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A STUDY OF EGGS AND IMMATURE STAGES OF TWO CLOSELY RELATED SYMPATRIC SPECIES OF OXYRHACHIS GERMAR (HOMOPTERA : MEMBRACIDAE)

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Abstract. The eggs and immature stages of two closely related sympatric species, *Oxyrhachis taranda* (F.) and *Oxyrhachis serratus* Ahmad and Abrar are described and illustrated. The total time taken to complete the life cycle of former species from egg to adult is noted to be 34–38 days. As the eggs of *O. serratus* never hatched in the laboratory, the time taken to complete life cycle from 1st instar to adult is noted to be 34–36 days. The characters of eggs and immature stages are compared and used in separating the above closely related sympatric species. A key to separate various instars of both species is also presented. The correlation coefficient (*r*) of the values of corresponding lengths and widths of eggs of the two species is calculated by standard statistical methods.

Capener[2] stated that nymphal characters of Membracidae provided differences only at the tribal level, however, Capener[3] pointed out thier importance in any systematic study of this group and stressed that the mounting of the immature forms should receive greater care.

In the recent years more and more attention is being given to the evaluation of the characters of immature stages of this group in view of rapidly growing phylogenetic problems as a result of systematic studies throughout the world. Kopp and Yonke[5] (also personal communication) haveemphasized this need in view of extensive sexual dimorphism which often makes it almost impossible in many cases to group both sexes in 1 species. Ahmad[1] has also studied biology and nymphal systematics of Pakistani centrotine species in view of great sexual dimorphism and variability within specific populations.

Funkhouser[4] and Weiss and Dickerson[7] described various immature stages of the species they studied. Capener[2,3] also illustrated and described the 5th instar of Membracinae and Centrotinae respectivley.

With reference to the species of the Indo-Pakistan subcontinent only Lefroy and Howlett[6] illustrated and described the eggs and 1st three instars of one of the presently studied species *Oxyrhachis taranda* (F.) listing the host plants alongwith some of their habits. They, however, did not give distinguishing features between various instars.

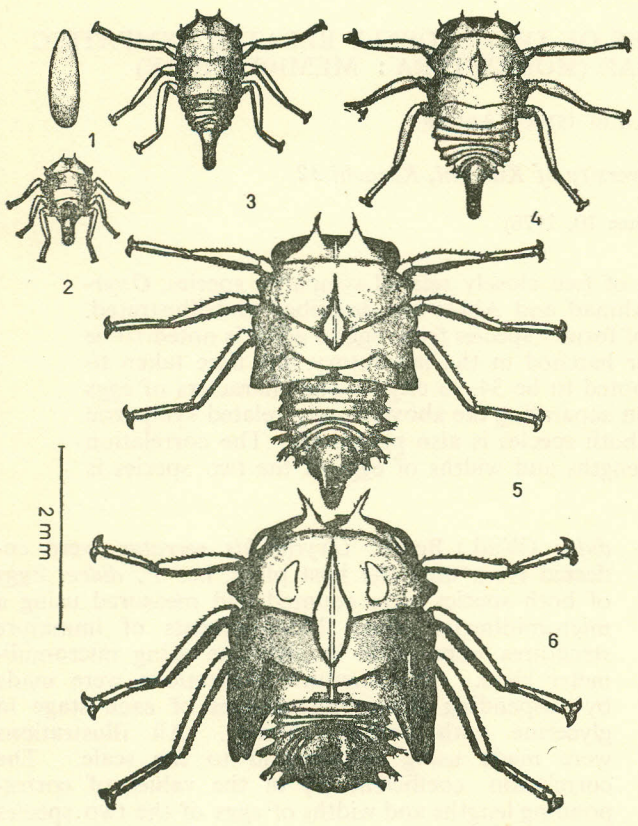
The present study aims to evaluate the characters of the eggs and immature stages particularly with reference to thier use in separating two closely related sympatric species. A key to separate various immature stages of both species is also presented.

Material and Methods

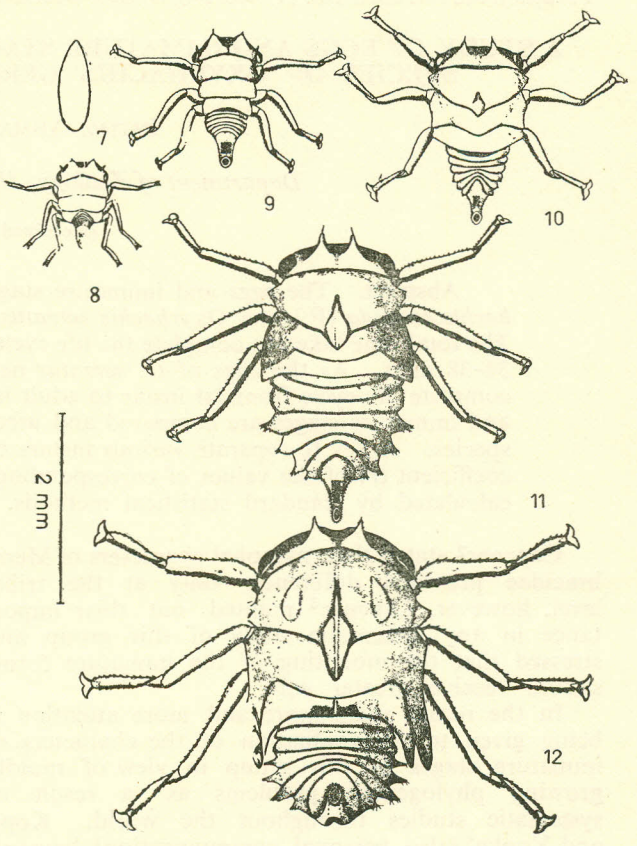
Immature stages and the adults of both sexes of *O. taranda* were collected on the following host plants: *Prosopis julifiora* D.C., *Acacia nilotica* (Lamk.) Wild., *Albizzia lebbeck* Bth. and *Pithoclobium dulce* (Wild.) Benth. *Oxyrhachis serratus* were collected from only the host plant, i.e. *P. dulce*. Eggs of both species were counted and measured using a micromillimeter slide. Measurements of immature structures were made in glycerine using micromillimeter slide. All immature illustrations were made by suspending the representatives of each stage in glycerine with cotton threads. All illustrations were made using ocular grid to the scale. The correlation coefficient (*r*) of the values of corresponding lengths and widths of eggs of the two species was calculated by standard statistical methods.

Key to Immature Stages of O. taranda and O. serratus

1. Body shorter, length ranging from 0.90–1.95 mm. 2
   Body longer, length ranging from 2.3–4.8 mm..7.
2. Labium shorter, usually reaching onto 3rd abdominal venter, mesothoracic wing pads and small pleural lobes present, caranial and pronotal processes appearing fully developed..... .....3 (3rd instar)
   Labium longer, at least reaching onto 4th abdominal venter, metathoracic wing pads and pleural lobes not developed, latter hardly or just appearing, cranial and pronotal region showing prominence but processes as above not developed....4
3. Comparatively larger in size, length ranging from 1.90–1.95 mm, processes pointed at apices (Figs. 4, 18), pronotum distinctly more than twice as wide as long, median pronotal processes comparatively larger and pointed..... .....*O. taranda*
   Comparatively smaller in size, length ranging from 1.67–1.87 mm, cranial processes rounded at apices (Fig. 10, 17), pronotum about twice as wide as long, median pronotal process comparatively smaller and rounded..... .....*O. serratus*
4. Labium comparatively very long, reaching onto 6th abdominal venter, body shorter, length ranging from 0.90–1.08 mm, pronotal prominence



Figs. 1–6. *O. taranda* (1) egg, (2) first instar, (3), second instar; (4) third instar, (5) fourth instar, (6) fifth instar.



Figs. 7–12. *O. serratus* (7) egg, (8) first instar, (9) second instar, (10) third instar, (11) fourth instar, (12) fifth instar.

or any trace of process not in evidence..... ..... 5 (1st instar).
Labium comparatively shorter, reaching onto 4th abdominal venter, body longer, length ranging from 1.57–1.61mm, pronotal processes just appearing.. ..... 6 (2nd instar).

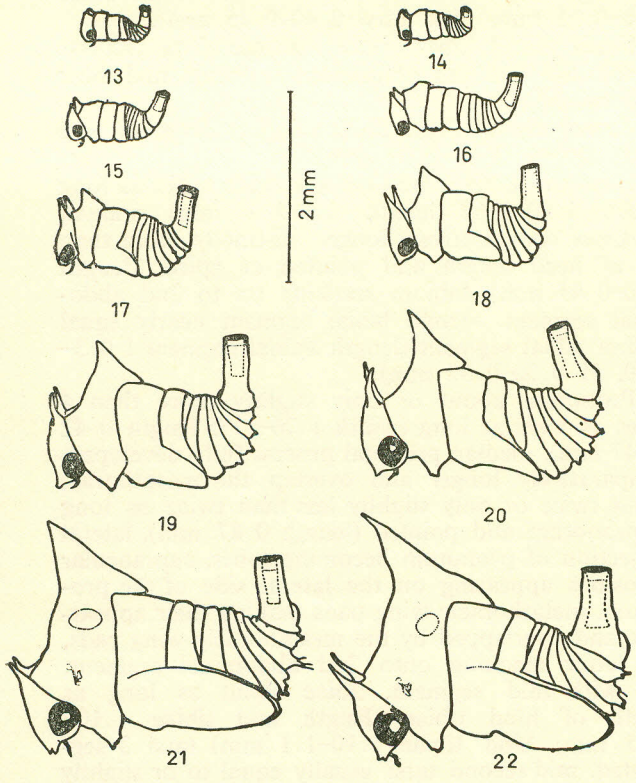
5. Cranial prominence pointed (Figs. 2, 14), pronotum about twice as wide as long..... ..... *O. taranda*
Cranial prominence blunt (Figs. 8,13), pronotum distinctly more than twice as wide as long..... .....*O. serratus.*

6. Head about as wide as pronotum, cranial processes pointed at apices (Figs. 3,16)..... ..... *O. taranda*
Head distinctly less wide than pronotum, cranial processes rounded at apices (Figs. 9, 15)..... ..... *O. serratus.*

7. Body comparatively longer, length ranging from 3.3–4.8 mm, labium comparatively shorter, reaching onto the middle of 1st abdominal venter, posterior pronotal process somewhat prominent, suprahumeral buds appearing on both sides of the median pronotal process, wing pads more elongated, reaching onto 5th abdominal segment .....8 (5th instar)
Body comparatively shorter, length ranging from 2.3–2.8 mm, labium comparatively longer, reaching onto 2nd abdominal venter, posterior pronotal process just appearing, not as above, suprahumeral buds absent, wing pads relatively less elongated, hardly passing beyond 2nd abdominal segment..... .....9(4th instar).

8. Comparatively larger in size, length ranging from 4.1–4.8 mm, cranial processes slightly larger, distinctly more than 1/3rd of head length and pointed at apices (Figs. 6, 22)..... .....*O. taranda*
Comparatively smaller in size, length raning from 3.3–3.8 mm, cranial processes slightly shorter, only about 1/3rd of head length and rounded at apices (Figs. 12, 21)..... .....*O. serratus*

9. Comparatively larger in size, length ranging from 2.50–2.80 mm, cranial processes longer, distinctly more than 1/3rd of head length and pointed at apices, head distinctly more than 1/2 again as wide as long, median pronotal process pointed (Figs. 5, 21)..... .....*O. taranda*
Comparatively smaller in size, length ranging from 2.30–2.57 mm, cranial processes shorter, about 1/-3rdagain of head length and rounded at apices, head



Figs. 13, 15, 17, 19, 21. Lateral views of immature stages of *O. serratus.*

Figs. 14, 16, 18, 20, 22. Lateral views of immature stages of *O. taranda.* (13, 14) 1st instar, (15, 16) seeond instar, (17, 18) third instar, (19, 20) fourth instar, (21, 22) fifth instar.

distinctly less than half again as wide as long, median pronotal process rounded (Figs. 11, 19). ..... *O. serratus.*

Oxyrhachis Taranda

Descriptions. Eggs : (Figs. 1, 23; Table 2). Elongate, average length 1.17 mm and average width 0.33 mm. Ovate smooth, one side convex, smoothly tapering to tip. When freshly laid, appear greenish in colour, approaching the colour of the bark. After 3–4 days these turn to greenish yellow, gradually turning yellowish brown and then a pair of red eye spots appear. Following development these turn darker and darker. There appear to be no egg burster, operculum or micropyles, the young first instar emerges head in front from the egg. Total time taken to complete the life cycle from egg to adult 34–38 days (Table 2).

First Instar (Figs. 2,14). Slightly larger in size (total length 1.0 –1.08 mm), head about 1/5th as wide again as long (width 0.57–0.60 mm, length 0.50–0.52 mm), cranial prominences rather pointed. pronotum about twice as wide again as long (width 0.55 length 0.18–0.20 mm).

Body elongate-oval, general colour yellowish brown to green. Head appear deflexed downward extending ventrally to the first pair of legs, and is about 4 times as broad as long. Dorsal and ventral surfaces are covered with minute hairs. Dorsal

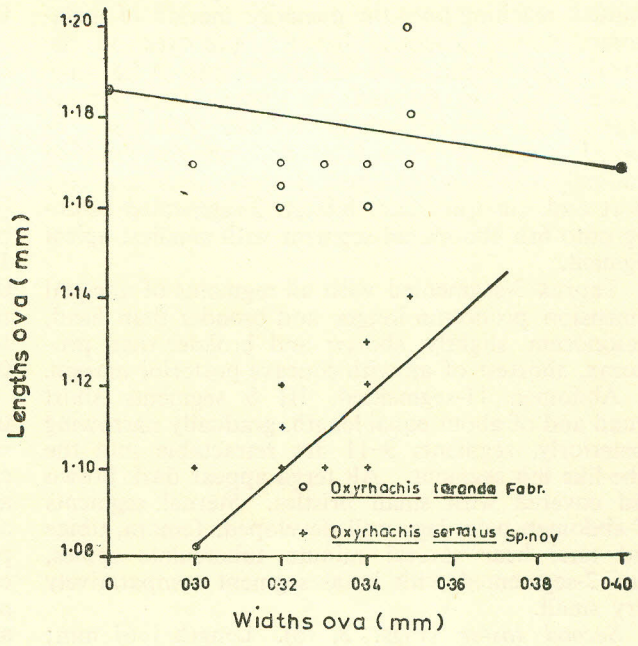


Fig. 23. Grap showing different values of *r'r'* (corelation coefficient) of eggs lengths and widths of *O. tranda* and *O. serratus.*

TABLE 1. VALUES OF CORRESPONDING LENGTHS AND WIDTHS OF THE EGGS OF *O. serratus* and *O. taranda.*

Name of species	ΣL Observed values of lengths	ΣW Observed values of widths	ΣL^2	ΣW^2	ΣLW	n No of egg
O. taranda	17·56	5·04	20·58	1·6966	5·9008	15
O. serratus	14·6	4·27	16·0807	1·4051	4·7516	13

The correlation coefficient (r) given by:

$$r = \frac{\Sigma LW - \frac{1}{n}\Sigma L \Sigma W}{\sqrt{\left(\Sigma W^2 - \frac{(\Sigma W)^2}{n}\right)\left(\Sigma L^2 - \frac{(\Sigma L)^2}{n}\right)}}$$

is +0·70 in the case of *O.serratus* and —0·79 in *O. taranda*

TABLE 2. DURATION IN DAYS OF EGGS AND IMMATURE STAGES OF *O. taranda.*

Stage	Duration
Egg	10–12 days
Immature I	3–4 days
II	4
III	5
IV	4
V	7

Total time taken to complete the life cycle from egg to adults=34–38 days.

ecdysial line in the middle is Y–shaped, short and pointed, reaching onto the posterior margin of metathorax, cranial processes between the eyes on the dorsal side of the head terminate into a hair-like bristle which is pointed in shape. Eyes appear large, oval and reddish in colour. Antennae 3-jointed, apical joint long and narrow tapering gradually towards the apex, 2 basal segments very short and quadrangular; labium 2-segmented reaching onto 6th abdominal segment with smallest apical segment.

Thorax 3-segmented with all segments of unequal dimension pronotum longer and broader than head, mesonotum slightly shorter and broader than prothorax, shortest of all with concave posterior margin.

Abdomen 11-segmented, 1st 8 segments short broad and of about equal length, gradually narrowing posteriorly, segments 9–11 are retractable into the tube-like 8th segment. All terga appear dark brown and covered with small bristles. Sternal segments of abdomen pale, legs well developed, femora, tibiae and tarsi bear several minute tuberculate spines, tarsi 2-segmented with basal segment comparatively very small.

Second Instar (Figs. 3, 16). Length 1.61 mm; width at head 0.77 mm, width at pronotum 0.77–0.85 mm. Shape and colour similar to first instar.

Head wider than long (width 0.77 mm, length 0.70 mm), of about same width as pronotum, small ridge appearing on lateral margins of the subocular expenditures, cranial processes further pronounced and pointed at apices, labium reaching onto 4th abdominal segment, first labial segment comparatively longer, about 1/3 again as length of second labial segment (0.30–0.22).

Pronotum more than 1⅔ again as wide as long (width 0.77–0.85 mm, length 0.27–0.30 mm), lateral lobes of pronotum and mesonotum making their appearance, median pronotal process arising as projection, legs turning to dark brown having more tuberculate spines, mid tibiae about as long as hind tibiae (midtibae 0.50–0.55 mm, hind tibiae 0.50mm) mid second tarsi as long as hind second tarsi (0.25–0.30 mm).

Abdominal segments appearing dark brown in the middle.

Third Instar (Figs. 4,18). Slightly larger in size (total length 1.90–1.95 mm);

Head always more than 1/3 wide again as long (width 1.10–1.13 mm, length 0.60–0.82 mm), cranial processes fully developed with their apical portion pale in colour and pointed at apices (length 0.22–0.25 mm), labium reaching onto 3rd abdominal segment, apical half of 3rd antennal segment turning pale.

Pronotum usually distinctly more than twice as wide again as long (width 1.20–1.25, length 0.37–0.42 mm), lateral lobes of the pronotum and mesonotum becoming well developed, median pronotal process well developed comparatively larger and pointed (0.35–0.37 mm), mesothoracic wing pads making their appearance, often of thick consistency and overlapping the lateral borders of the mesonotum, legs with hind second tarsi comparatively longer but hind tibiae usually distinctly more than 2/3rd again as long as hind second tarsi (hind tibiae 0.70–0.75 mm, hind tarsi 0.40–0.45 mm).

Small plural lobes appear as lateral projections of 4th, 5th and 6th abdominal segments and bear small bristles.

Fourth Instar (Figs. 5, 20.) Slighly larger in size (total length 2.50–2.80 mm).

Head distinctly more than ½ as wide again as long (width 1.60–1.62 length 1.0–1.1 mm) cranial, processes comparatively longer, distinctly more than 1/3 of head length and pointed at apices (length 0.40–0.45 mm), labium reaching on to 2nd abdominal segment, second labial segment nearly equal to first labial segment (length liabial segment I 0.3–0.40, II 0.30–0.37 mm).

Pronotum about or only slightly more than 4 times as wide as long (width 1.70–1.75 length 0.42 –0.47 mm), median pronotal process fully developed, comparatively longer and overlap the mesothorax, about twice or only slightly less than twice as long as pronotum and pointed (length 0.87 mm), lateral projection of pronotum becoming lobes, supraocular callosities appearing on the lateral side of the pronotum, metathoracic wing pads making their appearance and overlapped by the mesothoracic wing pads, the latter reaching onto 2nd abdominal segment, legs with mid segment, tibiae about as long as length of hind tibiae (length mid tibiae 1.10–1.15 mm, hind tibiae 1.10–1.1 mm) tarsi 3–segmented. mid second tarsi usually equal to or slightly less than hind second tarsi (0.62–0.67 mm).

Middle portion of 5th and 6th abdominal sterna turning dark, pleural lobes of abdomen becoming well developed.

Fifth Instar (Figs. 6, 22). Slightly larger in size (total length 4.1–4.8 mm). Head distinctly less than ½ as wide again as long (width 1.90–1.93 length 1.34–1.37 mm), cranial processes slightly longer, usually more than ½ of head length and pointed at apices (length 0.45–0.50 mm), labium reaching onto the middle of 1st abdominal segment, 2nd labial segment nearly equal or slightly shorter than 1st labial segment (length labial segment I 0.35–0.45, II 0.34–0.40 mm).

Pronotum about or less than ⅓ as long as wide (width 2.50–2.55, length 0.80–0.85 mm), median pronotal process comparatively longer, distinctly less than twice as long as pronotum and pointed (length 1.50–1.62 mm), lateral projection of pronotum comparatively developed, supraocular collosities appearing on the lateral sides of the anterior portion of pronotum, metathoracic wing pads more elongated, reaching onto 5th abdominal segment, legs with mid and hind tibiae of equal length (length midtibiae 1.50 mm, hind tibiae 1.50 mm), tarsi 3-segmented, mid and hind 2nd tarsi of about equal lengths (length mid 2nd tarsi 0.87 mm, hind 2nd tarsi 0.87 mm).

Middle portion of 5th and 6th abdominal sterna dark, pleural lobes of abdomen comparatively more developed.

Oxyrhachis Serratus

Description. Eggs (Figs. 7, 23, Table 3). Sub-

globate, average length 1.12 mm and average width 0.32 mm. Shape, colour and other characterstics very similar to that of *O. taranda*. Total time taken to complete the life cycle from 1st stage to adult 34–36 days.

First Instar (Figs. 8, 13). Slightly smaller in size (total length 0.90–1.0 mm); head at least 1/6 as wide again as long (width 0.55, length 0.45–0.47 mm); cranial prominences blunt, pronotum distinctly more than twice again as wide as long (width 0.52 mm, length 0.15 mm).

Second Instar (Figs. 9, 15). Slightly smaller in size (total length 1.57 mm), width of head distinctly less than width pronotum (width of head 0.67 mm, length, 0.62 mm), cranial processes rounded at apices; pronotum about 1⅔ as wide again as long (width pronotum 0.70 mm, length 0.27 mm), midtibiae shorter than hind tibiae (mid tibiae 0.37 mm, hind tibiae 0.42 mm) mid 2nd tarsi shorter than hind 2nd tarsi (mid tarsi 0.25 mm, hind tarsi 0.27 mm), Ist labial segment comparatively shorter, never 1/3 again as long as 2nd labial segment (0.25–0.28/0.20–0.22 mm).

Third Instar (Figs. 10, 17). Slightly smaller in size (total length 1.67–1.87 mm), head usually about 1/3 wide again as long (width 0.95–1.07 length 0.72–0.75 mm) cranial processes rounded at apices (length 0.20–0.22 mm), pronotum about twice as wide again as long (width 1.10–1.14 mm, length 0.37–0.40 mm), median pronotal process comparatively smaller and rounded, not pointed (0.25–0.28 mm), mid tibiae usually equal to 1/2 width of pronotum (length 0.55–0.66 mm), hind 2nd tarsi comparatively smaller but hind tibiae usually equal to 2/3 again as long as hind 2nd tarsi (hind tarsi 0.37 mm, hind tibiae 0.60 mm.).

Fourth Instar (Figs. 11, 19). Slighly smaller in size (total length 2.30–2.57 mm), head distinctly less than 1/2 as wide again as long (width 1.45–1.47 mm length 1.01 mm); cranial processes comparatively shorter, only slightly more than 1/3 of head length, rounded at apices (length 0.34–0.37 mm), pronotum distinctly more than 4 times as wide as long (width 1.62–1.68 mm) length 0.39–0.40 mm; median pronotal process comparatively smaller, distinctly less than twice as long as pronotum, rounded (length 0.70–0.75 mm), midtibiae distinctly shorter than hind tibiae (length mid tibiae 0.90–0.95 mm, hind tibiae 0.98–1.10 mm), mid 2nd tarsi always distinctly less than length hind 2nd tarsi (length mid second tarsi 0.50–0.55 mm, hind 2nd tarsi 0.60–0.65 mm) 2nd labial segment nearly subequal to 1st but usually about or slightly less than half length of 2nd hind tarsi (labial segment I, 0.26–0.37 mm. II, 0.26–0.32 mm).

Fifth Instar (Figs. 12, 21). Slightly smaller in size (total length 3.3–3.8mm) head comparatively longer, width pronotum usually less than 2/3 again of head length (head length 1.30–1.37 mm width 1.87–1.90 mm), cranial processes slightly shorter, about 1/3 of head length, rounded at apices (length 0.43–0.45 mm), pronotum about 1/3 or more than 1/3 as long as wide (width 2.1–2.12, length 0.70–0.78 mm), median pronotal process comparatively shorter, length almost equal to head length (length 1.3–1.4 mm), mid tibiae smaller than hind tibiae, (mid tibiae 1.30–1.35 mm, hind tibiae 1.40–1.45 mm), mid 2nd tarsi usually slightly smaller than hind 2nd tarsi (mid 2nd tarsi 0.80–0.83 mm hind 2nd atrsi 0.85 mm), 2nd labial segment comparatively shorter, usually less than 1/2 length of fore 2nd tarsi (length labial segment I, 0.32–0.41 II, 0.30–0.37 mm).

Discussion

The eggs of *O. serratus* differed from the eggs of *O. taranda* in being less elongated. The correlation coefficient (*r*) of the values of corresponding lengths and widths of the eggs of the two species was calculated (Table 1, Fig. 23) and the straight lines were drawn on a graph paper plotting the fitted values of 'L' and 'W'. The correlation coefficient (*r*) was calculated to be +0.70 in the case of *O. serratus* and −0.79 in *O. taranda*. This proved that in the case of the eggs of *O. serratus* as the length of the eggs increased in various samples the widths of the eggs also increased, whereas in case of *O. taranda* the negative value of '*r*' signified that as the egg increased in length the widths of egg decreased.

The various instars also showed significant differences in the following characters as noted in the descriptions and Figs. 13–22.

1. Acutely pointed or rounded cranial processes.
2. Comparative sizes of the cranial processes and of the pronotal horns in the two species.
3. Comparative sizes of the first two labial segments and other characters used in the description of the instars.

Lefroy and Howlett[6] (in the eggs of *O. taranda* noted a spine-like process, curving back from the end and to this structure they attributed the function of fixing the eggs in the plants but they suspected also other probable functions of this structure. During the present observations such structure in the eggs was not noted. The eggs are deposited by the females in the slit of the stem which she produces by cutting the stem open by means of her ovipositor. Then these eggs are firmly glued.

The present studies agree with Capener[2] that in the entire subfamily Oxyrhachinae the last instar possesses a pair of large or rudimentary cranial tubercles, pronotum possessing a prominence in front that might be developed into a distinct horn and has ruidementary posterior process extending onto the mesonotum.

These characters have been noted absent in the species of *Otinotus* Buckton by Funkhouser[4] in

TABLE 3. DURATION IN DAYS OF EGGS AND IMMATURE STAGES OF *O. serratus*.

Stage		Duration
Egg		..
Immature	I	5
	II	4–5
	III	6–7
	IV	8–9
	V	10

Total time taken to complete the life cycle (from 1st stage to adult) = 34–36 days.

Gagara genistae (F) by Weiss and Dickerson[7], and by Capener[3] in various diagrams of the immature stages he has drawn of the species belonging to the subfamily Centrotinae. These characters were also noted to be absent in the various instars of the species belonging to the genera *Gargara* Amyot et Serville and *Tricentrus* Stål of the subfamily Centrotinae by Ahmad.[1]

Contrary to the conclusions made by Capener[2] that the immature stages only provided difference at the tribal level, during the present studies these were found providing differences even for separating two closely related sympatric species as noted above.

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