

FURTHER NOTES ON EPHEMEROPTERA FROM INDIA AND
SOUTH EAST ASIA.

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THE types of the new species described in this paper have been presented to the British Museum (Natural History) and descriptions all apply to specimens in 2 per cent. formaldehyde unless otherwise stated. Mr. D. E. Kimmins of the British Museum very kindly made available to me his lists of the world fauna.

POLYMITARCIDAE.

Povilla cambodjensis Ulmer.

This species was described by Ulmer in 1919 from material from Indo-China, in the vicinity of the river Mekong, and from a single specimen from Bangkok. Vejabhongse in 1937 described the habits of a "black-winged insect" in Bangkok that "bore a great resemblance to *Povilla corporaali*." He gave an account of the damage done to underwater structures through the wood-boring activities of the nymphs, together with a drawing of one that agrees well with Ulmer's more detailed figures published two years later. The adults emerged at night and behaved much as described below. The wings of *P. cambodjensis*, however, are white with mauve neuration, and it could under no circumstances be described as black-winged. The description could, on the other hand, reasonably enough be applied to the dark basal half of the wing of *P. corporaali*, as figured by Chopra (1927), and it seems likely that it was indeed this species that Vejabhongse observed.

During my short stay in Bangkok in the winter of 1945-6 adults of *P. cambodjensis* presented a striking instance of the ephemeral existence and abundance for which mayflies are renowned. Every night from 26th December till 9th January the house was suddenly filled with fluttering swarms of these insects. They entered from half to three-quarters of an hour after nightfall and stayed as long as an hour, if they did not die sooner. During this time they would congregate round the lamps, fall onto the supper table, settle on clothing or the floor and there awkwardly divest themselves of their subimaginal skins. In their struggles to become airborne, and when they could presumably contain themselves no longer, the females would extrude a particularly glutinous mass of eggs onto whatever surface they might be lying ~~off~~. Males were only on seldom seen, and outside the house no specimens of either sex were ever found alive, nor was their point of emergence from the innumerable waterways of the city located.

The nymph of *P. cambodjensis* remains unknown, and it is yet to be seen whether, as Kimmins (1948) has shown for the other two members of the genus, it too has the inconvenient habit of burrowing in wood.

Polymitarcys indicus Pictet.

The status and distribution of this species was discussed in detail by Chopra. It had been found up to that time in Bihar, Assam, Burma, Ceylon and in parts

of the East Indies. Dried specimens of this insect, which agree well with Chopra's description and figures, were found in profusion in cobwebs along the banks of the river Narbada some miles above Hoshangabad in the Central Provinces of India. Conditions at that time of year, April, 1945, were hot and extraordinarily dry, and it was impossible to judge how long previously the flies had emerged.

LEPTOPHLEBIIDAE.

Ulmer (1939) discussed the status of the known Oriental species of LEPTOPHLEBIIDAE in relation to the genera described from other parts of the world. He found that the species of the *Thraululus* group could not be placed satisfactorily in this genus and erected two new genera, *Thraululus* and *Choroiterpides*, for them. Hagen's species *Cloë signata*, placed in *Thraululus* by Eaton, remains the sole Oriental representative of the genus. Eaton's description does not readily permit comparison.

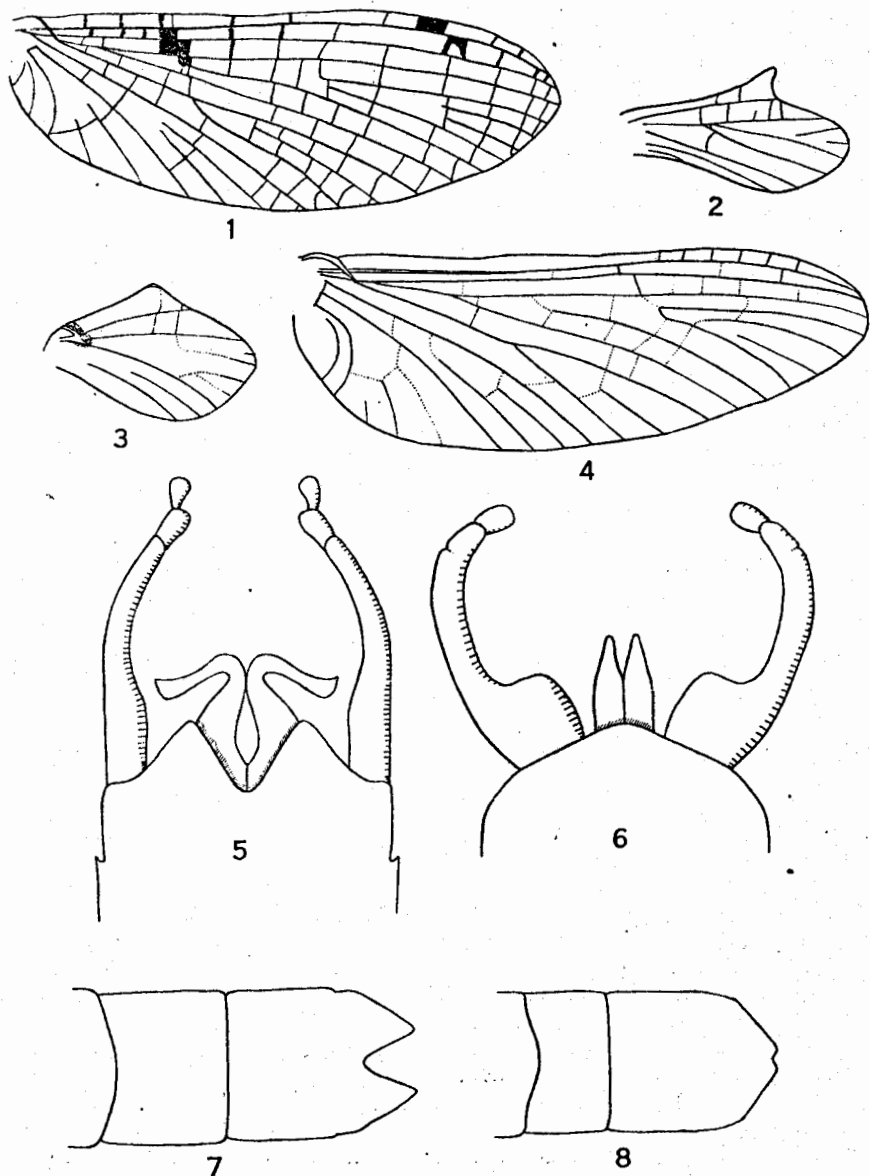
Of the two new Indian species that follow, the first, *hindustanicus*, seems nearer the American species of *Thraululus* than any of the Oriental types discussed by Ulmer. It lacks the additional pair of appendages in the male figured by Traver (1935) for the North American species, and it is not dissimilar to the Neotropical *T. bradleyi* and *T. maculatus* depicted by Needham and Murphy (1924). Despite the deviation of all these forms in certain respects from the type *T. bellus* of Europe it seems best to place this new Indian species in the old genus *Thraululus*. The second species, *parvulus*, is intermediate in genitalia and form of hind wing between the New World *Thraululus* and *Choroiterpes*. It is in fact very close to Ulmer's *Thraululus*, particularly in the reduced venation of the wings and in the shape of the female subanal plate, and is accordingly placed here in that genus. But the position of both these species, as of *Habrophlebiodes semicastanea* sp. n., must be considered provisional in the absence of nymphal material. So little is known of the Oriental fauna in any case that the limits and status of any particular genus can only be guessed at.

Thraululus hindustanicus sp. n. (figs. 1, 2, 5, 7, wings and genitalia).

Male imago (in life): A delicate white and brown insect; eyes duck-egg green, thorax buff with darker markings, abdomen white; posterior margins of tergites 1-7 dark brown, most of tergites 8-9 chocolate brown. Tails white. Legs white; fore femur banded chocolate and white, other femora with a ginger spot at the apex; fore tibia with a dark spot at the distal end; wings translucent, spotted with areas of burnt umber in the anterior portion.

(In fluid): Head: oculi contiguous, blackish grey, lower portion darker, ocelli white; antennae white. Thorax cream with chocolate markings; pronotum unmarked, mesonotum with strongly marked sutures, especially at the wing root, and with two dark wedge-shaped areas posteriorly; metanotum brown in the posterior portion; mesosternum tinged with yellow antero-laterally. Abdomen: tergites 2-6 translucent white, 7-10 opaque cream; posterior margins of tergites 1-7 ringed with black; 8th tergite with a rather broader greyish band extending on to tergite 9; sternites white. Genitalia white (fig. 5). Forceps base prolonged into a deeply cleft bi-lobed plate; forceps three-jointed; basal joint three times as long as two other joints together, slightly broadened proximally, middle joint ovoid, distal joint small and bulbous; penes separate, broad at the base and tapering strongly, sinuous in form and recurved at the apex to form an acute lateral angle; in the lateral view a marked ventral angulation of the terminal portion is also apparent;

no auxiliary processes present. Tails white. Legs white; fore femur with a brown spot at the apex, another just proximal to this and with a less definite brown band in the middle third; tibio-tarsal joint pitch brown; mid and hind femora with an apical brown spot; fore tibia equal to tarsus, which is twice as long as femur; proportions of fore tarsal joints 1:10:8:6:2. Wings (figs. 1, 2) generally colourless; veins amber; in the fore wing outer fifth of costal and subcostal area faintly milky; the subcostal portion of the costal



FIGS. 1-8.—(1) *Thraululus hindustanicus*, fore wing; (2) ditto, hind wing; (3) *Thraululus parvulus*, hind wing; (4) ditto, fore wing; (5) *T. hindustanicus*, ♂ genitalia; (6) *T. parvulus*, ♂ genitalia (from mounted specimen); (7) *T. hindustanicus*, ♀ genitalia; (8) *T. parvulus*, ♀ genitalia.

brace, all costal, most subcostal and some of the first radial cross-veins together with the immediately adjacent areas of wing chocolate brown; in some specimens the pigment is concentrated round the bulla and at the wing tip; venation typical of the family, cross-veins numerous, three costal cross-veins before the bulla. Hind wing small and ovoid, unpigmented, and with well formed costal spur, radial branches well developed, outer fork absent, cross-veins scanty.

Female imago (in life): Eyes yellowish brown, thorax and abdomen chocolate, Tails white, with basal joints faintly brownish, femora striped with chocolate, fore tarsus with basal dark spot.

(In fluid): Head dark brown, oculi black, ocelli light grey. Thoracic notum uniform dark brown; pleurites and sternites cream, anterior border of mesosternum brown. Abdomen dark orange brown, posterior margins of the first 8 tergites pitch brown, sternites rather lighter; 7th sternite scarcely elongated over openings of oviducts, 9th sternite (fig. 7) produced to form deeply cleft bi-lobed subanal plate as in male. Tails white. Legs cream; fore femur with brown central and sub-apical bands; apex of fore tibia deep chocolate brown; hind and mid femora brown apically, tibiae and tarsi white. Wings as in the male, but the long veins are rather darker and most cross-veins are deeply pigmented.

The *male subimago* has duck-green eyes, body cream with chocolate markings; tails and legs white with ginger stripes on the femora and wings cream spotted distinctly with chocolate.

Body length: male and female 6 mm. Wings: male 7 mm., female 7½ mm.

INDIA: Mirik, Darjeeling District, N. Bengal. Four males and six females were caught between 18th and 23rd September, 1946, over mountain streams between 3500 and 5000 ft. altitude.

The speckled wings and shape of the male genitalia serve to distinguish this species from the clear-winged *T. signatus* Hagen from Ceylon. In the abdomen of two of the female specimens a number of nematode worms are visible through the chitin.

Thraululus parvulus sp. n. (figs. 3, 4, 6, 8, wings and genitalia).

Male imago (in fluid, specimen a little dried before preservation): Head generally pitch brown; oculi not quite contiguous; ocelli brownish black, antennae dark brown. Thorax pitch brown; metanotum with a median lighter patch. Abdomen dark brown; segments 2-7 scarcely translucent; tergites 9 and 10 pitch brown; a small lateral darker line on tergites 2-7 running inwards and backwards; sternites rather paler. Genitalia (fig. 6) pitch brown; forceps base not divided, but is extended to cover base of penes in a gently rounded curve; forceps stout, four-jointed, basal joint broad and rounded, second joint long and curved, arising from the outer half of the basal joint, third joint incompletely divided from preceding, fourth joint thick and elongate; penes simple, without appendages, skittle-shaped, contiguous at the base, separated apically. Tails (basal segments only present) dark brown. Legs: fore femur dark brown, tibia and tarsus yellowish, claws darker; mid and hind femora brown with a dark spot in the middle third and the apex, tibiae and tarsi amber; fore femur four-fifths as long as tibia, which is slightly longer than tarsus; proportions of tarsal joints 4:20:11:7:6. Wings (figs. 3, 4) colourless except for extreme base of fore wing and costal brace, which are dark brown; base of hind wing also distinctly pigmented; main veins well formed but cross-veins very scarce and poorly developed; no costal cross-veins before the bulla and about 6 in the outer third and pterostigma; hind wing small and somewhat spherical, costal spur obtuse and poorly developed, venation scanty.

Female imago (in fluid): Head and antennae dark brown; eyes black. Thorax chestnut brown. Abdomen uniform dark sherry brown; sternites buff, 8th sternite dark brown; no prolongation of 7th sternite over openings of oviducts; subanal plate well

developed and with a very slight apical notch. Tails white, basal segments with brown rings at the joints. Legs: femora light brown with dark spots in the middle third and at the apex; tibiae and tarsi cream. Wings as in male.

Body length: male 4 mm., female 4½ mm. Wings: male 4½ mm., female 5 mm.

INDIA: Branch of the river Sonar at the 12th milestone on the Saugor-Damo road, Central Provinces. River Narbada at Hoshangabad, Bhopal State. The type-specimens, one male and three females, were caught emerging as duns at dusk, 11th March, 1945. The Narbada specimen, a male, was one of a small swarm of spinners dancing by the river, also at dusk, 14th April, 1945.

This species should be readily distinguished from the only other member of this genus, *T. marginatus* Ulmer, by the absence of pigment in the costal and subcostal regions of the fore wing and by its presence at the base of the hind wing. The costal spur of the hind wing is also less developed than in that species.

Habrophlebiodes semicastanea sp. n. (figs. 9, 10, 13, wings and genitalia).

Male imago (in life): A rather uniformly dark chestnut-brown fly with femora and proximal portion of tibiae ginger but rest of legs white; tails white with dark red joints.

(In fluid): Head brown; compound eyes broad and rather flattened, contiguous above, buff; lower portion small and much reduced, black; basal antennal segments brown, filament white. Thoracic notum dark chestnut brown, pleurites paler. Abdomen pale chestnut with diffuse dark shading on the tergites, especially along the lateral border. Genitalia (fig. 13) brown; forceps base entire, not projecting beyond exertion of forceps limbs; these stout, three-jointed, basal joints bearing fine hairs along inner margin; terminal joints small and globular; penes simple, narrow and divided but closely appressed; tips slightly thickened and bearing a minute terminal ventral hook. Tails white. Legs: femora yellowish brown, proximal one-third to a half of fore and mid tibiae and rather more than half of hind tibiae deep chestnut brown, distal portion and tarsi white. Proportions of fore leg, femur: tibia: tarsus 20:38:28; tarsal joints 1:12:8:5:2. Wings (figs. 9, 10) translucent colourless; main veins of fore wing amber, cross-veins fine and numerous; two cubital intercalaries only; stigma containing 9-11 simple, sinuous veinlets. Hind wing short, somewhat triangular, with tall costal spur and sharply upturned subcosta.

Body length 5-6 mm. Wings 5½ mm.

INDIA: River Mutha, near Poona. Five males caught as spinners alive in cobwebs and resting on the underside of the fronds of date palm bushes, 10th-13th September, 1945.

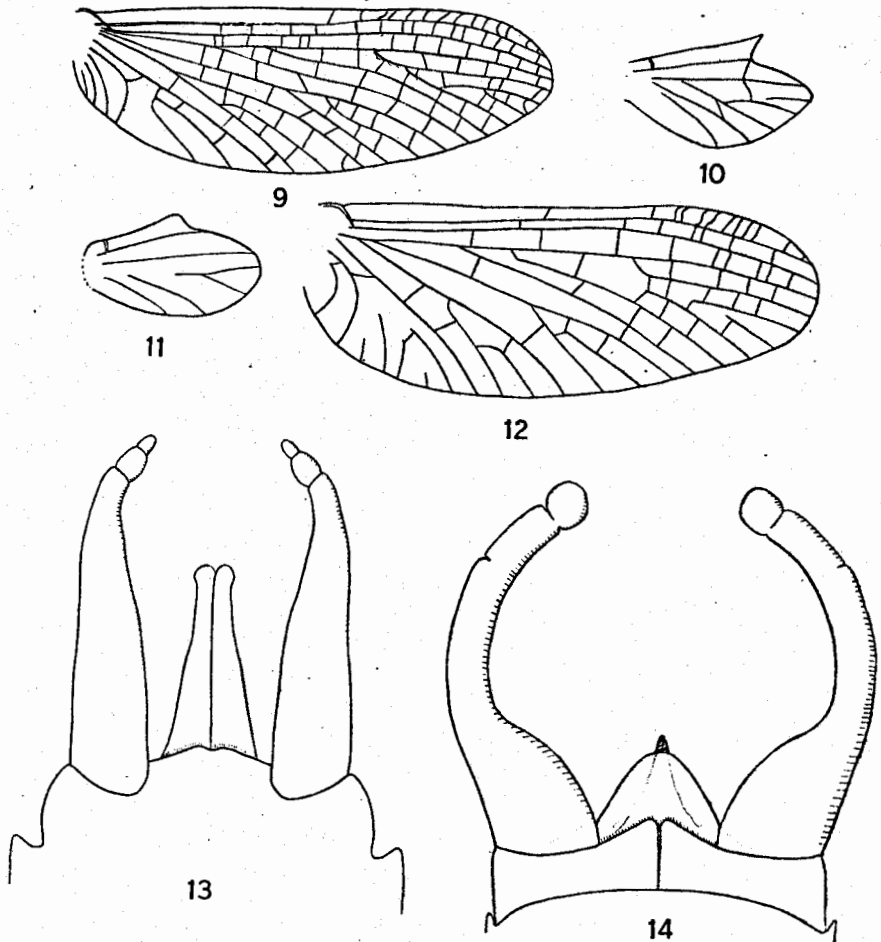
This species should be readily distinguishable by the striking colouring of the legs and unpigmented wings. It resembles *H. prominens* Ulmer, the only other species described from the Oriental region, in the form of the hind wing with tall costal spur, in the venation of the fore wing with but two cubital intercalaries, and in the forceps. It differs from this species and from the New World species by the simple, unextended forceps base and by the divided simple penes, resembling in this respect *Hagenulus karnyi* Ulmer.

Cryptopenella gen. n.

Medium-sized flies characterized by marked development of the facial region and, in the male, by prolongation of the forceps base into a penis-cover almost completely occluding the penis.

Head: nasal carina well formed and ridge-like; lower margin of face everted and projecting directly forwards to form an irregular transverse shelf; basal antennal joint

small, arising from the centre of a little depression and overlapped by this shelf; second joint elongate and slightly tapered, filament fine. Compound eyes flattened and contiguous. Thorax: pronotum saddle-shaped, its lateral lobes slightly overlapping the mesopleura; prosternum forming a small intercoxal hump. Abdomen: forceps of male stout, three-jointed and strongly curved; basal joint three times as long as middle joint, which is



FIGS. 9-14.—(9) *Habrophlebiodes semicastanea*, fore wing; (10) *ditto*, hind wing; (11) *Cryptopenella facialis*, hind wing; (12) *ditto*, fore wing; (13) *H. semicastanea*, ♂ genitalia; (14) *C. facialis*, ♂ genitalia.

twice the length of the globular terminal joint; middle joint incompletely divided from basal joint; forceps base projecting backwards and upwards below and behind penes to form entire penis-cover, concealing all except the tips, which are closely applied to its dorsal aspect. No elongation of 7th sternite of female; subanal plate entire and cone-shaped, extending beyond tip of abdomen. Male fore tibia $1\frac{1}{2}$ times femur and subequal to tarsus; claws unlike. Wings: main veins of fore wing well developed, cubital area containing five intercalaries; cross-veins fine but numerous, absent from marginal areas; a single

cross-vein before bulla, which contains 10-12 simple sinuous veinlets; hind wing ovoid with prominent right-angled spur, radius 1 reaching to just beyond spur.

Nymph unknown.

Genotype: *C. facialis* sp. n.

***Cryptopenella facialis* sp. n. (figs. 11, 12, 14, wings and genitalia).**

Male imago (in life): Eyes cherry red, thorax and abdomen brownish green with paired darker stripes down the midline of the abdomen; tails white with dark brown basal annulations. Fore femora chocolate, tibia brownish, tarsi grey; hind and mid femora grey with a dark spot on the trochanter, apex of the femur and two-thirds of the way down the shaft.

(In fluid): Head chestnut brown, tips of antennae white; eyes reddish brown, cream round the sides, lower portion black; lateral ocelli white, median ocellus grey. Thorax: mesonotum chestnut brown; lighter mottled areas along the flank; sternite yellowish brown, 9th sternite darker; posterior corner of each tergite distinctly notched. Genitalia (fig. 14): forceps base and penis cover dark brown; forceps pale grey at base, becoming lighter distally; tips of penes yellow, simple and closely appressed. Tails white, basal joints ringed dark brown. Legs: fore femur chestnut brown with darker apical and sub-apical bands, tibia yellow, tarsus and claws white; mid and hind femora buff, similarly banded; tibiae and tarsi white; proportions of fore femur: tibia: tarsus 48:64:70; tarsal joints 2:30:22:12:4. Wings (figs. 11, 12) generally hyaline, slightly milky in costal and subcostal areas; a reddish-brown area behind costal brace.

Female imago: Markings and coloration almost exactly as in male.

Subimago (in life): Body greyish green, tails light grey, legs speckled, wings ash grey. Body length: 5 mm. Wings: 5½ mm.

HONG KONG: River Shing Man, near Kowloon. Eight males and 3 females were caught as duns and spinners along the banks of this rocky river, 22nd March, 1947, day temperatures 57-63° F. The river was fast, but there was an abundance of water weeds and only few Ecdyonurid nymphs were seen. This species appeared to be the dominant type at that time of year.

This genus would seem to be fairly clearly defined by the unusual and distinctive development of the penis-cover and forwards extension of the facial region. Wing venation is typical of the family. Nymphal material was unfortunately lost, but a note made at the time records that the first gill has a single filament and remaining gills several.

***Isca* gen. n.¹**

Small, elongate flies characterized by absent hind wing and persisting cilia in the imaginal fore wing.

Head shallow in dorso-ventral aspect. Male eyes (figs. 16, 17) compound, adjacent but not quite contiguous, the two portions of each quite distinct; width of upper portion greater than the height; facets square, unusually large and approximately 100-120 in number. Lateral ocelli pedunculate, median ocellus rather smaller. Eyes of female (fig. 18) small, ovoid and widely separated; lateral ocelli arising opposite base of antennae. Basal antennal joint narrow and ring-like, second joint cylindrical, filament fine. Pronotum simple, posterior margin deeply excavated; prosternum a little broader than long but fore coxae not widely separated. Abdomen narrow, tergites extending round on to ventral

¹ From *Isca Dumnorum*, the Roman fort of Exeter, now headquarters of the Devonshire Regiment, whose indulgence towards their medical officer made these far from military studies possible.

aspect to a considerable degree, this being most marked on segment 7 but scarcely at all on segments 1 and 2; sternites correspondingly reduced in width (fig. 22). Ninth and 10th tergites produced backwards to form short, lateral spines; 10th segment much reduced in size. Ninth sternite in male only very slightly produced to form entire forceps base; forceps stout, three-jointed; penes simple, contiguous but not fused. Female abdomen lacking any posterior extension of 7th sternite; subanal plate well formed and bi-lobed. Tails 3. Fore leg of male very fine, $1\frac{1}{2}$ to $1\frac{1}{4}$ as long as the body; middle and hind legs short. Claws unlike on all legs. Anterior and posterior margins of fore wing more or less parallel, the apex rounded; cubito-anal region poorly developed, fork of radial 4 and 5 extending half-way to wing root, whole fork sagged to rearward; cross-veins scanty and extremely fine. Whole length of posterior margin of wing ciliated. Hind wing entirely absent.

Nymph not known.

Genotype *I. purpurea* sp. n.

Isca purpurea sp. n. (figs. 15-22, wing, head and genitalia).

Male imago (in fluid). Head generally dark brown; eyes orange brown, rather paler round the sides, lower portion blackish purple; lateral ocelli white, median ocellus grey; antennae dark brown. Notum dark mahogany brown; mesonotum bearing a single, incomplete, median and two diverging, lateral, buff streaks; metasternum concolourous with abdominal sternites. Abdomen dark brown; tergites darker along posterior borders; sternites uniform dark brown; posterior half of 9th sternite cream. Genitalia (figs. 19, 20) brownish pink. Forceps scarcely tapered; basal joint forming more than $\frac{2}{3}$ of total forceps length; inner margin swollen at base of middle third and also bent inwards sharply at this point; middle joint somewhat elongate, its separation from other two joints well defined; terminal joint globular, and no less thick than preceding joint. Penes closely appressed at base, diverging distally, but the tips turned in sharply at apex; broad at base, tapering evenly to apex, distal two-thirds with a marked inward, spiral twist; inner surface of penis tip has 5-6 fine dentations. Tails long, cream, with brown basal annulations. Legs generally dark brown; middle third of femora paler, fore tibia pinkish brown, fore tarsus and claws colourless. Proportions of fore leg, femur: tibia: tarsus 2:6:5; middle leg 4:3:1; hind leg $4\frac{1}{2}$:4:1 $\frac{1}{2}$. Fore tarsal joints 1:18:15:9:2. Wings (fig. 15), translucent pinkish brown, darker in costal and subcostal areas, main longitudinal veins dark brown; cross-veins entirely absent from tip and periphery, none before bulla, which contains 6-7 simple veinlets; posterior margin of wing clothed with fine hairs extending from just below apex to wing root, longest in the cubito-anal region.

Female imago (in fluid): Head and antennae dark brown; eyes black, ocelli grey. Thorax and abdomen dark brown; sternites rather lighter. Subanal plate (fig. 21) with two rounded lobes and deep dividing cleft. Tails and wings as in male. Legs: fore femur dark brown with pale central area, tibia and tarsus rather darker, other legs dark brown; demarcation of mid tarsal joints indistinct, proportions of fore femur: tibia: tarsus 35:30:13; middle leg 30:30:13; hind leg 44:40:14.

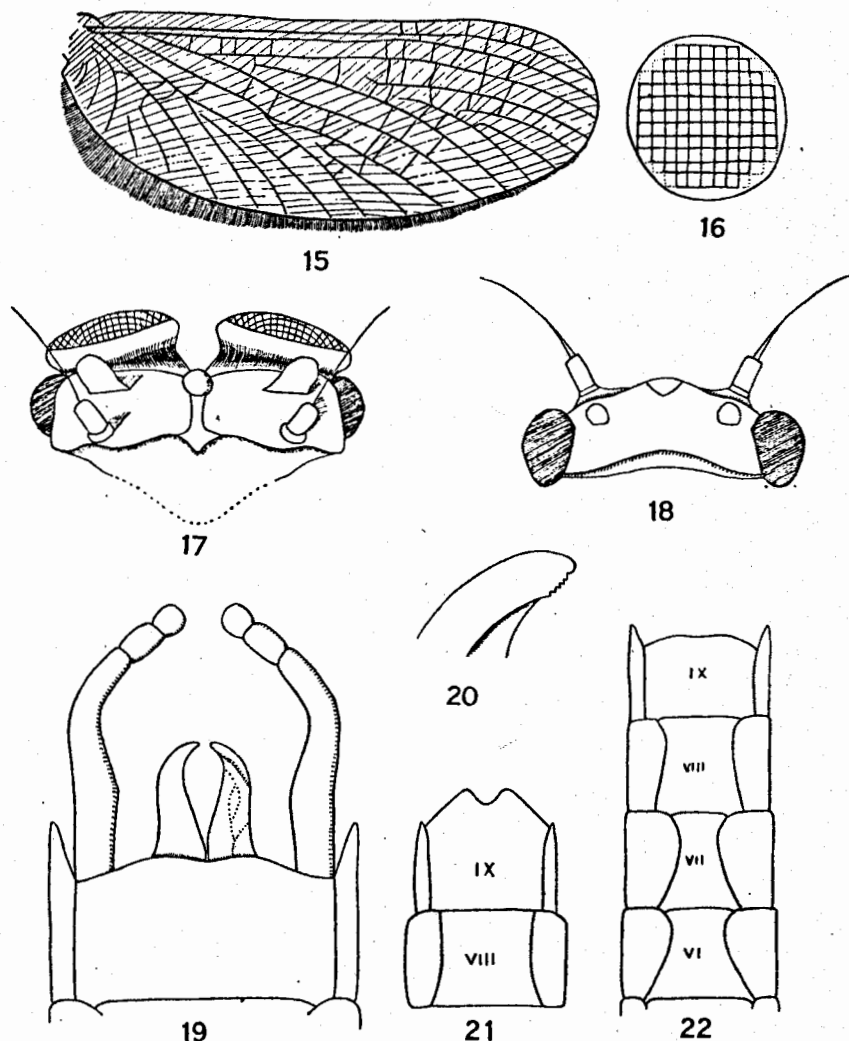
The *subimago* (in fluid) has semi-opaque dark brown wings and a darker body than the imago.

Body length: male 5 mm., female $4\frac{1}{2}$ -5 mm. Wings: male $4\frac{1}{2}$ mm., female 4- $4\frac{1}{2}$ mm.

HONG KONG: From two mountain streams near San Wai and Fan Ling, 15-20 miles inland from Kowloon, mostly from the upper reaches of the little river "Chenab" round "Birds Hill," 15th-30th March, 1947. The material includes the male and female types, 8 males and 3 females and 8 subimagines, many of them fragmented.

INDIA: Mirik, N. Bengal, from a mountain stream, altitude 4000 ft. One male imago, 20th September, 1946.

No live specimens were found. The material was collected from cobwebs and from a few spent specimens on the surface of pools. In fresh and dried specimens the wings and body have a marked purple sheen. The Bengal specimen has rather darker eyes, but in other respects is very similar to the



FIGS. 15-22.—*Isca purpurea* (imago), (15) Fore wing; (16) Diagram of arrangement of facets in ♂ eye; (17) ♂ head (from in front and slightly below); (18) ♀ head (from above); (19) ♂ genitalia; (20) Tip of penis; (21) ♀ terminalia; (22) ♂ venter.

type material. In the absence of any further examples it was thought better to include it in the same species.

The exact position of this genus presents some difficulties. At first sight the absence of hind wing, persistence of cilia in the imago and possible nocturnal habits suggests a certain nearness to the CAENIDAE. The wing of *Leptohyphes*

Eaton is generally similar to *Isca*, although in the latter cubital 2 at its base is quite distinct from, and is not braced against, anal 1. In addition, in certain species of *Leptohyphes* the hind wing has not been lost. *Leptohyphodes* Ulmer (1919) differs markedly in possessing fused plate-like penes. The predominance of the abdominal tergites over the sternites in the construction of the abdomen in *Isca* is not a common feature in Ephemeroptera. The venation of the fore wing, however, is typical of the LEPTOPHLEBIIDAE, and the well differentiated genitalia and unfused penes in the male and presence of a subanal plate in the female are also features characteristic of this family. The complete absence of hind wing distinguishes *Isca* from all others of the family except *Hagenulopsis* Ulmer and *Hagenulcides* Ulmer. The former, from Brazil, has colourless wings, and the female a well-developed ovipositor. The latter, from the Seychelles, has very numerous cross-veins and the forceps are but two-jointed. The very clear division of the compound eyes in the male of *Isca* with relatively few, large facets would not seem to be a feature typical of most members of this family, although it is not without interest to note Ulmer's observation that the upper portion of the male eyes of *Hagenulopsis* is almost turbinate as in the BAETIDAE.

In conclusion it seems best to consider *Isca* as an aberrant member of the LEPTOPHLEBIIDAE, and one which may have a wide distribution in the Oriental region.

SUMMARY.

This paper is a further record of material collected during military service in several areas of the Oriental region in the years 1945-47. In a previous paper (1949) I dealt with the BAETIDAE and gave some brief general notes on Oriental Ephemeroptera. Notes are given here on two species belonging to the POLYMITARCIDAE and five LEPTOPHLEBIIDAE including two new genera and five new species.

REFERENCES.

- CHOPRA, B., 1927, The Indian Ephemeroptera. PALINGENIIDAE and POLYMITARCIDAE. *Rec. Indian Mus.* 29 : 91-138.
- EATON, A. E., 1883-1887, A revisional monograph of recent EPHEMERIDAE or Mayflies. *Trans. Linn. Soc. Lond. (Zool.)* 3 : 1-352.
- GILLIES, M. T., 1949, Notes on Ephemeroptera BAETIDAE from India and South-East Asia. *Trans R. ent. Soc. Lond.* 100 : 161-177.
- KIMMINS, D. E., 1948, Ephemeroptera from Nyasaland, with descriptions of new species. *Ann. Mag. nat. Hist.* (12) 1 : 825-836.
- NEEDHAM, J. G., and MURPHY, H. E., 1924, Neotropical Mayflies. *Bull. Lloyd Lib.* 24 (*Ent.*) 4 : 1-79.
- — —, TRAYER, J. R., and HSU, Y., 1935. *The Biology of Mayflies.* Ithaca.
- ULMER, G., 1919, Neue Ephemeropteren. *Arch. Naturgesch.* 85 : 1-80.
- — —, 1939, Eintagsfliegen (Ephemeropteren) von den Sunda-Inseln. *Arch. Hydrobiol. Plankt. Suppl.* 16 : 443-692.
- VEJABHONGSE, N. P., 1937, A note on the habits of a May-fly and the damage caused by its nymphs. *J. Siam Soc. nat. Hist. Suppl.* 11 : 53-56.