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Odonates of Zilpi Lake of Nagpur (India) with a note on the emergence of the libellulid dragonfly, *Trithemis pallidinervis*

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ABSTRACT

Zilpi lake is a small water-body, formed by the construction of an earth fill dam in 1974 under the irrigation project of the Govt. of Maharashtra. The maximum live storage capacity of the dam is 1.51 MCM. It lies 25 km west of Nagpur city and is today a well known spot for scenic beauty and aquatic birds. A survey of dragonfly fauna of this lake was undertaken during the post monsoon period of 2012. A total of 34 odonate species belonging to the family-Coenagrionidae (7), Lestidae (1), Aeshnidae (3), Gomphidae (1) and Libellulidae (22) were found breeding in this lake. Except the libellulids *Diplacodes nebulosa* (Fabricius, 1793) and *Rhodothemis rufa* (Rambur, 1842), all other species are commonly found in the water bodies of central India.

The libellulid *Trithemis pallidinervis* (Kirby, 1889) abundantly breeds in this lake. Study of the emergence pattern of *T. pallidinervis* demonstrates that there is a direct correlation between choice of direction of the larva for emergence and the presence of emergent support and geographic condition of the water edge. 94% of the larvae of *T. pallidinervis* prefer the erect dried twigs of *Cassia tora* (Caesalpiniaceae) to emerge. Maximum larvae (61%) preferred the west side of the lake for emergence because of the gradual sloping edge and large cluster of emergent support. The sex ratio is male biased (53.5% male, 46.5% female) and there was no correlation between the sex of the emerging larva and choice of direction.

Key Words: Odonata, *Trithemis pallidinervis*, dragonfly, emergence, Zilpi lake, Nagpur, India.

INTRODUCTION

A perusal of literature shows that before 1955, the dragonfly fauna of central India was represented by only 28 species (Fraser, 1932, 33, 36). Later Mitra (1988) and Andrew (1995) added 24 species bringing the regional total to 51 species. Most of these collections were undertaken in the rural and forest areas of central India. Andrew &Tembhare (1997) recorded 43 species and sub-species of Odonata near the three major ponds (Ambazari, Telenkhedi and Gorewada) of Nagpur city. In the last decade Andrew and co workers have documented the odonate fauna from various small and large waterbodies in Nagpur city (Andrew *et al.* 2010-13, Tiple *et al.* 2008). Most of the water bodies in Nagpur are more than a century old with a stable invertebrate fauna. For the conservation strategy of any group of animal, the basic resource needed for planning is an up to date inventory of the biodiversity of that group specifying the occurrence and relative abundance of the species in each biotope and when possible, gathering information on the status of the species (Schmidt, 1995). An autecological investigation of this kind is a prerequisite to effective planning of conservation (Corbet, 1999).

At the completion of its aquatic larval stages, an odonate larva leaves the water, clamps upon some suitable surface and the winged adult emerges from the larval exoskeleton (exuvia). When the adult departs a durable record of emergence remains, in the form of the final-instar exuviae which can be identified at species level. Thus as Corbet (1962) has ably demonstrated that regular collections of final-instar exuviae can provide information on the duration of the emergence period, the numbers and

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species of dragonflies and damselflies emerging, and the sex ratios for the population (Winstanley, 1981). Collection and documentation of the exuviae is one of the best methods to monitor odonate populations, before any bias by dispersal or differential adult mortality appears (Michiels & Dhondt, 1989; Aoki, 1999; Purse & Thompson, 2003). This method has been adopted not only to predict larval densities and life history information of endangered species (Foster & Soluk, 2004) but also to predict the emergence of dragonflies in a changing climate. Doi (2008) reported a corresponding delay in emergence of the dragonfly *Orthetrum albistylum speciosum* with global warming. Except the work of Andrew (2010, 12) and Andrew & Patankar (2012) on the final metamorphosis of *Pantala flavescens*, no major attempts have been undertaken to study the phenomena of final emergence of dragonfly in India. The present work was undertaken to document the odonate diversity at Zilpi lake in central India and also to record the emergence pattern of the libellulid dragonfly *Trithemis pallidinervis.*

MATERIAL AND METHODS

Site

Zilpi lake has been officially designated as Zilpi Dam Irrigation Project– "Zilpi Dam, D - 04419 ". It was constructed as a part of irrigation projects by Government of Maharashtra in the year 1974. It is an earth-fill dam built on a local drain/ravine. Length of the dam is 409 m (11341.86 ft), while its height above lowest foundation is 18.85 m (62.1719 feet). The dam's catchment area is not known but the Maximum/ Gross storage capacity is 1.559 MCM while the live storage capacity is 1.51 MCM. This area lies at the southern fringe of Satpuda mountain range (21o 10'N 79^0 12' E) and is an undulating plateau with altitude ranging from 274 to 305 m above mean sea level. The diurnal temperature varies from10^0 C in Dec-Jan (winter) to a maximum of 46^0 C in May/ June (summer). The normal rainfall varies from 100-200 cm which precipitates mostly during monsoon from June to September (Figs.1-5). To study the odonate biodiversity of Zilpi Lake, the dragonfly were photographed in their natural habitat, some individuals were collected and photographed under high magnification to substantiate their classification. Standard taxanomic literatures were refereed to confirm their identity (Fraser, 1933, 34, 36; Andrew *et al*. 2008; Subramanian, 2009a, b).

Trithemis pallidinervis: It is a medium size libellulid, normally found in grasslands and open marshes. It likes to perch high on grass blade with wing slightly pointing up. The male and female have similar marking. However, the face of male is metallic purple but is rather yellow white in female. It breeds only in stagnant water and usually in marshy zones. It has very long spidery legs and is found perched on the top of tall reeds and emerging plants elevating itself by its characteristic long spidery legs (Fraser, 1936). A survey was undertaken in the first and third week of November 2012 to study the emergence pattern of *T. pallidinervis.* The exuvia of the ultimate instar nymph of *T. pallidinervis* were recorded with respect to position of the exuvia, height from the water surface and sex.

OBSERVATION

At Zilpi lake, a total of 34 odonate species belonging to 24 genera representing 5 families- Coenagrionidae (7), Lestidae (1), Aeshnidae (3), Gomphidae (1) and Libellulidae (22) was found breeding in this lake (Figs. 6-11,Table 1).

A total of 343 exuviae, comprising of 184 males and 165 females was collected from the lake. The dried emerging twigs of *Cassia tora* (Caesalpiniaceae) are the most perfect supporting base for the emerging larva and 323 (94%) larvae were collecting from the twigs of this plant. The collection of exuviae from different directions of the lake is illustrated in Table 2. Maximum number of exuviae were collected from the west (209) followed by south (93) while only 24 and 17 exuviae were collected from the east and north side of the lake, respectively. Table 2 also illustrates the number of male and female exuvia collected from the various directions of the lake. The sex ratio is male biased (53.5% male, 46.5% female) and Chi square test indicates that there was no significant correlation between the sex of the emerging larva and choice of direction. The larva almost climbs to the terminal tip of the dried twigs of *Cassia tora* before initiating the process of moulting. The tenacity of the larva to reach a higher distance can be gauged by the presence of two exuviae at the same height positioned one above the other (Figs. 12-18). The distance between the water level and the exuviae collected from various directions of the lake is illustrated in Table 3. Maximum numbers of exuviae 37% and 28% were collected at a height between 45-60 cm and above 60 cm, respectively and 5% and

Fig. 1. Satellite view of Zilpi Lake near Nagpur city (Note the Dam is constructed at the eastern border of the lake)

Table 1. The list of Odonata found breeding in Zilpi Lake.

S.No	Species
	Sub Order- ZYGOPTERA
	Family: Coenagrionidae
1	*Agriocnemis femina* (Brauer, 1868)
2	*Agriocnemis pygmaea* (Rambur, 1842)
3	*Ceriagrion coromandelianum* (Fabricius, 1798)
4	*Ischnura aurora* (Brauer, 1865)
5	*Ischnura senegalensis* (Rambur, 1842)
6	*Pseudagrion rubriceps* (Selys, 1876b)
7	*Rhodischnura nursei* (Morton,1907)
	Family: Lestidae
8	*Lestes umbrinus* Selys,1891
	Sub Order- ANISOPTERA
	Family: Aeshnidae
9	*Anax guttatus* (Burmeister, 1839)
10	*Anax immaculifrons* (Rambur, 1842)
11	*Hemianax ephippiger* (Burmeister, 1839)
	Family: Gomphidae
12	*Ictinogomphus rapax* (Rambur, 1842)
	Family: Libellulidae
13	*Acisoma panorpoides* Rambur, 1842
14	*Brachydiplax sobrina* (Rambur, 1842)
15	*Brachythemis contaminata* (Fabricius,1793)
16	*Bradinopyga geminata* (Rambur, 1842)
17	*Crocothemis servilia* (Drury, 1770)
18	*Diplacodes trivialis* (Rambur,1842)
19	*Diplacodes nebulosa* (Fabricius, 1793)
20	*Neurothemis tullia* (Drury, 1773)
21	*Orthetrum sabina sabina* (Drury, 1770)

Table 1. contd.....

S.No	Species
22	*Orthetrum glaucum* (Brauer, 1865)
23	*Orthetrum pruinosum neglectum* (Rambur, 1842)
24	*Pantala flavescens* (Fabricius, 1798)
25	*Potamarcha congener* (Rambur, 1842)
26	*Rhodothemis rufa* (Rambur, 1842)
27	*Rhyothemis variegata* (Linnaeus, 1763)
28	*Tholymis tillarga* (Fabricius, 1798)
29	*Tramea basilaris burmeisteri* (Kirby,1889)
30	*Tramea limbata* (Rambur,1842)
31	*Trithemis aurora* (Burmeister, 1839)
32	*Trithemis festiva* (Rambur, 1842)
33	*Trithemis pallidinervis* (Kirby, 1889)
34	*Zyxomma petiolatum* (Rambur, 1842)

Table 2. Collection of male and female *Trithemis pallidinervis* exuviae from the four directions of Zilpi lake

Direction	Number of exuviae	Sex	
		Male	Female
East	24 (07%)	10	14
West	209 (61%)	112	97
North	17 (05%)	7	10
South	93 (27%)	55	38
Total	**343**	**184 (53.5%)**	**165 (46.5%)**

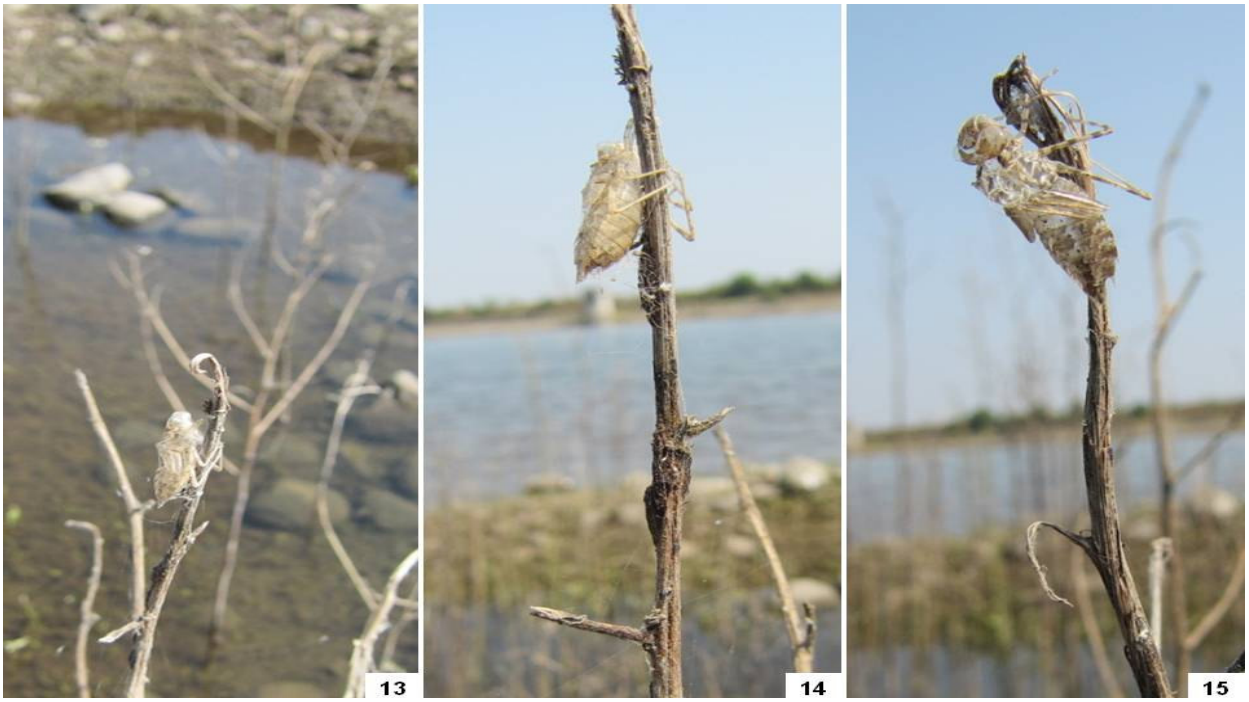
Table 3. The collection of exuviae from different heights (from water surface) of the dried twigs of *Cassia tora* plant

	Height of the exuviae from the water surface					
Direction	**1-15 cm**	**15-30 cm**	**30-45 cm**	**45-60 cm**	**>60 cm**	**Total**
East	2 (8%)	3 (13%)	8 (33%)	6 (25%)	5 (21%)	24
West	8 (4%)	24 (12%)	28 (13%)	96 (46%)	53 (25%)	209
North	3 (18%)	2 (12%)	5 (29%)	3 (18%)	4 (23%)	17
South	4 (4%)	13 (14%)	22 (24%)	21 (23%)	33 (35%)	93
Total (%)	17 (5%)	42 (12%)	63 (18%)	126 (37%)	95 (28%)	343

Figs. 2-5. Zilpi lake. View from South east (fig.2), the south bank (fig. 3), view from the south bank (fig. 4), the west bank with clumps of *Cassia tora* (fig. 5)

Figs. 6-11. Some odonates of Zilpi lake. ***Pseudagrion rubriceps*** **(fig.6 & 7),** ***Orthetrum sabina sabina*** **(fig. 8),** ***Trithemis aurora*** **(fig. 9),** ***Brachythemis contaminata*** **(fig. 10),** ***Trithemis pallidinervis*** **(fig. 11)**

Fig. 12. Clumps of *Cassia tora* along the edge of Zilpi lake



Figs. 13-15. Exuvia of *Trithemis pallidinervis* on the twig tips of *Cassia tora*

Figs. 16-18. Exuvia of *Trithemis pallidinervis* on the twig of *Cassia tora* (note the thick clumping of dried *Cassia tora* and the overlapping of exuvia in Fig. 17)

12% were collected from a height between 1-15 cm and 15-30 cm, respectively.

DISCUSSION

Except the libellulids *Diplacodes nebulosa* (Fabricius, 1793) and *Rhodothemis rufa* (Rambur, 1842), all other species breeding at Zilpi lake are commonly found in most of the water bodies of central India (Andrew *et al.* 2010-13, Tiple *et al.* 2008). In central India, the dragonfly fauna is mostly dominated by the Libellulidae and Coenagrionidae and in Zilpi lake too, the libellulids and coenagrionids account to 65% and 21 % of the odonate fauna, respectively. Lestidae and Gomphidae account for only 3% and Aeshnidae for 10% of the odonate fauna. Although members of other families (Macromiidae Lestidae Platycenemididae and Protoneuridae) and one member of family: Chlorocyphidae [*Libellago lineata indica* (Fraser)], are reported in other water bodies of central India, they could not be found in Zilpi lake probably because of its recent origin and small size (Tiple *et al*. 2008).

The height climbed by the larva for final metamorphosis presumably reflects the preference of the species. Biswas *et al.* (1994) reported that the height climbed by five libellulid species, under laboratory conditions, were: *Brachythemis contaminata* 25.4 – 27.94 cm, *Tholymis tillarga* 9.14-19.81 cm, *Crocothemis servilia servilia* 4.31-17.52 cm, *Diplacodes trivialis* 11.43-15.74 cm and *Orthetrum pruinosum pruinosum* 8.38-12.95 cm. Andrew (2012) found that in *P. flavescens* it is difficult to standardize the height climbed by the larva since it shows a great variation from 1 cm to more than 45 cm. Zilpi lake is fringed with clumps of *Cassia tora* shrubs. Dried emerging branches of this shrubs form a perfect emergent support for the larva. This plant contains phenols in large quantity. The Xylem and sclerenchyma are well developed in the stems which keep it stiff and straight even after the death of the plants. Maximum (94%) larvae were collected from the twigs of this plant. In *T. pallidinervis* the height climbed by the larva varies, but 65% climb above 45 cm to undergo final metamorphosis indicating that it is one of the highest climbers among all anisopteran dragonflies. This probably has to do with its typical habit of perching high on the terminal tip of shrubs. Maximum larvae (61%) preferred the west side of the lake for emergence probably because of the gradual sloping edge and large clusters of emergent support although ultraviolet rays and temperature gradient are also the known cues to orient the larva to the surface or edge of water (Corbet, 1962; Lavoie-Dornik & Pilon, 1987). Andrew (2011) described the emergence pattern of *Pantala flavescens* and found that sunlight and temperature not only determine the choice of direction of the emerging larva but also initiates an early commencement of Stage I of metamorphosis. The present observation suggests that geographic condition of the edge/bank of the water body and presence of effectual emergent structures are two more features to promote the larva to choose the direction for final metamorphosis. Biased sex ratio during emergence is not uncommon in dragonflies. In most of the cases during emergence, zygopteran males usually outnumbered females while the reverse is true for Anisoptera (Purse & Thompson, 2003). Although Crowley & Johansson (2002) postulated that the sex ratio should be more male-biased in non-territorial dragonflies but *T. pallidinervis* which is a territorial dragonfly also exhibits a male biased ratio during emergence.

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