

NOTES ON SOME EPHEMEROPTERA BAËTIDAE FROM INDIA
AND SOUTH-EAST ASIA.

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Communicated by Dr. T. T. MACAN, F.R.E.S.

Manuscript received 10th May, 1948.

(Read 1st June, 1949.)

With 22 Text-figures.

THIS paper is an account of material collected during the course of military service in India, Siam and Malaya from 1945-1947. Only the family BAËTIDAE is considered here, but it is hoped to work out the rest of the material at some future date. It must be emphasized that this is not a comprehensive review of the natural history of the species concerned. Much of the work was done under active service conditions. Moves were frequent, the duration of stay in each locality was short, opportunities for collection restricted and materials inadequate. No area was revisited at a later date, so it was difficult to obtain a clear picture of periods of emergence in the different seasons. Most of the collecting was done in a number of areas in India and in a small part of South Malaya. The Indian fauna was found to be much more abundant and varied, but it is likely that the more mountainous regions of Central Malaya may show as great a variety of species as Ulmer has described from Java and Sumatra.

Certain elementary observations on the habits of tropical forms can be made here. Stagnant water forms, such as *Cloëon*, are mostly nocturnal in appearance and emerge the whole year round. They predominate in a constantly hot climate such as Malaya, where even fast-running streams contain nymphs of few other species. In the mountain streams of Northern India there is an abundant hatch in the autumn, and it may be that this continues throughout the spring and summer as well. In the larger rivers of Central India, such as the Narbada and Sonar, adults were found in small numbers during the dry season, but on the Mutha, in Bombay Presidency, they were found in much larger numbers towards the end of the monsoon. Careful search of the neighbourhood of the Sohan in the North-West Punjab during one week in May produced very few of either adults or nymphs, suggesting that here at least the main hatch had been earlier in the dry season. Hatches of duns appear to be infrequent or nocturnal, and so not observed. They were seen on two occasions only, on the Sonar in March, where a mixed hatch of BAËTIDAE and LEPTOPHLEBIIDAE occurred at dusk, and on a mountain stream in North Bengal in September, also at dusk. Clouds of "dancing" spinners, so familiar in England, were very rarely seen, apart from the winter broods of *Cloëon*. The underside of vegetation along river banks was, however, a much more profitable source of specimens and it was felt that this, together with the

associated cobwebs, gave a fair picture of the fly life that had emerged during the previous twenty-four hours.

Much of the previous work on Oriental Ephemeroptera has dealt with the larger and more primitive families, e.g. PALINGENIIDAE, POLYMITARCIDAE, EPHEMERIDAE and POTOMANTHIDAE. Little has been written about the BAËTIDAE. Ulmer, however, in a very detailed and comprehensive work (1939) has covered the whole known fauna of the Netherlands East Indies, and Kimmins (1947) has recently reviewed critically the Indian species of *Cloëon*. Traver (1939) has also described some BAËTIDAE amongst a collection from Kashmir. Notes are given here on five genera and twenty species, all of this family, of which five have been previously described and eleven are new. The types of all new species have been presented to the British Museum (Natural History), and the descriptions all apply to specimens in 2 per cent. formaldehyde unless stated to the contrary.

I must record here the great assistance that I have received from Mr. D. E. Kimmins, of the British Museum, and the free use of files and references that he has very kindly permitted. I should also like to express my thanks to Dr. T. T. Macan, of the Freshwater Biological Association, for much useful advice and criticism and for communicating this paper, to Dr. B. N. Chopra, late Director of the Zoological Survey of India, and to Mr. M. W. F. Tweedie, of the Raffles Museum, Singapore. I am also indebted to the Secretary of the Bombay Natural History Society for the storage of specimens after I left India.

Baëtis Leach.

No species of *Baëtis* or *Acentrella* have up to now been described from India. Eaton (1885) mentions in a few lines an undescribed female from "Hindustan." From Ceylon, Hagen (1858) described *B. consuetus* and *B. solidus*, and Eaton, after his account of these two, adds *B. feminalis*. He gives, unfortunately, no figures of these species. *B. feminalis* may, indeed, not have been a *Baëtis* at all, as he remarks on the absence of hind wings in all available specimens. From Java and Sumatra, Ulmer, in 1913, described *B. javanica* and later (1939) *B. sumatrana*, *B. olivascens* and *Acentrella fulmeki*.

An account is given here of eight species from India and one from Malaya, of which six are described and figured as new species. The remainder are only known as females and it was not considered justifiable to describe them. They were collected mostly in two widely separated areas in India, namely, the foothills of North Bengal and the River Mutha, near Poona, both very different habitats.

They are similar in general to European species, although the Malayan specimen is noteworthy for the remarkably small size of the hind wing, smaller than in most species of *Centroptilum* yet typical of *Baëtis* in shape. Two species, *B. dipsicus* and *B. palmyrae*, belong to the *Acentrella* group. I have here placed them all in *Baëtis*, as the exact relationship of *Acentrella* to *Baëtis* is still in doubt. These two differ from the others only in lacking a costal spur in the hind wing and, in *palmyrae*, by the hind wing being smaller than usual and very slightly smaller in the female than in the male.

Towards the end of the monsoon appears to be a favourable time in India for their emergence. *B. fluitans* was particularly abundant in the rain-swollen

waters of the River Mutha (air temperature 70–85° F. in September) together with fewer numbers of *B. palmyrae* and *B. dipsicus*. On the other hand, a single specimen of *B. palmyrae* was caught on the Narbada in the hot dry weather of April. In the cooler waters of the Himalayan foothills (c. 70° F., air 65–78° F. in September at 4000 ft.) their period of main emergence is probably a little sooner than in the plains. Few nymphs were found then, although those of other genera, e.g. *Epeorus*, were abundant.

A table is set out below giving some of the principal characteristics of the new species and those of other authors :

Principal characteristics of species of *Baëtis*.

Species.	Body (mm.).		Wing.		Turb. eyes.	H.W. veins.	Tergites 2-6.	Tails.	Stigma veins.
	♂.	♀.	♂.	♀.					
<i>solidus</i> Hag. ¹	4	-	4½-5	-	.	2	Yellow-brown	White	3-6 comp.
<i>consuetus</i> Hag. ¹	3-4	4½	4½-5	5-6	.	3	Reddish brown	Sepia grey	2-5 simple
<i>feminalis</i> Etn. ^{1, 4}	4½	4½	5½	6	.	-	Reddish brown	Sepia brown	2-5 simple
<i>javanica</i> Ulm. ²	9	10	9	11	Brown grey	2	White and red	Grey brown	14-20
<i>sumatrana</i> Ulm. ³	5	5	5	5	Hazel	2	White	Grey	4 simple
<i>olivascens</i> Ulm. ^{2, 5}	4-5	4-5	4-4½	4-4½	Umber	2	Olive brown	-	4-5 comp.
<i>fulmeki</i> Ulm. ^{2, 6}	5	5	5	5	Yellow-brown	2	White	Light amber	8-9 simple
<i>dipsicus</i> sp. n. ^{2, 6}	6	7	6-6½	8	Blue-grey	2	Yellow-green	White	6-10 simple
<i>palmyrae</i> sp. n. ^{2, 6}	4	4	4-4½	4-4½	Buff	2	White	White	4-7 simple
<i>fluitans</i> sp. n. ²	3½	3½	3½-4	3½-4	Dark red	2	White	White	5-6 comp.
<i>tigroides</i> sp. n. ^{2, 7}	6½	6½-7	6½	7½-8	Reddish yellow	3	Red and yellow	Dark brown	7-9 simple
<i>thurbonis</i> sp. n. ²	6	.	6	.	Dark red	3	Lemon	White	3-6 comp.
<i>solitarius</i> sp. n. ²	4½	.	4½-5	.	Brick red	2	Lemon	White	6-7 comp.

¹ Dried specimens. ² In spirit. ³ In life. ⁴ Femora banded. ⁵ C, Sc area olive brown. ⁶ *Acentrella* group. ⁷ Sooty wing-tip and root.

***Baëtis dipsicus* sp. n. (figs. 1, 10 ; forceps, hind wing).**

Male imago (in life).—Eyes pale bluey grey. Thorax buff. Abdomen yellowish green, olive green at posterior margins of segments ; tergites 8–10 buff. Forceps and tails white. All femora sandy brown with a ginger spot at the apex ; tibiae and tarsi translucent white.

(In fluid).—Head orange brown ; turbinate eyes separated apically, brownish red in colour, yellow round the sides ; lower portion black, ocelli white ; first two antennal segments yellowish cream, amber at the joint, remaining segments colourless. Thorax generally orange brown, sternites rather darker. Abdomen : Tergites 2–6 semi-opaque white, shading off to faint brownish laterally ; posterior margins dark brown, this margin broadening on the flanks and being most distinct on segments 2 and 3 ; tergites 7–10 opaque brownish cream, 8 rather darker ; sternites 1–6 cream, 7–10 orange cream. Genital forceps (fig. 1) white ; basal joint as long as second, which tapers evenly distally and has a small rounded tubercle on the inner side near the base ; third joint twice as long as second, broader in the distal two thirds ; fourth joint very small, globular and incompletely divided from the third joint. Tails white. Legs : Fore femur yellowish orange, tibia and tarsus

white except for the last two tarsal joints and claws, which are dusky; other femora yellowish, tibiae and tarsi white. Proportions of fore leg, femur: tibia: tarsus, 22:34:35; tarsal joints, 1:10:6:4:3. Wings translucent colourless, veins very pale yellow; stigmatic area contains 6-10 simple or very occasionally forked, slanting veinlets; hind wing 0.8×0.2 mm., small, narrow, with rounded end and complete absence of costal spur (fig. 10).

Female imago (in life).—Thorax and abdomen deep ginger brown, metanotum darker. Proximal half of tails grey, distal half white. Femora ginger, tibiae sandy brown.

(In fluid).—Head mauve; oculi blackish mauve, ocelli grey; antennae grey. Thorax: Pronotum buff; mesonotum the same but darker round the margins and with a very distinct pitch brown median line; metanotum darker and more of a chocolate brown; pleurites orange brown; sternites orange, except in the inter-coxal area of the mesothorax, which is cream. Abdomen, when void of eggs, translucent white tinged with pink; when full, deep orange brown; posterior and lateral margins of tergites 1-9 tinged with pink, most marked in segment 1; by reflected light there appears on tergites 6-9, on either side of the mid line, a light brown line extending from the posterior margins two-thirds of the way to the anterior margin and interrupted at its middle; tergite 10 orange; sternites pinkish cream. Tails white. Wings as in male, except that the veins are rather darker, especially at the wing root. Legs: All femora orange; tibiae and tarsi white, except for last tarsal joints and claws, which are dusky.

Body-length: Male 6 mm., female 7 mm. *Wing*: Male $6-6\frac{1}{2}$ mm., female 8 mm. *Tails*: Male 11 mm.

INDIA: River Mutha, four or five miles above Poona.

The type-specimens, four males and two females, were found on the under-side of the fronds of palm trees in the bushes along the bank of the river, on 10 and 11. ix. 45.

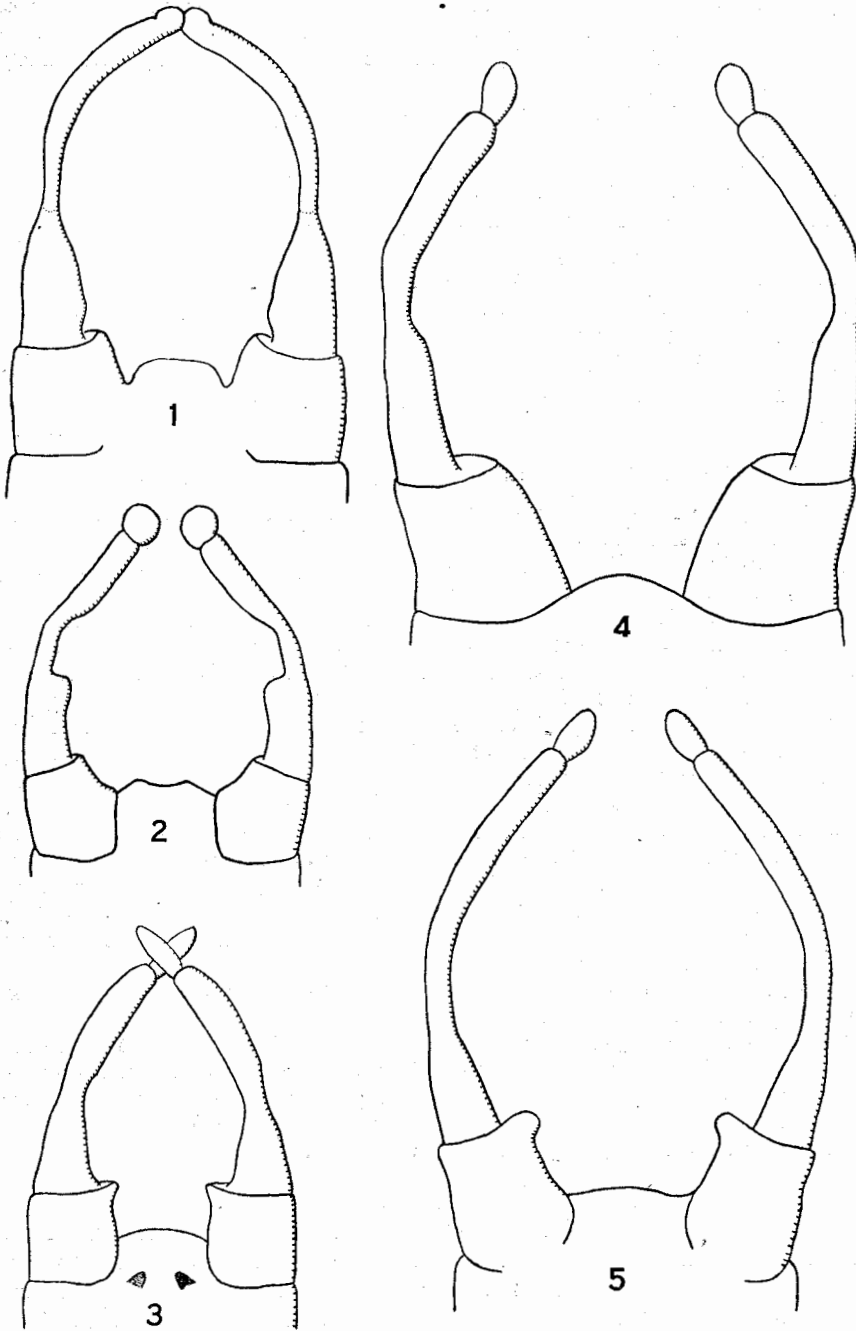
This is a largish species of the *Acentrella* group, readily distinguished by its size, brown and green coloration and characteristic forceps. *A. fulmeki* Ulmer has a similar hind wing, but differs in the shape of the forceps and in coloration, and the eyes are contiguous apically.

Baëtis palmyrae sp. n. (figs. 2, 14, 15, forceps, hind wings).

Male imago (in life).—Eyes light sandy brown. Thorax pitch brown. Abdomen translucent cream; segments 1, 3, 5 and 6 tinged with pink, 7-10 sandy brown. Tails and forceps white. Legs cream except for the fore tibia, which is dusky; femora all bearing a red spot at the distal end.

(In fluid).—Head: Turbinate eyes orange red, contiguous at their apex and overlapping the pronotum completely, lower portion blackish; ocelli white; basal two antennal segments white, remainder colourless; basal joint has a small spine on the lateral aspect of its distal end. Thorax uniform reddish brown. Abdomen: Tergites 2-6 translucent white, 7-10 opaque cream; sternites as tergites. Forceps (fig. 2) white; basal joint as long as second, directed slightly outwards; second joint untapered and without tubercle; third joint twice as long as second, bent sharply inwards at the end of its proximal one-third and becoming thicker at this point; fourth joint large and globular, and completely separated. Tails white. Legs uniformly white, claws dusky. Proportions of fore leg, femur: tibia: tarsus, 23:32:25; tarsal joints, 1:12:8:4:2. Wings translucent colourless; veins very pale yellow, except round the wing root, where they are reddish brown; stigmatic area contains 4-7 incomplete slanting veinlets; hind wing 0.6×0.1 mm., narrow, spurless and with two veins (fig. 14).

Female imago.—Head: Oculi purplish black, ocelli white; basal antennal segment brown, second segment cream. Thorax orange brown. Abdominal tergites semi-translucent brownish pink, brown along the posterior margins; on tergites 2-6 the spiracular



FIGS. 1-5.—Forceps of *Baëtis* species (to scale). (1) *B. dipsicus*. (2) *B. palmyrae*. (3) *B. fluitans*. (4) *B. tigroides*. (5) *B. thurbonis*.

line is marked clearly blackish along the lateral margins; sternites white, tinged with pink, especially in segment 10. Tails missing. Legs: Femora brownish cream, tibiae white, claws dusky. Wings as in male, except that the hind wing is slightly, but distinctly, smaller (fig. 15).

Body-length: Both sexes, $3\frac{1}{2}$ –4 mm. *Wing*: 4–4 $\frac{1}{2}$ mm.

INDIA: River Mutha, four or five miles above Poona. River Narbada, six miles above Hoshangabad, C.P.

The type specimens were four males and two females from the Mutha, taken on 10 and 11.ix.45. The males were found resting underneath the fronds of low palms along the bank of the river, the females spent on the surface of the river. The Narbada specimen was caught alive in a cobweb at midday on 19.iv.45, air temperature 100–108° F.

This is a small species, easily recognized by the very reduced, spurless hind wing and the characteristic forceps with the large globular terminal joint.

Baëtis fluitans sp. n. (figs. 3, 18, forceps, hind wing).

Male imago (in life).—Eyes dark red. Thorax pitch brown. Abdominal segments 2–6 translucent white, 7–10 dark reddish brown. Tails white.

(In fluid.)—Head amber; turbinate eyes dark red, separated apically, lower portion blackish; ocelli white; basal two antennal segments brownish cream, remainder white. Thorax uniform amber, sutures darker. Abdomen: Tergites 2–6 translucent white, 7–10 opaque sandy brown; sternites 2–6 white, 7 and 8 cream, 9 and 10 sandy brown, darker at the margins and round the forceps base; at the junction of the ninth and tenth sternites, between the basal joints of the forceps, are a pair of dark brown spots, slightly elongated laterally and forwards. Forceps (fig. 3): First joint brown, remainder white; first joint subequal to second and with a distinct tubercle on its inner distal lip; second tapering slightly and evenly; third joint one and a half times as long as second, tapered slightly proximally; fourth joint thin, pointed and rather less than half the length of the third joint. Tails white. Legs translucent colourless. Proportions of fore leg, femur:tibia:tarsus, 16:25:21; tarsal joints, 1:8:6:4:2. Wings translucent colourless; subcosta and first radial branch brownish by reflected light, yellowish by transmitted light; other veins tinged with the very faintest yellow; stigmatic area contains 5 or 6 simple, slanting veinlets; hind wing small, 0.6×0.25 mm., rounded with an acute spur, two veins and a trace of a third vein (fig. 18).

Female imago (in life).—Thorax and abdomen dark sherry brown, cream on the underside. Tails white. Legs sandy brown.

(In fluid.)—Head orange brown; oculi black, ocelli blackish grey; first two antennal segments reddish brown, remainder pinkish. Thorax orange brown. Abdominal tergites 2–6 semi-translucent pink, posterior margins rather redder; remaining tergites reddish orange; sternites white. Tails white. Legs uniform translucent white, hind claws dusky.

Body-length: Both sexes, 3–3 $\frac{1}{2}$ mm. *Wing*: 3 $\frac{1}{2}$ –4 mm.

INDIA: River Mutha, four or five miles above Poona.

The type specimens, four males and two females, were caught on 10 and 13.ix.45. On the former occasion the females were coming down, floating on the surface of the river, in large numbers all day. Both sexes were also abundant in the bushes and cobwebs along the bank. This species seemed to be much the most common fly at this time of year, when the river is swollen with the rains and weather not too hot.

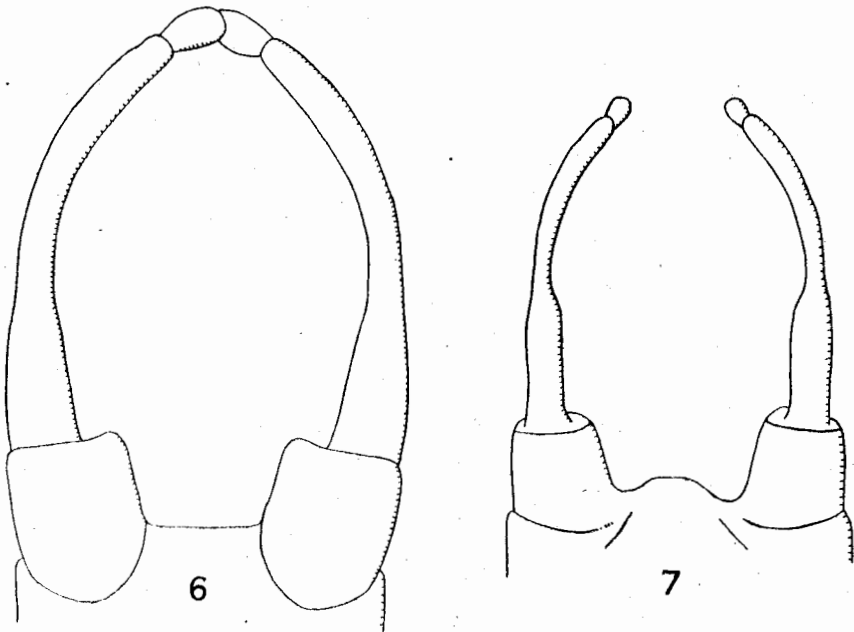
This is a small species, recognized by the characteristic forceps in the male,

lack of pigment in the wings and small rounded hind wings with two veins and a trace of a third. The females are very similar in appearance to *B. palmyrae* and are only distinguishable with certainty by the hind wings.

***Baëtis tigroides* sp. n.** (figs. 4, 8, 9, forceps, wings).

Male imago (in life).—A rather handsome red and yellow fly, striped in parts. Head yellow, eyes brick red, paler at the sides, ocelli black. Thorax pitch brown. Abdomen generally red and yellow, tergites 1-5 yellow with the posterior margins red, 6-9 yellow background with striking red markings, 10 mainly yellow. Tails yellowish red, forceps white. Fore wing bimaculate. Fore legs reddish ginger throughout; other legs, femora yellow, proximal half of tibia brownish ginger, distal half and tarsi yellow.

(In fluid).—Head pale orange; turbinate eyes strikingly tall and cylindrical, only slightly broader at the apex than at the base, reddish orange on top, yellowish round the sides and becoming redder at the base; lower portion black, ocelli pale grey, each with a



FIGS. 6-7.—Forceps of *Baëtis* and *Pseudocloëon*. (6) *B. solitarius*. (7) *P. inopinum*.

black ring round its base; antennae white throughout. Thorax generally chocolate brown and white; pronotum white; tip of mesonotum white, remainder chocolate, except for two irregular white lines that radiate from the posterior end of the median furrow to just in front of, and just behind, the wing root respectively; metanotum rather paler chocolate; pleurites and sternites white, except for a narrow chocolate band extending from the wing root to the middle of the anterior border of the mesosternum. Abdomen semi-opaque cream; tergites 2-5 cream, 6 and 7 pinkish, 8-10 browner; posterior margins of 2 and 3 dark brownish red, broadening out at the sides; tergite 9 also has dark brown flanks; on tergites 4-8 is a paler median line and on either side of this, on segments 6 and 7, is a faint, pale, divergent stripe running backwards and slightly laterally, this being most distinct on segment 6, less so on 7 and doubtfully present on remaining segments; sternites uniform cream. Forceps (fig. 4) white; basal joint rather longer than broad, equal to

second joint, which is thin and with a few distinct hairs on its inner border; third joint long and thin, bent in rather sharply near the base; fourth joint small and ovoid. Legs white; proximal half of hind and mid femora brownish. Proportions of fore leg, femur: tibia: tarsus, 28:48:40; tarsal joints, 1:17:12:7:2½. Wings generally translucent colourless; area round wing root and outer one-quarter of costal and subcostal areas sooty brown (fig. 8); veins strongly formed; main veins round the wing root, C, Sc and R₁ in the pigmented area of the wing tip, all cross veins and occasional portions of the main veins where they are adjacent to the cross veins, sooty brown; stigmatic area contains 7-9 simple, slanting cross veins; marginal intercalaries rather long; hind wing 0.7 × 0.2 mm., spatulate with central spur and three veins (fig. 9).

Female imago (in life).—Eyes and thorax dark brown. Abdomen burnt umber, with indistinct darker markings. Tails deep umber. Legs: Femora ginger with lighter patches, tibiae with proximal half umber, distal half translucent grey.

(In fluid).—Head dark brown; oculi blackish grey, ocelli paler; basal two antennal segments cream, remainder sooty. Thorax: Notum dark sherry brown, pleurites and sternites cream. Abdominal tergites 1-9 dark sherry brown, shading off to yellowish brown laterally; tergites 4-5 rather paler, 8-9 contain rather more yellow; tergite 10 yellow; sternites 1-7 yellowish cream, 8 and 9 browner; sternites are marked with a distinct single yellow dot on either side of the mid line; posterior margin of segment 7 is slightly broadened over the openings of the two oviducts. Tails uniform dark sherry brown. Legs: Femora yellowish cream; proximal half of tibiae reddish brown, distal half and tarsi sooty, darkest in the fore tarsus. Wings pigmented as in the male, but all veins are sooty brown throughout, including those of the hind wing.

Body length: Male 6½ mm., female 7-7½ mm. *Wing*: Male 6-6½ mm., female 7½-8 mm. *Tails*: Female 19-20 mm.

INDIA: Mountain streams between 4000 ft. and 5000 ft. round Mirik, N. Bengal.

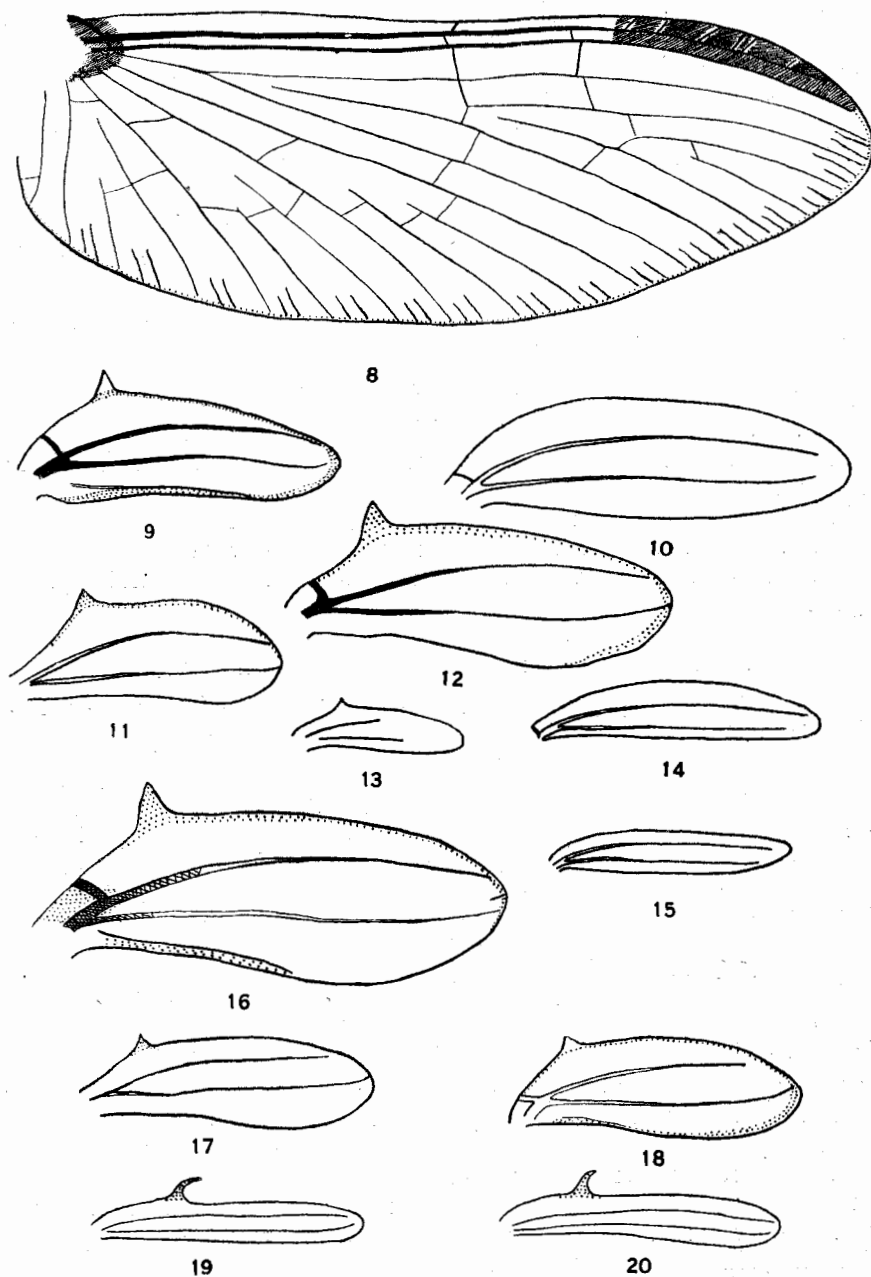
The type specimens, one male and four female imagines, were caught at rest on the underside of foliage overhanging streams between the 18th and 24th September, 1946. Females were seen not infrequently, but only one male was found. One female was observed egg-laying over a small waterfall, bearing a bundle of orange eggs.

This is a large species recognized at once, in both sexes, by the bimaculate pigment in the wings, which readily distinguishes it from all other species.

I also have specimens of two subimagines and one imago, all females, that appear to vary a little from the above description. They differ in that the stigma contains a series of horizontal veinlets in addition to the simple cross veins, the abdominal sternites are marked with a dash on each side as well as a dot and the pigment in the wings is slightly fainter. They have, however, a similar shaped hind wing, characteristic dark venation and long tails. These specimens were seen to emerge at dusk, temperature 67-68° F., from a small, fast-flowing aqueduct. The hatch continued after dark. On first hatching these duns had black eyes, chrome yellow bodies and legs, with ginger margins to the segments and pale grey wings.

Baëtis thurbonis sp. n. (figs. 5, 16, forceps, hind wing).

Male imago (in life).—Eyes dark red; thorax burnt umber. Abdominal tergites 1-6 very pale lemon, posterior margins ringed with dark orange, 7-10 dark orange brown. Tails white, ringed faintly with red. Femora sandy brown, darker at the apex; claws dusky, remainder of legs white.



FIGS. 8-20.—Wings of *Baëtis* and *Centroptilum* species (to scale). (8) *B. tigroides*, fore wing (not to scale). (9) *B. tigroides*, hind wing. (10) *B. dipsicus*. (11) *B. solitarius*. (12) *Baëtis* sp. 1. (13) *Baëtis* sp. 3. (14) *B. palmyrae*, ♂. (15) *B. palmyrae*, ♀. (16) *B. thurbonis*. (17) *Baëtis* sp. 2. (18) *B. fluitans*. (19) *C. campestre*. (20) *Centroptilum* sp.

(In fluid.)—Head: Turbinate eyes not especially large, separated apically, orange red, lower portion purplish black; ocelli grey with dark basal ring; antennae reddish brown. Thorax generally pale chocolate brown with pale cream areas on either side of the mesonotum opposite the wing roots and in the mid line posteriorly; pleurites and sternites buff, metasternum paler; anterior margins of mesopleurites and mesosternum burnt umber, forming a dark ring from wing root to wing root. Abdominal tergites 2-7 translucent white, 8-10 opaque yellowish cream. Basal forceps joint cream, remainder translucent white (fig. 5); first joint rather longer than broad, second narrow and evenly tapered, third long and of uniform thinness, fourth joint slightly elongate. Tails white. Legs white, claws dusky; fore femur pale brownish cream, darker at the distal end. Proportions of fore leg, femur: tibia: tarsus, 35:46:36; tarsal joints, 1:14:12:6:3. Wings translucent colourless, except for a little dark brown pigment round the wing root; veins pale amber; stigmatic area very faintly milky, containing 3-6 irregular, slanting cross veins and a broken line of irregular, horizontal veinlets; hind wing rather large, 1×0.4 mm., ovate, with three veins, and a sharp spur (fig. 16).

Body-length: Male 6 mm. *Wing*: Male 6 mm. *Tails*: Male 16-17 mm.

INDIA: Thurbo Tea Estate, Mirik, N. Bengal, alt. 4000 feet.

One male imago was caught at rest under foliage over a mountain stream on 20.ix.46.

This species is best distinguished by the large hind wing with three veins, the dark mesosternal ring in the thorax and the shape of the forceps. *B. consuetus* Eaton would appear to be smaller and to have simple veins in the pterostigma.

Baëtis solitarius sp. n. (figs. 6, 11, forceps, hind wing).

Male imago (in life).—Eyes brick red; thorax buff; abdominal segments 2-6 pale lemon yellow, 7-10 buff; tails white; femora lemon, rest of legs white.

(In fluid.)—Head reddish brown; turbinate eyes red, orange round the sides, lower portion black; ocelli purple; basal antennal segments reddish brown, remainder colourless. Thorax: Mesonotum dark sherry brown, metanotum paler; pleurites and sternites cream. Abdominal segments 2-6 translucent white, 7-10 yellowish cream. Forceps (fig. 6) cream; basal joint slightly longer than broad, second joint narrow and tapered, third long and uniformly slender, fourth joint rounded and slightly elongate. Tails white. Legs generally white, fore femur yellowish. Proportions of fore leg, femur: tibia: tarsus, 20:30:36; tarsal joints, 1:17:10:5:3. Wings translucent colourless; costal and subcostal area appear faintly milky by reflected light; veins pale amber; stigmatic area contains 6-7 irregular, branched, horizontal and vertical veinlets; hind wing 0.5×0.2 mm., ovoid with well-formed costal spur and two veins (fig. 11).

Body length: Male $4\frac{1}{2}$ mm. *Wing*: Male $4\frac{1}{2}$ -5 mm. *Tails*: Male 13-14 mm.

INDIA: Mirik, N. Bengal, 4000 ft.

One male imago was caught at rest on foliage on 20.ix.46.

This species superficially resembles *B. thurbonis*, but is smaller, lacks the dark mesosternal ring, and the hind wing has only two veins. The relatively long fore tarsus would appear distinctive, unless this is due to malformation. Eaton's description of *B. solidus*, from dried specimens, might possibly apply to this species, although the darker thorax of the latter would probably distinguish it.

Baëtis sp. 1 (fig. 12, hind wing).

Female imago (in life).—A small dark species. Eyes blue. Thorax buff. Abdomen dark sandy brown, posterior margins darker reddish brown, tergites 8-10 still darker.

Tails burnt umber and rather long. Wing venation blackish, stigma contains 4-5 veinlets. Hind wing as in fig. 12.

Several females from Mirik, N. Bengal, 18-23.ix.46.

Baëtis sp. 2 (fig. 17, hind wing).

Female imago (in life).—A small fly. Thorax reddish brown. Abdomen uniform claret red, underbelly cream. Tails white. Stigma contains 7 incomplete, slanting veinlets. Hind wing as in fig. 17.

One female imago was caught at sunset on 23.v.45 on the river Sohan at Chak Lala, near Rawal Pindi.

Baëtis sp. 3 (fig. 13, hind wing).

This specimen, from Malaya, is represented by one fragmentary female and is characterized by the extremely small hind wing, by the single marginal intercalary in the second medial interspace of the fore wing and by the absence of intercalaries behind this.

From a cobweb, 15.i.47, at Kota Tinggi, Johore State.

Pseudocloëon Klapálek.

This genus is widely distributed in India and the Far East. From the Western Ghats Navás has described *P. rubellum* and another species is here added to the Indian list from N. Bengal. *P. kraepelini* Klapálek is also recorded here from Malaya.

Pseudocloëon kraepelini Klapálek.

One male imago, very probably of this species, was caught on overhanging foliage at the waterfall near Kota Tinggi, S. Malaya, on 15.i.47. The fore tarsus is only slightly longer than the femur (*cf.* Ulmer, 1939, tarsus $1\frac{1}{2} \times$ femur) but in other respects the specimen agrees well with his description.

Several nymphs were also caught on the sandy bed of this fast-flowing stream, where they seemed to represent the only fauna. These are very similar to Ulmer's *Pseudocloëon* sp. 1, although differing slightly in the shape of the tenth tergite and in the marking on the head.

Pseudocloëon inopinum sp. n. (fig. 7, forceps).

Male imago.—Head: Turbinate eyes very tall, separated apically, reddish orange on top, yellow round the sides; lower portion black, ocelli grey; basal two antennal segments brownish mauve, remainder colourless. Thorax: Notum and pleurites buff, sternites cream. Abdominal segments 2-7 translucent white, 7-10 greyish brown, 10 rather lighter; sternites 7-10 brownish cream. Basal forceps joint (fig. 7) brownish, remainder dusky; basal joint rather longer than broad, second joint long and narrow, third joint tapered slightly proximally, fourth joint ovoid. Penis cover present. (Tails probably white.) Legs uniform white, fore femur touched with yellow. Proportions of fore leg, femur: tibia: tarsus, 10:32:21; tarsal joints, 1:8:7:3:2. Wings translucent colourless; by reflected light the outer half of C and Sc area is faintly milky; veins very pale amber; marginal intercalaries in first cubital interspace paired, in second interspace single and absent behind this; stigmatic area contains 1-2 incomplete cross veins.

Body length: Male 5 mm. *Wing*: Male $4\frac{1}{2}$ mm.

INDIA : Mirik, N. Bengal, 4000 ft.

Two males were caught at rest on foliage on 20.ix.46.

This species differs from *P. kraepelini* Klapalek and *P. obscurum* Ulmer, in the tall, narrow, turbinate eyes, which are well separated apically, and from *P. boettgeri* Ulmer by the short fore femur and thinner forceps. The nearly related *Baetiella ladakae* Traver has a shorter fore tarsus (equal to femur) and the terminal joint of the forceps is elongate. *P. rubellum* Navás, apparently described from a female, would appear to be smaller and to have characteristic markings on the notum, as well as on the abdomen.

Centroptilum Eaton.

Only one species of this genus, *C. vitellinum* Ulmer (1939) from Borneo, has been described from the Orient (outside Japan). Two species are here recorded from India, one being described as new.

Centroptilum campestre sp. n. (fig. 19, hind wing).

Male imago (in life).—Eyes red. Thorax light buff. Abdomen greyish buff, shading off to yellowish posteriorly, sternites cream. Tails pure white.

(In fluid).—Head: Turbinate eyes pale orange, slightly separated apically, lower portion greyish black, ocelli grey; basal two antennal segments cream, remaining segments colourless. Thorax generally buff, darker at the sutures; pronotum yellowish. Abdominal tergites 2-6 translucent yellowish orange, whiter along posterior margins, 7-10 opaque pale orange; sternites yellowish cream, ninth sternite bordered laterally with dark brown. Basal joint of forceps yellowish cream, remaining joints white; structure much as in *C. pennulatum* Eaton, second joint short, tapering sharply distally, third joint long, tapering markedly proximally, fourth joint small and thin. Tail(s) white. Legs: Fore femur lemon yellow, tibia and tarsus translucent white; other femora yellowish cream, tibiae and tarsi white. Proportions of fore leg, femur : tibia : tarsus, 17 : 21 : 24; tarsal joints, 1 : 10 : 7 : 4 : 2. Wings generally colourless; C and Sc areas, in the inner two-thirds tinged with the very faintest yellow, in the outer one-third, distinctly clouded pale yellow; C, Sc and R1 pale yellow, other veins colourless; stigmatic area contains 6 simple, slanting cross veins; hind wing very small, narrow, with rounded apex and tall, thin and recurved costal spur (fig. 19).

Body length: Male 5 mm. *Wing*: Male 4-4½ mm.

INDIA : River Sonar, near Saugor, C.P.

One male was captured at dusk as a subimago on the surface of the river, 11.iii.45.

This species is distinguished from *C. vitellinum* Ulmer by the yellow tinting in the wings and the uniform light colouring of the thorax.

Centroptilum sp. (fig. 20, hind wing).

Female imago (in life).—Eyes and thorax emerald green. Abdomen slightly darker green, posterior margin of each segment reddish brown; ninth sternite emerald green. Tails uniform very pale green. Legs white, femora reddish brown. Wings translucent colourless; stigma contains 4-5 cross veins; hind wing as in fig. 20.

Body length: Female 6 mm. *Wing*: Female 6½ mm.

INDIA : Mirik, N. Bengal, 4000 ft.

One female was captured over a mountain stream on 18.ix.46. The dun has dusky wings and a light olive green body.

Cloëon Leach.

This genus is the most commonly encountered by the casual collector in the tropical parts of the East, and it is not surprising that a considerable number of species have been described. Some of these accounts are of males and some of females, and it is not always possible to arrive at a definite conclusion as to the specific differences involved. Lestage (1929) gave a key to the identification of the then known species and also commented on the difficulties of comparing descriptions based on different sexes. Perhaps the idea of using females as holotypes, as suggested by Kimmins (1947), would do much to clarify the position until more certain specific characters for the males can be found. This method has certainly simplified the identification of Indian species.

In a hot, humid country such as Malaya few other genera are met, unless more careful search is made. Their flying time is almost entirely confined to twilight or the night, but in India, and also in Rangoon and Bangkok, males may be seen dancing by day in the winter. The same may be said of the nearly related genus *Procloëon* Bengtsson. *P. harveyi* Kimmins seems to flourish under all climatic conditions, ranging from the intense dry heat of the summer in Central India to the sticky warmth of Malaya or Bengal during monsoon times. *C. bicolor* Kimmins also seems to have a wide climatic as well as geographic range.

Fourteen species of *Cloëon* and two of *Procloëon* have been described from India and South-East Asia, exclusive of four species not known outside China (Ulmer, 1936). Of these, *C. rubellum* Navás (1923) and *C. taeniatum* Navás (1932) are described from males only and are difficult to compare. *C. viridis* Kimmins (1947), *C. virens* Klapálek (1905) and *C. coomani* Navás (1934) would seem to form a closely related group with greenish marginal pigment in the wings. *C. bicolor* Kimmins (1947) and *C. kashmiri* Traver (1939) are distinctive species from India, and *C. marginale* Hagen and *C. bengalense* Kimmins (1947) are mutually similar species, all four with mainly brown marginal areas. *C. fluviatile* Ulmer (1919) from New Guinea, and *C. exiguum* Navás (1918), from the Philippines, both have very faint yellow pigment in the wings. *C. apicatum*¹ Navás (1932) has pigment in the apex of the wings and *C. variegatum* Chopra (1924) and *C. pulchellum* Banks (1913), both from India, have clear wings.

I give notes here on two of these species from India and Malaya and also describe two new clear-winged species from Malaya and Siam and one from India. I follow Kimmins in placing *bimaculatum* and *harveyi* in *Procloëon*, though without adding any new species to the genus. I am indebted to him for very kindly comparing my specimens with his types.

Like the European *C. dipterum* L., several Oriental species are ovoviviparous. Ulmer (1912) has described the phenomenon in *P. bimaculatum*. Dissection of specimens in my collection has shown the presence of one-half to two-thirds grown embryos in *C. bicolor* from Saugor and *P. harveyi* from Bengal.

Cloëon bicolor Kimmins.

This species was described from Bengal. My specimens are from Calcutta, 6.xii.45; Saugor, C.P., 8.iii.45; Budni, Bhopal, 11.iv.45; Bangalore,

¹ Navás has also given this name to a species from Central China, in which the marginal area is yellowish. (1933, *Notes ent. chin.* 9: 17).

7. xi. 45; Bangkok, 6. i. 46; and Singapore, 17. i. 47. The Malayan specimen is a little smaller than the rest. Some examples from Bangalore appeared in life to be similar to *C. bengalense* Kimmins, but are now so faded as to be indistinguishable from *bicolor*.

Cloëon viridis Kimmins.

This was also described from Bengal. I have specimens from Jhikargacha, W. Bengal, 4. vii. 45; from a ship at the mouth of the Hooghly in October, and from Bangalore, 15. xi. 45. Examples, possibly of this species, were also seen at Khandala in the Western Ghats and Malacca. Some of these specimens in life were pure apple green in colour, with little if any reddish brown markings (cf. Kimmins, p. 98), and it is just possible that this may represent the difference between *C. virens* Klapálek and this species.

Cloëon siccum sp. n.

Female imago (in life).—Whole body light sandy brown, abdomen cream underneath. Tails white. Legs translucent. Wings translucent colourless.

(In fluid).—Head yellow; oculi black, ocelli mauve; antennae white. Thorax yellowish brown, mesonotum rather lighter. Abdomen orange yellow, greyer when empty of eggs; sternites cream. Tails white. Fore femur yellowish, rest of legs white, claws dusky. Proportions of hind tarsal joints, 9:4:3:7. Wings and veins colourless; all marginal intercalaries single and none posterior to Cu2; stigmatic area contains 5-7 close, simple, slanting veinlets.

Body length: Female 4-4½ mm. *Wing*: Female 4-5 mm.

INDIA: Branch of the River Sonar, where it crosses the Saugor-Damoh road at the 12th milestone, C.P.

Three females were caught as duns at dusk on 11. iii. 45. Day temperatures 80-85° F. Probably a dry season form. The duns have light grey wings.

This species is recognized by the small size, unpigmented wings and the uniform yellow colouring without distinctive markings. Banks' *C. pulchellum* would appear very similar to this, though probably differing in having "2-3 (cross veins) in the pterostigma, widely separated and two intercalaries behind median, cubitus and first anal." *C. variegatum* Chopra has characteristic thoracic markings.

Cloëon septimum sp. n. (fig. 21, abdomen).

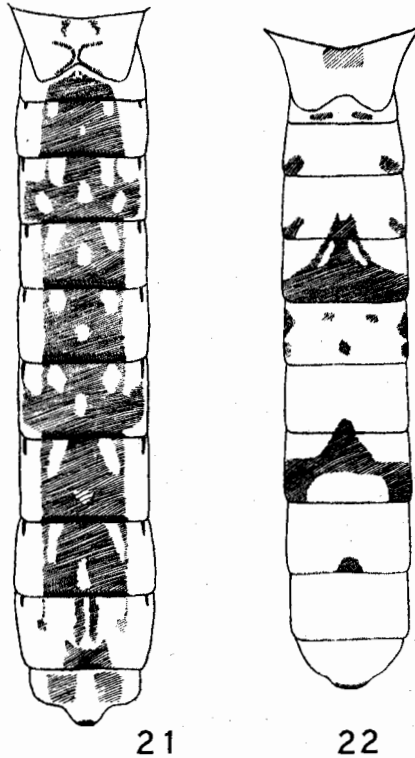
Female imago.—Head cream; oculi grey, ocelli white; antennae cream, basal segment with a reddish chocolate spot on the inner apical ring, distal segment ringed apically with the same colour (as in *C. bicolor*). Thorax cream; pronotum with faint red markings, metanotum with minimal red markings in the central area and a faint red lateral dot. Abdomen (fig. 21) cream with a central dorsal cherry red band, fading away on tergites 9-10 to a thin median line; on tergites 2-8 this central band has three or five pale dots on each segment and along the lateral margins of each of these tergites is a discreet red dash; on tergites 3 and 6, and to a lesser extent on tergite 8, the central band has broad lateral extensions; along the lateral margins of each of the first seven sternites is a broad longitudinal red line, slanting a little outwards and backwards. Tails white, with dark red joints. Legs white; fore femur reddish, mid and hind femora with a red subapical spot

on the inner surface. Proportions of hind tarsal joints, 63 : 26 : 12 : 23. Wings vitreous, C and Sc area virtually colourless but with the very faintest milky tinge; base of radius and costal brace tinged with red, veins otherwise amber; stigmatic area contains two to three cross veins.

Body length : Female $4\frac{1}{2}$ mm. Wing : Female 5 mm.

MALAYA : Batu Pahat, Johore.

The type female was captured as a dun at night in a house on 24.iv.46. Paratypes, three spent females found on the surface of a tank in the same



FIGS. 21-22.—*Cloëon* species. (21) *C. septimum*, abdomen of ♀ imago, dorsum.
(22) *C. julia*, abdomen of ♀ imago, dorsum.

locality, on 27.vi.46. A specimen, possibly a variant of this species, was found in Bangkok in January. It differs in being darker and browner in colour, in having femoral spots on the hind leg only, in the posterior margins of sternites 1-5 being dark red laterally and the pattern on the tergites being less distinctive.

This species is recognized by the absence of pigment in the wings, by the spots on the femora and by the characteristic markings on the abdomen, which distinguish it from other clear-winged species, though similar in this respect to *C. bengalense* Kimmins. *C. variegatum* Chopra has a characteristic variegated pattern on the thorax.

Cloëon julia sp. n. (fig. 22, abdomen).

Female imago.—A small, rather delicate fly. Head: Vertex orange; oculi black, rather prominent and squarish in lateral view; ocelli white; antennae white, basal and distal joints relatively longer and more slender than in the preceding species. Thorax generally cream; pronotum reddish along the posterior margin; mesonotum with two faint paramedian red lines; anterior portion of metanotum with a central dark red band. Abdomen (fig. 22) white; tergite 1 with a horizontal maroon line on either side of the mid line; on the lateral portions of tergites 2, 3, 5 and 7 are patches of the same colour spreading round, on tergite 7, to the mid line; tergite 4 almost wholly blood red, the colour overlapping in the mid line onto tergite 3; small patches of the same colour dorsally on 5, 6 and 7; along the lateral margins of tergites 2-8 is a thin intermittent maroon line; sternites unpigmented. Tails white. Legs white, fore femur with red spot at inner end, claws dusky. Proportions of hind tarsal joints, 20 : 6 : 2 : 6. Wings rather narrow, translucent colourless; veins colourless, except for the extreme base of radius and adjacent portion of costal brace, which are red; no marginal intercalaries behind first cubital interspace; stigmatic area contains one cross vein.

Body: Female $3\frac{1}{2}$ -4 mm. *Wing*: Female 4 mm. *Tail*: Female 6 mm.

MALAYA: Kluang, Johore.

One female was caught at dusk on the surface of a little sandy river, six miles from Kluang along the Mersing road, on 9. vii. 46.

This species might be placed in the genus *Procloëon* on the grounds of the relative lengths of the hind tarsal joints. It was thought better, however, to leave the matter until further material was available. It is easily distinguished from other clear-winged species by the pigment on the abdomen, which is maximal on tergite 4, and to a lesser extent on tergite 7, by the absence of markings on the hind and mid-femora and by the white tails.

Procloëon bimaculatum (Eaton).

This species has been reported from a fairly wide area by previous authors, notably Ceylon, Eaton (1885) and Bengal, Kimmins (1947). It is possible that some of the reports of its occurrence in Indo-China, Java, Sumatra, the Philippines and Formosa may refer to *P. harveyi* Kimmins and further observations on this point are required. The nymph attributed by Ulmer (1939) to this species may also possibly belong to *P. harveyi*. It is interesting to note his description of the gills as "genau so gestaltet wie bei *Cl. simile* Etn.," suggesting that these two species might be placed in *Cloëon*, despite the proportions of the hind tarsi in the imago.

I have typical specimens from Bangalore, 19. xi. 45, and Rangoon, 24. xii. 45.

Procloëon harveyi Kimmins.

This species appeared to be much commoner than *P. bimaculatum*. Spent females were found at dawn in a jungle pool at Budni, Bhopal, on 14. iv. 45, at Jhikargacha, W. Bengal, in July, at Poona in some numbers throughout August and September, and males were caught dancing in the early morning at Mirik, N. Bengal, at 4000 ft. in September. Outside India, females and males were caught in Bangkok in January, females probably of this species in Malacca and Batu Pahat in Malaya, and one very dried female in a cobweb at Fan Ling, in Hong Kong, on 15. iii. 47.

Females of two clear-winged species, that might belong to this genus, were found in Central India, but they are not sufficiently well preserved now to warrant description.

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Vol. 100. Part 6. Pp. 161-177. 32 figs.

4th October, 1949

THE
TRANSACTIONS
OF THE
ROYAL
ENTOMOLOGICAL SOCIETY
OF
LONDON

World List abbreviation: Trans. R. ent. Soc. Lond.

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LONDON:

PUBLISHED BY THE SOCIETY AND
SOLD AT ITS ROOMS, 41, QUEEN'S GATE, S.W. 7

Price 6s. 6d.