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131

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On an account of Odonata including larval stages of selected species from three protected areas of North Chhattisgarh, India

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Abstract

Survey in three protected areas of Chhattisgarh reveals the presence of 50 species of Odonata belonging to 34 genera and 9 families. Specimens were sampled from different lotic and lentic ecosystems. 17 species were exclusively found in or around running water. Larvae or exuviae of 23 species were found and photographed. Habitat availability, larval abundance, species composition and phenology are discussed.

Key words: Odonata, dragonfly, damselfly, Chhattisgarh, larvae, exuviae, lotic, lentic

Introduction

Most protected areas of the state Chhattisgarh are newly designated and rarely have proper management plans and documentation of the faunal resources. Early studies on Odonates from Chhattisgarh territory include Mitra (1995), Prasad (1996), Mishra (2007), Tiple & Chandra (2013) and Prasad (2014). Later Dawn & Chandra (2014) documented 85 species from the state. Dawn & Chandra (2016) again added ten more species to the list later on. Study on the larval stages of odonates is very limited in India, and larvae of very few species are known so far. This study was planned to work out species composition of the odonates from the study area, as well as to explore about the larval stages and habitat preferences of different species.

Material and Methods

Field survey was conducted in 2013/14 within the study area for three times to cover three different seasons viz. Pre-monsoon [May], Monsoon [July – August] and post-monsoon [September]. Aquatic sampling for the larvae was done using D-loop net with mesh size of 1 mm. Across the landscape surveyed during the study eight different types of habitats were identified (see Figure 6 in appendix). Three types of each lotic and lentic habitats were surveyed viz. i) River, with shallow depth and rocky or mostly sandy floor, moderate to slow running water [Lo1]; ii) Small Stream, with rocky floor, moderately to fast flow, forest cover, algal growth [Lo2]; iii) Very narrow streams with stagnant water-

holes, with rocky floor, high forest cover [Lo3]; iv) Ponds or Lakes [Ln1]; v) Flooded grasslands and paddy-fields [Ln2]; vi) Artificial water tanks [Ln3]; larvae, exuviae and adults were collected from these habitats. Two types of terrestrial habitats were also surveyed, viz. vii) Grasslands [G] and viii) Bushes adjacent to forests [B]; these habitats serve as foraging ground for the adult odonates.

The larvae were directly preserved in 90% ethanol, then after returning from field, were transferred to 75% ethanol mixed with glycerol (2:1). The exuviae were either collected dry and preserved dry or collected in 70% ethanol after serial hydration and softening. The adult insects were collected using butterfly net, preserved dry either pinned or in paper envelop. Common species were identified in the field and photographed. Few larvae were collected alive and kept in captivity to rear up to imago stage (Figure 9A,B,C & D) for identification confirmation, and some larvae were observed during final emergence in the field (Figure 9E & F).

The dragonfly larvae were kept in aquarium supplied with pond water. The pond water collected at midnight retains plenty of zooplanktons which serve as natural food source for the larvae. Additionally the larvae were fed with bloodworms (Chironomidae larvae), small fishes and mosquito larvae. An uneven stone was placed inside aquarium as emergence substratum (Figure 7A). The damselfly larvae were kept in 500 ml glass jars or flat tray supplied with aquatic weeds. The damselfly larvae were also supplied with zooplankton rich water and often fed individually with bloodworms. The damselfly larvae were supplied with small wooden pieces which they used for emergence.

The preserved larvae and the exuviae were examined under Leica EZ4 HD Binocular Microscope and photographs were taken under Leica Stereo Zoom Microscope (Leica M205A) using Nikon Camera. Identification for the adult insects was done following Fraser (1933, 1934 & 1936) and Mitra (2002). Larval specimens were identified following Kumar (1973, 1997) and nomenclature and hierarchy followed Subramanian (2014) and Schorr & Paulson (2015).

Study Area

For this study three protected areas of North Chhattisgarh were chosen, Guru Ghasidas National Park, Tamor-Pingla Wildlife Sanctuary and Badalkhol Wildlife Sanctuary. Sampling was done in total 16 locations within the study area (Figure 1). All the three protected areas fall under the Deccan Peninsula biogeographic zone – the first one under Central Highlands province and both the others come under Chhota Nagpur province. This area is mostly occupied by dry and wet deciduous forests dominated by trees like *Shorea robusta*, *Tectona grandis*, *Madhuka longifolia* etc.

Guru Ghasidas National Park

Guru Ghasidas National Park is situated in the northern part of Chhattisgarh, ranging from 81.8167° to 82.733°E and 23.5° to 23.867°N covering an area of 2898 km² and altitude range of 300-800 m.a.s.l. The park consists total five ranges (Range: Certain spatial demarcation used by Chhattisgarh forest department to divide a forest division; range contains Circles, each Circle consists few Beats); Sonhat, Ramgarh, Janakpur, Kamarjee in Koriya district and Rihand range in Surguja district. The park

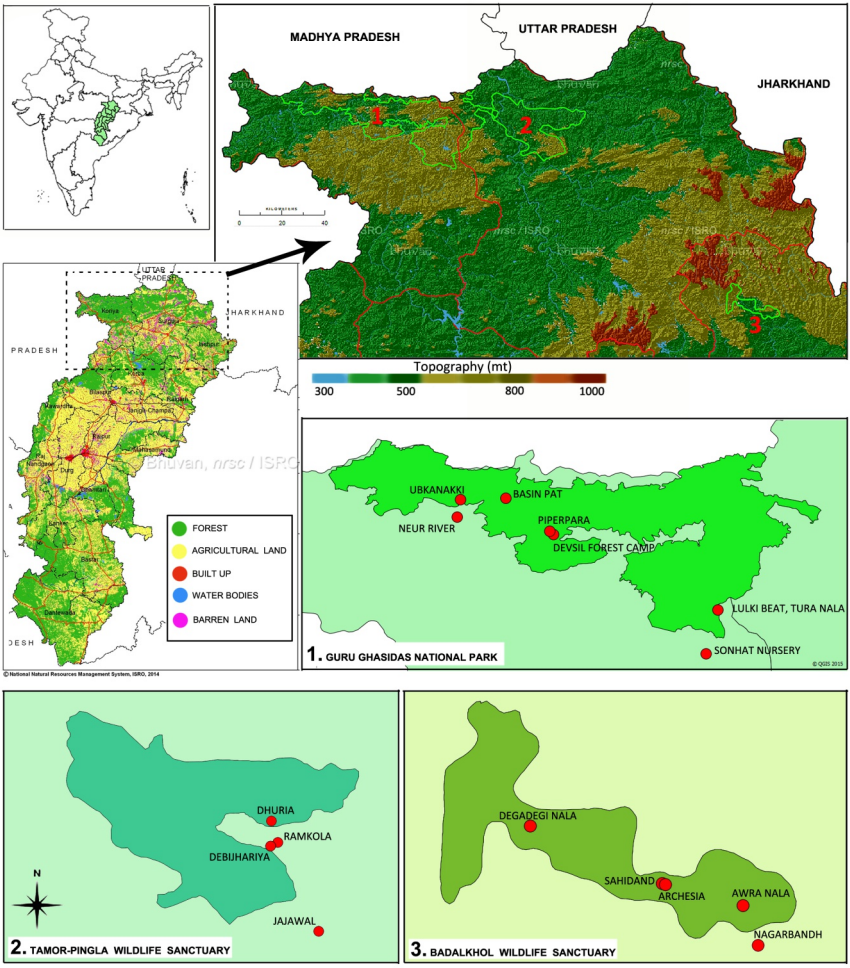

Figure 1. Map showing the study area. Red points indicate the sampling sites.

is attached with the Sanjay National Park in Madhya Pradesh state. Some part of the park comes under the Chhotanagpur plateau and some part in Baghelkhand plateau. The principle rivers of the park are Rihand, Hasdeo, Gopad which are the distributaries of river Son, itself a major tributary of River Ganga.

Tamor-Pingla Wildlife Sanctuary

Tamor-Pingla WLS is located in Surajpur (formerly part of Surguja) between 23.82473° to 23.53634°N and from 82.71059° to 83.10473°E with an average elevation of 400 m.a.s.l. It is named after the Tamor hills and Pingla Nalla, the old and prominent features of the area. Northern boundary is the Moran river, Eastern Boundary is Bonga nalla

and western boundary is Rihand river. This was notified as Wildlife Sanctuary in 1978 and as a part of Sarguja-Jashpur Elephant Reserve in 2011. The sanctuary has a spread of 608.55 km² comprising Sal, mixed and bamboo forests.

Badalkhol WLS

Badalkhol WLS is situated in the north-eastern part of district Jashpur from 22.86945° to 23.02051°N and from 83.6973° to 83.92128°E covering an area of 104.35 km² with an average elevation of 450 m.a.s.l. The Sanctuary has only one Range i.e. Narayanpur and 5 circles. The terrain is undulating mostly, interspersed with low lands and plains. There is no big river but a number of fast flowing streams drain the Sanctuary.

Results

Total 50 species of odonates were recorded from the study area during the survey which includes 30 species of dragonflies and 20 species of damselflies belonging to 21 and 12 genera and four and six families respectively. (Table 1)

Survey in different habitats show more species were recorded from lotic ecosystems than the stagnant water. Among the lotic habitats narrow forest streams showed occurrence of maximum number of species, followed by riverine ecosystems. Among the stagnant water sources flooded grasslands and paddy fields show highest number of species (Figure 2). Populations in lotic ecosystem were more diverse and represented by species from all nine families (Figure 3) but in lentic ecosystems only four families were found, Libellulidae being most dominant (Figure 4)..

The Pre Monsoon months (May – June) show presence of highest number of larvae in the water bodies with gradually decreasing count in Monsoon (July) and least in post-monsoon (September) until the next summer (March – April). Simultaneously number of exuviae increased as the monsoon came (Figure 5).

Discussion

Chhattisgarh have most of its running water sources fed by rainwater, so, most of the lotic ecosystems are not perennial and persists mostly for the monsoon season. During the hottest period of many small waterbodies and open streams dry off. Forest streams often loses its flow in places and form small temporary stagnant water puddles inside forest. There are clear indications that the Odonata species composition and the species turnover show a remarkable variation with the seasons and availability of potential breeding habitats (Kulkarni & Subramanian, 2013). Multiple study on the temperate and tropical Odonata species have revealed their ability to survive dry season by aestivating or siccatating at different life stages, sometime as pre-reproductive adults (Corbet 1999). The species recorded by us probably show aestivation rather than siccatation as the dry season completely coincides with the hottest summer. During our study we encountered *Lestes umbrinus* Selys, 1891, *L. viridulus* Rambur, 1842, *Neurothemis intermedia* (Rambur, 1842) etc. inside drier areas of forests away from water, but couldn't check the reproductive stages of the individuals so cannot comment on the exact reproductive condition of the adults. During summer larvae of

Table 1: Systematic List of the Odonata species recorded from the study area.

*Abundance Status: Very Rare: 1-2 Encounter; Rare: Up to 10 Encounter; Common: >10 encounter; Abundant: Frequently recorded from most sampling sites.

Yes indicates the larva of the species were recorded during the study.

**Habitat Codes: Lo1 - Shallow river with rocky or sandy floor; Lo2 - Small Stream with rocky floor, moderately to fast flow and moderate forest cover; Lo3 - Very narrow forest streams with stagnant waterholes; Ln1 - Ponds or Lakes; Ln2 - Flooded grasslands and paddy-fields; Ln3 - Artificial water tanks; G - Grasslands away from water; B - Bushes adjacent to forests.

Sl. No.	Systematic list	Habitat*	Larva Studied#	Abundance Status**
Zygoptera				
Lestidae				
1	*Lestes praemorsus* Hagen in Selys, 1862	Lo3	Yes	Common
2	*L. umbrinus* Selys, 1891			Rare
3	*L. viridulus* Rambur, 1842	G		Rare
Calopterygidae				
4	*Neurobasis chinensis* (Linnaeus, 1758)	Lo2	Yes	Common
5	*Vestalis apicalis* Selys, 1873	Lo2		Common
6	*V. gracilis* (Rambur, 1842)	B		Common
Chlorocyphidae				
7	*Heliocypha bisignata* (Hagen in Selys, 1853)	Lo2		Common
8	*Libellago lineata* (Burmeister, 1839)	Lo2		Common
Platycnemididae				
9	*Copera marginipes* (Rambur, 1842)	Lo2, Lo3	Yes	Common
10	*C. vittata* Selys, 1863	Lo2	Yes	Common
11	*Disparoneura quadrimaculata* (Rambur, 1842)	Lo2		Rare
12	*Prodascineura verticalis* (Selys, 1860)	Lo2		Rare
Coenagrionidae				
13	*Agriocnemis lacteola* Selys, 1877	Lo2, Ln2, G	Yes	Abundant
14	*A. pygmaea* (Rambur, 1842)	Lo2, Ln2, G		Abundant
15	*A. splendidissima* Laidlaw, 1919	Ln2		Common
16	*Ceriagrion coromandelianum* (Fabricius, 1798)	Lo1, Lo2, Ln2, G, B	Yes	Abundant
17	*Enallagma parvum* Selys, 1876	Ln2		Rare
18	*Ischnura rubilio* Selys, 1876	Lo1, Lo2, Lo3, Ln2	Yes	Common
19	*Pseudagrion decorum* (Rambur, 1842)	Ln1		Common
20	*P. rubriceps* (Selys, 1876)	Lo1, Lo2, Ln1, Ln2	Yes	Common

Sl. No.	Systematic list	Habitat*	Larva Studied#	Abundance Status**
Anisoptera				
Aeshnidae				
21	*Anax guttatus* (Burmeister, 1839)	Lo3, Ln1		Rare
22	*Gynacantha millardi* Fraser, 1920	Lo3	Yes	Common
Gomphidae				
23	*Ictinogomphus rapax* (Rambur, 1842)	Lo1, Lo2, Ln1	Yes	Abundant
24	*Macrogomphus seductus* Fraser, 1926	Lo1	Yes	Very Rare
25	*Paragomphus lineatus* (Selys, 1850)	Lo1, Lo2, Lo3, G	Yes	Abundant
Libellulidae				
26	*Acisoma panorpoides* Rambur, 1842	Ln2		Common
27	*Brachythemis contaminata* (Fabricius, 1793)	Lo1, Lo2, Ln1, Ln2, G, B	Yes	Abundant
28	*Bradinopyga geminata* (Rambur, 1842)	Lo1, Lo2, Ln3	Yes	Rare
29	*Crocothemis servilia* (Drury, 1770)	Ln1, Ln2, G, B	Yes	Abundant
30	*Diplacodes lefebvrii* (Rambur, 1842)	Ln1, Ln2		Very Rare
31	*D. trivialis* (Rambur, 1842)	Lo1, Lo2, Ln1, G	Yes	Abundant
32	*Neurothemis fulvia* (Drury, 1773)	Lo2, Ln1		Common
33	*N. intermedia* (Rambur, 1842)	Lo2		Common
34	*N. tullia* (Drury, 1773)	Ln1		Common
35	*Orthetrum glaucum* (Brauer, 1865)	Lo2		Common
36	*O. luzonicum* (Brauer, 1868)	Lo1, Lo2, Ln2		Common
37	*O. pruinosum* (Burmeister, 1839)	Lo1, Lo2, Lo3, Ln2	Yes	Common
38	*O. sabina* (Drury, 1770)	Lo1, Lo2, Ln1, Ln2, Ln3	Yes	Abundant
39	*O. taeniolatum* (Schneider, 1845)	Lo1, Lo2		Rare
40	*Palpopleura sexmaculata* (Fabricius, 1787)	Lo2, Ln2, B		Rare
41	*Pantala flavescens* (Fabricius, 1798)	Lo1, Lo2, Ln1, Ln2, Ln3	Yes	Abundant
42	*Potamarcha congener* (Rambur, 1842)	Lo1, Ln2		Common
43	*Rhyothemis variegata* (Linnaeus, 1763)	Lo2, Ln1, Ln2, Ln3		Abundant
44	*Tholymis tillarga* (Fabricius, 1798)	Lo1, Ln1	Yes	Common
45	*Tramea basilaris* (Palisot de Beauvois, 1805)	Ln2, B		Common
46	*Trithemis aurora* (Burmeister, 1839)	Lo1, Lo2, Lo3, Ln1, Ln2, Ln3	Yes	Abundant
47	*T. festiva* (Rambur, 1842)	Lo1, Lo2, Lo3, Ln1	Yes	Abundant
48	*T. pallidinervis* (Kirby, 1889)	Lo1		Common
49	*Zyxomma petiolatum* Rambur, 1842	Lo2, Ln1	Yes	Rare
Macromiidae				
50	*Macromia cingulata* Rambur, 1842	Lo1, Lo3	Yes	Rare

several species such as *Trithemis* sp. (Figure 8J), *Macromia* sp. etc. were found to congregate in some of these small water puddles, which might be the strategy for these species to survive the summer and thus the forest streams and puddles appeared to

be most species diverse habitat during summer. The highest number of larvae of *Paragomphus lineatus* were seen during the hottest summer in the shallow perennial rivers with sandy floor. The number of larvae drastically dropped after the rainy season arrived; it indicates that the species spend the summer as larvae and majority emerges as the monsoon approaches (Figure 10A).

We encountered larvae of dragonflies like *Macrogomphus* cf. *seductus* Fraser, 1926 (Figure 8B), *Burmagomphus* sp. (Figure 8D)], *Macromia* sp. but hardly have seen any adult near those habitats, only one adult each of *M. seductus* and *Macromia cingulata*

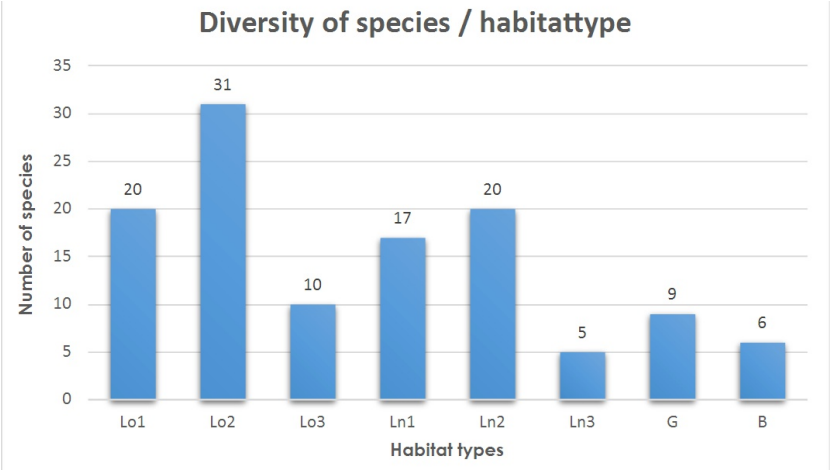

Figure 2. Distribution of species in different habitats surveyed.

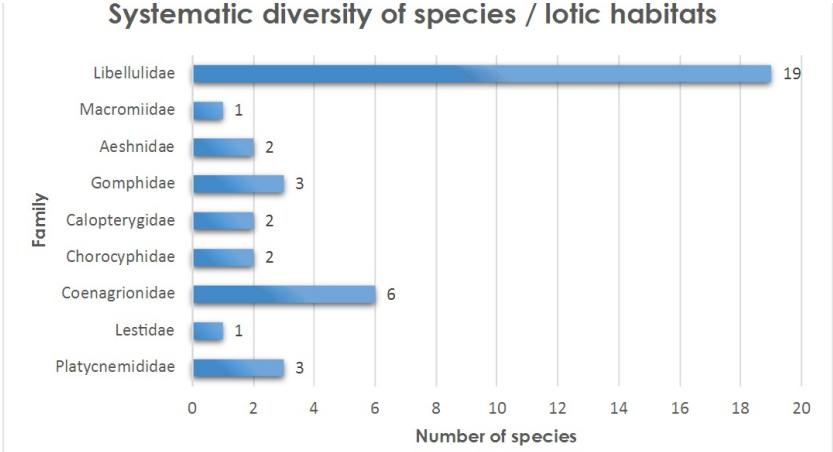

Figure 3. Species composition in lotic habitats.

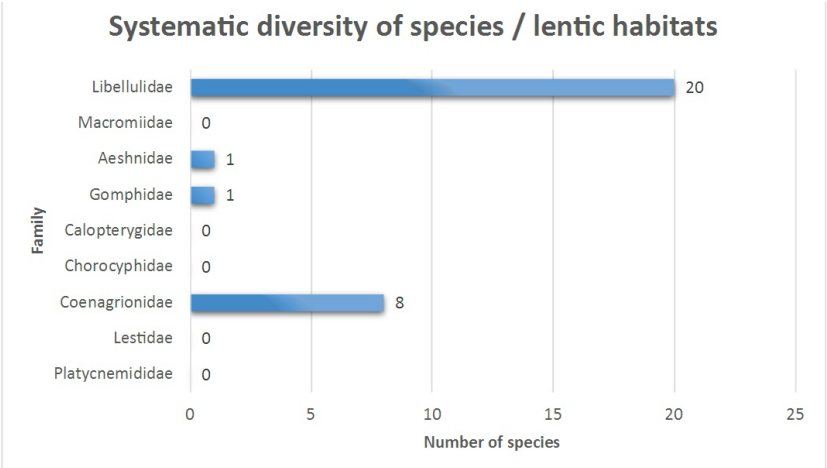

Figure 4. Species composition in lentic ecosystems.

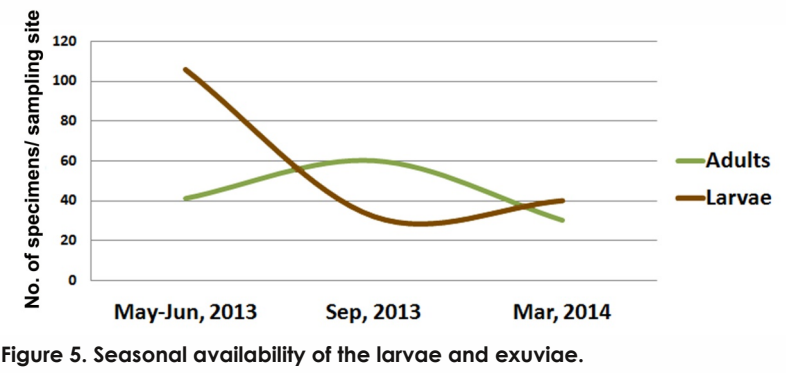

Figure 5. Seasonal availability of the larvae and exuviae.

Rambur, 2842 were recorded from other parts of the study area. These species females might visit the waterbody to lay eggs but we didn't see any; in such cases where the teneral adults leave the breeding place after emergence, larvae and exuviae were very much helpful to understand the breeding habitat of those Odonata species.

Gomphid species like *Paragomphus lineatus* (Selys, 1850) (Figure 8C), *Burmagomphus* sp. were found to breed in shallow rivers with moderate flow and sandy floor which allowed their larvae to hide themselves by burrowing. *P. lineatus* larvae were very fast burrowers and there legs are specially modified for burrowing in loose sand. Most *P. lineatus* larvae were found burrowed under a thin layer of sand occasionally few centimeters. Every time the larvae were released in water after capturing they tried to burrow themselves under a thin layer of sand by removing sand sidewise using their first two pair of legs and moving forward with the help of last pair. The dorsal side of the larvae, with small red and black spots on yellow base color easily resembles

the sand and helps the larvae to camouflage themselves even without burrowing completely under sand. *Macrogomphus* larva was found to be deep burrower and shows presence of elongated 9th abdominal segment that acts as syphon. Flat bodied larvae of *Macromia* sp. preferred sandy floor but little murky water, preferably in the muddy water pools. These larvae were very sluggish and allowed mud to settle down over their body to cover themselves. *Orthetrum* (Figure 8H) larvae on the other hand used to trap mud particles with numerous small hairs all over the body and concealed themselves with the substratum. The larva of *Anax* sp. (the larva was of an earlier stage and there are more *Anax* species recorded from the study area, so we couldn't confirm beyond genus level) (Figure 8A), *Crocothemis servilia* (Drury, 1770) (Figure 8F), *Brachythemis contaminata* (Fabricius, 1793), *Diplacodes trivialis* (Rambur, 1842) (Figure 8G) larvae showed clasping behavior and mostly was clinging with submerged logs or leaflitter, exhibited high thigmotaxis. The larva of *Gynacantha millardi* Fraser, 1920 is described for the first time from this study (Dawn & Chandra 2016) was found associated with *Lestes praemorsus* Hagen in Selys, 1862 larvae (Figure 9E) in a forest puddle full of aquatic vegetations, several larvae were emerging out (Figure 9F) leaving many more attached with the submerged vegetations.

Among the damselfly larvae Chlorocyphidae larvae were least recorded, only in one incidence we came across a very early instar larva, but were unable to identify, though from the same habitat only adult Chlorocyphidae recorded was *Heliocypha bisignata* (Hagen in Selys, 1853) (Figure 10B). Larvae of *Neurobasis chinensis* (Linnaeus, 1753) (Figure 7A) were found in shaded forest stream with clean steady flow and the larvae were attached to the submerged roots of adjacent trees.

Most stagnant water bodies, flooded grasslands and paddy-fields adjacent to forest areas were crowded by coenagrionid larvae; *Ceriagrion coromandelianum* (Fabricius, 1798) (Figure 7B) larvae were the stout ones and their body was covered with mud siltation and they preferred to stay concealed in the mud substratum, *Pseudagrion rubriceps* Selys, 1876 (Figure 7D), *Ischnura* sp. (Figure 7E) and *Agriocnemis* sp. (Figure 7F) larvae were mostly abundant in flooded grasslands, attached with the submerged grass blades. Larvae of *Copera* sp. (Figure 7C) (*vittata* and *marginipes*) were found in narrow forest streams with good forest cover, leaflitter and plenty of water side vegetation. Along with these two species some other platycnemidid such as *Disparoneura quadrimaculata* (Rambur, 1842) (Figure 10C), *Prodasineura verticalis* (Selys, 1860) (Figure 10D) and coenagrionid species like *Pseudagrion rubriceps* were observed to oviposit (Figure 10E, F, G & H) inside the submerged roots, algae or fallen logs in water. Aeshnids like *Anax guttatus* (Burmeister, 1839) and coenagrionids like *Pseudagrion microcephalum* (Rambur, 1842), *P. decorum* (Rambur, 1842) were seen laying eggs in submerged grass-blades in flooded grasslands or shallow water-bodies with plenty of aquatic vegetation. Libellulidae was the most abundant group in almost every habitat and larvae of species such as *Pantala flavescens* (Fabricius, 1798) (Figure 8I), *Bradinopyga geminata* (Rambur, 1842) (Figure 8E) and *Orthetrum sabina* (Drury, 1770) were found in artificial water tanks.

In one incident, in one shallow river with moderate flow only few larva of *Trithemis aurora* (Burmeister, 1839) and *T. festiva* (Rambur, 1842) were found but no Gomphidae whereas

similar habitats showed presence of many *P. lineatus* larvae in other places. It was found that upstream in the same river villagers were cultivating paddy and when enquired they admitted about the use of pesticides in their crop but type of pesticide was not clear. The runoff from the paddy-fields could be the probable cause behind the significantly less number of dragonfly larvae in the river downstream.

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Figure 6. Different type of Habitats surveyed: A. Temporary rainwater stream; B. Shallow river; C. Fast flowing forest stream; D. Narrow streamlet with high forest cover; E. Waterhole inside forest; F. Aquatic sampling using D-loop net.

Figure 7. Zygoptera larvae: A. *Neurobasis chinensis*; B. *Ceriagrion coromandelianum*; C. *Copera* sp. D. *Pseudagrion rubriceps*; E. *Ischnura* sp.; F. *Agriocnemis lacteola*.

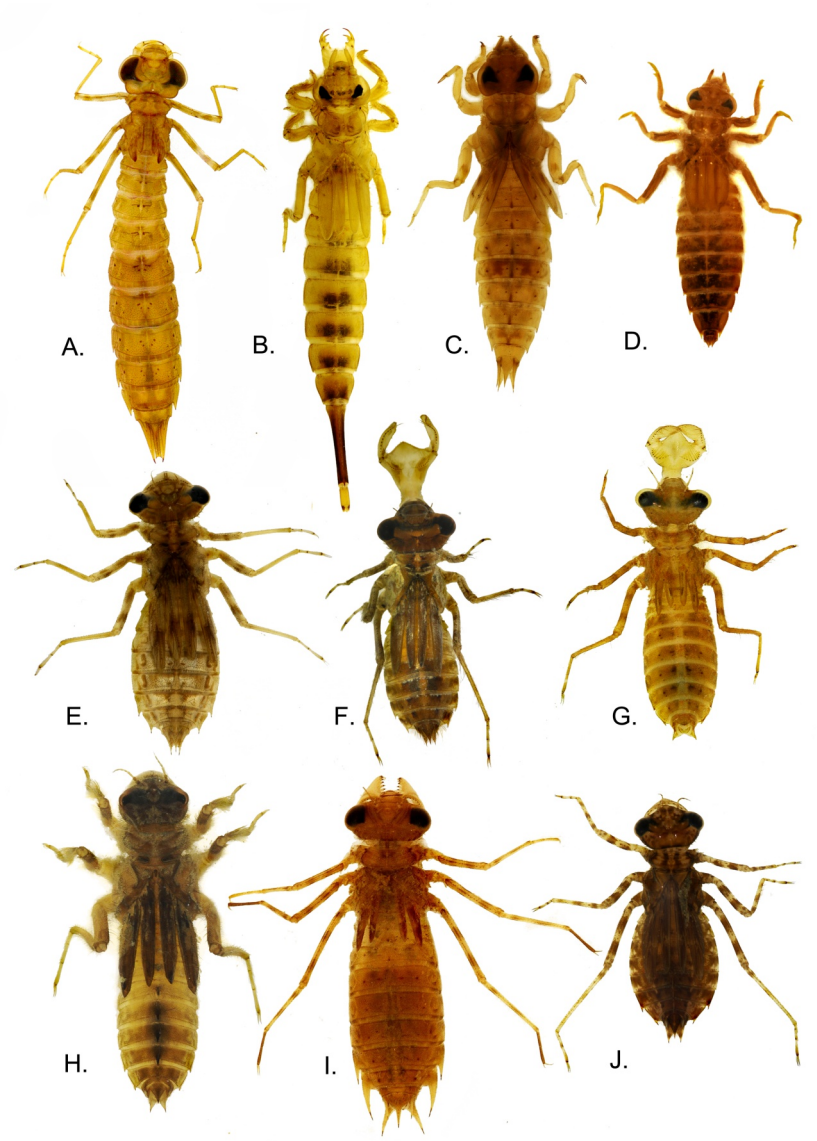

Figure 8. Anisoptera larvae: A. *Anax* sp. B. *Macrogomphus* sp.; C. *Paragomphus lineatus*; D. Unidentified Gomphidae larva; E. *Bradinopyga geminata*; F. *Crocothemis servilia*; G. *Diplacodes trivialis*; H. *Orthetrum pruinosum*; I. *Pantala flavescens*; J. *Trithemis* sp.

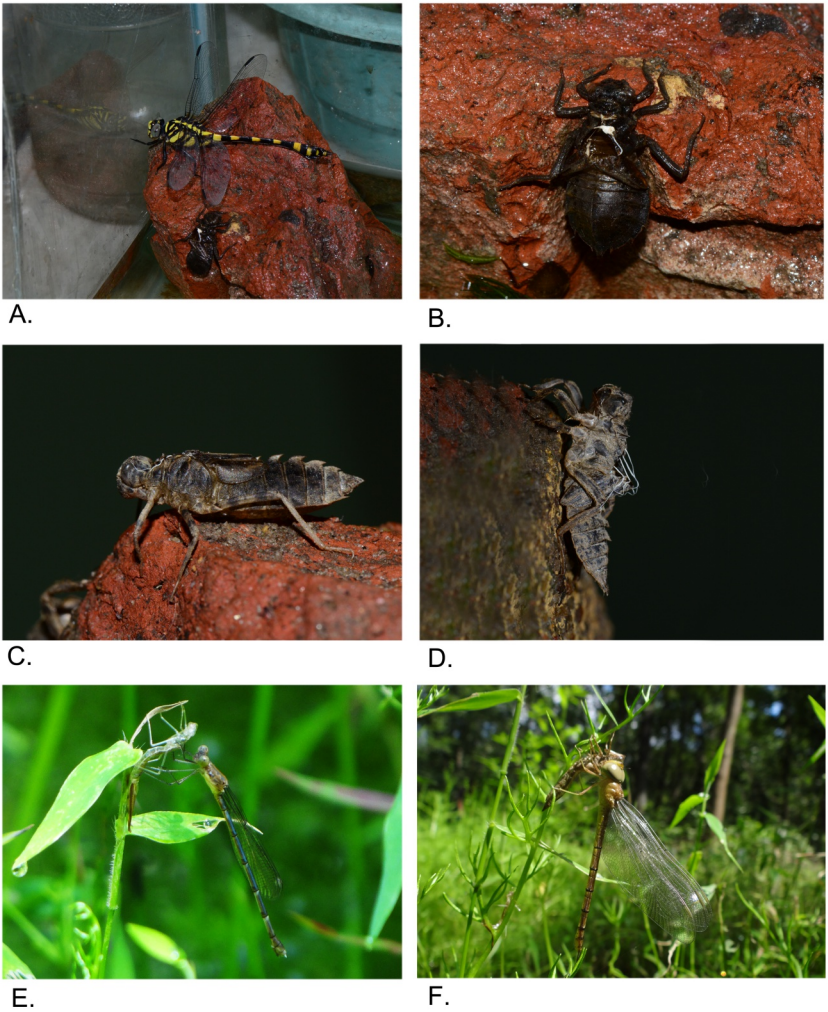

Figure 9. A. Newly emerged *Ictinogomphus rapax* in aquarium. B. Exuvia of *Ictinogomphus rapax*; C. Larva of *Brachythemis contaminata* just before emergence; D. Exuvia of *Orthetrum sabina*; E. Emergence of *Lestes praemorsus*; F. Emergence of *Gynacantha millardi*.

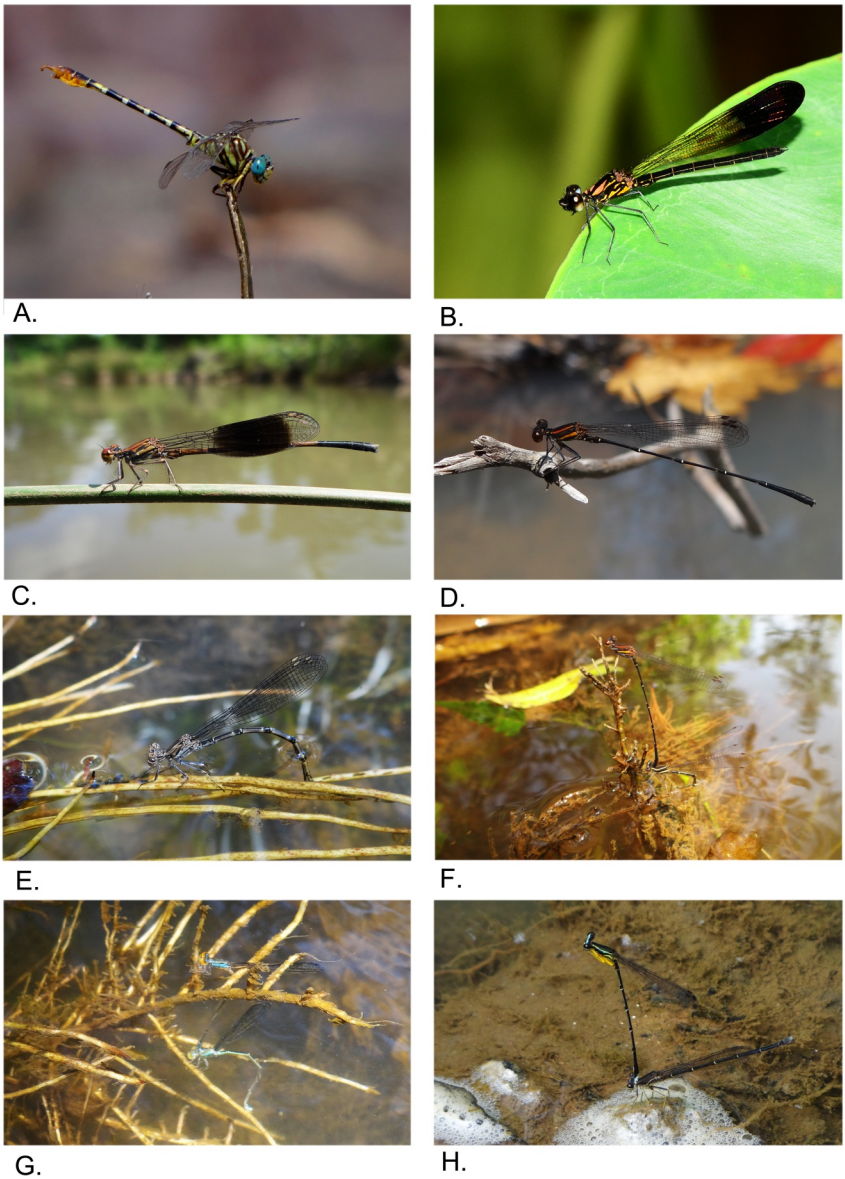

Figure 10. A. *Paragomphus lineatus*, species that had most number of larva collected during the study. B. *Heliocypha bisignata*; C. *Disparoneura quadrimaculata*; D. *Prodascineura verticilis*; E. *Disparoneura quadrimaculata* laying eggs within plant roots in forest stream; F. *Prodascineura verticlis* laying eggs; G. *Pseudagrion rubriceps* mating pair laying eggs under water; H. *Copera marginipes* laying eggs.

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