

**FURTHER NOTES ON THE SPECIFIC CHARACTERS OF  
CALICNEMIA STRAND, WITH A KEY TO THE MALES AND  
REMARKS ON SOME LARVAL FORMS (ZYGOPTERA:  
PLATYCNEMIDIDAE)**

M.A. LIEFTINCK

"Kalliste", Nwe Veenendaalseweg 224, 3911 MS Rhenen, The Netherlands

*Received April 10, 1984*

Following the introduction, the systematic part deals with the male sex of all 14 spp. and ssp. presently known of this mainly continental Asiatic genus. These are re-defined, illustrated, and arranged in an elaborate descriptive key. The latter includes the characters of 3 new taxa, viz. *C. sinensis* sp. n. (China), *C. carminea* sp. n. and *C. c. pyrrosoma* ssp. n. (Nepal and NW India, resp.). The females of all taxa (3 of which are still unknown), will be fully treated on a later occasion, although the characters of a few species are here also included. At the end of the systematic part, 2 recently named Indian taxa are placed in the synonymy, or as species *incertae sedis*. The last chapter contains brief notes on the geographical distribution of the genus, which are followed by an illustrated discussion of the known larval forms of *Calicnemia*.

**INTRODUCTION**

Instead of pretending to offer a revision of the genus *Calicnemia* as a whole, the present paper should be considered merely as a continuation of a former article of a more faunistic nature (LIEFTINCK, 1977: 13-34), in which some imperfectly understood species of *Calicnemia* from the continent of tropical Asia were redefined and illustrated. In that same paper further examples were described in some detail of the extraordinary changes in colour and body pattern which both sexes are liable to undergo during the maturation period. This phenomenon has often given rise to much confusion and misidentifications in the existing literature. In the treatment here presented I have attempted to supply a characterization of the males of all the species so far described, and at the same time to arrange them into two fairly well defined groups based on the secondary sex organs. As a means of distinction it was found convenient to use penile

structure of the male as a character of great specific importance and reliability. The unisexual nature of this feature has, of course, the disadvantage of possibly not furnishing any clue to the interrelationship of the species, nor does it support any evidence to that effect indicated by colour-pattern, presence or absence of pruinosity, and proportions or general build. To avoid partiality in the use of the present descriptive key, I have taken pains to include in it as many specific features as possible beside those found in the genitalia, thus trying in each case to give an impression of the facies of the whole insect. Unfortunately, in most cases I had to leave out key characters or descriptions for the females. Unlike the allied genus *Coelliccia*, the latter are much more uniform structurally and, apart from the fact that females of some species are still to be discovered, they are often very hard to distinguish, unless pairs are taken in tandem position or in the act of oviposition. However, good descriptions of females of several taxa are to be found in the works of F.C. FRASER (1932, 1933a). On the other hand, it must be emphasized that the writer's main object is to supply reliable illustrations that would obviate elaborate descriptions.

At the end of this paper a chapter will be found recapitulating the geographical distribution, and the better known facts and data relating to the morphology and habitat of the early stages of *Calicnemia*.

This paper is dedicated to my colleague, Dr SYOZIRO ASAHINA, on the occasion of his 70th birthday.

## DESCRIPTIVE KEY TO THE MALES OF *CALICNEMIA* SPECIES

To ensure rapid recognition of the 14 taxa dealt with in the following descriptive key, two distinct species-groups can be distinguished on the basis of the shape of the male penile organ, or ligula:

### Species-group I (couplet 1-7)

Recurved penis lobe narrow, ribbon-like or filamentous apically

*c. carminea*  
*c. pyrrosoma*  
*erythromelas*  
*eximia*  
*imitans*  
*mukherjeei*  
*sinensis*

### Species-group II (couplet 8-13)

Recurved penis lobe broad, variously expanded, lacking filaments

*chaseni*  
*miles*  
*miniata*  
*mortoni*  
*nipalica*  
*pulverulans*  
*rectangulata*

I Recurved terminal lobe of ligula ending in a pair of narrow, ribbon-like branches, frequently curved and embracing the stem of the organ to form curled filaments (Figs 1-8). Species-group I .....

— Recurved terminal lobe of ligula much broader in ventral view, either undivided, forming one .....

- shield- or cup-shaped whole, its hind margin at most shallowly emarginate; or distinctly bilobed and ending in a pair of broad, outwardly convex lamellae separated by a deep, V- or U-shaped incision (Figs 13, 17-20). Species-group II ..... 8
- 2 Body and legs mainly black, lacking any red or orange colouring, but slaty blue pruinescence present on many parts and overlying also complete, straight and narrow, antehumeral thoracic stripes. Front of head, including labrum, obscured. Neuration variable (e.g., 16-18 Px in f.w., 13-17 in h.w.), Abd. + app. 29-31.5 mm, hind wing 19.5-22 mm (cf. also LIEFTINCK, 1948: 12-14, fig. 7). Ligula, Fig. 1. — Hab.: Burma, Thailand..... *imitans*
- Body at least partly red or bright ferruginous ..... 3
- 3 Sup. anal apps acutely pointed, armed with two robust, equally pointed interior spines. Recurved end lobe of ligula scutiform, divided into pair of shorter, broadly ribbon-like, curved processes separated by a tiny V-shaped incision (LIEFTINCK, 1977, figs 15-17). Head above black, variegated with bright yellow or light orange spots and stripes (cf. FRASER, 1933: 181, fig. 81); mandible-bases, genae and a pair of irregular transverse marks, in front of frons confluent along eye-margin with a genal spot and surrounding a black dot on either side of clypeus; transverse, isolated, median light bar on top of frons and a very irregular, subinterrupted band of orange connecting the eyes behind antennal base, the ocellar triangle remaining black; labrum and postclypeus also jet black. Antehumeral stripes complete, light orange; ante-alar triangles black. A complete dark band, continued ventrad along infraepisternal suture, covering the second lateral one, the latter subequal in width to yellow band anterior to it, which includes metaspiracle. Legs yellow, heavily striped with black. Abdominal segments 2-6 red, 1 yellow with black dorsal mark, 7-10 and anal apps black. Slender, narrow-winged species. Abd. + app. 29.5-30.5 mm, hind wing 20-22.5 mm. — Range: Burma to Vietnam ..... *erythromelas*
- Sup. anal apps finger-shaped, never acuminate, each armed on the inside with a prominent, submedian projection directed ventrad, this process variable in shape, frequently bifid or toothed. Recurved lobe of ligula shaped otherwise ..... 4
- 4 Sup. anal apps subequal in length to inferior pair, slightly longer than segm. 10, distinctly shorter than 9; intero-ventral process of sup. app. long, placed slightly before midway length, directed obliquely ventrad and basad, shaped much as in *miles* (LIEFTINCK, 1977, figs 13-14), extreme tip of process and inf. apps black. Ligula, Fig. 2. Abdomen stout, with subcylindrical segments, entirely scarlet lacking dark terminal rings and including appendages; 1 often orange laterally. Mouth-parts and whole anterior surface of head as far back as level of posterior ocelli, inclusive of ocellar triangle and first two antennal segments, bright scarlet or orange. A pair of transverse, bright yellow postocular spots, rounded off near eye-margin, tapering inward. Rear of head black with large, subquadrate or oval patch of yellow broadly coalescent all along orbits with light colour in front of head. Dorsum of pro- and synthorax black, sides of prothorax uninterruptedly bright orange, the black on synthorax, about as far down as anterior limit of metepisternum, enclosing broad, complete, bright scarlet or orange antehumeral stripes extending into ante-alar triangles, and invariably also with isolated spot of same colour just outside upper end of humeral suture; laterally and underneath bright yellow with sharply defined, narrow black stripe, tapering to a point at level of metaspiracle, mapping out second suture. Legs, except orange-yellow coxae, totally scarlet or carmine red, with somewhat darker bristles. Wings relatively broad with rather rounded tips; pterostigma smallish, oblique, slightly longer than high; fore wings with 14-18, hinder pair with 13-16 Px of first series; 3 postquadragonal antenodal cells in fore wing, 2-3 in hinder pair. Size very variable, e.g. Thailand: abd. + app. 28-28.5 mm, hind wing 19.5-20.5 mm; Shillong: 33 and 22.5 mm, respectively. — Hab.: Himalayan Range to Szechuan (China) ..... *eximia*
- Sup. anal apps always distinctly shorter than inferior pair. Abdomen more slender, basal and terminal segments slightly expanded, predominantly red, but segm. 8-10 either wholly black, or with ill-defined blackish annules or spots. No isolated light spot just outside upper end of humeral

- suture. A complete, band-like black stripe mapping out second lateral suture, broader dorsally than the yellow stripe crossing metaspiracle anterior to it, and including also most of metinfraepisternite. Rear of the head black, either entirely so, or with pair of isolated yellow patches or spots bordering orbits.....5
- 5 Antehumeral stripes inconspicuous, dull yellow, either absent altogether or indicated by complete or interrupted slaty-blue (pruinulent) lines not quite reaching rims of ante-alar triangles, which are black. Abdominal segments 1-2 invariably obscured: either totally reddish black thinly overlaid with bluish pruinescence, or 1 with bright yellow lateral spot and 2 with red colouring toward apex, all intergradations existing. Front of head orange-red to vinaceous as far upward as posterior limit of antefrons, labrum with black midbasal pit, postclypeus, mandible-bases and genae frequently obscurely reddish-black. Horizontal portion of frons, first two antennal segments (save their tips) and all the rest of head, dull black, thinly pruinulent grey-blue; light marks reduced to pair of oblique, irregular, elongate streaks running from anterior ocellus to base of antenna; also pair of narrow orangish postocular streaks tapering to a point inward; rear of head all black. Pro- and synthorax black, as far down on the latter as first suture and including mesinfraepisternites; sides with complete chrome yellow metepisternal band crossing spiracle, a little narrower than thick black band mapping out second suture and including most of metinfraepisternites; metepimeron for the rest, as well as whole ventral surface of thorax, chrome yellow, but all carinae black and ventral portions of metepimera often with cloudy brown central patch. Coxae, trochanters and femora black, all more or less pruinulent blue externally; outer faces of all tibiae dull yellow to orange, the inner faces black; tarsi black, all bristles brownish or obscurely yellow. Wings rather broad, venation close, fore wing with 18-20, hinder pair with 15-17 Px of first series; pterostigma a little longer than high, dark sepia. Segm. 3-10 of abdomen and anal appendages, red, 3-7 with fine blackish annules at extreme apices of each, 8-10 and appendages often obscured toward end. Anal apps, Figs 9-11; ligula, Fig. 3 Abd. + app. 34-35. hind wing 24.5-25 mm. — Hab.: E China; ? Hainan ..... *sinensis*
- Antehumeral stripes scarlet or bright orange-red, complete and band-like. Abdominal segments 1-2 predominantly yellow and/or red.....6
- 6 Segm. 9-10 and anal apps deep black, distal portions of 8 and 7 also with ill-defined cloudy dark markings; 1 obscured on middorsum, its sides bright yellow, 2-7 red. Antehumeral stripes orange-red, much narrower than each of the mesepisterna, slightly curved, 0.3-0.4 mm broad, widest before midway whole length from base. Upper mouth-parts and front of head, red; a short, fine black streak at base of postclypeus and a continuous black stripe connecting the eyes at base of antennae, narrow between the latter but widening toward orbits; first two antennal segments red. A broad, bright orange-red band of even width connects the eyes across anterior ocellus; longish, transverse, light orange streak placed on each side at occiput; rear of the head black with pair of large, isolated, somewhat reniform yellow patches touching orbits. Prothorax black, upper two-thirds of propleuron yellow, lower down black. Meso- and metinfraepisterna black; most of metepimeron and whole ventral surface of thorax, yellow. Legs not definitely red: yellowish or dirty ochreous, coxae slightly pruinulent blue, trochanters black-spotted posteriorly, at least outer faces of femora heavily striped with brown or black; tibiae orange-yellow, unmarked. Wings shaped much as in *carminea*, fore wing with 16-18, hinder pair with 16 Px of first series (15-18 and 14-18, respectively, as stated for holotype); 2½-3 postquadangular antenodal cells. Pterostigma relatively short, diamond-shaped, slightly longer than high in fore wing, a trifle higher than long in hind wing, costal side longer than anal side in all. Abdomen rather robust. 1 bright yellow with some basal obscuration on middorsum only; 2-6 light red with extremely fine black apical annules (incomplete laterally) on 2-6, and a diffuse blackish ring, narrowest aside, occupying apical one-sixth of 7; base of 8 red changing indefinitely to black distally on dorsum and sides; 9-10 wholly black. Anal apps black, tips of superiors and the subapical tubercle of inferior pair, yellow; subbasal interior process of sup. app. short and stout,

- subrectangular, its apex slightly excised. Ligula, Fig. 4. Body stout, but less robustly built than *eximia*. Abd. + app. 34, hind wing 26 mm (paratype). — Hab.: NE India . . . . . *mukherjeei*
- Segm. (8) 9-10, and anal apps at least partly, red. Antehumeral stripes broader and straighter, almost fully as broad as each of the mesepisterna. Black band covering second lateral suture complete, at least as broad as an orange-red or bright yellow stripe crossing the metaspiracle; most of the metinfraepisternites also black. Ante-alar triangles either orange heavily framed in black, or unmarked. First two antennal segments and front of head, as far back as anterior border of lateral ocelli, throughout orange-red, the posterior limit of this colour straight or only feebly undulated; at least traces of obscuration at sides of frons beside antennal bases, and a transverse streak in the depth of fronto-epicranial sulcus. Legs red or orange-red, only coxae posteriorly and femora externally, incompletely spotted or striped with black. Recurved apical portion of ligula at first rather broad and deeply divided into subparallel band-like lobes, then again abruptly curved caudad, ending in a pair of twisted filaments (Figs 5-8) . . . . . 7
- 7 Ante-alar triangles invariably red, though heavily framed in black. No trace of a red mesepimeral spot just outside upper end of humeral suture. Metasternum and metepimeron obscured ventrally, forming a conspicuous arched patch of black upon most of the latter's surface, the poststernum pale. Fore wing with 14-17, hind wing with 14-15 Px of first series; 3 postquadrangular antenodal cells in fore wing, 2-3 in hinder pair. Stature slenderer, and abdomen less brilliantly scarlet, than *C. eximia*, yet more stoutly built than next subspecies *carminea pyrrhosoma*. Dorsum of abd.-segm. 1 obscured basally, its sides yellow or pale reddish, and both 1 and 2 narrowly ringed with black; 2 moreover invariably with wedge-shaped black mark bordering sides of tergite, this spot extending from base (where it is broadest) to about one-third to one-half its whole length and tapering to a point; usually traces of fine black apical annules on the back of succeeding segments; dorsum of 9-10 at least diffusely spotted with black upon basal portion and lower border of tergites, on 9 these spots occasionally deep black and tripartite. Anal apps light red, subbasal interior process of sup. app. relatively short, apex distinctly bifid, extreme tips of inferiors always narrowly bordered with black (Fig. 12). Median slit separating terminal lobes of ligula comparatively wide, its borders slightly diverging (Fig. 5). Light marks on lower surface of head isolated, reduced to pair of tiny yellow spots, one pointing toward eye-margin, the second beside hinge of labium. Prothorax deep black, propleuron only with small reniform orangish spot. For further details, see discussion. Abd. + app. 32.5-33.8 mm, hind wing 22.5-24.5 mm. — Hab.: Nepal . . . . . *carminea carminea*
- Ante-alar triangles deep black, or at most with minute orangish central spot or point. Red mesepimeral spot outside upper end of humeral suture usually wanting, but a vestige of this occasionally present. Metasternum, ventral portions of metepimeron and poststernum, all yellow, not or only slightly obscured. Fore wing with 14-16, hind wing with 12-14 Px of first series; 3 postquadrangular antenodal cells in fore wing, 2-3 in hinder pair; length of discoidal cell variable, costal side usually about one and one-fifth as long as distal side in fore wing, more than twice as long in hind wing. Abdominal tergite 1 yellow with black middorsal stripe; 2 with diffuse brownish cloud on either side of a pale middorsal streak, incomplete distally, upon middle of tergite, and a somewhat larger, marginal one placed alongside basal one-third of same; obscure spots and streaks, placed lengthwise, also on dorsum and sides of 8-10. These ill-defined obscure tergal marks as in typical *carminea* and apparently equally variable in extent, but less defined and generally smaller, especially the wedge-shaped black basal mark at sides of 2 less pronounced. Anal apps much as in nominate type, but subbasal interior process of sup. app. a little longer, apex not definitely bifid. Median slit separating terminal lobes of ligula equally deep, though narrower (Figs 6-8). Light marks upon lower surface of head, though varying in shape and size, considerably more conspicuous than in typical *carminea*, the hindermost spot bright yellow, subrectangular or oval, broadly attached to eye margin. Abd. + app. 27.5-31 mm, hind wing 20.5-23 mm. — Hab.: NW India . . . . . *carminea pyrrhosoma*

- 8 Abdomen for the greater part, or almost entirely, red in full-coloured, mature males . . . . .9  
 — Abdomen predominantly or wholly black in full-coloured mature males only basal segments (2-3 to 2-6) sometimes partly red; immature males frequently much lighter, with segm. 1-5 (6) dirty reddish or pale orange . . . . . 12
- 9 Antehumeral stripes narrow, yellowish when immature, becoming pruinose, lilac or grey-blue, with age; sides with complete brownish black metepisternal band mapping out second suture and including most of metinfraepisternite. Mouth-parts and front of head (except yellow genae) largely obscured, postclypeus darkest and often shiny black; head above largely dull black, slightly pruinose, with pair of isolated, elongate, dirty orange spots extending obliquely up from just behind antennal base as far as lateral ocellus; pale postocular spots vestigial or unapparent. Abdominal segments 2-6 brick red, 1 obscurely yellowish becoming fuscous and slightly pruinose, 2-5 with very fine dark apical rings, the one on 6 diffuse, though usually a little broader; 7-10 deep black but extreme base of 7 with red dorso-lateral annule varying in size. Neuration rather dense, 18-19 Px of first series in fore wings, 16-17 in hinder pair. Pterostigma oblique, regularly parallel-sided, only little longer than high, colour dark sepia. Anal apps entirely orange-red, shaped as in Fig. 14-16. Ligula of characteristic form: the strongly convex terminal flaps divergent, deeply divided medially by a V-shaped incision almost as far back as the bend (Fig. 13). Abd. + app. 33-34.5 mm, hind wing 24-24.8 mm. — Hab.: E Nepal . . . . . *nipalica*
- Antehumeral stripes broad, invariably red and lacking pruinoscence. Mouth-parts and front of head also red, variably marked with black . . . . . 10
- 10 Recurved terminal lobe of ligula shaped much as in *nipalica* (Fig. 13) and *portoni* (LIEFTINCK, 1977, fig. 2), ending in a pair of deeply separated flaps (LIEFTINCK, 1977, fig. 8). Abdominal segments 1-6 mostly red, sides of 1 lighter with small black basodorsal spot; intersegmental membranes black; end of 6 black at sides, the red dorsal mark narrowing gradually toward apex and replaced by black at extreme end; 7 black with red basal mark, tapering to a point slightly beyond halfway total length; 8-10 deep black. Anal apps varying in colour, inferior pair usually yellow and bases of superiors obscured, but sometimes all are black; sup. app. (LIEFTINCK, 1977, fig. 9). Head in front red; a narrow, irregular, though complete, black stripe connecting the eyes between frons and vertex, this stripe not or hardly broadened between antennal bases, most of the frons remaining red; a red band, much broader than the black stripe anterior to it and usually slightly constricted at level of ocelli, includes median ocellus; rear of head all black, or with smallish yellow spot at eye margin. Antehumeral red band complete and straight, narrowing upward; ante-alar triangles black. Sides with complete black band mapping out second suture, frequently also partly invading metepimeron and somewhat constricted at level of metaspiracle, beyond which thorax is throughout orange-yellow. Legs also pale on the inside, but femora and tibiae heavily striped with black and often wholly obscured. Fore wings with 16-20, hinder pair with 15-18 Px of first series. Pterostigma small, varying somewhat in length but not much longer than high. Abd. + app. 30.5-32.7 mm, hind wing 24-26 mm. — Hab.: NE India; Nepal . . . . . *miniata*
- Recurved terminal lobe of ligula escutcheon-shaped, more or less trapezoidal in ventral view, lacking a median slit, but apices of side flaps broadened and simply rounded off (LIEFTINCK, 1977, fig. 12, and this paper, Fig. 19) . . . . . 11
- 11 Abdomen entirely red, except tergite 1 clear yellow, narrowly black-ringed and with X-shaped or squarish black dorsal mark; a black speck also aside at extreme base of tergite 2; all intersegmental rings finely dark brown. Head, including middle of frons, orange-red to scarlet anteriorly, only postclypeus shiny black; an irregular, deep black band connecting the eyes at level of antennal bases, around which it suddenly broadens, filling out fronto-epicranial sulcus at middle and touching anterior ocellus; behind this a somewhat broader, irregular, orange-red band also extending from eye to eye but widening, and partly embracing, the ocelli in front of the

latter, the ocellar triangle remaining black. Narrow, citron-yellow postocular streaks, and a more or less comma-shaped oblique patch of greenish yellow, broadly touching the eye margin, upon ventral surface of head. Dorsum of pro- and synthorax black, propleuron largely yellow, synthorax black as far down as first suture and occupying most of mesinfraepisternite; a pair of complete, fairly broad carmine-red antehumeral bands, widening below halfway length and rounded off at both ends; sides pale orangish to greenish yellow with sharply defined, deep black metepisternal streak along upper portion of second suture, abruptly stopping short before level of metaspiracle; this stripe passes on to a much larger, ill-defined patch of dark grey-brown (not black!) on the opposite side of the suture, occupying most of the metepimeron, the latter remaining yellow only posteriorly; for the rest thorax yellow inclusive of coxae; trochanters behind with tiny black spot. Legs otherwise black, anterior faces of femora yellow, tibiae, tarsi and all bristles, black. Wings rather narrow, fore wing with 14-16, hinder pair with 13-14 Px of first series; pterostigma oblique, regularly parallel-sided, distinctly longer than high, uncoloured sepia brown. Abdomen very slender. Anal apps obscurely reddish black (cf. Kimmins in LAIDLAW, 1932 : 98, fig. 2b). Ligula, Fig. 19. Abd. + app. 27.5-28.5, hind wing 19.2-20.5 mm. — Hab.: Malay Peninsula . . . . . *chaseni*

- Abdomen red, except tergites 1-2 as in *chaseni*, but 9-10 with obscure markings varying in extent: usually base of 9 with patch of black, narrow middorsally, broadening at sides but regressing again ventrad until forming a black stripe bordering ventral margin of tergite; dark also along hind border and merging into black marks at basal portion of tergite, i.e., on middorsum and/or postero-lateral edge; 10 above with thick X-shaped mark, or whole dorsum obscured. Head in front and above coloured differently from *chaseni*: transverse black band in front of antennal bases considerably broader, including upper surface of frons; the red band behind antennal bases broader and more regular, not widening on either side of lateral ocelli but narrowing instead, or subinterrupted in front of ocellar triangle, which remains black. Yellow patches upon ventral surface of head larger and still more broadly attached to eye-margin, than in *chaseni*. Dorsum of pro- and synthorax as in *chaseni*; carmine antehumeral bands complete, subparallel-sided but slightly broadening and incurved at lower end, subtruncated at both ends; sides bright yellow with complete, sharply defined, deep black band mapping out second suture and narrowly invading metepimeron as well, this band subequal in breadth to, or even broader, than the yellow area anterior to it, but usually somewhat constricted at level of metaspiracle and narrowing beyond; posterior (lower) two-thirds of metepimeron, the thorax ventrally, as well as coxae, yellow; trochanters behind with small black spot. Legs otherwise light orange to pinkish yellow, all femora heavily striped with black externally, less distinctly so just before reaching the knees, which are black-ringed; inner carina of fore tibiae frequently obscured; distalia of tarsi as well as all bristles, obscured. Wings shaped and veined much as in *chaseni*, fore wing with 13-16, hinder pair with 12-14 Px of first series; pterostigma also as in that species. Anal apps blackish, tips of superiors usually yellow on the inside, the inner faces of the subapical projection, as also basal half of inferior pair, clear light red. Ligula (LIEFTINCK, 1977, fig. 12). Abd. + app. 30.5-34, hind wing 22-24 mm (Thailand); 28.8 and 22.2 mm, respectively (holotype, S Burma). — Hab.: Burma, Thailand . . . . . *miles*

- 12 Body and legs (of adult!) largely black, lacking any red colouring; mouth-parts, head above, sides of thorax, and first abdominal tergite, marked with citron-yellow, chrome, or pale greenish yellow, most parts becoming obscured with age by fine grey-blue pruinescence. Vertex only with pair of isolated yellow dots placed just behind antennal bases (only in subadult ♂ forming a complete band from eye to eye); transverse yellow postocular streaks conspicuous. Rear of head and all the rest of abdomen entirely black, the latter more coarsely pulverulent dorsally than on head and thorax. Distal portion of labrum and genae invariably bright yellow. Thorax with complete, though narrow, black stripe mapping out second lateral suture. Wings long and rather broad with bluntly rounded tips; fore wing 18-20, hinder pair with 16-18 Px of first series; medio-

- anal link frequently entire (sic). Anal apps partly black, of the usual form, very similar to those of *eximia* and *mortoni*. Ligula escutcheon-shaped, Fig. 20. A stout species of large size, abd. + app. 34-36 mm, hind wing 26-28.5 mm. — Hab.: NE India; Nepal ..... *pulverulans*
- Body of adult not so dark: at least first two basal segments of abdomen with some bright yellow and/or red colouring. Size generally smaller ..... 13
- 13 Anal apps black, of the usual form (LIEFTINCK, 1977, figs 3-5), sup. app. lacking robust plate-shaped intero-ventral process; inf. app. neither strongly S-shaped nor with bituberculate tips. Recurved terminal lobe of ligula much as in *miniata* (LIEFTINCK, 1977, figs 7-8) and *nipalica* (Fig. 13): rather narrow at base, but soon widening and ending in a pair of deeply separated, broad flaps (LIEFTINCK, 1977, figs 1-2). Body mostly black; vertex with pair of small, isolated, oblique ferruginous spots, placed between roots of antennae and lateral ocelli; light postocular streaks short and narrow. Rear of head with rather broad, flame-shaped yellow band running inward from eye-margin. Prothorax black, thinly pruinose, sides with two small ferruginous spots; synthorax black as far down as first suture, beyond which sides are purplish black from thin pruinescence, dorsum with narrow, slaty-blue antehumeral stripes; sides also pruinose; epimera olivaceous yellow on anterior ends; under surface predominantly black. Legs black. Fore wing with 20-22, hinder pair with 16-20 Px of first series. Abdomen black, inclusive of lower portion of tergites 1-2 and base of 3, only the dorsum of 1-2 and a smallish, subquadrangular basal spot on 3 (widest at extreme base) being cherry- to brick red; 3-4 with obscure, paired apical ferruginous spots. Abd. + app. 33-36, hind wing 26-29 mm (sec. FRASER, 1933); immature Bhutan examples, 32 and ca. 25 mm, respectively. — Hab.: Darjeeling distr. (terr. typ.), Sikkim and (doubtfully), Bhutan ..... *mortoni*
- Anal apps of quite distinctive shape (LAIDLAW, 1932, fig. 2a): sup. app. armed with enormous, subrectangular, plate-shaped intero-ventral process directed ventrad; inf. app. markedly sinuous, tips after constriction expanded, distinctly bituberculate. Recurved terminal lobe of ligula much broader at base, more or less escutcheon-shaped, resembling *chaseni* (Fig. 19), *miles* (LIEFTINCK, 1977, figs 11-12), and *pulverulans* (Fig. 20), the apical border of the expanded apex only shallowly emarginate (Figs 17-18). Body mostly deep black, light head marks as in *mortoni*, but oblique yellow band inward from eye-margin ventrally, greatly reduced, halter-shaped or obliterated; no conspicuous purplish pruinescence, thorax devoid of slaty blue antehumeral stripes, sides partly and ventral surface entirely, bright greenish ochreous. Legs black. Wing membrane tinged with yellow; fore wing with 16-18, hinder pair with 14-15 Px of first series. Two, apparently constant, colour varieties occur in full-coloured males, tergite 1 of abdomen in both forms deep black with bright yellow, reniform, lateral spot; (var. a), tergite 2 entirely and 3 (save obscuration at extreme end), bright red, succeeding tergites all black (typical colour form); or (var. b), 2-6 throughout red, with intersegmental rings darkened and apical 1/7-1/8 of tergite 6, gradually fading to black; 7-10 and most of appendages also black, save narrow reddish annule at base of 7 (much scarcer, atypical colour form). Abd. + app. 31-32.5, hind wing 23-24 mm. For further details, see additional description. — Hab.: Malay Peninsula ..... *rectangulata*

## SPECIES-GROUP I

### *CALICNEMIA ERYTHROMELAS* (SELYS)

*Calicnemis erythromelas* SELYS, 1891: 505-506, ♂♀ "Leito en juin — Cobapo et Monts Carrn en juin et novembre (Fea)". — FRASER, 1932: 142 (key), 149-150 fig. 32 (head ♂), ♂♀ Chin Hills; FRASER, 1933: 173 (key), 181-183 fig. 81 (head ♂).

*Calicnemis erythromelas*, LIEFTINCK, 1977: 23-24 fig. 15-17 (ligula & app., ♂



lectotype), ♂♀ types Puepoli and Leito redefined.

Additional material. — N Thailand: 12 ♂ 3 ♀, Doi Pa Hom Pok, 1600 m, 22.X.1981, P. Nielsen (MC, 2 ♂ 1 ♀ ML). 1 ♀, Thailand, Chiangmai, III.1980, S. Tsuda & K. Kitagawa (CT).

### *CALICNEMIA IMITANS* LIEFTINCK

Figure 1

*Calicnemia imitans* LIEFTINCK, 1948: 12-15 fig. 7 (app. ♂), ♂♀ Tenasserim; LIEFTINCK, 1960: 238, addit. & compar. notes ♂♀ Burma; status & nomencl. confirmed. — ASAHINA, 1961: 212, ♂♀ Thailand record; ASAHINA, 1981: 4, ♂♀ Thailand records.

*Calicnemis pulverulans*, SELYS, 1891: 506-507, ♂♀ Monts Carin.

? *Calicnemia pulverulans*, SCHMIDT, 1964: 148-149 (pars), discussion of ♂♀, Sadon, 1200 m, NE Burma, & different species?

Additional material. — Thailand: 1 ♂ (ad., penis exposed, Fig. 1), Nakhon Sithammarat Prov., Banna, 5-10.V.1958, T.C. Maa (ex BISH, ML); 1 ♂ (ad.), Chiang Mai Prov., Chiang Mai Hoey Kaw, 400 m, 18-20.VI.1980, T.W. Donnelly (CD); 1 ♂ 2 ♀ (ad., penis exposed), Doi Suthep-Pui natn. Park, Konthathan waterfall area, 600 m, 20-27.X.1979 and N of Chiangmai Mae Sa waterfall area, 350 m, 5.XI.1979, Zool. Mus. Copenhagen Exped. (MC). India: 1 ♂ 1 ♀ (ad.), Assam, "Shillong India 1969", coll.? (ML).

The immature specimens from Burma described by Schmidt, may or may not be this species. The two males mentioned by that author are stated to have the basal abdominal segments red, but were not alike in the extent of that colour, so that the identity of both must remain doubtful. I have not seen juvenile males of *imitans*, but it is clear that these Burmese examples are not conspecific with *C. pulverulans*. The characters distinguishing *imitans* from the latter were first enumerated by LIEFTINCK (1948: 14), called in question by SCHMIDT (1964), but explained and substantiated by later authors (see also the present key and illustrations).

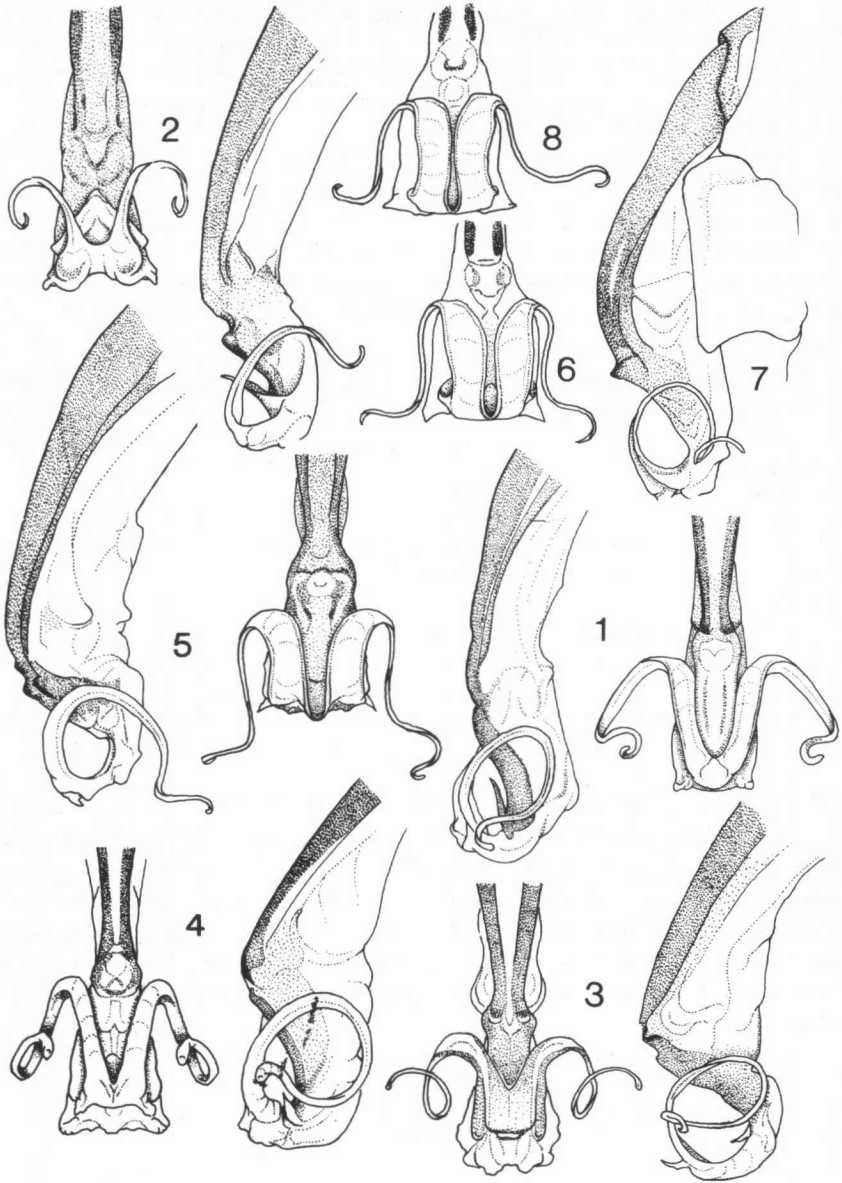
### *CALICNEMIA SINENSIS* SP. N.

Figures 3, 9-11

? *Calicnemia pulverulans*, SCHMIDT, 1964: 149 (pars), ♂♀ Fukien, no descr.

? *Calicnemia spec.* ASAHINA, 1965: 496 fig. 8 (♂ app.), ♂♀ Hongkong record, no descr.; [ASAHINA, 1977: 485 fig. 3 & 15-16 (♂ body & struct.), brief notes, Szechuan.]

Material. — SE China: 2 ♂ (holotype and paratype), prov. Fukien, Chungan distr., Lower Kuantun, ca. 500 m, 4.VIII.1945, T.C. Maa; 2 ♂ 2 ♀, same prov., Tsilichiao, 1000 m, 25.VIII.1945, same coll. (1 ♂), Upper Kuantun, 1400 m, 22.VIII.1945, same coll. (1 ♂ 1 ♀), Sanchang, 11-12.VIII.1945, same coll. (1 ♀); 1 ♀, same prov., Kyonyang, distr. Nwangkeng, 23.VII.1942, same coll.; 2 ♂ 1 ♀, same prov., Shaowu, distr. Tachulan, 1000 m, 21.VI, 11 & 20.VII.1942, same coll.: 1 ♂,



Figs 1-8. Exterior and right lateral view of ♂ ligula (penile organ) of *Calicnemia* species: (1) *C. imitans*, Thailand (Banna); — (2) *C. eximia*, Sikkim; — (3) *C. sinensis* sp. n., SE China (Fukien); — (4) *C. mukherjeei*, Shillong, Assam; — (5) *C. e. carminea* sp. n. Nepal (Kodari); — (6-8) *C. e. pyrrosoma* ssp. n., Dehra Dun, two ex. to show variation. — (All sketches on the same scale).

with 2 labels: "Kwantung, Ying Tak distr., Wun Tong Shan (T52 Hai), *Calicnemis* sp. n.", and: "Hainan Is., Hau-ying-ts'uen, 6 mi SE of Nodoo, Lin-kao dist., 27-28.VII.1932, F.K. To" (Cornell univ., Ithaca). Holotype ♂ and first recorded ♀ (see above); paratypes ♂♀ (id.), all in ML.

Apart from the structural features (Figs 3, 9-11), the ♂ of this new species is readily distinguished from other red-bodied members by the reduced size of the yellow (not red or orange) antehumeral thoracic stripes, and also by the pruinescence overlaying certain body parts. Asahina's unnamed species from Hongkong is possibly not identical with the one he described and figured after specimens from Szechuan (1977), which I first thought might be conspecific with the present new species. As is evident from Asahina's sketch of the penile organ (ligula) of the Szechuan insect, the latter belongs to Species-group II, whereas *sinensis* can be immediately distinguished therefrom by possessing the ribbon-like filaments at that organ, which are characteristic for Species-group I (Fig. 3).

N.B. — The double-labelled origin of the ♂ (from Kwantung or Hainan) is uncertain and unfortunately must remain so.

#### *CALICNEMIA MUKHERJEEI* LAHIRI

##### Figure 4

*Calicnemia mukherjeei* LAHIRI, 1976: 273-276 fig. 1 (♂ app. and ligula), ♂&♀ Shillong (Assam).

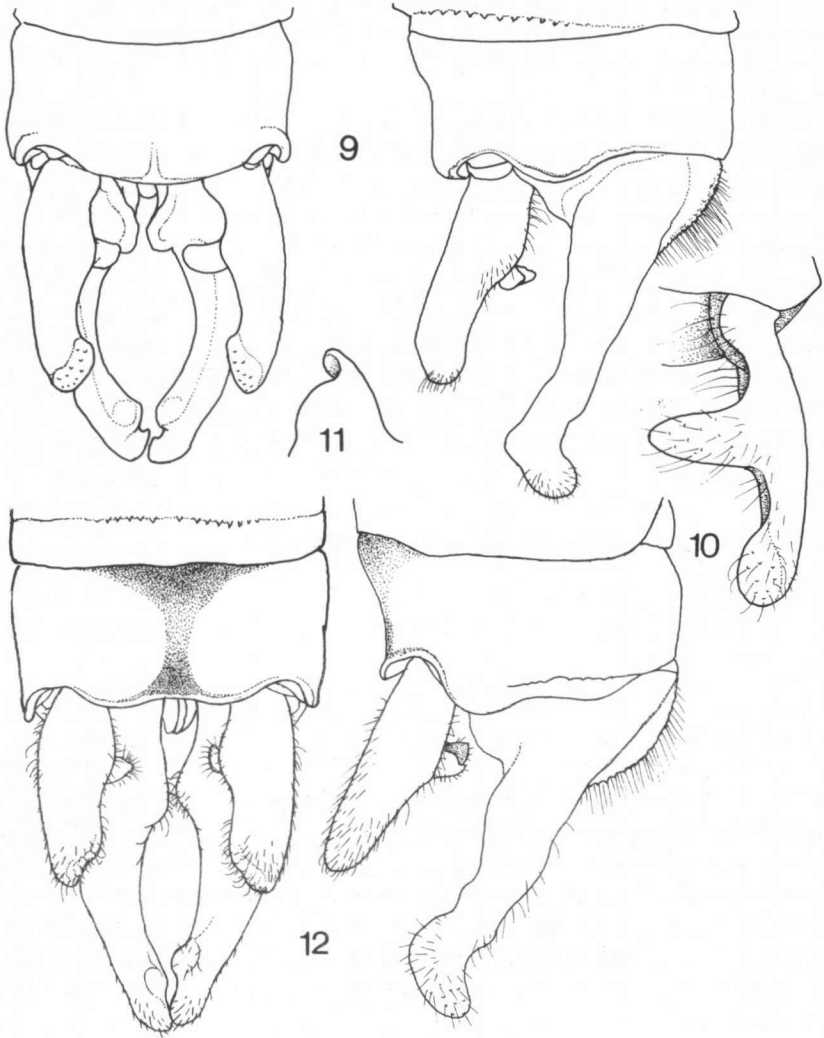
Material. — NE India: 1 ♂ (ad., paratype), Meghalaya, Khasi Hills, Old Barapani, 6.VI.1973. K. Rai, ex coll. A.R. Lahiri (ML).

The ♂ of this species resembles *miniata* very closely in most respects, but can be immediately distinguished from the latter by the very different form of the penile organ, *miniata* being a member of Species-group II. The males of *mukherjeei* "were collected at the foot of a small spring falling from some height, shaded with overhanging plants, but the ♀ was collected from dried up nulla, quite far away from water." (1976: 275). I have not seen the latter specimen but am much in doubt about the correctness of the sex association. Hence I consider the ♀ to be still unknown.

#### *CALICNEMIA EXIMIA* (SELYS)

##### Figure 2

*Calicnemia eximia* SELYS, 1863: 160, ♂ only! "Indes orientales"; SELYS, 1886: 131, ♂ Sikkim par Atkinson; et Kooloo (Indes orientales). — LAIDLAW, 1917: 327-328, fig. 2 (♀ abd.) 330 (key), ♀ Kumaon, descr. & fig. — LIEFTINCK, 1927: 87-88, fig. 2-3 (app. ♂ and abdomen ♀), ♂♀ Sutlej basin, Sholtu, 2300 m. — FRASER, 1932: 142 (key), 143-144, fig. 1 (wings ♀), 2 (app. ♂), ♂♀ NE India, Bengal, Sikkim &



Figs 9-12. Anal apps of ♂ *Calicnemia* species. Figs 9-11: *C. sinensis* sp. n. SE China (Fukien), dorsal view and right side (9). — inner view of right sup. app. (10), — and caudal view of intero-ventral process of right sup. app. (11). — Fig. 12: *C. c. carminea* sp. n. Nepal (Kodari).

Assam (pars?), Mangpu, Darjeeling. descr.; FRASER 1933: 173 (key), 174-175 (repeated descr.).

*Calicnemia eximia*. ASAHINA, 1974: 282, ♂♀ Nepal (record only); ASAHINA, 1977: 481-483, figs 1-2 (♂♀ bodies, Szechuan), 4-12 (♂ struct., partim? Szechuan & Nepal), notes & synonym.

*Calicnemia Atkinsoni* SELYS, 1886: 131-132, ♀ par Atkinson; SELYS, 1891: 504, ♀ only!

*Calicnemia miles*, CARFI et al., 1983: 262, ♂ Himachal Pradesh & Kashmir (record).

? *Calicnemia miles*, KUMAR & PRASAD, 1977: 225-229, figs 1-11 (larval struct.), larva & imago, Sulphur Springs, Dehra Dun.

Material. — NW India: 5 ♂ 5 ♀, Himachal Pradesh, Sutlej basin, Sholtu, 2400 m, 4 mi. from Kilba, 1-2.VII.1926, W.G.N. van der Sleen (MA). Uttar Pradesh, 6 ♂ 5 ♀ (ad.), Dehra Dun valley, Sahasradhara, 700 m, 11-19.XI.1981 (4 ♂ 2 ♀ on 10.XI taken the same day with 1 ♂ 1 ♀ *C. carminea pyrrhosoma* ssp. n., and 1 ♂ ditto on 19.XI.1981) all P. Nielsen (MC, ML). NE India: 3 ♂ 2 ♀, West Bengal, Darjeeling Distr., 5-7000 ft, Bom Busty, 1.VI.1976 (1 ♀), Gumpaha, 6.VI.1976 (1 ♂ 1 ♀), Kapkot and Loharkhet, 26.IX.1973 (2 ♂), V.K. Gupta et al. (ML); 1 ♂, Meghalaya (Assam) Shillong, Khasi Hills, 25.VI.1974, A.R. Lahri, no. 03 (near locality of *C. mukherjeei* Lahiri); 2 ♂ (ad., ligula exposed) Fig. 2, Sikkim, Staudinger, vend. 1903 (ML). Nepal: 2 ♂ 1 ♀, Tibetan frontier, ca. 950 m, Barabhise and Kodari, 1700 m (one pair juv.), 4.VI.1973, B. & M. Kiauta (1 ♂ Kodari together with 1 ♂ *C. carminea carminea* sp. n., no. 368); 2 ♂ (ad., ligula exposed), Charnawati Khola, 1200 m, pine forest, 15.IX.1974, B. & M. Kiauta; 1 ♂, Phedi, 1520 m, 14.IX.1974, id., no number; 1 ♂ (juv.), Kathmandu valley, waterfall W of Chauni, ca. 1400m, 24.V.1973, no. 273, B. & M. Kiauta (coll. BK & ML). Additional: 2 ♂, Himachal Pradesh & Jammu (Kashmir), recorded sub *C. miles* by CARFI (1983).

#### *CALICNEMIA CARMINEA CARMINEA* SP. N.

Figures 5, 12

*Calicnemia* spec. KIAUTA, 1975: 43, pl. 1 fig. 3 (karyotype, ex Saranpur).

Material. — **Holotype** ♂ and first ♀: Nepal, Kathmandu valley, waterfall W of Saranpur, W of Chauni, 26.VIII.1974 and 23.V.1973, respectively (coll. BK); paratypes of both sexes from all given locs (BK and ML); — Nepal: 14 ♂ 4 ♀, Kathmandu valley, waterfall W of Saranpur, W of Chauni, 1350-1400 m, 21.V.1973 (2 ♂ & 3 ♂ ZB-1-3), 23.V.1973 (1 ♂ 3 ♀), 2.VI.1973 (1 ♂ ZB-4), 3.VI.1973 (4 ♂ & 1 ♂ ZB-5), and 26.VIII.1974 (2 ♂); 5 ♂ 2 ♀, Tibetan frontier, Barabhise, ca. 950 m, 4.VI.1973 (4 ♂ 2 ♀), and Kodari, ca. 1700 m, 4.VI.1973 (1 ♂, ligula exposed) (probably collected simultaneously with both *C. eximia* and *miniata*), all B. & M. Kiauta.

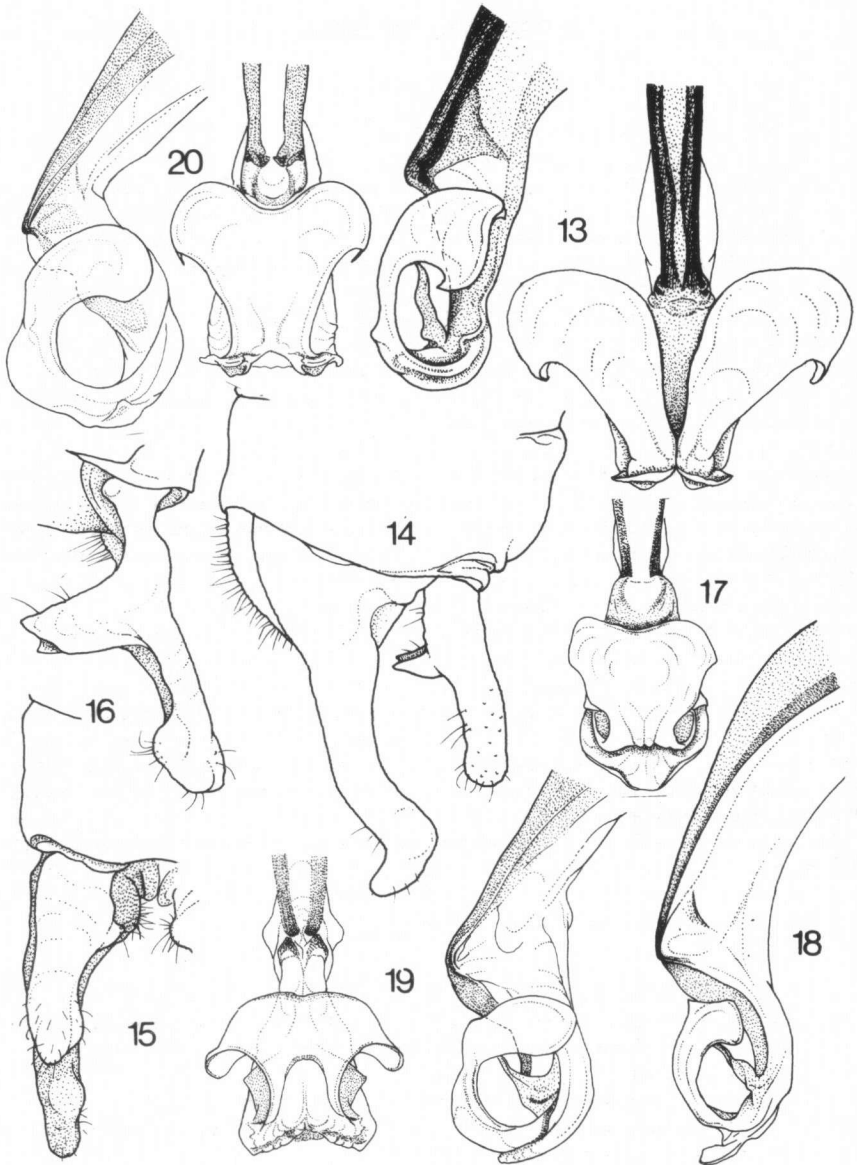
#### *CALICNEMIA CARMINEA PYRRHOSOMA* SSP. N.

Figures 6-8

? *Calicnemia miles*, KUMAR & PRASAD, 1977: 225-229 fig. 1-11 (larval struct.), larva & imago, Sulphur Springs, Dehra Dun.

*Calicnemia* spec., TYAGI, 1982: 9-10, ♂♀ Dehra Dun (nomenclat. note).

Material. — **Holotype** ♂ and first ♀: Dehra Dun valley, Sulphur Springs, 4-13.VIII.1978 (MC); — NW India: 3 ♂ 2 ♀, Uttar Pradesh, Dehra Dun valley, Sulphur Springs, ca 700 m, 4-13.VIII.1978, Copenhagen Zool. Mus. Exped. (MC, 1 ♂ 1 ♀ paratypes, ML); 2 ♂ 1 ♀, same area, Sahasradhara (= Sulphur Springs), 10 km West Dehra Dun, 700 m, 11.X (♂♀) and 19.X.1981 (♂), P. Nielsen (together with 6 ♂ *C. eximia*, 10-19.XI.1981, same coll. (MC); series ♂♀, same area, Dehra Dun valley, Sulphur Springs, 26.V.1976, B.K. Tyagi (ex coll. Tyagi 1977, 1 ♂ 1 ♀ ML).



Figs 13-20. Ligula and anal apps of ♂ *Calicnemia* species. Figs 13-16: *C. nipalica*, Nepal, right lateral and exterior view of ligula (13), — left lateral and partial dorsal view of anal apps (14-15), — and interior view of right sup. app., same specimen (16); — Figs 17-18: *C. rectangulata*, Cameron Highlands, Malaya, exterior (17), — and right lateral view (18) of ligula; — Fig. 19: *C. chaseni*, Cameron Highlands, Malaya, ventral and right lateral view of ligula; — Fig. 20: *C. pulverulans*, Nepal, right lateral and ventral view of same.

## SPECIES-GROUP II

*CALICNEMIA MINIATA* (SELYS)

Figures 21-24 (larva)

*Calicnemis miniata* SELYS, 1886: 132, ♂ "Darjeeling ou Sikkim, par Atkinson". — LAIDLAW, 1917: 328-329 & 331 (key), ♂♀ Darjeeling, ♀ first description. — FRASER, 1932: 142 (key), 146-147, fig. 3<sup>s</sup> (head ♂), ♂♀ Bengal & Sikkim, various locs; FRASER, 1933: 173 (key), 177-178 fig. 79 (wings ♂) (repeated descr.).

*Calicnemis eximia* SELYS, 1863: 160, ♀ only!

*Calicnemia miniata*, LIEFTINCK, 1977: 19-20, figs 6-9 (pterost., ligula & app., ♂ lectotype), ♂ lectotype Darjeeling & ♂ Nepal, descr. — ASAHINA, 1974: 282, ♂♀ Nepal (record only); ?ASAHINA, 1977: 484, figs 13-14 (♂ struct., Nepal). — KIAUTA & KIAUTA, 1982: 143-144, fig. 1 (karyotypic morphol. & notes on adult and larval habitat, Arun valley, E Nepal).

Additional material. — India: the type series of this species (from Darjeeling, Atkinson) in the Brussels museum (IRSN), comprises 3 ♂ including the lectotype, whose salient characters were illustrated in the paper cited above. In the general collection of the British Museum (BM), I found 1 ♂ from Darjeeling (ex coll. & det. MacLachlan), 1 ♂ from Mangpu, 9.VI, and both sexes from Pashok, 24.V.1925 (the last ones ex coll. & det. Fraser). These were compared with the lectotype and found to agree with the latter also in the form of the ligula. One ♂ in perfect condition, given to me in 1928 by the late Dr F.F. Laidlaw, is from Darjeeling distr., Gopaldhara, H. Stevens; this was re-examined also and returned to the Amsterdam museum (ITZ), where it stood for over half a century. — Nepal: 1 ♂ (ligula exposed), Nepal-Tibetan frontier, Kodari, ca. 1700 m, 4.VI.1973, B. & M. Kiauta, compared with lectotype, V.1975, M.A. Lieftinck (BK): 3 ♂, Nepal, between Irkua Khola & Bokua Khola, 550 m, 27.IV.1979, PCN1a-d, PCN3a-e & PCN4a-c, B. & M. Kiauta (no. 25) (BK & ML). It is worth noting that some Nepalese males of *miniata* collected in 1979, came from the same locality as the series of *C. c. carminea* sp. n., and that the *miniata* ♂ from Kodari, caught in 1973, was taken simultaneously with *eximia*.

Atkinson's females of *C. atkinsoni* Selys, from Sikkim, are examples of *eximia*, as stated already by Laidlaw.

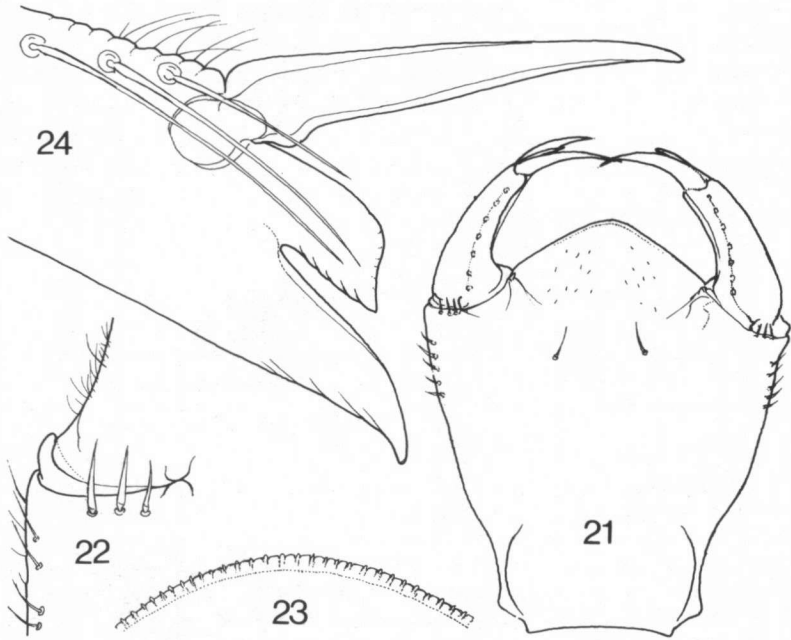
*CALICNEMIA MILES* (LAIDLAW)

*Calicnemis miles* LAIDLAW, 1917: 330, nom. nov. pro *C. atkinsoni* Selys ♂ (not ♀!), terr. typ. Puepoli, Burma. — FRASER, 1932: 142 (key), 147-148 Fig. 3<sup>1</sup> (head ♂), ♂♀ Gokteik, Upper Burma only; — FRASER, 1933: 173 (key), 178-181 (app. ♂) repeated descr.).

*Calicnemis Atkinsoni* SELYS, 1891: 503-504, ♂ only! "Puepoli le 22 juin".

*Calicnemia miles*, LIEFTINCK, 1977: 20-22 figs 10-14 (pterostigma, ligula and app., ♂ holotype) ♂ holotype Puepoli, redescrip.

Additional material. — Thailand: 4 ♂, Doi Suthep, 23.III.1980, S. Tsuda & K. Kitagawa, in coll. Tsuda, one ♂ (ML). 2 ♂ 1 ♀ (one pair in cop.). Chiang Mai Prov., 37 km N of Doi Saket, 1000 m, 22-24.VI.1980 (♂♀), and same area, Doi Inthanon Nat. Park, 22 km N of Chom Thong, 900 m, 23.VI.1980 (♂), T.W. Donnelly (CD, one ♂ ML); 1 ♂, N Thailand, Doi Inthanon, 1300 m, 8.X.1981, P. Nielsen (MC).



Figs 21-24. Labial structure of ultimate instar larva of *Calicnemia miniata* from Nepal: (21) labium, inside (dorsal) view; — (22) apical portion of same, left side, more enlarged; — (23) tip of median lobe of same, flattened out, more enlarged; — (24) apex of left palpus, flattened out, more enlarged.

For a redescription and sketches of structural organs of the type, cf. LIEFTINCK (1977); further details are contained in the specific key presently given on p. 357. The copulating pair caught by my colleague Donnelly, offers a welcome opportunity to add a few notes on the little known ♀ of *miles*, because that specimen does not correspond with FRASER's (1933) account of that sex, which almost certainly applies to a different species. The ♂ is quite typical but has the first abdominal tergite bright yellow! Here follows a brief characterization of its proper mate:

**Female.** — Most head and thorax markings bright chrome, but postclypeus obscured and shiny. Head marks and antehumeral thoracic stripes as in ♂, the transverse postocular streaks very long, though isolated. Black band covering second lateral suture thick, leaving off at level of metaspiracle but continued ventrad as a fine black line toward anterior border of metinfraepisternite. Ventral surface of thorax pale. Legs yellow with slight pinkish hue; outer faces of femora with a black stripe, broadest basally. Wings a little broader with slightly more rounded tips, than in ♂; fore wing with 18 and 17 Px, hind wing with 16 Px of first series. Pterostigma shaped as in ♂, colour sepia-grey lacking a pale border.



Abdomen predominantly orange-red; tergite 1 bright yellow, 2-7 uniform light red, then slightly obscured, 8 with almost black, diffuse, dorsal band, the sides remaining red; 9-10 and genital valves almost similar to 8, the latter projecting beyond tuberculum anale for about the length of segment 10; cerci conical, dark-tipped. All segments with extremely fine, darkish intersegmental membranes. Length of abdomen (incl. valves) 29.0 mm, hind wing 24.7 mm. (Accompanying ♂ has red anal appendages, the inferior pair tipped with blackish. Wings with 17 and 14 Px, respectively. Abd. + app. 31.4, hind wing 23.7 mm).

*CALICNEMIA MORTONI* (LAIDLAW)

*Calicnemia mortoni* LAIDLAW, 1917: 326-327 & 331 (key), ♂ Pashok, Darjeeling distr., 5500 ft, June 1916, F.H. Gravely (holotype No. 3463/H.I. Ind. Mus., lost?). — FRASER, 1932: 142 (key), 150-151 Fig. 3<sup>3</sup> (head ♂), pl. 1 figs 11-12 (app. ♂), ♂♀ Sikkim, Pashok and Gangtok, 5500-6000 ft; 1933: 173 (key), 183-184 (repeated descr.).

*Calicnemia mortoni*, LIEFTINCK, 1977: 13-18 figs 1-5 (ligula and app. ♂), ♂♀ descr. & compar. notes, all Bhutan.

Additional material. — N India, Sikkim: 2 ♂ (one incomplete), Sikkim, Gantok, 24-26.VI.1903, Thibet Exped., in general coll. of Brit. Mus. (Nat. Hist.) 1 ♂ 1 ♀ (subad.), W Bengal, Darjeeling-Gangtok, 5-7000 ft, Bom Busty, 1.VI.1976; 6 ♀ (subad.-juv.), Jor Bunglo, 23.V.1976, Teesta Valley; 4.VI.1976, and Kalimpong, 7.VI.1976, all V.K. Gupta et al. (ex coll. Dept Zool., Univ. Delhi) (ML). — Bhutan: 2 ♂ 3 ♀ (all immature, only 1 ♀ intact), 87 km from Phuntscholing, 1680 m, 22.V.1972, Nat. Hist. Mus. Basel-Bhutan Exped., 1972 (NMB & ML).

For an illustrated account of this, still rather puzzling species, see LIEFTINCK (1977). The description and sketches given in that paper were taken from immature specimens collected in Bhutan. Except for their colouring, the latter agree with Fraser's series of fully mature males from Sikkim in the British Museum collection (BM). The additional specimens from Bhutan are from exactly the same place as the earlier described ones. They differ from Fraser's lectotypical individuals in the same way as mentioned before and give no clue as to their proper status, all being still immature. As long as no full-coloured males are collected in this particular Bhutan locality, the position of the juvenile material has to remain somewhat doubtful.

The Sikkim specimens of *mortoni* in the British Museum collection (identified by D.E. Kimmins in 1931) were compared by me in 1975 with the teneral examples from Bhutan now before me. They agree with FRASER's (1932) description of the adult, except that only the dorsum of abdominal tergites 1-2 and the base of 3 are red, the sides of 1-2 and the rest of 3 being black. They differ in this respect from the Bhutan males, which are much lighter. The apical flaps of the exposed ligula are nearly identical in shape, though slightly narrower and more rounded off in the Sikkim males than in the juveniles from Bhutan (cf.

LIEFTINCK, 1977, figs 1-2).

*CALICNEMIA PULVERULANS* (SELYS)

Figure 20

*Calicnemis pulverulans* SELYS, 1886: 133, ♂ incomplete, "Sikkim, en septembre, par Atkinson". — LAIDLAW, 1917: 329-330 & 331 (key), pl. 15 fig. 3 (wings ♂), ♂♀ Darjeeling. — FRASER, 1932: 142 (key), 144-145, fig. 3<sup>b</sup> (head ♂), ♂♀ N Bengal & Sikkim, 4-6000 ft.; FRASER, 1933: 173 (key), 175-177 (repeated descr.).

*Calicnemis pulverulans*, LIEFTINCK, 1960: 237 (notes on holotype ♂). — SCHMIDT, 1964: 148-149 (discussion, with *imitans* Liefertinck). — ASAHINA, 1965: 5, ♂♀ Nepal, record only (sub *pulverulans*, err. typ.); ASAHINA, 1974: 282, idem. *Calicnemis nipalica*, KIAUTA, 1975: 43 & 72-73, fig. 1 (karyotype, ex Nepal).

Additional material. — Nepal: 31 ♂ 10 ♀, Kathmandu valley, Godavari, Royal Bot. Gardens, ca. 1600 m, 27.V.1973 (9 ♂ 5 ♀, and 2 ♂ ZC1-2), 29.V.1973 (7 ♂ 2 ♀, ligula exposed of 1 ♂ ZD-1), 18.V.1973 (3 ♂), and 6.VI.1973 (10 ♂ 3 ♀ and 1 ♂ ZC-3). The majority of specimens (BK), 4 ♂ 3 ♀ (ML).

An excellent wing-photograph of *C. pulverulans* is to be found in the fundamental (though frequently overlooked) work on Indian dragonflies published by LAIDLAW (1917: pl. 15 fig. 3), which was taken from a Darjeeling specimen.

*CALICNEMIA NIPALICA* KIMMINS

Figures 13-16

*Calicnemis nipalica* KIMMINS, 1958: 350-351, ♂ Nepal; — KIMMINS, 1970: 181, note on holotype.

Material. — Nepal: 10 ♂ (including holotype and one imm., with ligula exposed), Pheba Tal, near Pokhara, 2500 ft, 8.V.1954, J. Quinlan, Brit. Mus. Nepal Exped. (BM, one paratype ML).

*CALICNEMIA CHASENI* (LAIDLAW)

Figure 19

*Calicnemis chaseni* LAIDLAW, 1928: 136, ♂ Jor, Pahang; — LAIDLAW, 1931: 193 (colour note), ♂ Perak & Jor Camp, 1800 ft.

*Calicnemis chaseni* LAIDLAW, 1932: 98 fig. 2b (app. ♂), note on ♂ holotype. — LIEFTINCK, 1954 (handlist): 45. — KIMMINS, 1970: 179, note on holotype.

Material. — Malay Peninsula: 1 ♂ 1 ♀ (ad., in cop.), Pahang, Cameron Highlands, Jor Road, 23th mile, 700 m, 13.III.1963, M.A. Liefertinck (ML). 1 ♂ 1 ♀ (ad., in fragments, ♂ ligula exposed, fig. 19), labelled "O. Malacca, Kelantan, Waterstradt, Rolle vdt. 1903", ex coll. F. Foerster (Michigan Mus., Ann Arbor). 1 ♂ (ad., in fragments, ligula exposed), Selangor, Templer Park, nr Kuala Lumpur, 28.XI.-5.XII.1979, P. Nielsen (ex MC, ML).

The adult pair which I took in the Cameron Highlands, were ovipositing "per collum" in the soft tissue of a submerged *Utricularia*-like plant growing in the depth of a ponded streamlet running in a dark roadside gully.

*CALICNEMIA RECTANGULATA* LAIDLAW

Figures 17-18

*Calicnemia rectangulata* LAIDLAW, 1932: 97-98 fig. 2a (app. ♂), ♂ Kuala Boh, Pahang, Cameron Highlands; LAIDLAW, 1934: 552, 553 (Malay States). — FRASER, 1942: 96-97 fig. 1c (app. ♂), ♂ addit. descr., Fraser's Hill, 4000 ft. — LIEFTINCK, 1954 (Handlist): 45. — KIMMINS, 1970: 181, note on selected lectotype.

**Material.** — Malay Peninsula: 2 ♂ (ad., on beheaded pins), Fraser's Hill, 4000 ft, 10.IV.1936, paratypes, ex coll. F.F. Laidlaw via J. Cowley (BM); 1 ♂ (ad., ligula exposed), Larut Hills, 4500 ft, 15.II.1932, ex coll. Laidlaw to Lieftinck, "*Calicnemia rectangulata* Paratype" (in Laidlaw's handwriting) (ML); 4 ♂ & 1 ♀ (headless), Cameron Highlands, 4500-5000 ft, 13.VI.1935 (♀) and 14-16.VI.1935 (4 ♂ ad.), H.M. Pendlebury, ex coll. J. Cowley (BM, one ♂ ML); 1 ♀ (ad.), labelled "*Cameron Highlands, 4000-4500 ft, 6/6 35*" (pencil) and "*C. rectangulata* Laidl. ♀ not described", in F.C. Fraser's writing (? allotype, type coll. BM); 1 ♂ 3 ♀, all immature, ♂ ligula exposed), Pahang, Cameron Highlands, Mt. Batu Brinchang Rd, 5500 ft, 10 & 12.III.1963, M.A. Lieftinck (ML); further specimens from Pahang, Cameron Highlands (all papered, ex coll. Cowley and Fraser): a series of ♂ and 1 ♀ (head & prothorax missing), 12-24.VI.1935, coll. H.M. Pendlebury (BM); 1 ♂ (ligula studied), Larut Hills, 4500 ft, 20.II.1932 (BM), with Fraser's note: "*C. rectangulata*, segs 2-6 are red, should be 2-3 red, apps are similar!"

**Male (additional description).** — Labium yellowish at base but soon fading to brownish black distally; mandibles except yellow at extreme base, labrum and clypeus, all black; genae and antefrons bright greenish yellow to olive as far up as beyond base of postclypeus, forming a broad transverse band, straight-lined but interrupted by black mid-posteriorly. Pale isolated spots on vertex much obscured, the postocular streaks elongate, narrow and frequently more or less obliterated, colour ochreous. Rear of the head black, the pair of narrow, cloudy ochreous or yellow spots very oblique, in contact with the eye-margin (where widest) and tapering toward hinge of labium. Antennae black. Dorsum and sides of prothorax including anterior and posterior lobes, either wholly black or most of the lower part of propleuron bright ochreous; posterior lobe depressed, hind margin evenly convex. Legs including coxae anteriorly and trochanters, deep black, the former thinly overlaid with grey-blue pruinescence. Synthorax black dorsally, as far down as the lower (posterior) border straight-lined, this colour including most of infraepisternite. Sides bright greenish ochreous, with thick black band over second suture, varying in breadth but widest about midway length and tapering ventrally at metinfraepisternal suture, the enclosed metepisternal band widest below, completely surrounding metaspiracle; all lower parts and entire ventral surface of thorax, bright ochreous. Wings rather broad,

membrane distinctly tinged with grey-ochreous to amber, save most of the petiole. Pterostigma rhomboidal, moderately oblique, slightly longer than high, little expanded and a trifle widening distally, proximal and distal sides parallel; colour sepia between deep black nervures. Abdomen deep black, marked with bright yellow and brick red to scarlet (see specific key), the black at sides of tergite 1 continued for a short distance across intersegmental ring alongside of 2 as a small triangular basal spot at ventral border of tergite, the intersegmental membrane 1-2 for the rest red. Tergites 2-3, including genital sclerites (except black vesicle) and membrane 2-3, red, this colour becoming darker, reddish black, toward apex of 3, including the membrane 3-4; extreme base of 4, and less distinctly so also of 5, again obscurely red. All remaining segments, with the appendages, deep black, only lower portion of tergite 10 and basal trunk of inferior appendages, dirty reddish.

Female (hitherto undescribed). — F.C. Fraser's "allotype" (in BMNH) is a full-coloured specimen in perfect condition, well worth a brief characterization.

Resembles the male of the dark (typical) colour variety in many respects. Light markings obscurely orangish, but mandible-bases, anteclypeus, genae and antefrons ochreous, the frontal stripe narrow and almost interrupted at middle, labrum and postclypeus black. Pronotal tubercles not much raised, lower-levelled side-portions of prothorax protuberant, forming elongate rounded processes in dorsal view; posterior lobe of large size and peculiar shape, depressed, in the form of a conspicuous transverse lamella, the hind margin of this structure deeply indented at middle by a small but rather broad emargination. Dorsum of thorax with pair of complete, slender, orangish antehumeral stripes, widest below. Sides chrome yellow with incomplete dark stripe, tapering ventrad, over the second suture, the lower surface likewise pale. Tergite 1 of abdomen yellow with complete, almost square, black dorsal spot; 2-3 red, 2 with black subapical spot and 3 with pair of small yellow basal streaks separated from a black intersegmental membrane in front of which is placed a diffuse blackish apical patch; 4 dark reddish, spotted similarly to 3; 5-10 practically wholly black, except sides of tergite 9 and sternites 8-9 inclusive of the genital valves, which are pale orange-red, surpassing the cerci for the length of segment 10. Cerci black, forming a pair of flattened oval blades. Wing apices more broadly rounded than in other species; fore wing with 16-17, hinder pair with 14-15 Px of first series. Length of abdomen (incl. valves) 27 mm, hind wing 23 mm.

The immature specimens taken by myself at the Batu Brinchang roadside, were collected near a brook on a hill slope; the insects apparently had emerged not long before, resting amid a rich growth of low *Nepenthes*-pitchers in a marshy spot overgrown with *Lycopodium*. In spite of a careful search in a variety of habitats, no larvae or exuviae of *rectangulata* could be found.

## SPECIES INCERTAE SEDIS

*Calicnemia maheshi* SAHNI (1964), described and illustrated after a single ♂ from the Pithoragarh district in the Kumaon Hills (U.P., India), is evidently a species wrongly attributed to *Calicnemia*. This conclusion is based on the diagnosis itself, the sketches of the body marks, and on the measurements given (abd. 41, hind wing 21.5 mm), which are entirely unlike anything known in the genus *Calicnemia*. I venture to suggest that this specimen should be a species of *Coelliccia*, possibly *C. renifera* (SELYS, 1886), originally described from Darjeeling. See also KUMAR & PRASAD (1981, sub *C. maheshi*); and TYAGI (1983a, idem).

Yet another named taxon of quite uncertain status is the recently published, "*Calicnemia miniata doonensis*", new subspecies, of SANGAL & TYAGI (1984), from the Doon valley, also in the Dehra Dun area. As no description of this insect is given, it should be considered a nomen nudum for a race (?) of *miniata*, a species only known by these authors from very doubtful records in the literature.

## GEOGRAPHICAL DISTRIBUTION OF THE GENUS

All species of *Calicnemia* are peculiar to the Asiatic mainland, ranging from certain tropical parts of Afghanistan in the west, through Burma and Indochina far into eastern China, and as far toward the south as the Malay Peninsula. Few, little known, outlying representatives have been reported also from Hainan and (possibly) Taiwan. Remarkably enough, no single species has so far been discovered in the islands of the Malay archipelago nor yet in the Philippines or further eastward. The distribution centre is obviously the Himalayan range whence 11 species and subspecies are known to occur, apparently all of them being restricted to well forested areas at higher altitudes, in regions undisturbed by human agency.

THE LARVA OF *CALICNEMIA*

The distinctive characters of *Calicnemia* larvae are still insufficiently studied. This is due to the fact that most forms so far described could not be definitely associated with the adult since at places where larvae had been collected, the imagoes of two or even three different species were also present, occurring together in close proximity of the larval habitat. One of the last-instar larvae described and figured by KUMAR & PRASAD (1977), collected at the Sulphur Springs near Dehra Dun (U.P., India), was erroneously named *C. miles* (Laidlaw). This identification was based on a single immature male reared from one of these larvae. As I was not permitted to re-examine this specimen, the

specific name of the latter would still remain unknown. TYAGI (1983) suggested *C. miniata* or *mukherjeei* as the proper name for that species, but this would appear to be mere guesswork. Now FRASER's identification (1919) of the larva of *C. miniata* is undoubtedly also in error as this is not even a *Calicnemia* but obviously some protoneurid or coenagrionid damselfly! Concerning this *C. minata*, we are now somewhat better informed. The accompanying sketches of the labial structure (Figs 21-24), are taken from the ultimate instar larva discovered in Nepal, a species on which KIAUTA & KIAUTA (1982) based their investigation of the karyotypic morphology and chromosome numbers. These samples were collected in a forest between the Irkua Khola and Bokua Khola, April 1979, together with freshly emerged and mature specimens of *C. miniata*. The habitat of that species is described as "wet shady forest ground, without open water, the larvae being collected on permanently wet rocks covered by organic litter, mud and moss". (KIAUTA & KIAUTA, 1982: 144). This Nepalese larva, here definitely associated with adult *miniata*, is rather similar in general appearance (size, stocky build and shape of caudal gills) to the one from N India discussed by KUMAR & PRASAD (1977). Structurally, however, it differs markedly from the latter in the more elongate form of the labium, the more numerous (7) palpal setae, and the less conspicuous and finer hair covering its body parts. (I suppose that the unusual coarseness of the pilosity, as shown in the picture of the whole insect published by the Indian authors, is only due to exaggeration!).

It will be seen from the list of material presently studied, the difficulty of establishing the identity of the puzzling Indian *Calicnemia* larva, was caused by the concurrence of two instead of only one species in the Sulphur Springs area near Dehra Dun. The following tentative conclusion is based mainly on material collected in November 1981 by Mr Peter Nielsen (Copenhagen), who indiscriminately caught two closely similar, red-bodied species in a mixed population, one being *eximia*, the other a new taxon presently described as *carminea pyrrhosoma* ssp. n., both occurring in almost exactly the same spot whence Kumar's larvae had been collected, "... along a kind of helocrene, water running out from a limestone hill, completely covered with moss and other vegetation" (Nielsen, pers. comm., April 1982). In view of the sympatric occurrence of the above two species, we still have to make a choice between them. Considering the squad forms of Kumar's larva and the robust build of *eximia* as compared with the more slender stature of *carminea*, I am inclined to select the former as the most likely species to be associated with Kumar's larvae.

Apart from the *Calicnemia* species just mentioned, we also have P. Nielsen's unpublished observations on two other members occurring in similar surroundings. One is *C. erythromelas*, adults of which were found by him in Thailand, "sun-bathing in bushes bordering a kind of helocrene-water seeping out of the ground among vegetation and plenty of dead leaves" (in litt., 3 April

1982). A second interesting note which I owe to the same entomologist, concerns the habitat of *C. chaseni* in the Malay Peninsula. During the autumn of 1979, he collected a series of adult males and a few larvae as well, in Templer Park, a nature reserve near Kuala Lumpur, all taken at the same spring-brook, the larvae being assembled from "an absolutely vertical rock between some rootlets and with the water trickling down very slowly" (in litt., 30 May 1980). The larvae of that species are still to be described. Thus we see that the field notes here assembled are in agreement with those already published. Mention should also be made of the fact that all *Calicnemia* so far known possess more or less saccoid caudal gills of the form illustrated by KUMAR & PRASAD (1977), — a morphological feature strongly suggesting a functional adaptation to a particular environment, i.e., the above described microhabitat of certain *Calicnemia*.

It may be noted in passing that LAIDLAW (1917: 336) was the first to observe the curious form of the caudal gills of this kind of larva. He identified a specimen from Kalimpong as belonging to *Calicnemia* and noticed its different appearance as compared with the larva of e.g. *Copera annulata*, especially with regard to its gill lamellae which in his Kalimpong specimen are "very much shorter, strongly ridged, shaped like a spear-head, triradiate in transverse section, not so long as the mask".

It should be borne in mind that certain species of *Calicnemia* are evidently not strictly bound to habitats like those described above. For instance, two congeneric members inhabiting the hills and mountains of the Malay Peninsula, *chaseni* and *rectangulata*, may develop also in ponded streams and marshes with clear cold water, possibly fed by springs in more level country (see under these species).

#### ACKNOWLEDGEMENTS

For the present study roughly 260 specimens (including both sexes), mostly collected on recent field trips, have been made available to me by museum curators, friends and colleagues, as acknowledged in the preceding pages. Very important assistance has been afforded by Mr and Mrs B. and M.A.J.E. KIAUTA (Utrecht; indicated "coll. BK"), who paid particular attention to *Calicnemia* while exploring the Nepalese dragonfly fauna, and to them in the first place I would extend my hearty thanks for their kind interest and help. Beside those whose names were mentioned in my last paper dealing with the Indian and Bhutan members of the genus, I wish to express my thanks also to Messrs Stephan BROOKS (London, coll. BM), S. CARFI (Firenze, Italia), D.A.L. DAVIES (Cambridge, U.K., coll. AD), T.W. DONNELLY (Binghamton, N.Y., coll. CD), A.R. LAHIRI (Calcutta), Peter NIELSEN (Copenhagen, coll. MC), Sh. TSUDA (Habikigoaka, Japan, coll. CT), and B.K. TYAGI (Ukai, India). To all of these fellow-workers I am grateful for many courtesies and their generous offer to retain some duplicate specimens to be deposited in the collection of the Leiden museum (coll. ML).

#### SELECTED REFERENCES

ASAHINA, S., 1961. The Odonata from Thailand. *Nature & Life SE Asia* 1: 209-223, 16 figs.

- ASAHINA, S., 1965. Nepalese Odonata taken by Dr. R. Kano in 1964. *Akitu* 13: 4-7.
- ASAHINA, S., 1965. The Odonata of Hongkong. *Kontyû* 33(4): 493-506, 27 figs.
- ASAHINA, S., 1974. Nepalese Odonata taken by Dr. J. Martens in 1969/70 and 1973. *Senckenbergiana biol.* 55 (4-6): 281-291, pl. 1 & 16 figs.
- ASAHINA, S., 1977. Notes on Chinese Odonata. VI. Further studies on the Graham collection preserved in the United States Nat. Mus. Nat. Hist., Zygoptera. *Kontyû* 45(4): 479-494, 50 figs.
- ASAHINA, S., 1981. Records of little or unknown Odonata from Thailand. *Tombo* 23 (1-4): 3-16, 7 figs.
- CARFI, S., P.D. CENTINA & T. TERZANI, 1983. Odonati raccolti nel Jammu-Kashmir, Himachal Pradesh e Uttar Pradesh (India). *G. it. Ent.* 1: 261-264.
- FRASER, F.C., 1919. Descriptions of new Indian odonate larvae and exuviae. *Rec. Indian Mus.* 16(7): 459-465, pls 33-37.
- FRASER, F.C., 1924. Zoological results of the Percy Sladen Trust Expedition. Odonata. *J. Proc. Asiat. Soc. Beng. (N.S.)* [1923] 19(9): 447-464, 8 figs.
- FRASER, F.C., 1932. Indian dragonflies. 40. Subfam. Platycneminae. Genus: *Calicnemis*. *J. Bombay nat. Hist. Soc.* 36(1): 141-151, figs 1-7.
- FRASER, F.C., 1933a. *The fauna of British India, etc. Odonata I*. London.
- FRASER, F.C., 1933b. Dragonflies from the Laos country. *J. Siam soc. Nat. Hist. (Suppl.)* 9(1): 109-141, 8 figs.
- FRASER, F.C., 1942. Dr. Raymond Wheeler's collection of Odonata from the Federated Malay States, with the description of a new genus and two new species. *Proc. R. ent. Soc. Lond. (B)* 11: 95-104, 4 figs.
- FRASER, F.C., 1957. *A reclassification of the order Odonata*. Royal Zool. Soc. N.S. Wales, Sydney.
- KIAUTA, B., 1975. *Cytotaxonomy of dragonflies with special reference to the Nepalese fauna*. Nepal Research Center, Kathmandu.
- KIAUTA, B. & M. KIAUTA, 1982. The chromosome numbers of sixteen dragonfly species from the Arun Valley, eastern Nepal. *Notul. odonatol.* 1(9): 143-145, fig. 1.
- KIMMINS, D.E., 1958. New species and subspecies of Odonata. *Bull. Br. Mus. nat. Hist. (Ent.)* 7(7): 347-358, 7 figs.
- KIMMINS, D.E., 1970. A list of the type-specimens of Odonata in the British Museum (Natural History), pt 3. Zygoptera. *Bull. Br. Mus. nat. Hist. (Ent.)* 24(6): 173-205.
- KUMAR, A. & M. PRASAD, 1977. Last instar larvae of two Odonata species from Western Himalayas. *Entomon* 2(2): 225-230, figs.
- KUMAR, A. & M. PRASAD, 1981. Field ecology, zoogeography and taxonomy of the Odonata of Western Himalaya, India. *Occ. Pap. zool. Surv. India* 20: 1-118. [Key to species, distrib.].
- LAHIRI, A.R., 1976. *Calicnemis mukherjeei* spec. nov. from Khasi Hills, India. *Odonatologica* 5: 273-276, figs.
- LAIDLAW, F.F., 1917. A list of the dragonflies recorded from... Indian Empire, pt 2. The family Agrionidae. *Rec. Indian Mus.* 13: 321-348, figs & pls 13-15.
- LAIDLAW, F.F., 1928. Notes on Oriental dragonflies (Odonata), with descriptions of new species. *Proc. zool. Soc. Lond.* 1: 129-138, 3 figs.
- LAIDLAW, F.F., 1931. Dragonflies (Odonata) of the Malay Peninsula, with descriptions of new species. *J. fed. Malay St. Mus.* 16 (3-4): 175-233, 7 figs.
- LAIDLAW, F.F., 1932. Notes on Malaysian dragonflies (Odonata), with descriptions of new species. *Bull. Raffles Mus.* 7: 95-100, 3 figs.
- LAIDLAW, F.F., 1934. A note on the dragonfly fauna (Odonata) of Mount Kinabalu and of some other mountain areas of Malaysia, etc. *J. fed. Malay St. Mus.* 17(3): 549-561, 4 figs.
- LIEFTINCK, M.A., 1927. On a small collection of Odonata, chiefly collected in northern India.



- Tijdschr. Ent.* 70: 85-99, 4 figs.
- LIEFTINCK, M.A., 1948. Entomological results from the Swedish Expedition 1934 to Burma and British India. Odonata. *Ark. Zool. (A)* 41(10): 1-23, 8 figs, 1 map.
- LIEFTINCK, M.A., 1954. Handlist of Malaysian Odonata. A catalogue of the dragonflies of the Malay Peninsula, Sumatra, Java and Borneo, including the adjacent small islands. *Treubia (suppl.)* 22: xiii + 202 pp., map.
- LIEFTINCK, M.A., 1960. On the identity of some little known Southeast Asiatic Odonata in European museums described by E. de Selys Longchamps, with descriptions of new species. *Memorie Soc. ent. ital.* 38: 229-256, 13 figs.
- LIEFTINCK, M.A., 1977. Ergebnisse der Bhutan Expedition 1972 des Naturhistorischen Museums in Basel. Odonata. *Entomol. basil.* 2: 11-37, 30 figs.
- NEEDHAM, J.G., 1931. Additions and corrections to the Manual of the dragonflies of China. *Peking nat. Hist. Bull.* 5(4): 1-10, figs.
- SAHNI, D.N., 1964. Some new species of Odonata from Kumaon Hills (India). *Agra Univ. J. Res. (Sci.)* 13(3): 79-86, 13 figs.
- SAHNI, D.N., 1972. Studies on the Odonata of Kumaon, pt 3. Suborder Zygoptera. *Bull. Ent.* 12(2): 69-84, figs.
- SANGAL, S.K. & B.K. TYAGI, 1984. *Calicnemia miniata doonensis*, a new subspecies from the Dehra Dun valley (Dehra Dun, India). *Abstr. First Indian Symp. Odonatol., Madurai*, p.2.
- SCHMIDT, Er., 1961. Ergebnisse der Deutschen Afghanistan-Expedition 1956, etc. Libellen (Odonata). *Beitr. naturk. Forsch. Südw-Dtl.* 19(3): 399-435, 12 figs.
- SCHMIDT, Er., 1964. Libellen aus Burma, gesammelt von Dr. R. Malaise, Stockholm. *Ent. Tidskr.* 85 (3-4): 141-164, figs, 1 map.
- SELYS LONGCHAMPS, E. de, 1863. Synopsis des Agrionines, 4e légion: Platycnemis. *Bull. Acad. Belg.* (2) 16: 147-176.
- SELYS LONGCHAMPS, E. de, 1886. Revision du Synopsis des Agrionines, I. *Mém. cour Acad. Belg.* 38(4): 1-233.
- SELYS LONGCHAMPS, E. de, 1891. Viaggio di Leonardo Fea in Birmania, etc. Odonates. *Annali Mus. civ. Genova* (2) 30: 433-518.
- TYAGI, B.K., 1982. Notes on some dragonflies from the Dehradun valley (U.P., India). *Fraseria* 3: 9-10.
- TYAGI, B.K., 1983a. A preliminary list of the little-known dragonflies of north-western India. *Fraseria* 5: 18-19.
- TYAGI, B.K., 1983b. Some interesting dragonflies from Dehra Dun valley. *Geobios* 2 (1): 63-65.