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THE LARVAL STAGES OF *UROTHEMIS ASSIGNATA* (SELYS) (ANISOPTERA: *LIBELLULIDAE*)

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The larval stages have been reared in the laboratory from eggs to adults. *U. assignata* has 13 larval instars and larval development averaged 124.4 days. Each instar has been studied and described, with emphasis on the principal characters of the external morphology which distinguish the various instars (antennary segments, size of the compound eyes, setal arrangement on the prementum and palpus, wing sheath, tarsal segments etc.). The phenology of the species is also described.

INTRODUCTION

There is paucity of information on the larval stages of the dragonflies of Nigeria, the only works being those of GAMBLES (1963) on a number of species and GAMBLES & GARDNER (1960) on *Lestinogomphus africanus* (Fraser). The author has started a study of the larval stages of the common libellulids in the Ibadan area of Nigeria (HASSAN, 1974, 1977). This paper deals with the larval stages of *Urothemis assignata* (Selys), one of our commonest libellulid species.

The adults are pond inhabitants which fly all the year round in the humid tropics, their population reaching a peak in the dry season, October-March (HASSAN, 1974). They also oviposit all the year round, in tandem, usually in areas where *Pistia stratiotes* abounds. PINHEY (1961) described the Ethiopian distribution of the species as stretching from Natal (S. Africa) to East and West Africa and Malagasy. The larvae are perchers and very agile. They live amongst submergent and emergent plants (*P. stratiotes, Utricularia* spp., *Azolla pinnata* v. *africana*, etc.), usually mixed up with larval populations of *Acisoma panor-*

poides inflatum Selys, *Orthetrum trinacria* (Selys), *Crocothemis erythraea* (Brullé) and *Aethriamantha rezia* Kirby. The larval population is most abundant between April-June and October-February. Emergence occurs all the year round, with peaks in October-March.

MATERIAL AND METHOD

Eggs were obtained in the field, from females that had just mated or when oviposition had just started. The eggs were incubated at air room temperature (26.8°-32.1°, $\bar{x}$ 29.6°C in a crystallizing dish (300 cm^3, 10.0 cm diameter). The larvae were also reared at the same temperature. When hatching started, larvae were separated individually into crystallizing dishes after the total length of the body (from the anterior end of the labial mask to the posterior end of the paraprocts) and the (mesothoracic) width had been measured. Measurements were made with a calliper. Microscopic measurements of the antennae and the labium were done with an ocular micrometer, calibrated against a stage micrometer. The length of the labium was the distance between the distal end of the palpus and the posterior end of the prementum while the widest part of the mask was regarded as the width.

Individual advanced larvae were transferred into separate chambers of a breeding tank. This breeding tank, made of perspex, has been described elsewhere (HASSAN, 1977). The chambers were aerated thrice weekly and each chamber was provided with a strand of *Commelina* sp. or *P. stratiotes* to provide support and hold for the larvae during emergence.

Seventy 2nd instar larvae that emerged from eggs in the laboratory and 49 larvae of various instars collected in the field, formed the basis of this study. Second to 5th instars were fed on infusoria, copepods (mostly *Cyclops* spp.) and daphnia (*Ceriodaphnia* spp.) while instars 6 to 12 were fed chiefly on ephemeropteran larvae (*Baetidae*). This meal was often alternated with *Cypris* sp. (ostracod). The final instar was fed largely on fish fry (*Tilapia* spp. and *Hemichromis* sp.) and ephemeropteran larvae.

BREEDING RECORD

Hatching did not follow any well-defined periodicity, though it occurred mostly during daytime (08.30-18.00 hours). The pro-larval stage was ephemeral and lasted between 48 to 162 seconds, average 67 seconds (125 specimens). The mean data obtained on the number and duration of the larval instars and the length and width of the various instars are shown in Table I. There were 13 instars, no intercalation of instars was observed. The duration of larval development averaged 124.4 days. The key stages of the larvae are illustrated by the 2nd instar (Fig. 2), 5th instar (Fig. 4), 8th instar (Fig. 8), 11th instar (Fig. 11) and

the 13th (ultimate) instar (Fig. 14). The larval characters are summarised in Table II, the antennary morphometrics in Table III and the labium morphometrics in Table IV.

Mortality was high during breeding, only one of the seventy larvae reared from egg reached the final instar. Mortality was highest between 2nd and 4th instar. It was also high during emergence, 9 larvae died out of 22 individuals that attempted emergence. Field observations suggest that this is likely the trend in nature.

Table I

Life history record (mean, with standard deviation) of *Urothemis assignata*

Instar	Number* of larvae bred	Length (*mm*)	Width (*mm*)	Duration (*days*)
2	72 (2)	0.95 ± 0.06	0.20 ± 0.02	3.9 ± 0.6
3	50 (6)	1.30 ± 0.07	0.33 ± 0.04	4.9 ± 1.7
4	38 (14)	1.68 ± 0.16	0.45 ± 0.06	4.7 ± 2.5
5	34 (28)	2.27 ± 0.30	0.59 ± 0.11	5.2 ± 2.5
6	34 (32)	3.05 ± 0.25	0.78 ± 0.10	7.0 ± 2.8
7	41 (39)	4.11 ± 0.47	0.95 ± 0.09	6.8 ± 2.0
8	37 (36)	5.33 ± 0.77	1.15 ± 0.12	5.9 ± 2.9
9	32 (31)	7.05 ± 0.73	1.39 ± 0.18	6.4 ± 2.9
10	26 (25)	9.47 ± 0.70	1.95 ± 0.15	7.5 ± 2.0
11	25 (24)	12.16 ± 0.70	2.38 ± 0.21	10.2 ± 1.4
12	24 (23)	15.63 ± 0.48	3.39 ± 0.23	20.9 ± 6.9
13	23 (22)	20.08 ± 0.85	4.37 ± 0.22	41.0 ± 10.7
Exuvia	13 (13)	21.37 ± 0.84	4.55 ± 0.22	
Duration of larval development				*124.4 days*

* Figures in bracket indicate the number of larvae supplemented from the field.

Table II

Summary of the development of larval character in *Urothemis assignata*

Character	Instar 2	3	4	5	6	7	8	9	10	11	12	13
Antennary segments	3	3	4	4	5	6	7	7	7	7	7	7
Abdominal segments covered by wing sheath	–	–	–	–	–	R	R	½	1¼	2	4	6
Tarsal segments	1	1	1	2	2	3	3	3	3	3	3	3
Anal cerci	–	–	–	–	R	R	+	+	+	+	+	+
Mid-dorsal abdominal spines	–	–	–	–	+	+	+	+	+	+	+	+

(–) absent; (R) rudimentary; (+) present

Table III

Morphometrics (in mm) of the antennae of *Urothemis assignata* instars

Instar	Antennary segments							Total length of antenna
	Scape	Pedicel	Flagellum segments					
			1	*2*	*3*	*4*	*5*	
2	0.038	0.065	0.209					*0.312*
3	0.042	0.083	0.291					*0.416*
4	0.053	0.088	0.161	0.219				*0.521*
5	0.055	0.098	0.197	0.256				*0.606*
6	0.072	0.114	0.140	0.117	0.311			*0.754*
7	0.089	0.123	0.199	0.163	0.203	0.183		*0.960*
8	0.107	0.158	0.161	0.141	0.213	0.224	0.220	*1.244*
9	0.157	0.222	0.228	0.224	0.330	0.352	0.298	*1.811*
10	0.191	0.245	0.291	0.273	0.396	0.401	0.347	*2.144*
11	0.238	0.286	0.432	0.365	0.493	0.515	0.449	*2.778*
12	0.260	0.318	0.492	0.427	0.537	0.540	0.483	*3.057*
13	0.326	0.356	0.669	0.577	0.730	0.716	0.631	*4.005*

THE EGG

The eggs were pale yellow at oviposition, but turned brown within 15 to 18 hours after oviposition. The spherical eggs (Fig. 1) were longer than wide: length 0.496-0.605 mm (mean 0.58 mm), width 0.33-0.38 mm (mean 0.36 mm). The incubation period amounted to 7-10 days, while the total mass of eggs laid by the females ranged from 240 to 451 (30 counts).

LARVAL STAGES

P r o l a r v a. – Length 0.80 mm, cream coloured. Hatching occurs through a longitudinal slit half way down the long side of the egg. Duration: 48-162 seconds (mean 67 seconds). Head out of proportion to body. Antennae 3-segmented, directed posteriorly. Legs adhere to body, also directed posteriorly.

2 n d i n s t a r (Fig. 2). – Duration 2-5 days (3.9 ± 0.6 days). Length 0.85-1.00 mm (0.95 ± 0.06 mm); width 0.20-0.26 mm (0.24 ± 0.02 mm). Head roughly rectangular, length 0.21 mm, width 0.34 mm. Eyes small, each about 1/12 of head width. Antennae colourless, 3-segmented comprising scape, pedicel and one-segmented flagellum. Labium (Fig. 3): median cleft is wanting in the median lobe of prementum, premental setae 0 + 0; palpal setae 2 + 2. Tarsi single segmented. Colour: cream to light brown.

3 r d i n s t a r. – Duration 3-7 days (4.9 ± 1.7 days). Length 1.20-1.40 mm (1.30 ± 0.07 mm); width 0.30-0.40 mm (0.33 ± 0.04 mm). Each eye about 1/10

Table IV

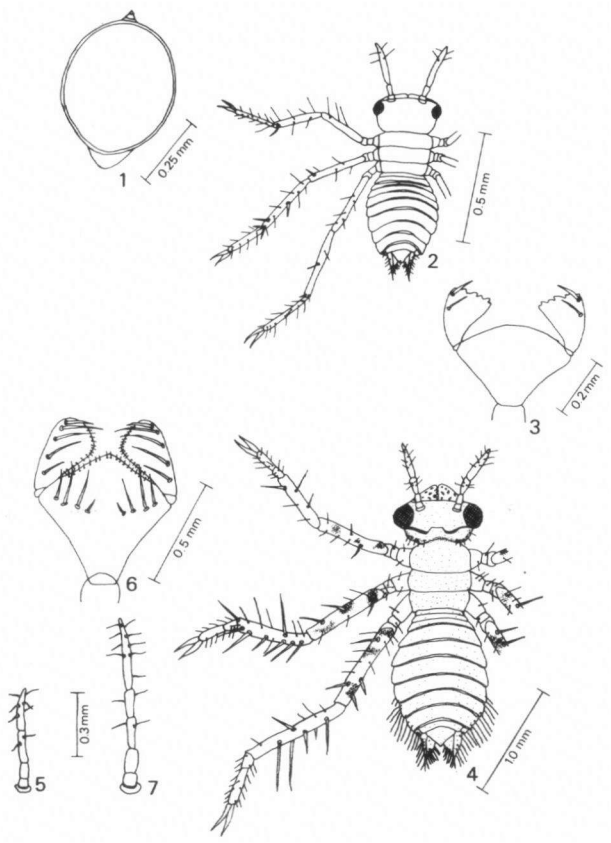
Labium morphometrics of *Urothemis assignata* instars

Instar	Prementum		Number of premental setae	Number of palpal setae*	
	Length (mm)	*Width* (mm)		*Left*	*Right*
2	0.33 ± 0.02	0.31 ± 0.01	0(0+0)	2	2
3	0.53 ± 0.02	0.47 ± 0.01	2(1+1)	2	2
4	0.65 ± 0.02	0.54 ± 0.02	6(3+3)	3(4)	3(4)
5	0.81 ± 0.03	0.67 ± 0.02	8(4+4), 9(5+4), 10(5+5)	5	5
6	1.02 ± 0.07	0.81 ± 0.05	8(4+4), 10(5+5), 11(5+6), 12(6+6)	5	5
7	1.31 ± 0.16	1.02 ± 0.11	11(5+6), 12(6+6), 13(6+7), 14(7+7), 15(8+7)	6(7)	6(7)
8	1.90 ± 0.14	1.40 ± 0.13	14(7+7), 15(8+7), 16(8+8)	7(8)	7(8)
9	2.55 ± 0.20	1.95 ± 0.15	16(8+8), 17(8+9), 18(9+9), 19(9+10)m 20(10+10), 21(10+11), 22(11+11)	9(8)	9(8)
10	3.39 ± 0.14	2.61 ± 0.12	20(10+10), 21(10+11), 22(11+11), 23(11+12)	9(10)	9(10)
11	4.80 ± 0.30	3.47 ± 0.11	22(11+11), 23(12+11), 24(12+12), 25(12+13), 26(13+13), 27(13+14)	10	10
12	5.96 ± 0.23	4.69 ± 0.20	24(12+12), 25(12+13), 26(13+13), 27(13+14), 28(14+14), 28(15+13), 29(15+14)	11(10)	11(10)
13	7.58 ± 0.37	6.02 ± 0.18	26(14+12), 28(14+14), 29(14+15), 30(15+15), 31(15+16), 32(16+16)	11(10)	11(10)

* Figures in brackets were less frequently obtained.

of head width (head width 0.46 mm). Antennae 3-segmented. Labium: premental setae 1 + 1; palpal setae 2 + 2, distal margin of palpus bears claviform setae. Tarsi one-segmented.

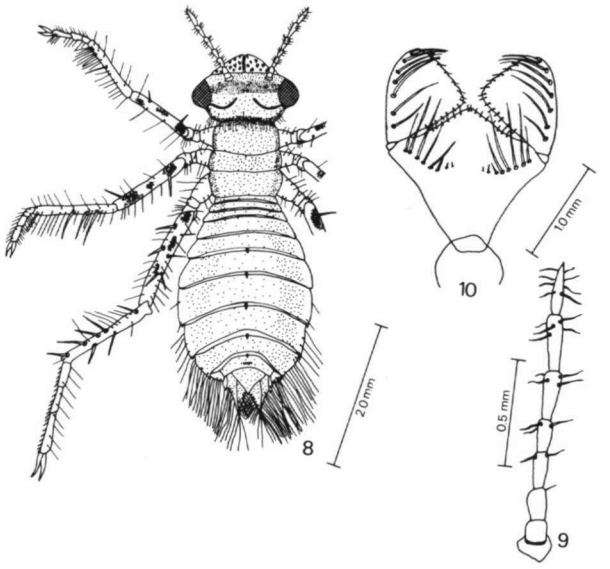
4 t h i n s t a r. – Duration 2-7 days (4.7 ± 2.5 days). Length 1.55-1.90 mm (1.68 ± 0.16 mm); width 0.43-0.55 mm (0.45 ± 0.06 mm). Antennae 4-segmented, flagellum divided into two segments, scape and pedicel now brownish. Labium: premental setae 3 + 3, claviform setae developing on the distal margin of prementum, lateral margins glabrous; palpal setae 3 (4) + 3 (4). Tarsi one-segmented.



Figs. 1-7. *Urothemis assignata* (Sel.), egg and early larval stages: (1) egg; – (2-3) 2nd instar, larva and labium; – (4-6) 5th instar: larva, antenna and labium respectively; – (7) 6th instar, antenna.

5 t h i n s t a r (Fig. 4). – Duration 2-8 days (5.2 ± 2.5 days). Length 1.90-2.50 mm (2.27 ± 0.30 mm); width 0.50-0.70 mm (0.59 ± 0.11 mm). Body now brownish, with dark brown spots on head, labium and the legs. Each eye about 1/10 of head width (head width 0.74 mm). Antennae (Fig. 5) 4-segmented, flagellum segments colourless. Labium (Fig. 6): premental setae variable, 4 + 4, 5 + 4, 5+ 5; palpal setae 5 + 5. Tarsi 2-segmented.

6 t h i n s t a r. – Duration 3-9 days (7.0 ± 2.8 days). Length 2.75-3.20 mm (3.05 ± 25 mm); width 0.65-0.86 mm (0.78 ± 1.10 mm). Antennae (Fig. 7) 5-segmented, the basal segment of flagellum of 5th instar dividing into two unequal segments. Labium: premental setae variable, 4 + 4, 5 + 5, 6 + 6; Palpal setae 5 + 5. Tarsi 2-segmented. Mid-dorsal spines developing on 5th-8th abdominal segments.



Figs. 8-10. *Urothemis assignata* (Sel.), 8th instar: (8) larva; – (9) antenna; – (10) labium.

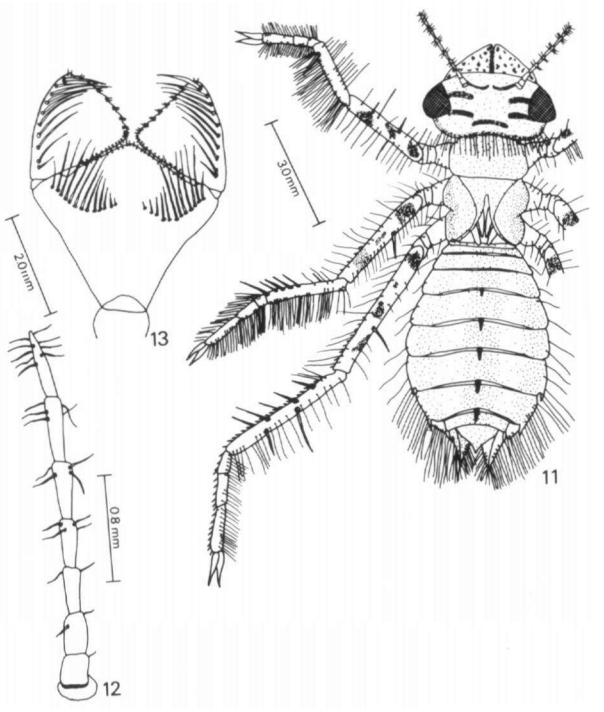
7 t h i n s t a r. – Duration 4-9 days (6.8 ± 2.0 days). Length 3.50-4.60 mm (4.11 ± 0.47 mm); width 0.83-1.00 mm (0.95 ± 0.09 mm). Each eye about 1/10 of head width (head width 1.39 mm). Antennae 6-segmented, the terminal segment of flagellum of 6th instar dividing into two. 3rd flagellum segment black, others colourless. Labium: premental setae variable, 5 + 6, 6 + 6, 6 + 7, 7 + 7, 8 + 7; palpal setae 6 (7) + 6 (7), distal margin of palpus formed into crenations, each bearing a claviform seta. Tarsi now 3-segmented. Mid-dorsal spines on the abdominal segments becoming more prominent. Rudimentary wing sheaths appear.

8 t h i n s t a r (Fig. 8). – Duration 2-8 days (5.9 ± 2.4 days). Length 5.00-7.10 mm (5.33 ± 0.77 mm); width 1.10-1.30 mm (1.15 ± 0.12 mm). Each eye about 1/8 of head width (head width 1.79 mm). Antennae (Fig. 9) 7-segmented, basal segment of flagellum of 7th instar divides. Length of each segment from scape in mm: 0.107, 0.158, 0.161, 0.141, 0.213, 0.224 and 0.220; total length 1.244 mm. Scape and pedicel dark brown, flagellum segments black except the terminal one which is colourless. Labium (Fig. 10): premental setae variable, 7 + 7, 8 + 7, 8 + 8; palpal setae 7 (8) + 7 (8). Mid-dorsal spines distinct on abdominal segments 4-9. Wing sheaths still rudimentary.

9 t h i n s t a r. – Duration 4-9 days (6.4 ± 2.9 days). Length 6.70 ± 8.20 mm (7.05 ± 0.73 mm); width 1.20-1.70 mm (1.39 ± 0.18 mm). Antennae increasing in length, length of each segment from scape in mm: 0.157, 0.222, 0.228, 0.224,

0.330, 0.352 and 0.298; total length 1.811 mm. Labium: premental setae very variable, 8 + 8, 8 + 9, 9 + 9, 9 + 10, 10 + 10, 10 + 11, 11 + 11; palpal setae 9 (8) + 9 (8). Mid-dorsal abdominal spines becoming more prominent. Wing sheaths covering about 1/2 of first abdominal segment.

10th instar. – Duration 5-11 days (7.5 ± 2.0 days). Length 9.00-10.30 mm (9.47 ± 0.70 mm); width 1.60-2.10 mm (1.95 ± 0.15 mm). Antennae 7-segmented, length from scape in mm: 0.191, 0.245, 0.291, 0.273, 0.396, 0.401 and 0.347; total length 2.144 mm. Labium: premental setae variable, 10 + 10, 10 + 11, 11 + 11, 11 + 12; palpal setae 9 (10) + 9 (10), crenations at the distal margin of palpus now bear two claviform setae each. Wing sheaths extending up to anterior quarter of 2nd abdominal segment.



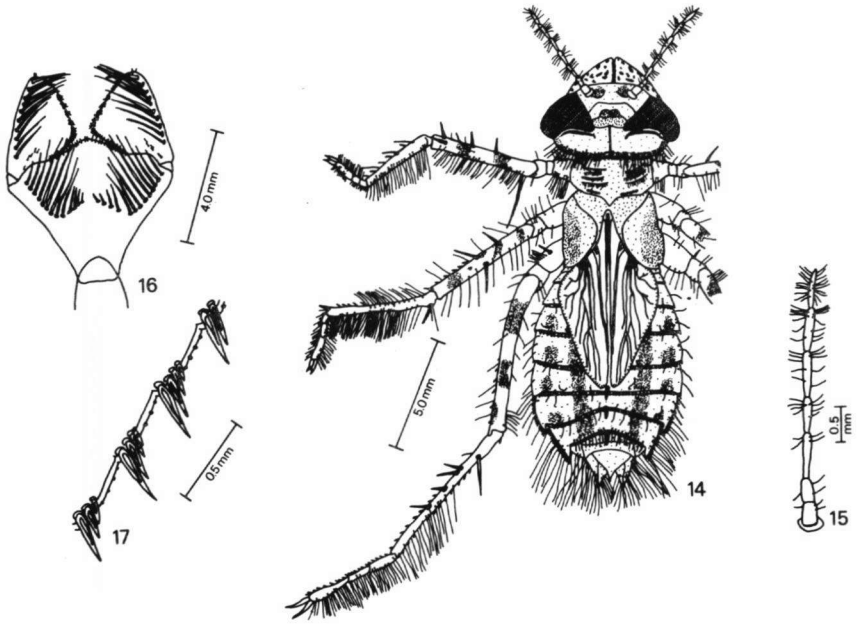
Figs. 11-13. *Urothemis assignata* (Sel.), 11th instar: (11) larva; – (12) antenna; – (13) labium.

11th instar (Fig. 11). – Duration 9-13 days (10.2 ± 1.4 days). Length 11.50-12.80 mm (12.16 ± 0.70 mm); width 2.00-2.60 mm (2.38 ± 0.21 mm). Each eye about 1/6 of head width (head width 3.96 mm). Antennae (Fig. 12) still increasing in length, length from scape in mm: 0.238, 0.286, 0.432, 0.365, 0.493, 0.515 and 0.449; total length 2.778 mm. Labium (Fig. 13): premental

setae very variable, 11 + 11, 12 + 11, 12 + 12, 12 + 13, 13 + 13, 13 + 14; palpal setae 10 + 10, two claviform setae on each crenation of the distal margin of palpus. Tarsi 3-segmented. Wing sheaths covering the 2nd abdominal segment.

12th (penultimate) instar. – Duration 11-26 days (20.9 ± 6.9 days). Length 15.40-16.30 mm (15.63 ± 0.48 mm); width 2.90-3.60 mm (3.39 ± 0.23 mm). Each eye about 1/5 of head width (head width 5.09 mm). Length of antennary segments from scape in mm: 0.260, 0.318, 0.492, 0.427, 0.537, 0.540 and 0.483; total length 3.057 mm. Labium: premental setae very variable, 12 + 12, 12 + 13, 13 + 13, 13 + 14, 14 + 14, 15 + 13, 15 + 14; palpal setae 10 + 10 and 11 + 11, the former being typical, 2 or 3 claviform setae on each crenation at the distal margin of palpus. Wing sheaths extending up to the 4th abdominal segment.

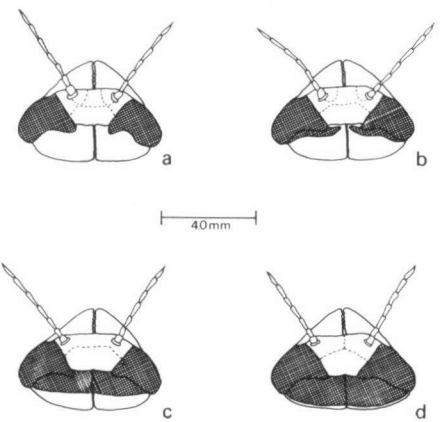
13th (ultimate) instar (Fig. 14). – Duration 26-48 days (41.0 ± 10.7 days). Length 19.40-22.00 mm (20.08 ± 0.85 mm); width 3.90-4.80 mm (4.37 ± 0.22 mm). Each eye about one third of head width (head width 6.20 mm). The body still brown or tanned brown with specks of dark brown band on the labium and legs until it changed to pale green at the onset of metamorphosis. Occasionally, this greenish colouration was noticed immediately after moulting into this ultimate instar. Antennae (Fig. 15) still increasing in length, length



Figs. 14-17. ***Urothemis assignata*** **(Sel.), 13th (ultimate) instar: (14) larva; – (15) antenna; – (16) labium; – (17) part of the distal margin of palpus.**

from scape in mm: 0.326, 0.356, 0.669, 0.577, 0.730, 0.716 and 0.631; total length 4.005 mm. Labium (Fig. 16): premental setae still variable, 14 + 12, 14 + 14, 14 + 15, 15 + 15, 15 + 16, 16 + 16; palpal setae 10 + 10 and 11 + 11, the latter being typical. Distal margin of palpus has 14 crenations, each crenation bearing 3 to 4 claviform setae (Fig 17). Mid-dorsal abdominal spines very prominent. The hind-wing sheaths extend up to the end of the 6th abdominal segment.

Prior to emergence, the area between the eyes was encroached upon both laterally and posteriorly, along the medium epicranial suture, leaving only the area occupied by the ocelli. This resulted in the merging together of both eyes laterally and posteriorly. This was observed in four stages (Fig. 18). This final stage in the development of the eyes was achieved 6-8 days prior to emergence. The transformation of the larval to adult mouthparts was completed later than that of the compound eyes. This occurred three days prior to emergence. These stages CORBET (1957) termed metamorphosis prior to emergence. Emergence usually took place during the early hours (04.27-06.32 hrs).



Figs. 18. *Urothemis assignata* (Sel.), stages of metamorphosis of the compound eyes in the ultimate instar larva.

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