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## Taxonomic and Diversity Studies on Odonate Nymphs by Using Their Exuviae

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### ABSTRACT

Taxonomic and diversity studies of odonate nymphs are conducted by collecting them from breeding places or by rearing them in the laboratory which is time consuming and affects the natural population of nymphs and adults. The present study attempts to examine the characters of odonate nymphs by using their exuviae (the larval skin of the last instar) having all the larval characters. These taxonomic characters can also be used to identify the odonate nymphs up to species level and throw of light on the species diversity of a habitat without affecting the live specimens of odonates (nymphs and adults). Five species belonging to three families were identified by comparing the larval characters present on exuviae, collected from a temporary pond at Ammadam, Thrissur district, Kerala state, India.

**Keywords:** Odonata, Anisoptera, Exuvia

### 1. Introduction

Odonates have aquatic and (larval) and terrestrial (adult) stages, in most surveys the adults are being used to study the conservation status <sup>[4]</sup>. This was mainly due to the relative ease of monitoring adult dragonflies by field observations, compared with collecting and identifying exuviae <sup>[6]</sup>.

The odonate nymphs are almost entirely aquatic in habitat, and living among macro vegetation and littoral sediments, and burrowing into surficial sediments. They are strictly predacious, using their modified extensible labium or mask to capture insects, crustaceans, molluscans or oligochaete. Being primarily aquatic, their life history is closely linked to specific aquatic habitats <sup>[1]</sup>. Both adults and larvae undoubtedly prey extensively on mosquitoes, and it has already been established this can affect the incidence of arthropod-borne diseases in human populations. Moreover they are biocontrol agents; many species of odonates inhabiting agro ecosystems play a crucial role in controlling pest populations (Tiple *et al.* 2008).

Corbet and Hoess <sup>[3]</sup> commented on the desirability of undertaking standardised exuviae collections, noting that exuviae normally remain on emergence supports for several days and, especially in Anisoptera, are conspicuous and readily identifiable to species, that counts of exuviae give a clearer picture of real dragonfly abundance than do male biased counts, and that numbers emerging from a small or medium sized water body can usually be monitored by a single researcher. Exuviae are nothing more than the dried skin of the last larval instar and are therefore vulnerable. At the end of the larval life the larvae find a support such as a rock or plant stems, where it can tear up its skin.

After splitting the skin the adult emerge from the skin and expand its wings and abdomen. Exuviae can be seen on plant stems or on rock that present near the water bodies such as ponds, streams and riparian vegetation, and usually they are found just above the surface to about 50cm high. In some cases they may go further; even several meters far.

ISSN 2320-7078

JEZS 2013;1 (4): 47-53

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Received: 14-07-2013

Accepted: 21-07-2013

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## 2. Materials and Methods

Exuviae were collected from a temporary pond (10°27'50.526" N and 76° 11'31.455"E ) which is close to a paddy field in Ammadam, a small village , 8 kms away from Thrissur town. A total of 57 exuviae were collected during the monsoon months (June-August, 2012) from the study site by hand picking. Wet specimens (due to monsoon rain) were dried by placing them under a incandescent lamp. The collected specimens were preserved in plastic bottles of the photographic film and brought into the laboratory for analysis. The exuviae were dissected using forceps and needle by observing through the Stereo Dissection Microscope (CZM 4, LABOMED). Larval features present on exuviae were noted. The dissected parts were photographed using the digital

camera (Nikon D 70) and Stereo Research Microscope (Lx 400, LABOMED). The larval features thus observed were compared with relevant studies by Kumar and Sangal [7] and Kumar 1972, 1973, 1984a, 1984b) who described the larval characters of various odonates.

## 3. Results

Five species belonging to 3 families Gomphidae, Aeshnidae and Libellulidae were identified by studying the larval characters that were present in the exuviae of the collected specimens (Table 1). The characters present on exuviae were tabulated. (Table 2).

**Table 1:** List of dragonfly species identified from exuviae with habitat and breeding place

S. No.	Families	Binomial	Habitat	Breeding place	No. of exuviae collected	Perc-entage
1.	Gomphidae	<i>Paragomphus lineatus</i> (Selys, 1850)	SM	SM/P bodies	4	7.02
2.	Aeshnidae	<i>Anax guttatus</i> (Burmeister, 1839)	P and SM	still We H <sub>2</sub> O	17	29.82
3.	Aeshnidae	<i>Anax immaculifrons</i> (Rambur, 1842)	M and SM	R, S still We H <sub>2</sub> O	20	35.09
4.	Libellulidae	<i>Pantala flavescens</i> (Fabricius, 1798)	P and SM	We, Ma and Sh H <sub>2</sub> O	10	17.54
5.	Libellulidae	<i>Trithemis aurora</i> (Burmeister, 1839)	P and SM,	sluggish S and IC	6	10.53
Total		-	-	-	57	100.00

SM: Sub Montane; P: Plain; M: Montane; We: Weedy; H<sub>2</sub>O: Water; S: Streams; R: Rivers; IC: Irrigation Channels; Ma: Marsh; Sh: Shallow

**Table 2:** Nymphal characters Observed in Collected Exuviae

No.	Morphological Characters	<i>Paragomphus lineatus</i>	<i>Anax guttatus</i>	<i>Anax immaculifrons</i>	<i>Pantala flavescens</i>	<i>Trithemis aurora</i>
1.	Length mm	23	41	52	23	15
2.	Width mm	5	7	10	7	6
3.	Colour	Greyish-brown	Light brown	Light brown	Pale yellowish with black markings	Yellowish greyish spots dorsally
4.	Head	Large number of setae present on scape .	Large	Large	Large	Small
5.	Antenna	4 segmented	7 segmented	7 segmented	7 segmented	7 segmented
6.	Labium	Trapezoidal, Spiniform setae present on either side of prementum. Distal margin bears setae.	Large, pear shaped. Extending to the coxae of mid pair of legs. Prementum convex. Distal margin bears setae and a cleft	Large, spoon shaped, Extending to the coxae of hind pair of legs. Prementum convex. Distal margin bears setae and a cleft	Enormous. No cleft present	Small. No cleft present
7.	Palpal Setae	absent	absent	absent	13+13	7+7
8.	Pre mental setae	absent	absent	absent	17+17	10+10
9.	Crenations	absent	absent	absent	Large crescentric	present

10	Wing pads	Extends to end of 6*	Extends to 4*	Extends to middle of 4*	Extends to 5*	Extends to middle of 6*
11	Abdomen	Convex dorsally, Elongated	Robust, Convex dorsally, Possess a dark stripe	Robust, Convex dorsally Possess a dark spots	No stripe	Dark dots present
12	Mid dorsal spines/hooks	Protuberances on 2 to 9*	absent	absent	absent	3 to 9*
13	Lateral spines	Present from 3 to 9*	Present from 6 to 9*	Present from 7 to 9*	Present from 8 to 9*	Present from 8 to 9*
14	Epiproct	-	Present	Present	Larger than paraproct	Shorter than paraproct
15	Paraproct	-	Present	Present	Present	1-
16	Legs	Short, strong, with setae	Long, slender	Robust and strong	Tarsal segments of Mid and hind pairs are black	Long and slender
17	Caudal gills	Present with setae	absent	absent	-	absent

#### 4. Discussion

The nymph of *Paragomphus lineatus* (Family: Gomphidae) has been described by Kumar <sup>[9]</sup> as *Mesegomphus lineatus*. In his description, the larvae possess a large number of setae on scape, pedicel and proximal segment of antenna; spiniform setae on either side of prementum just below insertion of palpus. The inner margin of palpus is slightly serrated. The wing sheaths are strongly divergent; legs short and beset with setae; small lateral spines were present on 3<sup>rd</sup> to 9<sup>th</sup> abdominal segments. Four of the collected exuviae exhibited all the larval characters. The Gomphid characters observed were a slightly convex (Fig.1E) and trapezoidal labium (Fig.1D); absence of premental and palpal setae. The lateral spines were clearly seen on abdominal segments 3-9 (Fig.1C). The legs were short and robust (Fig.1A). From these observed characters, the exuviae were identified as that of *Paragomphus lineatus*.

The larvae of *Anax guttaus* (Family: Aeshnidae) has been described by Kumar and Sangal <sup>[7]</sup>. According to their description, the larvae possess a dark mid dorsal stripe on abdomen and paler lateral areas. Labium reaches upto the coxae of middle pairs of legs, the thorax is well built and hind wing bud reaches the anterior end of 4<sup>th</sup> abdominal segment. Strong and robust abdomen bears lateral spines on segments 6 to 9. Among the collected exuviae, 17 possess all the above described characters such as a dark mid dorsal stripe on abdomen and paler lateral areas (Fig. 2A). Labium reaching upto the coxae of middle pairs of legs (Fig. 2B). Prementum is convex with a distinct cleft and small setae on the distal margin Strong and robust abdomen bears lateral spines on segments 6 to 9 (Fig. 2C). From these characters the exuvia was identified as that of *Anax guttaus*.

The larvae of *Anax immaculifrons* (Family: Aeshnidae) was described by Kumar <sup>[11]</sup>. In his description the last instar possess a darker mid dorsal and paler areas on abdomen. The labium reaches upto the upper half of the coxae of hind pair of legs. It is widest distally and more or less spoon shaped. Wing buds are parallel to abdomen and the hind pair reaches the posterior half of the 4<sup>th</sup> abdominal segment. Abdomen is very robust, convex dorsally with three rows of cloudy spots and lateral spines on segments 7 to 9. Twenty of the collected exuviae, were exceptionally large with its spoon shaped labium reaching upto the upper half of the coxae of hind pair of legs (Fig.2E). Prementum is convex with distinct cleft and small setae on the distal margin. Abdomen is very robust, convex dorsally with lateral spines on segments 7 to 9 (Fig.2F). These characters indicate that the exuviae belongs to *Anax*

*immaculifrons*.

The larvae of *Pantala flavescens* (Family: Libellulidae) was described by Kumar <sup>[10]</sup>. In his description, the labium is enormous and premental setae are 17+17, and palpal setae are 13+13 in numbers. The distal margins of the labium possess large crescentic crenations. The epiproct is distinctly larger than the paraprocts. In the collected exuviae, ten exuviae possess enormous labium (Fig.3C) with the premental setae 17+17 and palpal setae 13+13. The crenations on the labium is also found on the exuviae (Fig. 3B) and by observing abdomen it has been found that the epiproct is longer than paraproct (Fig. 3F). These characters helped to conform the exuvia as that of *Pantala flavescens*.

The nymph of *Trithemis aurora* (Family: Libellulidae) was studied by Kumar <sup>[9]</sup>. In his description the larvae possess 10+10 premental setae and 7+7 palpal setae. Abdomen bears mid dorsal hook which help the larvae to cling to substratum. Anal appendages are small and hairy. The epiproct is shorter than paraprocts. In six of the collected exuviae the prementum possess 10+10 (Fig.4B) setae, 7+7 palpal setae, the distal margin of labium possess crenations (Fig.4C), which matched with known larval characters. The mid-dorsal hooks on the larva can be clearly seen on the abdomen of exuviae (Fig. 4D), which is also an identification character. Thus the exuvia is identified as that of *Trithemis aurora*.

As noted by Moore and Corbet (1990), the best method for monitoring odonate populations, particularly Anisoptera, at a specific wetland is to undertake regular counts of exuviae, and such counts should ideally be conducted daily, failing this at a minimum of once per week throughout the emergence period. This is because exuviae provide irrefutable proof of successful breeding, and exuviae counts give a measure of the dragonfly production of particular wetlands <sup>[6]</sup>. Exuvial collections provide a reliable estimate of larval population density, help link larval ecology to adult ecology and are a useful tool for assessing habitat suitability <sup>[5]</sup>.

Estimates of larval population density using exuvial data were similar to those obtained through intensive direct sampling for larvae. Odonate diversity monitoring would benefit from applying the best survey method using exuviae to avoid wasting valuable financial resources while providing unbiased data, necessary to achieve conservation objectives.

But, the study of the biology dragonfly nymphs is time consuming since the larval period of odonates ranges normally from one month to one year and exceptionally six to ten years. The rearing of

nymphs in laboratory condition is not easy. Even though Kerala State is very rich in the diversity of Odoantes, 137 species of Dragonflies and Damselflies with good number of endemics,

(Emiliyama, 2003) no research has been done on the nymphs of odonate, maybe due to the above reasons. Hence, this study is pioneering in this field.

***Paragomphus lineatus***



Fig. 1 A DORSAL VIEW



Fig. 1 B VENTRAL VIEW

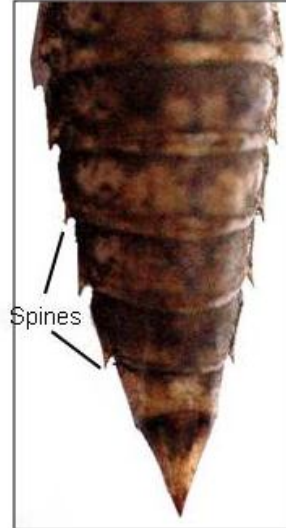


Fig. 1 C ABDOMEN



Fig. 1 D TRAPEZOIDAL LABIUM



Fig. 1 E LABIUM (DORSAL VIEW)

***Anax guttatus***



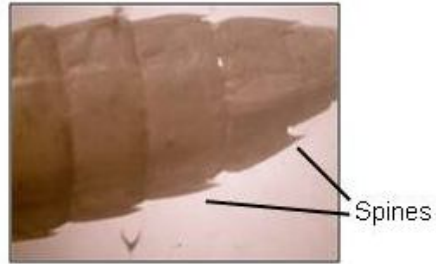
Mid Dorsal  
Stripe

**Fig. 2 A DORSAL VIEW**



Labium extending  
to base of middle  
pair of legs

**Fig. 2 B LABIUM**



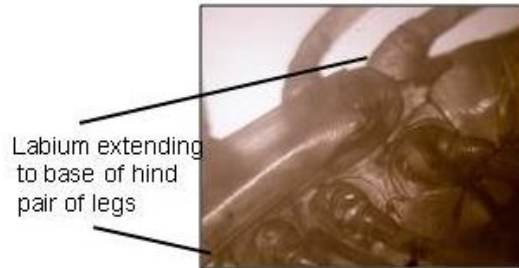
Spines

**Fig. 2 C ABDOMEN**

***Anax immaculifrons***

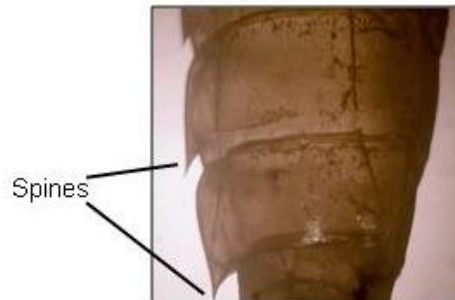


**Fig. 2 D DORSAL VIEW**



Labium extending  
to base of hind  
pair of legs

**Fig. 2 E LABIUM**



Spines

**Fig. 2 F ABDOMEN**

### *Trithemis aurora*



Fig. 4 A DORSAL VIEW



Fig. 4 B PREMENTAL SETAE

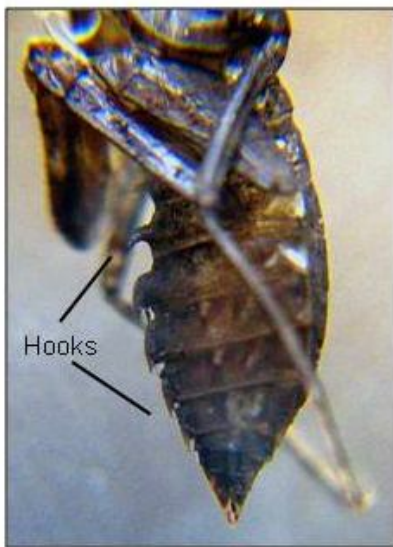


Fig. 4 C ABDOMEN

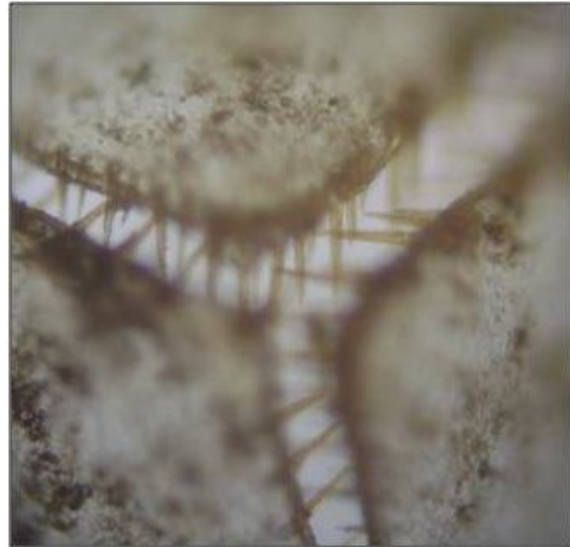


Fig. 4 D CRENATIONS

#### 5. Conclusion

Studying nymphs collected either from the field or reared in laboratories has a major drawback. Identification of the instar may not be possible because the larvae may not have all species specific characters. Study of exuviae is a taxonomic tool for the nymph identification, which overcomes such difficulties. In the present study, five species of Dragonflies, such as *Paragomphus lineatus*, *Anax guttatus*, *Anax immaculifrons*, *Pantala flavescens*, and *Trithemis aurora* were identified by comparing the nymphal characters present on the exuviae collected from the study site. Destruction of live odonates was completely avoided. This work has opened up the way for dragonfly nymph studies in Kerala by

using their exuviae. We found this taxonomic tool effective and suggest implementation of such indirect non-destructive methods for biodiversity studies without damaging the existing biodiversity.

#### 6. Acknowledgements:

Authors thank to Dr. P.O.Jenson, Principal, St.Thomas' College, Thrissur for providing the facilities. The authors also thank to Dr. Joyce Jose, Assistant Professor, Research & Postgraduate Department of Zoology, St.Thomas' College, Thrissur for her assistance in compiling the photographs and editing.

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