

## Notes on the oviposition behaviour of three *Elattonneura* damselflies from India (Odonata: Platycnemididae)

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**Abstract.** Oviposition behaviour of three Indian *Elattonneura* spp. is described and discussed. Endophytic oviposition in dry rigid substrates away from water by the endemic *E. nigerrima* and *E. tetrica* is recorded; this differs from the typical recorded use of submerged vegetation substrates in the genus. Contrasting behavioural observation of oviposition in *E. campioni* is also discussed.

Further key words. Dragonfly, Zygoptera, endophytic oviposition, oviposition substrate, reproductive biology, animal behaviour

### Introduction

Selection of suitable habitat and oviposition sites is a crucial part of the reproductive cycle of odonates as this affects egg survival (CORBET 1962: 1–2). While the eggs are typically laid either endophytically or exophytically in lentic or lotic freshwater ecosystems, oviposition sites other than open water bodies include microhabitats such as damp soil (SUBRAMANIAN 2009: 4), phytotelmata (ORR 1994; NISHADH & DAS 2012; DAS et al. 2013), dead stems above water (CORBET 1999: 18), submerged aquatic vegetation (CORBET 1999: 17; MUJUMDAR et al. 2018), and wet moss bed besides the waterfall (DAWN 2019). Many Anisoptera oviposit exophytically by directly releasing eggs into the water, whereas all Zygoptera and most aeshnids perform the characteristic endophytic oviposition by inserting the eggs into submerged or floating aquatic vegetation or inside loose decaying plant material in the waterbody (SUHLING et al. 2015: 912). Different oviposition strategies (*i.e.*, above or below water surface) are known to affect egg survival and thus, reproductive success of the species (HARABIŠ et al. 2019).

The genus *Elattonneura* Cowley, 1935, consists of 45 species worldwide (PAULSON et al. 2021). On the Indian subcontinent, the genus comprises eight taxa (seven species and a subspecies), five of which are endemic to India (*cf.* SUBRAMANIAN & BABU 2017; KALKMAN et al. 2020). Of these, four species are recorded from peninsular India, viz.

*E. nigerrima* (Laidlaw, 1917), *E. nihari* Mitra, 1995, *E. souteri* (Fraser, 1924), and *E. tetrica* (Laidlaw, 1917) with *E. souteri* and *E. tetrica* being endemic to the Western Ghats. Three species, *E. atkinsoni* (Selys, 1886), *E. campioni* (Fraser, 1922), and *E. coomansi* Lieftinck, 1937, are known from north-eastern India. SUBRAMANIAN (2009: 122) and SUBRAMANIAN et al. (2018) provide an outline of the breeding ecology of peninsular *Elattonneura* mentioning the habitats broadly such as streams and large lakes.

In Sri Lanka, five endemic species of the genus are found, viz. *E. caesia* (Hagen in Selys, 1860), *E. centralis* (Hagen in Selys, 1860), *E. leucostigma* (Fraser, 1933), *E. oculata* (Kirby, 1894), and *E. tenax* (Hagen in Selys, 1860) (BEDJANIČ et al. 2014). All are known to oviposit endophytically in submerged vegetation (SUMANAPALA 2017: 72–76) or among the mosses in case of *E. leucostigma* (SUMANAPALA & PODDUWAGE 2016).

### Study site and methods

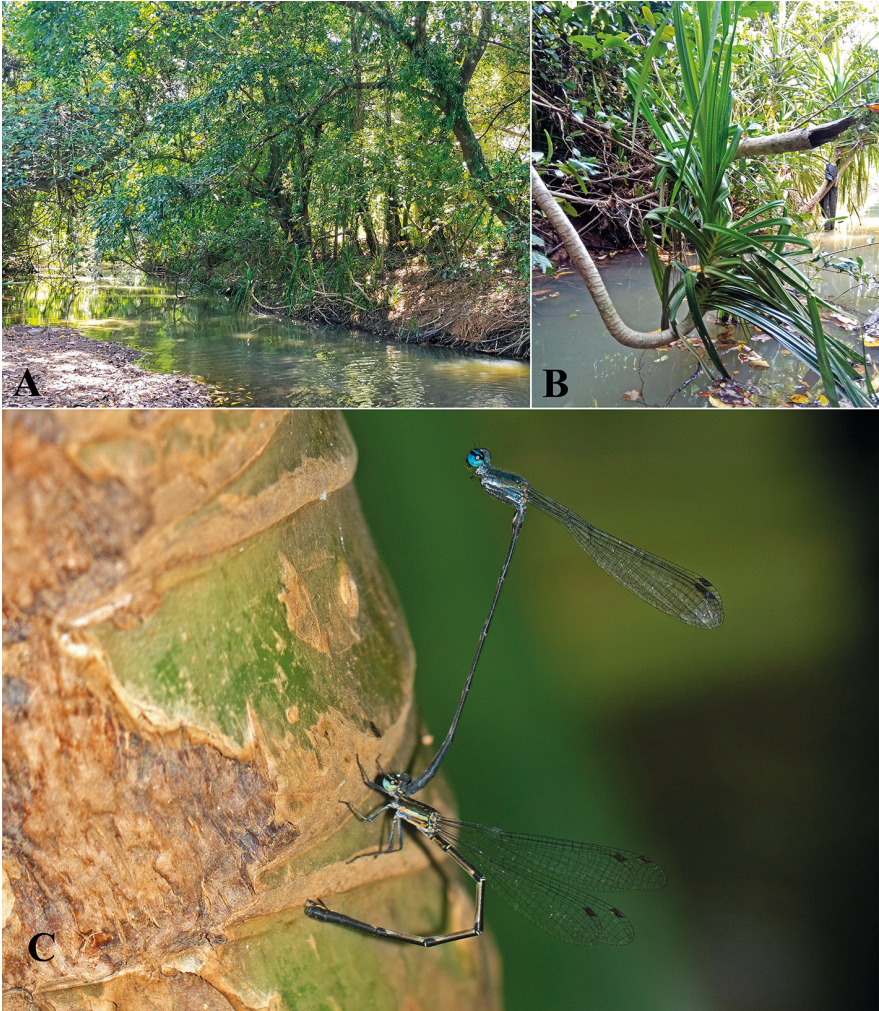
We recorded observations on oviposition behaviour of two species, *E. tetrica* and *E. nigerrima*, in November 2020 at two different localities in Maharashtra State and of *E. campioni* in September 2014 from the northern part of West Bengal, India. All the observations were opportunistic. The former two locations in the Maharashtra State are situated in the northern Western Ghats, a global biodiversity hotspot and *E. campioni* was observed at Gorumara National Park, West Bengal, situated on the fringe of Indo-Burma biodiversity hotspot. We noted the date and duration of observation, habitat characteristics such as vegetation, depth of water, and details of the oviposition site.

### Results

#### *Elattonneura tetrica*

A total of three individuals including two males and a female of *E. tetrica* were observed at a seasonal stream (15°47'59.14"N, 73°49'35.51"E; 12 m a.s.l.) at Madura village, Sindhudurg district, on 23-xi-2020 (Fig. 1A). The stream was approximately 6 m wide. It was surrounded by vegetation on both sides and had a closed canopy at various places of trees such as *Pongamia pinnata*, *Ficus* spp., and vines. Water depth varied from ankle deep to around three feet in places. The weather conditions were somewhat humid. NM observed a pair of *E. tetrica* in tandem around 13:00 h IST (UTC+5:30) on a *Pandanus* palm present in the shaded part of the stream. On closer inspection, the female was seen probing with her ovipositor at the node of the stem with a possible attempt at oviposition (Fig. 1C). This process continued for at least 25 minutes. Throughout the period of observation, the male remained in tandem with the female (contact guarding). Another solitary conspecific male perched slightly above while the tandem pair continued ovipositing. The point on the stem where the female was seen inserting her ovipositor was about 15 cm above the water surface (Fig. 1B).

Other species observed at the stream included *Pseudagrion indicum*, *P. rubriceps*, *Heliocypha bisignata*, *Copera marginipes*, *Libellago indica*, and *Prodasineura verticalis*. All these damselflies, except *P. verticalis*, were recorded ovipositing endophytically at different parts of the stream.



**Fig. 1.** A – Stream habitat of *Elattoneura tetrica*. B – *Pandanus* sp. Habitat. C – *E. tetrica* ovipositing on *Pandanus* sp. Madura, Sindhudurg, Maharashtra state, India (23-xi-2020). Photos: Saunak Pal (A, C), NM (B)

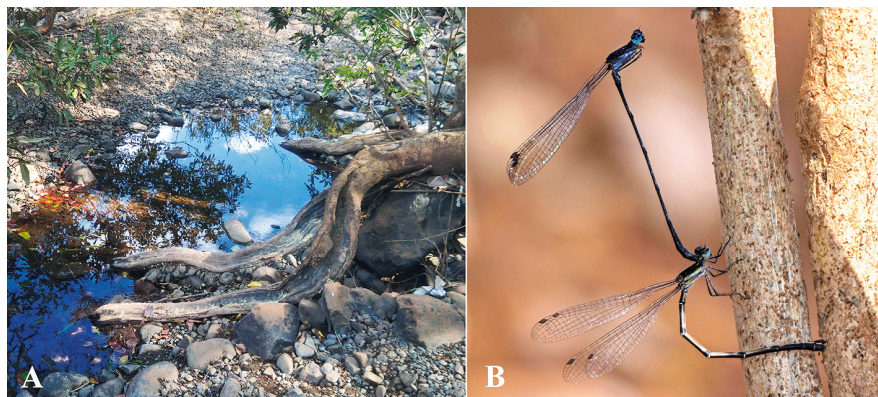
*Elattonneura nigerrima*

On 29-xi-2020, AD observed a pair of *E. nigerrima* in tandem near a stream (17°53'19.9"N, 73°37'18.98"E; 670 m a.s.l.) at Kasrud village, Satara district. The stream, located near the Koyna river, was covered by the thick canopy of semi-evergreen vegetation with water 30 cm deep. Around 13:30 h IST (UTC+5:30), AD observed the pair perching on the bark of an unidentified woody plant approximately 40 m away from the stream. Closer examination revealed that the female was inserting her ovipositor into the stem of the small tree (Fig. 2B). The female continued this process for at least 20 minutes, which seemed a possible attempt at egg-laying. The male remained in tandem (contact guarding) during the entire period of the observation, after which the pair flew away from the site. The point of oviposition was nearly 30 cm above the ground with very little water nearby (Fig. 2A).

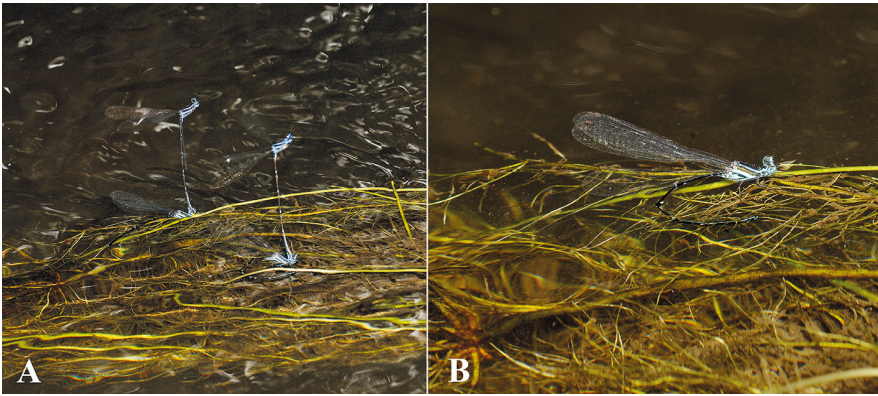
*Elattonneura campioni*

Several pairs of *E. campioni* were observed laying eggs in the submerged root system of trees in a perennial stream of Gorumara National Park, Jalpaiguri, West Bengal (26°45'13.91"N, 88°46'54.28"E; 119 m a.s.l.), in the afternoon around 15:30 h IST (UTC+5:30) on 10-ix-2014 (Fig. 3A). The pairs were observed in non-contact and in-contact guarded oviposition. The eggs were inserted in the root tissue (Fig. 3B) and under laboratory condition the eggs hatched after ten days from the date of oviposition.

A pair of *Pseudagrion rubriceps* was also observed laying eggs in the same habitat and a pair of *Coeliccia bimaculata* was observed in tandem position on the nearby vegetation. Other species recorded from the same locality included *Copera vittata*, *Heliocypha biforata*, and *Neurobasis chinensis*.



**Fig. 2.** A – Small water puddle near oviposition site of *Elattonneura nigerrima*. B – Female *E. nigerrima* ovipositing in woody plant; male contact guarding. Kasrud, Satara, Maharashtra state, India (29-xi-2020). Photos: AD



**Fig. 3.** A. – Contact guarding pairs of *Elattonneura campioni* during oviposition. B. – Female of *E. campioni* ovipositing in root tissue. Gorumara National Park, Jalpaiguri, West Bengal, India (10-ix-2014). Photos: PD

### Discussion

Oviposition site selection has a major effect on the fitness of both the adult odonates and their larvae (THORNTON & SWITZER 2015). Vegetation plays a key role in the survival of the eggs influencing the choice of oviposition among female odonates (MARTENS 2001) and hatching success (LAMBRET et al. 2015, 2018). Parasitoid infection is another potential factor affecting the egg survival giving rise to different oviposition strategies in the closely related European damselflies (HARABIŠ et al. 2019).

In both observations of *Elattonneura nigerrima* and *E. tetrica*, the females were seen ovipositing away from the water, a phenomenon which is not reported yet for Indian *Elattonneura* damselflies. Specifically, earlier observations on endophytic oviposition of *E. nigerrima* and *E. tetrica* mentioned submerged vegetation like roots, logs, leaf litter, and moss as a substrate (K.A. Subramanian, A. Sumanapala, and S. Joshi, pers. comm.). The present observation of the third species *E. campioni* also exhibits similar oviposition behaviour in submerged root systems. Whereas the substrate used by the former two species in our case was not soft aquatic plants, but woody stems.

The observations on *E. nigerrima* and *E. tetrica* were recorded in November when the water level in the stream was very low and the oviposition sites may get flooded during monsoon which could be a trigger for eggs to hatch and for larvae to emerge and get into the water easily as was in the case mentioned by LAMBRET et al. (2018). It is evident that some species of genera like *Lestes* and *Gynacantha* that experience seasonal drought, often oviposit endophytically at a certain height (KUMAR 1972; DUNKLE 1976) or several metres away from eventual water source (LARO-

CHELLE 1979) to make sure that the eggs get immersed in rising water only after few events of heavy rainfall. Thus, oviposition strategy followed by the *E. nigerrima* and *E. tetrica* in November could be an adaptation to ensure the survival of the eggs during the coming dry season. In case of *E. campioni* the observation was made in a somewhat perennial stream during post-monsoon and in a more wet zone than Maharashtra; eventually the eggs hatched after ten days from the oviposition, which is probably the result of better availability of water. Studies on the European damselflies of family Lestidae showed that the females successfully avoid parasitoids and reduce egg mortality when laid eggs in stiff and unsuitable substrates such as bark of soft-wood trees (HARABIŠ et al. 2019). Hence, avoiding parasitoids might be a probable reason due to which the observed females laid eggs on the stems not in contact with the water. The western Palaearctic *Chalcolestes viridis* (Vander Linden, 1820) is well known to oviposit almost exclusively into the bark of shrubs and trees above water. After hatching, the prolarvae fall onto the water. If they miss it, they jump over wet soil to reach water (PIERRE 1902, 1904; MÜNCHBERG 1933). Such behavioural adaptations need to be studied in the case of Indian *Elattonneura* spp.. It has been shown by MATUSHKINA & LAMBRET (2011) that the oviposition in stiff tissues is related to the mechanical properties of the substrate and the ovipositor adaptabilities of the odonates. In some damselflies, preference towards using certain plants as an oviposition site depends upon the intermediate characteristics of stiffness and specific anatomical characteristics of the plant (MATUSHKINA et al. 2016a). In the present observation, the plant used by the female *E. tetrica* for oviposition is a monocotyledon. Observations on use of different monocotyledons as oviposition substrates have been earlier reported (e.g., MÜNCHBERG 1933; MARTENS 2001; MATUSHKINA & LAMBRET 2011; MATUSHKINA et al. 2016a), stating that they provide necessary upright and emergent parts of the plant growing above the water surface (MATUSHKINA et al. 2016b). Considering our limited observation and a serious lack of published studies on oviposition substrates used by Indian damselflies, it is difficult to draw a conclusion on the generality of use of such substrates. In contrast, oviposition in submerged substrates such as herbaceous material or tree roots, as observed by us in *E. campioni*, is a rather common phenomenon in many representatives of zygopteran genera. However, it should be pointed out, that observed probings on the substrate is no warrant for egg deposition (MARTENS 1992).

Our observations on *E. tetrica* and *E. nigerrima* opens up to an array of questions for future research. It would be interesting to study the probable causes of the choice of substrates for *Elattonneura* spp. and other damselflies that are observed to oviposit away from the water, morphology of the ovipositor of the female damselflies, egg clutch pattern and behavioural adaptations in the respective larvae. *Elattonneura tetrica* and *E. nigerrima* are Least Concerned and Data Deficient respectively according to the IUCN Red-List of Threatened Species (KAKKASERY 2011a, 2011b). KOPARDE-HALALI et al. (2021) reassessed these two morphologically similar look-

ing species adding important data on their morphology and distribution. Current observations add spatiotemporal and ecological information of these endemic odonates that can be useful for the IUCN assessments.

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