow, 2009). The information available on the breeding biology of the species is still lacking.

Materials and Methods

Study area

Opportunistic observations on underwater oviposition of *P. indicum* were recorded at two different localities– 1) Perennial stream at Urulanthanni, Kerala and 2) Sanguem river, Sanguem, Goa. Urulanthanni is situated in Thattekkaddu area which is famous for its low land forests and avifaunal diversity. This area

forms a part of Salim Ali Bird Sanctuary which mostly comprises of mixed vegetation like tropical evergreen and semi-evergreen forests, tropical moist deciduous forest, plantations and patches of grassland and riparian vegetation. This area receives 400cm rainfall on an average annually (Varghese *et al.*, 2014).

Sanguem or Salaulim River is a tributary of Zuari River present in southern part of Goa. This study site is close to human habitation, where the river is flanked with coconut plantations. Annual rainfall recorded all over the state is 300-400cm (Rangnekar *et al.*, 2010).

Observations

1) Perennial stream at Urulanthanni, Kerala
During the second National DragonflyIndia Meet at Thattekkaddu Bird Sanctuary, we observed the egg-laying behavior of *P. indicum*. As a part of exploratory surveys conducted during the meet, we observed the oviposition behavior at one of the streams at Urulanthanni (10°7'41.07"N, 76°45'19.08"E, 62m a.s.l.) at 11:30 hrs on 13 September 2015. The stream we visited was perennial with a varying width in the range of 10-25m and about a foot deep at the site of the observation with no canopy cover. The water-flow was moderate enough for us to stand and observe the oviposition activities without much disturbance. We observed, identified and photographed a pair of *P. indicum* which was initially in tandem. The female began to oviposit immediately after copulation. Initially, the abdomen of the female was partially submerged underwater and later she started descending underwater. The female was laying eggs inside the plant tissue (endophytic oviposition), as apparent from the movement of the abdomen. The male, on the other hand, was hovering above, in front of the female with his abdomen slightly curved downward, occasionally perching on vegetation around (non-contact guarding) (Figure 1). We observed that the female was 1-2 centimeters under the water surface. We timed our observation when the female went underwater and noticed that she remained underwater for at least 16 minutes (11:28 to 11:44 hrs). The presence of many observers interrupted the guarding by the male for a while, hence we left the site.

2) Sanguem River, Goa

While surveying the river for odonates, in total five observations on underwater oviposition were recorded from 3rd to 9th December 2015. All observations were recorded between 11:00 to 14:00 hrs on a transect (50m length and 20m width) along river with submerged aquatic vegetation (15°13'48"N, 74°10'12"E, 21m a.s.l.). There was no canopy cover at the site of observation and the flow of water was moderate. Although the time spent by the female under the water could not be timed, other interesting observations about the pairs in tandem were noted down.

Males clasped the female prothorax in flight and tandem was formed in air. Upon formation of the tandem, male and female descended down to suitable perch for mating wheel formation. In the tandem, male guided female to the oviposition site which basically consisted of submerged vegetation with small part of the plant above the water surface in the middle of the river for initiating oviposition (Figure 2). On few of the occasions, rival males of *P. indicum* and also other sympatric species like *Pseudagrion microcephalum* (Rambur, 1842) and *Pseudagrion rubriceps* (Selys, 1876) were seen attacking the mating pair. Physical impacts on the lateral side of female's thorax and the lower abdomen of the clasping male by rivals were considered as attempts to break the tandem.

In case of rigorous aggression, tandem continuously shifted its position or moved to the bank of river and headed back to the water after some time to resume oviposition. After finding a suitable oviposition site, they perched on aquatic vegetation just above the water surface. The female slowly started descending under water while still in tandem exhibiting contact guarding by the male. Male held the female till his abdomen was completely submerged and water level was up to the thorax. Then the male released female which then continued descending further into water to lay eggs. On one occasion, the male accompanied female under water for some time where it was submerged entirely (Figure 3). After few minutes, it emerged to the surface and female continued descending (Figure 4 and 5). Similar observations were also made for sympatric

Observations on underwater oviposition in *Pseudagrion indicum* Fraser

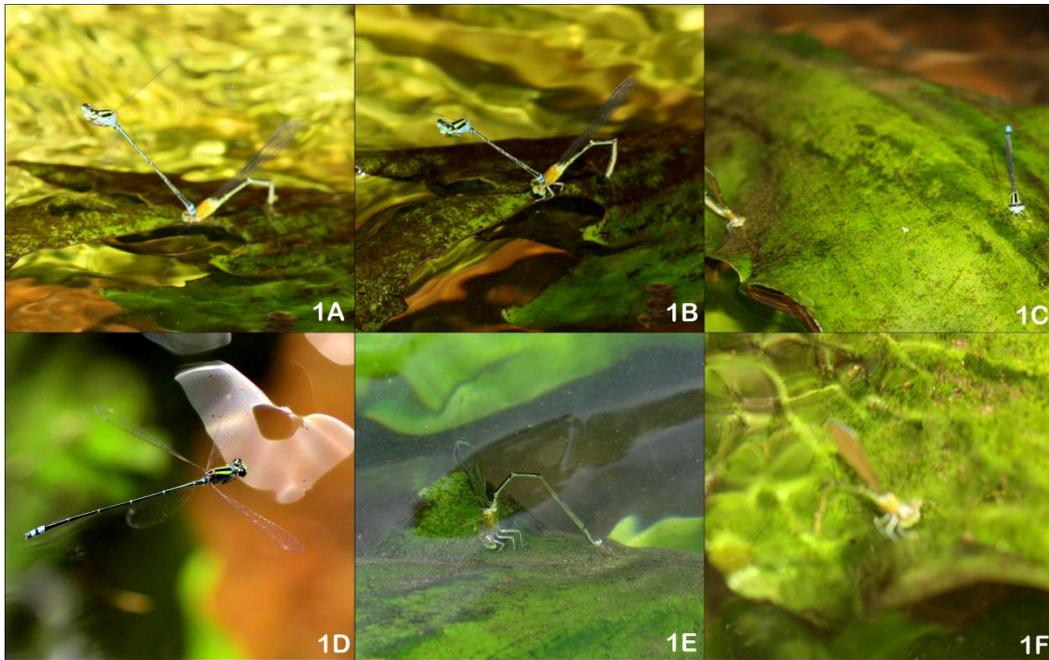


Figure 1. Sequence of probable egg laying in observed pair of *P. indicum*. Figures 1A-C and 1F by Pankaj Koparde. Figure 1D by Prosenjit Dawn and 1E by Kalavanti Mokaria.



Figures 2-5: 2. Submerged vegetation used for oviposition at Sanguem river, Goa; 3. Male of *P. indicum* under water with female during oviposition; 4. Female of *P. indicum* ovipositing without male; 5. Female descending further down for oviposition without male. Figs. by Dheeraj Halali

species *Pseudagrion microcephalum* (Rambur, 1842).

Results

We identified the plant on which the female oviposited at Urulanthanni as Dark Lettuce, *Ottelia alismoides* (L.) Pers. (Nayar *et al.*, 2006; The Plant List 2013). It was about two to five meters away from the shore. The leaf on which the female was ovipositing, was almost submerged leaving only some portion near its tip above the water surface. It is worth to note that this observation was only one instance of mating though we saw multiple individuals of *P. indicum* in a walk of around 1km. We could observe the reproductive and mate-guarding behavior of *P. indicum* pair only for 16 minutes. Hence, we do not know whether the female was alive and emerged out of water successfully later on. Other zygopterans present nearby the site included a male individual each of *Heliocypha bisignata* Hagen in Selys, 1853 and *Neurobasis chinensis* (Linnaeus, 1758). On the other hand, the plant used for oviposition at Sanguem was not identified. Also, we don't know if the female emerged alive to the surface after the completion of oviposition. Other odonates sighted nearby were *Pseudagrion microcephalum* Rambur, 1842, *Pseudagrion rubriceps* Selys, 1876, *Pseudagrion decorum* Rambur, 1842 and *Libellago lineata* Burmeister, 1839.

There is no information available on the breeding season of *P. indicum*. In order to understand the possible breeding season of the species, we mined information from few citizen science projects such as Dragonflies of India (<http://indiabiodiversity.org/group/dragonflies_of_india/show>), Odonata of India (Anonymous 2018) and DragonflyIndia (<<https://www.facebook.com/groups/dragonflyindia/>>). We found 37 observations, of which five observations were reproduction related. Of the five observations, three were taken in April, one in May and one in September in Kerala (South Western Ghats). Apart from these, there are observations in September and December (Pankaj Koparde Pers. Comm.) from Maharashtra (North Western Ghats).

Discussion

According to Corbet (2004), underwater oviposition is dominant in certain species of *Calopteryx* Leach, 1815, *Coenagrion* Kirby, 1890, *Enallagma* Charpentier, 1840 while infrequent in some genera e.g *Anax* Leach, 1815, *Chlorocypha* Fraser, 1928 and *Ischnura* Charpentier, 1840. During underwater oviposition, it is normal for the male to guard and wait for the submerged female, but in the genus *Pseudagrion* Selys, 1876, the male sometimes submerges completely while accompanying the submerged female (Furtado, 1972). The male of *P. microcephalum* may accompany the female in tandem, beneath the water; but then separates after two minutes, floating to the surface and then resting on the nearest perch; but the male of *P. perfuscatum* Lieftinck, 1937 may submerge for 15 minutes and hover above the female while she descends beneath the water surface (Furtado, 1972). Babu (1986) reported that the female of *P. decorum* (Rambur, 1842) showed oviposition behavior in two forms - oviposition above water surface which was accomplished in tandem with the male and underwater oviposition by female alone while the male maintained a guard at the site. The oviposition in tandem was brief (One and a half minutes), whereas the underwater oviposition lasted for 14-27 minutes. Underwater egg-laying forms the main oviposition behavior in *P. decorum*.

Various hypotheses have been proposed for such behavior. A habitat must meet the ecological needs of all the stages of life cycle from egg to adult. Selection of suitable sites by female affects the survival of eggs directly as they are exposed to various biotic and abiotic factors. According to Corbet (1962), various factors might be influencing this behavior such as selecting securely rooted vegetation and thereby reducing chances of eggs not getting swept downstream, getting respite from interference of other males, and avoiding desiccation in case of seasonal fluctuation in water level.

As stated in Corbet (2004) by Fincke (1988), a convincing interpretation of the functional significance of post copulatory behavior helps us to understand about some

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other taxa which lack post-copulatory guarding behavior and exhibit sperm competition and female mortality due to predation. Post-copulatory guarding has manifold effects for the taxa for lessening sperm competition. By failing to guard after copulation a male *Enallagma hageni* entails a 38% risk of losing potential fertilization to other males via sperm displacement, or 3% risk of death of his mate before she has laid all her current clutch.

Odonates are very good indicators of riparian and wetland ecosystems. Most of the endemic odonates of Western Ghats are habitat specialists (Subramanian *et al.*, 2008; Babu *et al.*, 2013; Koparde *et al.*, 2014; Kulkarni and Subramanian, 2013) and therefore, highly sensitive to changes in their habitat. Lack of proper data on their reproductive biology in conjugation with loss of habitats poses a serious threat to their survival that might lead to species extinction. Our current observation in September from Southern Western Ghats and Goa is suggestive of possible lack of data on the species breeding season. From the compilation of the observations, it seems that the species breeds during pre-monsoon (March-May) and post-monsoon (October-February) seasons. In the light of this, the grave and accelerating destruction of habitats may pose serious threat to the odonates. Therefore, an opportunistic observation like the one reported here are worth recording and it strongly highlights the need for focused studies on odonate ecology. Such information provides the basis from which principles of conservation management can be inferred.

Acknowledgments

We are grateful to David Raju for his guidance throughout the observation and sharing duration of the observation with us at Kerala. We would like to thank the participants Kalavanti Mokaria and Prosenjit Dawn for providing images. We would like to acknowledge Rajdeo Singh from Bombay Natural History Society for helping in plant identification. NM would like to express sincere gratitude towards Bombay Natural History Society for financial support to attend the meet. DT would like to express heartfelt thanks to her guide Professor Jatin Kalita,

Gauhati University for his continuous support and guidance throughout research work and encouraging to attend the meet. We are grateful to the organizers of the Dragonfly India meet 2015, Kerala Forests and Wildlife Department, Kottayam Nature Society and Diversity India.

References

- Anonymous. 2018. *Pseudagrion indicum* Fraser, 1924 – Yellow-striped Dart. In: Joshi, S., P. Koparde, P. Dawn, P. Roy and K. Kunte (eds.). *Odonata of India*, v. 1.10. Indian Foundation for Butterflies. Accessed online at <http://www.indianodonata.org/sp/392/Pseudagrion-indicum> on 19 April 2018
- Babu, B.S. 1986. Ecological studies on Odonata larvae and their role in the biological control. Ph.D. Dissertation. Doctor Harisingh Gour Vishwavidyalaya Sagar (M.P) India. 161 pp.
- Babu, R., Subramanian, K.A. and Nandy, S. 2013. Endemic odonates of India. Records of the Zoological Survey of India. 347: 1–60.
- Corbet, P.S. 1962. Biology of Dragonflies. H. F. & G. Witherby Ltd. 12 pp.
- Corbet, P.S. 2004. Dragonflies Behavior and Ecology of Odonata (Revised Edition). Habitat selection and oviposition. Colchester, UK: Harley Books. Pp. 9 – 43,427–558.
- Dow, R.A. 2009. *Pseudagrion indicum*. The IUCN Red List of Threatened Species 2009:e.T163676A 5634305. Downloaded on 21 November 2017. Accessed online at <http://dx.doi.org/10.2305/IUCN.UK.2009-2.RLTS.T163676A5634305.en>.
- Furtado, J.I. 1972. The reproductive behavior of *Ischnura senegalensis* (Rambur), *Pseudagrion microcephalum* (Rambur) and *P. perfuscatum* Lieftinck (Odonata, Coenagrionidae). Malaysian Journal of Science 1: 57-69.
- Kulkarni, A.S. and Subramanian, K.A. 2013. Habitat and seasonal distribution of Odonata (Insecta) of Mula and Mutha river basins, Maharashtra, India. Journal of Threatened Taxa 5: 4084 - 4095

- Koparde, P., Mhaske, P. and Patwardhan, A. 2014. New records of dragonflies and damselflies (Insecta: Odonata) from the Western Ghats of Maharashtra, India. *Journal of Threatened Taxa* 6: 5744–5754
- Koparde P., Mhaske, P. and Patwardhan, A. 2015. Habitat correlates of Odonata species diversity in north Western Ghats, India. *Odonatologica* 44 (1/2): 21–43
- Nair, M.V. 2011. Dragonflies and Damselflies of Orissa and Eastern India, Wildlife Organisation, Forest & Environment Department, Government of Orissa. 22 pp.
- Nayar, T.S., Rasiya Beegam, A., Mohanan, N. & Rajkumar, G. 2006. Flowering Plants of Kerala – A Handbook. Tropical Botanic Garden and Research Institute, Thiruvananthapuram. pp. 710-711.
- Rangnekar, P., Borkar, M. and Dharwadkar, O. 2010. Additions to the Odonata (Insecta) of Goa. *Journal of Threatened Taxa* 2(4): 805-814.
- Subramanian, K.A., Ali, S. and Ramchandra, T.V. 2008. Odonata as indicators of riparian ecosystem health a case study from south western Karnataka, India. *Fraseria* (NS) 7:83–95
- Subramanian, K.A. 2009. Dragonflies and damselflies of peninsular India—a field guide. In: M. Gadgil (ed.), *Project lifescape series*. Vigyan Prasar. New Delhi. Pp. 4, 5,104.
- The Plant List. 2013. Version 1.1. Accessed online at <http://www.theplantlist.org/tpl1.1/search?q=ottelia+alismoides> on 22nd November 2017
- Varghese, A.P., Nikesh, P.R. and Mathew, J. 2014. Odonata (Insecta) diversity of Salim Ali bird Sanctuary and its adjacent areas in Thattekkad, Kerala, India. *Journal of Threatened Taxa* 6(6): 5887–5893.